

Tender Specification

Proposed Bottle Shop, Bar & Restaurant
70 – 82 Hopkins Highway, Warrnambool

for

Mr. G. Dwyer

MECHANICAL SERVICES

Issue 01 – 25th May 2011
Ref : 3051

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001 DESCRIPTION OF WORK

The work covered by this specification includes the provision of all materials, plant and labour as necessary for the complete installation, commissioning and testing of the various mechanical services as described in this specification and as shown on the accompanying drawing Nos. 3051 M.1 & M.2.

The work shall comprise the supply, delivery, installation, commissioning, warranty and maintenance of the following systems and components, including the following items :

- (a) Three (3) reverse cycle split ducted air conditioning units (ACU/CU-1, 2 and 4)
- (b) One (1) reverse cycle split wall mounted type air conditioning unit (ACU/CU-3)
- (c) Three (3) roof mounted toilet exhaust fans (TEF-1 to 3)
- (d) One (1) roof mounted evaporative cooler (EC-1)
- (e) Stainless steel kitchen exhaust hoods complete with exhaust fan (EF-1), ductwork, filters, wiring and controls
- (f) Stainless steel dishwasher hood complete with exhaust fan (EF-2), ductwork, wiring and controls
- (g) Connection of gas reticulation from the new gas meter to all gas equipment including final connections complete with isolation valves
- (h) Remove redundant gas pipework and blank off
- (i) Refrigeration piping complete with fittings, valves, insulation, hangers etc. associated with the split system air conditioning units.
- (j) Condensate drain pipe work from air conditioning units drain trays and drain/overflow from the evaporative cooler
- (k) All electrical and controls work for the complete operation of the mechanical services. The work shall include the following :
 - Supply and installation of mechanical services switchboard (MSSB-1)
 - Electronic control systems including wiring
 - Termination and connection of sub-mains to the mechanical services switchboard
 - Provide local isolator to all equipment including wiring from MSSB-1
- (m) Overflashing to all ducts and pipes penetrating external walls and the roof
- (n) Flashing collars on all duct penetrations exposed to view
- (o) Escutcheon plates at all pipe work penetrations exposed to view
- (p) Sealing of penetrations to the equivalent fire, acoustic and/or pressurisation rating as the materials penetrated

- (q) Painting and identification of all equipment as specified
- (r) Holding down bolts, screws, pipes, pipe supports, conduits and any other fittings required to be built-in during construction and provision of drawings showing their accurate location
- (s) Detail drawings showing locations and dimensions of all penetrations required
- (t) Supply of door grilles as shown on the drawings
- (u) Hoisting and craning
- (v) Provision of all required scaffolding
- (w) Preparation and supply of shop drawings
- (x) Testing, commissioning and balancing
- (y) Twelve (12) months maintenance and warranty services
- (z) Provision of three (3) sets of Operating and Maintenance Manuals including as-installed drawings

002 WORK BY OTHER TRADES

01 By Builder

- (a) Hot dip galvanized structural steel support structures suitable for supporting packaged outdoor condensing units
- (b) Internal wall penetrations for ducts, conduits etc. and making good after installation of same
- (c) Cutting of openings in ceilings and ceiling tiles for supply air, return air and exhaust air grilles. Provide trimming as necessary
- (d) All removal, cutting, replacement etc. of ceiling tiles during installation and commissioning of the plant
- (e) Access openings in ceilings, bulkheads, walls and at other locations as required for adjustment, access and maintenance purposes
- (f) Roof penetrations including trimming members, upstand and underflashing. Overflashing by the mechanical services contractor
- (g) Kerbs 150 mm high at all penetrations through the roof
- (h) The building in of all pipes, pipe sleeves, holding down bolts, equipment and the like required to be built in during construction
- (i) Painting of exposed ductwork and pipework other than outside the building and range hood booster fans
- (j) Provision of roof insulation equivalent to not less than 50mm glasswool faced with sisalation but with rating equal to or better than R2

- (k) Installation of door grilles and under-cutting of doors where shown on the drawings
- (l) Supply and installation of gas meter enclosure to meet all Supply Authority requirements including concrete base, chain wire enclosure and bollards

02 By Electrical Services Contractor

- (a) Provision of three phase 415V 50Hz electrical submains to mechanical services switchboards (MSSB-1), left as cable tails adjacent to the switchboard
- (b) The mechanical contractor, prior to cable installation, shall confirm actual requirements.

03 By Hydraulic Contractor

- (a) Tundishes and drains for overflow and condensate
- (b) Cold water supply to evaporative cooler complete with stop valves

003 DOCUMENTATION

The contractor shall compile his tender price on the basis of this specification and the drawings referred to in this specification, which, to the best of the Consulting Engineer's knowledge, reflect the regulations of the relevant Authorities.

Should the contractor, during tendering procedure, notice any discrepancy between these documents and the regulations or requirements of an Authority, he shall note the matter on his tender document and adjust his tender price accordingly.

These documents reflect the minimum quality acceptable in this contract. Any omissions of detail applicable to the regulations and requirements of the Authorities having jurisdiction over these works shall be adjusted, amended and incorporated by the contractor without cost variations.

004 SITE LOCATION

The site is located at 70 – 82 Hopkins Highway, Warrnambool.

The contractor is to visit the site by arrangement with the builder and satisfy himself as to the location conditions, the full extent and character of the proposed development and the execution of the contract generally.

No claim will be entertained for any misunderstanding as to the nature and extent of the work to be done due to non-compliance with this clause.

The contractor will be given access to the site as required for carrying out the work under this contract. He must cooperate with the builder regarding access in general.

005 TENDER PRICE

The price submitted for this work shall be a fixed lump sum and shall include for all matters relating to the installation and commissioning as called for in this specification.

006 TAXES

GST is applicable to this contract.

007 CONTINGENCY SUM

Tenderers shall include in their tender prices the amount of \$10,000.00 to cover contingencies.

008 TENDER CLOSING DATE

Tenders shall be submitted in a sealed envelope marked 'Tender for Mechanical Services – Bottle Shop & Restaurant, Warrnambool' to the office of **refer to invitation to tender**.

009 LIQUIDATED DAMAGES AND SITE ALLOWANCES

Liquidated and Ascertained Damages as well as any site allowances shall be ascertained from the Builder.

010 DEFINITION OF TERMS

The Proprietor	Mr. G. Dwyer
The Builder/Construction Manager	Will be the contractor carrying out the work covered by the architectural specification
The Architect	Clarke Hopkins Clarke 115 Sackville Street COLLINGWOOD 3066
The Engineer	Robertson Consulting Group Pty. Ltd. Unit 3 38 Prospect Street BOX HILL 3128
The Subcontractor	Will be the contractor carrying out the work covered by this specification

011 CONTRACT DRAWINGS

Drawing No.	Title
3051 M.1	Mechanical Services Ground & First Floor Ductwork Layout
3051 M.2	Mechanical Services Roof Plan & Gas Piping Layout

012 PROGRAM

Work on site will commence on **refer to invitation to tender** and is due for client handover by **refer to invitation to tender**.

This work program must adhere strictly to the builder's program.

Tenderers shall allow in their costs for any overtime necessary in order to achieve the builder's program dates and the staging of the works.

013 REGULATIONS

The contractor shall throughout the execution of the works comply with the requirements of all Statutory Regulations, Local Government By-Laws, Workplace Health & Safety Acts and Regulations, as appropriate, The Building Code of Australia and all Authorities having jurisdiction at the site.

The entire installation including but not limited to the design, supply and installation of all plant and equipment, ductwork, piping, insulation and controls shall comply with the requirements of the BCA Appendix J Energy Efficiency.

The contractor shall exercise duty of care throughout the works and shall carry out a risk assessment and identify hazards.

In addition the contractor shall ensure that all moving parts are adequately protected in accordance with the Regulations and for the prevention of reasonably foreseeable harm.

The contractor shall also comply with the requirements of all relevant Australian Standards and Codes of Practice applicable to the works.

The contractor shall obtain all certificates, pay all fees and obtain all approvals, including Registration of Plant and Design Registration necessary to enable the work to proceed. The contractor shall complete certificates of ownership, when required.

Copies of all approvals and certificates shall be forwarded to the Proprietor for record purposes.

A certificate of Practical Completion will be withheld pending receipt of all certificates and approvals.

014 SHOP DRAWINGS

The contractor shall, at the request of the engineer, produce working drawings of all or any part of the installation for approval prior to installation or erection.

Shop drawings are required as listed in the specification.

The contractor shall obtain and submit to the Builder, comprehensive installation and shop drawings, with notes and/or specification, (hereinafter called "the drawings"), as is reasonably necessary for various parts of the works and also where the same are called for in the specification.

Before submitting the same to the Builder, the contractor shall satisfy himself that the work so shown or described complies with the requirements of the contract, the on-site dimensions and all relevant regulations.

Each drawing set shall be of one uniform sheet size.

The Builder shall forward the documents to the relevant Consultant who shall examine and promptly return the drawings to the Builder, signed and appropriately endorsed as approved, or accompanied by an appropriate letter. Where the Consultant requires amendments to the drawings, the amendments shall be made and submitted promptly by the contractor to the Builder.

The contractor shall not stockpile, manufacture, assemble or supply anything affected by the drawings, until he has obtained the drawings endorsed with the approval of the Builder,

which approval shall not be unreasonably delayed, but delays caused by late submission or inadequacy of such drawings shall not be recognised as a reason for variation to the contract time or contract sum.

015 SETTING OUT

The contractor shall thoroughly examine the specification and drawings, check all figured dimensions immediately after the contract is entered into and obtain such measurements and information as may be required to carry out the work.

The precise location of all openings and other work required by the contractor shall be coordinated with other trades and determined by the contractor at such times as not to cause delay to the work. If openings or work are wrongly located due to incorrect information supplied by the contractor, the contractor shall be responsible for the cost involved in rectifying the errors.

The drawings furnished by the Consulting Engineer are generally diagrammatic and unless otherwise specified shall not be used for determining the precise positions of equipment, outlets, etc. The exact location of these shall be determined by the contractor on site in conjunction with the Builder.

016 HOLES, RECESSES, CHASES, FASTENINGS

The contractor shall cooperate with the Builder to the fullest extent possible to reduce cutting, chasing, etc. to finished work to a minimum and shall, wherever possible, supply to the Builder full particulars of such requirements in advance so that recesses, holes, etc., as required can be built-in as the work proceeds.

The contractor shall carry out all cutting, boring, drilling etc. necessary for this contract and shall be deemed to have allowed for all such work. Such cutting, boring, drilling, etc. shall be undertaken only after receipt of the Builder's approval to proceed.

The contractor shall during progress of the work provide, fix and build-in bolts, sleeves, fastenings, hooks and other equipment required for the works of the contract.

017 OPERATING INSTRUCTIONS

The contractor shall within seven days before the date of practical completion, provide in triplicate, Operating Instructions and Maintenance Manuals in hard bound vinyl covers, together with a CD of the Operating Instructions and Maintenance Manuals and as installed drawings in DWG format.

Refer to Clause 709 Operating Instructions and Maintenance Manuals.

