



Mechanical Services Specification

NPARC Community Housing

Prepared For:



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Commercial in Confidence



SPECIFICATION AMENDMENTS					
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1 General Requirements

1.1 Form of Contract

The Specification and Drawings shall be read in conjunction with all other relevant documentation, including but not necessarily limited to the Architectural, Structural, Hydraulic, Electrical Drawings and the Energy Efficiency Report.

This document is written in the directive style. Where an obligation is given and it is not stated who is to undertake the obligation, it is to be undertaken by the Mechanical Subcontractor.

1.2 Schedules of Prices and Returnable Schedules

The tender submission shall include completed Returnable Schedules, which are located at the back of this specification. The Schedule of Prices attached to this specification shall be completed and submitted as part of the Tender.

Any alternative equipment selection that lead to a change on the design requirements, such as electrical supply or spatial requirements, shall be the responsibility of the mechanical sub-contractor to rectify and coordinate.

1.3 Capacities

The capacities of all items of equipment provided shall be not less than as nominated by the specification, equipment schedules and drawings. The design is based on equipment complying with NCC (National Construction Code) energy requirements. Guarantee that the required inside conditions shall be achieved under the design criteria stated below. The capacities listed, however, are minimum capacities for the design inside and outside conditions stated.

1.4 Operating Duty

The Contractor shall be responsible for the correct selection of all equipment and power of driving motors and for any other such design requirements which affect system performance. Static pressures (for fans) noted in Equipment schedules for Tender purposes are "indicative only" and the Contractor shall determine actual static pressures from their own "shop drawings".

2 Scope of Works

2.1 General

Mechanical services shall be manufactured, supplied, delivered, installed, tested, commissioned and maintained in accordance with all relevant codes and standards, the requirements of all relevant statutory authorities and the requirements of this specification; to provide a fully functional building at completion.

In order to deliver the above outcome, the mechanical sub-contractor shall provide all manufactured items, materials, tools, plant, appliances, fixings, cartage and labour together with all minor and incidental works necessary for the complete and proper execution of the contract.

The drawings and specification show the general intent and do not necessarily show all equipment required to complete the entire mechanical works. Minor items as used in normally accepted trade practice with installations of this type and which are not specifically mentioned, shall be included in the tender and final installation.

The mechanical contract shall include the following major systems;

- Mechanical ventilation systems

2.2 Detailed Scope of Works

The mechanical services shall include but not necessarily be limited to the following:

No.	Description
1.	Mechanical ventilation systems including, but not limited to, fans, on-board run on timers for toilet exhaust fans, vibration isolation mounts, rigid sheet metal ductwork (as required), flexible ductwork, grilles, controls and volume control dampers (as required). Fans operating in parallel shall include backdraft dampers and interlocks as required.
2.	All associated electrical power and control wiring and equipment to facilitate automatic operation of equipment
3.	Provision of workshop drawings in time to enable design and coordination of trusses and other building elements to accommodate mechanical systems.
4.	Liaise with the hydraulic and electrical services to ensure all interfaces between trades have been correctly tendered.
5.	Painting of all exposed mechanical plant.
6.	All transport to site, positioning and hoisting of equipment.
7.	Instruction of the Client in the operation and use of the mechanical services systems.

No.	Description
8.	All equipment testing, commissioning and maintenance for the specified period after the Date of Practical Completion.
9.	Supply of operating and maintenance manuals and "as installed" drawings. Labelling of all plant and systems.
10.	Twelve months service warranty maintenance period.
11.	Any additional work necessary to provide a complete, operative installation in accordance with performance requirements and miscellaneous work as specified or shown on the drawings.

2.3 Works by Other Trades

The mechanical sub-contractor shall proactively liaise with other trades in regards to the nature of the interface and location of the services.

No.	Work Performed by the Mechanical Sub-Contractor	Work Performed by Other Trades
Builder/Main Contractor		
1.	Identification on shop drawings of final position, actual dimensions and access requirements of plant and ductwork located in the roof space.	Roof truss design incorporates adequate space in the roof space for the mechanical plant including servicing.
Electrical Trade		
2.	Provide details of power requirements to the electrical sub-contractor at tender.	Shall review the power requirements of the mechanical sub-contractors equipment selections.
3.	Provide locations of isolators for future air conditioning equipment.	Shall provide power, terminating in a local isolator, to future air conditioning unit locations.
4.	Wiring and final connection to local electrical isolator.	Shall provide power supplies for all the mechanical equipment terminating in a local isolator adjacent each item.
5.	Wiring and final connection to local electrical isolator for toilet & laundry exhaust fans.	Shall provide power, terminating in a local isolator, to toilet exhaust fans that is interlocked with the lighting in the area that the fan serves.
Hydraulic Trade		
6.	Provide insulated condensate drain terminating over hydraulic supplied tundishes.	Provision of tundish connected to stormwater or sanitary drainage in accordance with the relevant standards and local authority requirements.

