PART D

SCOPE OF WORKS OR SERVICES

TABLE OF CONTENTS

SECTION 1	I GENERAL REQUIREMENTS	1
1.01	General	1
1.02	Extent of Works	
1.03	Alternatives	
1.04	Quality And Workmanship	
1.05	Contract Parties Roles And Obligations	4
1.06	Drawings And Layouts	5
SECTION 2	2 TECHNICAL REQUIREMENTS	7
2.01	Equipment General	7
2.02	Chillers	7
2.03	Variable Speed Drives	10
2.04	Insulation.	10
2.05	Pipework	
2.06	Corrosion Protection, Painting And Labelling	14
2.07	Electrical	
2.08	Automatic Controls	
2.09	Vibration And Noise	
SECTION 3	3 INSPECTION, TESTING AND COMMISSIONING	28
3.01	General	
3.02	Testing and commisioning	
3.03	Witnessing Of Acceptance Testing By The RailCorp Representative	
3.04	Commissioning	
3.05	Post Commissioning Operation	
3.06	Certification	30
SECTION 4	4 WARRANTY, SERVICE AND MANUALS	31
4.01	General	
4.02	Manufacturer's Guarantees	
4.03	Defects Liability Period	
4.04	Performance Protection	32
4.05	Operating And Maintenance Manuals	32
SECTION S	5 APPENDIX D1 Drawings /Sketches	34

SECTION 1 GENERAL REQUIREMENTS

1.01 GENERAL

The Contractor is to provide the services in accordance with the scope of work contained in the RFQ documents including drawings.

It is the full responsibility of the Contractor to provide a workable solution to meet the specified requirements. The Contractor is at liberty to provide alternative design concepts for approval by the RailCorp Representative.

The work to be carried out under or in relation to this Contract is as set out below, and as may be further described elsewhere in this RFQ documents or drawings.

All work and materials not specifically mentioned in this RFQ documents but obviously necessary for the proper and complete installation and operation of the services, shall be deemed to have been included in the Contract.

The Contractor is referred to site for all local information required for the Contract and to establish the extent of any work involved and the nature and extent of all work to be carried out. No variations will be allowed for necessary work unforeseen by the Contractor through not having taken this precaution.

Unless specified otherwise all equipment and materials installed under this Contract shall be new.

The Contractor is to co-ordinate the specified work with services trades and Local Authorities.

It is the Contractor's responsibility to check initially and during the Contract installation stages to ensure that their program of equipment ordering and work scheduling complies with the program of work on site.

If the Contractor fails to perform through the construction or the maintenance period, the RailCorp Representative will engage another Contractor to carry out the work and the cost will be deducted from any payment to the Contractor.

1.02 EXTENT OF WORKS

1.02.01 GENERAL

The existing Petersham RailCorp Training (RCT) facility provides the majority of RailCorp's training needs and must remain in operation to meet demand. This RCT facility is being expanded to provide accommodation for new train driver and guard simulators, additional training rooms, administration areas and other support facilities.

The three existing air-conditioning chillers currently servicing the existing RCT facility are located at ground level in a location to be built out by the expanded RCT facility and therefore will require removal in future so that the expansion works can proceed. The future chillers servicing the facility will be located on the roof of the RCT expansion. In addition, two of the existing chillers no longer function and the third is reaching the end of its economic life.

1.02.02 SCOPE

The work covered by this RFQ documents also comprises the preparation of workshop drawings, supply, obtaining of all approvals and permits, installation, commissioning, testing, placing into service, warranty on installation, and maintenance of the new mechanical services and shall include but not be restricted to the following:

- Purchase the two (2) new chillers that will be required for the future expanded RCT facility.
- Install one (1) of these new chillers in a temporary location adjacent to existing RCT building but outside of the area of the expansion works.
- Deliver the second chiller in 12 to 18 month's time, as advised by the client. The second chiller will be installed under a separate contract.
- Carry out all builders work (such and excavation, concrete slab etc) necessary for the works.

- Provide and install/connect all pipe work, controls, electrical connection etc so that the
 existing two non functioning chillers are disconnected (but not removed) from the
 system, the existing operating chiller remains operational and connected to the system
 and the new chiller is connected to the air-conditioning system and is functional.
- Arrange existing controls to control the new chiller as the duty chiller and the existing carrier chiller to be standby. No automatic or unattended rotation.
- Not cause disruption to the facility air-conditioning system during all RCT operating hours.
- Design the new pipe work etc to facilitate the future disconnection and relocation of the new chiller, pumps etc to the new roof plant room.
- For the new installed chiller and associated works, provide the 12 month warrantee from the date of commissioning, service the installation for up to 18 months (with options to extend the duration of the servicing) and novate any remaining warrantees etc to the future contractor nominated by RailCorp as responsible for the RCT expansion works.
- For the new chiller in storage, provide and novate to the future RCT Expansion contractor nominated by RailCorp, the 12 months manufacturer's warrantee to commence from the date of commissioning of the chiller.
- It is necessary that the new chiller be installed and commissioned prior to the end of 2007 so that the new chiller can replace the existing operating chiller as soon as possible to reduce risks of air-conditioning failure at the RCT facility particularly during the 2007/2008 summer.
- Disconnection of redundant chilled water plant and equipment, piping and power supplies and control wiring.
- Carry out works without damage to existing trees as they belong to Council)
- Re-use existing controls for the chilled water plant (including the existing chiller) controlling the chillers and pumps.
- After hours work as required to minimize any disruptions to the buildings occupants. Where this is not possible, temporary cooling (i.e. Rented chillers complete with integral pumps and power supplies etc.) shall be provided as part of this Contract to maintain design conditions in the building at all times.
- Training of end-users.
- Detailed workshop drawings for approval.
- Operation and Maintenance Manuals, together with 'As Installed' drawings as specified.
- Painting of the completed installation including labelling of equipment, piping and services as specified.
- All other items necessary to form a complete installation.
- Testing and demonstrating the performance of all systems supplied in this Contract.
- Provision of Design and Installation Certification

The following works may also be required and are to be included in the work to be performed under this Contract where necessary:

- Undertake all coring, cutting and making good of fire rated and non fire rated building elements
- Provision of secured on-site space for storage of materials and equipment
- Provision of and making good around all openings in the building structure for the penetration of power supply and control trunking, and chilled water pipe work and the like and all cutting, patching, framing up, furring in and making good associated with the building structure.
- General attendance including use of temporary light, water and electrical services, etc.
- Installation of grid mesh and openings for outside air intakes and exhaust air discharges.
- Co-ordination of the integration of services with each other during all stages of the works.
- Access and maintenance platforms to AS 1657 (Fixed platforms, walkways, stairways and ladders Design, construction and installation.
- Supply and install bases and plinths for equipment including steel fabricated bases and reinforcement steel mesh.
- Supply and installation of louvres in external walls
- Provision of penetrations and under flashing and over flashing

1.02.03 STANDARDS

Installation shall comply with, but not limited to the following:

- Building Code of Australia
- AS 1045 Measurement of sound absorption in a reverberant room

•	AS 1055	Acoustics – Description and Measurement of Environmental Noise		
•	AS 1100	Technical Drawing		
•	AS 1324	Air Filters for Use in General Ventilation and Air Conditioning		
•	AS 1345	Identification of the Contents of Pipes, Conduits and Ducts		
•	AS 1359.10	Rotating electrical machines, General requirements, Designation and Dimensions		
•	AS 1359.20	Classification of types of enclosure		
•	AS 1432	Copper Tubes for Plumbing, gas fitting & drainage applications		
•	AS 1571	Copper – Seamless Tubes for Air Conditioning and Refrigeration		
•	AS 1657	Fixed platforms, walkways, stairways and ladders – Design, construction and installation		
•	AS1668.1	Fire and smoke control in multi-compartment buildings		
•	AS1668.2	Ventilation design for indoor contaminant control		
•	AS 1668.3	The Use Of Air Conditioning & Ventilation In Buildings-Smoke Control Systems For Large Single Compartments Or Reservoirs		
•	AS 1677	Refrigeration Systems		
•	AS 1682	Fire Dampers		
•	AS 1851.6	Management Procedures for Maintaining the Fire and smoke control features of Air Handling Systems		
•	AS 1861	Air Conditioning Units – Methods of Assessing and Rating Performance		
•	AS 2053	Conduits and fitting for electrical installations.		
•	AS 2107	Acoustics – Recommended Design Sound Level for Building Interiors		
•	AS 3000	Australian, New Zealand Electrical Installation wiring rules		
•	AS 3100	Approval and Test Specification and general requirements for electrical equipment		
•	AS 3102	Approval test spec for electric duct heaters		
•	AS 3350.40	Safety of household and similar electrical appliances – Particular requirements - Electrical heat pumps, air conditioners and dehumidifiers		
•	AS 3439	Low Voltage Switchgear and Control Gear Assemblies		
•	AS 3688	Water supply – copper and copper alloy body compression and capillary fittings and threaded end connectors.		
•	AS 4254	"Ductwork for Air Handling Systems in Buildings" 1995		
•	HB 40	The Australian Refrigeration and Air-conditioning Code Good Practice		

All work shall be undertaken in accordance with New South Wales Workplace Health and Safety Regulations.

1.03 ALTERNATIVES

Offer alternatives only if providing advantages of system equipment or price over and above the specified item.

Include specified items in base price. Separately schedule technical details and cost savings of all alternatives.

Where alternatives of equipment are permitted under the RFQ documents and more than one (1) item is to be supplied, all similar items shall be of the same manufacture and type.

1.04 QUALITY AND WORKMANSHIP

All materials, equipment, components and devices shall be new and unused, of current manufacture and first quality. The manufacture shall be approved by the RailCorp Representative where this has not been specified.

All materials and equipment shall be clearly marked and suitable for the supply system to which they will be connected. All materials, equipment, components and devices shall be rated for use on a 240/415V, 50Hz power supply system unless otherwise noted.

Unless specified otherwise the manufacturers recommendations shall be followed with regard to both workmanship and associated materials, equipment, components and devices.

Where vibration is present, all materials, equipment, components and devices, which could be affected by vibration, shall be selected and installed to ensure satisfactory operation. Vibration isolation shall be provided where necessary.

All equipment and/or appliances provided under this RFQ documents shall be designed and installed to:

- a) not interfere with other equipment in the building or its immediate surrounds; and
- b) be able to withstand likely interference levels present in the vicinity.