018 MAINTENANCE

The installation and/or equipment will be fully maintained, including statutory essential services until practical completion and for a further twelve months thereafter. Refer to Clause 7.10 Maintenance.

019 EQUIPMENT PERFORMANCE GUARANTEE

The subcontractor shall guarantee that all equipment items installed under the contract, when installed in accordance with the manufacturer's recommendations shall operate as specified.

It shall be the subcontractor's responsibility in cases where design conditions are not met, to check and establish that all equipment complies with the specified performance criteria.

020 CERTIFICATE OF COMPLIANCE

Prior to the date of practical completion, the subcontractor shall issue a Certificate of Compliance declaring that the entire installation complies with the relevant Codes and Regulations.

021 INFORMATION SUPPLIED ON MAGNETIC STORAGE MEDIA

Robertson Consulting Group Pty. Ltd. may supply one copy of tender drawings and/or the specification via email for production of shop drawings subject to the following :

All drawings will be supplied in (DXF) drawing exchange format suitable for use with an IBM compatible personal computer.

All documentation text will be supplied in Microsoft Word Version 6.0 or higher suitable for use with an IBM compatible personal computer.

Robertson Consulting Group Pty. Ltd. will not be responsible for errors resulting from the accuracy of any information supplied via email.

The information supplied by Robertson Consulting Group Pty. Ltd. is copyright, shall be used solely for the production of shop drawings for this project and is not to be disclosed or sold to other parties.

The information supplied by Robertson Consulting Group Pty. Ltd. via email does not form part of the contract documents.

Robertson Consulting Group Pty. Ltd. reserves the right to withhold the issue via email of part or all of the information that forms this set of tender documents.

022 AS CONSTRUCTED DRAWINGS

As constructed drawings shall be produced electronically (computer based) on Autocad Version 13 or 14. The contractor shall provide three (3) copies of each drawing reproduced on good quality paper and one (1) copy of each electronic file of each drawing on disk clearly marked. An electronic copy of each contract drawing can be obtained from the Engineer's office at cost to assist in the production of 'as constructed' drawings.

201 DUCTWORK SPECIFICATION

All ductwork shall be manufactured and installed strictly in accordance with Australian Standard AS.4254-1995 - Ductwork for Air Handling Systems in Buildings.

All dimensions in mm.

01 Low Pressure Rectangular Ductwork

Material Thickness

Largest Side	0 - 600	625 - 1200	1225 - 2100	2125+
Material Thickness	0.60	0.80	1.0	1.2

Circumferential Joints

On nominal 1200 centres (effectively 1175)

Duct Dimension	Largest Side	Smallest Side
0 - 450	Hemmed 'S' Slip	Drive Side
475 - 900	30 Bar Slip 38 x 38 x 3	Companion Angles
925 - 1500	40 Bar Slip 38 x 38 x 3	Full Angle Frames

The above joints will be used for all ductwork except duct over 1500 wide or 900 deep which will be angle framed.

All companion and full angle frames shall be spot welded and shall be turned back against the flange face. The corners of sheet metal slip type joints shall be sealed with strip caulk.

Non standard ductwork required for special application eg. perfosteel lined, double duct, etc. shall have circumferential joints on 1200 or 2400 centres using the following angle section:

Largest Side	Angle
0 - 450	32 x 32 x 3
475 - 2100	38 x 38 x 3
2125 and over	51 x 51 x 5

Perfosteel Lined Duct

No. 11 type perfosteel 0.60 thickness which has the following specification shall be used where applicable :

Hole Diameter	2.33
Pitch	6.35 staggered
Percentage Open Area	11%

Stiffening of Straight Ducts

All uninsulated ducts and all ducts either externally or internally insulated shall be stiffened circumferentially by rolled formed swage beads on 305 centres. Duct having semi-perimeter dimensions up to 500 shall not be bead rolled.

Fittings

Fittings shall not be cross broken or bead rolled but shall be stiffened as per the intermediate bracing.

Intermediate Bracing

0 - 1500	Nil	(Circumferential joints on 1200 centres)
1525 - 2100	38 x 38 x 3	M.S. angle 600 from each joint (or joint centres 600)

02 Low Pressure Circular

Material Thickness

Diameter	Up to 200	200-600	600-1000	1000-1500	1500+
Thickness	0.50	0.60	1.00	1.20	1.60

Reinforcing Angles

For all ducts above 1250mm diameter 25 x 25 x 3.2 angle rings 600mm from joint, angle welded or riveted to duct.

202 FABRICATION

All longitudinal joints in ductwork shall be Pittsburg type. Circumferential joints in ductwork shall be riveted and soldered where specified or flanged and bolted. Rivets shall be spaced at no more than 65mm centres. Ductwork shall be free of buckles or waves and shall be machine bent. Unless otherwise specified or detailed on plans, all changes in duct direction shall be made with an inside radius of not less than duct width, but where this is not practicable, square bends with approved turning vanes may be used. All changes in dimension and shape of ducts shall be bolted together with an approved sealing gasket or compound between angles which are drilled to match each other. All ductwork shall be suitably supported at intervals of 2m to 2.5m centres with approved type hangers, cradles or angle iron supports.

All ductwork shall be cross broken.

Circumferential joints shall be at least 40mm in the direction of air travel.

If angle iron frames are used they shall be prime coated with one coat of rust inhibitive paint.

Clean all ducts before erection and maintain them clean until put into service.

203 DAMPERS

Opposed blade and splitter dampers constructed of 1.62mm thick galvanised iron with 10mm diameter bright steel shafts shall be installed. Spindles shall rotate in brass or nylon bearings. Operating lever shall be external to duct and fitted with locking devices and damper position indicator. Multi-leaf dampers shall be used where single leaf dampers would be more than 230mm across the face.

Opposed blade dampers are to be interconnected and operated by a single operating level. All dampers shall be accessible.

Modulating dampers shall be opposed blade type with edges bent to line up with air flow. When tight shut operation is required, blade edges shall be fitted with effective rubber seals.

204 FLEXIBLE CONNECTIONS

Airtight flexible connections of 150mm wide Neoprene Silent-Duct shall be fitted to isolate the air handling units and fans from the supply and return air ductwork. The connections shall be so arranged as to permit their removal without disconnecting the ductwork.

Flexible connections shall be wrapped externally with fibreglass or polyester insulation blanket double faced each side with A1 Foil Trilam and securely fixed with duct sealing tapes to minimise noise break out and thermal transfer. Flexible connections located externally shall be protected by removable galvanised steel covers that permit movement each side without clashing during operation.

205 FLASHING

Where vents, ducts, piping, boiler flues, etc. penetrate the roof, flash and make watertight.

206 INSULATION

01 General

Ductwork insulation shall be in accordance with BCA Specification J5.2 "Ductwork Insulation and Sealing" Clause 3 Ductwork Insulation. Minimum total R-values for ductwork insulation shall be in accordance with Tables 3a and 3b.

02 Ductwork – External Insulation

All supply air and return air ductwork unless noted shall be externally insulated with aluminium foil covered flexible mineral wool or fibreglass firmly adhered to ducts with speed clips and pins welded to the ducts at spacings not exceeding 400mm centres.

Insulation shall have a thermal conductivity not greater than .034 W/mK at 10°C and shall be applied to form an effective vapour barrier over the whole surface of ductwork including flanges, stiffeners and support angles with all joints butted together with aluminium foil lapping at least 50mm fully adhered with approved non-flammable adhesive or sealed with an approved vapour impervious tape.

Aluminium foil lining shall be not less than .076mm thick factory applied.

03 Ductwork - Internal Acoustic Insulation

All supply air and return air ductwork shown hatched shall be internally lined with acoustic insulation in compliance with the following requirements.

All acoustic lining shall comply with AS.1530 Part 3 'Test for Early Hazard Properties of Materials' and shall have the following properties :

Ignitability	Index O
Speed of Flame	Index OP
Heat Evolved	Index O
Smoke Developed	Index O

All acoustic lining shall have a thermal conductivity rating of not more than .036 W/mK at a mean temperature of 24°C and shall be of the semi-rigid batt type manufactured from mineral wool or fibreglass having a density of not less than 48 kg/m³.

Insulation shall comprise semi-rigid batts faced with perforated aluminium foil having a free area of approximately 10% and adhered to the ducts with welded pins and speed clips located not more than 75mm from the edges of the ducts and spaced at not more than 400mm centres. A matt black insulation facing shall not be accepted as a substitute for aluminium foil.

All joints between insulation batts shall have a surface layer of perforated aluminium foil adhered and lapped in the direction of air flow.

All end pieces shall be complete with sheet metal nosings and all corners shall be held firm with angles formed from p.g.i. sheet.

Ductwork shown hatched and shaded shall have minimum 50mm thickness internal insulation.

All trafficable floors in air handling units and large ducts requiring internal insulation shall be covered with perforated zincalume sheeting to prevent damage to insulation during servicing.

207 REGISTERS AND GRILLES

01 Supply Air Diffusers

All side wall registers will be double deflection with either stream splitter or opposed blade dampers. Ceiling diffusers shall be square pattern louvre face type of steel or aluminium construction. Provide cushion heads and opposed blade dampers. Blow direction shall be as shown on the drawings. Diffusers shall be selected for correct blow dimensions and volume and 'no measurable sound'. Overall face dimensions shall be as shown on the drawings. Volume control dampers shall be provided at duct take-off branches.

02 Fresh Air Grilles

All louvres shall be constructed of aluminium blades riveted or welded into aluminium frame. Blade, shape depth, angularity and spacing shall be correlated to prevent entry of rain, give a rigid construction and low frictional resistance. A 12mm mesh 1.62mm galvanised bird screen with frame shall be provided at the rear of the intake louvres.

03 Exhaust Grilles

The ceiling return air and exhaust grilles shall be 12mm² eggcrate design. Side wall return and exhaust grilles shall be double chevron blade type. Opposed blade adjustable dampers shall be fitted to all return air and exhaust grilles.

04 Door Grilles

Unless otherwise specified, door grilles shall be of the double face chevron blade type and of aluminium construction and shall have a minimum of 45% free area.

Door grilles shall be Cameron & Jason Pty. Ltd. or equal approved manufacture.

Openings in doors to receive grilles and their installation will be by the builder.

208 FIRE DAMPERS

Fire dampers shall be of M. & E. Air Control, Dunn Air Conditioning or approved equal manufacture and are to be installed in all supply and return air ducts shown and where required by the Fire Underwriters Regulations or Local Authority. Dampers shall be held in the open position by a 70°C fusible link and arranged to lock in position on closure. Access doors of suitable size shall be provided in ducts to allow resetting of dampers.

Fire dampers shall be separately and securely anchored to walls. All fire dampers shall be wire brushed to remove loose metal, scale and rust and shall be painted with coating of full strength zinc chromate or other approved protective paint.

209 EXPOSED DUCTWORK

All ductwork exposed to weather shall have soldered seams, including air intake ducts.

210 BENDS

Radius bends shall have internal radius equal to duct width. Square bends shall be internally fitted with double hollow blade splitters.