2.4 Detailed Requirements

2.4.1 Definitions

Unless the context otherwise requires, the following definitions apply:

Term	Definition
Project Superintendent	Architect, main builder, project manager directed by the client to oversee the contracted works.
Contractor	Mechanical Services Sub-Contractor
Supply	'Supply', 'furnish' and similar expressions mean 'supply only'
Provide	'Provide' and similar expressions mean 'supply and install'
Approved	'Approved', 'reviewed', 'directed', 'rejected', 'endorsed' and similar expressions mean 'approved (reviewed, directed, rejected, endorsed) in writing by the Superintendent'.
Give notice	'Give notice', 'submit', 'advise', 'inform' and similar expressions mean 'give notice (submit, advise, inform) in writing to the Superintendent'.
Obtain	'Obtain', 'seek' and similar expressions mean 'obtain (seek) in writing from the Superintendent'.
Proprietary	'Proprietary' means identifiable by naming manufacturer, supplier, installer, trade name, brand name, and catalogue or reference number.
Samples	Includes samples and prototypes.
Zinc-coated steel	Includes zinc-coated steel, zinc/iron alloy-coated steel and aluminium/zinc-coated steel.
BMS	Building Management System
AC	Air Conditioning
Defects Liability Period	Shall be twelve (12) calendar months from the date of Practical Completion.

2.4.2 Standards and Regulations

The list below does not preclude any other relevant Act and Regulation, Local Authority Requirement, Australian Standard and Code having jurisdiction.

Ref	Title
NCC/BCA 2019 Vol 2	National Construction Code/Building Code of Australia 2019 Volume 2
QDC MP4.1	Queensland Development Code Mandatory Part 4.1 Sustainable Buildings
AS 1044	Limits of electromagnetic interference for electrical appliances and equipment
AS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1324	Air filters for use in general ventilation and air-conditioning
AS 1470	Health and Safety at Work – Principles and Practices
AS 1530.1	Combustibility Test for Materials
AS 1530.2	Test for Flammability of Materials
AS 1530.3	Methods for fire tests on building materials, components and structures - Simultaneous determination of ignitability, flame propagation, heat release and smoke release
AS 1530.4	Methods for fire tests on building materials, components and structures Fire-resistance tests for elements of construction
AS 1668.2	Mechanical Ventilation in Buildings
AS 2107	Acoustics - Recommended design sound levels & reverberation times for building interiors.
AS/NZS 2311	Guide to the painting of buildings
AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings Paint coatings
AS/NZS 3000	Wiring Rules
AS/NZS 3012	Electrical installations - Construction and demolition sites
AS 61439	Low Voltage Switchgear and Controlgear Assemblies
AS 3666	Air handling and water systems of buildings - Microbial control
AS 3715	Metal finishing - Thermoset powder coating for architectural applications of aluminium and aluminium alloys
AS/NZS 3750.9	Paints for steel structures Organic zinc-rich primer
AS 4254.1	Ductwork for Air Handling Systems in Buildings – Flexible Ductwork
AS 4254.2	Ductwork for Air Handling Systems in Buildings – Rigid Ductwork

AS 4508	Thermal resistance of insulation for ductwork used in building air conditioning
AS/NZS 4859.1	Materials for the thermal insulation of buildings - General criteria and technical provisions
NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems

2.4.3 Materials and Workmanship

All materials, labour and plant shall be supplied and installed by the contractor unless otherwise specified. All materials shall be the best of their respective kinds and free from all defects.

Workmanship in each trade shall be carried out in a first-class manner to the entire satisfaction of the Project Superintendent.

So far as it is reasonably and economically practicable and where it is not prejudicial to the Proprietor to do so, the Contractor shall in the performance of the Contract use labour, materials, plant, equipment, supplies and services available within the State of Queensland.

All materials, equipment and work shall comply with the appropriate the Project Superintendent's approved equipment list and the Australian Standard Specification or Code, or if such have not been prepared with the appropriate British Standard.

All materials, equipment and work shall also comply with the relevant rules and regulations laid down by any Statutory Authority having jurisdiction over such work, and shall conform to the requirements of Insurance Underwriter's Codes.

Any workmanship, materials or installation, which on inspection by such authorities, is found to require modification to be acceptable to the authority concerned shall be replaced, changed, modified, or otherwise put in a form to pass the relevant regulations. Such modifications shall be at the expense of the Contractor and at no cost to the Project Superintendent.

The Contractor shall take all necessary precautions with the supply and installation of equipment specified to prevent corrosion.

Any component or accessory showing signs of rust or corrosion during the maintenance period shall be renewed or otherwise made good in an approved manner.

2.4.4 Uniformity

All fittings, accessories and equipment of the same type shall be of the same manufacture and catalogue number.

2.4.5 Manufacturer's Warranty

Where applicable, provide manufacturer's warranty agreements. On behalf of the Owner, complete all necessary documentation. The maintenance manuals shall include copies of all warranties.

2.4.6 Submissions

2.4.6.1 General

Prior to ordering or installation submit shop drawings, samples, technical data or other details as applicable for systems as specified. Sufficient time shall be provided for the Engineer to check and return the submissions.

2.4.6.2 Drawings

Provide PDF versions of the “shop drawings” and “construction drawings” for review.

Final ‘as-built’ drawings shall also be submitted in AutoCAD format.

Co-ordinate shop drawing design with other building and services elements.

Workshop drawings shall indicate the following:

2.4.6.2.1 Ductwork

- gauge of sheet metal
- duct types & jointing methods
- duct hanging methods
- duct numbering
- duct heights
- duct insulation types
- duct access panels

2.4.6.2.2 Equipment

- Identify extent of manufacturer’s recommended access space

2.4.6.3 Samples

Provide samples labelled to indicate type, part or catalogue number.

2.4.6.4 Technical Data

Provide manufacturers technical specifications, type test report, performance data, installation details etc. as required.

2.4.7 Certification

Certify that the works have been installed to the requirements of all applicable rules and regulations.