All equipment shall be manufactured to comply with the relevant Australian standards for emission and immunity to electromagnetic interference and shall be certified with C tick compliance.

All workmanship shall be of a high standard throughout as accepted by the respective specialist trades. Only first class competent tradespeople shall be employed on the work in their respective trades.

Only suitable licensed tradespeople shall be employed on work which any authority having jurisdiction requires to be carried out by licensed tradespeople.

Where the RailCorp Representative considers workmanship is not consistent with good trade practice or standards or that any materials, equipment, components or devices are inferior in quality or deficient in quality to that specified, the RailCorp Representative may give notice in writing setting forth the defect or deficiency.

1.05 CONTRACT PARTIES ROLES AND OBLIGATIONS

Unless noted otherwise in the conditions of Contract provided directly by the RailCorp Representative, the roles of the RailCorp Representative and Contractor are clarified below for tender purposes.

1.05.01 OBLIGATIONS OF THE RAILCORP REPRESENTATIVE

During the tender and construction phase the RailCorp Representative's role is as follows:

- a) Review of tenders received.
- b) Analysis of schedule of technical data and alternatives offered.
- c) Review of shop drawings.
- d) Review of samples for the purpose of establishing compliance with the RFQ documents.
- e) Review of Contractor's inspection and test plans for each section of the works.
- f) Periodic review of the progress of the works, noting any observations with respect to quality and workmanship of the installation or materials used.
- g) Issue of any clarification instruction required to interpret the RFQ documents or drawings.
- h) Issue any instructions required to change the RFQ documents or drawings.
- i) Randomly inspect and verify test records achieved.
- j) Review and randomly verify commissioning data achieved.
- k) Inspect the works at Practical Completion and schedule any defective or incomplete items.
- I) Review "As Installed", and operating and maintenance documents.

1.05.02 OBLIGATIONS OF THE CONTRACTOR

During the construction phase, the Contractor has the following obligations:

- a) To raise in good time, issues requiring design input or clarification from the RailCorp Representative, particularly in respect to:-
 - I. Interpretation and coordination of the RFQ documents or drawings
 - II. Problems in complying with the RFQ documents
 - III. Omissions from the tender documents
 - IV. Suggested alternatives/substitutions
- b) To allow the design verification costs of the RailCorp Representative when suggesting alternatives and departures from the RFQ documents.

- c) To certify compliance with Contract documents, including all variation instructions, at Practical Completion.
- d) To certify compliance with Authority requirements.
- e) To pay all inspection and connection fees applicable to the works.
- f) To obtain all Authority permits and certificates to allow the progress of the work.
- g) To provide manufacturer's and construction drawings.
- h) To provide samples and prototypes where specified.
- i) Minimise, coordinate and acceptable disruption to facility operations
- j) No damage to Council existing trees in footpath

1.05.03 CONTRACTOR'S DESIGN RESPONSIBILITIES

The Contractor shall be responsible for the detailed design activities associated with the mechanical services, including:

- a) Size and location of penetrations in walls and floors
- b) Physical coordination of installation with all trades
- c) Coordination of the construction of the installation
- d) Accommodate thermal expansion and construction joint movement in all services, taking into account final installation details and consistency with specified requirements
- e) Equipment mounting details and fasteners, including compliance with requirements for seismic restraint
- f) Details of electrical wiring and control diagrams of all equipment supplied by the Mechanical Installer showing all interconnections between equipment to enable the necessary wiring to be undertaken
- g) Settings for time clocks, run-on timers, etc.
- h) Capacity, design and sizing of support and conduit systems.
- i) To obtain structural approval for penetration in any floors or walls.
- j) Installation plan to demonstrate acceptable disruption etc
- k) Design to facilitate future relocation of chillers and pipework

The Contractor shall be responsible for ensuring that the detailed design of the mechanical services, which they undertake, is fully co-ordinated and compatible with the remainder of the project design.

1.06 DRAWINGS AND LAYOUTS

1.06.01 LAYOUT

Co-ordinate the works within this scope with all other services and the building structure. Locate all equipment for convenient operation, maintenance and future replacement.

1.06.02 WORKSHOP DRAWINGS AND TECHNICAL DATA

Prepare dimensioned construction (workshop) drawings of the whole of the installation.

Within 2 weeks of award of the Contract, supply to the RailCorp Representative a comprehensive schedule of all workshop drawings and samples to be produced to meet the requirements of this RFQ documents. The schedule shall also indicate the time of submission of the workshop drawings and samples for approval. The RailCorp Representative may require the modification of schedule and submission dates to more closely fit the overall requirements of the project. Amend the schedule in accordance with the RailCorp Representative's requirements and comply with it. Failure to comply with the final approved schedule may make the Contractor liable for any additional costs incurred by the RailCorp Representative as a result of late information. Workshop drawings must identify all work and items of installed building work required to be performed by others and required to be carried out to ensure the optimum performance of the services installation.

Three (3) prints of each workshop drawing shall be submitted to the RailCorp Representative for checking and approval.

The purpose of this review is to minimise the likelihood of inconvenience to the RailCorp Representative, which would result from rejection of unsatisfactory equipment or work following installation.

The review is in no way intended to relieve the Contractor's responsibility to check the shop drawings and technical data and to meet the Contract requirements especially where some items have been missed out or substituted. In this instance, the Contractor shall be responsible for installing the original items specified.

Submit all shop drawings and technical data in accordance with the program, and sufficiently in advance to allow time for checking and possible amendment and resubmission.

In general allow ten (10) working days turnaround within the RailCorp Representative's office and make specific arrangements where this presents a problem.

1.06.03 "AS INSTALLED" DRAWINGS

At the completion of construction update the original dimensioned shop drawings to 'As-Built' record drawings without individual revision notations. Produce additional drawings as required to form a complete record of the installation.

The 'As-Built' drawings shall faithfully show precise details of all services exactly as installed and shall record any variations or modifications made during testing and commissioning.

Provide the following drawings to the RailCorp Representative:

- 1. One (1) full set of hard copies.
- 2. One (1) set of CAD files in AutoCAD 2000 Release format.
- 3. One (1) full set of soft copies in PDF format.

One set of 'As-Built' drawings shall also be incorporated in each Maintenance Manual.

SECTION 2 TECHNICAL REQUIREMENTS

2.01 EQUIPMENT GENERAL

The requirements of this clause shall apply unless contradicted on drawings or in other sections of this RFQ documents.

All equipment shall:

- Be new;
- Be suitable for the duty with due allowance being made for dynamic loads, stress concentrations the operating temperature and pressure range and the environment at the installation site.
- Be of service proven design, and have spare parts available from stock in New South Wales for parts required for routine servicing and in Australia for all other parts;
- Be fitted with approved guards over all safety hazards;
- Be suitable for safe reliable operation under installed conditions of service;
- Be protected against operation in conditions which could cause damage to the equipment, danger to personnel, or damage to the building or its contents;
- Comply with requirements of Statutory Authorities with jurisdiction at the work site;
- As far as is practicable be constructed using fire resistant materials.

Uniformity of type, life expectancy, protection and finish shall be preserved within practicable limits throughout the installation.

2.01.01 LAYOUT

Equipment shall be designed, constructed and installed with provision for easy access for operation, servicing and maintenance.

The equipment offered shall comply with the above requirements when installed in the positions allocated. Should any additional space or services or revised layouts be required submit details of these requirements at the time of tendering.

2.01.02 BASES AND PLINTHS

Bases shall be provided for all vibration-isolated equipment.

Bases shall:

- Have a rigid rolled-steel section frame
- Have sole plates welded to the frame
- Extend at least 100 mm beyond the extremities of the equipment support pedestals
- Be supported by vibration isolating mountings

Concrete shall have a steel trowelled finish. Drilling of structural concrete for fixings shall comply with the Structural Engineer's directions. Holes in columns shall not be located within 75mm of a corner (dimension to edge of hole).

Power fasteners shall not be used without the written approval of the RailCorp Representative.

2.02 CHILLERS

2.02.01 GENERAL

Two identical chillers are to be provided under this Contract. The first is to be delivered and installed according to the current program, but at leats prior to summer 2007/2008. The second chiller is to be included in the fixed sum price, but is to be manufactured and delivered at future date, up to eighteen months from the supply of the first. The second chiller will be handed over as part of this Contract, but installed under a separate contract.

2.02.02 PRE-COMPLETION TESTS

- Type tests: To ARI 550/590.
- Pressure tests Standard: To AS/NZS 1677.2.

2.02.03 CHILLER SETS

- Provide proprietary chiller sets including components, accessories, internal power circuits, controls and motor starters.
- Performance rating: To ARI 550/590.
- Motor starters Type: soft start
- Structure/enclosure: Provide weatherproof sheet metal enclosures for equipment requiring weather protection.
- Vibration isolators Mount chiller on vibration restrained spring or neoprene waffle pad isolating mounts with isolation efficiency equal to 95%

2.02.04 LIQUID COOLERS

- Type: Direct expansion or flooded.
- Cold surface insulation: either 1) minimum 50 mm expanded polystyrene with zinc-coated steel or aluminium sheathing or 2) minimum 19 mm elastomeric foam.

2.02.05 CONDENSERS

- Coil corrosion protection: Provide proprietary coil protective coating.
- Coil mechanical protection: Provide protection against mechanical damage during transport and installation.
- Coil grilles: Provide corrosion protected grilles to prevent the entry of birds and foreign matter into coils.

2.02.06 REFRIGERATION SYSTEM

- Design refrigeration systems for minimum refrigerant leakage potential.
- Standards: AS/NZS 1677.2 and SAA HB40.1.
- Acceptable refrigerants: Screw chillers: HCFC-134a or HCFC-123

2.02.07 ACCESSORIES

Provide necessary refrigerant circuit accessories, including the following:

- Discharge muffler (internal or external type).
- Liquid line filter drier.
- Isolation valves both sides of the filter drier.
- Liquid line solenoid valves.
- Liquid line sight glass moisture indicator.
- Refrigerant charging valve.
- Suction, discharge and oil pressure indication, either gauges or digital readout from transducers via the microprocessor based control module, as appropriate.

2.02.08 EXPANSION DEVICE.

Provide at least 2 independent refrigeration circuits.

2.02.09 CONTROL SYSTEM

- Type: Menu driven, microprocessor based module.
- Provide for chillers to start unloaded and for subsequent loading and unloading to be by the control system.
- Provide a control system which senses the leaving chilled water temperature and maintains it at the desired setting by modulation of the compressor slide valve, unloading ports or inlet guide vanes, as appropriate.
- Provide control to limit the maximum current drawn by the compressor motor by monitoring the 3 phases of supply power.
- Provide control to permit continuous manual control of power demand at operating points from 40 to 100% of full load power.
- Provide fan speed control for head pressure control, winter operation and nighttime's operation. Provide preset and scheduled control of fan speed.

