



Umow Lai

The Winn

50 McLachlan Street

Fortitude Valley, QLD

MECHANICAL SERVICES SPECIFICATION



SPECIFICATION AUTHORISATION

PROJECT: 50 MCLACHLAN STREET
FORTITUDE VALLEY, QLD

DISCIPLINE: MECHANICAL SERVICES

SPECIFICATION NO: B.PDS-0101 / T2

Date	Rev	Revision Name	Prepared by	Checked by	Authorised by
29-06-2015	T1	Tender Issue	JXM	BMD	
02-07-2015	T2	Tender Issue – Fan schedule/louvers amended.	JXM	BMD	

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1.0 INFORMATION TO TENDERERS

1.1

Contract Conditions are set out in the Head Contract.

Specific Contract Conditions relevant to the Services Installation are set out in this Specification. Where Contract Conditions differ, between the Head Contract and this Specification, the Contract Conditions in the Head Contract shall be adopted.

Execute a contract on the basis of the above conditions. Conditions on any other basis are not acceptable.

Tenders shall be lump sum fixed prices not subject to Rise and Fall.

1.2 SCHEDULES

Tenderers shall complete and provide the following schedules to be submitted with their tender:

Schedule 1 Schedule of Itemised Costs.

Schedule 2 Schedule of Technical Data.

Schedule 3 Schedule of Unit Rates for Variation.

Provide a covering letter with the Schedule of Technical Data from each proposed equipment manufacturer confirming that the equipment offered meets the specified requirements

1.3 GOODS AND SERVICES TAX (GST)

Goods and Services Tax (GST) shall be applicable as prescribed by Government Regulation for goods and services provided in the Works of this Contract. The allowance made for GST shall be 10% as legislated, and clearly stated in Schedule No. 1 – Schedule of Itemised Costs.

The Tenderer's Company ABN shall be clearly stated in the Tender.

1.4 NOMINATED CONTRACTORS

Company 1 Name	Company 1 Address
	Company 1's Contact Person's Name.
	Company 1's Telephone No.
Company 2 Name	Company 2 Address.
	Company 2's Contact Person's Name.
	Company 2's Telephone No.

Alternative Mechanical Subcontractors wishing to tender must provide complete written information in relation to the company profile stating at a minimum the following items:

- Company structure;
- Company size, including list of permanent and casual staff as well as all subcontractors, broken into management, technical and support sub-groups;
- List of previous works of similar size and complexity, including reference contact details;



- Demonstrate contract control, project management and reporting policies;
- Certificates of professional indemnity, public liability, and WorkCover insurance;
- Quality Assurance policy;
- Workplace Health & Safety policy;
- Risk Management policy;
- Discrimination & Harassment policies.

All information is to be submitted prior to the close of tender and not as part of this tender submission. Company profiles submitted with or after the tender closure will not be evaluated.

If the company profile is deemed satisfactory, then the company may be asked to submit to an interview with the Consulting Engineer for evaluation prior to acceptance.

The Consulting Engineer reserves the right to reject any application without providing written justification.

1.5 INSPECTION OF SITE

Inspect site and be conversant with all visible existing conditions in, and surrounding, the site. Conditions of access, use of the site for building purposes, and anything likely to affect the execution or performance of the Contract must be allowed for in the Tender.

Variations arising from a failure to inspect site and identify execution or performance impediments, which such an inspection should have reasonably disclosed, will not be entertained.

1.6 SUBCONTRACTING

No work under this contract shall be subcontracted without the written approval of the Project Manager.

Subcontractors shall have all necessary permits, accreditations and the like to carry out the works as specified.

All works carried out by Subcontractors shall be the responsibility of the Contractor.

Any works that are not completed to the requirement of this Specification and associate Drawings shall be rectified to the satisfaction of the Project Manager and at no cost to the Project.

1.7 COORDINATION

1.7.1 Services Coordinator

The Mechanical Subcontractor will engage a dedicated on-site Services Coordinator for the duration of the project. The Services Coordinator shall be responsible for all on-site coordination and resolution of services related issues. The Services Coordinator shall exhaust all reasonable efforts to resolve site issues relating to services prior to issuing a Request for Information (RFI) to the Project Manager.

Regular coordination meetings shall be arranged and chaired by the Services Coordinator prior to submission of Shop Drawings. All services, particularly in ceiling spaces, shall be carefully coordinated and included onto the Mechanical Services Shop Drawings.



Rework as a result of failure to carry out this coordination exercise will not be considered as a reason for variation.

1.7.2 Lead Trade Subcontractor

The Mechanical Subcontractor shall take the lead role in the coordination of all building services for the Project. Regular coordination meetings shall be arranged and chaired by the Mechanical Subcontractor prior to submission of Shop Drawings. All services, particularly in ceiling spaces, shall be carefully coordinated and included onto the Mechanical Services Shop Drawings.

Rework as a result of failure to carry out this coordination exercise will not be considered as a reason for variation.

1.8 ALTERNATIVES

The manufacturer and model numbers specified herein or on the associated Drawings indicate the preferred type of equipment and the design intent. Alternatives may be proposed with the Tender Submission, if accompanied by evidence that the equipment proposed is equivalent to that specified, and include supplementary information on the proposed alternative.

Submit a comparison table between the specified and the proposed equipment, for evidence of:

- Identical construction details;
- Identical materials specification;
- Identical technical performance.

Any proposed alternative shall also include the following supplementary information with the Tender Submission:

- Compliance with the relevant Standards, Codes and Regulations and any other approving authority having jurisdiction over these works;
- Appropriate technical literature;
- Technical calculations;
- Any initial and running cost savings.

The Consulting Engineer reserves the right to reject proposed alternatives without providing written justification.

Any proposed alternative which requires redesign of a system shall have all costs associated with redesigning and implementing that system; as well as other systems which it impacts, including those from a different trade; included as part of the Tender Submission. These costs shall also include preparation of drawings, showing the redesign of the system resulting from use of the proposed alternative equipment. Such drawings shall be prepared to the satisfaction of the Project Manager.

Any proposed alternative, as well as other systems which it impacts, including those from a different trade; that require a different quantity or arrangement of materials and equipment from that originally specified, shall have all associated costs included as part of the Tender Submission.

The use of proposed alternatives shall not compromise the intent or performance of the original design.



All costs associated with the use of proposed alternatives are deemed to be included in the Tender Submission, whether this is stated explicitly or not by the Tenderer.

Proposals for the submission of alternatives after the acceptance of tenders will only be considered where:

- The original offer is not available, or delivery cannot meet the required project timetable, or
- The alternative offers a cost saving to the Project.

The Project Manager reserves the right to deduct the cost of considering post tender alternatives from the Contract Sum.

The Contractor is to assume all responsibility for the design, installation, and impact on all other systems as a result of the proposed alternative.

Should the Consulting Engineer be required by the Principal to review the design or calculation data of the proposed alternative, then the Consulting Engineer reserves the right to seek fees from the Contractor, via the Project Manager, to carry out these review works

Where the Contractor wishes to install an alternative water supply pipe to copper tube, the alternative pipe shall be sized according to Table 1.1 of AS 3500.1.2.

Submitted alternatives must have MP 52 approval and conform to the sizes, standards and installation procedures as described for the product in AS 3500 and be stamped with the applicable Authority Water Mark approval.

1.9 TRADE AND BRAND NAMES

Trade and brand names are used in this Specification as an aid in setting the level of quality required. This does not relieve the Subcontractor of the responsibility to ensure that the product offered will perform to the requirements of this Specification.

1.10 TEMPORARY PROVISIONS

Provide temporary provisions to assist in progressive hand over and occupancy of the Project.

1.11 REGULATIONS AND FEES

Obtain all necessary permits, consents, approvals and certificates from all authorities having jurisdiction over any part of the work of this contract. Pay all royalties and costs relating to patent rights, trade marks or other protected rights. Comply with all regulations and by-laws of the authorities and fully indemnify the Principal against any claims arising there from.

1.12 PROGRESS CLAIMS

Progress claims shall be submitted to the Project Manager exclusive of GST. A Progress Certificate including GST shall be issued by the Project Manager nominating the amount of claim. On receipt of the Progress Certificate issue a Tax Invoice for the amount of claim inclusive of GST to the Principal for payment, with a copy to the Project Manager.

Clearly identify Progress Claims and Tax Invoices. Payments shall only be made against a Tax Invoice for the sum nominated on the Progress Certificate.

Provide an itemised break-up of the Progress Claim.



Progress Claims shall not include items purchased but not installed, unless provided with a bank guarantee to the same value as the purchase price of the item.

1.13 CHARGEABLE FEES TO THE CONTRACTOR

The Consulting Engineer will reserve the right to seek fees from the Contractor, via the Project Manager, to carry out additional attendance and works outside of, but not limited to, those outlined below. Such Consulting Engineer's fees will be submitted via the Project Manager, and must be accepted by the Contractor prior to the requested attendance or works being conducted.

1.13.1 During Construction

It is expected that the Contractor and all Subcontractors will have an appropriate level of engineering and management capability, and a functional Quality Assurance System in place to successfully complete the works.

The following activities will be carried out during the construction phase of the project as part of the Consulting Engineer's normal responsibilities:

Review and comment on the Contractor's Quality Plan;

Review of shop drawings, noting that any such review is only to ensure compliance with the intent of this Specification and associated Drawings, and does not relieve the Contractor from the responsibility to correctly complete the works;

Review samples submitted to ensure compliance with the intent of this Specification and associated Drawings;

Conceptually review if alternatives proposed are appropriate. Should the Consulting Engineer be required by the Principal to review the design or calculation data of the proposed alternative, or recalculate data; then the Consulting Engineer reserves the right to seek fees from the Contractor, via the Project Manager, to carry out these works.

Carry out periodic walk-through inspection of the works to ensure that the works are being carried out in compliance with:

- All relevant regulations;
- The intent of this Specification and associated Drawings;
- The Contractor's Quality Plan.

Non-compliances resulting from inspections will be provided to the Project Manager in a written report and shall be remedied by the Contractor;

Periodic walk-through inspections will be scheduled to coincide with site Project Client Group (PCG) meetings, as appropriate;

Respond in a timely manner to Requests for Information (RFI) correspondences via an Engineer's Advice. It is expected that the Contractor has exhausted all reasonable efforts to obtain the information before submitting an RFI;

Review and comment on the justification and quantum of variation claims in terms of both time and cost;

Assess monthly progress claims;



Carry out random reviews of commissioning activities and test records. The Consulting Engineer will advise the Contractor in a timely manner of those commissioning activities to be witnessed;

Review and comment on Operating and Maintenance Manuals and As-Installed documentation;

Review and comment on status of the works with respect to achieving Practical Completion;

Review the works prior to the expiration of the Defects Liability Period. The Consulting Engineer shall not be responsible for reviewing maintenance of the works during the Defects Liability Period, including Essential Services Maintenance.

1.13.2 At Practical Completion

Once the Consulting Engineer is satisfied that the extent and scope of works still to be rectified on the final comprehensive defects list is reasonably complete, a final inspection walk-through will be conducted by the Consulting Engineer with the attendance of the relevant Trade Subcontractors and Contractor.

If the final defect list submitted is found not to reflect the extent and scope of works to be rectified on-site, and a recommendation of practical completion is not appropriate, the Consulting Engineer will reserve the right to charge for subsequent attendances.

1.13.3 Operating and Maintenance Manuals and As-Installed Drawings

Requirements for the Operating and Maintenance Manuals and As-Installed Drawings are detailed further in this Specification.

Should the Operating and Maintenance Manuals and As-Installed Drawings demonstrate major deficiencies in meeting the requirements, formats, details and information set out in this Specification, the Consulting Engineer will provide a general note "to refer to the Specification". No detailed comments will be provided by the Consulting Engineer.

Should the Operating and Maintenance Manuals and As-Installed Drawings demonstrate minor deficiencies in meeting the requirements, the Consulting Engineer will provide comments regarding specific areas to be improved upon.

The Consulting Engineer will reserve the right to charge for any subsequent reviews, in addition to the two (2) reviews mentioned above.

There will be no revisional changes to the construction issue documentation throughout the construction phase unless it is determined by the Project Manager or at the discretion of the Consulting Engineer that the revision of the documentation is significant and is required for clarity reason, the Consulting Engineer may issue revised documentation.

Any request to provide up-dated contract documentation will be chargeable.



2.0 GENERAL REQUIREMENTS

2.1 ROLES, OBJECTIVES AND EXPECTATIONS

2.1.1 Definitions of Entities

Principal	Royal Duke Development (McLachlan Street Development) Pty Ltd
Project Manager	PDS Group
Architect	Kowalski Architects
Consulting Engineer	Umow Lai
Structural Engineer	Odyssey Consulting Group
Building Surveyor	RPS Australia East
Fire Safety Engineer	Omnii Consulting Fire Engineers
Quantity Surveyor	Slattery
Building Certifier	Building Certifiers Australia
Contractor	The party contracted for the whole of the works
Trade Subcontractor	A party subcontracted for one of the specialist trade sections of the works, also referred to as the Service Provider / Installer / Subcontractor in the Trade Subcontract documents
Hold point	A point which work may not continue beyond subject to authority, Project Manager or client agreement
Witness point	A point that allows the opportunity to review / inspect the works within a suitable time frame before the works proceed
Inspection	Random / intermittent monitoring of the work
Self Inspection	The Contractor undertakes their own review / inspection of the works with the aid of schedules
Work Area	Defined as part or whole work area by the location and trade
ITP	Inspection and Test Plan: prepared to at least AS/NZS ISO 9001

2.1.2 Definition of Terms

- Provide – and similar expressions means to supply and install;
- Supply – and similar expressions means to supply only;
- Install – and similar expressions means to install only;
- Approved, Rejected – and similar expressions means such acknowledgement in writing by the Project Manager;
- Give Notice, Submit – and similar expressions means to do so in writing to the Project Manager;
- Obtain, Seek – and similar expressions means to request for such in writing from the Project Manager;
- Proprietary – means identifiable by naming manufacturer, supplier, installer, trade name, brand name, and catalogue or reference number.



2.1.3 Specification Objectives

The intent of this specification and the associated documentation is:

- To provide documentation to the Principal to confirm the scope and quality of the project.
- To provide a basis for competitive tendering by appropriately competent companies.
- To set out contractual requirements against which compliance can be assessed.
- To provide documentation for relevant Authorities to enable compliance with statutory requirements at design stage to be confirmed.
- To define the roles and expectations of the parties involved in the works.
- To define the obligations of the installer with respect to Quality Assurance including having the necessary resources to complete the detailed "For Construction" documentation and schedules, testing and commissioning of the installation in accordance with the design intent and the requirements of the specification.

2.1.4 Obligations of The Installer

Pursuant to this Specification the Principal expects and relies upon the Installer possessing specialist trade expertise and resources necessary to complete the works in accordance with documentation and programme.

In addition, the Installer has the following obligations:

- To raise in good time, issues requiring clarification from the Consulting Engineer, particularly in respect to:
 - Interpretation of the Specification or Drawings
 - Problems in complying with the Specification
 - Proposed alternatives/ substitutions
- To allow for verification costs of the Consulting Engineer when requesting alternatives/substitution or departure from the Specification
- To obtain all Authority permits and certificates to allow the progress of the works
- To provide samples and prototypes where specified and 'For Construction' drawings in sufficient detail to allow proper fabrication, coordination and installation of the works
- Arrange for specialist suppliers to provide onsite inspections, installations supervision and commissioning
- To certify compliance with the Contract at Practical Completion
- To comply with the Quality Assurance requirements of the Contract
- To demonstrate and certify that the contract works have been accepted by relevant Authorities
- To pay all fees applicable to the works



2.1.5 Obligations of The Consulting Engineer

During the Construction Phase, the Consulting Engineer's role is:

- Review and audit installer's shop drawings and other technical information which the installers are required, or may submit, for technical compliance with the Contract and report thereon
- Respond to requests for information
- Answer queries raised on Contract documentation. Issue responses via Consultant's Advice Notices (CA's) with marked sketches of drawings, if appropriate. Design CAD drawings will not generally be updated to incorporate revisions/ variations/ sketches or information which is included in responses, engineering reports, etc.
- Attendance at site meetings on a minimum monthly basis
- Audit works and Installers Quality records monthly for achievement of Contract intent and issue reports or non conformances as appropriate from such audits
- Review samples as per the head contract submission regime and issue reports thereon
- Review Installer's QA records including ITP's for construction and commissioning of works
- Attend spot checks of commissioning and witness testing in accordance with accepted Commissioning Test programme to audit compliance with the Contract intent as described in the documentation
- Provide progressive inspection reports on site audits and any non compliances /corrective action reports arising, particularly in the lead-up to Practical Completion
- Audit "As-Installed" drawings, Operator briefing /tuition material, operating and maintenance manuals prepared by the installer and report thereon
- Review and respond to installer's claim when Practical Completion is claimed
- Provide advice on Progress Claims
- Review claims for contract variations

During the Warranty Period, the Consulting Engineer's role is to:

- Participate in the final inspections of project prior to the end of warranty period, and report thereon.
- Review of outstanding work subject to corrective actions and prepare and update list of items requiring attention, including issues identified by the operator.
- Review of log books for equipment fault/rectification and preventive maintenance reports.

2.1.6 Installers Detailing Responsibilities

Be responsible for the detailing and documentation activities listed below, in addition to those activities normally undertaken through the custom and practice of the trade concerned.

The tender documentation which includes this specification and the tender drawings as scheduled is the complete set of design documentation to be issued by the Design Consultant.

The design documentation for tender is complete and final and the Services Installer is to complete detailing of the works "For Construction" documentation.



Be responsible for ensuring that the detailing for construction is fully co-ordinated and compatible with the remainder of the Head Contract works.

Obligations include:

- Check space and load requirements of equipment and services which are indicated diagrammatically in the Contract documents. Select equipment with dimensions to suit the available space.
- Lay out equipment and services to be accessible for safe operation, maintenance and replacement and so as not to interfere with access to other installations. Make offsets if necessary.
- Set out access ways to all major plant clear of all obstructions, unless otherwise approved.
- Undertake pump and fan pressure drop, voltage drop and similar calculations commensurate with the adopted equipment and layouts.
- Review plant equipment sizes, duct/ pipe/cabling layouts.
- Interface details with other trades.
- Size and location of penetrations in walls, floors and roofing.
- Physical co-ordination and scheduling of installation with other trades.
- Details of electrical wiring and control diagrams of all equipment supplied by the Installer showing all interconnections between equipment to enable the necessary wiring to be undertaken.
- Thermal expansion accommodation and anchorage, including provision of bellows or bends, taking into account final installation details and consistent with specified requirements.
- Capacity, location, sizing and detail of electrical and controls cable tray, conduit, trunking and wiring system.
- Acoustic works based on actual selected equipment. Any resulting change to approval of the Engineer. Specified levels to be achieved with all plant operating.
- Detailing valve, damper, control unit access locations.
- Detailed selection of all anti-vibration mountings to suit the particular application.
- Final locations of control sensors, detectors and thermostats.
- Coordination of all control cabling conduits to be cast in the slab/ built into the walls where no ceilings installed.
- Coordination of the construction of the installation.
- Equipment mounting details and fasteners.
- Settings for protection equipment, time delays, time switches, etc.
- Ensure all detailing duties optimize OH&S requirements.

2.1.7 Required Submissions

2.1.7.1 Timing

Provide in good time to allow review without impediment to the programme:

- Copies of correspondence with Authorities.



- Certified schedule of compliance for all plant and equipment, prior to placing orders.
- Certified schedule of competency for all tradesmen intended to work on the project.
- Samples as per schedule.
- Factory test results where applicable.
- All product data, performance test and commissioning results required by this Specification.
- Detailing drawings including drawing submission register.
- Shop drawings for fabrication of all equipment and items supplied.
- Inspection, test and commissioning plans for every section of works, including:
 - The procedure of how to complete the task.
 - The skill or competency of the person undertaking the works.
 - The review or testing procedure to assure satisfactory completion of the task.
 - The detailed documentation to record the process.
- Requirements for acceptance or rectification if further testing is required to confirm satisfactory outcome.
- Record of sign off for each section or item
- Prestart up Testing and Commissioning programme, Operator familiarization and training programme
- Maintenance and operating manuals.
- As built records
- Preventive and breakdown maintenance and servicing records during the warranty period.

2.2 QUALITY MANAGEMENT

Implement a Quality Management System for the whole of the Contract works.

The Quality System must comply with:

- AS/NZS ISO 9000 : Quality Management Systems – Fundamentals and vocabulary
- AS/NZS ISO 9001 : Quality Management Systems – Requirements

The Quality Management System and Plan must be submitted for acceptance as a part of the submission of the initial claim for progress payment.

The complete Plan, including programs for progressive testing, draft ITP's, commissioning programme and outlines of O& M manuals, as built records and Operator familiarisation and training must be submitted and accepted as part of the submission of the second claim for progress payment.

Staff engaged as internal auditors under the Quality System must be:

- independent of the staff undertaking the work being reviewed and or tested
- accepted as being appropriately skilled to carry out the review or witnessing



Records of all ITP's and reviews must be held on site available for inspection. These records must be incorporated into the overall commissioning and as constructed records.

ITP's shall be prepared to at least the standard referenced in the New South Wales Government Quality Management System Guidelines: Appendix E: Guideline for Inspection and Test Plans.

2.2.1 Hold Points

When a specification indicates an inspection, testing and or submission hold point is necessary, be responsible to hold the associated works within sufficient time for an assessment of the item in question to be undertaken. Work associated with assessments at hold points will not provide a basis for any Extension of Time claim.