211 DUCT SUPPORTS AND TRIMMERS

Provide and install steel trimmers between purlins and framework at roof level to enable suspension of ductwork. Provide vertical angle supports from floor wherever required to support ducting in plant rooms.

Provide and install timber trimmers at roof penetrations for supporting roof mounted exhaust fans, air intake and exhaust ducts and cowls.

212 DUCT SIZES

Unless otherwise specified, all ductwork dimensions shown on drawings are clear airway sizes.

213 ELECTRIC DUCT HEATERS

Electric heaters shall be capable of easy withdrawal for maintenance. Heaters shall have a maximum surface temperature of 538°C with a minimum air velocity of 1.27 m/sec. Heaters shall be installed greater than one duct width from any bend or tee.

The ductwork sections in which the heaters are installed shall be adequately protected against fire and shall be internally insulated for 600mm on both sides of the heater with 10mm thick Carborundum Duraboard or Morganite Kaowool fibreboard or equivalent lining. Heater elements shall be fully wired to an external terminal box with cover. Wiring shall be insulated with a material suitable for the operating temperature. A safety thermostat shall be mounted 300mm upstream of the heater elements and shall be set at 75°C. Duct heaters having capacity less than 3.6 kW shall be single phase, otherwise heaters shall be three phase.

The entire installation shall comply with AS.1668 Part 1, Clause 4.4.

214 FLEXIBLE DUCTWORK

All flexible ductwork shall be non-combustible and shall comply with AS 1530 with respect to early fire hazards properties to give spread of flame index of 0 and smoke developed index of 3.

The insulation surrounding the duct core shall be encapsulated in an aluminium/polyester laminated sleeve.

Flexible duct serving individual ceiling diffusers shall not exceed a total length of 5.0 metres from the duct take-off.

Each run of flexible duct shall consist of one factory produced length, shortened as necessary to suit the application. The connection of lengths of flexible ductwork will not be accepted.

01 Insulated

Insulated flexible duct shall have an inner skin fabricated from a resilient, coated wire helix, which is fully encapsulated in multiple layers of aluminium foil and tough polyester film with factory applied external insulation of a minimum total R-value in accordance with B.C.A. Specification J5.2 "Ductwork Insulation and Sealing" Clause 3 Ductwork Insulation Tables 3a and 3b.

The outer skin shall be reinforced aluminium laminate.

Insulated flexible duct shall be equal to Bradflo Isodec 4 Zero, perforated core.

02 Uninsulated

Uninsulated flexible duct shall be fabricated from a resilient, coated wire helix, which is fully encapsulated in multiple layers of aluminium foil and tough polyester film.

Uninsulated flexible duct shall be equal to Bradflo Aludec 4 Zero.

Flexible ductwork forming part of a ventilation system serving wet areas and showers shall be non-perforated non-insulated non-compressible aluminium duct.

Flexible ductwork shall be installed strictly in accordance with AS.4254. The duct shall have minimum number of joints.

301 REFRIGERATION PIPEWORK

01 Materials

Refrigeration piping shall be of solid drawn seamless copper tube of quality not less than that specified in AS.1571 or type 'L' of the American Standards Association above 25mm O.D.

Tubes of 10mm O.D. and smaller may be of soft, annealed, dehydrated refrigeration tube.

All elbows shall be long radius wrought copper. Miscellaneous fittings such as tees, reducers, couplings, etc. shall also be wrought copper.

Forged fittings shall be permitted only on written authority of the Engineer.

Flare type fittings shall be acceptable on sizes up to 20mm. They shall be of forged brass or manufactured from extruded brass rod. All flare coupling nuts shall be of the type especially designed for high pressure refrigerant work.

302 JOINTS

Silver soldered capillary joints shall be used throughout. Soft soldered joints shall not be used. Capillary fittings shall be close fitting type, which are mechanically rigid without solder, the solder being used as a seam only.

Brazed joints will be accepted only when silver soldering cannot be used.

Joints in small soft copper tube may be made with approved flare compression fittings.

Connections at coils shall be turned away clear of the end of the coil and arranged to allow any coil to be removed from its casing and replaced without disturbing other pipes.

303 VALVES

All shut-off valves shall be bronze alloy or forged brass back seating globe or angle valves of the packed wing sealed cap design.

They shall be of the sweat solder capillary type unless otherwise called for on the drawings. Precautions shall be taken to prevent distortion of the valve by heat while making the joint.

Charging valves shall be provided for each system. Each valve shall be packed angle valve with seal cap, non-back seating, 20mm flare x 20mm MPT with flare fitting cap and flare gasket.

All valves shall be provided where necessary for the correct operation of the system and shall be mounted in accessible positions for easy operation and maintenance.

304 ACCESSORIES

Check valves, liquid indicators and related accessories shall be properly selected for their indicated duty and shall conform to all applicable safety Codes. Check valves shall be of the spring loaded piston type. A combination liquid line sight glass and moisture indicator shall be installed in each liquid line.

Driers shall be of the angle type, shall have a capacity as detailed on the drawings, be refillable and shall have an inlet or dispersion tube and outlet filter. Sweat solder connections shall be provided and the drier shall be brass or steel with a removable bolted end flanged for easy changing of the silica gel cartridge charge. The drier shall be Sporlan or approved equal.

Strainers shall be angle type with solder connections. They shall have brass shell with forged brass caps. Strainers shall be 100 mesh welded seam monel screen reinforced with 10 mesh brass screen.

305 EXPANSION VALVES

Thermostatic expansion valves shall have the required refrigeration capacity under the specified conditions and shall be suitable for the application. Valves shall be supplied with external equaliser connections and gas filled bulbs. Expansion valves shall be Sporlan or approved equal.

306 HANGERS

Hangers shall be of the standard clevis type with steel hanger rods and standard manufactured devices as required to properly fasten hanger rods to building construction. Hangers shall be spaced in accordance with the following table :

Pipe Size O.D.	Max. Spacing
15mm - 22mm	1800mm
25mm - 40mm	2400mm
45mm - 55mm	3000mm
66mm - 130mm	3600mm

Close attention shall be given to the positioning of hangers to prevent straining joints due to expansion or vibration.

At each hanger or clamp supporting insulated pipe a half round iron shield shall be provided to fit tightly to the insulation. The shield shall be of sufficient thickness and size to support the pipe and its contents without crushing the insulation.

At each hanger or clamp supporting uninsulated piping the pipe shall be wrapped with rubber or insulation tape.

307 WORKMANSHIP

All piping shall be installed so as not to interfere with the motion of access doors, or the removal of any parts of the air conditioning or process equipment that might require occasional removal. No piping shall be installed in ductwork or interfere with plumbing, heating, electrical or other services.

All piping shall be run level and true, except where definite pitch is called for, in which case the slope shall be built in a neat, workmanlike and accurate manner. The use of fittings in concealed work shall be limited to the fewest possible number. Tubing in the greatest lengths that can be handled into position shall be used to reduce the number of joints.

If considered necessary, vibrating pipes shall be fitted with rigid brackets incorporating approved rubber or spring isolating mounts at the clamp.

Particular attention shall be paid to removing all dirt, flux, swart and turnings from the refrigeration system and to keeping it clean and dry.

The interior of each section of pipe work shall be blown through with carbon dioxide or dry nitrogen as erected and the open ends sealed until the next section is connected.

308 GENERAL

Particular attention shall be paid to the design of the piping systems and placing of equipment so that the following results will be achieved.

Risers shall be sized, or double pipe risers shall be used to return oil to the compressor at all loads.

Unless otherwise indicated, pipes, coils, etc. shall be sloped in direction of flow so that no liquid or oil will be retained in the pipes.

The oil system shall contain enough oil either in crankcase or in a reserve vessel to prevent the compressor running dry at any time either due to oil foaming on start up after a long shut down or due to oil lodging in parts of the system at low loads.

The contractor shall add any oil traps, reservoirs, oil stills, suction separators, etc. which are required for the successful operation of his plant.

Pipe connections at the compressor shall be designed with sufficient length and curves to absorb any vibration set up by the compressor or other equipment without straining the pipe system or transmitting any noticeable vibration to the building. Vibration isolators of the Anaconda type shall be provided on the suction and discharge pipe work of the compressor.

The piping shall be sized and designed to have a pressure drop when working under full load of not more than 20kPa for the suction line and 27kPa for the discharge line. This drop does not include that due to oil traps or interchanges but includes all valves and fittings.

Hot gas mufflers shall be installed on the compressor discharge pipe to eliminate noise and pulsation. Care shall be taken in selection of the muffler to ensure that resonance is not created.

309 INSULATION

Suction pipe work up to 20mm diameter shall be insulated with 13mm thick closed cell nitrile rubber pipe insulation equal to Armaflex applied as a continuous unlit sleeve. Pipe work over 20mm diameter shall be insulated with 20mm thick closed cell nitrile rubber pipe insulation. Liquid lines shall be insulated where exposed to solar radiation. Insulation shall be continuous over the length of the refrigeration pipes.

All valves and fittings are to be covered with 13mm Armaflex or approved equal to make a continuous vapourproof barrier of the piping run.

Insulated suction lines exposed to the weather shall be covered with 0.7mm swaged aluminium sheathing.

401 GENERAL

Supply and install all pipe work, fittings, supports and insulation necessary for the correct and satisfactory operation of all services described in this specification.

This section of the specification is concerned in general with materials to be used and standards of construction and shall be read in conjunction with the schedules and other sections of this specification and with the associated drawings.

The materials and construction of all pipe work are to be suitable in all respects for the class of service in each instance and shall be in accordance with any special requirements.

All piping and fittings are to be suitable for working pressure of 1035kPa or as may be required for the particular service.

All Standard Codes quoted shall be interpreted in conjunction with all relevant amendments current at time of fabrication.

The layout of pipe work and accessories shown on the drawings is approximate only, but is sufficient to show the manner in which the various systems of piping are to be run.

All work whether shown on drawings or specified shall be installed in an approved manner to meet structural and architectural conditions and avoid interference with the work or other trades, all subject to approval of the Engineer.

Special care shall be taken in the arrangements of piping to secure a neat and workmanlike appearance and true alignment and grade.

Pipe diameters are indicated on the drawings and shall not be varied without the approval of the Engineer.

All piping shall be protected and closed against entry of moisture and foreign matter while stored on site. During installation all open ends shall be securely plugged.

All pipe lengths are to have square-cut ends with all sharp edges and burrs removed from the bore of the pipe with a reamer.

All heated pipe work and all refrigerant pipe work shall be installed with due respect to expansion and contraction without interference to other piping, fittings, etc.

Expansion bends where shown shall be fitted. Where space does not permit expansion bends, linear bellows type may be used, with guides, anchors, etc. in conformity with bellows type maker's instructions.

402 MATERIALS

Piping shall be supplied according to the following specification :

01 Condenser Water

Condenser water pipe work system shall be constructed of copper. Copper alloy pipes and fittings shall comply with AS.1572.