2.02.10 INDICATION

Provide indication of the following:

- System on.
- Fault requiring manual reset.
- Entering and leaving liquid cooler water temperature.

- Entering and leaving condenser water temperature.
- Chilled water set point.
- Voltage on each phase, for solid state starters.
- Drawn current on each phase, for solid state starters.
- Electrical current limit set point, for solid state starters.
- Chiller diagnostics.
- Remote chilled water set point signals.
- Hours run.
- Start counter.
- General fault relay.

2.02.11 SAFETY CONTROLS

Provide electrical interlocks to protect against the following:

- Chilled water low flow.
- Condenser fan motor overload, for air cooled units.
- Compressor motor overload.
- Oil pressure failure on refrigeration compressors.
- High and low pressure for compressors.
- Short cycling of compressors.
- Low chilled water temperature.

For screw chillers, provide electrical interlocks to protect against the following:

- Motor high temperature.
- Contactor weld-in.
- Phase failure under voltage, single phase and phase rotation protection.
- High oil or bearing temperature.
- Pre-lube prior to compressor start and post-lube during compressor spin down.
- High refrigerant discharge temperature.

2.02.12 REMOTE MONITORING

- Common alarm: Provide for a common alarm signal to be connected into a remote monitoring system.
- BMS interface: Provide an interface to enable a building management system to interrogate the control panel, or reset the chiller set points.

2.02.13 CONSTRUCTION

- Casing: Close-grain cast iron.
- Rotors: Carbon steel individual rotors with male rotor directly driven or connected to the motor by a flexible coupling.
- Capacity control: Positive hydraulic capacity control assembly including machined cast iron single slide valve, a piston and interconnecting spindle or fixed port unloading with solenoid valves.
- Lubrication: Provide oil separator, pump or pressure differential oil system, filter and oil cooler.
- Crankcase heaters: To operate during off cycles of the compressor.

2.02.14 MARKING

Show the following:

- Manufacturer's name.
- Model number.
- Serial number.
- Refrigerant type.
- Refrigerant charge.
- Water side pressure drop and design water flow rates.

2.02.15 INSTALLATION

Install in accordance with instructions supplied by chiller manufacturer. Include completed manufacturer's check lists in commissioning data.

Provide removable piping sections to allow pipe cleaning.

2.02.16 COMPLETION

Check operation of the chiller system including auxiliary equipment and control systems. After starting up, adjust and calibrate the chiller system.

Commission the chiller system under the supervision of the equipment manufacturers' authorised field technicians.

2.03 VARIABLE SPEED DRIVES

Variable speed drives shall be Siemens SED2 or approved equal specifically designed for HVAC pump and fan applications.

The units shall be suited for modulating control of the rotary speed for pumps and fans driven by standard asynchronous three-phase current motors.

Standard	Product standard EN 61800-3 CE, UL, cUL, C-tick
Operating temperature	-10 to +50°C
	(Output Current derating between 40°C and 50°C)
Overload	Periodic of 110% during 60 seconds
Supply voltage	3 AC 200 V to 240 V ± 10% 50/60 Hz
	3 AC 380 V to 480 V ± 10% 50/60 Hz
	3 AC 500 V to 600 V ± 10% 50/60 Hz
Energy Metering & Heat Cost Allocation	47 Hz to 63 Hz
Output frequency	0 Hz to 650 Hz
PWM-frequency	4 kHz to 16 kHz (2 kHz steps)
Protection functions	 Overvoltage and undervoltage
	- Inverter for overtemperature
	 Motor temperature using PTC via digital input
	- I² t motor, thermal
	- Ground fault, short circuit
	- Stalling current and locked rotor
Control I/Os	6 fully programmable, isolated inputs
Analog inputs	2 scalable 0-10 V, 0-20 mA, Ni 1000
Analog outputs	2 scalable 0-10 V, 0-20 mA,
Relay outputs	2 fully programmable, 30 VDC /2 A, 250 VAC /2A
Communication	RS485: P1, N2, USS Protocol

2.04 INSULATION

2.04.01 INSULATION, GENERAL

Insulation shall be applied to the extent as indicated on the drawings. Insulation shall have all joints close butted, be applied to clean surfaces, be fixed closely to the surfaces insulated and not be crushed by the fixings. Insulation fixings shall not bridge insulation to the point where either condensation occurs on cold surfaces or the temperature of hot surfaces exceeds 50°C.

2.04.02 CHILLED WATER PIPEWORK INSULATION

Chilled water pipework insulation shall have:

- Minimum R value of 1.2 M2.K/W
- Not less than 50mm thick
- Colourbond metal sheathed
- Comply with BCA2007 Sect J 5.4, Climate Zone 5

2.04.03 REFRIGERATION PIPEWORK INSULATION

All refrigerant suction lines shall be insulated with 38 mm thick self-extinguishing inhibited expanded styrene having physical properties in accordance with AS 1366.4, for nominal apparent density of 20 kg/m³ and vapour sealed with Sisalation 450.

A Superion or Bradflex based insulation system may be offered as an alternative, subject to the approval of the RailCorp Representative. Minimum thickness shall be 9.5 mm and thermal conductivity of not greater than 0.039 w/m°C at a mean temperature of 24°C. 0,0,0,3 fire indices where inside the building structure.

Wherever refrigerant suction and liquid lines are run in contact with each other they may share common insulation formed to match the cross-section of the two (2) pipes or be insulated separately.

Insulation shall be vapour sealed against condensation on the suction line only with unsplit insulation, slipped over the work as it progresses. Insulation shall be on cork blocks and vapour sealed over. All joints in the insulation shall be glued with an approved waterproof adhesive and taped.

2.04.04 METAL SHEATHING

All insulated piping that runs outside the building and is exposed to the weather shall be finished with 0.5mm thick 316 stainless steel sheath, with grade 2B bright finish.

Longitudinal joints shall have not less than 50mm overlap located at the bottom of the pipe and arranged to shed water. Longitudinal joint shall have a single continuous 6mm diameter bead of silicone cement applied within each overlap.

Sheathing shall be held in place by 12mm x 0.5mm thick 316 stainless steel proprietary strapping to the approval of the RailCorp Representative applied by means of a special purpose tool at 600mm maximum centres.

All 90° bends shall have at least five sections, which shall have 50mm overlap, silicone cement beads in joints and be held in place with similar straps.

At pipe hangers, provide an additional reinforcing band of 0.5mm thick 316 stainless steel between hanger strap and sheathing.

2.05 PIPEWORK

2.05.01 GENERAL

Pipework shall comply with the RFQ documents sections Corrosion Protection and Painting', 'Insulation', 'Noise and Vibration' and 'Commissioning and Testing'.

Pipework in the material scheduled shall be provided to interconnect the components of the following system:

Condensate: Copper to Table B AS 1432

Pipework shall be sized and run as shown on drawings or specified. Drawings are schematic indicating the route, connections and fittings required but may not in all parts show piping in its true position. This shall not absolve the Contractor from responsibility for the proper erection of pipework suitable for the duty intended.

Pipework shall be suitable for the working and test pressures specified.

Alternative piping systems for the chilled and heating water systems only may be proposed at time of tender, eg. systems such as 'Victualic' Schedule 40 or approved equal.

2.05.02 HANDLING, PREPARATION, INSTALLATION

2.05.02.01 GENERAL

Piping shall be carefully handled to avoid damage to piping and building surfaces.

Only new, clean and undamaged piping shall be used unless specified otherwise.

Piping shall be stored in a dry area remote from materials likely to cause contamination.

Piping and fittings shall be mechanically cleaned prior to installation

Pipes shall be machine cut by a method giving square ends and undistorted sections.

Burrs shall be removed from both internal and external surfaces

Pipework shall:

- Be neatly installed in locations shown on drawing or specified;
- Have risers arranged vertical and horizontal runs either parallel or normal to enclosure walls;
- Have parallel runs neatly grouped;
- Be graded up towards air release valves and down towards drain valves;
- Not include any sections which will not drain or can trap air;
- Not transmit vibration perceptible to human senses nor noise perceptible above the noise of components for which sound power level limits have been specified;
- Be installed with provision for expansion and contraction;
- Not interfere with the removal of equipment, coils or other piping, nor
- Restrict access to doors, hatches or windows;
- Pass all specified tests prior to being insulated or otherwise concealed.

2.05.02.02 JOINTS

A minimum of joints shall be made in the piping systems.

Permanent joints shall be brazed for copper pipework.

Non-permanent joints shall be provided at connections to: equipment tanks, drip trays, flexible connections valves.

Non-permanent joints shall be one of the following:

- Flanges for any pipe diameter.
- Screwed unions for any pipe of 50 mm diameter or smaller.
- Flared fittings for any pipe of 20 mm diameter or smaller.
- Screwed for any pipe of suitable wall thickness and of 50 mm diameter or smaller.

Non-permanent joints shall be easily accessible and shall permit dismantling without disturbing plant or other piping.

All screw threads shall be lubricated with graphite grease.

2.05.02.03 BRAZING

Brazing shall:

- Comply with BS 1723;
- Be carried out by skilled tradesmen using a minimum of heat, flux and brazing alloy;
- Be carried out on joints which are clean and properly prepared.

Brazed joints shall be of the spigot and socket type achieved either by use of capillary joint fittings or machine formed integral sockets in one end of the meeting pipes. Integral sockets shall have a length of one pipe diameter or 25 mm maximum.

2.05.02.04 FLANGES

Flanges shall

- be of a compatible material with the piping joined;
- be brazed to copper piping;
- comply with AS 2129 or match flanges on equipment or valves and
- be suitable for the temperatures and pressures of the system in which installed;
- have a gasket selected for the duty fitted in the joint;
- be connected by zinc plated bolts, nuts and washers

2.05.02.05 SCREWED UNIONS

Screwed unions shall:

- be brazed to copper;
- have ground mating surfaces for metal joints, have hexagon nuts.

2.05.02.06 FLARED FITTINGS

Flared fittings shall not be used on vibrating pipes,

Pipe ends shall be annealed and flared pipe ends machine formed.