Indicate and allow for all hold points within the construction program.

Arrange for the hold point assessments to be aligned where possible with the regular site meetings.

2.2.2 Performance Requirements

When a specification references "performance specifications", "performance requirements", or where documentation does not provide detailed construction arrangements, or where the documentation does not indicate detailed services connections, terminations or arrangement to fulfil the successful completion and operation of a system:

- Undertake any additional design/detailing work including calculation and or drawings to fulfil the completion of the system.
- Select and obtain suitable material to carry out the construction and installation.
- Warrant that the designed and constructed item and or system comply with the performance base specification and to a high standard expected of a competent contractor.
- Warrant that the designed and constructed item and or system are fit for purpose.
- Works shall be complete with all incidental items of work required to comply with the performance and durability of the specification, including compliance with all legislative requirements.

2.2.3 Additional Documentation Issues

In addition to the contractual documentation provided at the project commencement the Project Manager will issue an additional electronic copy of all documents for Contractor information. Subsequent copies would be provided by the Project Manager at their discretion.

Unless determined by the Project Manager or at the discretion of the Consulting Engineer there will be no revisional changes to the construction issue documentation throughout the construction phase. If it is determined that the revision of the documentation is significant and required for clarity reason the Consulting Engineer may issue revised documentation.

Any request to provide up-dated contract documentation will be chargeable.

2.2.4 Tests

Pre-completion Tests

- Prototype Tests : carried out to demonstrate suitability of an item or assembly for use in the project



- Type Tests & Production Tests : Pre delivery test on a normal production item, usually undertaken by an independent body
- Site tests: progressive tests undertaken during the course of installation work

Completion tests: Tests carried out before the date for practical completion on installations or systems which have been completed and commissioned. Tests are to demonstrate that the installations operate correctly, safely and efficiently, meet performance and other requirements and are correctly integrated.

Deferred tests: Acceptance tests carried out during the warranty period (e.g. capacity tests deferred until climatic conditions and/or occupancy are sufficient to provide required load)

2.3 REGULATORY AUTHORITY REQUIREMENTS

Notwithstanding that stated herein, the entire services installation shall fully comply with the regulation of the following relevant Authorities having jurisdiction over such works:

- Australian Building Regulations;
- Occupational Health & Safety Organisation;
- Building Regulations incorporating Building Code of Australia;
- Fire and Emergency Services Authority;
- Water Authority and Company;
- Gas Authority and Company;
- Electricity Authority and Company;
- Telecommunications Authority and Company;
- Together with all relevant Australian Standards and all Amendments to those Standards.

2.4 STANDARDS

Execute all work in accordance with this Specification and associated Drawings, and in compliance with the following Australian Standards and all relevant parts and amendments to these Standards, including but not limited to the standards listed below.

The edition of the Australian Standard applicable shall be as nominated in the National Construction Code – Building Code of Australia (BCA). Where a Standard is not nominated in the BCA, the latest edition of the Standard including all relevant parts and amendments shall be used.

MECHANICAL INSTALLATIONS	
AS 1074	Steel tubes and tubulars for ordinary service
AS 1210	Pressure Vessels
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes conduits and ducts
AS 1359	Rotating electric machines-General requirements
AS 1360	Rotating electric machines of particular types of particular applications
AS 1397	Steel sheet and strip-Hot-dipped zinc-coated or aluminium /zinc-coated
AS 1432	Copper tubes for plumbing, gasfitting and drainage applications



MECHANICAL INSTALLATIONS	
AS 1571	Copper-Seamless tubes for air-conditioning and refrigeration
AS 1668.1	Fire and smoke control
AS 1668.2	Ventilation design for indoor air contaminant control
AS 1674	Safety in welding and allied processes
AS 1677	Refrigeration systems
AS 1677.2	Safety requirements for fixed applications
AS 1682	Fire dampers
AS 2053	Conduits and fittings for electrical installations
AS 2129	Flanges for pipes, valves and fittings
AS 2280	Ductile iron pressure pipes and fittings
AS/NZS3000	Electrical installations (Australian/New Zealand Wiring Rules)
AS/NZS3008	Electrical installations-Selection of cables



3.0 SCOPE OF WORKS

3.1 PROJECT DESCRIPTION

The project involves a new 9 storey residential tower consisting of 63 residential units with retail units on the ground floor and 3 levels of basement car park. The new building is to be constructed in place of an existing building.

3.2 SCOPE OF WORKS

Supply, deliver, install, test and set to work the following works in accordance with drawings :

The scope of works is for:

- Manufacture, supply, installation, testing, commissioning and subsequent maintenance during the Defects Liability Period;
- ITP's for all operating systems.

including, but not limited to the list below, to complete the Works specified for this Contract.

Provide all manufactured items, materials, labour, cartage, tools, plant, appliances and fixings necessary for the proper execution of the works, including associated charges and all minor and incidental works.

Equipment and materials provided for the Project shall be new and comply with all the relevant Australia Standards.

3.3 VENTILATION SYSTEMS

3.3.1 General

- Supply and install all ductwork and accessories, diffusers, registers, grilles, regulating dampers, fire dampers, as indicated on the drawings and as specified herein.

All mechanical ventilation systems will generally be in accordance with NCC incorporating AS1668.

3.3.2 Residential Exhaust

- Provision of residential combined bathroom and utility exhaust systems, including exhaust fans, ductwork, acoustic wrapping, grilles, registers and dampers.

Exhaust systems will be provided to each apartments to exhaust from the bathrooms and utility area. Each system will discharge horizontally to atmosphere via an inline duct fan and external air brick or louvre as agreed with the architect.

3.3.2.1 Controls

Each fan shall be speed controlled to two set volumes, pre set at commissioning. Activation and speed control shall be via individual light switches within the bathrooms. The set flows shall be in accordance with AS 1668.

Upon detection of fire within the apartment the exhaust fans shall be disabled.



3.3.3 Ground Floor Tenancy Toilets

- Provision of ground floor tenancy toilet exhaust systems, including exhaust fans, ductwork, acoustic wrapping, grilles, registers and dampers.

The 2 toilets and PWD toilet on the Ground Floor are to be ventilated via a single in line extract fan to vent to the undercroft toilets. Fire dampers shall be installed where fire barriers are crossed as indicated on the drawing.

3.3.3.1 Controls

Each fan shall be speed controlled to two set volumes, pre set at commissioning. Activation and speed control shall be via individual light switches within the toilets. The set flows shall be in accordance with AS 1668.

Upon detection of fire the exhaust fans shall be disabled.

3.3.4 Car Park Ventilation

- Provision of car park ventilation systems, including fans, ductwork, grilles, registers and dampers.

The basement car park will be provided with a fully compliant ventilation system, comprising of 1No ducted In-line extract fan and 1No Supply fan, both located at high level within Basement - 1 level as indicated on drawings. Outside air will be drawn through an up stand duct piece with two side louvers, located in the car park entrance as indicated on the drawings. Air distribution and movement will be created with a configuration of ducts complete with extract grilles and supply diffusers to create a compliant car park system with adequate air movement across the levels.

The car park exhaust will discharge at high level at ground floor by the loading bay via a weatherproofed louvre suitable to the application and compliant with AS 1668.2.

The car park ventilation will be in accordance with NCC incorporating AS 1668.2.

3.3.4.1 Controls

The Car Park Exhaust fan shall act as master controller to the Car Park supply fan. The Car Park Exhaust and supply fan shall be connected back to a central controller located within the ground floor managers office. The Exhaust fan shall modulate according to the CO2 levels recorded within the exhaust air whilst the supply fan shall run at 85% of the exhaust rate at any time.

Upon detection of fire the exhaust fans shall be disabled.

3.3.5 Plant Room Ventilation

- Provision of plant room ventilation systems, including fans, ductwork, grilles, registers and dampers.

Plant room ventilation for the combustion of the gas central hot water system will be via a wall mounted extract fan, exhausting air into the car park. Borrowed air will be drawn passively through a low level louvre as indicated on the drawings.

3.3.5.1 Controls

The fan shall run continuously to provide ventilation to the space.



Upon detection of fire the exhaust fans shall be disabled.

3.3.6 Fire Pump Room Ventilation

- Provision of Fire Pump room ventilation systems, including fans, ductwork, grilles, registers and dampers.

The fire pump room shall be provided with a full ventilation system to allow sufficient ventilation to the fire pumps when in operation. The system will comprise of a supply and extract fan independently ducted to the plant room and under croft area. All ductwork shall be fire rated and the system will be in accordance with NCC incorporating AS 1668.2.

Air shall be ducted and supplied at low level within the room via an operable louvre as indicated on the drawings and detailed within the schedules. Air shall be extracted at high level within the fire pump room via an operable louvre as indicated on the drawings and detailed within the schedules.

3.3.6.1 Controls

The fire pump room ventilation system shall be controlled to operate at full speed on detection of fire. Supply and Exhaust rates shall match so as not to adversely affect the stair pressurisation system acting upon the adjacent stairs.

Upon detection of fire the exhaust and supply fan shall simultaneously be enabled to run at full speed.

3.3.7 Basement Stair Pressurisation

- Provision of Basement stair pressurisation ventilation systems, including fans, ductwork, grilles, registers and dampers.

The stairwell serving the basement will provide a protected fire escape via a stair pressurisation system. The stairwell pressurisation system will comprise a single fan to pressurise the stairs from high level ground floor. Relief air will be discharged into Basement level -3.

The Stair Pressurisation supply fan shall be located at high level within the bin store and draw air from the under croft area as indicated on the drawing.

Air shall be supplied to the stairwell via two operable louvers indicated on the drawings and detailed within the schedules.

All connected ductwork shall be adequately fire rated in accordance with AS 1668.1.

The stair pressurisation system will be in accordance with NCC incorporating AS 1668.1.

3.3.7.1 Controls

The Basement Stair pressurisation fan shall be enabled to operate upon detection of fire to run at full volume.

3.3.8 Kitchen Hood System

Individual kitchen hob recirculation hoods shall be installed within each apartment. Kitchen hoods shall be selected by the Architect and installed under the main builders package.



3.3.9 Barbecue Exhaust Hood System

- Provision of Barbecue exhaust ventilation systems, including fans, ductwork, exhaust hood.

The exhaust hood final selection shall be based upon confirmation of Barbecue by Architect.

3.3.9.1 Controls

The Exhaust hood shall operate on standalone controls provided by the manufacturer of the hood.

3.3.10 Switch Room Ventilation

- Provision of Basement Switch room ventilation systems, including fans, ductwork, grilles, and dampers.

A ventilation system shall be supplied to the switch room, located on Basement Level 1 via a single in line exhaust fan located at high level and ducted to the car park area adjacent.

Motorised fire dampers shall be installed on both the air intake and exhaust duct penetrations to fail safe close on detection of fire.

3.3.10.1 Controls

The Switch room exhaust fan shall be controlled via a temperature sensor located within the switch room as indicated on the drawings. Upon a temperature detection above 38 degrees the exhaust fan shall run until a temperature below 30 degrees is recorded.

Upon detection of fire the exhaust fan shall be disabled and all fire dampers closed.

3.3.11 Ground Floor Tenancy Units Services Provision

The ground floor tenancy units will be constructed as shell only with provision for a later fit out only. Space allowance is to be made for a full AC installation.

Tenancy units 2&3 are to be provided with an external louvre to allow the future connection of a full commercial kitchen extract. The Louvre will be located in a location to comply with AS 1668.1 and of an adequate size to meet expected exhaust rate at acceptable velocities.

There shall be allowance made for 4 ground floor tenancies. Tenancy 1 shall be provided with an external weatherproof louvre for outside air provision by the fit out contractor.

Tenancies 2,3 & 4 (Note: These are indicated only as Tenancy two on tender drawings) shall be provided with external weatherproof louvre for outside air provision by the fit out contractor with additional space allowance for kitchen exhaust ducts to run to exhaust to atmosphere as indicated on the drawings.

Outside air louvers indicated on the drawings and detailed within the schedules.

Space provision shall be allowed for future VRF AC installation for tenancy spaces.

3.3.11.1 Controls

Individual control to all tenancy provisions shall be provided by the fit out tenant. Space shall be allowed for at the FIP to allow relays to all possible future installations within the tenancy spaces.



3.4 AIR CONDITIONING SYSTEMS

3.4.1 General

Supply and install all ductwork and accessories, units, pumps, piping, valves and fittings and controls as indicated on the drawings and as specified herein.

- Ensure compliance with the energy efficiency requirements of NCC including Section J and AS1668.

3.4.2 1 Bed Apartments

- Provision of individual Split refrigerant AC systems to 1 bedroom apartments as detailed within schedule including, external condensing units, Internal wall mounted AC units, pumps, piping, valves and fittings and controls.

Each 1 bed apartment will be provided with individual 'Split' system AC to serve the bedroom only. The system will comprise an external condensing unit located on the balcony of the unit it is serving and an internal wall mounted AC unit located within the bedroom. The system shall be controlled via a single wall mounted controller within the bedroom as indicated on the accompanying drawings.

All external condensing units located on the enclosed balconies will be sited in an acoustically treated enclosure as detailed by the architect. These shall provide full access to the units for maintenance. Adequate outside air exposure will be achieved via a front facing external weatherproof louvre. Refer to drawings for details of enclosed balconies.

3.4.2.1 Controls

The system shall be controlled via a single wall mounted proprietary controller within the bedroom as indicated on the accompanying drawings.

3.4.3 2 Bed Apartments

- Provision of individual Multi head refrigerant AC systems to 2 bedroom apartments as detailed within schedule including, external condensing units, Internal wall mounted AC units, pumps, piping, valves and fittings and controls.

Each 2 bedroom apartment shall be provided with multi head AC systems comprising of a single external condenser on the balcony and 2 No internal wall mounted AC units serving the master bedroom and living space.

All external condensing units located on the enclosed balconies will be sited in an acoustically treated enclosure as detailed by the architect. These shall provide full access to the units for maintenance. Adequate outside air exposure will be achieved via a front facing external weatherproof louvre. Refer to drawings for details of enclosed balconies.

3.4.3.1 Controls

Each room served by a wall mounted AC unit shall be supplied with a wall mounted intelligent controller applicable to that unit, as recommended by the manufacturer. In the case of the 2 bed apartments, where there is to be more than 1 No internal unit off of the single external condensing unit, the controller within the living space shall act as the master controller.



3.4.4 Ground Floor Office

- Provision of individual Split refrigerant AC systems to Ground floor office as detailed within schedule including, external condensing units, Internal wall mounted AC units, pumps, piping, valves and fittings and controls.

The external unit serving the Ground floor office shall be located above the car park ramp. Adequate and compliant access shall be provided to allow safe maintenance of the system.

3.4.4.1 Controls

The ground floor managers office shall be supplied with a wall mounted intelligent controller applicable to that unit, as recommended by the manufacturer.

3.4.5 Fire Mode Operation

- Provision of control circuit relays and interlocks at mechanical services switchboards for fire mode operation.
- Provision of control circuit relays and interlocks at switchboards for fireman's override controls (i.e. manual fan start and stop) in accordance with AS/NZS 1668.
- Provision of indication circuit relays and interlocks incorporating air pressure differential switches at mechanical switchboards for fan start, stop, fault and power available in accordance with AS/NZS 1668.
- Provision of terminal strips within the mechanical services switchboards for connection of indication and control signals to and from the FIP and FFCP.

3.4.6 Miscellaneous Works

- Space allowance for future provision of Kitchen Exhaust and outside air intake to serve dedicated tenancies on the ground floor.
- Provide all labour, materials, equipment, chemical and services for the complete water treatment of the systems specified herein for the duration of the Defects Liability Period and for the duration of any extensions authorised thereto.
- Provision of all electrical works including mechanical services switchboards, wiring, cable trays, conduits and the like.
- Provision of all access systems for the full maintenance access of all mechanical plant as detailed on drawings and specified herein.

Any other work required for the correct operation of the mechanical services as specified.

3.4.7 Building Works In Conjunction

- Delivery and hoisting to place into position equipment, plant and materials.
- Scaffolding and access equipment as required for the installation of equipment and materials.
- Plinths as required for the proper install of equipment or plant.
- Supports as required for the proper install of equipment.
- Removal of all rubbish and debris from site associated with the works.
- Removal of all contaminants related to the Trade Sub-Contractor's scope.

3.4.8 General Works

- Provision of fully detailed assembly, installation and Shop Drawings.



- Provision of samples and setting up of prototypes.
- Protection of equipment.
- Labelling of all equipment and services.
- Painting of all exposed mechanical services such as air handling units, ductwork, piping and plinths.
- Comprehensive testing (including in fire mode), commissioning and balancing of each specified system.
- Demonstration of systems and training of system operation.
- Provision of detailed Operating and Maintenance Manuals including As-Installed drawings.
- Provision of maintenance during the Defects Liability Period.
- Defects Liability Period from the date of Practical Completion.
- Provision of warranties.

3.5 ASSOCIATED WORKS

References to Sub-Contractors in this Specification are for the purposes of identifying intended work demarcation and clarification. The Contractor may re-assign the scope of the Trade works amongst the approved Trade Sub-Contractors for this project.

The following is a guide for the interface between the Mechanical Sub-Contractor and other Trade Sub-Contractors, and will be provided to the Mechanical Sub-Contractor at no cost.

Provide all Mechanical Services works required for the completion and operation of the Scope of Work of other Sub-contractors on the site.

Ensure all associated works applicable to the completion and operation of the Mechanical Services Scope of Work are included in the Scopes of other Sub-contractors.

Furnish at the correct time and in the prescribed manner all necessary co-ordination, shop drawings and other information necessary for the satisfactory interface and execution of works to be carried out by other trades.

3.5.1 Work By Contractor

Provision of the following works associated with Mechanical Services.

- Combined services drawings for Project Manager's approval. The Mechanical Sub-Contractor shall provide details and co-ordinate.
- Equipment platforms and plant room enclosures for mechanical services plant, including access doors, stairs and ladders.
- Openings and access hatches in walls, ceilings, roofs etc for concealed mechanical services equipment.
- Service ducts, bulkheads and shafts for the installation of ductwork, pipework and wiring where required.
- Penetrations in floors, walls, roofs, ceilings etc for the passage of mechanical services ducts, pipes and wiring, including the under flashing of roof penetrations. Over flashing by Mechanical Sub-Contractor.
- Sealing of all penetrations through fire and smoke walls.



- Built in pipe sleeves, anchor points etc where required for mechanical services.
- Acoustic sealing of all penetrations through acoustically treated walls and ceilings.
- Chasing of concrete floors and masonry walls.
- Installation of door relief grilles supplied by the Mechanical Sub-Contractor.
- Weatherproof louvres complete with vermin proof mesh for mechanical services intakes and discharges.
- Temporary lighting, power, fire protection and telecommunication services during the Project.
- Temporary hoardings, barriers and signage.

3.5.2 By Mechanicals Sub-Contractor

Provision of the following works associated with Mechanical Services.

- Tundishes, floor wastes and sewer waste points for drains from Mechanical Services equipment and cooling pits where required.

3.5.3 By Electrical Sub-Contractor

Provision of the following works associated with Mechanical Services.

- Electrical sub-mains to mechanical switchboards (MSSB's). Final connection of sub-mains to MSSB by Mechanical Sub-Contractor.
- Switched socket outlets (SSO's) for minor mechanical services equipment. Mechanical Sub-Contractor to provide exhaust fans, flexes and plugs, and associated controls.
- Power supply with local isolator for mechanical equipment where nominated in the Equipment Schedules. Mechanical Sub-Contractor shall make final connection to equipment from the isolator.

3.5.4 By Fire Sub-Contractor

Provision of the following works associated with Mechanical Services.

- Provide wiring from the Fire Indicator Panel (FIP) to Fire Fan Control Panel (FFCP) with all information required AS/NZS 1668.1 control and monitoring of Mechanical Services plant. Mechanical Sub-Contractor to terminate in FFCP.
- Smoke detectors / air sampling points for AS/NZS1668.1 control of Mechanical Services plant.

3.6 CONTRACT DRAWINGS

The following Mechanical Services drawings shall form part of this specification and shall be read in conjunction with this specification:

<i>DRAWING TITLE</i>	<i>DRAWING NO.</i>	<i>REV. NO.</i>
Drawing Index and Legend of Symbols	M000	T1
Basement Level 3 Air conditioning & Ventilation Layout	M100	T1
Basement Level 2 Air conditioning & Ventilation Layout	M101	T1
Basement Level 1 Air conditioning & Ventilation Layout	M102	T1
Ground Level Air conditioning & Ventilation Layout	M103	T1



<i>DRAWING TITLE</i>	<i>DRAWING NO.</i>	<i>REV. NO.</i>
Level 1 Air conditioning & Ventilation Layout	M104	T1
Levels 2-6 Air conditioning & Ventilation Layout	M105	T1
Level 7 Air conditioning & Ventilation Layout	M106	T1
Level 8 Air conditioning & Ventilation Layout	M107	T1

3.7 SUBMISSIONS

3.7.1 Programme

Provide a proposed submissions programme detailing the date and description of all shop drawings, samples and Inspection and Testing Plans (ITP's).

3.7.2 Shop Drawings

The following mechanical services Shop Drawings shall be submitted.