02 Hot Water Piping & Oil Piping

Heavy gauge steel pipe or copper

03 Chilled Water Piping

Heavy gauge steel pipe or copper

04 Domestic Hot Water or Cold Water Piping

Copper piping of the following gauges shall be used :

12mm to 25mm	1.63mm
30mm and larger	2.03mm

05 Floor Heating Coils

Copper or heavy gauge rigid PVC (ACI Garnite).

06 Vents, Drains, Wastes and Minor Refrigerant Piping

Copper of the following diameters and gauges shall be used :

12mm to 25mm	1.2mm
30mm and larger	1.62mm

Note: Run-outs to the coils shall be in copper.

The minor refrigerant piping will be of dehydrated copper of sizes for the required capacity.

All refrigerant piping shall be kept closed against entry of air, moisture and foreign particles before, during and after installation.

Copper shall be used for gas piping below ground.

403 PIPE JOINTS

The types of pipe joint to be used in each instance shall be suitable for the materials and service concerned and is to be in accordance with any particular requirements of this specification.

01 Inaccessible Location

Joints in piping run in inaccessible locations shall be kept to a minimum possible number. Unless otherwise specified, joints in such positions are to be welded or brazed.

02 Change of Size

Where pipes of different diameters are to be jointed, the larger pipe shall be swaged to the bore size of the smaller before jointing. Alternatively, reducing fittings may be used.

Where the pipe reduces in size and grades downwards in the direction of the flow, the inverts of the adjoining lengths of piping shall be kept in line, so as to ensure complete drainage and venting. Conversely, where the piping reduces in size and grades upwards in the direction of the flow the inside top surfaces of the adjoining lengths of pipe shall be kept in line.

Where dissimilar metals are used between piping and equipment, flanges shall be used.

Holes in flanges shall be reamed out and fibre or approved plastic sleeves fitted over bolt shanks, with fibre or plastic washers under bolt heads and nuts.

404 FLANGES AND UNIONS

Flanged or union connections shall be provided as follows :

- (a) Where approved for easy assembly
- (b) To facilitate removal of all valves and equipment for inspection and maintenance.
- (c) At each pipe joint to plant

Flanges shall be used on all valves on headers. Unions may be used on pipes of 50mm or less diameter unless otherwise specified.

Running joints or barrel unions will not be permitted in any pipe work.

Connection at coils or other components of plant which may be withdrawn for maintenance are to be turned away clear to enable the removal of the component from its housing without disturbing pipe work.

405 WELDED JOINTS

01 Steel Pipe

Welding of joints in steel piping shall be carried out by experienced qualified welders.

The following Codes as applicable to the type of welding employed shall be complied with:

- (a) AS.1554 Part 1-1980 for metallic-arc welding for mild steel construction
- (b) AS.CB-15

02 Copper Pipe

Bronze welded joints in copper pipe work shall be made by forming a bell mouth for a length of approximately 12mm on one pipe, inserting the other pipe into this bell mouth and running bronze fillet welded around the joint in the bell mouth. In making the welded joints, care shall be taken that the weld does not project into the bore of the piping and so restrict flow. All welding shall be of first class workmanship and to the satisfaction of the Engineer and shall comply with the requirements of any Australian or British Code deemed to be relevant.

Where a branch pipe is to be connected to a main, a hole smaller than the section of branch pipe at the point of connection shall be cut in the main and then flared to form a bell mouth without projecting into the bore of the main. A bronze fillet weld shall be made around the joint in the mouth. The branch shall be annealed for a distance of 1.0m before being finally fixed in position.

406 BRAZED JOINTS

01 General

Brazed joints are to be either sleeve type or screwed and brazed.

The jointing surfaces are to be thoroughly cleaned immediately before assembly. The brazing alloy is to contain not less than 15% silver. The type of alloy and technique is to be fully in accordance with the manufacturer's recommendations for the pipe materials and the duty involved.

02 Sleeve Type

Sleeve type brazed joints shall be made by means of an accurately fitting sleeve and a suitable silver brazing alloy. The sleeve is to be either a bronze fitting or is to be made by expanding one end of one pipe with a suitable expanding tool of 'Jury' or other approved make. The capillary clearance is not to exceed 0.08mm and the joint length is to be not more than 16mm.

03 Screwed and Brazed

Screwed and brazed joints shall be made by means of accurately fitted screwed joints sealed with a suitable silver brazing alloy as specified above.

Threads on pipes shall be accurately cut so as to match the threads of the fitting or valve being jointed in both thread profile, length and taper. Threads are to be smooth and free of gaps.

Where not being used for form brazed or soldered joints, screwed joints are to be made with a jointing compound approved as suitable for the service concerned.

Where the pipe walls are not heavy enough for screwing, a short length of the requisite thickness for screwing may be used and jointed to the pipe after making the screwed joint.

407 CAPILLARY JOINTS

Capillary or sleeve type joints made with a suitable silver brazing alloy may be used where approved as an alternative to welding.

Unless written approval is obtained for other practice, capillary joints shall be made as follows.

The sleeve shall provide a joint length of 40mm x pipe diameter and shall be accurately formed to an inside diameter 0.13mm greater than that of the pipe for the full length of the joint. The end of the pipe and sleeve are to be thoroughly cleaned.

The pipe is then to be fully inserted and the capillary space is then to be completely filled with silver alloy.

The type of alloy and the technique shall be fully in accordance with the manufacturer's recommendations for the pipe material and the duty concerned.

408 FITTINGS

01 General

The number of fittings used to be minimum having regard to the provisions of Clause 'Pipe Joints'.

The bore size of all fittings is to be not less than the internal diameter of the pipelines in which they are connected.

Fittings for welding or brazing are to have a wall thickness at least equal to those of pipes to which they are joined.

02 Bends and Tees

All bends are to be long radius pattern complying with Clause 'Pipe Bends'.

Where bends are fabricated from welded straight pipe, the seam shall be placed in the nature bending zone.

03 Flanges

All flanges are to conform with the metric sizes and thicknesses specified in AS.2129 and with the appropriate Table therein according to working pressure and services.

Flanges are to be in correct alignment with opposing faces parallel before being pulled together.

Jointing material is to be suitable for the particular service and not less than 1.6mm thick. Bolts and nuts are to be mild steel, galvanised or cadmium plated or of corrosion resisting metal. Bolts and nuts are to be hexagon headed and of the correct diameter, length and number for each pair of flanges.

409 PIPE BENDS

Bends in all pipes shall have a radius not less than five times the diameter. If the radius cannot be obtained then bends in steel lines shall be bevelled-end welding pipe fittings. Alternatively, bends for copper lines shall be cast bronze bends.

All bends shall be pulled in an approved manner and no appreciable flattening or corrugating of the pipe will be allowed.

410 PIPE SUPPORTS AND ANCHORS

Pipe supports and anchors shall be provided in the positions indicated on the drawings and as otherwise required for pipe lines. Supports for horizontal pipe lines shall be spaced at intervals not greater than as indicated in the following schedule.

Diameter of Pipe	Span Between Supports
12mm	2.0m
20mm	2.5m
25mm - 40mm	3.0m
40mm and over	3.5m

Hangers and supports shall be approved design with means of adjustment for securing proper grade and alignment.

In addition to the pipe supports specified above, supports shall be provided at all welded joints.

Pipe work shall be anchored with due regard to expansion and contraction of mains. Where pipes are grouped, they shall be run on approved steel racks and shall be properly secured with pipe clips and screws.

411 PIPE SLEEVES

Where pipes pass through walls, floors or ceilings, sleeves constructed from 1.62mm galvanised iron shall be fitted. Sleeves shall be sized to give clearance around pipe and when installed, pipe and sleeve shall not be in contact.

The inside of sleeves and the outside of pipes shall be freed from all burrs, etc. and sleeves shall project 6mm beyond the building surface on either side. Openings exposed to view shall be covered with chromium plated brass or copper cover plate, the hole in which shall permit free movement of the pipe.

412 FLASHING

Where the flue and any vent or other piping passes through the roof, the flashing will be with a 'Decklite' or approved equivalent.

413 GRADING, VENTING AND DRAINING

Provide and install all pipe work of the sizes and in the positions shown, all arranged and installed to give a free circulation of water and carefully graded to provide natural air venting, where possible. All high points shall be fitted with air release vents. Where air release vents are necessary and inaccessible, venting pipes must be taken to an accessible position with termination valve. Open vents shall be installed where shown.

Provide 20mm diameter draining valves to enable any section of pipe work to be drained. Valves shall be located in an accessible position and suitably tagged for identification.

Vents and equipment relief valves shall be drained to nearest floor wastes. Pumps with packed glands shall be drained to floor wastes.

414 STRAINERS

Provide pipe line strainers of M.E. Mack or other approved make as shown on plans and diagrammatic arrangements. Strainers shall be of pipe line size with bronze or cast iron bodies rated for hydraulic service of 1035 kPa and equipped with an easily removed cover for access to brass perforated sediment basket which shall have a nett free area of at least four times that of the pipe. Strainer mesh shall in all cases be considerably less than the smallest flow aperture in the system.

415 FLEXIBLE CONNECTIONS

Where pumps are later specified to be fitted with isolation mountings, approved flexible connections shall be fitted between suction and discharge piping and pump.

416 THERMOMETER POCKETS

Where thermometers, or thermometer pockets are shown on the drawings, pipe work shall be enlarged to allow a free area equal to pipe diameter.

417 VALVES

Globe valves shall be used where shown on drawings. Valves shall be bronze bodied with stainless steel renewable valves and seats and shall be of M.E. Mack, S.T.G., John or other approved make. Gate valves shall be used where on/off control only is required. Valve bodies shall be non-ferrous castings of S.T.G., John or other approved make.

Check valves shall be bronze body of swing check type with bronze moving disc and hinge and shall be of John Fig. 48 or other approved make.

Plug cocks shall be of John Fig. 3A and shall be used as balancing valves where shown on drawings.

Valves will have arsenical bronze stems. Unless otherwise specified, valves shall be of the same nominal bore as the pipes to which they are fitted. Valves shall be placed in accessible positions for operation and repair. All valve connections shall be made with a flange OR a union.

Where gate and globe valves are shown in the plant room, Audco or approved equal butterfly valves may be used.

Control valves are specified under Controls.

On completion of the installation, all hand operated valves shall be carefully packed with new approved graphite packing and the threads shall be oil coated with graphite and oil.

418 LABELLING OF PIPES AND VALVES

The function of each pipe and direction of flow arrows in the plant room shall be designated by means of Brad's Zip Strip or other equal approved engraved traffolyte labels fixed to the lagging cover or pipe.

419 PAINTING

A priming coat of red lead in linseed oil or of a chromate type and two finishing coats shall be applied. The final coat shall be of a glossy finish to AS.1345 for the respective services. All pipe in positions not generally visible shall not be painted. Any ungalvanised steel hangers, angles or brackets where unseen shall be prime coated only.

420 PIPE TESTING

As pipe reticulation proceeds and before pipes are hidden, the various systems shall be tested from time to time at the following pressures :

Condenser and chilled water	690 kPa
Heating pipe	1035 kPa
Hot water - domestic lines	1035 kPa
Gas lines	690 kPa

Condensate and miscellaneous drain systems shall be water tested for unobstructed drainage.