2.05.02.07 BENDS

Bends shall:

- Have a minimum centre line radius of 1.5 times pipe diameter;
- Have an undistorted cross section;
- Have at least the same pressure rating as the piping of the system in
- Which they are installed.

2.05.02.08 TEES

Tees shall:

- Be of the streamlined type with the branch making a tangential intersection in the direction of fluid flow;
- Have at least the same pressure rating as the piping of the system in which they are installed.

2.05.02.09 CHANGE IN DIAMETER

Fittings providing a streamlined change in diameter shall be used to connect pipes of different diameters.

Fittings shall be eccentric where necessary to provide complete venting or drainage of the pipe system.

2.05.02.10 SUPPORTS

Piping shall be supported by clips, rollers and hangers.

Supports shall:

- Be fabricated in steel and hot dip galvanized;
- Be "Unistrut" or approved equivalent manufacture;
- Permit appropriate movement for expansion and contraction in controlled directions;
- Be arranged so that stresses or loads due to expansion or contraction
- Pressure reaction, and the weight of the pipes and their contents do not exceed the safe loads for the support, supporting structure, any pumps or other equipment to which the pipes connect, and the pipes themselves;
- Not bridge any vibration isolation;
- Be fixed to structural elements with adequate strength for the duty.

Fixings shall not weaken the supporting structure.

2.05.02.11 EXPANSION, CONTRACTION

Pipework shall be completed with provision for controlled expansion and contraction.

When possible piping shall be arranged to be sufficiently flexible to expand and contract without:

- Development excessive stresses in the pipework;
- Transferring excessive stresses to connected equipment or the structure supporting pipework.

When the inherent flexibility or pipework is inadequate expansion loops, bellows or telescopic connectors shall be provided.

2.05.02.12 ANCHORS

Anchors shall:

 Provide a reaction for expansion forces at positions where forces can be adequately supported;

- Be spaced as shown on drawing, or, to proportion expansion approximately equally to each section of the pipework;
- Be welded to steel and PVC piping;
- Be clamped to copper piping;
- Provide restraint at changes in direction or ring jointed pipework;
- Be bolted to welded to supporting structure without causing any weakness in the structure;
- Be fixed to sections of piping free from vibration.

2.05.02.13 SLEEVES

Sleeves shall:

- Be provided at all piping penetrations through floors, walls, roof and equipment casings;
- Be fabricated in 1.0 mm thick Galvabond;
- Be installed flush with the underside of floor slabs and with the upper side projecting 75 mm above floor slabs.
- Project 50 mm each side of wall penetrations;
- Terminate flush with external surfaces of equipment casings;
- Be 1.0 mm larger in diameter than pipe plus any insulation;
- Be sealed at sound barriers, equipment casings, and penetration of masonry air shafts;
- Have lock seamed and spot welded joints;
- Be supplied by the Contractor and installed by the Contractor where the penetrations are through surfaces provided by the Contractor and installed by the Contractor where penetrations are through surfaces installed by the Contractor.

Sleeves penetrating fire-rated floors and walls shall have the space between piping and the sleeve packed with a fire resistant packing to the thickness of the fire barrier.

Seals shall be:

- Sewn boots fabricated in Wavebar 120 leaded vinyl;
- Clipped to piping and pipe sleeves with 'Cheney' worm drive hose clips;
- Airtight;
- In installed on both sides of the sleeve at penetrations through plantroom walls and slabs.

2.05.02.14 ESCUTCHEON PLATES

Escutcheon plates shall be fitted where exposed pipes pass through walls or ceilings.

Plates shall:

- Trim the piping opening;
- Be of 1.0 mm thick "Galvabond" construction;
- Be in one piece, slipped over the pipe before joints are made; being screw fixed to walls.

2.06 CORROSION PROTECTION, PAINTING AND LABELLING

2.06.01 GENERAL

Corrosion protection shall comply with following clauses of this section of the RFQ documents.

Where galvanising is mentioned throughout the RFQ documents it shall mean hot dip galvanising complying with the treatment specified in clause 'Galvanising'.

Corrosion protection shall be applied after all cutting, drilling and welding has been completed.

Sheetmetal work is excepted from the clause above except in the case of equipment casings containing water or having cold surfaces on which condensation could form.

There shall be no pockets anywhere in the system and equipment installed which can collect and retain water.

There shall be no direct contact between dissimilar metals in other than permanently dry location. In moist locations I mm thick polychloroprene, PVC or polythene gaskets shall separate metals.

Treated surfaces shall be handled carefully to prevent damage to the coatings.

The repair of defective or damaged surface coatings shall be at the Contractor's expense. Cleaning and repair shall be in accordance with the treatment originally specified.

2.06.02 PAINTING SCOPE

The mechanical services installation shall be painted where exposed to view. This definition extends to all ductwork, pipework and plant areas exposed to view such as walk in risers, plantrooms, but excludes above ceiling, below floor concealed areas and any carpark areas.

Allow for services colour selection according to Australian Standards and have them approved by the RailCorp Representative.

2.06.03 PAINTING, GENERAL

All painting shall be performed in a neat, thorough and workmanlike manner.

Upon completion of painting work the Contractor shall remove any paint spilt on adjacent surfaces leaving their finish in a clean and acceptable condition.

Wherever practicable, metal work shall be painted in the factory before despatch to the site of the work. Metal work that requires blast cleaning shall be fully primed before leaving the factory.

Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation.

After installation of equipment any damage to finished painted surfaces shall be made good.

2.06.04 PROTECTIVE TREATMENTS

2.06.04.01 GALVANISING

Surfaces shall be prepared by pickling.

The zinc coating shall:

- Be applied to all surfaces to comply with AS 1650;
- Be smooth, uniform and free from defects;
- Not clog intricate surfaces such as screw threads;
- Be applied to give average weight of 750 g/m² and to give a minimum 600 g/m².

Components damaged during galvanising shall be made good to approval or replaced.

2.06.04.02 PAINTING OF METAL (ENAMEL FINISH)

Prepare surfaces by degreasing and hand cleaning.

Galvanised surfaces shall be wash primed, washed and dried.

Surfaces shall be given:

- One coat of red oxide zinc chromate primer;
- One undercoat;
- One finishing coat of enamel.

2.06.05 PAINTING MATERIALS

Paint shall comply with requirements of the following Australian Standards:

- Enamel AS K126;
- Enamel Undercoat AS K127;
- Red Oxide Zinc Chromate Primer AS K108.

Paint shall be delivered to the site in the manufacturer's sealed containers bearing the manufacturer's label, the date of manufacturer and the batch number.

Where possible, all paints used for one painting system shall be supplied by one manufacturer.

2.06.06 LABELLING

Identify all piping exposed to view and in ceiling spaces by means of supplementary 400 mm wide colour bands as listed in Table 1 of AS 1345, every 3 metres in plantrooms and 8 metres in concealed spaces.

Label, including lettering and directional flow arrows, all services where exposed to view and in plant areas, service ducts and ceiling spaces at every 3 metres using stick on labels with min. letter height of 32 mm and arrow length of 150 mm.

Label all instruments, gauges, control equipment, indicators, valves and switchboard equipment, all items of plant eg. fans, pumps using traffolyte labels, 12 mm high lettering, white on black background.

2.07 ELECTRICAL

2.07.01 EXTENT OF WORK

Supply, install, adjust, test and maintain the complete electrical system associated with the Mechanical Contract.

Specifically the work involved includes:

- Provision of mechanical services switchboards located as shown on the drawings complete with isolating switch, starters, relays for the control of all air conditioning and ventilation equipment;
- All power and control wiring between motors, starters and isolators etc. serviced from mechanical services switchboards.
- Provision of isolation switches adjacent to each plant item.
- Provision and connection of all associated isolators, contactors, thermostats etc. for the operation of equipment.

2.07.02 STANDARD SPECIFICATIONS AND LOCAL RULES

All equipment supplied and work carried out shall comply with the requirements of the latest appropriate S.A.A. Specification or Code, or if no S.A.A. publication has been issued then the appropriate BS Specification shall apply.

The electrical installation shall be carried out in accordance with the requirements of the local Supply Authority.

2.07.03 EQUIPMENT AND UNIFORMITY

All items of equipment shall be of first grade with regard to design and manufacture and shall be completely satisfactory for operation, control, safety and maintenance under all conditions of service.

Uniformity of type and manufacture of switchgear, control gear, fittings and accessories shall be preserved throughout the whole of the installation.

2.07.04 BALANCE OF LOAD

As far as is possible, the load shall be balanced between the individual phases of supply.

2.07.05 TESTS

Tests shall include insulation and continuity tests, current measurements on all motors, heaters and other loads, tests of operation and settings of motor overload protection devices (thermal overload relays, thermistors and thermistor relays), tests of functions of control wiring circuits and interlock systems.

These tests shall form part of the acceptance tests to be witnessed by the RailCorp Representative.

2.07.06 ELECTRICAL DRAWINGS

Prepare wiring diagrams and switchboard drawings for all equipment installed and submit four prints of each to the RailCorp Representative for approval prior to commencing work.

A non-fade print of the wiring diagrams shall be mounted adjacent the appropriate switchboard in suitable plywood backed glass face frames. Diagrams shall be reduced scale prints where appropriate.

Wiring diagrams shall show all circuit and corresponding terminal strip connection numbers.

2.07.07 FORM OF ELECTRICAL SUPPLY

The electrical supply to the installation shall be a single supply 415/240 volts, 3 phase and neutral, 4 wire, 50 Hz.

2.07.08 COLOUR IDENTIFICATION

Identification, Colour Codes, Labelling and Wiring Diagrams Sub-mains shall be colour coded at terminations to match the colour coding of the Supply Authority mains. Sub-mains shall be labelled at their origin and termination with details of size, number and material of conductors.

Individual power circuits shall be phase colour coded and taped together (A, B, C phase and N) at approximately 0.6 m intervals when run throughout switchboard cable zones and in cable ducts.'

Controls wiring shall be colour coded as appropriate to the system (e.g. active, common, signal).

2.07.09 EARTHING

Earthing throughout the installation shall comply with the SAA Wiring Rules and the requirements of the Local Energy Authority.

2.07.10 WIRING METHODS

Power and control wiring for the electrical installation associated with the Mechanical Services shall be by the following method:

- a) In Plant rooms and where exposed to weather: TPI conductors in galvanized steel cable ducts or galvanized steel conduit run overhead and on the surface;
- b) Through false ceiling space, roof spaces or accessible risers: TPS at spaces based on accessible areas or TPI conductors in metal cable ducts or PVC or steel conduits;
- c) Down columns or walls in occupied areas: TPI conductors in conduit cast in concrete columns and walls, or chased into masonry walls if to be rendered or faced, or run concealed behind timber of other surface finishes.