- Floor plans and sections covering all Mechanical Services ductwork, pipework and equipment at 1:50 maximum scale
- Drawings of all Mechanical Services switchboards including all single line and control details
- Mechanical Services piping schematics
- Mechanical services air schematics
- Automatic controls schematics and wiring
- Automatic controls functional description
- Combined Services floor plans and reflected ceiling plans, co-ordinated and prepared by the Mechanical Sub-Contractor prior to preparation of individual services shop drawings
- Drawings detailing all wall, floor, ceiling and roof penetrations and equipment plinths/platforms.
- Any other drawings the Project Manager may require to be satisfied that the work proposed meets the Specification requirements and conforms to good trade practice;

All Shop Drawings submitted will be taken to have been fully co-ordinated with all other relevant Trade Sub-Contractors for locations, structural and electrical load ratings, etc.

Shop Drawings shall comprise three (3) sets of prints for each submission. Re-submissions shall occur until such time the Shop Drawings are approved.

Shop Drawings shall be submitted in sufficient time to allow for review, resubmission if required and approval, as well as ordering and fabrication lead times, in order to meet the construction programme.

At least one (1) working week shall be allowed for review and approval of the Shop Drawings from the time it is received by the Consulting Engineer.

Failure to submit Shop Drawings in a timely manner to facilitate ordering, fabrication or installation shall not constitute grounds for an Extension of Time to the Contract.



Ensure that no structural member is weakened or overloaded by the weight of the installed equipment or the method of attachment.

Such drawings will be examined by the Project Manager to verify only that they represent the Consulting Engineer's design intent. The endorsement of such drawings by the Project Manager does not relieve the Contractor of his responsibility for detailed checking.

Make any necessary adjustments in conjunction with the Project Manager before manufacture. Check all layouts before and after erection, and be fully responsible for the accuracy of the Contract Works.

All Shop Drawings shall be prepared using AUTOCAD Release 2000 or later.

Shop Drawings shall be regularly updated during construction to reflect the actual installed works, so that at the end of the project the final shop drawings become the As-Built Drawings.

3.7.3 Samples

Prior to commencement on site and the ordering of materials, submit for review the following samples, including their respective data sheets:

- Registers of each type proposed;
- Grilles of each type proposed;
- Diffusers of each type proposed;
- Internally insulated duct;
- Cushion head;
- Sensors.

Each sample shall be provided with a unique identifier and shall be recorded on a sample register.

Samples register shall contain a complete list of all samples as required and updated with submission date, approval date and authorised sign-off personnel.

Each sample shall also be accompanied by a technical data sheet from the manufacturer.

Approved samples will be retained by the Project Manager for the duration of the contract.

3.7.4 Construction Quality Plan (CQP)

At the first site meeting, provide a Construction Quality Plan (CQP).

The CQP shall encompass project objectives together with the assurance that the project can be completed in compliance with the specification and drawings, and within the allocated time.

The plan should include, but not be limited to, the following:

- A copy of the Contractor's Safety Plan, inclusive of work method statements;
- A list of proposed key personnel, including vehicle registration numbers;
- Bank guarantees, where required by the Contract;
- Preliminary programme;
- Shop drawing and sample schedules nominating the proposed submission dates;



- Method statements and sequence of work;
- Construction process QA / QC / NCR systems;
- Identification, labelling and protection of work before handover;
- Inspection and testing programme (ITP) for each operating system;
- Handover Plan.

3.7.4.1 Inspection and Testing Plans (ITP)

The (ITP) plan should list the various stages of work from project commencement to Practical Completion.

The plan shall include, but not be limited to, the following:

- Testing;
- Inspections;
- Hold points;
- Witnessing;
- Defect Inspections.



4.0 DESIGN CONDITIONS

The systems shall operate to maintain the specified indoor design conditions within all areas serviced by the respective system when the ambient conditions are within the specified outdoor design conditions.

<i>INDOOR DESIGN CONDITIONS</i>		
<i>STANDARD</i>		
Summer	23.0 deg C DB +/-2.0 deg C DB/60% RH (max)	Summer
Winter	21.0 deg C DB +/-1.0 deg C / 60% RH (max)	Winter

<i>OUTDOOR DESIGN CONDITIONS</i>	
<i>STANDARD</i>	
Summer	30.8 deg C DB/24.9deg C WB
Winter	9.2 deg C DB / 80% RH



5.0 FANS

5.1 GENERAL

This section covers all fans and fan types including those installed in packaged equipment.

Prior to ordering any fan, calculate the fan static pressure of the system and select the fan size and motor kW accordingly. Note that the given fan static pressure in the Equipment Schedules is approximate only.

Fans shall be selected for maximum efficiency, i.e., minimum kW input to meet the required duty.

Fan impellers shall be factory statically and dynamically balanced and shall be keyed to the fan shaft.

Fan bearings shall be sealed ball or roller type, rated for 100,000 operating hours minimum.

Fans shall be mounted on anti-vibration mounts with 98% minimum isolation efficiency.

Backdraft dampers shall be provided where required to meet BCA Section J requirements.

A flexible connection shall be installed anywhere a fan connects to ductwork or equipment. Where fans are located within the occupied space, provide acoustic treatment to flexible connectors to minimise noise break-out.

5.2 FAN TYPES

Duct-mounted fans greater than 200 l/s shall be either in-line centrifugal or in-line mixed flow. Axial fans may be used where both inlet and discharge conditions are good with two straight diameters or bell mouth inlet.

Duct-mounted fans up to 200 l/s shall be either centrifugal, mixed flow, axial or propeller fans.

Wall-mounted and ceiling mounted fans in industrial environments including plantrooms shall be either centrifugal, mixed flow axial or propeller fans.

5.3 FAN MOTORS

Motors shall comply with AS 1359 and AS 1360 and shall comply with current MEPS standards table 2, in accordance with AS/NZS 1359.5.

Motors shall be three phase, externally commutated type (EC), EBM-Papst, Ziehl-Abegg or equivalent, where available.

Where EC motors are not available, motors shall be TECO MAX-E3 series, CMG or WEG equivalent.

Motors shall have Class F insulation minimum.

Motor bearings shall be sealed for life, ball type.

Fan motors in the airstream may be totally enclosed air over (TEAO) type.



Motors shall be readily accessible for maintenance or replacement. Motor noise shall not be audible in the ductwork.

Motors for variable speed applications shall be suitable for operation between 10 Hz and 60 Hz without undue noise or overheating. Motors exhibiting high tonal noise will be rejected.

Thermistor protection shall be provided for all motors 15kW and above, in addition to overload protection. Three PTC thermistors, (thermo-variable resistors with a positive temperature coefficient) shall be fitted to the end-windings (one per phase), and shall be connected in series. Six thermistors shall be installed on two speed motors. Standard thermistors shall have a trip temperature of 140°C.

5.4 CENTRIFUGAL FANS

Fans shall be backward curved centrifugal type with aerofoil blades. Fans may be double width, double inlet type mounted on a common galvanised steel base or single width, single inlet plug type.

Fans shall be mounted on anti-vibration mounts with 98% minimum isolation efficiency. Fan impellers shall be statically and dynamically balanced and shall be keyed to the fan shaft.

Fan bearings shall be sealed ball or roller type with not less than 100,000 hours operating life.

Fans shall be selected for peak efficiency and low noise. The efficiency shall be within 10% of the optimum fan selection and the noise level within 3dB of optimum. These may be relaxed where space constraints require smaller fans.

Motors serving direct driven fans shall be sized for the peak load at the maximum motor speed.

All fans shall have a means of speed adjustment by speed controller or variable speed drive.

5.5 IN-LINE CENTRIFUGAL AND MIXED FLOW FANS

In-line centrifugal fans up to 300 l/s shall be equal to Fantech VM, TD or JCE series, with spigots suitable for connection to ductwork.

In-line centrifugal fans greater than 300 l/s and up to 4000 l/s, shall be equal to Fantech Powerline, Multiflow or Neta series, of galvanised steel construction with spigots suitable for connection to ductwork.

5.6 AXIAL FANS – FIXED PITCH

Fixed pitch axial fans up to 500 l/s shall be equal to Fantech silent series with galvanised steel impeller and casing, where specified in the Equipment Schedule.

Maximum fan speed shall not exceed 24rps except where specified in the Equipment Schedule.

5.7 AXIAL FANS – ADJUSTABLE PITCH

Adjustable pitch axial fans shall equal to Fantech silent series.

Where multiple selections are available for the duty, the selection shall be based on peak total efficiency and minimum dBA.



Fans shall be selected for a maximum speed of 24 rps and a maximum pitch angle of 32° except where specified otherwise in the Equipment Schedule.

Fan casings shall be hot dip galvanised and fitted into adjoining ductwork using matching angle flanges.

Fan impellers shall have GRP or die cast aluminium blades and impellers except for smoke spill operation.

Provide an inspection panel incorporating sash fasteners in the adjoining ductwork.

Motor terminal boxes shall be mounted externally on casing.

5.8 KITCHEN EXHAUST FANS

Over Hob Kitchen hoods shall be selected by the architect.



6.0 FAN COIL UNITS

Inverter type packaged air conditioners and room air conditioners shall be manufactured by Daikin, Mitsubishi Electric, Fujitsu, Temperzone or equal approved.

Refrigerant shall be r410a or other approved refrigerant with an ozone depletion potential odp of 0.

All external surfaces of air conditioners which are in contact with conditioned air or return air shall be insulated with closed cell polyethylene insulation with 25 mm minimum thickness. Air-cooled condenser coils shall be either passivated or epoxy coated or equal coating if the coil is cut after coating, the coil shall be recoated. Epoxy coating shall be used in corrosive environments where specified in the equipment schedules.

All air-cooled air conditioners shall have inverter capacity control.

Run a ø25mm copper drain pipe from each evaporator coils unit to the nearest tundish. Allow 10m of drain pipe for each unit unless otherwise noted on the drawings. An automatic condensate pump shall be installed for each unit where specified in the equipment schedules.

Run a ø25mm copper drain pipe from each heat pump outdoor coil.

6.1 UNIT CASING

The unit casing shall enclose all major components including fans, coils and filters.

All external surfaces of units shall be insulated in accordance with the current BCA section J, with no thermal tracking paths.

A hinged gasketed access panel shall be provided to the fan compartment, equal to Bullock or I&M.

6.2 AIR FILTERS

Filter types shall be as specified in the schedules and shall comply with the Air Filters section of the Specification.

6.3 FANS

Fans shall be direct drive, centrifugal type with backward inclined impellers.

Plug type centrifugal fans shall be used where stable, efficient selections are available. Plug fans shall be direct driven

Where suitable plug fan selections are not available, belt driven, double width, backward curved centrifugal fans shall be used.

Fans shall be mounted on anti-vibration mounts with 98% minimum isolation efficiency. Fan impellers shall be statically and dynamically balanced and shall be keyed to the fan shaft.

Motors shall be sized for the maximum motor speed and shall comply with AS 1359 and AS 1360 and shall comply with current MEPS standards table 2, in accordance with AS/NZS 1359.5.



Motors 0.75 kW and larger and shall be TECO MAX-E3 series, CMG or WEG equivalent.

Motors up to 0.75 kW shall be three phase, externally commutated type (EC), Ziehl-Abegg or equivalent.

Motors shall have Class F insulation minimum.

Motor bearings shall be sealed for life, ball type.

Motors shall be readily accessible for maintenance or replacement. Motor noise shall not be audible in the ductwork.

Motors for variable speed applications shall be suitable for operation between 10 Hz and 60 Hz without undue noise or overheating. Motors exhibiting high tonal noise will be rejected.



7.0 MOTOR SPEED CONTROL

7.1 VARIABLE SPEED DRIVES – THREE PHASE MOTORS

Variable speed drives shall be suitable for control of three phase centrifugal fan motors and shall be of the variable frequency, variable voltage type.

VSD's shall be suitable for either a three phase or single phase incoming power supply

VSD's shall be selected for the nameplate motor current (not the motor kW rating).

VSD's shall be ABB ACH series or Danfoss equivalent and shall have the following features and/or be capable of the following :

- Three phase units shall be designed for continuous full load operation with a supply voltage of $415V \pm 10\%$ and a supply frequency of $50Hz \pm 5\%$.
- Single phase units shall be designed for continuous full load operation with a supply voltage of $240V \pm 10\%$ and a supply frequency of $50Hz \pm 5\%$.
- Output frequency range of 10 to 50Hz and output voltage range of 10 to 415V.
- Frequency ramp uptime and ramp downtime of 3 to 30s. (adjustable)
- VSD default switching frequency shall be 4 kHz.
- Inverter losses shall be less than 5% at 50 Hz and 16% at 25 Hz.
- Motor efficiency reduction due to the VSD waveform shall be no more than 1.5%.
- Operating conditions - 0 to 45° C ambient and 10 to 90 % relative humidity.
- Drives shall be housed in IP54 enclosures with external heat sinks.
- The input power factor shall be 0.95 minimum.
- RFI and Harmonics - Radio interference from controllers shall conform with AS/NZS CISPR 15, and harmonics generated into the incoming supply shall conform with AS61000.3.6 requirements.
- Safety features to protect the speed controller:
 - Over-voltage trip
 - Under-voltage trip
 - Over-current trip
 - Over-temperature trip
 - Phase to phase short circuit trip
 - Phase to earth short circuit trip
- Power interruption - No damage shall result from the momentary or sustained opening or closing of an input or output power contactor during operation of the controller.
- Automatic restart of the motor on reinstatement of the power supply after a momentary or sustained power failure. In the case of a momentary failure the controller shall automatically adjust to the motor speed and restart the rotating motor including a reverse rotating motor.
- Electronic thermal overload for the motor.



- Capable of pre-set maximum and minimum speeds during automatic operation and manual operation at a fixed speed set either by the VSD or and external source.

7.2 VARIABLE SPEED CONTROL – SINGLE PHASE MOTORS

This clause applies to all manual and automatic control of speed for single phase motors.

Variable speed drives shall be suitable for control of single phase centrifugal fan motors and shall be of the variable frequency, variable voltage type.



8.0 AIR FILTERS

8.1 BARBECUE EXHAUST FILTERS

Carbon filters for barbecue exhaust hood shall be 50 mm thick honeycomb type equal to Airepure GW50 series and as integrated into canopy exhaust hood selected.



9.0 PIPING, VALVES AND FITTINGS

9.1 GENERAL

This section applies to all piping, valves and fittings associated with refrigeration systems and drains.

Changes in pipe size shall occur as close to the branch connection or equipment connection as practical.

Provide all fittings, supports and accessories necessary for the efficient operation of the system.

9.2 SYSTEM PRESSURES

All pipework, valves and fittings shall be suitable for the operating pressures nominated in the Equipment Schedules.

In all cases where the system pressure exceeds 1000 kPa, the contractor shall submit evidence that all components and joints in the system meet the design pressure. Particular care shall be used with copper piping in high rise buildings to ensure that the static pressure does not exceed the pressure rating of the piping.

9.3 PIPING SCHEDULES

Piping materials for the various services scheduled shall comply with the following standards.

Service	Pipe Material	SAA Material Code
Vents, Drains, Overflow, (Low Pressure)	Copper – Type C	AS 1432
Refrigerant	Copper	AS/NZS 1571

9.4 PIPE INSTALLATION - GENERAL

Take particular care to deburr and clean out all piping before, during and after erection. Take every precaution to avoid steel cuttings and debris from being left in pipes during installation.

Where any section of pipe is left incomplete for any reason, open pipes shall be securely sealed with purpose made plastic or metal caps until the pipe can be connected.

Install pipework in a neat and workmanlike arrangement, parallel to walls and graded to drain and vent points. Pipe lengths shall be as long as possible to minimise the number of pipe joints.

Arrange pipework connections to equipment to facilitate routine and breakdown maintenance of the equipment. Ensure all valves and gauges are accessible for operation and maintenance.

Pipework shall be installed with 2100 mm clear below insulation, valves, hangers and other fittings, where possible. Where pipes are installed below this height they shall be clearly labelled with hazard markers, and hazard protected with padding to all edges and sharp corners and with ramps or steps for floor mounted pipes.

Refer to Painting, Identification & Labelling section for painting and identification of pipework.



Flush out and fill systems on completion of installation.

Clean out, as part of maintenance, all dirt pockets and strainers after the system has been in operation one month. Notify the Project Manager in writing when this work is to be carried out.

9.4.1 Welding and Brazing

All welding, soldering, brazing, etc. shall be carried out by skilled, qualified welders experienced in mechanical services.

9.4.2 Pipe Sleeves

To holes in walls, floors, etc. Provide black medium grade steel sleeves to the Head Contractor for installation and ensure that pipes are free to move through the sleeves. Sleeves shall terminate 12 mm above the finished floor level. Sleeves through walls shall finish flush with the wall on either side. Provide cover plates where exposed pipes pass through walls and floors, and cover plate shall fit snugly over the pipe and cover the penetration. Pack each annular space between pipe and sleeve with 'Bradford Fireseal' or similar and equal approved loose packing with a fusion temperature in excess of 1000°C. Ensure that provision is made for the required holes prior to pouring or erection of walls. Allow at least 12mm clearance around pipe and/or pipe insulation. Take every care to minimise later cutting.

9.4.3 Dissimilar Metals

All contact between dissimilar metals where electrolytic action may take place shall be avoided. Use malthoid sleeves or other approved similar materials to suit system temperature between pipework and brackets as applicable.

Approved insulating flanges shall be used to connect dissimilar pipe materials.

9.5 PIPE INSTALLATION - COPPER

9.5.1 Installation

Install pipework in a neat and workmanlike arrangement, parallel to walls and graded to drain and vent points. Pipe lengths shall be as long as possible to minimise the number of pipe joints.

Arrange pipework connections to equipment to facilitate routine and breakdown maintenance of the equipment. Ensure all valves and gauges are accessible for operation and maintenance.

Lengths of piping, except where required to be connected to a fitting outlet or header, shall be joined by welding, brazing or silver soldering as approved and not by flanges, unions or other similar fittings.

All bronze flanges shall be welded on the flat face.

Bolts, nuts and washers for bronze flanges shall be cadmium-plated steel with machined brass.

Unions for copper pipe shall be bronze unions machined all over.

Accurately cut all tubing to dimensions determined on site and work into position without springing or forcing.

Fit at least one union at each screwed valve of any type including control valves, and additional unions to ensure that each valve may be readily removed.



9.5.2 Solder, Welding and Brazing Copper Tubes

The jointing of pipes and the attachment of flanges shall be carried out by silver soldering with minimum 15% silver content and brazing with phosphor bronze - sample joint to be submitted before approval will be given.

Remove scale and any gross oxidation by emery cloth, filing or grinding. Care shall be taken in preparation of the joints to ensure surfaces are thoroughly clean and close contact made when surfaces are pressed together to induce effective capillary action.

Where not covered elsewhere by the specification or drawings all external exposed pipework, supports, fixings, etc. shall be non-corrosive protected against corrosion by galvanising or painting to approval.

9.5.3 Press-Fit Joints

Press fit joints shall be Viega Propress, using genuine Viega fittings and Pressgun electro-Mechanical pressing tool. Joints shall be installed strictly in accordance with the manufacturers recommendations.

No alternative press fit systems will be accepted.

9.6 BENDS, TEES, BRANCHES AND REDUCERS

9.6.1 Fittings Generally

All bends, tees, reducers and caps shall be proprietary fabricated fittings except where noted below, with a wall thickness equal to or greater than the pipe wall thickness.

All copper fittings shall be capillary type complying with AS3688 with silver soldered connection and shall be stamped AS3688 compliant.

9.6.2 Bends

All bends shall be proprietary fabricated fittings with the maximum available centreline radius.

9.6.3 Branches and Tees

All branch connections shall sweep in the direction of flow, where possible.

The following branch and tee configurations may be used ;

- Proprietary fabricated tees shall be used wherever possible. Full sized or over-sized branches with reducers are preferred to reduce the branch pressure loss.
- Where branches on copper pipes are formed by cutting in and brazing to the main, special forming tools shall be used to produce a capillary joint with the branch line. The main line formed spigot shall lap the branch line forming the projection of branch line inside main pipe shall be allowed.
- Hot tap connections to existing pipes shall be carried out by a specialist contractor.

9.6.3.1 Reducers

Eccentric type reducers shall be used where horizontal pipes are reduced in diameter, installed flat on top to prevent air pockets and permit emptying of piping systems.

Concentric reducers may be used on vertical pipework.



Bushes shall not be used for reducing pipe size.

9.7 VALVES

9.7.1 General

Valves shall be selected for the operating pressures nominated in the Equipment Schedules in accordance with the following Schedule of Valves.

Isolating and check valves shall be the same size as the nominated pipe size to which they are fitted, not the connection size of the equipment.

Locate all valves in accessible positions for operation and maintenance.

Valve connections up to 50 diameter shall be screwed.

Valve packing materials suitable for the service.



9.8 DRAINS AND OVERFLOWS

Drain sizes shall be equal to the equipment drain outlet size or as indicated on the drawings, but shall in no case be less than 20mm diameter. Provide plugged clean-out tees.

Safe tray drains shall be not less than 50mm.

Safe trays shall discharge from the bottom unless space limitations require the drain to be from the side.

Discharge points shall be readily visible and to approval.

Where practicable, group discharges at a common tundish.

Tundishes shall be approved sizes and layout to prevent spill. Minimum size shall be:

- 100mm diameter at top;
- 75mm diameter at bottom;
- 32mm outlet.

Supply and install tundishes to all drains from domestic hot water heaters and expansion tanks pressure relief valves.

9.9 MULTI-PURPOSE TEST PLUGS

Multi-purpose test plugs shall be Twinlock, Binder or equal manufacture complete with brass screwed cap and rubber seals.

9.10 PIPE SUPPORTS

Adequate support and anchoring shall be provided to maintain grading and allow for expansion and contraction. Where required, provide seismic restraints in accordance with AS 1170.4.