Provide electrical installer certificates and Form 12 at the completion of the project. These shall be inserted in the O&M manuals.

2.4.8 Quality Assurance

A project specific quality assurance plan shall be provided to cover the design, purchase, fabrication, installation and completion of the works.

The company quality system third party certification shall be submitted and a copy of the company quality manual.

2.4.9 Hazard Assessment and Risk Management

Comply with the requirements of the Work Health and Safety Act and Regulations with respect to hazard identification and risk management.

Submit a hazard assessment and risk management plan for the construction phase of the works.

2.4.10 Electromagnetic Compatibility

The electromagnetic compatibility requirements of the Australian Communications and Media Authority shall be met throughout the entire installation covered by this specification.

2.4.11 Site Conditions and Precautions

Throughout the duration of the contract the site will be occupied and operational. Unless when shutdowns have been pre-arranged, ensure that systems remain fully connected and operational.

Where required, shutdowns of systems shall;

- Written notification at least 5 days in advance of the intended shutdown time shall be provided to the Client's Superintendent.
- Shutdown time shall be kept to a minimum.
- Before leaving site for the day, ensure that the systems are fully operational.

Carry out the work in such a manner as to interfere as little as possible with other trades and persons having access rights. Ensure that normal access ways within the buildings are unobstructed.

2.4.12 Access to Site

At the pre-contract site meeting, access to the site, working hours and storage facilities shall be agreed with the Client's Superintendent. However, certain restrictions may be applicable to the project and the Contractor shall include within his tender for any restrictions on access, working hours that may be imposed by the Local Authorities.

2.4.13 Packing Storage and Protection

Any items suffering damage in transit or whilst on site shall be rejected and replaced without cost to the Contract.

- All plant, equipment, apparatus, materials and parts shall be delivered to the site in a new condition and properly packed and protected against damage due to handling or due to adverse weather or other circumstances and so far as practicable shall be kept in the packing cases or under protective covering until required for use.
- The Contractor shall arrange suitable storage areas for materials, plant and equipment, as necessary. Storage shall be on purpose made racks, mounts, etc., to ensure no damage or deformation of items. Plant and equipment should preferably be placed in final location, and should not be brought on to site before the area is ready, subject to access requirements. All plant and equipment brought on to site whether in final location or not shall be protected as described below.
- The Contractor shall suitably protect, encase, cover over etc., as may be appropriate all plant and equipment, instruments, pipework insulation etc. installed by him against damage due to building operations or adverse weather or other causes up to date of completion and shall make good any damage and hand over the entire installation in a new and undamaged condition. This shall apply to fixed and unfixed materials, plant, equipment etc.

2.4.14 Setting Out

The positioning of equipment as shown on the drawings is approximate and diagrammatic only, and these drawings shall not be used for exact setting out. Locations shall be confirmed prior to installation.

2.4.15 Demolition

All existing redundant mechanical services shall be decommission, disconnect and remove from site. Salvage equipment and deliver to the Client's Superintendent where specified. Re-use equipment only where specified.

2.4.16 Installation

Equipment and services shall be installed square and in line with the building elements, plumb and at consistent mounting heights. Reticulated services shall be installed neatly and with applicable segregation from each other. Where possible, duct shall be fixed directly to the building structure. Provide separate cable support systems for each reticulated service and support all cables over their entire route length.

Provide noggings, brackets, fixings and supports to manufacturer's recommendations and as required. Where timber is used for supports or noggings provide Cyprus pine or similar termite resistant species.

Provide all access equipment and temporary lighting necessary for the installation of mechanical services.

2.4.17 Building Penetrations

At building penetrations, maintain integrity of building systems such as waterproofing and termite management.

2.4.18 Corrosion Protection

Suitably protect against corrosion, all metallic materials and components. Bolts, screws, rivets, etc. for external use shall be non-ferrous or stainless steel, or where approved galvanised steel. Brackets, plinths, rods, etc. shall be hot dip galvanised after fabrication.

As a minimum provide corrosion protection by degreasing, priming and painting all steel sheets.

2.4.19 Finishes

Unless the equipment material is chromium, anodised aluminium, plastics, stainless steel or other non-ferrous metals, it shall be painted. Paint and paint application shall comply with AS/NZS 2311 and AS/NZS 2312. Carry out all powder coating to AS3715. Refer to Section 10 for further details.

2.4.20 Adhesives

Provide adhesives and sealants capable of transmitting imposed loads, sufficient to ensure the rigidity of the assembly or the integrity of the joint and which will not cause discolouration or lack of adhesion of finished surfaces.

2.4.21 Fasteners

As required for installation of the mechanical services, provide masonry anchors, bolts, nuts, washers, screws, nails and plugs. These shall be specifically selected based on the finished materials, finishes and physical sizes of the loads, the types of materials in contact with the fastener and the environment.

2.4.22 Metals

Provide metal sections and sheet as required for the mechanical services. Finish invisible joints by welding, brazing, soldering, grinding and buffing prior to application of finishes such as galvanising or painting. Repair galvanised or electroplated metals using two pack organic primers to AS/NZS 3750.9.

2.4.23 Fire Integrity

Maintain the fire and smoke integrity of smoke and fire rated building elements by appropriately sealing all penetrations. Use only certified fire sealing products, installed as per detailed in the relevant fire test report and in accordance with AS1530.4. Provide a detailed

schedule of each fire rated penetration including the method of sealing and the location of each penetration. Provide copies to the Client's Superintendent for compilation into complete schedule of all fire rated penetrations.