Each wiring method shall comply with the relevant clause of the Specification.

Minimum size of conductors shall be 7/0.67 mm for power and 7/0.50 mm for control wiring. All wiring in TPI shall be by loop in method. All fire rated cabling shall be in MIMS (or approved equivalent) mounted on cable trays.

2.07.11 CONDUIT INSTALLATION

All conduits shall:

- Be installed using the loop in system;
- Be free from conduit fittings other than junction boxes, wall boxes, bends or couplings;
- Be 20 mm minimum diameter;
- Be installed so that conductors are only drawn into conduit at outlet positions, switch positions, draw-in boxes and switchboards;
- Be concealed from view by running in ceiling spaces, concrete slabs, air space of stud or double brick (or block) walls or chased into rendered masonry walls unless otherwise specified or agreed by the RailCorp Representative.
- Be set at all changes of direction where concealed within the structure;

- Be set using approved type conduit benders that prevent flattening of the conduit. (Application of heat in bending conduit will not be permitted.);
- Be located clear of the thermal insulation where installed in ceiling spaces;
- Be provided with draw-in boxes at 20m (maximum) intervals;
- Have standard depth junction boxes for outlets above false ceilings;
- Have steel wall boxes for all flush wall outlets and switches;
- Be erected with a maximum of two right angle bends or sets without a draw-in box being interposed;
- Be equipped with flexible couplings for 600mm on either side where runs cross construction joints;
- Be positioned within concrete walls or columns with a minimum of 10 mm of cover.

Conduit exposed to view shall:

- Be installed in straight runs which are parallel or normal to the building structure;
- Be installed over routes as agreed by the RailCorp Representative.

Flexible conduit shall:

• Be provided between fixed conduit and equipment which is likely to be moved or subject to vibration;

Steel conduit shall:

- Comply with A.S. 2052;
- Be provided with heavy protection to AS 2052 where installed in exterior or damp situations and in plant rooms;
- Be cut square, threaded with the minimum number of threads being cut consistent with the union, painted over the threads with conductive paint, reamed to remove burrs and adequately terminated into threaded connections or locknuts with no threads showing after assembly;
- Be fixed at 1200 mm (minimum) centres where surface run.

Rigid PVC conduit shall:

- Be of light duty complying with A.S. 2053;
- Be jointed together and to fittings with an approved solvent cement;
- Be provided with one approved expansion joint for each straight section exceeding 6 metres in length where exposed to ambient conditions;
- Be secured in position by approved saddles spaced at 600 mm (maximum) apart;

Rigid PVC conduit shall <u>not</u> be used in the following locations:

- Where exposed to mechanical damage
- Where subject to ambient or contact temperature in excess of 50^oC;
- In hazardous locations.

2.07.12 CONDUCTOR SELECTION

All conductors shall be selected to not exceed 80% of their capacity after considering all rating factors such as group circuits, installation configuration, thermal insulation and ambient temperatures.

2.07.13 TPI CONDUCTORS

TPI conductors shall be:

- PVC insulated .6/1.0 kV grade type V75 copper conductors enclosed in conduit or ducts;
- Fitted with approved lugs or terminal clips where terminated in bolted connections;
- Terminated by baring, twisting together and inserting in minimum 30 amp rating tunnel type clamp terminal strips for cable sizes up to 4.0 mm;
- Terminated using suitable lugs or ferrules soldered or crimped on using suitable tools for cable sizes larger than 4.0 mm.

2.07.14 TPS CONDUCTORS

TPS Conductors shall:

- Be insulated with 0.6/1kV grade PVC compound type V75 or higher
- Comply with AS3147
- Incorporate an earth conductor for multicore cables up to 6mm2 and as specified herein
- Be multi-core for sizes up to 10mm²

2.07.15 ELECTRONIC INSTRUMENT CONDUCTORS

Conductors for wiring thermistors, thermocouples, electronic sensors, digital control equipment, etc, shall be of types as necessary for the application and shall be screened if necessary to prevent spurious signal pick up.

2.07.16 CABLE TERMINATION LUGS

Cable termination lugs shall:

- Be installed on conductor terminals except where tunnel terminals are provided on equipment
- Comprise of an approved clamp type cable lug with bolted connection to the conductor or crimp type installed with a ratchet type crimping tool
- Be copper
- Be in accordance with the cable manufacturer's recommendations.

2.07.17 MOTORS

Motors and starters shall have ample capacity and suitable characteristics to perform the specified duties without overheating under all possible starting and running conditions.

All motors shall be capable of carrying overload torques for 16 seconds in accordance with BS 2613.

Motors 0.37 kW and over shall be drip proof squirrel cage induction type except where specified otherwise in the schedules and shall be designed and rated for continuous full load operation on 415 volt, 3 phase, 50 cycle power supply and shall comply with AS 1360.10.

2 pole motors shall not be used.

Motors shall be foot mounted.

Motors less than 0.37 kW shall be single phase, rated for continuous full load operation on 240 volt 50 cycle power supply, and shall comply with AS 1360.11.

All motors shall have grease packed ball or roller bearings installed in housings. Motors with frame size D160 and larger shall have grease nipples and grease relief openings.

Bearings for motors driving refrigeration compressors or pumps, where two or more motors are mounted on a single inertia base, shall be maximum capacity deep groove ball type.

All motors supplied shall be backed by local service organisations able to provide rewinding and all other servicing.

Motors installed in damp locations or exposed to weather shall be TEFC and weatherproof.

Insulation class shall be Class E.

Motors 37 kW and more shall have p.t.c. thermistor sensors installed in pockets wound into each of the stator windings during manufacture with each thermistor wired separately back to the motor terminal box.

Kilowatt and current ratings of motors are given for tendering purposes only and shall be adjusted as required to suit the particular equipment supplied.

All belt driven or variable pitch fan motor kilowatts shall be sufficient to supply 10% more air than specified against the resultant resistance of the system. Fan kilowatts in any case shall be not less than the nominated kilowatt figures given in the schedule.

2.07.17.01 MOTOR ISOLATING SWITCHES

All items of equipment shall be provided with M rated isolating switches located adjacent to the equipment in a convenient accessible position.

Generally, isolating switches shall be "Federal WR" series heavy-duty type, "Clipsal WH" series or equal approved, three pole or four pole.

Isolators shall have provision for padlocking and shall be capable of interrupting 800% motor full load current.

Alternatively motors 30 kW and above may be fitted with single pole control isolators of the type specified above in lieu of three or four pole isolators.

2.07.18 SWITCHBOARDS - GENERAL

All switchboards shall be strictly in accordance with AS 3439 Low Voltage Switchgear and Control Gear Assemblies. Prior to commencement of construction of the any switchboards the successful tenderer shall submit detailed drawings for approval. Ample time shall be allowed for correction of drawings prior to manufacture and installation, such that any delays in the construction and completion of the works are avoided.

The work of the switchboard manufacturer shall be fully co-ordinated with the mechanical services installation, such that overall dimensions are satisfactory and that manufactured sections can be installed within the designated areas. Clearance between the switchboard and fixed obstructions shall be strictly in accordance with AS 3000. Cable entries shall be readily accessible when the switchboard is in its installed location. Shop drawings shall be checked for co-ordination requirements prior to submission for approval.

Interlocks between switchboards shall be carried out at extra low voltage, nominally 24 volts 50 Hz.

Switchboards shall be constructed from zinc seal commercial grade sheet steel, suitable for machining and welding. Sheet steel shall be 1.6 mm minimum thickness. Where equipment is to be mounted using drilled and tapped holes, panel thickness shall not be less than 2 mm.

Switchboard cabinets shall be fully welded, machine bent and folded, smooth and free from warps, twists, and other distortions, to present a totally enclosed dead front finish. Switchboard doors shall be fitted with key lockable handles.

Controls wiring shall be numbered where joining switchboard terminal strips for systems having 20 or more control circuits, using slip-on neoprene rubber, coloured ferrules with printed numbers, or crimp on plastic ferrules with engraved or moulded numbers, or self adhesive plastic tags with printed numbers, except that all control wiring to be terminated in control panels or switchboards provided by others shall be numbered at their origin and termination.

All terminal strips shall be numbered for each wiring connection.

Labels shall be provided for all switchboard equipment and all local isolating switches and control switches. Labels shall be machine engraved traffolyte plastic laminate with bevelled edges fixed adjacent the item using nickel-plated round head screws. Lettering shall be 5 mm minimum height black characters on white background except that white characters on red background shall be used for danger or fire services labels.

Labels in switchboards shall not be fastened to cable duct lids

All control switches shall be labelled to indicate "on-off" or other positions.

Labels shall be provided on each switchboard to indicate the origin of the sub-mains and the switchboard number.

2.07.18.01 FINISH

All visible welds shall be filled and ground smooth. After removal of scale, rust and grease and after fabrication, treatment shall be as follows, (allowing ample time for thorough drying between coats).

- One coat of zinc chromate self-etching primer.
- One coat of lacquer primer surfacer.
- Three finish coats of lacquer finished to a high gloss.

Cabinets shall be painted inside and out as specified in the "Painting and Finishes" section of this RFQ documents. All equipment mounting panels shall be finished in gloss white.

2.07.18.02 POWER ISOLATING SWITCHES

All power isolating switches shall have the operating handle protruding through the front of the switchboard, such that operation of the switch and isolation of the power supply can be achieved without opening any doors.

Switches shall be quick make quick break on load isolators, rated for fault making load breaking, with provisions for padlocking, complying fully with AS 1775. Switches rated at 100 amps and above shall incorporate double break contracts specifically designed to increase contact pressure under fault current conditions.

Each switchboard shall be provided with a main power-isolating switch connected into each incoming supply unless otherwise specified. Power isolating switches shall be "Hazemeyer-Holec, Duco or Dumeco" range or approved equivalent adequately rated for the full load current of all equipment including future equipment.

Alternatively CFS units fitted with copper links in lieu of fuses may be used.

2.07.18.03 FUSES

All fuses shall be of the HRC type and fitted with HRC fuse cartridges. Fuse holders, bases and cartridges shall comply with BS 88 and AS 2005.

All fuse bases and contacts shall be shrouded so that there is no possibility of electric shock while the fuse carrier is in place, being withdrawn or when fully withdrawn. Fuse holders and bases shall be selected so that they may accommodate a fuse cartridge with a rating one step above that installed. The extended range of type T fuse cartridges for motor starting and transient duties may be used to supplement the range of standard type T fuse cartridges.