Provide hangers, rollers and supports within 600mm of direction change and at intervals as scheduled below.

Where possible pipes shall be grouped and hung on pipe racks consisting of shaped steel frames fixed to walls, ceilings or structure generally.

Use hangers of split ring adjustable type on mild steel or brass rods. Fix pipes generally 50mm clear of walls with PVC covered steel ring clips for copper pipes and mild steel ring clips for steel pipes.

Clamp clips direct to pipes, where a rigid insulating spacer shall be used ensuring a continuous vapour seal.

Ensure adequate fixing to building. Do not overstress pipe or structure. Fixings to brick or concrete shall be 'Rawlbolt', 'Rawlock' or 'Rawlset' and two fixings per bracket of the following sizes shall be used:

- Up to 65mm pipe: 7mm

All fixings shall be to the approval of the Project Manager and details of proposed supports shall be submitted for approval prior to installation.



PIPE SIZE (MM)	MAXIMUM INTERVALS FOR STEEL PIPE (M)		MAXIMUM INTERVALS FOR COPPER PIPE (M)		MINIMUM DIAMETER OF HANGER ROD (MM)	
	HORIZONTAL	VERTICAL	HORIZONTAL	VERTICAL	SINGLE PIPE	DOUBLE PIPE
15	2	2.5	1.5	2	7	10
20 & 25	2.5	3	2	2.5	7	10
32 & 40	2.5	3	2.5	3	7	10
50 & 65	3	3.75	2.5	3.75	10	13

9.11 REFRIGERANT PIPING

Pipe work shall be refrigerant grade copper tube complying with AS 1571 with brazed connections.

The refrigerant route shown on the drawings is indicative only - confirm, adjust and finalise the refrigeration pipe sizing and route to suit the final system arrangement.

Refrigerant piping arrangement shall be in accordance with the unit manufacturers recommendations and requirements.

Provide fully dimensioned and detailed shop drawings indicating the proposed refrigeration piping arrangement including; valves, fittings, falls, traps, sizes, charging valves, branch boxes etc required for the correct and efficient operation of the system.

Shop drawings shall be reviewed and endorsed by the unit manufacturer prior to submission to the Project Manager for review.

Longest possible lengths of copper pipe should be utilised to minimise joints on site. Appropriate refrigeration installation tools must be utilised to avoid the use of elbows and dry nitrogen must be in the system during brazing. Cold brazing is not permitted, as contamination of the system will result.

All pipe work running externally or in a location where direct sunlight is possible must be adequately protected against damage and corrosion. In addition to insulation, secure metal cladding shall be installed.

Precautions shall be taken to prohibit contamination of pipe work with dirt or moisture during installation. All pipe ends shall be sealed and kept sealed until immediately prior to making a joint.

Immediately after installation of pipe work and prior to sealing of insulation joints and starting of equipment, pipe work should be pressure tested to 28kg/cm^2 , held for 24 hours and checked for leaks, vacuumed/ dehydrated to 752mm (Hg) and held at that setting for 1 to 4 hours depending on pipe length.

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

Pipe work to be properly and tidily fixed and supported at a minimum of 1.5m centres by galvanised mild steel brackets. All pipe work to be tagged with condensing unit identification number at 3m intervals.



10.0 DUCTWORK AND ACCESSORIES

10.1 GENERAL

Ductwork sizes shown on the drawings are clear internal dimensions. Where internal insulation is required, the external duct size shall be increased to achieve the specified internal size.

All air systems including ductwork, acoustic and thermal insulation and fire dampers, shall comply with BCA, AS/NZS 1668 and all applicable statutory requirements.

All ductwork systems shall be complete with transitions, bends, tees, supports, dampers, offsets, flexible connections, take-offs and similar fittings necessary for the balancing and full operation of the air distribution system.

Provide all balancing dampers to ensure proper balancing of the air system.

Ductwork shall be installed with 2100 mm clear below insulation, frames, hangers and other fittings, where possible. Where ducts are installed below this height they shall be clearly labelled with hazard markers and hazard protected with ramps or steps for flow mounted ducts and with padding to all edges and sharp corners.

As a general rule ductwork shall not be painted internally. Where duct is visible through grilles the contractor shall paint the duct matt black internally.

10.2 DUCTWORK CONSTRUCTION AND INSTALLATION

10.2.1 General

Construction and installation of ductwork shall comply with AS 4254 - 'Ductwork for Air-Handling Systems in Buildings'.

Duct systems shall be constructed for the following duct minimum pressure classifications unless specified otherwise elsewhere:

<i>Supply air ducts - typical</i>	500 Pa
<i>Exhaust air ducts - typical</i>	250 Pa

These pressures may be reduced at the discretion of the Engineer, if it can be demonstrated that the actual peak operating or shut-off pressure is within a lower class.

The successful tenderer shall submit their proposed duct construction and installation method equivalent to reinforcements tabled in AS 4254, for approval prior to commencing shop drawings.

10.2.2 Material

Ductwork material shall be prime quality lock forming galvanised steel, grade G2 or G3 to AS 2338 with Z275 coating to AS 1397, except where specified otherwise in this specification or on the drawings.



10.2.3 Duct Sealing

Ducts shall be sealed against leakage in accordance with AS 4254 with one or more of the following sealing materials:

- Reinforced aluminium foil tape equal to Baron PPC 493 shall be used for sealing aluminium foil vapour barriers.
- Closed cell polyethylene foam tape equal to Baron WF-8305, for sealing between duct frames and flanges.
- Water-based duct sealant equal to Foster 32-19 for sealing duct joints and seams and between duct frames and flanges.

Duct sealants shall have a smoked developed index not greater than 3 and a spread of flame index not greater than 0 when tested in accordance with AS 1530.3. Sealants shall have a Maximum VOC Content of 100 g/litre or 100 g/kg.

Transverse duct joints shall be sealed on all ductwork. Ductwork seams shall be sealed on all ducts subject to 500Pa or more positive or negative pressure.

Ductwork shall be leak tested by hand feel and audio checking of all joints. All obvious leaks shall be sealed with appropriate and approved sealant.

10.2.4 Rectangular Ducts

Jointing and reinforcement of rectangular ducts shall comply with Table 2.3 of AS 4254.

Duct sides that are 400mm and over and are less than 1mm thick, shall be cross-broken or beaded between joints or reinforcements, unless they are internally insulated.

Reinforcement components shall be galvanised steel.

Bends shall be radius type with a throat radius not less than the duct width. When space does not permit or where shown on the drawings, mitre bends with turning vanes may be used.

Mitre bends without turning vanes may be used where the bend is 30° or less.

Turning vanes shall be constructed from 0.8mm galvanised steel sheet, pivoted at each end on steel runners by steel rods.

Branch take-offs shall have a 45° entry to the main duct with a minimum length of 150 mm for small ducts and 250 mm for ducts wider than 500 mm.

Branch take-offs to single outlets shall be complete with volume dampers.

Duct expansions shall have a maximum included angle of 15°.

Duct contractions shall have a maximum included angle of 30°.

Mitred offsets shall have a maximum offset angle of 30°.

10.2.5 Round Ducts and Oval Ducts

Round and oval ducts shall be spiral seam type.

Construction of duct and fittings shall comply with Tables 2.4 and 2.5 of AS 4254.



Bends up to 300 mm diameter shall be pressed radius type or 3 piece segmented type.

Bends over 300 mm diameter shall be 5 piece segmented type.

Branch take-offs shall be 45° lateral type complying with AS 4254.

Branch take-offs to single outlets shall be complete with volume dampers.

Exposed ducts in foyers, offices etc shall have concealed reinforcement and support frames.

10.2.6 Ducts Exposed To Weather

Ducts exposed to weather shall be fabricated from one gauge thicker sheetmetal than specified for standard duct.

The top side of ductwork shall be shaped so that ponding of water does not occur.

Flexible connections shall be protected by weather covers.

10.2.7 Barbecue Exhaust Ducts

Ductwork construction and installation shall comply with AS 4254, AS/NZS 1668.1 and AS 1668.2.

Duct material shall be minimum 1.2mm thick galvanised steel for barbecue exhaust ducts and 1.0mm stainless steel for dishwasher exhaust ducts.

Access panels shall be provided as per AS/NZS 1668.1.

10.2.8 PVC Ducts

10.2.8.1 Circular

Small diameter PVC ductwork up to 150 dia shall be formed using stormwater pipe with solvent welded joints.

Support of PVC ducting shall be as specified for the equivalent diameter sheet metal duct.

Provide fire dampers or approved fire collars where ductwork penetrates fire resistant construction.

10.2.8.2 Rectangular

Rectangular ducts for internal locations shall be formed using extruded grey UPVC sheet. Ducts for external locations shall use pressed grey UPVC sheet with UV inhibitors.

Sheet stiffeners shall be provided at 600mm maximum centres if necessary, provide additional stiffening to prevent flexing, drumming or sagging.



UPVC ductwork thickness and stiffening shall be not less than as tabled below:

<i>CIRCULAR</i>	<i>RECTANGULAR</i>	<i>UPVC SHEET</i>	<i>RECTANGULAR</i>	<i>FLANGES</i>	
<i>DIAMETER (MM)</i>	<i>LONGEST SIDE (MM)</i>	<i>THICKNESS (MM)</i>	<i>DUCT STIFFENING (MM)</i>	<i>WIDTH (MM)</i>	<i>THICKNESS (MM)</i>
up to 400	up to 400	3	-	25	4
401 to 600	401 to 600	4	-	30	6

10.2.8.3 Welding

Continuously weld joints, including seams, stiffeners, flanges and corners of fabricated bends, tees and fittings. Weld stiffeners on both sides. Back weld slip socket joints.

Butt welding: vee type. Use hot air equipment.

Thickness ≤ 4mm: one run of 3mm welding rod.

Thickness ≥ 4mm: triple welding rod or 3 runs of 3mm welding rod.

Locations inaccessible for butt welding: solvent weld, using continuous UPVC h-section jointing sockets, heat formed for circular cross joints.

10.2.8.4 Bending

Immediately before bending sheet material, heat both sides to avoid thinning and high stress concentrations. Heat bend corners of rectangular ductwork to an inside radius equal to the material thickness, or 5mm, whichever is the greater.

10.3 DUCT HANGERS AND SUPPORTS

Duct hangers and support systems shall be in accordance with AS 4254.

Where required provide seismic restraints in accordance with AS 1170.4.

Hanger straps shall be cut from galvanised steel sheets.

Hanger rods, trapeze angles, channels, brackets and fasteners shall be galvanised steel.

Trapeze angles, channels and brackets shall be cut from full length sections. Short lengths of sections welded together to form a longer length shall not be used.

Exposed duct supports shall be painted as per the associated duct.

Structural Engineer approval is required prior to fixing supports to structural beams or columns.

Fixing to structural steel shall be by beam clamps or similar. No drilling or welding is allowed.

Fixing to masonry or concrete shall be by masonry anchors. Explosive anchors shall not be used.

Fixing materials shall be galvanised steel.



10.4 FLEXIBLE DUCTS

Flexible ducts shall be Bradford air, Westaflex or equal and shall conform to AS 4254 and the BCA.

Insulated flexible ducts shall have acoustic lining comprising thermally bonded polyester 32kg/m³ density or equal internal insulation wrapped around block permeable fabric core and covered with aluminium laminate.

Flexible duct lengths shall not be more than 3m. For lengths over 3m, galvanised circular ductwork shall be inserted, with no more than 3m of total flexible duct length.

10.5 DUCT THERMAL MOVEMENT AND VIBRATION

All ducts shall be carefully designed and provided with all necessary anchoring and flexible connections to prevent damage to either the ducts or the building structure due to thermal expansion and/or contraction of the ducts and to obviate transmission or vibration from any motive or noise generating equipment such as fans, air handling units and mixing boxes.

All anchor points and flexible connections shall be shown on the shop drawings and specific approval shall be obtained from appropriate authority before proceeding with the installation of any anchors or fixings to the building structure.

10.6 FLEXIBLE CONNECTIONS

A flexible connection shall be installed at the inlet and discharge duct connection to every fan.

Flexible connections shall be air-tight and water-tight.

Flexible connections for smoke spill fans shall comply with the requirements of AS/NZS 1668.1.

Flexible connections shall be arranged to permit the removal and replacement of the connection without disturbing the ductwork or plant.

The flexible material shall be solidly fixed to a 100 mm galvanised strip on each side, which shall be attached to the duct on each side.

Ductwork on each side of the connection shall be aligned. The spacing shall be set to ensure that the connection is neither tight nor the metal touching under any operating condition.

10.7 CLEANING AND PROTECTION

All ductwork shall be fabricated under cover, and delivered to site and stored in a weatherproof and dry area. Open ends of duct sections shall be covered with plastic sheet or tarpaulins until required for installation. Special care shall be given to internally insulated ducts, silencers etc., for protection against dust and moisture.

Ductwork shall not be installed unless adequate cover and protection is available to protect it from possible construction damage and the elements.

Prior to and during installation, ducts shall be thoroughly cleaned out and shall have all ends covered in an approved manner to prevent ingress of dust and general building debris.



10.8 TEST OPENINGS

Test openings in ducts shall be made by the commissioning staff and are covered under Commissioning.

10.9 SEALING AND FLASHING

All ducts protruding through walls and floors and exposed to view shall be provided with neat galvanised steel sealing frames fixed to ducts and walls or floors as appropriate.

All external installations and roof penetrations shall conform to Section 3 of AS 4254.

10.10 SMOKE DETECTORS

Refer fire services drawings for location of duct mounted smoke detectors.

Cut openings in ductwork where required to facilitate installation of smoke detectors to these units and seal openings afterwards.

Supply and install minimum 300 x 200mm access panels in the ducts adjacent to each smoke detector to facilitate future servicing.

10.11 DUCT ACCESS PANELS

Access panels shall be 'I & M Industries model AP' or equal approved manufacture. No part of the panel shall project into airstream and when the panel is shut, it shall be flush with the inside surface of the duct.

10.12 ACCESS DOORS

Access doors shall be equal to 'I & M Industries model AD', complete with hinges and handles.

Access doors shall be provided at air mixing plenums for filter access and where shown on the drawings.

10.13 VOLUME DAMPERS

A volume control damper shall be fitted in the branch to every supply air outlet and exhaust grille, at each major duct branch and where shown on the drawings.

Volume dampers in ducts up to 300 mm x 300 mm shall be single blade butterfly type galvanised steel construction with nylon or bronze bush bearings.

Volume dampers larger than 300 mm x 300 mm shall be opposed blade type, and shall be equal to Celmec type 40 MLA or 40 MTA, constructed from extruded marine grade aluminium, and suitable for the velocity and pressure classification of the system.

10.14 FIRE DAMPERS

Fire dampers shall be installed where required by AS/NZS 1668.1 and where shown on the drawings.

Fire dampers in masonry walls shall be rated for 4 hours to AS 1682.

Fire dampers installed in floor slabs or plaster walls shall be rated for 2 hours to AS 1682.



Fire dampers shall be curtain type or blade type and shall be equal to I & M Industries ABC, Celmec Firelock, Bullock or High Fire Ruskin.

Curtain and blade type fire dampers shall have a fusible link which is readily accessible for maintenance. Blade type fire dampers shall close in the direction of airflow.

Fire dampers which are required to close automatically shall have an electro thermal link (ETL).

Intumescent fire dampers shall be used where specified on the drawings.

Fire dampers shall be installed in accordance with the requirements of AS 1682, AS/NZS 1668.1 and the fire damper manufacturer's installation instructions and prototype test.

Construction and fixing of fire dampers shall comply with AS 1682 and AS/NZS 1668 Part 1.

If requested, provide evidence that the prototype of the proposed fire damper has been tested to the requirements of AS 1682.1.

Fire dampers in fume exhaust systems shall be type 316 stainless steel.

10.15 FIRE RATED DUCTWORK

Ductwork shall be fire rated where required on the drawings. Fire rating shall be achieved using fire resistant spray or board applied to the duct. The fire rating of the system shall be 2 hours minimum, or higher where nominated on the drawings. The fire rating system shall comply with AS 1530.4.

Duct supports shall be increased to account for the additional weight of the fire rated material.

10.16 INSECT SCREENS

Supply and install removable 250 micron screens in ductwork where nominated on the drawings. Ductwork shall be locally increased in size to accommodate the increased pressure drop of the screens.



11.0 DIFFUSERS, REGISTERS AND GRILLES

11.1 GENERAL

Supply and install all diffusers, registers and grilles as shown on the drawings.

All diffusers, registers and grilles shall be of extruded aluminium or zinc-anneal steel and shall have a durable powder coat finish, with the colour directed by Project Manager. Internal surfaces shall be painted matt black.

Outlet velocity, net airway, and design of the diffusers shall be such as to give satisfactory air distribution without draughts or noise nuisance.

All diffusers, registers and grilles shall be Holyoake, Bradflo, Air Grilles or other approved manufacture.

All diffusers, registers and grille sizes shown are based on the above manufacturer's data. Any alternative equipment offered should be checked against this data to ascertain if the peculiarities of such equipment make them suitable for use.

All supply air and exhaust air diffusers, registers and grilles shall be selected for a maximum pressure drop of 30 Pa and a maximum noise level of NR35. Return air grilles shall be selected for a maximum pressure drop of 15 Pa.

11.2 BALANCING DIFFUSERS, REGISTERS AND GRILLES

Provide a balancing damper for each diffuser, register and grille except where it is the only outlet in the system.

Dampers shall generally be opposed blade type with screw adjustment via the face of the diffuser. Where this configuration is not possible, butterfly dampers with locking quadrants shall be installed at the flexible duct connection to the main duct. Coordinate ceiling access panels where the ceiling is not accessible.

11.3 GRILLES IN PLASTER CEILINGS AND WALLS

All diffusers, registers and grilles mounted in plaster ceilings and walls shall be installed in a mounting frame. The mounting frame along with the plenum or cushion head, the damper and the flexible duct connection shall all be installed, supported and sealed prior to plastering.

11.4 EXHAUST AIR GRILLES

Return air and exhaust air grilles shall be either egg crate type, half chevron type or bar grille type, as noted on the drawings. All grilles shall have a framed removable core.

Half chevron type grilles shall be 'Bradflo ARG' or Holyoake type RLHL.

Egg crate type grilles shall be 'Bradflo AEC' or Holyoake type EC125.

Bar type grilles shall be 'Bradflo AEC' or Holyoake type LD1200 mullions at 450 mm centres.

Carpark exhaust and supply grilles shall be bar grille type equal to Holyoake LDH2500 with 50 mm frames and double mullions at 300 mm centres.



Ducted exhaust grilles shall have an opposed blade damper with a removable core for damper access.

11.5 DOOR RELIEF GRILLES

Door relief grilles shall be equal to Holyoake type DG-52. Check the mounting detail with the main contractor. Supply door grilles to the main contractor for installation.

11.6 WEATHERPROOF LOUVRES

Weatherproof louvres shall be equal to Holyoake type DG-52. Check the mounting detail with the main contractor.

Louvres shall be manufactured from extruded aluminium with natural anodised finish.

Intermediate supports and stiffeners shall be provided to prevent blades from vibrating and from sagging.

Fix vermin proof corrosion resistant screens to the internal face of all air intakes and exhaust louvres.

11.7 INSECT SCREENS

Supply and install removable 250 micron screens in diffusers and grilles where nominated on the drawings.



12.0 THERMAL INSULATION- BCA2015

12.1 GENERAL

Insulation shall be installed progressively to suit the contract work program.

Where pressure testing of pipework and ductwork is required, the tests shall be completed and passed prior to commencing insulation.

Where ductwork and/or pipework is to be concealed by the building structure, insulation shall be carried out at such time as to allow inspection prior to the services being enclosed.

No insulation shall be applied until permission has been obtained.

All insulation materials, sealants, fixings shall be VOC and zero ODP compliant and shall have zero Spread of Flame and Ignitability Indices and 2 maximum Smoke Developed Index, when tested to AS 1530.3.

12.2 STANDARDS

Insulation material, installation and finish shall comply with the following standards :

- BCA specification J5.2
- AS 1530.3 Methods for fire tests on building materials components and structures
- AS 4426 Thermal insulation of pipework, ductwork and equipment – Selection, installation and finish
- 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

12.3 DUCTWORK INSULATION AND SEALING

All ductwork and fittings used for heating, cooling or evaporative cooling shall be insulated and sealed, except for the following

- Ductwork and fittings located within the only or last room served by the system
- Air registers, diffusers, outlets, grilles and flexible fan connections
- Return air ductwork in or passing through a conditioned space
- Outside air, spill air and exhaust air ductwork associated with a heating or cooling system

12.3.1 Ductwork Insulation R-Values

Ductwork insulation thicknesses and materials shall be sufficient to achieve the minimum R-Value to meet the requirements of the BCA. Table 3 from specification J5.2 of the 2013 BCA is included below for information.

Minimum material R-Value for each climate zone is:

LOCATION OF DUCTWORK AND FITTINGS	CLIMATE ZONE 2
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<i>LOCATION OF DUCTWORK AND FITTINGS</i>	<i>CLIMATE ZONE 2</i>
<i>Within a conditioned space</i>	1.2
<i>Where exposed to direct sunlight</i>	3.0
<i>All other locations</i>	2.0

Where flexible ductwork to an outlet is no more than 3 m in length, an insulation R-Value of 1.0 may be used.



12.4 DUCTWORK INSULATION SCHEDULE

12.4.1 Ductwork Insulation R-Values

Ductwork insulation thicknesses and materials shall be sufficient to achieve the minimum R-Value to meet the requirements of the BCA. Table 3 from specification J5.2 of the 2011 BCA is included below for information.