Notice shall be given to the Engineer 48 hours before the date when tests will take place to enable him to be present if he wishes.

The method of test shall be to pump the system to 1.25 times the working pressure which shall be maintained with all valves shut for a period of 24 hours or for such time as necessary to carefully inspect all points and valves whichever is the longer, without perceptible pressure loss.

421 INSULATION

01 General

Pipe work insulation shall be in accordance with BCA Specification J5.4 'Insulating Piping Vessels, Heat Exchangers and Tanks' Clause 2 Insulation.

Minimum total R-value shall be in accordance with Table 2.

02 For Chilled Water Piping

This piping shall be insulated with moulded sectional styrene foam or approved equal. Insulation shall be applied over clean dry surfaces with all joints firmly butted together with Flintkote bitumen emulsion adhesive applied to both surfaces and so applied to form an effective vapourproof barrier. The sectional piping insulation shall be staggered halves and shall be secured with three metal straps per section. All fittings and valves shall be insulated with removable boxes of insulation shaped to fit snugly around the fittings and valves and held securely by aluminium sheathing and clips. Where the chilled water piping is exposed to view in plant rooms it is to be covered with 0.7mm swaged aluminium sheathing.

All joints to be full segmented lobster back. Screws to be stainless steel hidden from view on top of joints.

Where the pipe work is not exposed to view in the building, Armstrong Armaflex or Insolex may be used as alternative insulation. However, if used, it must be installed strictly in accordance with the manufacturer's instructions to form an effective vapour seal.

The chilled water pump should also be insulated with minimum 50mm of styrene foam broad cut into blocks and fitted around the pump and held in position with Bostik 46 and bonded with 1.62mm gauge galvanised annealed wire. The whole shall be enclosed in 0.56mm aluminium cover designed for easy removal of service without damage to the casing.

03 For Heating Water Piping

This piping shall be insulated with Armstrong Armaflex or sectional fibreglass sections scrim backed. Each section shall be held securely in position by glueing the seam and the strapping with three metal straps per section. Insulation at all valves, flanges and fittings shall be coned down using a non-asbestos cement. Where the hot water piping is exposed to view and in the plant rooms, it shall be finished with 0.7mm swaged aluminium sheathing as above.

04 Domestic Hot Water Piping

The domestic hot water piping shall be insulated with Armstrong Armaflex or equal. The insulation shall be held in position by means of metal straps.

422 COMMISSIONING

Whether shown on the drawings or not, all the necessary balancing valves, isolation valves, drain valves and air bleed valves shall be installed to enable the pipe work system to be correctly balanced and commissioned.

The pipe work system shall also conform with the requirements of the manufacturer of the equipment connected to it.

501 GENERAL

Supply and install all materials, apparatus, fittings, switchboards and controls as may be necessary for the correct and satisfactory operation of the services being provided under the terms of this specification and as may be shown on the drawings and/or specified in the following clauses and schedules.

The power for mechanical services switchboards shall be as specified in the Preamble under 'Work by Others'.

502 STANDARDS AND RULES

The requirements of the AS.3000 Wiring Rules and any other Australian Standard Publications relating to the design, manufacture or installation of the electrical equipment shall be taken as minimum standards for this installation. The latest publications and amendments to the relevant specification shall be used in each case.

The installation shall be in accordance with any additional requirements of this specification and any particular requirements of the Local Electricity Supply Authority.

503 EQUIPMENT AND UNIFORMITY

All items of equipment shall be first grade as regards 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 each individual fitting and accessory shall be preserved throughout the whole of the installation.

504 CONTINUITY OF SUPPLY

Where electrical facilities exist on the site and/or premises, these facilities shall be maintained to suit the convenience of the consumer and no interruptions shall be made to the electricity supply without the consent of the Proprietor.

505 WIRING DIAGRAMS

Three copies of wiring diagrams of the installation as required under this contract together with front-of-switchboard arrangement shall be provided by the contractor for approval before commencement of work.

A diagram of the electrical wiring and equipment as finally installed shall be mounted in a glazed frame on, or adjacent to the switchboard.

506 WIRING AND CABLES

All wiring and cables except where otherwise specified shall be T.P.S. (or building wire in conduit), and shall be Australian manufacture to the approval of the Electrical Authorities.

Each coil of wire or cable delivered to site shall bear the maker's label intact otherwise it will be liable to rejection.

Distinctive colours shall be used for the braiding or insulation of all conductors throughout the installation. The colours used shall be red, white and blue for the phase wires, black for neutral, green for covered earth wires and white for control wires. In the event of any errors occurring in colours of cables the circuits shall be rewired at the contractor's expense with the correct colours.

All wiring in which abrasions of the braid or other insulation occur shall be replaced by the contractor at his own expense.

All cable connections to terminals on switchboards and distribution boards shall be fitted with lugs or approved terminal clips.

The sizes of all conductors shall comply with the requirements of this specification and, in any case, shall be not less than that required by the Australian Standard Code.

Earthing conductors shall in no case be smaller than 2.5mm². Stranded cables shall only be used of minimum size 1.5mm² for control wires. Power cables shall be minimum size 2.5mm².

All cables shall have stranded copper conductor.

Cables used on hinged control and instrument escutcheons shall be of the flexible type.

507 CONDUIT

Conduit shall be of such sizes as will permit the easy drawing in or removal of any one conductor while all others are in place and shall be a minimum diameter of 20mm.

Where it is impractical to carry conduit into equipment and where otherwise specified, approved flexible conduit shall be used.

All T.P.S. (or building wire in conduit) and earth wires shall be enclosed in conduit.

Draw-in boxes shall be provided where necessary to facilitate the drawing in of conductors on long runs. Bends shall be used in lieu of elbows in runs involving 6mm² insulated conductors or larger.

Conduits and conduit accessories shall be installed complete with draw wires before wiring of a particular section is commenced.

Class B rigid PVC conduit and fittings shall be used where not subject to mechanical damage or temperatures exceeding 60oC.

Galvanised screwed steel conduit shall be used where required by Regulations and/or subject to mechanical damage.

508 EARTHING

The complete installation shall be earthed to approval in accordance with the AS.3000 Wiring Rules and the requirements of the Supply Authority.

509 FASTENINGS

All nuts, bolts, screws, washers, clamps etc. used in contact with brass or copper or used as terminals for wire shall be brass.

Those used in contact with steel may be steel but shall be cadmium plated or similarly treated to resist corrosion. All bolts or screw heads exposed to view (eg. on the outside of distribution boards shall be chrome plated and polished.

All screw threads and nuts shall be standard.

Square or pressed nuts will NOT BE PERMITTED.

510 APPROVAL OF FITTINGS

All materials, fittings, accessories, apparatus shall be of first grade design and manufacture and shall comply with the latest Australian Standard Specifications.

511 ISOLATING SWITCHES

Supply and install isolating switches for motors as and where required by AS. Rules or by the Local Supply Authority.

Where isolating switches are exposed to the weather they shall be weatherproof type.

512 MIMS CABLING

MIMS cabling shall be of copper to AS.3187 with PVC sleeving installed in accordance with manufacturer's recommendations including sealing, terminations, earthing, support, testing, identification and connections to motors.

513 TERMINATION

At the point of termination all cables shall be fitted with approved cable ferrules to enable the identification of the circuit. This shall include power and control wiring.

514 PHASE FAILURE

Supply and install in each switchboard, a phase failure device to eliminate the possibility of single phasing.

Phase failure relays to be protected by H.R.C. fuses.

515 SWITCHBOARDS

Provide a mechanical services switchboard where shown on the drawings. The switchboards shall be of good quality, totally enclosed 1.6mm thick sheet metal cabinet, of folded construction. It shall be fabricated by a competent switchboard manufacturer. The switchboard shall have a fixed top panel carrying switches and indicators and the lower section shall consist of a recessed panel carrying fuses and switchgear for each of the motors served with hinged and lockable doors over.

The switchboard shall contain the following flush mounted equipment :

- (a) Main isolator - Dumeco or equal
- (b) Ammeters and voltmeters - M. & W. Type MEQ 144 or equal
- (c) Pilot lights which are to be of the neon high visibility type
- (d) Hour run meter - Warburton & Frankie or equal
- (e) Rotary switches of Sprecher and Schuh or equal
- (f) Time switch - Warburton & Frankie or equal

Inside behind hinged door there shall be circuit breakers, motor starters, contactors, relays, transformer, test switches, fuses and time switches which shall be mounted on the equipment chassis.

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

Contactors shall be D.O.L. type of approved manufacture with three pole thermal overload, under voltage protection and 240 volt operating coils. Start-delta starters shall be supplied for all motors with a starting current exceeding 153 amps. All contactors shall have a utilisation category of AC.3.

All motors shall be provided with English Electric Red Spot approved HRC fuses. Each motor control circuit shall be provided with rotary auto-off-manual switch fitted on the fascia panel of the switchboard, together with a green pilot light to indicate that the motor is running.

Doors shall be rigid, have compression gaskets for dust-proofing and shall be fitted with good quality handles and locks.

The metal of the cabinet is to have good quality finish in synthetic lacquer to the approval of the Engineer.

The interior is to be painted gloss white.

Ivory type machine engraved labels shall be provided for all equipment on the board and for the voltage and general designation.

Provide 10A power outlet and switch, separately fused, on the exterior of the switchboard.

Provide three spare cartridges of each applicable current rating to fuses in use.

516 FIRE PROTECTION RELAY

The contractor shall supply and install a low voltage transformer and fire relay on the mechanical services switchboard to carry out the smoke mode cycle/fire shutdown requirements as specified.

Fire rated wiring between the FIP, FFCP or sprinkler control valve and the mechanical services switchboard shall be by this contractor. The fire alarm relay will energise the circuit.

A manual reset button shall be provided on the top front panel of the switchboard with a red fault light.

All work shall comply with AS.1668.1.

601 PAINTING

Unless otherwise specified, all exposed surfaces of equipment including pipe work, brackets, diffusers, registers, compressors, pumps, boilers, air handling units and ductwork shall be cleaned and painted in accordance with this Clause and AS.2700, 1345 and 1345C.

01 General

All painters plant, tools, gear, steps, trestles, scaffolding, dust covers, etc. shall be provided as necessary for the completion of the work and for the protection of the finished work in all trades. No painting shall be done in unsuitable weather.

All surfaces shall be thoroughly dry, cleaned down, free from dirt, dust and grease and shall be prepared in a proper manner and as approved by the Consulting Engineer before painting.

Each coat shall be applied in a different shade, finished and allowed to dry sufficiently before the next coat is applied.

Finishing coats shall be left smooth and even, free from brush marks and other defects on completion.

All required tarpaulins, sheets and covering sufficient for the protection of all building surfaces shall be provided. No paint mixing shall be carried out on any floor.

All paint and other preparations, lead-free prepared, synthetic products of approved brand shall be brought onto the job ready mixed in the manufacturer's sealed containers and used to the manufacturer's specification.

02 Preparation of Surfaces

All metal surfaces shall be thoroughly wire brushed to remove loose rust, scale and shall be free from grease, etc.