All control circuits shall be protected by HRC fuses connected to the red phase, (including those in packaged equipment) unless otherwise specified. The mechanical plant shall be logically grouped and a separate control fuse shall be provided for each group.

Similarly extra low voltage control fuses shall also be grouped. Three spare HRC fuse cartridges shall be supplied to match each rating type of fuse incorporated in the fuse fittings and switches and be mounted in racks or on clips fixed to the rear of the fuse compartment door within each switchboard. Mounting brackets shall be labelled to indicate the spare fuse cartridge rating. All fuses shall be permanently numbered and a typed fuse schedule indicating fuse number, circuit served and fuse rating shall be enclosed in a clear perspex cover and fitted into a suitable holder fixed to the rear of the door adjacent to the spare fuse holders.

All fuse cartridge elements shall be non-deteriorating and manufactured from fine silver of "Silverbond" elements, similar to GEC. Fuse elements shall be designed to ensure positive discrimination performance within the tolerances specified in BS 88 Part 2 and with a low watts loss. All fuse cartridges shall be certified to "ASTA 20" and stamped to indicate this certification.

2.07.18.04 CIRCUIT BREAKERS

Circuit breakers shall have instantaneous short circuit and inverse-time over-current tripping characteristics and shall also have positive identification of breaker status "ON" and "OFF" positions.

They shall be Terasaki or equal and shall be selected to match the nominated fault levels.

2.07.18.05 ROTARY SWITCHES

Control circuit switches shall be of the level operator rotary type similar to "Ixumi Denki ASN", Kraus and Naimer C series" with black "type F" handle or other approved alternative. Key operate switches shall match the above.

Each switch shall be front panel mounted unless otherwise specified, and clearly labelled indicating its function and controlled equipment.

2.07.18.06 PHASE AND POWER FAILURE RELAYS

All mechanical switchboards shall be installed with phase and power failure relays.

2.07.18.07 CONTACTORS

Contactors shall:

- Conform to AS 1029
- Be suitable for ACB utilisation category;
- Be of the same manufacture selected from the following:
 - i) Sprecher & Schuh
 - ii) Siemens Schuckert
 - iii) or approved equal;
- Have renewable main contacts, auxiliary contacts and operating coils.
- Be AC.3 selection for motors with at least 20% spare capacity.
- Where used for higher frequency operation, eg duct heaters, shall be also rated for intermittent duty class 0.1 or higher.

2.07.18.08 THERMAL OVERLOAD PROTECTION

Thermal overload relays in accordance with AS 1023 Part 2 shall be fitted to all motors.

Thermal overload relays shall have the following features:

- Block type for mounting direct to the contactor;
- Same manufacture as contactor;
- Rated to suit contactor sizes;
- The motor full load current shall be mid range of the overload adjustment range;
- Ambient temperature compensated;
- Single phasing protection, by way of differential trip action between bimetallic heater elements on each phase;
- Manual reset and test button.

2.07.18.09 PILOT LIGHTS

Pilot lights shall be of the incandescent type installed in the fascia panel to indicate the following functions for motors and associated equipment and as further detailed in the "Controls" section of this RFQ documents.

Generally lamp colours shall be as follows:

- Green: Run
- Red: Fault

Pilots for motors or other associated equipment shall be grouped on the fascia panel adjacent to the rotary switch or switches controlling the motor or equipment clearly labelled to denote their functions. Pilot lights shall be connected via auxiliary contacts to the load side of the control fuses and not parallel connected with the starter or relay operating coil.

Pilot and indicator lamp circuits shall be designed to ensure long lamp life consistent with clear visibility in the surrounding level of illumination but shall be clearly "off" when de-energised. Pilot lights shall be of the transformer operate type with extra low voltage lamps, alternatively operated from a common 24 volt 50 Hz supply, and fitted with 28 volt (minimum) lamps. Neon type pilot lights will not be acceptable.

Spare lamps shall be provided equal to 15% of those installed (with a minimum of 5 lamps). Lamps shall be neatly packaged in a cardboard box and placed in the switchboard.

Lamp test facility shall be provided.

2.07.18.10 CONTROL CIRCUIT TRANSFORMERS

Transformers supplying extra low voltage for control interlocks and other equipment shall be double wound, and adequately rated for their duty.

The primary and secondary terminals shall be physically separated and clearly marked. HRC fuse protection shall be provided in both conductors of the secondary circuit. Where the transformer rating exceeds 300 VA a separate primary fuse shall be provided. For transformers rated at 300 VA or less, the primary may be connected to the common control circuit fuse

where applicable. Transformer primary shall be rated for 240 volts, and secondary for 24 volts. Cabling from the secondary winding to the control circuit fuses shall be rated for full secondary current.

2.07.18.11 RELAYS AND TIME DELAY RELAYS

Relays and time delays shall have inbuilt LED indication and be interlocked to give fail-safe operation. Time delays shall be provided to properly time the starting and stopping sequences, and to limit the number of starts per hour to within the capacity of the motor starters. Start limit timers shall be of the "stop to start" delay type. Relays shall be "Izumi Denki", "Siemens" "NHP", "Omron" or equal approved.

Time delay relays shall be Izumi Denki", "Siemens", "Telemecanique", "Omron" or equal approved, generally of the plug in rail mounted type similar to the relays and suitable for continuous energisation. Timing mechanism shall be electronic or of the synchronous motor driven type which does not depend on a stalled motor condition to maintain contact positions. Timing ranges and time settings shall be clearly marked on the face of the timer and delay times shall be readily adjustable throughout the range nominated in the "Controls" section of this RFQ documents or as required to suit the application.

2.07.18.12 TERMINALS

All outgoing control circuits shall be connected to numbered tunnel type rail mounted terminals similar to "Sprecher and Schuh VR" series or equal approved.

Motors and heaters shall have their power circuit cables connected directly to the motor starter, fuse or associated switchgear as appropriate.

2.07.18.13 EARTH AND NEUTRAL LINKS

Each switchboard shall be provided with separate earth and neutral bars. Bars shall be of adequate cross section and length to accommodate all earth and neutral cables associated with the circuits controlled from that switchboard.

2.07.18.14 LABELS

All components on the switchboard shall be clearly labelled with black traffolyte labels machine engraved with white lettering. The drawings to be submitted for approval shall include a label schedule nominating each label and letter size. Labels shall be fixed with screws. Minimum letter size shall be 3 mm. Component labels shall be mounted on stand off supports, so that labels are in front of equipment wiring and clearly visible. Labels shall not be fixed to removable cable duct covers etc.

2.07.18.15 MOUNTING OF EQUIPMENT

Generally all contactors, motor starters, fuses, relays and timers etc. shall be panel mounted within the cabinet, front connected and front wired. Equipment shall be fixed to drilled and tapped steel mounting panels as previously specified, using zinc plated steel metal threads with shake proof washers. Self-tapping screws shall not be used.

Other equipment necessary for operation and control of the plant, such as pilot lights, selector switches, ammeters, hours run meters, and the like shall be mounted on the front of the cabinet.

Equipment shall be logically grouped in sequence to approval.

2.07.18.16 WIRING AND TERMINATIONS

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

Terminal blocks shall be numbered and control wiring shall be numbered at each end with permanent plastic ferrules.

All control cables entering or leaving the switchboard or switch panel shall be brought to numbered terminals. Field power wiring for motors, heaters etc. shall be run direct into the control equipment, via adequately sized cabling ducts in the panel. All switchgear and control gear shall be suitable for accepting approved crimp pins or lugs, which shall be used on all power cables and control wiring.

2.07.18.17 ON SITE PROTECTION OF SWITCHBOARDS

Switchboards and control panels shall be adequately protected after delivery to site, to avoid damage to paintwork and components.

Damaged paintwork shall be neatly touched up to match the original finish.

2.08 AUTOMATIC CONTROLS

2.08.01 PRE-COMPLETION TESTS

Before delivery to site, test software under all possible operating and fault sequences using simulated inputs and outputs.

2.08.02 SUBMISSIONS

Submit proposed project specific software and documentation in hard copy form with fully developed plain English functional descriptions of all systems and supporting material such as point schedules and set points. Provide manuals and other explanatory material needed to interpret the descriptions if requested.

Demonstrate by software simulation that the project specific software achieves the required functions using simulated inputs and outputs.

Submit:

- Data sheets for each hardware component.
- Control valve schedules showing flow rate, pressure drop, static pressure at location, valve body working pressure and shut-off head.

2.08.03 CONTROL COMPONENTS

Provide sensors and controls components that are:

- Of corrosion resistant construction.
- Suitable for the respective operating environment.
- Not affected by the accumulation of dust or moisture, extraneous influences or variation in supply voltage of ±30% from nominal value.
- Selected for a response time appropriate to the application.
- Provided with tunnel type screw terminals for cable connection.

As part of the automatic control installation provide:

- Software to perform the required project specific functions.
- Facilities to alter time schedules, set points and manually override control functions.
- Diagnostic routines within the controller to continuously monitor for faults and to raise alarms.
- Time scheduling including provision for weekends, holidays and automatic adjustment to daylight saving times.
- Control algorithms for standard control functions to meet the functional RFQ documents including proportional-integral-derivative (PID) loops and calculate psychrometric properties.

2.08.04 CONTROLLERS

- Provide modular and expandable electronic controllers either application specific or universal type programmed for the required functions. Mount controllers within the mechanical control switchboard.
- Memory: Hold programs and set points in non-volatile memory or provide > 30 day battery backup of memory.
- Programming: Provide for programming through attached laptop computer. Provide for upload and download of programs and logged data.
- Display: Provide backlit alphanumeric liquid crystal display (LCD) for sensed values, faults and the like.

 Operator interface: In addition to the laptop computer interface provide the controller with keyboard or push buttons operating through a menu system to permit password limited access to change set points, time schedules and manually override control functions.

Provide connections for the following:

- External modem.
- Laptop computer.
- Each external input or output point.

2.08.05 SENSORS

Provide tamperproof sensors that are stable and accurate over time and require maintenance or re-calibration at a minimum of 12 month intervals.

Locate sensors so they are protected from extraneous influences and easily accessible for calibration and maintenance.

House room sensors in an ABS or polycarbonate case ventilated to the room air and thermally insulated from the wall.