2.4.24 Smoke Barriers

Where pipes or cable support systems penetrate smoke barriers, install and support this equipment to fully comply with all statutory requirements for smoke barrier building elements. Label all smoke barrier penetrations and provide a penetration schedule in accordance with AS1851 Section 17.

2.4.25 Acoustic Integrity

All related electrical works by mechanical services are to comply with acoustic isolation requirements of the National Construction Code, AS/NZS 3000 and statutory requirements.

2.4.26 Inspection at Practical Completion

Arrange for a Practical Completion Inspection by the Client's Superintendent. A minimum of 5 working days' notice shall be given. Ensure that the installation is fully operable and practically completed before requesting an inspection. Should the inspection reveal that the installation is not fully operable or practically completed and require further inspections, these inspections will be charged to the Mechanical Subcontractor.

2.4.27 As Installed Drawings and Installation Manuals

2.4.27.1 As Installed Drawings

Provide as-installed drawings in hard copy (3 copies) and electronic formats for the works showing the completed works. Verify each drawing certifying accuracy, completeness, correctness and compliance with CAD conventions under the Contract and Specifications.

All Drawings should be marked as AS-BUILT to denote that they have been checked by the subcontractor and accurately reflect the works. Drawings marked FOR CONSTRUCTION or other descriptions are not acceptable and shall be rejected.

Ensure the content, accuracy and level of detail of as-installed drawings are sufficient to describe, and sufficient to enable and ensure the efficient operation of the assets created under the Contract. Where required to describe the Works, include digital photographs of specific aspects of the Works in as-installed drawings or operations and maintenance manuals.

All drawings must be provided as full 3D modelled electronic documents in an AutoCAD compatible format

Ducting layout drawings showing the actual sizes and locations of all ducts, dampers, supply outlets, return inlets, fresh air intakes, etc. and the final measured air flow rates at all relevant locations.

Plant room and/or equipment layout drawings with full identification of each and every item of equipment.

Piping layout drawings, showing the actual sizes and locations of all refrigerant, and any other lines applicable to the system.

Schematic flow and control diagrams of all refrigerant, and any other systems incorporated in the installation. The drawings shall show all motorised automatic and hand-operated controls including dampers, valves, relief valves, cut-outs, thermostats, expansion valves, solenoid

valves, bleeds, vents, drains, strainers, gauges, thermowells, by-passes, sight glasses, and all similar items pertinent to the functioning of the installation.

Control wiring diagrams showing all electrical controls, relays, cut-outs, timing devices, interlocks, fuses, over-loads, contactors, solenoids, starters, etc. with all items clearly identified as to type and function, and "as installed" switchboard layout drawings.

The above drawings shall be neatly prepared and photographically reduced to A3 size and bound in hard covers matching those specified for the installation manual.

Provide a USB Flash Drive in latest AutoCAD format of all drawings.

3 Ventilation Fans

3.1 General

Fan static pressures and electrical characteristics listed in the Equipment Schedules are provided for guidance purposes only. The Mechanical Contractor shall calculate the system resistance prior to the submission of equipment selections/ workshop drawings.

Fans shall be selected with a minimum 10% additional capacity to allow for increases in system resistance.

Non-return dampers shall be installed on all exhaust fans where fans operate in a parallel arrangement.

3.2 Wall Mounted Fans

Wall mounted fans with airflow rates shall be Fantech Stylvent series fitted with electric shutters, external louvre, weather cap and sealed for life bearings.

3.3 Header Box Fans

Fans shall be complete with a diffuser on the room side.

Impellers shall be forward-curved centrifugal and driven by a squirrel cage motor with integral thermal protection.

They shall be fitted with high strength swing clips, removable spigot, low resistance non-return backdraft damper and removable clip-in diffuser. They shall include a plug and lead, and its housing and diffuser be made of injected moulded, fire retardant, ABS plastic. They shall be tested to ISO5801: 2007 for air flow and ISO3744: 2010 for noise.

Ceiling mounted header box type fans shall be the Fantech RRSPF Series or approved equal.

4 Air Distribution System

4.1 General

All sheet metal air distribution systems required for the works and including all necessary control dampers, air diffusers, registers, grilles, insulation and painting, all as specified in the relevant Clauses of this Specification and as shown on the drawings, shall be supplied as part of the Mechanical Systems.

4.2 Circular Flexible Ductwork

All flexible ductwork shall comply with AS 4254.1 and AS 4508. Flexible ductwork shall be suitable for the duties and pressures required for the system.

Duct core shall be constructed of two layers of polyester film, one metallised, helically wound to encapsulate a spring steel wire.

The insulation surrounding the core shall be polyester encapsulated in a UV resistant, aluminium / polyester laminated sleeve

Bends made in flexible ductwork shall be formed to manufacturer's recommendations and shall have a centre-line radius of not less than 1.5 times the diameter of the duct. Support structures shall be used where necessary to prevent deformation or damage.

Fittings such as tee-pieces, Y-pieces and reducers shall be constructed from galvanised sheet metal as specified for circular sheet metal ductwork.

In buildings of class 1 to 3 inclusive, and buildings of class 10 as defined in the NCC, flexible duct shall be installed using not more than two lengths of up to 6m length of any one duct diameter in a given duct run between air terminal devices. All in-line connections of two flexible ducts the same diameter shall use a joiner.