Minimum material R-Value for each climate zone is:

LOCATION OF DUCTWORK AND FITTINGS	1, 2, 3 AND 5
Within a conditioned space	1.2
Where exposed to direct sunlight	3.0
All other locations	2.0

Where flexible ductwork to an outlet is no more than 3 m in length, an insulation R-Value of 1.0 may be used.

Zones 1, 2, 3, and 5 include Coastal NSW from Wollongong to Queensland border, including Sydney, virtually all of Queensland and Northern Territory including Brisbane, west coastal areas of Western Australia including Perth, tropical areas of Western Australia and most populated areas of South Australia including Adelaide but excluding the south east corner.

Check the ABCB website for detailed maps of Climate zones.

12.4.2 Ductwork Insulation Types

Two basic types of insulated ductwork are shown on the drawings

- External insulation - Shall be used where the ductwork is concealed in a shaft, ceiling space, void etc, and where acoustic insulation is not specified.
- Internal insulation - Shall be used where the ductwork is exposed in a plantroom, outside the building or within the occupied space of the building, and where acoustic insulation is required

12.4.2.1 External Duct Insulation

Where ductwork is required to be pressure tested, apply no insulation prior to acceptance of test results.

Duct surface shall be clean and dry. The insulation material shall be dry when installed and shall be kept dry at all times.

On rectangular ducts up to 300mm wide and flexible round ducts, wrap the insulation around the duct lapping all joints in the vapour barrier by 40mm minimum.

On all ducts over 400mm wide or high, metal or nylon pins either spot welded or mechanically shall be fixed to the duct at 400mm maximum centres along and around the duct. Wrap insulation around the duct lapping all joints in the vapour barrier by 40mm minimum. Impale the insulation over the pins and secure using 25mm minimum speed clips or nylon washers.

Seal all joints using 100mm pressure sensitive, Sisalation 450 vapour impervious tape to form a continuous vapour barrier.



Prior to application of tape all contact surfaces of sisalation shall be wiped clean of dust and grease using cloth and a suitable cleaning spirit if required.

Where the vapour barrier is impaled by fixing pins, seal using a 100mm x 100mm pieces of the tape used at joints.

Ductwork insulation shall be protected against the effects of weather and sunlight

Ductwork insulation shall abut adjoining insulation to form a continuous barrier

Ductwork insulation shall be installed so that it maintains its position and thickness, other than at flanges and supports.

12.4.2.2 Internal Duct Insulation

Internal duct insulation shall be used where called for on the drawings.

Duct sizes shown on the drawings are internal free area dimensions. For internally lined ducts, make necessary allowance for insulation thickness and increase sheet metal sizes accordingly.

There are distinct applications for internal insulation; Acoustic lined duct and Exposed duct.

12.4.2.3 Acoustic Lined Duct

Acoustic lined duct shall be used in plantrooms, in fan inlet and discharge ducts, and where noted on the drawings. There shall be at least 3 metres of acoustic insulation and an acoustic bend on the suction and discharge side of all exhaust fans whether or not shown on the drawings.

The internal face of the acoustic insulation shall be one of the following :

- Acoustituff with all joints taped - shall be used where vapour barrier or moisture in the air is an issue
- Perforated Sisalation 450
- Perforated sheetmetal - shall be used where the insulation may be subject to traffic, high velocity airflow (greater than 15 m/s) or damage from air borne particles

Fix pre-cut insulation into the duct with sections overlapping at corners. On ducts with width above 400mm, metal or nylon pins either spot welded or mechanically fixed shall be inside duct at 400mm maximum centres. Impale insulation over pins and fix using 25mm minimum speed clips or nylon washers.

Arrange 25mm x 0.6mm galvanised steel "Z" sections as necessary to protect joints in the insulation other than at corners.

"U" sections from 0.6mm galvanised steel shall protect insulation at the ends of each duct piece.

Both "U" and "Z" sections shall be fixed to duct using blind pop-rivets.

Fit 25mm x 0.6mm galvanised steel angles into corners at full length of insulation for protection and fix to duct using pop-rivets.

Submit a sample 600 x 600 x 450mm (WxHxL) long section of internally lined ductwork and obtain approval before proceeding with any further internally lined ductwork construction.



Acoustic lining shall have sound absorption coefficients not less than those listed below when tested by the reverberation room method (AS 1045) at the frequencies listed.

Frequency (Hz)	125	250	500	1000	2000
50mm lining	0.39	0.72	1.14	1.19	1.05
75mm lining	0.52	1.02	1.15	1.07	1.02

12.4.2.4 Exposed Duct

Where duct is shown as internal insulated on the drawings and is exposed, the duct shall be insulated as per Acoustic Lined Duct above except the lining shall be as follows :

- Acoustituff with all joints taped - shall be used where a good vapour barrier or moisture in the air is an issue
- Plain Sisalation 450 - may be used where a more durable liner is required and acoustic performance is of less importance
- Sheetmetal - shall be used in Hospitals, Cleanrooms and other applications where frequent cleaning of the duct is required

12.5 PIPEWORK INSULATION SCHEDULE

All piping, heat exchangers, tanks etc which contain condensate or refrigerant shall be insulated in accordance with specification J5.4 of the current BCA, and the following:

SERVICE	LOCATION	PIPE SIZE DIA. (MM)	THICKNESS (MM)	TYPE	FINISH
Refrigeration	All	Up to 15	19	'Armaflex FR' or Equal	-
		20 to 40	32	'Armaflex FR' or Equal	-
		50 and above	50	'Armaflex FR' or Equal	-
Condensate Drain	Concealed within Ceiling Space, Shafts and Wall Cavities	All	13	'Armaflex FR' or Equal	-

12.5.1.1 Pipe Insulation Application

Insulation shall be installed strictly in accordance with the manufacturer's recommendation. This applies particularly to

Immediately before applying insulation, clean all surfaces free of rust, scale, and grease, and dry thoroughly. Under no circumstances shall insulation be applied to wet surfaces.

Firmly butt sections together at all joints, ensuring that insulation sections interlock or overlap to form a continuous barrier to heat transmission.

Secure sections to pipework using either aluminium fixing bands or spirally wound 1.6mm soft annealed wire with not more than 150mm between turns.



Insulation damaged by cutting or distortion due to being pulled too tight will be rejected.

Provide removable insulation to all valves, flanges and fittings using insulation of the same type, thickness and finish as for the respective piping system unless specified otherwise.

Where valves, flanges, or fittings are not insulated, insulation shall be 'coned down' providing sufficient clearance from fitting bolts to permit their removal without damaging insulation.

At all welds and joints, install a 200mm long section of removable insulation.

12.5.1.2 Vapour Barriers and Aluminium Foils

Vapour barriers and aluminium foils shall be 'Bradford Thermafoil 750' or equivalent foil laminates, with 50mm laps that can be glued down.

Complete the installation by applying to all radial joints 100mm wide fire resistant, vapour impermeable pressure sensitive tape, PPC 415 foil tape or equivalent.

At insulated bends, valves, flanges and fittings apply foil laminate by means of PPC 415 foil tape. Additionally, apply a layer of suitable reinforced vapour seal mastic (such as fosters 30-80) to a dry finish thickness of 0.9mm.

Closed cell insulation materials may be installed without a foil vapour barrier providing the

12.5.1.3 Metal Cladding

Cladding material shall be 0.55mm thick 'Galvabond' or equal approved.

Cut and roll to size metal of the specified type and thickness. Lateral joints shall be swagged and lapped, circumferential joints shall be lapped 40mm and concealed from view where possible. All horizontal joints shall be lapped downwards so as to shed water. Secure cladding with either 15mm galvanised steel straps or Cadmium plated self-tapping screws at a maximum pitch of 150mm.

At bends, cut and form the metal to lobster back segments. Fit segments to bends and secure as for piping, ensuring that no buckling of the cladding occurs.

Where valves, flanges and fittings are required to be insulated and the piping insulation is metal clad, construct and fix a metal box of the same cladding material as for the piping to encase the insulation. Hinge the box on one joint and provide suitcase clip fastenings to the other joint.

12.5.1.4 Insulation at Pipe Supports

Insulation blocks shall be used at pipe supports on all pipes 50 mm diameter and larger. Blocks shall be 50 mm wide with thickness to match the insulation and shall be closed cell, high density, polyethylene, equal to Baron Fibreglass Ezybloc. The blocks shall be taped to provide a continuous vapour barrier at the joint with the pipe insulation.

Fittings

All fittings shall be factory fabricated and insulated so that the only site insulation shall be the straight joints between the pre-insulated units.

All casings for fittings shall be prefabricated from high-density polyethylene. Casing fabrication shall be effected by either hot plate, hot gas or extrusion welding processes.



Joints

Only the straight joints between the pre-insulated units shall be site insulated. Straight joints shall be site insulated using rigid polyurethane foam.

The casing joint shall be complete with a polyethylene wrap-around heat shrink sleeve.

Arrangement and Layout of Piping

The drawings indicate the designed and approximate positions and arrangement of all piping.

Contraction and expansion shall be accommodated by sufficient bends so that the system is sufficiently flexible to absorb the whole of its contraction or expansion, without developing excessive stresses in either the piping itself or the connection equipment.

In the installation drawings, which shall be submitted to the Project Manager for approval prior to installation, all pipework shall be positioned with due regard to these requirements and shall be in accordance with the manufacturer's recommendations.

Tenderers are expected to be fully conversant with the manufacturer's installation and handling recommendations. Published technical literature is available.

12.5.2 Armaflex Insulation

Armaflex or equal insulation shall be in accordance with the manufacturer's instructions. Paint with Armaflex Finish where installed externally.



13.0 NOISE AND VIBRATION CONTROL

13.1 GENERAL

This section deals with vibration control of all rotating equipment.

Ensure that vibration from all moving machinery installed under this contract is effectively isolated from the building structure to the extent specified in this section.

Obtain and submit with the tender documents the recommendations of 'Embelton Pty Ltd' or 'Mason Industries Ltd' and install all vibration isolators in strict accordance with the manufacturer's recommendations.

13.2 EXTENT

In addition to providing isolation of all vibrating machinery from the building structure, isolate such machines from all piping and electrical connections, through approved flexible connections.

Submit for approval complete details of the treatment proposed before ordering any vibration isolators.

13.3 ISOLATORS

Locate and level vibration isolators in such a manner that in each application all will carry the same load and have the same deflection.

Isolation efficiency for air handling units, pumps and centrifugal fan isolators shall be not less than 98%.

Design mounting assemblies at all isolators to withstand and isolate lateral as well as axis-symmetrical vibration movements.

Protect flexible mountings of the rubber-in-shear type from contact with oil.

Flexible pipework connections to vibrating equipment shall be corrugated metal vibration eliminator with external braid.

13.4 PIPEWORK

Isolate bolts, brackets and frames built into the building structure to support pipework and ductwork likely to transmit vibration or noise; from the piped service by means of 'Bradflex' lined hangers or equal approved anti-vibration supports. At pump suction and discharge support pipe anchors and support on the inertia block and not from the structural floor or slab above.

Isolate from the building structure, with spring and neoprene hangers, all pipe connections to vibrating machinery to a minimum distance of 100 pipe diameters from the machinery and all pipework within the ground floor plant room. Spring hangers shall have a minimum static deflection of 25mm.

13.5 DUCTWORK

Provide flexible connections between ductwork and fans as specified.



13.6 NOISE LEVELS

Provide and install sound control equipment on all air systems as necessary to comply with the maximum noise levels stated herein.

Consider each system throughout the entire installation, both as an individual item and in conjunction with other air systems when arriving at the sound control equipment necessary.

The maximum sound pressure levels occurring in occupied spaces as a result of mechanical services system or equipment operation shall be such as to not exceed specified Noise Rating (NR) values as follows:

AREA	NOISE RATING (NR)
<i>Car Park</i>	55
<i>Residential Bedrooms</i>	30
<i>Residential Living Spaces</i>	30
<i>Bathrooms, Toilets</i>	45
<i>Ground Floor Office</i>	40
<i>Communal areas, Lobbys etc</i>	45

Following commissioning of the mechanical system, the above sound levels shall be measured in the respective areas at a radius of 1.5m from the terminal points of the installation or from the equipment. All sound measurements shall be taken on approved and certified measuring instruments which shall include as a minimum the following:

An octave band analyser with sound level meter and microphone of 'Breul' and 'Kjaer' or equal approved.

A sound level meter having A, B and C scale weighted and unweighted networks.

Record all measurements in the presence of the consulting engineer or his nominated representative, and forward a copy of all readings taken for approval.

13.7 ATTENUATORS

Attenuators shall be of NAP, Fantech or equal approved manufacture selected to achieve the sound criteria stated above. Submit details of the attenuators for approval. Factory fabricated units only are acceptable unless otherwise approved.

13.7.1 Casing

Manufacture each attenuator casing from 'Galvabond' sheet steel of a gauge not less than that of the duct into which it is fitted.

Case seams shall have standing type joints and provide two matching angle frames at each end of the attenuator for ductwork connection.

Fabricate the unit in such a manner as to be entirely suitable for operation at static pressures up to 1kPa at which pressure the unit shall be airtight, and show no signs of distortion.



13.7.2 Lining Materials - Factory Manufactured Units

The lining materials shall be as normally fitted by the manufacturer and entirely suited to achieve the stated insertion loss, complete with a cloth facing or equal approved so as to prevent erosion of the fibre.

13.7.3 Lining Materials – Barbecue Application

Where used in Barbecue exhaust a polyester membrane shall be provided, selected and installed to resist high pressure hot water spray at 80°C.

13.7.4 Metal Facing

Line the internal face of the insulation with perforated 'Galvabond' sheets having minimum perforations of 2.4mm diameter, with a free area of not less than 10%, and a maximum perforation of 4.8mm diameter, and with a free area of not greater than 20% and proportional for other hole sizes.

Adequately fit and fix the lining to approval.

13.7.5 Performance

All ductwork attenuators shall be rated on the 'insertion loss' basis having air flow through the attenuator so that the self generated air noise is considered in the final attenuator analysis.

13.8 PIPE AND DUCT PENETRATIONS

Pipe and duct penetrations from plant rooms shall be packed with high density Glasswool, 48kg/m³ density or approved fire resistant packing as applicable.

13.9 ACOUSTIC WRAPPING

Where noted, items of plant or ductwork shall be wrapped in acoustic sheet wrapping.

Wrapping shall be 10kg/m² lead sheet vinyl, 'Nylex Soundfab' or equal, mechanically fixed to the plant item.

Wrapping shall completely enclose the item of plant, whilst retaining access to service panels etc., via removable sections.



14.0 ELECTRICAL

14.1 SCOPE

Be responsible for:

- Provision of all mechanical services switchboards, including all control panels, switchgear and interface devices
- Provision of wiring to all mechanical plant, including cable management systems
- Provision of shop drawings, as-built drawings and input to Operating & Maintenance Manuals and Instructions
- Provision of variable speed drives
- Commissioning and testing of the mechanical electrical system, including all necessary interface to other systems
- Assistance in building tuning
- Provision of Certificate of Electrical Safety for each switchboard and the overall system
- Provision of demonstration and training of the mechanical electrical system for the Principal
- Provision of warranty and maintenance of the mechanical electrical system during the Defects Liability Period

and as necessary for the safe and correct operation of the mechanical services electrical system and as specified herein.

14.2 GENERAL

Mechanical services switchboards shall be complete with all switchgear and wiring.

The switchboard shall serve all mechanical plant installed in this contract unless otherwise noted.

Refer to the drawings for location of the switchboard. Generally switchboards shall be located in plantrooms or communication rooms on each floor.

Electrical equipment shall have input power factor always better than 0.9 lagging. Should the power factor of any equipment be below 0.9 lagging, the mechanical sub-contractor shall provide, at no extra cost, all power factor improvement equipment to meet this requirement to the approval of the Project Manager.

14.3 REGULATIONS

Notwithstanding anything stated elsewhere in this specification be responsible for ensuring that all work covered by this specification shall be in accordance with the regulations of the power supply company, and the requirements of all authorities having jurisdiction.

Obtain all permits, pay all fees and prepare and submit to the Project Manager all necessary forms requiring the signature of the Principal and arrange for the inspection of the installation by a representative of the Project Manager and of the supply authority.



14.4 WIRING METHODS

14.4.1 Office Areas with Removable Tile False Ceilings

Cables shall be run on cable tray and tied to catenary when taking off to the field outlets in ceiling space.

Cables in LD PVC conduit to be chased into masonry walls to final outlets direct.

Cables in LD PVC conduit in partition to final outlets direct.

All cabling shall be concealed throughout.

Provide flush mounting plates.

Metal accessory box to be chased into masonry walls for installation of equipment.

14.4.2 Circulation Spaces (Corridors, Stairs, Foyers)

Cables in LD PVC conduit to be chased into masonry walls.

Metal accessory box to be chased into masonry walls for installation of equipment.

All cabling shall be concealed throughout.

Submit shop drawings showing the proposed wiring route and wiring method for Project Manager's approval prior to installation.

14.4.3 Plant Rooms and Switchrooms

Cables in surface mounted LD PVC conduit.

Outlets installation in surface mounted PVC accessory boxes.

14.4.4 Exposed To Weather

Cables in galvanised steel conduit.

14.4.5 Submains

MIMS cables unless noted otherwise, shall be fixed with stainless steel straps to cable ladder/tray.

MIMS cabling shall be segregated from PVC or XLPE cables to avoid derating.

14.4.6 Derating

All cabling shall be installed with adequate spacing to avoid derating to AS/NZS 3008.1.

14.4.7 At Plant

Where cable connections are made to motors the conduits shall terminate at an isolating switch as specified, mounted free of the motor or other vibrating equipment or framework. The cable connection between the isolating switch and motor shall be carried out using 'Sealflex' or anaconda flexible metal tubing of adequate length to accommodate vibration and/or movement of equipment.



14.4.8 Control Cabling

Installed concealed throughout as for power cabling.

Control cabling located in the car park shall be enclosed in sheet metal ducts.

14.5 CABLING AND WIRING SYSTEMS

14.5.1 Mims Cables

Mineral insulated metal sheath cables shall be of 'Pyrotenax' manufacture, 1000 volt grade having copper conductors and sheathed in copper. Supply, install, terminate and test all such cables to the requirements of the supply authority and 'Pyrotenax'. Use flameproof glands only.

MIMS cables shall be fixed to perforated cable tray or directly to structure. Single core cables shall be installed in trefoil configuration.

Test all seals immediately after fitting off and remake seals until infinite megger values at 1000 volts are achieved.

14.5.2 Fire Resistant Cables

Fire resistant cables shall have a certification of WS5W to AS/NZS 3013, halogen free and meet the specifications of AS/NZS 3000, AS/NZS 1668, and AS 1670. Cables shall be of 0.6/kV grade for power and 250/440v grade for fire alarm and communication systems.

14.5.3 PVC/PVC Cabling

The cabling installation shall comply with AS/NZS 3008 and AS/NZS 3000.

PVC insulated and PVC sheathed (PVC/PVC) cables shall comply with AS/NZS 5000, of 0.6/kV, V75 grade. XLPE insulated and PVC sheathed (XLPE/PVC) cables where applicable shall comply with AS 3198, of 0.6/1kW R90 grade.

Use single or multi-core cables with copper conductors and colour code, each core using standard approved colours.

Preserve the uniformity of phase colours throughout the installation.

Run cables straight and true, parallel with, or perpendicular to the main axis of the building.

Rate the cable to match the rating of the circuit protective device and equipment.

Each circuit shall incorporate an insulated earthing conductor of appropriate size in accordance with AS/NZS 3000.

Run single core cables in trefoil. Space circuits in accordance with AS/NZS 3008 so that derating factors need not be applied. Cable sizes indicated on drawings have been selected without applying derating factors.

Through joints in cables will not be acceptable.

Clip or saddle cables to approved supporting systems, generally on cable trays.

Where cables are installed within a removable ceiling tile system install the cables in a manner that they will not interfere with the removal of the tiles.



14.5.4 PVC/PVC Wiring

Use TPI (PVC insulated) cables where wiring is enclosed within either steel or PVC conduits, otherwise use TPS cables. TPS and TPI cables shall comply with AS/NZS 5000.

The cabling installation shall comply with AS/NZS 3008 and AS/NZS 3000.

Joints in cables will not be permitted.

Run cables straight and true, parallel with, or perpendicular to the main axis of the building.

Rate the cable to match the rating of the circuit protective device and equipment.

Where cables are installed within a removable ceiling tile system install the cables in a manner that they will not interfere with the removal of the tiles.

Wiring to recessed luminaires shall be via a flex and plug system. Surface luminaires shall be direct-wired.

Power cable sizes shall have a minimum size as follows:

- Power sub-circuits: 2.5mm²
- Single earthing conductor: 2.5mm²

Control cable sizes and types are indicated in relevant sections of the specification.

14.5.5 Conduits

14.5.5.1 General

Install conduits truly vertical or horizontal and parallel to the main axis of the building.

The minimum diameter of conduit used shall be 20mm.

Install draw-in boxes in accessible positions.

Terminate conduits in switch and outlet boxes of the same material as the conduits.

Sharp edges shall be smoothed prior to drawing-in wires.

14.5.5.2 PVC Conduit

PVC conduit shall be rigid, heavy or light duty as appropriate, complying with AS/NZS 2053.

Form sets using an internal bending spring of approved type and size.

Use approved jointing cement to all conduit connections.

14.5.5.3 Steel Conduit

Steel conduit using screwed fittings shall be used.