The surfaces shall then be prepared with an approved rust inhibiting primer and two gloss enamel finishing coats unless otherwise noted, to the approval of the Consulting Engineer. On galvanised metal surfaces the rust inhibiting primer shall be replaced by an etch prime coat and then finished as above.

All exposed surfaces of apparatus, lagging, sheathing, bare piping, vents, steelwork, drains, pipe parts and brackets and all other work covered in this specification except where otherwise specified, shall be thoroughly cleaned down, primed, given one white undercoat and two finishing coats of first grade full gloss synthetic enamel.

602 COLOUR SCHEMES

Pipe work, ductwork and conduits shall be painted to AS.2700. Where colour schemes are not specified they shall be as instructed by the Consulting Engineer.

Pumps shall be cleaned and spot painted where necessary to match manufacturer's standard colour.

Ceiling diffusers, wall registers, return and exhaust grilles, with the exception of anodised aluminium return air and fresh air grilles, shall be supplied finish painted with semi-gloss enamel to approved colour.

603 SAFETY MARKING

All heated piping and equipment surfaces shall be painted with diagonal black and yellow bands to Code.

604 DUCTWORK AND EQUIPMENT CASINGS

Exposed ductwork and casings shall be given one coat of etching primer and two coats of full gloss enamel to approved colour.

605 PIPING AND PLATFORMS

All equipment supplied by this contractor shall be given one coat of full gloss enamel to approved colour. If already painted, it shall be touched up where required.

All duct hangers and steelwork shall be wire brushed and given one coat of red oxide zinc chromate primer, where exposed to view or the weather it shall be given two coats of full gloss enamel to approved colour.

607 VALVES

Valves which are exposed during normal operation shall have their bodies painted black and machined surfaces polished and given two coats of clear lacquer. Handwheels shall be painted green if normally open and red if normally closed.

608 IDENTIFICATION

After final finishing and painting, all ductwork, pipe work and equipment in plant rooms and other areas where they are exposed during normal operation, shall be fitted with engraved traffolyte labels indicating direction of flow and contents of the ducts or pipe and equipment names. The height of the labels on ducts and equipment shall be 75mm high.

701 FIRE PRECAUTION

This contractor shall take all precautions against fire risk when welding adjacent to inflammable materials. At all times this contractor shall use non-inflammable type shields and shall have water or a fire extinguisher adjacent in the event of fire breaking out. Contractors shall familiarise themselves with and carry out the Fire Underwriters Association Fire Precautions in Cutting and Welding Operations and AS.1674.

702 ASSOCIATED WORK

This contractor shall consult with the Engineer and other contractors in arranging for the installation of the system to eliminate interference. The particular attention of the contractor is drawn to Clause 1.20 General Conditions. The precise location of all openings and other work required by the contractor and to be provided by others shall be determined by the contractor at such times as not to cause delay to the work. If openings or work are wrongly located due to incorrect information supplied by the contractor, he shall be responsible for the cost of remedying the error. The contractor shall guarantee material and workmanship supplied by him against defects for a period of twelve months from date of practical completion.

703 CLEANING

Upon completion, all heating water pipes, chilled water pipes, condenser water pipes, equipment, vessels and cooling towers shall be flushed and cleaned free of foreign matter.

704 PRESSURE VESSEL TESTS

All vessels which come under the Code as pressure vessels shall, before delivery to site have been tested and stamped by the Testing Office of the Department of Labour and Industry.

All test certificates shall be mounted in a glazed frame in the plant room adjacent to the respective vessel.

705 TESTING

The contractor shall be responsible for the following :

- (a) Provide labour and materials necessary to balance out the system and achieve the specified air quantities.
- (b) Make capacity tests on all equipment.
- (c) See that all controls are operating in the range for which they were designed.

706 PERFORMANCE TESTS

Before the end of the maintenance period, when the climatic conditions are favourable, capacity tests to determine full load capacity shall be carried out to the satisfaction of the Engineer.

The contractor shall submit full details of such calculations which may prove necessary in determining the total plant capacity for the cooling and heating systems.

The contractor shall provide a minimum of two temperature and humidity recorders for a period as determined by the Consulting Engineer which are to be located in specified positions for the above tests.

707 TEST LOG SHEETS

All tests shall be carried out to the satisfaction of the Consulting Engineer.

The contractor shall submit fully detailed test log sheets for inspection and approval by the Consulting Engineer.

The test log sheet shall present a clear and precise record of all tests required to be carried out during the commissioning of the project.

It shall indicate, but not be limited to the following tests :

- (a) Fan selection, air volume, speed, static pressure reading and amps drawn and include fan curves to indicate the running condition
- (b) Pump characteristics and motor amps drawn. Water volume.
- (c) Heating and cooling coil temperature readings.
- (d) Room temperature readings.
- (e) Air quantities at outlets readings.

All other items of equipment shall be recorded and tested in a similar manner to that specified above so that a true indication is given of the plant performance.

708 OPERATION OF PLANT

The contractor shall provide, at his own expense, a skilled operator to instruct employees of the Proprietor in the efficient operation of the plant for a period to be determined by the Engineer.

709 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

The contractor shall supply to the Engineer through the Builder, not later than seven days before practical completion, three copies of maintenance manuals which shall include instructions to cover every action necessary for the efficient operation and maintenance of the plant and equipment supplied by the contractor. A preliminary submission of a draft manual shall previously have been made in sufficient time to permit adequate checking and, if necessary, correction. The form of the maintenance manual shall be as follows and shall include additional items listed in the technical clauses of this specification.

- (a) Index
- (b) General description
- (c) List of equipment giving manufacturers and agents and nameplate data
- (d) Maintenance instructions for each item of equipment
- (e) Catalogue list of spare parts

- (f) List of spare parts supplied under this contract
- (g) List of normal operating conditions
- (h) List of all motor currents determined by test and of all control and cut-out settings
- (i) Instructions for adjusting controls and cut-outs
- (j) Instructions for operating plant
- (k) Emergency instructions
- (l) Photographs of concealed works that may require maintenance
- (m) As built drawings for the complete installation

Operating and maintenance instructions shall be in metric units. All drawings and schedules shall be of reduced scale reproduced on A2 sheets.

Maintenance manual covers shall be of hard backed, PVC coated, three ring binder type. The following shall be printed in gold lettering:

On the front cover and spine: The contract name and type of installation

On the front cover only: Architect's name and address
Engineer's name and address
Contractor's name and address

In addition, the contractor shall provide as necessary, one or more photostats of functional diagrams of the installation, indicating all equipment, controls and electrical wiring which shall be mounted in framed laminated transparent plastic sheets or behind glass and which shall be permanently fixed in suitable locations as directed on site.

The contractor shall also provide a CD containing the operating and maintenance instructions together with as installed drawings in DWG format.

710 MAINTENANCE

The contractor shall start up the system and shall maintain the whole of the equipment, materials and work for a period of twelve months after satisfactory completion of the contract. He shall replace any materials or work found to be faulty during the maintenance period at his own expense and shall extend the warranty period a further twelve months on any material or equipment required or replaced during the warranty period.

The contractor shall, for a period of twelve months after the plant has been handed over, inspect the plant at regular monthly intervals and attend to the following without any additional charge :

- Perform all essential services testing and maintenance
- Renew any works which prove defective due to faulty workmanship, material or corrosion.
- Replace any equipment or component which does not comply with the performance guarantees or operating conditions specified.

- Make any necessary adjustment or conduct any tests to ensure all sections of the plant perform in accordance with the specification.
- Replace any component or equipment which has excessively worn and may cause plant breakdown or cause the plant not to maintain conditions.
- Clean and generally attend to the air filters. Replace filter media or oil as necessary.
- Check all bearings and lubricate all moving machinery.
- Check all motors for excessive operating temperatures and check current draw.
- Check fan and pump drives. Replace worn belts.
- Check valve and pump glands and packing,.
- Check all piping systems for leaks and repair where they have occurred.
- Check for damage or deterioration of insulation or sheathings.
- Clean all strainers.
- Check all anti-vibration mounts for deterioration of rubber or springs and for freedom of movement.
- Examine all flexible duct connections for correct adjustment and air tightness.
- Check all cooling and heating coils for cleanliness and ensure condensate trays and drains are clear.
- Check operation of all modulating dampers. Lubricate all damper bearings and linkages.
- Check operation and setting of all electronic and electric temperature control and indication equipment at least three times a year.
- Check and reset electrical equipment. Clean contacts of electrical switchgear, contactors and starters. Check overloads.
- Record all meter readings at each visit.
- Check operation of all test and control switches and relays.
- Check operation of all control sequences in rotation.
- Replace burnt out pilot lights in control panel and conditioner housing lights.
- Ensure that plant rooms are left in clean and tidy condition.
- Replace all tools and accessories in correct position.
- Replace all paintwork damage resulting from maintenance work.
- Leave plant in correct operating order.

- Test refrigerant system for leakage, repair and replace refrigerant.
- Check operation and setting of all float valves in expansion tanks.
- Check compressor operation, check oil level, supply oil if required, check feed and expansion tanks.

All work shall be executed by qualified tradesmen. Breakdowns of the plant reported to the contractor during the warranty period shall be attended to promptly.

After each monthly visit, the contractor shall submit to the Consulting Engineer a complete report of all items attended to and a report of any plant failures noting the action taken to remedy defects. All reports are to be countersigned by the Proprietor's representative.

Where such maintenance and servicing is required during the defects liability period specified, it shall be performed promptly and within the time specified or on failure to comply in such time the Builder reserves the right to engage and thus to finish or rectify such work at the contractor's expense without further notice and all associated costs shall be deducted from amounts otherwise due or payable to the contractor, or shall be deemed a debt of the contractor to the Proprietor. Such action by the Builder shall not vitiate any of the contractor's responsibility.

The plant shall not be considered to have received twelve monthly service visits unless twelve signed reports have been received by the Consulting Engineers within seven days of the due inspection date. Final payment of retention monies shall not be certified by the Consulting Engineer unless the twelve service reports have been submitted.

711 SERVICE CONTRACT

The contractor shall at the end of the warranty period submit a quotation for a twelve month preventative maintenance program.

The program shall include all work detailed in items 1 - 29 above but shall exclude replacement of any components.

712 CERTIFIED COMMISSIONING FIGURES

The mechanical contractor shall employ an independent firm, at his own expense, to certify all commissioning figures. This shall include air quantities, fan static pressures, water flow rates, pump heads and coil pressure drops. Balancing shall be carried out by NEBB certified technicians.

The final air quantities shall be within the following tolerances:

- (a) At any outlet +/- 10%
- (b) Total system air quantity +/-5%

The water flow rates shall be within +/- 5% of the design quantities.

801 NOISE AND VIBRATION

The contractor's attention is drawn to the following precautions which shall be taken in order to ensure that minimum noise and vibration are transmitted.