All connections between lengths of flexible ductwork shall be made with short spigots of galvanised sheet metal circular duct to form a slip joint.

All duct connections shall be spigotted slip joint type fixed with proprietary line duct bands. Bands shall be continuous type metal or PVC bands. Self-tapping metal screws and/or rivets shall not be used.

All flexible ducts shall be adequately supported with hanger straps and half saddles of "guttergard" located at 1500 maximum centres, to prevent undue sagging and strictly in accordance with the requirements of this section of the specification.

Flexible acoustic ductwork shall be of the metal helix type incorporating perforated acoustic lining and reinforced external vapour barrier.

4.2.1 Fire Performance

All Flexible ductwork shall comply with the requirements of AS4254.1 including the following:

- Bulk insulation shall have a smoke development index not greater than "3" and a spread of flame index not greater than "0" when separately tested in accordance with AS1530.3.
- Duct system, i.e. the assembled final product, shall have a smoke developed index not greater than "3" And spread of flame index not greater than "0" when tested in accordance with AS1530.3.
- Duct system, i.e. the assembled final product, shall pass the UL 181 burning test.
- Duct core, when separately tested shall pass the the UL 181 burning test.

4.3 Air Terminal Equipment

4.3.1 General

The mechanical contractor shall supply and install all air diffusers, registers and grilles necessary for the as indicated on the drawings and where specified. The drawings show indicative locations for air terminal equipment but in each instance, outlets shall be installed to coordinate with building structure and in accordance with Architectural final detail drawings and reflected ceiling plans.

Internal surfaces of air terminal equipment, take-off ductwork and damper assemblies, where visible, shall be painted matte black.

All diffusers and grilles installed internally shall be powder coated white unless otherwise noted.

Where dampers have not been installed on the main duct branch they should be provided at the individual terminals for balancing purposes.

4.4 Diffusers

4.4.1 Exhaust Grilles

Ceiling mounted exhaust grilles shall be Holyoake "EC-125" egg crate style grilles or approved equal. All grilles shall be manufactured from powder coated aluminium.

4.4.2 Plenum Heads to Exhaust Grilles

All ceiling grilles shall be supplied with plenum cushion heads. Cushion heads shall be complete with dampers and neck adaptor, to enable control of supply air where indicated. Plenum heads shall be internally insulated with matte black insulation.

6 Electrical

6.1 General

Electrical services contractor shall supply single phase power supplies adjacent the mechanical services equipment. Termination and connection of mechanical equipment shall be by Mechanical Services Contractor.

All switching flush plates shall match those specified for the Electrical Services installation.

Each item of equipment shall be provided with an electrical isolator.

Load requirements of the plant shall be detailed with the Tender. Where electrical loads differ significantly from those shown on the schedules, the equipment loads shall be referred back to the Consultant to ensure that electrical requirements are coordinated with Electrical Services prior to the Tender period closing.

6.2 Power Supplies

The following supplies, terminating with an isolator, shall be provided by the Electrical Services Contractor. Final connection to mechanical equipment shall be by the Mechanical Services Contractor:

- Air Conditioning outdoor units – Single phase isolator
- Toilet exhaust fans –switched with local lighting circuit

6.3 Method of Wiring

Wiring to mechanical services equipment shall be completed in accordance with the requirements of AS3000.

Approval shall be sought from the relevant Supply Authority to ensure that the installation is satisfactorily balanced.

All wiring shall be installed on the loop-in system with connections made only at equipment. The use of junction boxes shall not be permitted unless otherwise noted.

Cables shall be supported over their entire route length on trays or grouped together and supported at regular intervals to minimise sag. Where cable trays are used they shall be appropriately earthed.

All circuits shall be provided with separate earth wires that originate at the switchboards and run in the same conduit or within the thermoplastic-sheathed (TPS) cable of the circuit.

All wiring shall be installed in conduits concealed in concrete slabs, walls, partitions and the ceiling space, unless otherwise specified.

A draw wire shall be used to pull cables through conduits. Where more than one cable is run in a conduit, all cables shall be pulled at one time and the total number of cables shall be 75% of that allowed under AS 3000. Where more than one (1) circuit is to be installed in any conduit, cable sizes shall be increased to allow for derating in accordance with AS3008.1.

Where possible cable shall be installed to avoid derating in accordance with AS3008.1.

Chasing of face brick walls is not permitted except where 110mm brick walls will be rendered or plastered.

Wiring within wall cavities and ceiling spaces shall be in TPS conductors unless noted otherwise.

Wiring to equipment mounted on brick walls shall be installed in conduits.

Where the locations of equipment are critical and do not coincide with stud locations, supply and install suitable brackets or noggings, etc., as required to ensure equipment is mounted securely in the correct locations.

Where conduits or TPS cables are installed in external cavity brick walls, they shall be fixed to the internal skin. Penetrations through the damp course shall be at the highest point.

Installation of conduits and brickwork shall be co-ordinated during construction to prevent additional penetrations being required.

All cable routes runs shall be checked before installation commences. Where it is not possible to conceal wiring or conduits, the Client/ Architect shall be informed and approval shall be granted prior to installation.

Provide mechanical protection for cables and conduits where required by Australian Standards.

6.4 Cables

6.4.1 General

All control and power sub-circuits for equipment shall be wired using stranded copper conductors of approved manufacture, grade V75 PVC insulated and 250V or 660V grade as applicable. All cables shall be from new stock.

All control and power sub-circuits for smoke vent systems shall be wired using a wiring system of classification not less than WS52 when tested in accordance with AS3013.