Treat threaded joints on metal conduits with aluminium paint or other rust preventative to ensure good electrical continuity.



Make sets using a standard proprietary bender of proportional size to the conduit being used. Any sets which do not retain substantially circular section or which open seams, joints or welds will be rejected.

Where conduit is exposed to view it shall be cleaned free of dust, primed and painted with two coats of the best oil paint in accordance with the Painting Section herein.

14.5.5.4 Flexible Conduit

Use flexible conduit for final connection to motors and items of fixed power equipment. Flexible conduit shall comprise helical wound, interlocking, flexible galvanised metal tubing having a close fitting PVC outer sleeve, equal to 'Sealflex' or 'FGS' manufacture. Terminate using galvanised screwed adapters of the same manufacture as the flexible conduit.

Ensure that the flexible conduit is of adequate length to avoid any strain on the conduit or terminations under all conditions of use.

14.5.5.5 Mini-Trunking

Provide white PVC mini-trunking as specified. Mini-trunking shall be rectangular or square in section with the following dimensions:

- For vertical droppers to equipment, width of trunking shall be 25mm throughout.
- For horizontal run along ceiling, width of trunking shall be 40mm throughout.

Provide all turning pieces and junction boxes required. Provide separate trunking for power and communication cables.

14.5.5.6 Cable Trays

Cable trays shall be perforated 'Galvabond' sheet steel with 50mm sides, 'ACS Supa' tray or equal complete with all bends, tees, risers, splice plates etc.

Support and fix the tray at intervals not exceeding 900mm. Install trays parallel to main axis of the building. The lowest part of the tray installation shall be no less than 2100 mm above finished floor level.

Attach cables to the tray using approved cable fasteners.

Sharp edges shall be smoothed prior to installation of cables.

Where trays cross building expansion joints they shall be so installed not to resist relative movements of building sections and not to cause likely damage to the cables carried on the tray.

Ensure earth continuity of all cable trays.

14.6 SWITCHBOARDS

The switchboards shall contain circuit breakers the necessary equipment for the correct functioning of the mechanical plant to which it feeds.

The switchboards shall be complete with all equipment to satisfy the AS/NZS 3000, and shall present a clean flush and neat appearance.

The mechanical services switchboards shall be Form 1 or 2 to AS/NZS 3439, as indicated on the switchboard schedule.



The switchboards shall provide sufficient space within the board to accommodate the equipment nominated, plus an additional 25% increase in space capacity to allow for future additions.

Busbars shall comply in all respects with AS 3439.2 busways, and AS 2067 busbars and busbar supports, and shall be sized to accommodate the load on the incoming submain.

Busbars shall comply in all respects with AS 3439.2 busways, and AS 2067 busbars and busbar supports.

In no case shall busbars be less than 20 x 6mm section.

All busbars to the live side of the sub-circuit fuses shall be enclosed within a sheet steel bus chamber. Where busbars are required to pass through the sheet steel walls of the bus chamber, an insulating block shall be mounted on the steel and the busbars shall pass through the block.

The switchboards shall be provided with adequate ventilation, particularly at the top of the board, comprising filtered high and low level vents. Heat generating equipment shall be located or arranged so that the heat generated can escape without passing through the switchboard.

All equipment installed within the board shall be in accordance with AS 3439.

Any equipment not specified which is necessary for correction operating of plant to comply with regulations shall be supplied and fitted.

Small wiring as necessary for the operation of switchgear, instruments, etc. Shall be insulated throughout and suitably coloured for ready identification of circuits.

Each wire shall have a clearly marked thermosetting thimble with an identification number and/or letter engraved or moulded thereon securely fixed near the point of connection to the terminals. Each wire shall be labelled at all terminations, both at switchboard and equipment.

All labelling shall conform to the letters and/or numbers indicated on the circuit diagrams.

All wiring shall be run square and shall be neatly clipped. Special wiring clips and lugs suitable for switchboard use shall be used in all cases.

All control circuits shall operate at 24Vac. A suitable 415/24V double wound transformer of adequate rating shall be installed in the switchboard for the control circuit wiring.

Where located within a switchboard, BAS FIDs shall be enclosed within a sheet steel chamber. Provide a power supply to FID's in each switchboard to the automatic controls manufacturer's requirements.

Provide a power supply to fids in each switchboard to the automatic controls manufacturer's requirements.

Each switchboard housing shall be fabricated from sheet steel of minimum thickness 1.6 mm. The sheet steel panels shall be securely mounted on an angle iron frame of welded construction and of sufficient strength to prevent distortion when all equipment is mounted within the switchboard.

Screwed lift off panels shall be provided at the front of the cubicle.



All components shall be arranged to form as a whole a totally enclosed, flat top, dust protected, flush front cubicle.

Each cubicle shall be fitted with a fascia panel at the top front. On the fascia panel flush mounted ammeters, pilot lights and push buttons etc. shall be installed. Each unit shall be labelled with a label as specified.

14.6.1 Certification

Each switchboard shall be provided with a Certificate of Electrical Safety.

14.7 HRC FUSES

All HRC fuses shall comply with AS 60269 and shall be of GEC or equal approved manufacture.

14.8 LABELS

All labels shall consist of suitably engraved black-on-white-on-black Traffolyte plates with 6mm high letters, screwed on, unless noted otherwise.

Labels shall be installed on all items of equipment mounted within the switchboard and on the motor isolating switches, and all remote control push button stations.

The Form of switchboard to AS/NZS 3439 shall be clearly labelled, along with the source of power supply.

14.9 STARTERS AND CONTACTORS

All starters and contactors shall be of 'Sprecher & Schuh' or equal approved manufacture with integral push buttons where specified, and with auxiliary contacts for pilot lights and other control gear which may be specified. Type, sizes and accurate ratings of these starters shall be determined by the sub-contractor and submitted for approval before installation.

All motors 0.37kW and above shall be 3 phase, others may be single phase.

Starters fitted to all motors 11kW and above shall be of the reduced voltage type to confine the motor starting current to less than 3.5 times full load current.

Thermal overloads shall be selected with an adequate margin of safety to prevent overload operation on days on high ambient temperature.

All starters shall be rated for frequent duty in accordance with BS 587. Contactors shall be rated in accordance with AS 3947 as follows:

- Rating Class 1
- Making and breaking category AC4

For all motors 11kW and above (except fire mode fans) provide and fit a positive temperature co-efficient thermistor protector with warning and control function similar and equal to 'Westinghouse Guardistor'. Submit details of such protection with the tender documents. This requirement is in addition to thermal overload protection specified. Thermistor circuitry shall prevent locking out of relay in the event of power failure.



14.10 AUTO - OFF - MANUAL SWITCHES

All auto-off-manual switches shall be of 'Kraus and Naimer' or other approved manufacture, and of the rotary type with positive positioning.

14.11 SUB-CIRCUIT PROTECTION

All sub-circuits shall be protected by miniature circuit breakers (MCBS) of standard (ie not motor protection) type complying with AS 3111. Minimum fault rating of MCBS shall be 18kA. Sizes of these shall be determined by the contractor and submitted for approval before installation commences.

14.12 PILOT LIGHTS

Supply and install on the switchboard for each motor control circuit, flush mounted pilot lights of approved manufacture. All pilot lights unless otherwise specified, shall be of the long life light emitting diode (LED) type, to approval.

14.13 MOTOR ISOLATING SWITCHES

Isolating switches shall be fitted for all motors irrespective of the positioning of the motor relative to the switchboard. Isolating switches shall be rated to withstand locked rotor current and continuously, the rated motor current.

Switches shall be 610mm minimum above floor level, adjacent to the motor.

All isolating switches shall be of the lockout type suitable for locking out. The padlocks shall have hasps manufactured from 10mm diameter material.

14.14 PAINTING OF SWITCHBOARD

All exterior surfaces shall be cleaned and treated by painting or other means to resist corrosion as noted in this specification.

All external surfaces of the cubicle shall be finished in gloss enamel. All surfaces shall be primed and undercoated. All interior surfaces shall be cleaned as above and finished in white enamel.

14.15 CONTROL CIRCUITS

Each sub-circuit supplying the 24V control voltages for each motor shall be fitted with a miniature circuit breaker.

14.16 CONTROL CIRCUITS, RELAYS AND INTERLOCKS

Provide all the necessary control circuits, relays and interlocks and refer to automatic controls section for control functions.

14.17 VARIABLE SPEED DRIVES

14.17.1 General

Variable speed drives (VSD) shall be solid state electronic type suitable for control of three phase induction motors (squirrel cage) and shall be of the variable frequency type. VSD's shall be 'CMG Facon' or equal approved.



The input circuit shall consist of an uncontrolled, three phase, and six pulse minimum, rectifier. The output stage shall consist of three phase, minimum six pulse converter bridge operating in sine code pulse width modulated mode (sine coded PWM) with a variable voltage/operating ratio to provide the highest efficiency possible for a centrifugal load.

The VSD shall be totally enclosed and protected to classification IP54, AS 60529. Forced (fan-assisted) ventilation, if used, shall only be provided to the heat sinks located outside of the enclosure housing the electric and electronic components. The units shall be wall mounted and shall not be mounted within switchboards.

The VSD shall be capable of operating at a minimum ambient temperature of 0°C and maximum of 45°C without impairment to its operation.

14.17.2 Interference

The radio interference of VSD's shall conform to AS/NZS CISPR 15 and harmonics generated into the supply system shall be no greater than permitted by AS 61000.3.6.

All necessary chokes, filters and the like necessary to meet this requirement shall be included. The performance of the VSD in this respect shall be demonstrated during commissioning.

14.17.3 Rating

The VSD shall be selected on the basis of maximum full load motor nameplate current rating, and not motor kW rating.

14.17.4 Speed Control Signal

The VSD shall accept an electrical input signal, either 4 to 20mA or 0 to 10Vdc. (to suit remote device output) and shall produce an output frequency proportional to the input signal within $\pm 1\%$.

The VSD shall have manual adjustments allowing pre-setting of maximum and minimum speeds arranged such that these limits will be maintained regardless of the input signal.

Provision shall be made for the unit to run at the pre-set speed upon closure of an external contact.

The VSD shall include a "MANUAL-AUTO" switch and manual speed adjustment potentiometer to allow testing and commissioning of the unit.

14.17.5 Protection

The VSD shall be equipped for both self protection and protection of the connected motor. The overload current setting of the protected motor shall be externally adjustable.

A control isolator located adjacent to the motor shall prevent the application of a voltage to the motor terminals when in the "OFF" position. Isolators shall be single or double pole to suit the controller interlock circuit.

The following safety protection features shall be provided as a minimum requirement:

- Current Limit;

To limit output current to 110% of that of the VSD rating. The current limit shall be designed to function automatically to prevent a trip on overcurrent due to momentary overload conditions, allowing the VSD to continue operation.



- Over-Current;

Should the output current exceed 110% but be less than 150% of the rated current, then the VSD shall automatically limit the output to 110% by ceasing to accelerate or decelerate until the current drops below 110%, when acceleration or deceleration shall resume.

The VSD shall not be damaged by currents up to 150% of nameplate rating. Should the output current exceed 150%, then the VSD shall be protected by the operation of an instantaneous overcurrent trip.

- Instantaneous Overcurrent Trip;

To safely limit the output current in under 30 microseconds, due to phase-to-phase short circuits or severe overload conditions.

- Undervoltage Trip;

To protect the VSD from non-momentary power or phase loss. The undervoltage trip shall activate automatically when line voltage drops below rated input voltage.

- Over-Voltage Trip;

To protect the VSD due to voltage levels in excess of its rating. The over-voltage trip shall activate automatically when the DC. Bus voltage exceeds 150% of nominal.

- Overtemperature Trip;

To protect the VSD from elevated temperatures in excess of its rating.

14.17.6 Automatic Reset/Restart

The VSD shall be equipped such that a trip condition resulting from overcurrent, undervoltage, overvoltage or overtemperature shall be automatically reset and the VSD shall automatically restart upon removal, or correction of the causative condition. The number of reset/restart attempts for undervoltage, overvoltage and overtemperature shall not be limited. For safety and equipment protection, the number of reset/restart attempts for overcurrent shall be limited and if in these attempts a reset/restart is not successful, the VSD shall shut down safely, requiring a manual restart. If a successful reset/restart occurs, the auto reset/restart circuit shall reset the attempts counter to zero after approximately 10 minutes of continuous operation.

Loss of unit reference voltage due to power loss or shut down, such as in a fire trip condition, shall not cause the unit to suffer any time delay in attempting to restart.

14.17.7 Sustained Power Loss

In the event of sustained power loss, the VSD shall be designed to shut down safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation if the start is in the "ON" condition.

14.17.8 Restart of Rotating Motor

The VSD shall be capable of restarting a rotating motor (either forward or reverse rotation) with controlled deceleration and acceleration. Time delays are not acceptable as a means of achieving this feature.

14.17.9 Momentary Power Loss

In the event of a momentary power loss, the VSD shall be designed to shut down safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation (if the start is in the "ON" condition), ie: being able to restart into a rotating motor and regaining positive speed control without shut down or component failure.



14.17.10 Short Circuit Protection

In the event of a phase to phase short circuit on the output, the VSD shall be designed to shut down safely without component failure.

14.17.11 Earth Fault Protection

In the event of a phase to earth short circuit on the output, the VSD shall be designed to shut down safely without component failure.

14.17.12 Power Interruption

In the event that an input or output power contactor is opened or closed while the VSD is activated, no damage to the control shall result.

14.17.13 Stand Alone Operation

To facilitate start up and troubleshooting, the VSD shall be designed to operate without a motor or any other equipment connected to the inverter output.

Any of the alarms or trips shall raise a fault alarm on the associated mechanical switchboard.

14.17.14 Controller Performance

VSD's shall be capable to maintaining adequate motor torque throughout the complete speed range for the particular application. Speed control shall be stepless.

Efficiency, when operating with centrifugal load characteristics shall not be less than the following:

- 100% speed, with 95% efficiency;
- 50% speed, with 84% efficiency.
- The increase in motor losses caused by the use of the VSD shall be demonstrated to the Project Manager to be not greater than the following when compared to operation on a sinusoidal waveform:
- 100% speed, with 1.5% of the input power.

14.17.15 Input Specification

Supply voltage: 415V \pm 10%

Supply frequency: 50Hz \pm 5%

Minimum input power factor: 0.95

14.17.16 Output Specification

Frequency range: 10 to 50Hz

Voltage range: 10 to 415V

Frequency ramp uptime: 3 to 30s. (adjustable)

Frequency ramp downtime: 3 to 30s. (adjustable)

Overload capacity: 150% for 30s minimum



14.17.17 Status Indication

Indication provided on the unit shall be by LED's or other approved means and shall include the following:

Input power on output frequency

Overcurrent under voltage

Overtemperature over voltage

Electric motors supplied by the VSD shall be carefully selected for low speed operation especially with respect to noise and motor cooling.

14.18 MECHANICAL SERVICES SWITCHBOARDS SCHEDULES

Equipment below shall be wired from the switchboard nominated with the switchboard equipment scheduled.

The switchboard schedules are for guidance only to indicate the approximate power, required fault level, incoming cable sizes, connected plant, preferred starting, switching and metering arrangement etc.

Provide for all necessary hardware for the safe and efficient operation of the plant as required.

Schedule of the mechanical switchboards to be installed is as follows:

14.18.1 Switchboard Schedule

<i>SWITCHBOARD NO.</i>	<i>MSSB 01</i>
<i>Location</i>	Basement Level 1
<i>IP Rating</i>	43
<i>Fault Level</i>	Min 10kA
<i>Separation</i>	Form 2
<i>Incoming Cable & Size</i>	1x4C+E 10mm ² Radox
<i>Main Switch Size</i>	160A
<i>Energy Meter</i>	No
<i>Phase Failure Relay O/P</i>	Yes
<i>Lamp Test</i>	Yes



14.18.2 Switchboard Mounted Equipment For Each Plant Item

<i>PLANT ID</i>	<i>PLANT REF</i>	<i>KW</i>
Car Park Supply fan	SF01	2.2
Car Park Extract Fan	EF03	3
Stair Pressurisation Fan	SF03	4
Fire Pump Room Supply Fan	SF02	0.37
Fire Pump Room Extract Fan	EF05	0.37
Ground Floor Toilets Extract Fan	EF04	0.045
Switch room Extract Fan	EF06	0.1
Gas Water Heater room fan	EF07	0.04
Ground Floor Office AC unit	AC.G1	2



14.18.3 Notes On Switchboards

1. Fire alarm relay
 - Supply and install a fire alarm relay in each mechanical services switchboard. The fire alarm relay shall be a MFESB approved type. Fire alarm wiring from a volt free contact in fire indicator panel to the fire alarm relay in MSSB will be carried out by the fire services contractor.
 - On receipt of a fire alarm at MSSB the following fans wired from MSSB shall shut down: Car Park Extract; Car park supply; Switch room extract and ground floor toilet extract.
 - On receipt of a fire alarm at MSSB the following fans wired from MSSB shall run at full capacity: Stair Pressurisation Fan; Fire Pump Room supply and Fire Pump Room extract.
2. Allow 30% spare space in each switchboard for future equipment.
3. Supply and install a lamp test facility on the switchboard.
4. All DOL starters on motors shall be provided with thermal overloads. Provide motor isolators complying with AS/NZS 3000.
5. Motors for these fans shall be wired through a VSD. Variable speed drives shall be wired using neutral screened cable to minimise RFI. The screen shall be connected to the ac drive earth and the motor frame. External control connections shall be made with screened cable.
6. Fire dampers shall spring shut on fire alarm.

14.19 ELECTRIC MOTORS

14.19.1 General

Supply and install electric motors of approved manufacture.

As far as possible, all electric motors provided under this contract shall be of the same manufacture for standardisation.

All electric motors shall comply with AS 1359 and AS 1360 and AS/NZS 1668 Part 1 in applicable cases.

Three phase motors from 0.73kW to <185kW shall comply with minimum energy performance standards (MEPS) in accordance with AS/NZS 1359.5.

Motors shall be capable of running continuously with a 5% drop in rated voltage at an overload condition of 15% increase in design power.

Select motors with a minimum of 15% between full load rated current and running current.



All motor winding insulation shall be double varnish impregnated and in no case shall the operating temperature of the windings exceed a rise of 80% of the maximum permissible temperature rating of the particular insulation class used. All motor stators shall be wound with at least class e insulation with the exception of motors fitted to fans required to run under fire mode operation or fans which operate continuously which shall be wound with class h insulation in accordance with AS/NZS 1668 Part 1.

14.19.2 Frame Size and Type

All totally enclosed, fan cooled, ventilated, drip proof and flameproof motor dimensions shall comply with AS 1360 and AS 2380.2.

Provide totally enclosed, fan cooled, frames to all motors located external to the building including roof mounted fan motors.

14.19.3 Bearings

Provide pre-packed and sealed ball and roller bearings selected for a life of 100,000 hours with no external lubricator.

14.19.4 Noise Levels

Motors shall be selected for quiet operation.

14.19.5 Winding Protection

For all motors 15kW and above provide and fit a positive temperature co-efficient thermistor protector with warning and control function equal to 'Westinghouse Guardistor', 'Siemens PTC' thermistors or equal approved.

The thermistors shall be installed in the stator windings at the anticipated hot spot position. Provide a minimum of three thermistors in the windings of single wound stator motors and six thermistors in multiple wound stator motors in positions as recommended by the manufacturers.

Thermistor protection shall be in addition to any overload protection specified herein.

14.19.6 Slide Rails

For each motor not direct coupled to the equipment served, provide and fit a set of slide rails of approved manufacture.

The slide rails shall be of substantial construction and selected to suit the motor concerned.

14.19.7 Motor Speed and Phase

All motors shall have a maximum speed of 24rps.

All motors below 0.37kW may be single phase and all motors 0.37kW and above shall be three phase.

14.19.8 Vee Belt Drives

The size and number of each vee belt shall be to the recommendation of the fan manufacturer but shall have a minimum of two belts to each motor drive and each belt rated to at least 120% of the full load.



14.19.9 Reduced Frequency Operation

Motors on variable volume systems shall be selected for operation on 15 to 50Hz supply without undue noise or overheating.

Motors exhibiting high tonal noise will be rejected.

14.20 SHOP DRAWINGS

A complete set of shop drawings of the switchboards shall be submitted for approval a minimum of four weeks before manufacture is commenced.

These drawings shall include:

- A schematic wiring diagram showing wires, and the proposed numbering system, and the rating of all HRC fuses and/or circuit breakers;
- A fully dimensional drawing of the busbar chamber showing the size of busbars, the mounting details of busbars, and a typical penetration of the steel wall;
- A complete layout of all equipment;
- All constructional details necessary for manufacture.

A copy of the schematic diagram as constructed shall be prepared in dyeline form, glazed and mounted at the side of the cubicle.

On completion of the contract, as-constructed drawings of the equipment layout and schematic circuit diagrams shall be delivered to the Project Manager.

All drawings mounted at the cubicles or delivered to the Project Manager shall employ Australian Standard symbols.

On the schematic drawings the number of each wire and the name of each section of control equipment shall correspond to the labels as specified above.

14.21 PRECAUTIONS

All care shall be taken that all conduits and conductors covered by this specification shall not be in contact with telephone conduits, gas pipes or other wiring systems.



15.0 PAINTING, LABELLING AND IDENTIFICATION

15.1 PAINTING

This section specifies the quality of painting provided under this contract.

Refer to the Scope of Work for the extent of painting.

15.1.1 Paint Materials

Paint shall be Dulux, Wattyl or other approved manufacture.