Mount pipe mounted sensors in stainless steel tube and insert into thermometer pockets or test plug fittings in pipework. Provide a thermometer pocket or test plug fitting adjacent to each sensor for calibration purposes. Provide sensor with a metal, ABS or polycarbonate case. Protect against internal condensation.

Protect sensors exposed to the building exterior from the entry of insects.

Temperature sensors to be accurate within $\pm 0.3^{\circ}$ C over the temperature range required for the project application.

2.08.06 ACTUATORS

Provide electronic type incorporating means for manual operation in the event of power failure. Provide position indicator and AUTO-OFF-MANUAL override facilities that will enable the position of the dampers or valves to be manually set.

Mounting: Select and mount actuators to provide sufficient torque to allow changes of position with the fans or pumps operating.

Enclosure: Minimum IP54.

Protection: Protect actuators against overload and stall.

Damper actuators to be power driven in both directions except where spring return is required by AS/NZS 1668.1.Permanently mark normal operating position.

Sizing: < 1.5 m2 of damper face area per damper motor. Provide multiple actuators operating in parallel for dampers \leq 1.5 m2

2.08.07 CONTROL VALVES

Provide valves with characteristic and porting to suit the application (i.e. mixing or diverting).

Use equal percentage characteristic for heating and cooling coils. Do not use 3-way valves for 2-way control.

Construction:

Plug type with screwed connections: Gunmetal valve body with stainless steel plug and spindle.

Plug type with flanged connections: Cast iron valve body with stainless steel plug and spindle.

Ball type with screwed connections: Chrome plated brass valve body with stainless steel spindle and equal percentage ball.

Seals: Provide double 'O' rings with dirt seals on the spindle.

Connections: Flanged > DN 50, screwed \leq DN 50.

Valve pressure drop: Between 100% and 200% of the pressure drop of the equipment being controlled as necessary to achieve accurate control under all operating conditions.

Body operating pressure rating: \geq 2 times static pressure at the valve location and at the maximum fluid temperature.

2.08.08 AUTOMATIC CONTROL FUNCTIONS

Provide an automatic control installation to perform the specified functions.

Pumps:

- The chilled water pumps are constant pressure, variable flow pumps in a duty/standby arrangement.
- New controllers adjust the pump speed via the variable speed drives to maintain a constant chilled water system pressure.
- Automatic weekly change over of the duty pump.
- Flow failure and TOL alarm.

Chillers:

- The chillers are in a duty/duty/standby arrangement, when not scheduled to run, their associated chilled water valves are closed.
- Automatic weekly change over of the chillers.
- Pressure, temperature and flow failure alarms to be interfaced with the BMS to alert building management staff of alarms and unit shut down.
- High and low refrigerant pressure, high oil temperature and flow failure automatic shut down provisions required to protect chillers from damage.

2.09 VIBRATION AND NOISE

2.09.01 GENERAL

Control of the noise output and vibration from the installed plant is required.

The plans and RFQ documents indicate the extent of acoustic treatment and vibration isolation required to obtain the noise level ratings in the occupied areas.

Where noise limitation and reduction is critical then the maximum sound power levels of the individual items of equipment are specified.

Where equipment which has a greater sound power level than that specified is offered, examine the acoustic treatment specified and provide any additional treatment necessary to maintain the noise levels within the limits specified below.

The maximum noise level due to the plant in any part of the building other than Plantrooms and unoccupied utility rooms shall not to exceed the noise ratings set for the following areas.

General Offices, Class Rooms
Private office
Conference room/Auditorium/ Boardroom
General air-conditioned areas
Utility areas
Kitchen and canteens
Boundary
Local Authority Requirements

Other areas will be designed in accordance with AS2107.

(The noise rating curves shall be as defined in the I.S.O. Draft Secretariat Proposal TC/43, 1961 and as hereafter shown under NOISE RATING CURVES.)

Equipment and plant shall be installed and adjusted in accordance with the Specification and the manufacturer's recommendations. The installation, balancing and adjustment of all air systems and water systems shall be carried out in such a way as to avoid noise generation at dampers and valves due to incorrect balancing procedure or incorrect installation or adjustment of splitter dampers, guide vanes and the like.

2.09.02 NOISE MEASUREMENTS

If noise from the plant is obviously excessive due to noisy bearings or scraping of rotating parts or other similar malfunctions, then the equipment shall be repaired or replaced without first carrying out noise measurements.

Noise measurements shall be made at the completion of the installation and after the system has been balanced. Noise measurements shall be made with a sound level meter and octave band filter set of approved manufacture. The meter shall be calibrated prior to and after noise measurements.

If such measurements show that noise from items of equipment exceeds the sound power levels specified, or alternatively if no sound power level is specified and the noise exceeds the manufacturer's catalogue data, then pay the cost of remedial work.

Noise measurements shall be made no closer than 1 metre from any air outlet or intake or wall, and at a height of at least 1 metre from the floor.

2.09.03 VIBRATION

The following minimum precautions shall be taken to prevent the generation and transmission of vibration to the building structure.

2.09.03.01 MACHINERY

Machinery shall be statically and dynamically balanced and shall be isolated from the building structure as required.

Vibration isolators shall be selected with due regard to the weight and speed of the equipment to be isolated and shall have isolating efficiencies as specified below for the particular equipment or in any case, not less than 95%. Springs shall be selected to have a length when loaded approximately equal to their diameter.

When inertia blocks are required, the selection of vibration isolators and the mass of the inertia block shall be co-ordinated to give the required isolation efficiency.

For static deflections up to 12 mm vibration isolation mountings shall be single or double deflection neoprene mountings incorporating steel top and base plates and a tapped hole to facilitate bolting to equipment.

For static deflections exceeding 12 mm vibration isolation mounting shall be housed steel spring mountings incorporating levelling bolts and lock nuts and a 6 mm neoprene pad bonded to the base. Steel springs shall have a ratio of mean coil diameter to compressed length at the specified static deflection of not less than 0.8 to 1 and shall have an additional travel to solid of at least 50% of the specified static deflection.

2.09.03.02 CONNECTIONS

The connection of electrical cables, piping and ductwork to vibrating machinery shall be sufficiently flexible to prevent transmission of vibration.

SECTION 3 INSPECTION, TESTING AND COMMISSIONING

3.01 GENERAL

On completion of the installation, submit a programme to the RailCorp Representative, itemising the systems and the proposed dates for conducting acceptance tests.

Start up, operate, test and adjust the systems in accordance with the agreed programme. The manufacturer's representative, who shall remain on site until the equipment is operating satisfactorily, shall supervise the setting up of major equipment. Advise and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.

When satisfied that a system is operating satisfactorily, test the system and forward a copy of the recorded test results to the RailCorp Representative. The RailCorp Representative will witness acceptance tests when he considers the test results to be satisfactory. Remain on site until the plant is operating to the satisfaction of the RailCorp Representative.

The RailCorp Representative will make two complete tests of all equipment if necessary. If the equipment fails the second test and it, in the opinion of the RailCorp Representative, the Contractor has not made any serious endeavour to correct the fault, all further tests will be charged at current A.C.E.A. Hourly Rates plus expenses and such charges will be deducted from the Contract Price.

3.02 TESTING AND COMMISIONING

3.02.01 GENERAL

The plant and its components shall be given the following tests and such other tests as the RailCorp Representative considers necessary to bring the plant into running order. The RailCorp Representative shall be given reasonable notice, generally not less than seven (7) days, regarding the nature of tests, the time and location.

Test requirements for each component shall be either as specified under the particular component's clause, AS Codes, Statutory Regulations and the following.

Provide and pay for all materials, instruments, power and labour necessary for the tests. Ensure that mechanical trades experienced in balancing and commissioning of mechanical services are employed, or alternatively, the services of a specialist balancing company shall be engaged.

Accredited representatives of the particular component's manufacturer or supplier shall undertake acceptance tests of individual system components.

Acceptance tests, incorporating water-circulating systems, must be undertaken with each system's circulating supply water maintained at its specified operating temperature.

The RailCorp Representative shall witness acceptance tests. Compliance with the drawings and RFQ documentss and code requirements shall be certified.

Test instruments shall be check for accuracy by a N.A.T.A. approved laboratory not more than one (1) month prior to their anticipated use and copies of the calibration certificates showing the degree of accuracy shall be supplied to the RailCorp Representative prior to acceptance testing.

Minimum requirements are as follows:

- Test all plant components and system operations to ensure that all specified requirements have been achieved.
- Balance all air and water circulating systems.
- Pressure test all new condenser and/or chilled water pipework.
- Provide the RailCorp Representative with copies of these test and balance results prior to offering the plant components and systems for acceptance testing.

The established air system balance and test results shall be submitted to the RailCorp Representative on the standard test and/or balance data sheets for approval along with the Commissioning Programme.

3.02.02 CONTROL

The operation, correct settings, sequences and interlocks of all controls shall be demonstrated. Recalibration and modification of controls shall be carried out as necessary up to expiry of Defects Liability Period to maintain manufacturer's specified tolerances.

3.02.03 PIPE WORK

Pressure test all pipework before concealing, insulating or connecting to equipment to not less than 1 MPa hydrostatic for water systems unless other wise specified. Test all pipework in accordance with the relevant Australian Standard. Provide a written certificate that the pipework has been satisfactorily tested.

3.03 WITNESSING OF ACCEPTANCE TESTING BY THE RAILCORP REPRESENTATIVE

The RailCorp Representative shall be given 7 days notice of all acceptance tests and as a minimum requirement, arrangements shall be made for RailCorp Representative to witness the following tests:

- Chiller factory tests
- Controls tests
- System capacity tests.

Submit a proposed Testing Procedure to RailCorp Representative for approval not less than seven (7) days prior to the anticipated commencing date of the test.

3.04 COMMISSIONING

Prerequisites for achieving "Practical Completion" shall include the acceptance by the RailCorp Representative that the following commissioning activities have been satisfactorily completed.

- a) Establishment of the settings and operation of all automatic controls and ancillary devices, safety interlocks and the like.
- b) Water balancing of new chilled water systems.

The water quantities shall be balanced to within plus ten percent (10%) minus zero percent (0%) of those specified.

3.04.01 ACCEPTANCE TESTING OF ALL PLANT COMPONENTS AND SYSTEMS.

All acceptance testing shall be undertaken in accordance with the requirements specified under the Clause 'Testing' herein. Acceptance tests on any one (1) system shall be subject to the satisfactory completion of all work associated with items a) and b) above. Acceptance tests on any one (1) operating system shall be undertaken with all specified systems operating concurrently.