Building wires shall be black for neutral and coloured for active and control wires. TPS cables shall have the earth continuity conductor incorporated in the same sheathing as the circuit wiring.

6.5 Conduits

All conduits and ducts shall comply with the requirements of the relevant Australian Standard. Conduits with a diameter of less than 20mm shall not be used.

Conduits shall be high impact PVC conduit to AS 2053. Heavy-duty and/ or UV resistant conduits shall be used where applicable.

Conduits shall be laid in straight lines with gradual sets or bends. The cross section of the conduit shall not be altered at the locations of sets or bends. Where it is not practical to set the conduit, spring bends may be used. Joints in PVC conduit shall be made using the manufacturers recommended adhesive in accordance with their instructions.

Conduits installed in screeds and chases shall be secured at intervals not exceeding 1800mm with approved fixings. Conduit stub-ups through concrete surfaces and foundations shall be adequately braced to prevent shifting during pouring and shall be adequately plugged to prevent ingress of dirt. Surface mounted conduits shall be fastened at intervals not exceeding 900mm using approved saddles.

7 Controls

7.1.1 Toilet Exhaust Fans

Toilet exhaust fans shall be switched with local lighting and complete with run on timer.

Fans operating in parallel shall be electrically interlocked with each other to ensure they operate together.

7.1.2 General Exhaust Fans

Exhaust fans shall be switched with local lighting and complete with run on timer.

8 Vibration Isolation

8.1 General

All moving equipment shall be isolated from the building structure to eliminate the transmission of excessive vibration.

The following criteria shall be used to determine the most suitable vibration isolation device:-

- Location of the machinery within the building (local building structure, roof or basement location, proximity to those effected by the vibration)
- Plant speeds and masses, static and dynamic forces, start-up forces and the associated magnitude and nature of vibrating forces.

Additionally, specific items of plant shall be isolated in accordance with the manufacturers recommendations. All plant shall be accurately balanced both statically and dynamically prior to commissioning.

(Vibration isolation devices shall be located/selected to ensure the following:-

- The quantity of mounts shall be such that each mount carries the correct and equal proportion of the equipment load.
- Ensure that equipment bases are level and sufficiently clear of structure so that vibrating parts cannot come into contact with structure.
- Ensure that machinery cannot rock excessively by installing mounts at the correct intervals.
- Devices shall be easily maintained and inspected when in service.
- Devices shall be designed/ treated for purpose. Adequate drainage, galvanised and coated springs etc shall be used where exposed to weather.
- Appropriate care shall be taken to ensure that vibration bridging does not occur via bolts.
- Structure point loads shall be exceeded. Ensure that load spreaders are used where necessary

Full schedules of vibration isolation mounts showing plant (weights, deflections, manufacturers and part numbers etc) shall be submitted to the consultant for approval prior to installation.

Mounts shall be protected from undue wear and should not be exposed to excessive or prolonged deflections that the device was not designed and selected for.

Peak to peak displacement (mm) shall comply with the following minimum values:

Equipment	Minimum Displacement (mm)
Fans <600 rpm	0.10
Fans 600-900 rpm	0.075
Fans 960-2160 rpm	0.05

Fans > 2160 rpm	0.025
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8.2 Waffle Pads

Mounts shall consist of a double pad of neoprene moulded into a waffle configuration with a 16 mm nominal thickness. The pad shall be sized so that the load on the ribbed element does not exceed the manufacturer's recommendations. Where necessary, a steel plate shall be used to spread the load over the pad.

Where it is necessary to anchor through machinery/plant mounting feet resting on neoprene or waffle pad isolators, a rubber collar of similar or slightly lower durometer hardness to the pad should be inserted between the bolt and mounting foot. When screwing down the anchor bolts care should be taken to ensure that the combined weight and bolt tension loadings do not exceed the limit specified in pad-isolation. A metal washer of appropriate size should be inserted between the head and rubber collar.

8.3 Waffle Pad Hangers

Checks should be made and approvals gained before fixings are made to determine if fixings are not allowed in any areas.

Waffle pad hangers consist of a double pad of neoprene minimum 16mm thickness, moulded into a waffle configuration between the hanger and the item being supported. The pad shall be sized such that the load on the pad does not exceed the manufacturer's recommendations or 350 kPa whichever is the lesser.

8.4 Neoprene Hanger

Checks should be made and approvals gained before fixings are made to determine if fixings are not allowed in any areas.

Hangers shall be of the neoprene in shear type. A neoprene grommet shall be provided where the hanger rod passes through the steel box supporting the isolating mount to prevent metal to metal contact. The minimum static deflection shall be 9 mm.

8.5 Flexible Connections

Rotating/vibrating plant (fans etc.) shall be isolated from ductwork using flexible connections. Flexible connections shall be located as close as possible to the plant and should be selected such that they accommodate all equipment, pipe and duct deflections.

Ensure that flexible connections are selected to accommodate the maximum fluid pressures and temperatures within the pipes and ducts over the lifetime of the plant operation.

Flexible connections shall not restrain the equipment that they are attached to and should be installed to align with pipe and ductwork in a neat and workmanlike manner.

The manufacturer's recommendation on permissible vibration amplitudes shall not be exceeded and care shall be taken not to introduce twisting

Electrical connections to all moving plant and motors shall be made with flexible conduit or double coiled MIMS cable.

8.6 Support of ductwork

8.6.1 Ductwork

Ductwork adjacent flexible connections to plant shall be supported using vibration isolating hangers.