- (a) All rotating machinery shall be accurately balanced statically and dynamically
- (b) All connections to rotating machinery and assemblies containing rotating machinery shall be rendered flexible by the following methods :
- (c) Flexible connections in ductwork connections to fans
- (d) Flexible braided wire hose connections to pumps or alternatively provide suitable bends in connecting pipe work to absorb vibration

802 AIR DIFFUSION EQUIPMENT

The air diffusion equipment to be supplied under this contract shall be selected and installed to comply with the specified sound level criteria.

Maximum Sound Levels

General Office & Cafeteria Areas	NC40
Conference Rooms, Private Offices & Reception Areas	NC35

The above sound levels shall be taken as being defined and measurable by the provisions of the following published Codes :

- (a) Air Diffusion Council Test Code No. 1062 RI
- (b) ASHRAE Standard No. 36 8-63
- (c) AS.1055

803 GENERAL

All items of driven equipment, including fans and pumps shall be mounted on isolating bases. They shall be equipped with spring or rubber isolation designed to give sufficient deflection to provide not less than 95% vibration isolation.

If the equipment to be isolated is of such a type that the required deflections for the mounting causes lateral instability, adequate inertia blocks of concrete shall be provided below the equipment.

Supply and install isolation equipment as required and of the type listed below.

804 COMPRESSORS RECEIVERS

Compressors shall be mounted on spring vibration isolators.

805 CENTRIFUGAL FANS WITHIN UNITS

The fan vibration mounting shall consist of rubber in shear elements.

806 FAN COIL UNITS AND AXIAL FANS - CEILING SUSPENDED

The ceiling suspended units shall be hung from the overhead structure by means of combination spring and neoprene-in-shear mounting and shall be selected in accordance with the load to act as an acoustic barrier. The neoprene-in-shear element shall have a minimum static deflection of 25mm.

807 COOLING TOWERS AND EVAPORATIVE CONDENSERS

The unit shall be mounted on a vibration mounting. The fan operating speed (r.p.m.) shall be considered as the primary disturbing frequency. The vibration mountings shall be designed to provide a minimum isolation efficiency of 90%. The vibration mountings shall consist of cast telescoping housings containing one or more steel springs of 50mm minimum diameter. The mountings shall have a built-in levelling device, resilient inserts to act as guides for the upper and lower housing and a corrugated neoprene acoustic pad bonded to the base.

901 SCOPE

This section of the specification covers the supply, installation, testing and commissioning of all controls other than the controls supplied with standard equipment.

902 GENERAL

The control system shall be electronic.

The tenderer is required to clearly state in his tender which type of controls he has allowed and intends to use on the project.

The subcontractor shall study the method of control as specified and as outlined on the drawing and shall satisfy himself that his controls can perform the functions specified. Any deviation from the principles in method of control specified hereafter and indicated on the plans must be fully described and justified at the time of tendering.

This subcontractor shall draw up a detailed control diagram to suit the control manufacturer's equipment selected by him which conforms to this specification and submit copies of the plan for approval before commencing installation of controls.

No instruments shall be located where they will interfere with the normal removal of cooling and heating coils, nor shall conduits or piping be run so as to interfere with the complete openings to any equipment or duct access doors.

Whilst it shall remain the responsibility of the subcontractor to ensure correct operation of the overall installation, it shall be the particular responsibility of the controls supplier to carry out the following :

- (a) Supply and install control instruments in correct locations.
- (b) Provide a fully detailed and correct control wiring diagram or alternatively check the correctness of the control diagram prepared by the subcontractor.
- (c) Thoroughly check by means of bell or meter and battery the correctness of the control wiring as installed and connected within a minimum of seven days before commissioning of plant.
- (d) The controls supplier shall arrange to discuss with the Consulting Engineer all aspects of the control system and the selection of controls within seven days of placing of order.

At the time of tendering, tenderers shall include a statement that allowance has been made for the above items.

With regard to item (c) the Consulting Engineer shall be given two days notice of the commencement of control system checking so that a representative may be present. Control instruments shall have a set point range capable of adjustment to suit duty involved.

903 WIRING METHODS

All wiring for the electronic control system shall be shielded cable of a type recommended by the controls manufacturer to prevent control system pick up of spurious signals.

904 WIRING AND SUNDRIES

Supply and install all necessary line and low voltage electrical wiring, relays, switches, transformers, etc. as required to complete the installation even though these may have been omitted in the control wiring diagram.

905 ADJUSTMENTS

The subcontractor shall adjust and calibrate the complete system for sequence of operation of controlling devices in accordance with the conditions to be maintained. This subcontractor shall make any further changes and adjustments to the equipment furnished under this contract that may be necessary to ensure continuous satisfactory automatic control and operation of the plant as required or directed by the Consulting Engineer.

On completion of the installation, the drawings shall be amended so that they become accurate "as installed" drawings incorporating any additions, deletions or alterations made during the progress of the installation. All set points, throttling ranges. etc. shall be indicated on the drawings.

908 CONTROL SEQUENCES

01 Bar, Restaurant and Staff Room Air Conditioning Units (ACU/CU-1, 2 & 4)

The air conditioning units shall be controlled by separate controllers which incorporate timeclock (24 hour 365 day) with battery back-up and set point change functions.

Cooling Stage	On 23°C Off 22.5°C
Heating Stage	On 23°C Off 22.5°C

Each air conditioning switch function shall be:

Manual :	Unit runs
Off :	Unit stops
Auto :	Time programmable control

The controllers shall be located in the mechanical switchboard.

02 Office Air Conditioning Unit (ACU/CU-3)

The split air conditioning unit shall come complete with temperature sensors integral with indoor unit. Control shall be via manufacturer's standard hardwire controller located in position as indicated on the drawing to provide the following functions :

- (a) Temperature set point change
- (b) Heating/Cool/Auto selector
- (c) Fan speed selector
- (d) Start/stop timer

03 Toilet Exhaust Fans (TEF-1 to 3)

Fans to operate as follows :

Manual :	Fan runs
Off :	Fan stops
Auto :	Time clock control

04 Evaporative Cooler (EC-1)

Evaporative cooler shall be controlled by local on/off switch.

05 Kitchen and Dishwasher Exhaust Fans (EF-1 and 2)

Fans shall be controlled separately by local on/off switch

1001 GENERAL

All work shall comply with current Gas Supply Authority regulations and AG601. Arrange and carry out all tests and pay all fees as required.

All gas piping shall be copper in accordance with AS.1432, Type B.

All joints shall be brazed and kept to a minimum.

All pipe work installed underground shall be surrounded by a 100mm thick layer of clean dry sand prior to backfilling.

The contractor shall allow for excavation, backfill, consolidation and making good of all necessary trenching.

The contractor shall be responsible for obtaining approval from the appropriate Authority for the entire gas reticulation system prior to commencing the installation and approval from the Office of Gas Safety during and at completion of the gas installation.

1002 IDENTIFICATION OF PIPING

The gas pipelines shall be painted "Biscuit 369" where they are exposed to view. The pipes shall be marked in accordance with Clause 4.1.12 of AG601, in all locations.

1003 METER ENCLOSURE

Builder to supply and install gas meter enclosure to meet all Supply Authority requirements. This will include, but not be limited to, concrete base, chain wire enclosure and bollards.

1101 AIR HANDLING UNITS

Supply and install a built-up air handling units where shown on the drawings. The units shall comprise supply air fan, cooling coils, heating coils, refrigerant heat reclaim heating coils (installation only), filter bank and shall have the capacities as scheduled. The unit shall be suitable for connection to the ductwork as shown on the drawings.

Casings shall be completely assembled from prefabricated floor wall and ceiling panels of stressed skin insulated sandwich construction consisting of metal internal and external skins bonded under high temperature and pressure with thermosetting adhesive to a core of rigid cellular insulation. Internal and external skins shall be 0.6mm zinc coated steel sheet, factory pre-coated on the exposed surface.

Cut and join the panels accurately without voids. Profile the panel edges to receive the required splines and joiner moulds. Make butt joints over a 60mm x 5mm hardboard spline, centrally placed, and locate the adjoining internal and external skins with H-section joiner moulds. Cover the external and internal corner joints with extruded aluminium angle trim moulds. Fit flanged PVC sleeves to service penetrations through wall and ceiling panels. Fill the void between the service and the sleeve with a non component polyurethane sealant. Form a continuous external vapour barrier and air-tight seal by sealing all joints and penetrations.

Where the ceiling span exceeds 3300mm, support the panels with a channel 100mm deep.

Panel construction shall be 75mm thick.

Where pipes penetrate the conditioner housing, neat cover plates shall be provided with rubber gaskets to achieve an airtight seal.

Where dissimilar metals make contact an insulating compound shall be used. The insulating compound shall be Flynte Cote No. 3, manufactured by the Shell Co. of Australia.

At the floor, and at other points where sheet metal joins masonry construction, panels shall be bolted at approximately 250mm centres and caulked airtight to 38mm x 38mm x 5mm galvanised steel angles which have been secured to the masonry with loxins at approximately 450mm centres and caulked airtight.

Provide a 100mm deep stainless steel condensate tray under the cooling coil bank (warm zone unit). All joints shall be continuously welded. Provide high density polystyrene packing as required to raise the trays to sufficient height to enable the water seal in the trap to be maintained.

Drain connections from the condensate tray shall be on the leaving air side of the coil.

The air handling unit shall be provided with rigid, gasketed, non-leaking access doors. Access doors shall open against air pressure and shall be secured by two heavy chromium plated bar linked refrigerator door type latches with external and internal handles. Access doors shall preferably be 750mm wide by 1600mm high set 300mm above the floor.

Motorised air damper shall be installed where shown on the drawings. Motorised actuators of adequate capacity shall be installed to provide smooth action and complete shutoff.

The scheduled static pressure is estimated only. The contractor shall allow for replacing the pulleys with correctly sized ones if necessary in order to obtain the specified air quantities against the actual installation resistances.

Provide at the filter bank a grommetted static pressure tapping in the upstream and downstream duct to enable the filter resistance to be measured. Provide a 100mm dial Dwyer magnehelic gauge, together with tubes and fittings, mounted on the external face of the air handling unit.

The scheduled motor kilowatts are provisional only. Motor ratings shall not be less than 125% of the fan absorbed power at the scheduled duty and shall also be selected to overcome starting inertia. Fan, motor and drive shall be as specified in the "Fans" sections. Cooling coils shall be as specified in the cooling coil sections.

1102 HEAT RECLAIM COILS

The refrigeration contractor shall supply heat reclaim coil for installation by the mechanical contractor.

Particular attention shall be paid to air pressure drop through the heat reclaim coil. Refrigeration contractor to provide advice on same to the mechanical contractor.

Mechanical contractor to ensure the air pressure drop across heat reclaim coil is known before rebalancing supply air fan (SAF-1) serving the selling area cold zone.

Refrigeration contractor shall check available heat energy which can be reclaimed from refrigeration plant the heat the trading area and advise to both Robertson Consulting Group and the mechanical contractor. Mechanical contractor shall not start any work before energy confirmation has been provided.

1103 AIR FILTERS

Supply and install air filters in the locations shown on the drawings and to the capacity, sizes and type as indicated.