All paint shall be delivered to the site in the manufacturer's branded and sealed tins. Prepare and apply all materials in strict accordance with the manufacturer's recommendations. Additions to or adulteration of the materials, except where specifically recommended by the manufacturer, constitutes sufficient grounds for rejection of the batch.

Select sealers, priming coats, undercoats and finishing coats suitable for the particular surface and capable of withstanding the surface temperatures without deterioration.

15.1.2 Total Volatile Organic Compound (TVOC) Content

All paints used on the project shall comply with the limits on volatile organic compounds laid out in the table below. These limits are taken from the Australian Environmental Labelling Association standard AELA 23-2005.

PRODUCT TYPE/SUB CATEGORY	MAXIMUM TVOC CONTENT (G/LITRE)
Interior gloss	75
Interior semi gloss, satin	16
Primers for duct and pipe	60

Note- VOC limits include water content.

VOC levels must be in accordance with The Australian Environmental Labelling Association, Inc. Standard No: AELA 23-2005 'Australian Voluntary Environmental Labelling Standard Architectural and Protective Coatings'.

Conformance with the Standard (refer to table below) must be demonstrated by test reports from laboratories accredited to carry out the relevant tests and/or calculations and appropriate documentation of production methods and quality controls.

For solvent-based coatings the paint shall not contain VOC's in excess of 200g/litre. For recycled paints the VOC level averaged across batches of paint must not exceed 100g/litre.

The paint's VOC content must either be calculated from the VOC data for each of the raw materials or experimentally by ASTM D3960, as qualified by the AELA 23-2005.

Where the raw material is a mixture of compounds, some of which contain VOC's the VOC content of the mixture may in turn be calculated from the VOC content of the individual components. Where this is not known, it must be determined by the methodology detailed in AELA 23-2005.



At the end of construction works undertake a final audit to ensure that the correct products have been used.

15.1.3 Paint Application

Apply one coat of primer, selected for the particular surface, and two finishing coats.

All gloss painting shall be brush-coated; rollers shall not be used.

All primers shall be lead and chromate free.

Spray painting shall not be used without permission.

Silicon sealers shall not be used under paintwork.

Employ only skilled painters on the work.

Keep all equipment clean and in good condition.

Clean out paint containers at the end of each day's work.

Provide clean drop sheets or other approved protective screens to prevent spotting of adjacent surfaces where the painting of mechanical equipment is to be carried out in areas or rooms where the painting sub-contractor has completed his work.

Scrape down and wire brush or sand blast to remove rust, mill scale and dirt, and dust off.

Where metal work has been shop primed, similarly treat any bare patches and touch up.

Colours shall be to the approval of the Project Manager.

15.2 PIPE AND DUCT IDENTIFICATION

Identify all pipes and ducts in accordance with AS 1345 with Safetyman labels or equal.

Locate labels on pipes at approximately 3m spacings in plantrooms and at each service access opening into pipe shafts. Locate labels at 8m spacings elsewhere. Where pipes run together group the labels together.

Labels shall indicate the service eg, Supply Air, Exhaust Air, Barbecue Exhaust etc. Labels shall also include an arrow showing the direction of flow in the pipe. Ducts entering or exiting risers or other inaccessible space shall also give the system served, eg AHU-3, PAC-7, TEF-2 etc.

Where identification labels on piping are provided for the benefit of users, the label shall spell out the full name of the service.

15.3 VALVE IDENTIFICATION

All valves in plant rooms shall be fitted with brass identifying tags numbered to correspond with a valve schedule.

Valve schedule shall include all new and re-used valves.



16.0 OPERATING AND MAINTENANCE INSTRUCTIONS AND MANUALS

16.1 GENERAL

On completion of the work and prior to making application for Practical completion, the Mechanical Sub-Contractor shall supply to the Project Manager, Operating and Maintenance Manual and Instructions covering all plant provided under or associated with this Specification.

The As-Installed Drawings shall form part of the Operating and Maintenance Manual.

The Operating and Maintenance Manual and Instructions shall be in English, with quantities in SI units.

Submit four (4) complete hardcopy sets of the Operating and Maintenance Manual, which includes the set required for Demonstration and Training; and one (1) complete hardcopy set of the Operating and Maintenance Instructions.

Provide four (4) complete colour softcopy sets of the approved Operating and Maintenance Manual in PDF format in each manual. As-Installed drawings shall also be provided in .DXF format. All information shall be provided on disc(s).

A draft of the proposed Manual and Instructions shall be provided for the approval of the Project Manager not later than four (4) weeks prior to Practical Completion.

16.2 OPERATING AND MAINTENANCE INSTRUCTIONS

The following diagrams and instructions shall be provided on fade proof material and mounted in positions to be nominated by the Project Manager. Drawings and lettered instructions shall be of a size and scale to permit easy reading and shall be of a high-grade drafting standard.

Each drawing shall be laminated. Eyelets shall be provided around the periphery of the finished drawings at approximately 300mm centres.

16.3 OPERATING AND MAINTENANCE MANUALS

16.3.1 General

A comprehensive Operating and Maintenance Manual shall be compiled for all equipment and plant installed.

One (1) hardcopy set of the Operating and Maintenance Manual shall be submitted to the Project Manager for comment. All comments shall be incorporated for final review by the Project Manager. With approval from the Project Manager, all sets of the Operating and Maintenance Manual shall be provided to reflect the approved draft.

One (1) hardcopy set of the Operating and Maintenance Manual shall contain all the original test reports, compliance certificates and manufacturers' catalogues. This set will be clearly labelled as "OPERATING AND MAINTENANCE MANUAL – ORIGINAL". The word "ORIGINAL" is to be omitted from all other copies.

Equipment and component designations and other identifying references shall be consistent throughout, including text, drawings and component schedules and actual equipment. Component designations shall also be consistent with those included in this Specification.



16.3.2 Presentation

Manuals shall be of International A4 size, with stiff plastic covers. The binding shall be for the loose leaf type and permit pages to lie flat and enable easy insertion and removal of pages. A minimum of 3 split rings shall be used.

Each section shall be started on a new page, separated from other sections by a stiff divider.

Good quality, 80g/m² minimum printing paper of shall be used for text. Double-sided printing is acceptable.

Drawings shall be folded into plastic pockets with each drawing occupying one pocket.

Each manual shall contain the information shown below, set out in logically divided sections including the following:

- Front Cover;
- Index;
- Contacts;
- Scope of Works executed;
- General Description of Plant, Equipment and Systems;
- Plant, Equipment and System Operating Instructions;
- Maintenance and Repair Instructions;
- Comprehensive Maintenance Schedule;
- Schedule of Plant and Equipment;
- Manufacturer's Data Schedules and Literature;
- Installation Diagrams and Drawings
- Testing and Commissioning Data & Reports;
- Job Safety Analysis (JSA);
- Certificates of Compliance;
- Other Information;
- Colour softcopy of complete Operational and Maintenance Manual PDF on disc(s).
- As-Installed Drawings in both PDF and .DXF format on disc(s).

Sufficient illustrations, diagrams drawings, pamphlets and photographs shall be included for the efficient operation, maintenance and repair of the various plant, equipment and systems.

Equipment and component designations and other identifying references shall be consistent throughout, including text, drawings and components schedules and actual equipment. Component designations shall also be consistent with those included in this specification.

As-Installed information by Specialist Sub-Contractors as part of the Mechanical Sub-Contractor's works shall also be collated and included in the manual.

16.3.3 Front Cover

The front cover of the manual shall clearly identify the project name, project address, volume number, volume title, and date of final issue on front cover and spine.



16.3.4 Index

A detailed index page shall be provided outlining sections and major sub-sections; and page numbers.

16.3.5 Contacts

Identify names, addresses, and telephone and facsimile numbers of Principal consultant, sub-consultants, contractor, sub-contractors and names of responsible parties inside the front cover.

16.3.6 General Description of Plant, Equipment and Systems

A general description of the systems including the plant and equipment function and its location in relation to the building. Description shall be written as briefly as possible, consistent with providing a general understanding of its features and operation.

16.3.7 Operating Instructions

Provide a fully detailed technical and functional description of the operation of each item/component under both normal test and fault conditions.

Description shall include, but shall not be restricted to, separate sub-sections dealing with:

- Starting and stopping;
- Manual control;
- Alarms and indications;
- Resetting after alarm or fault conditions;
- Isolation of equipment;
- Other information as appropriate to the works and necessary to describe the complete operation and scope of operating facilities.

16.3.8 Maintenance and Repair Instructions

Prepare a series of maintenance and repair instructions for each item/component of equipment in the installation. Each instruction shall be complete in itself and shall not refer to other instructions. Each instruction shall be given an identification number.

16.3.9 Comprehensive Maintenance Schedule During DLP

Provide a copy of the comprehensive maintenance schedule for maintenance works to be carried out during the Defects Liability Period.

16.3.10 Equipment Suppliers' Schedules

Provide a list of manufacturers and suppliers of equipment components.

Include Equipment Data Schedule and Test Reports.

Comprehensive equipment data schedules summarising information required for maintenance, repair, adjustment and replacement.

16.3.11 Equipment Manufacturer's Literature

Provide detailed handbooks, catalogues, and data schedules from manufacturers and suppliers for all parts of the system or equipment supplied in the Contract.



A mere assembly of manufacturer's catalogues, instructions and general descriptive matter is not acceptable, also this shall be included both to provide prime source information and to reduce text. Supplementary information and clarifying references in the text shall be included to identify clearly particular items incorporated in the work. Manufacturer's literature shall relate specifically to items and equipment supplied under the contract. Where such literature contains reference to alternative models and options on equipment not supplied under the contract, such references shall be deleted or marked "NOT APPLICABLE".

Manufacturer's literature will be assessed on its suitability of purpose, and reproduction. If considered unsuited to its purpose, written text shall be substituted. If considered to be unsuitable for copying, original literature shall be included both to identify clearly particular items incorporated in the work. Text shall be factual and written in clear, concise English language easily understood by tradesmen who may not be familiar with the equipment.

16.3.12 Testing and Commissioning Results

Testing and commissioning data results as required to be carried out in this Specification and all relevant Australian Standards, shall be provided.

16.3.13 Certificates

Statutory certificates of compliance for:

- Electrical works;
- Refrigeration or air conditioning works.

As well as:

- Copies of manufacturers' warranties;
- Certificates from authorities and utilities;
- Product certifications;
- Copies of test certificates for the mechanical installation and equipment used in the installation, eg: pressure vessels.

16.3.14 Other Information

Include manufacturer's brochures, catalogues, servicing bulletins, charts and performance curves.

16.4 AS-INSTALLED DRAWINGS

Provide As-Installed Drawings in print and CAD disc(s) in each Operating and Maintenance Manual.

All drawings shall be prepared using the computer aided drafting system AUTOCAD Release 2007 or later, Application CADS software. Where this version of AUTOCAD is not available, any drawings prepared on non current release AUTOCAD software shall be supplied with .DXF and .DWG files. All computer drawings shall be compiled and saved on CD-ROM or DVD.

Each drawing is to clearly indicate the words "AS-INSTALLED" on the drawing. All drawing revisions, notes and other information that are not relevant and related to design information, shall be removed.

As-Installed drawings shall include, but not limited to:

- Floor plans and sections covering all Mechanical Services ductwork, pipework, diffusers and equipment at 1:50 maximum scale;



- Mechanical Services switchboards including all single line and control details;
- Mechanical Services piping schematics;
- Mechanical services air schematics;
- Drawings detailing all wall, floor, ceiling and roof penetrations and equipment plinths.

As-Installed Drawings of plans shall be at least the same scale as that provided at Tender.

As-Installed Drawings derived from Shop Drawings, shall be at the same scale as that provided during submission of the shop drawings.



17.0 TESTING AND COMMISSIONING

17.1 SCOPE

This section sets out the commissioning, testing and balancing requirements of the mechanical services systems installed.

Test all plant as required by this specification. Testing for warranted performance may be at any time within twelve (12) months of the date of practical completion. Testing and balancing shall be carried out by technicians certified by the national environmental balancing bureau (NEBB) to NEBB standard.

Comprehensive pre-commissioning, commissioning, and quality monitoring are to be performed in accordance with either ASHRAE guideline 1 or CIBSE commissioning codes.

Carry out preliminary testing, checking, control setting, etc. Prior to the Project Manager being notified that the work has reached the state of practical completion. Provide during this period a skilled operator to operate the plant.

Give forty-eight (48) hours notice in writing prior to any sectional or complete tests on pipework, or any other tests called for by this specification being executed. Provide all necessary testing apparatus and be responsible for all costs associated with the testing.

Electric current, natural gas and towns water required for operating the systems during testing, adjusting and instruction of the Principal shall be provided by the Principal at no cost.

During the period of long term tests ensure that the sub-contractor's foreman is in attendance. In cases of the test extending over more than one shift, inform the name of the sub-contractor's foreman's deputy in sufficient time to enable both to be interviewed prior to the commencement of the test.

17.2 PITOT TUBE OPENINGS

Provide test openings in ducts in the following locations:

- Adjacent to the inlet and discharge duct connection to each fan
- Downstream of all balancing dampers;
- Upstream and downstream of all heating coils.

Locate the holes such that the air flow across the duct is sufficiently even to enable accurate temperature and flow measurements to be taken to permit correct balancing and adjustment.

Test holes shall be Ø25mm and be fitted with a rubber plug. Provide one spare rubber plug for each test hole.

Where the duct is externally insulated, cone down the insulation around the test hole. Where the insulation has a vapour barrier seal the barrier to the duct around the test hole.

The number and position of pitot tube openings to be provided at each location shall be as follows:

- For all ducts having diagonal dimensions or diameters up to 300mm, provide one opening at the centre line of the duct;



- For all ducts having diagonal dimensions or diameters more than 300mm but less than 600mm, provide two openings at 1/4 points on either side of the duct centre line;
- For all ducts having diagonal dimensions or diameters 600mm or larger, provide four openings at 1/8 points on either side of the duct centre line and on each side of the duct.

17.3 COMMISSIONING AGENT

- An independent and experienced commissioning agent shall be appointed to provide commissioning advice to the Principal and design team and to monitor and verify the commissioning of HVAC and building control systems.
- The commissioning agent shall be a suitably qualified. They shall not be an employee of the mechanical sub-contractor.
- The primary goal of the commissioning agent is to independently identify system deficiencies as early in the project as possible and track their status until they are corrected.
- The commissioning agent responsibilities must include:
 - Be an objective advocate of the Principal;
 - Review basis of design and design intent as well as preliminary working drawings;
 - Create a commissioning plan and direct the commissioning process that covers the following– air distribution systems, automatic controls and refrigeration systems.
 - Introduce standards and strategies early in the design process;
 - Set target requirements in the contract documents to ensure implementation of selected measures;
 - Coordinate with the Principal, design team and contractor throughout the commissioning testing and adjustment phases.

Observe all testing, review and approve contractor test results.

Prepare final commissioning report including recommendations to the Principal regarding the performance of commissioned building systems.

17.4 PIPEWORK

As pipework proceeds and before pipes are hidden or lagged, test the various systems hydrostatically to twice the maximum working pressure as set out in AS 4041. Maintain test pressures for not less than four (4) hours prior to inspecting all joints. Carry out similar tests on each system when all pipework has been completed.

17.5 AIR QUANTITIES

Effect all SMACNA tests and submit results, regulate and adjust the volume dampers on all ductwork systems to achieve the air quantities shown on the drawings and to the satisfaction of the Project Manager.

17.6 GOVERNMENT AND LOCAL AUTHORITIES

Perform at appropriate times during the currency of site work, all tests required by government and local authorities who may from time to time have jurisdiction over the work, and obtain the necessary certificates of approval. Lodge all these certificates of approval.



17.7 AUTOMATIC CONTROLS

Be responsible for the setting and calibration of all automatic controls, to achieve correct operation of the systems.

17.8 WITNESS TESTING

Provide a comprehensive witness testing program and schedule incorporating all systems and operating devices for review 3 months prior to any scheduled witness test. The formal witness test shall only occur after the contractor has carried out their own successful testing with all recorded commissioning data submitted for review. The test results and data must be provided no less than 48 hrs prior to any programmed or scheduled witness test.

Witness testing data results shall include as a minimum:

- Written witness testing process, in accordance with manufacturer's recommendations
- Legible and formatted test results.
- Commissioning equipment calibration certificates.
- Written correspondence from the sub-contractor confirming successful preliminary testing and confirmation from relevant certifier's, including for BCA compliance.
- Highlighted As-Built layouts associated with the test areas
- Confirmation of all associated BMS interfaces, eg: security, fire etc

The consulting engineer reserves the right to abort any witness test should there be significant delays, problems and defects detected on the day of the test.

The contractor may incur additional charges should the witness tests be incomplete, thus requiring repetition of the test.

17.9 INSPECTION PRIOR TO CLOSING OF CEILING

48 hour notice must be given to enable verification by the Engineer before closing up of ceiling. If verification is not provided by the Engineer and the ceiling is closed; the ceiling shall be re-opened, closed and painted as directed by the Project Manager and will be at the Contractor's cost.



18.0 DEMONSTRATION AND TRAINING

Prior to the issue of the notice of completion, spend sufficient time with the Principal or his appointed representative to show the location of all equipment, plant and systems which require maintenance and/or adjustment during the life of the installation.

Explain the operation of each equipment, plant or system to the Principal, and reference the information to the As-Installed Drawings and Operating and Maintenance Manual and Instructions.

Training on each item of equipment, plant or system must be conducted by a suitably qualified and skilled person.

Implement a Quality Management System for the whole of the Contract works.

Provide a copy of the Operating and Maintenance Manual including As-Installed Drawings and Operating Instructions for highlighting of systems during training.



19.0 SERVICE AND MAINTENANCE

19.1 GENERAL

This section sets out the maintenance requirements for the mechanical services installed under the contract.

Carry out instruction of the Principal and/or representatives in the operation of the plant together with the full servicing of, and preventative maintenance to all installed equipment during the term of the Defects Liability Period.

Supply the specified number of sets of the maintenance manual including manufacturer's servicing bulletins of all equipment supplied under this contract. These shall be provided not later than 3 weeks before the date of practical completion.

On completion of the work, supply the specified number of sets of operating and maintenance instructions, wiring diagrams, functional diagrams, as-installed drawings and CAD disks, generally as above, for any plant or installation.

19.2 PREVENTATIVE MAINTENANCE DURING DEFECTS LIABILITY PERIOD

Carry out full preventative maintenance and servicing to all equipment and systems installed during the term of the twelve (12) months Defects Liability Period.

In the event of major faults occurring, as defined by the Project Manager, the maintenance free period shall be extended a further twelve (12) months from the date of rectification.

The standard of service during this period shall include comprehensive maintenance and regular servicing of the system in accordance with the following requirements:

- Regular weekly servicing of the system during normal working hours, in accordance with the relevant parts of AS 1851;
- All defects and outstanding work noted at date of practical completion shall be completed within one (1) month of date of practical completion;
- Keeping of log records to AS 1851 for service visits, call outs, faults rectified and repairs carried out;
- Updating of wiring diagrams, drawings, software listings, etc. where changes occurred. All copies of the Operating and Maintenance Manual provided in this Contract shall be updated;
- Re-demonstrate to, and re-train the Principal and/or their nominated employees where changes in the operational or maintenance requirements of the equipment, plant or systems occur;
- Equipment which fails as a result of incorrect servicing, faulty workmanship, materials or design shall be immediately replaced, at no cost to the Principal.

19.3 COMPREHENSIVE MAINTENANCE DURING DLP

Comprehensive maintenance shall be to the system or equipment manufacturer's Comprehensive Maintenance Schedule and requirements, as a minimum, in order to keep the system or equipment operating at the optimum operational capacity for the life of the system or equipment.

Carry out servicing in strict accordance with this Comprehensive Maintenance Schedule.



A Comprehensive Maintenance Schedule shall be provided for all fire protection systems installed under this Contract.

19.4 ESSENTIAL SERVICES MAINTENANCE

During the Defects Liability Period, all essential services installed under this Contract shall be maintained to the minimum standard prescribed in the "Essential Services Maintenance Manual" published by the Building Control Commission.

19.5 MINIMUM ATTENDANCE AND RESPONSE TIME

Be responsible for four (4) 3-monthly maintenance and servicing visits during the warranty period as a minimum, in addition to visits as required.

Within seven (7) days of written notice make good all defects that are due to faulty material, apparatus, equipment or workmanship. Failing to do so within seven (7) days of written notice to make good defects, the Principal reserves the right to have such defects rectified by others at the Contractor's expense and responsibility.

Any defect that endangers or prevents operation of the installation shall be rectified immediately, on verbal or other advice.

During the term of the Defects Liability Period the Principal may:

- Shut down any item of plant, if, in his opinion, a major breakdown would occur if such a system continues to run;
- Immediately notify the Contractor of such a shut down;
- Notify the Contractor if any equipment requires replacement prior to the next scheduled visit.

19.6 EMERGENCY CALL-OUTS

Provide an emergency call-out service during the whole 24 hours of every day during the Defects Liability Period for attending to breakdowns within three (3) hours of notification.

19.7 MAINTENANCE REPORTS

After completing each maintenance visit, prepare a report and obtain the Principal's signature on the report.

The report shall include as a minimum:

- Date of inspection;
- Company name and name of inspecting person;
- List of items/equipment inspected;
- Status of inspected items;
- Action taken, eg: any repairs carried out and date completed;
- Signature of inspecting person;
- Principal's signature.

Provide a duplicate copy for forwarding to the Project Manager.