9 Acoustic Design Criteria

The following design sound levels shall be maintained under all conditions of operation of the mechanical systems.

Space	Design Sound Levels <u>L_{Aeq} dB(A)</u>	
	Satisfactory	Maximum
Living Areas	30	40
Sleeping Areas (night)	30	35

NR levels shall be determined by measuring the 60 second fast response octave band Leq levels in the respective octave bands. Background level measurements shall also be recorded in each octave band and the tests carried out at a time when the background levels are at least 6dB below the required criteria levels. Levels are measured no less than 1m from the floor or 1.5m from any wall.

10 Painting, Colour Coding and Labelling

10.1 General

External surfaces of pipework, machinery, equipment, fittings, tanks, conduits etc installed as part of this contract shall be painted.

Switchboards, distribution boards and control cabinets shall be painted white internally and externally to Client's specification.

Painted surfaces shall be appropriately prepared primed and under coated prior to the application of two finishing coats.

Finished surfaces adjacent to work being painted shall be masked and/or protected wherever this is necessary to avoid damage.

10.2 Scope of Works

The work shall include painting of all exposed work, equipment and machine bases, supports and the following items but excluding normally bright and polished metal components.

- Ductwork exposed to view, in the occupied areas, mounted externally and in plantrooms.
- Air diffusion equipment (pre powder coated).
- Roof cowls (factory finished).
- Machine bases, inertia bases, plinths and floating slabs.
- Switchboards, control panels,
- Hat sections (colourbond to approval)
- All plant and equipment which is not finish painted to approval in the factory.

10.3 Materials

Painting materials shall be from an approved manufacturer and of the best quality in their respective types. All painting materials shall be delivered to site in the original manufacturer's sealed and labelled containers.

All paints shall be such that if applied in strict accordance with specific instructions of that manufacturer the finished surfaces will remain of true colour, will not fade, tarnish, peel or otherwise deteriorate for a minimum of three years.

All sealers, primers, undercoats and finishing paints shall be of the type specified by the manufacturer as appropriate for the particular application. Sealing compounds shall be approved proprietary fillers.

10.4 Surface Preparation & Prime Coating

All surfaces shall be thoroughly dry, cleaned down, free from weld splatter, burrs, dust, rust, cement and grease.

Metal surfaces shall be thoroughly wire-brushed to remove loose rust and scale. Castings shall be either ground smooth or alternatively filled with filling compound and then rubbed to a smooth finish.

All galvanised or zinc sprayed steel surfaces and all non-ferrous surfaces shall be given an application of self-etching primer or similar before being prime coated as specified above.

Machinery, apparatus, equipment and fittings delivered to the site already prime or finish painted shall be thoroughly cleaned down.

Weave cloth, sheathing on insulated surfaces shall be sealed with an pigment sealer before being prime coated with a white undercoat.

10.5 Finishes

Each finishing coat shall be of a different shade in selected colour and shall be either gloss or matt finish in accordance with the Architect's specification. The final coat shall be left smooth, even and free from visible brush marks and other defects.

10.6 Supports, Hangers and Brackets

All supports, hangers and brackets, where associated piping or ductwork is to be finish-painted to gloss finish of colour black.

10.7 Labelling

All items of mechanical plant including fans, etc., shall be labelled with the equipment name and number indicated on the drawings or otherwise to approval. Labelling shall be not less than 20mm high in upper case.

All instruments, gauges, indicators, control equipment, valves, contactors, circuit breakers, switches, starters, relays and cable terminals on switchboards, etc. installed as part of the Works, shall be clearly labelled and identified with the correct associated function. Lettering, except where otherwise indicated, shall not be less than 12mm high. Lettering for items installed in switchboards and on control panels shall not be less than 9mm high.

Labels shall be of laminated plastic with neatly engraved upper case black letters on a white background unless notified otherwise. Warning labels or installation pertaining to fire/safety equipment shall utilise upper case white letters on a red background. Plastic labels shall be attached using screws or rivets.

Punch machine type strip lettering and stick-on labels will be rejected.

11 Testing and Commissioning

11.1 Cleaning

All rubbish shall be removed regularly and the site shall be kept clean and tidy during the construction works. Prior to Practical Completion and upon completion of the Mechanical Services installation, all debris and rubbish shall be cleared away and removed from the site. The installation shall be left thoroughly clean upon completion.

11.2 Tests

11.2.1 Constructional Tests

Systems and components shall be tested during construction in accordance with the requirements of the relevant clauses of the documents.

11.2.2 Compliance Tests

Certificates showing compliance with the requirements of these documents and of any authority having jurisdiction shall be provided.

11.2.3 Operational Tests

Operational tests shall be carried out prior to Practical Completion and a detailed report shall be provided to the project manager at completion for review by the consultant. The report shall include the following details:

- Preliminary readings and final balance figures for each system
- Name plate rating and full load operating current for each motor.
- Settings for each electrical and control element.

Air Systems

Air terminal shall be balanced such that there is an even distribution of air over the face. Air quantity shall be balanced to within $\pm 10\%$ of the value shown on the drawings with volume dampers set to achieve the lowest practical fan speed and power consumption.

The fans speed setting or blade pitch, where applicable, shall be used to adjust flow rate to deliver $+10\%$ -0% of the design value.

In each system, the sum of the individual terminal air quantities shall be within $\pm 5\%$ of the flow rate measured at the fan.