3.04.02 PLANT/SYSTEM OPERATION

On completion of all acceptance testing, to the satisfaction of the RailCorp Representative, all specified systems shall be run continuously for a minimum period of 12 hours. Any faults detected during this period shall be immediately rectified and the specified running period recommended.

3.05 POST COMMISSIONING OPERATION

The RailCorp Representative shall operate all systems associated with the new work. Make available the services of experienced technicians for the training and guidance of the RailCorp Representative

Recordings shall be taken of temperatures and humidities and room indicators and controls adjusted.

3.05.01 CAPACITY TESTS

If the installation is completed at a time when the ambient or such like conditions preclude the completion of capacity tests, the work may be deemed "practically complete" subject to the approval by the RailCorp Representative.

The outstanding capacity tests shall be undertaken, during the Defects Liability Period at a time selected by the RailCorp Representative when the plant is and has been in unserviced operation for more than seven (7) days.

The air conditioning system/s shall be tested on a day when the wet bulb temperature is equal to or greater than the specified design wet bulb temperature or when, subject to the RailCorp Representative's approval, the ambient wet bulb temperature approaches the design wet bulb temperature sufficiently close to allow the tests to be undertaken.

Outside air and return air dampers shall be adjusted to give the specified entering wet bulb temperature whilst maintaining the design air quantity.

The Contractor shall provide recording instruments during the Defects Liability Period, for a period of two (2) weeks during both summer and winter to ensure the plant is maintaining specified conditions. Records and logs of performance shall be presented in triplicate to the RailCorp Representative.

3.05.02 FINAL CHECKS

Prior to the issue of the 'Final Certificate' verify the performance of all safety and control functions of each system by way of a certified report from the respective Manufacturers, Contractors or Suppliers. Such checks shall be undertaken not earlier than one (1) month before the scheduled expiry date of the Defects Liability Period.

3.06 CERTIFICATION

Provide BCA Form 6 Essential Services Certificate on Practical Completion and Form 7 at end of Warranty. Provide Certificate of Installation in accordance with Form B of BCA/Council of City of Sydney Ventilation Code or the equivalent certification when in the jurisdiction of other councils.

SECTION 4 WARRANTY, SERVICE AND MANUALS

4.01 GENERAL

Commence a comprehensive preventative maintenance programme of the installation at the time of ' practical completion'. Practical completion shall be defined as that date when the system has been completed and commissioned, test reports indicating that the system is operating correctly and to the full extent of the design documents have been submitted and accepted by the RailCorp Representative and the system is capable of being used continuously and safely under automatic control. Defects liability period shall be 12 months from date of practical completion.

At hand-over instruct person/s nominated by RailCorp Representative of the correct operation of the plant. One week's notice shall be given to the RailCorp Representative of intension to start-up.

Instructions shall continue until a Certificate of Practical Completion is issued.

4.02 MANUFACTURER'S GUARANTEES

Provide manufacturer's guarantees for all equipment included in this Contract extending for a period of at least twelve (12) months from the date of Practical Completion of the Works.

The provision and acceptance of the certificate of essential services shall be a condition on being granted Practical Completion.

During the Defects Liability Period, arrange and co-ordinate and check any work required under the guarantees.

4.03 DEFECTS LIABILITY PERIOD

During the Defects Liability Period, RailCorp Representative will operate all building services, plant and equipment and may take an active part in the maintenance of equipment, even though under the control and direction of the Contractor. Maintain a maintenance log throughout the Defects Liability Period.

Carry out all scheduled and preventive maintenance work during this period in accordance with the recommendations of the Manufacturers and as detailed in the operation and maintenance manuals.

Send experienced and qualified technicians to site and monthly intervals or as required for testing. Carry out all service, routine adjustments, replacements, cleaning and lubrication needed to keep the whole installation operating in a first class condition. Carry out quarterly inspections (four during the defects liability period). Report to the RailCorp Representative or their nominated representative on arrival, receive any instructions about the work and issue a written report, in an approved format, on their activity and the condition of the installation both to the RailCorp Representative and the RailCorp Representatives within five days of each inspection.

As provided in the General Conditions of Contract, maintain the installation and make good any defect in workmanship or materials during the Defects Liability Period. Send a suitable technician to site at one hour's notice throughout the Defects Liability Period to meet any emergency calls for service at any time. Work continuously during all hours of any day as required to bring about the fastest possible restoration of normal system operation in the event of breakdown.

Supply complete lists of spare parts normally held in Manufacturer's stocks with sufficient details to permit accurate ordering by fax. Supply additional spare parts if specified and shall deliver them into store on site, properly packed and preserved.

Supply at the time of commissioning all special tools and equipment which may be required for routine operation, maintenance adjustment or cleaning of the installation as recommended by the equipment manufacturers.

No work or operation shall be carried out at any time in the building after hand-over without the full knowledge and prior approval of the RailCorp Representative.

4.04 PERFORMANCE PROTECTION

4.04.01 PERFORMANCE GUARANTEE

The Contractor shall guarantee the installation will perform within the design parameters. Should the system fail to do so the Contractor shall modify the system, replace components and recommission the system to achieve the required performance. The Contractor shall bear the cost of all associated work and consequential costs.

4.04.02 ROUTINE MAINTENANCE

Provide all materials, labour, tools and services necessary to service the plant during the Defects Liability Period.

Servicing provided shall comply with recommendations of the approved operating instructions and shall include regular oiling and/or greasing of all fans, electric driving motors regular cleaning of all filtering elements and electrical switchgear and all other machinery in accordance with the manufacturer's recommendations.

Check and adjust the following:

- All belt tensions, belt drives and couplings.
- Check all motor and equipment bearings for high operating temperature and high noise level.
- Check all vibration eliminators.
- Clean all air filters, once each month.
- Every three months check the complete control system and recalibrate if required.
- During service calls, check all switchgear for undue noise.
- All electrical switchgear shall be cleaned and checked for proper operation by a qualified electrician at least every twelve months.
- Repaint any damaged paintwork and leave the plant in correct operational condition.

As a minimum this service shall provide for monthly attendance by fully skilled servicemen. At the conclusion of each preventative maintenance visit a service report shall be prepared by the Contractor for signature and retention by the RailCorp Representative's representative, with a copy to be forwarded to the RailCorp Representative. The report shall cover observations of abnormal or unusual plant operation, the recommended corrective work, the extent of corrective work done, the routine attention, readings of the operating performance, and comments on the general condition of equipment.

Fourteen (14) days notice of the End of Period service shall be given to the RailCorp Representative so that a final inspection can be arranged to coincide with the work.

4.04.03 6 MONTH PERFORMANCE REVIEW

Six (6) months after Practical Completion, and after advising the RailCorp Representative, the Contractor shall visit the Site and meet with the RailCorp Representative to review the system performance, make adjustments as necessary, and report the results in writing to the RailCorp Representative.

4.04.04 12 MONTH PERFORMANCE REVIEW

Twelve (12) months after Practical Completion, and after advising the RailCorp Representative, the Contractor shall visit the Site and meet with the RailCorp Representative to review the system performance, check the function and calibration of all controls, make adjustments as necessary, and report the results in writing to the RailCorp Representative.

4.05 OPERATING AND MAINTENANCE MANUALS

Prior to Practical Completion prepare and issue three (3) copies of complete instructions for operating and maintaining the plant and equipment included in the Contract works.

Practical completion will be given at receipt of final maintenance manual "as-installed" drawings and CAD files.

One (1) draft copy of the manual shall be prepared and submitted to the RailCorp Representative for inspection one (1) month before the date set for Practical Completion.

All alterations required by the RailCorp Representative shall be made and the manuals resubmitted before Practical Completion is achieved.

Each manual shall be supplied in a hard backed binder and shall comprise one (1) complete set of 'As-Built' drawings and one (1) complete set of instructions for operating and maintaining the plant and equipment.

Binders shall be 3 post hinged, A4 size hard vinyl covers of adequate thickness, lettered on the face and the spine with the name of the project and titled "Mechanical Services - Operation and Maintenance".

The instructions for operating and maintaining the services shall detail:

- The installed services and describe the operation and use of the systems in various parts of the building.
- Safety features of equipment and controls.
- An inventory of installed equipment listing type, size and serial number, manufacturer, supplier, along with address, telephone and facsimile numbers.
- An inspection, testing and maintenance program in tabular form showing the frequency and level of routine attention required throughout the life of the equipment.
- Manufacturer's equipment brochures and literature.
- Spare parts and manufacturer's sectionalised diagrams for parts identification.
- Maintenance for each item of equipment as recommended in manufacturer's installation and maintenance pamphlets.
- 'As-Built' drawings, folded to binder size detailing all plant, pipework and control/functional diagrams.

Each manual shall be fully indexed and, wherever photocopies are included, the print quality shall be equal to that of the original and to be in English.

The format and content of each manual shall, as a minimum, comply with the following requirements:

- **Title Page** shall state name of Project, Engineer, The Contractor, and telephone numbers for normal and after hours service. Also state expiry date of service by the Contractor.
- **Table of Contents** allowing a reader to find items by most commonly used title and page number. A reasonable degree of cross-referencing shall be provided.
- **General Description** providing an easy to read description of the installation covering all systems and their functions. Reference shall be made to later and more detailed description of plant or systems.
- List of Plant & Equipment containing each item installed with maker's name and address, serial number and nameplate data.
- Electrical System.
- Control System.
- **Operating Instructions** for the correct starting, operation, etc. for each system including instructions for adjusting all controls and cut out settings. It shall include instructions for actions to be taken in event of abnormal or emergency conditions.
- **Maintenance Instructions** setting out in detail all requirements for preventative maintenance of the equipment supplied. This shall be arranged in sections and recommended daily, weekly, monthly and annual maintenance. Provide for each section a check sheet for recording maintenance done.
- **Drawings.** The drawings submitted shall be of no less a standard than that provided by the Engineer with respect to printing and setting out.

Where practical each drawing shall be folded and provided under a cover of a separate manual. Where the number of drawings exceeds 5 per set, they shall be supplied as an open 'flat' set with a hard cardboard cover with the Contractors name and relevant information.

SECTION 5 APPENDIX D1 DRAWINGS /SKETCHES

1	Drawing No. A0.03	Demolition Plans for location of Temporary Chiller Slab
2	Sketch SK –A	Temporary Chiller Slab reinforcement
3	Drawing No. S07514-M01- B	Mechanical Services for Chiller Upgrade