Maintenance visits that do not provide the above are to be conducted again without cost to the Project.

The final payment at the end of the Defects Liability Period will be withheld until preventative maintenance as scheduled has been carried out and sufficient maintenance reports, signed by the Principal, have been submitted.

19.8 SPARE PARTS

All specified system components are to be readily maintainable for a minimum period of five years following expiry of the defects liability period. All software upgrades during this period will be available to the Principal for examination and purchase if deemed appropriate.

19.9 MAINTENANCE AFTER FINAL COMPLETION

Tenderers shall include with their tender a proposal for future comprehensive maintenance. The proposal may be used by the Principal as a basis for negotiation of a maintenance contract, to commence at the expiration of the Defects Liability Period.

The proposal shall be based on weekly maintenance for a term of three (3) years, five (5) years and (7) years.

A copy of the Tenderer's standard comprehensive maintenance proposal shall be submitted with the tender.



20.0 WARRANTIES

20.1 SCOPE

This section sets out the requirements for the provision of warranties

Make good any defects caused by faulty workmanship and/or materials during the Defects Liability Period upon notice to do so.

Warrant to carry out regular inspections specified. Make any necessary adjustments during these inspections.

20.2 TIME WARRANTIES FOR WORKMANSHIP AND MATERIALS

The time warranties for the work commence at the agreed date of practical completion given for the completion of the whole building project.

Warrant the whole of the mechanical services installation for a period of twelve (12) months from the date of practical completion.

In the event of inclusion of equipment normally covered by a lesser time warranty, allow for and include the cost of extending such warranty to that specified for the whole installation.

20.3 EQUIPMENT WARRANTIES

Warrant the performance of all items of equipment used in the works are not less than those specified when operating under the specified conditions and that such equipment can be installed with adequate clearances for operation and maintenance.

Replace any items of equipment, not meeting the requirements, at no cost to the Principal.

Replacement and/or repair of equipment during the Defects Liability Period shall result in the Defects Liability Period being extended for the respective item/s.

20.4 NOISE AND VIBRATION WARRANTY

Warrant that the noise levels in the various spaces caused by the operation of the installed equipment when running at full load are not in excess of those specified.

20.5 AIR QUANTITY AND DISTRIBUTION WARRANTY

Warrant that the air quantities are balanced to within 5% of the quantities shown on the drawings and to approval.

Anemometer traversing over the face of diffusers and/or registers as a means of obtaining air quantities is approved only for the initial working balance.

For final balancing, fabricate a cone approximately 90mm long with the upper end dimension to suit diffuser size and the lower end dimension 300 x 300mm for air quantities 170l/s or greater; 300 x 150mm for air quantities less than 170l/s.

Fit a foam rubber or plastic strip for the full perimeter of the larger opening to give an effective air seal at the diffuser/register face.



Warrant that the supply air patterns are such that all areas are free from objectionable draughts.



21.0 EQUIPMENT SCHEDULES

21.1 BARBECUE CANOPY WITH FILTERS

	BE-01
Manufacturer	Beefeater
Model Ref	Canopy Rangehood 27300
Duct Connection, diameter(mm)	200
Canopy Type	Range Hood
Exhaust Flows (m3/hr)	2000
Canopy L X H X W (mm)	610x1067x1 220

- 1 Hood Dimensions (includes 150mm overhangs on free sides)
- 2 Final selection of canopy exhaust hood shall be made upon final selection of Barbecue by the Architect.

21.2 AIR CONDITIONING SYSTEMS

UNIT REFERENCE	ROOM	TYPE	ROOM AREA (M ²)	CALCULA TED LOAD KW	TOTAL COOLIN G KW	MANUFA CTURER	SELECTION OR APPROVED EQUIVALENT
AC-G.1	Ground Floor Office	Heat pump	8	1.4	-	Mitsubishi	MSZ-GE25VAD
AC-G.1.E	Outdoor			1.4	6.0	Mitsubishi	MUZ-GE25VAD
AC-L#-8.1	Bedroom 1	Heat pump	10.5	1.6	-	Mitsubishi	MSZ-GE22VAD
AC-L#-8.3	Living	Heat pump	36.0	5.4	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-8	Outdoor			7.0	8.0	Mitsubishi	MXZ-4D80VA
AC-L#-7.1	Bedroom	Heat pump	9.0	1.4	-	Mitsubishi	MSZ-GE25VAD
AC-L#-7	Outdoor			1.4	6.0	Mitsubishi	MUZ-GE25VAD
AC-L#-6.1	Bedroom	Heat pump	10.5	1.6	-	Mitsubishi	MSZ-GE25VAD
AC-L#-6	Outdoor			1.6	6.0	Mitsubishi	MUZ-GE25VAD



UNIT REFERENCE	ROOM	TYPE	ROOM AREA (M ²)	CALCULATED LOAD KW	TOTAL COOLING KW	MANUFACTURER	SELECTION OR APPROVED EQUIVALENT
AC-L#-5.1	Bedroom 1	Heat pump	9.0	1.4	-	Mitsubishi	MSZ-GE22VAD
AC-L#-5.3	Living	Heat pump	40.0	6.0	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-5	Outdoor			6.0	8.0	Mitsubishi	MXZ-4D80VA
AC-L#-4.1	Bedroom 1	Heat pump	9.5	6.0	-	Mitsubishi	MSZ-GE22VAD
AC-L#-4.3	Living	Heat pump	30.0	4.5	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-4	Outdoor			10.5	8.0	Mitsubishi	MXZ-4D80VA
AC-L#-3.1	Bedroom 1	Heat pump	11.5	1.7	-	Mitsubishi	MSZ-GE22VAD
AC-L#-3.3	Living	Heat pump	30.0	4.5	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-3	Outdoor			6.2	8.0	Mitsubishi	MXZ-4D80VA
AC-L#-2.2	Bedroom 1	Heat pump	16.0	2.4	-	Mitsubishi	MSZ-GE22VAD
AC-L#-2.3	Living	Heat pump	35.0	5.3	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-2	Outdoor			7.7	8.0	Mitsubishi	MXZ-4D80VA
AC-L#-1.1	Bedroom 1	Heat pump	11.0	1.7	-	Mitsubishi	MSZ-GE22VAD
AC-L#-1.3	Living	Heat pump	40.0	6.0	6.0	Mitsubishi	MSZ-GE60VAD
AC-L#-1	Outdoor			7.7	8.0	Mitsubishi	MXZ-4D80VA
AC-L8-7.1	Living		35.0	13.7	-	Mitsubishi	MSZ-GE60VAD
AC-L8-7.2	Bedroom 1		17.0	21.3	6.0	Mitsubishi	MSZ-GE22VAD
AC-L8-7	Outdoor			35.0	8.0	Mitsubishi	MXZ-4D80VA



21.3 DIFFUSERS, REGISTERS AND GRILLE SCHEDULE

TYPE	DESCRIPTION	SIZE	
		FACE (MM)	L/S (MAX)
LB-01	Stair Pressurisation Basement 2	2000x700	3000
LB-02	Stair Pressurisation Basement 1	700x2000	3000
LV-03	Switch Room Exhaust Louvre	400x400	250
LV-04	Gas Plant Room Louvre	400x400	150
LV-05	Tenancy 2	2000x500	-
LV-06	Tenancy 1	700x300	-
LV-07	Ground Toilet exhaust	400x400	75
LV-08	Fire Pump Exhaust	800x800	190
LV-09	Car Park Exhaust	1500x1500	7200
LV-10	Car Park Supply Intake	700x1300	5400
LV-11	Fire Pump Air Intake	800x800	190
LV-12	Stair Press Air intake	2000x1000	6000
EG-01	Toilet/Bathroom Exhaust	125mm circular	25
EG-02	Utility Exhaust	100mm circular	15
EG-C1	Car Park Extract Grille	450x450	300
SD-C1	Car Park Supply Grille	600x300	260

UNIT NUMBER	SERVING	TYPE	AIR QUANTITY L/S	MOTOR SIZE KW	MIN. FAN EFFICIENCY AT DUTY POINT	MAX. SPEED REV/S	NOMINAL DIAMETER MM	SELECTION OR APPROVED EQUIVALENT (FANTECH)
EF-01	2 Bed Apartment	Silent Series	65.0	0.02	-	1920	125	TD-350/125SIL (Lo speed)
EF-02	1 Bed Apartment	Silent Series	40.0	0.018	-	1800	100	TD-250/100SIL (Lo speed)
EF-03	Car Park Extract	AP Series In-Line Direct Drive	7100.0	3	72.5%	1440	800	AP0804BP7/25
EF-04	Ground Floor Toilets	Mixvent Series	75.0	0.045	-	1860	150	TD-500/150 (Lo speed)



UNIT NUMBER	SERVING	TYPE	AIR QUANTITY L/S	MOTOR SIZE KW	MIN. FAN EFFICIENCY AT DUTY POINT	MAX. SPEED REV/S	NOMINAL DIAMETER MM	SELECTION OR APPROVED EQUIVALENT (FANTECH)
EF-05	Fire Pump Extract	AP Series In-Line Direct Drive	190.0	0.37	-	1440	315	AP0314AP10/ 11
EF-06	Switch Room Exhaust	Short Case EC Series	200	0.10	58%	1605	250	SCEEC25
EF07	Gas Plant Room Extract	Wall Mounted	150	0.06	52%	1380	250	Vogue Series / VCW254
SF-01	Car Park Supply	AP Series In-Line Direct Drive	5600.0	2.2	64.1%	1440	710	AP0714AP10/ 27
SF-02	Fire Pump Supply	AP Series In-Line Direct Drive	190	0.37	-	1440	315	AP0314AP10/ 11
SF-03	Stair Press	AP Series In-Line Direct Drive	6000.0	4	49.2%	1440	710	AP0714BP14/ 26



TENDER FORM

I/We of _____
Full Name of Tendering Company

at _____
Tendering Company's Address

do hereby offer to execute and complete the works described and shown in the Specification, and Drawings and Addendums, prepared by Umow Lai in accordance with the Conditions of Contract

for the **FIXED LUMP SUM** of (\$ _____) including GST, _____
Amount In Words

Amount In Words

and enclose herewith the following:

- Tender Documents,
- Completed Schedules Nos. 1 to 3 inclusive,
- Addendum Nos. _____ inclusive
Umow Lai Addendums Nos & (Architectural Addendum Nos. in brackets)

Tenderer

Signature Date



REGISTERED BUILDING PRACTITIONER'S DETAILS:

.....
Registered Building Practitioner Name

.....
Registered Building Practitioner No.
Commercial Builder Limited – Fitout Structural

Tenderer

Signature Date



SCHEDULE 1 – SCHEDULE OF ITEMISED COSTS

This Schedule of Itemised Costs must be completed and submitted with the Tender and, will form part of the Tender Evaluation.

DESCRIPTION	COST
Toilet Exhaust System	\$
Residential AC systems	\$
Office AC system	\$
Car Park ventilation system	\$
Residential Exhaust systems	\$
Fire Pump room ventilation system.	\$
Switch Room Ventilation	\$
Barbecue Exhaust System	\$
Automatic Controls	\$
Electrical Works	\$
Engineering & Drafting	\$
Painting & Labelling	\$
Miscellaneous Equipment	\$
Miscellaneous Work	\$
Associated Building Works	\$
Site Allowance	\$
Testing and Commissioning	\$
Demonstration and Training	\$
Manuals and As-Built Drawings	\$
Services & Maintenance during Warranty Period	\$
Other (Specify)	\$
	\$
	\$
SUB-TOTAL	\$
GST	\$
FIXED TENDER PRICE	\$
Carry Forward this Amount to the Tender Form	

Tenderer

Signature Date



SCHEDULE 2 – SCHEDULE OF TECHNICAL DATA

This Schedule shall be fully completed and forwarded with the tender. Failure to comply with this may be grounds for rejection of the Tender.

A. SUB CONTRACTORS

SUB-CONTRACTORS	
Ductwork	
Pipework	
Insulation	
Electrical	
Switchboards	
Automatic Controls	
Painting	
Building Works	
Testing & Commissioning	

B. FILTERS

MEDIUM EFFICIENCY (BLUE BED) FILTERS	F-1	F-N
Make		
Media		
Face Velocity (m/s)		
Dimensions LxWxD (mm)		
Efficiency : No.1 Test Dust		
No.2 Test Dust		
No.3 Test Dust		
No.4 Test Dust		
Initial Resistance (Pa)		
Final Resistance (Pa)		
Cell Dimensions LxWxH (mm)		

Tenderer

Signature Date



C. DUCTWORK AND ACCESSORIES

DUCTWORK AND ACCESSORIES	MAKE	MODEL
Flexible Connections		
Flexible Ductwork		

DIFFUSERS & REGISTERS	MAKE	MODEL
Louvre Face Diffusers		
Side Wall Diffusers		
Linear Diffusers		
Jet Air Diffusers		
Displacement Diffusers		
Floor Grilles		
Return Air Grilles		
Exhaust Grilles		
Balancing Dampers		
Fire Dampers		
Motorised Dampers		
Door Grilles		

D. SILENCERS

SILENCERS	SEF-1	SEF-2	SEF-N
Make			
Model			
Air Flow (l/s)			
Dimensions, LxWxH (mm)			

SF-01 OCTAVE BAND CENTRE FREQUENCY (HZ)	63	125	250	500	1K	2K	4K	8K
Insertion Loss (dB re 10 ⁻¹² Watts)								

SF-02 OCTAVE BAND CENTRE FREQUENCY (HZ)	63	125	250	500	1K	2K	4K	8K
Insertion Loss (dB re 10 ⁻¹² Watts)								

SF-03 OCTAVE BAND CENTRE FREQUENCY (HZ)	63	125	250	500	1K	2K	4K	8K
Insertion Loss (dB re 10 ⁻¹² Watts)								

Tenderer

Signature Date



<i>EF-01 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

<i>EF-02 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

<i>EF-03 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

<i>EF-04 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

<i>EF-05 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

<i>EF-06 OCTAVE BAND CENTRE FREQUENCY (HZ)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1K</i>	<i>2K</i>	<i>4K</i>	<i>8K</i>
Insertion Loss (dB re 10 ⁻¹² Watts)								

E. AUTOMATIC CONTROLS

<i>AUTOMATIC CONTROLS</i>	
Manufacturer	
Distributor	

<i>AUTOMATIC CONTROLS</i>	<i>MAKE</i>	<i>MODEL</i>
Controllers		
Sensors		
Temperature Sensors		
Variable Speed Drives		
Description and Schematic of Controls:		

Tenderer

Signature Date



SCHEDULE 3 – SCHEDULE OF UNIT RATES

A. LABOUR RATES

LABOUR RATES	NORMAL RATE (\$/HR)	TIME AND HALF (\$/HR)	DOUBLE TIME (\$/HR)
Supervisor			
Plumber			
Electrician			
Foreman			
Painter			
Welder			
Labourer			
Fitter			
Controls Technician			
Commissioning Officer			
Draftsman CAD			
Draftsman Manual			
Engineer			
Maintenance Call Out			

B. COPPER PIPING

COPPER PIPING - EXPOSED (installed and painted c/w supports)	UNINSULATED STRAIGHT (\$/M)	UNINSULATED BENDS (\$/M)	INSULATED STRAIGHT (\$/M)	INSULATED BENDS (\$/M)
10mm				
15mm				
20mm				
25mm				
32mm				
40mm				
50mm				
65mm				
80mm				
100mm				

Tenderer

Signature Date



COPPER PIPING – CONCEALED (installed c/w supports)	UNINSULATED STRAIGHT (\$/M)	UNINSULATED BENDS (\$/M)	INSULATED STRAIGHT (\$/M)	INSULATED BENDS (\$/M)
10mm				
15mm				
20mm				
25mm				
32mm				
40mm				
50mm				
65mm				
80mm				
100mm				
125mm				
150mm				

C. DUCTWORK

RECTANGULAR DUCTWORK (installed cost rates, including supports)	EXTERNALLY LAGGED STRAIGHT (\$/M ²)	EXTERNALLY LAGGED BENDS (\$/M ²)	INTERNALLY LINED STRAIGHT (\$/M ²)	INTERNALLY LINED BENDS (\$/M ²)
25mm				
50mm				
Plain Ductwork (\$/m ²)				

FLEXIBLE DUCT (including take off spigot and butterfly damper)	FLEXIBLE DUCT (\$/M)	TAKE-OFF SPIGOT (\$/UNIT)
Ø150		
Ø200		
Ø250		
Ø300		
Ø350		

CIRCULAR DUTWORK	25MM LAGGED (\$/M)	UNLAGGED (\$/M)
Ø150		
Ø200		

Tenderer

Signature Date



CIRCULAR DUTWORK	25MM LAGGED (\$/M)	UNLAGGED (\$/M)
Ø250		
Ø300		
Ø350		

PVC DUCTWORK	25MM LAGGED (\$/M)	UNLAGGED (\$/M)
Ø150		
Ø200		
Ø250		
Ø300		
Ø350		

TEXTILE DUCTWORK	25MM LAGGED (\$/M)	UNLAGGED (\$/M)
Ø150		
Ø200		
Ø250		
Ø300		
Ø350		

BUTTERFLY VALVES (Including Matching Flanges and Geared Actuator, Installed)	(\$/UNIT)
Ø200	
Ø250	
Ø300	
Ø350	

OPPOSED BLADE DAMPERS	(\$/UNIT)
150 x 150	
200 x 200	
250 x 250	
300 x 300	
350 x 350	
400 x 400	

MOTORISED DAMPERS	(\$/UNIT)
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MOTORISED DAMPERS	(\$/UNIT)
150 x 150	
200 x 200	
250 x 250	
300 x 300	
350 x 350	
400 x 400	

SMOKE DAMPERS	(\$/UNIT)
150 x 150	
200 x 200	
250 x 250	
300 x 300	
350 x 350	
400 x 400	

FIRE DAMPERS	(\$/UNIT)
150 x 150	
200 x 200	
250 x 250	
300 x 300	
350 x 350	
400 x 400	

PHEONIX VALVES	(\$/UNIT)
150 x 150	
200 x 200	
250 x 250	
300 x 300	
350 x 350	
400 x 400	

D. DIFFUSERS, REGISTERS & GRILLES

600 X 600 LOUVRE FACE DIFFUSER	(\$/UNIT)
150 x 150 neck c/w insulated plenum box	
200 x 200 neck c/w insulated plenum box	

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600 X 600 LOUVRE FACE DIFFUSER	(\$/UNIT)
250 x 250 neck c/w insulated plenum box	
300 x 300 neck c/w insulated plenum box	
350 x 350 neck c/w insulated plenum box	
400 x 400 neck c/w insulated plenum box	

RETURN AIR GRILLES	EGG CRATE (\$/UNIT)	HALF CHEVRON (\$/UNIT)
200 x 200 egg crate		
250 x 250 egg crate		
300 x 300 egg crate		
600 x 300 egg crate		
600 x 600 egg crate		
1200 x 600 egg crate		

EXHAUST AIR GRILLES	(\$/UNIT)
200 x 200 c/w plenum box	
250 x 250 c/w plenum box	
300 x 300 c/w plenum box	
600 x 300 c/w plenum box	

DOOR GRILLES (Supply only)	(\$/UNIT)
600 x 100mm (W x H)	
600 x 150mm (W x H)	
600 x 200mm (W x H)	
600 x 250mm (W x H)	

PVC DUCTWORK (installed c/w supports)	HORIZONTAL (\$/M)	VERTICAL (\$/M)	45° BEND (\$/M)	90° BEND (\$/M)
Ø300mm				
Ø350mm				

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PVC DUCTWORK (installed c/w supports)	(\$/UNIT)
Ø350 to Ø300mm transition	
Ø300 to Ø250mm transition	

STAINLESS STEEL DUCTWORK (installed c/w supports)	HORIZONTAL (\$/M)	VERTICAL (\$/M)	45° BEND (\$/M)	90° BEND (\$/M)
Ø300mm				
Ø350mm				

STAINLESS STEEL DUCTWORK (installed c/w supports)	(\$/UNIT)
Ø350 to Ø300mm transition	
Ø300 to Ø250mm transition	
Ø350 discharge cone	
Ø300 discharge cone	
Discharge damper flaps	

FLEXIBLE CONNECTIONS (installed)	(\$/UNIT)
Ø300mm	
Ø350mm	

E. CONTROLS

CONTROLS (installed)	(\$/UNIT)
VSD to suit an 11 kW electric motor	
VSD to suit a 7.5 kW electric motor	
VSD to suit a 3 kW electric motor	
VSD to suit a 2.2 kW electric motor	
VSD to suit a 1 kW electric motor	
FID installed, connected to comms loop and power	
Wall mounted room temperature sensor and wiring	

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CONTROLS (installed)	(\$/UNIT)
Wall mounted FCU controller/temperature sensor and wiring	
Duct mounted temperature sensor and wiring	
Modem	
Air off the coil temperature sensor and wiring	
Differential pressure switch (for fans), piping and wiring	
Reed type flow switches and wiring	
Digital Input (software only)	
Digital Output (software only)	
Analogue Output (software only)	
Analogue Output (software only)	
Digital Input Hardware (..... points)	
Digital Output Hardware (..... points)	
Analogue Input Hardware (..... points)	
Analogue Output Hardware (..... points)	
VAV terminal controller	
Control valves, installed and wired	
Ø15mm	
Ø20mm	
Ø25mm	
Ø32mm	
Ø40mm	
Ø50mm	
Ø65mm	
Ø80mm	
Ø100mm	
Ø125mm	
Ø150mm	
Other (List all alternatives offered)	

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