Fan speed and pitch shall be recorded.

Controls

Temperature limit controls shall be tested and adjusted to safe operating settings and trip times.

Interlocked and multi-step systems shall be tested for operating sequence.

Thermal overloads and protective cutouts shall be tested and adjusted during a hot day for the operating load.

Generally

Any abnormalities in terms of vibration and noise shall be corrected. Unusual operation in rotating machinery shall be corrected by testing for alignment and support. Noisy air terminals shall be corrected by re-balancing.

11.3 Performance Tests

A detailed report shall be provided to the project manager upon completion of performance tests.

11.4 Acceptance Tests

At the beginning of the Defects Liability period, the Mechanical Contractor shall carry out acceptance tests to demonstrate that systems and components are performing in accordance with the requirements. The Project Manager and Client shall be given the opportunity to witness acceptance testing so that control characteristics, interlocks, and responses of all relevant control systems can be demonstrated.

Acceptance tests shall be carried out over a period of two days during which time the operation of control systems and the performance of the systems is be carefully observed and important parameters logged or recorded.

11.5 Logging and Documentation

During the commissioning and testing period, the settings of all control elements shall be logged and documented for inclusion in Operation and Maintenance Manuals. The logs shall provide a complete record of commissioning data for the plant including final settings, special adjustments or requirements, and other useful data. Three (3) copies of commissioning logs shall be forwarded to the Project Manager following final acceptance tests.

Where results are inconclusive tests shall be repeated.

11.6 Operator Instruction

At Practical Completion, instruction shall be given to the Project Manager and Client Representative in the operation of the installed services, the use of Instruction Manuals and the procedures for regular plant maintenance.

12 Maintenance and Servicing

This tender offer and contract shall also include for all necessary inspection, testing and maintenance needs during the Defects Liability Period. As a minimum this service shall provide for quarterly attendance by fully skilled servicemen. A service report shall be prepared at the conclusion of each maintenance attendance for signature and retention by the Client. The report shall include observations of plant including abnormal or unusual operation, recommended remedial work, the extent of remedial work completed during the visit, readings of the operating performance obtained from the equipment and comments on the general condition of equipment.

Inspection, testing and maintenance shall be undertaken in accordance with the maintenance schedule in the O&M Manual and shall include:

1. Air systems for pressure, flow and leakage.
2. Control systems for temperature and safety limits.
3. Electrical systems for thermals, circuit breakers, starters, interlocks, timers, indicators and alarms.

4. Belt drives for correct tension, shaft couplings for tightness and alignment, guards, holding down bolts, vibration isolators, brackets and clamps for integrity.
5. Motors and machinery for overheating, bearing noise and excessive vibration.
6. All rotating machinery for correct operating oil levels and for routine oiling and greasing at recommended intervals.

Specific service tasks to be carried out prior to the expiration of the Defects Liability Period are:

1. Clean away external scale and corrosion, prepare and repaint the surfaces as prescribed under "Painting".

Adequate notice of the End of Period service shall be given so that a final inspection can be arranged to coincide with the work.

13 Tender Form A – Schedule of Prices

Provision of the following:

Service	Total Price \$ (Excl. GST)
Ventilation Fans	\$
Air Distribution System and Ancillaries	\$
Controls	\$
Electrical	\$
Painting and Labelling	\$
Testing and Commissioning	\$
Project Management and Engineering	\$
Drafting, O&M Manuals and associated items	\$
Warranty, Service and Maintenance	\$
Miscellaneous	\$
TOTAL LUMP SUM FIXED PRICE (excl. GST)	\$

14 Tender Form B – Returnable Schedules

The schedule of technical details forms part of the specification and shall be completed in full and returned with the tender.

14.1 Ventilation Fans

Provide manufacturers selection data taking into account system losses and air volume flow rates.

Details/Reference	A1-TEF-1	A1-TEF-2A	A1-TEF-2B
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	A1-TEF-3	A1-GEF	A1-KTH
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			

Details/Reference	A2-TEF-1	A2-TEF-2A	A2-TEF-2B
System			
Manufacturer			
Model			
Fan Type			

Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	A2-TEF-3	A2-GEF	A2-KTH
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	B1-TEF-1A	B1-TEF-1B	B1-TEF-2
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			

Details/Reference	B1-GEF	B1-KTH	B2-TEF-1A
System			
Manufacturer			
Model			
Fan Type			

Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	B2-TEF-1B	B2-TEF-2	B2-GEF
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	B2-KTH	C1-TEF-1A	C1-TEF-1B
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			

Details/Reference	C1-TEF-2	C1-GEF	C1-KTH
System			
Manufacturer			
Model			
Fan Type			

Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	C2-TEF-1A	C2-TEF-1B	C2-TEF-2
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	C2-GEF	C2-KTH	C3-TEF-1
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			

Details/Reference	C2-GEF	C3-TEF-1A	C3-TEF-1B
System			
Manufacturer			
Model			
Fan Type			

Airflow l/s			
Static Pressure pa			
Motor kW/ph			
Details/Reference	C3-TEF-2	C3-GEF	C3-KTH
System			
Manufacturer			
Model			
Fan Type			
Airflow l/s			
Static Pressure pa			
Motor kW/ph			

14.2 Flexible Ductwork

Description	Ventilation
Manufacturer	
Material/ Method of Construction	
Method of Fixing	
R Value	

14.3 Grilles and Diffusers

Grille Type	Manufacturer	Type
Ceiling Mounted Exhaust Grilles		