Air filters shall be installed in accordance with the manufacturer's recommendations. In all cases filters shall be readily accessible for removal. Filter frames shall be rigidly supported to prevent distortion under high dust load and arranged to prevent bypassing of media. Frames must be suitably corrosion protected.

Filters shall be mounted in a rigidly constructed frame, with stiffening bars arranged to prevent distortion when filters reach full dust holding capacity.

Provide an approved sealant between each filter frame and between the mounting frame and chamber walls to prevent bypassing of air.

Only filters which have been tested to AS.1132 shall be acceptable.

Provide at each filter bank, a grommetted static pressure tapping in the upstream and downstream duct to enable the filter resistance to be measured. Provide a 100mm dial Dwyer Magnehelic gauge, together with tubes and fittings, for each filter bank.

Air filters shall generally be 'F5' disposable dry media pleated or bag type to AS.1324-1996.

Deep Bed Filters

Filters shall be Email Multi Peak. Filter frames shall be plastic coated.

Grease Filters

Filters shall be 50mm thick Email GW constructed of aluminium. Provide collapsible handles on filters and rigid holding frames with means to permit easy removal of filters.

Panel Filters

Filters shall be Email V form panel filters, 50mm thick.

1104 FANS

Supply and install fans where indicated and of the various types as scheduled.

The scheduled static pressures are estimated quantities only and in all cases the subcontractor shall allow for replacing the pulleys with correctly sized ones if necessary, in order to obtain the specified air quantities against the actual installation resistances.

The scheduled motor kilowatts are provisional only. Motor ratings shall not be less than 125% of the fan absorbed power at the scheduled duty and shall also be selected to overcome starting inertia.

Only fans which have been tested in accordance with BS848 or equivalent shall be acceptable. All fans other than roof or wall mounted type shall be mounted on spring and neoprene anti-vibration mountings selected for 95% isolation efficiency.

Supply air fan within main air handling unit to include the following :

- (a) Bearings to be skf 50,000 hour grease relief type
- (b) Fan wheels shall be mounted on a single full width shaft carried on suitable flange bearings mounted on the sides of the unit
- (c) Vee belts shall be B section matched and selected for 150% of drive motor torque
- (d) Drive pulleys to be "taper lock type"
- (e) Provide 40mm diameter holes in each belt guard opposite fan and motor shafts for use of tachometer
- (f) Dual speed drive motor mounted externally to fan

1105 SPLIT SYSTEM AIR CONDITIONING UNITS

Supply and install Temperzone, Mitsubishi Heavy Industry or equal approved, air cooled split system packaged air conditioning units where indicated.

Provide interconnecting refrigerant piping and wiring in accordance with the manufacturer's requirements and other relevant sections of this specification.

The system shall contain a control panel with all the controls necessary to operate and protect the components. These controls shall include contactors, thermal overloads on each phase for each motor, high pressure and low pressure cutout switches on the

refrigeration system, compressor safety thermostat and overloads, control circuit fuse and lockout relay. All of the protective devices shall be of the automatic reset type.

The unit shall be reverse cycle, containing all the necessary devices including automatic defrost controls.

Time delays shall be included to prevent frequent stopping and starting of the compressors.

The indoor section shall be of the horizontal ducted type and contain fan, refrigeration coil, condensate tray and twin duct connections. The indoor section shall be supported from the roof support structure. Vibration isolation spring hangers shall be provided.

The outdoor section shall contain compressors, condensers, condenser fans and controls.

The outdoor section shall be mounted on minimum 25mm deflection steel spring vibration isolation mounts, incorporating a rubber or neoprene acoustical isolating pad at least 9mm thick. The mounts shall be installed on min. 2mm thick steel plates.

The scheduled static pressure is estimated external to the unit and the subcontractor shall make the necessary adjustments to cater for the actual installation resistances in order to obtain the specified air quantities.

Provide trapped copper condensate drain as shown on the drawings.

The unit shall include factory installed refrigerant and oil and the subcontractor shall replace any leakage until the end of the defects liability period.

The unit shall be suitable for low ambient temperature heating and capable of operation at condenser air entering temperatures of up to 45°C.

Install with epoxy coated corrosion protection on all coils and fins.

1106 ELECTRIC MOTORS

Motors shall be selected on the basis of low sound power levels and high efficiencies. Motors shall be sized to be non-overloading under all conditions of operation.

Motors shall be suitably mounted to obtain the highest degree of performance and efficiency. Motors shall be mounted to keep vibration and noise to a minimum.

Motors of 5 kW or less shall have Class E insulation while motors above 5 kW shall have minimum Class B.

1107 COMPRESSORS

Compressors shall be reciprocating semi-hermetic or hermetic scroll compressors, with in built unloading capacity control, (415v/3/50Hz) of Bitzer, Bock or Copeland/DWM manufacture within in-built motor thermal protection and cooling fans as per manufacturer's specification. Sump heaters required to all compressors.

1108 CONDENSERS

Shall be constructed of heavy duty aluminium casing and legs, copper tubing and passivated aluminium fins and three phase totally enclosed Ziehl Abegg fan motor

assemblies with wire guards to cowled openings, and IP55 terminal box pre-wired to approved IP54 waterproof junction boxes.

1109 LIQUID RECEIVERS

Each refrigeration circuit shall be fitted with a liquid receiver of sufficient capacity to hold the entire pump down refrigerant charge plus twenty percent (20%) reserve capacity.

The liquid receiver shall be manufactured in accordance with the Australian Standard for Refrigerating Systems and be fitted with a pressure relief device.

1110 HEATING WATER BOILER

The boiler shall be a factory built packaged assembly complying with the Equipment Schedule.

All safety controls and devices shall be factory fitted.

Commissioning and start-up shall be carried out by the boiler manufacturer's authorised agent.

1111 PUMPS

Each pump shall be factory assembled complying with the Equipment Schedule.

Each pump shall be connected to pipe work with flexible connections located parallel to the pump axis. Pump drain shall be piped to discharge over a tundish. Each pump shall be selected to suit the calculated duty with one standard impeller size spare.

1112 HEATING COILS

Heating coils shall be supplied by a reputable manufacturer and shall comply with the Equipment Schedules.

Coils shall be leak tested at manufacture to 2100 kPa minimum. Coils shall have a vent connection at the highest point and a drain connection at the lowest point. Coils shall be installed true without distortion.

1113 EXPANSION TANK

Supply and install a sealed flexible diaphragm expansion tank of Flexcon or equal in the piping system. The unit shall be sized to cater for the water content of the entire system and range of operating temperatures and complete with all necessary auxiliary components.

The tank liner shall be of a non-toxic, non-corrosive material and the air chamber shall be precharged to a suitable pressure having regard to the foregoing and the operating range of the supply water system.

1114 DOSING POT

Allow to supply and install a chemical slug dosing pot system complete with all valves, stands, etc. for the heating water pipe work system. The pot shall be of Hydro-Chem manufacture.

The complete installation shall be commissioned by Hydro-Chem including supply of all chemicals to initially dose the system, provision of water sampling test kits and chemicals etc. during the twelve months warranty/free service period.

1115 AIR CURTAINS

Each air curtain shall be as scheduled and located where shown on the drawings. Air curtains shall be mounted to ensure that the doors are fully screened over the whole of their opened area. The air curtains shall be Conditionaire or approved equivalent, electrically heated type.

1201 SPLIT AIR CONDITIONING UNITS

Designation :	ACU/CU-1	ACU/CU-2
Area Served :	Bar	Bistro
Type :	Split reverse cycle ducted	
Supply Air (l/s) :	1,100	1,500
Outside Air (l/s) :	300	525
Air On (°CDB/WB) :	25.9 / 18.0	26.5 / 18.2
Total Cooling (kW) :	21.9	32.5
Sensible Cooling (kW) :	17.3	24.7
Outdoor Design (°CDB) :	31 (summer), 3.3 (winter)	
Nominal Selection :	Temperzone	Temperzone
Model :	ISD270K / OSA270RKT	ISD 330K / OSA330RK
Designation :	ACU/CU-3	ACU/CU-4
Area Served :	Offices	Staff Room
Type :	Packaged reverse cycle ducted	Split reverse cycle ducted
Supply Air (l/s) :	N/A	680
Outside Air (l/s) :	N/A	90
Air On (°CDB/WB) :	N/A	25.0 / 17.5
Total Cooling (kW) :	3.5	10
Sensible Cooling (kW) :	N/A	9
Outdoor Design (°CDB) :	31 (summer), 3.3 (winter)	
Nominal Selection :	Daikin	Temperzone
Model :	FTXS35J2	ISD135K / OSA135RKTG

1203 EXHAUST FANS

Designation :	TEF-1	TEF-2
No. Off :	1	1
Area Served :	Bar/Bistro Toilet	Public Toilet
Type :	Roof mounted centrifugal	Roof mounted centrifugal
Air Quantity (l/s) :	470	70
Estim. Ext. Pressure (Pa) :	100	80
Motor Speed (rps) :	15	23
Make :	Fantech	Fantech
Model :	CD406V	CE224V
Designation :	TEF-3	
No. Off :	1	
Area Served :	Staff Toilet	
Type :	Roof mounted centrifugal	
Air Quantity (l/s) :	50	
Estim. Ext. Pressure (Pa) :	80	
Motor Speed (rps) :	41	
Make :	Fantech	
Model :	CE192V	

EQUIPMENT SCHEDULES

MECHANICAL SERVICES

Designation :	EF-1	EF-2
No. Off :	1	1
Area Served :	Kitchen Hoods	Dishwasher Hood
Type :	Roof mounted centrifugal	Roof mounted gamma
Air Quantity (l/s) :	3500	300
Estim. Ext. Pressure (Pa) :	250	100
Motor Speed (rps) :	24	22
Make :	Fantech	Fantech
Model :	CHD716	CD314VGL

1203 EVAPORATIVE COOLER

Designation :	EC-1
Area Served :	Kitchen
No. :	1
Mounting :	Roof
Air Quantity (l/s) :	3900 (high)
Est. Static Pressure (Pa) :	60
Make :	Bonaire
Model :	B33 Commercial

SCHEDULE OF PRICES

To be completed and returned with Tender.

	Fixed Lump Sum
(a) Split Air Conditioning Units	\$
(b) Exhaust Fans	\$
(c) Evaporative Cooler	\$
(d) Gas Pipework	\$
(e) Ductwork	\$
(f) Registers & Grilles	\$
(g) Refrigeration Pipework	\$
(h) Electrical	\$
(i) Insulation	\$
(j) Controls	\$
(k) Testing & Commissioning	\$
(l) Operating & Maintenance Manuals	\$
(m) Defects Liability Maintenance	\$
(n) Other (list below)	
.....	\$
.....	\$
(p) GST	\$

TOTAL AMOUNT (Inc. GST)	\$

TENDERER:

SIGNATURE:

NAME:(Please Print)

DATE:

SCHEDULE OF TECHNICAL DATA

To be completed and returned with Tender.

SUBCONTRACTORS PROPOSED BY TENDERER

- (a) Ductwork
- (b) Ductwork Insulation
- (c) Hoisting and Craneage
- (d) Electrical
- (e) Controls
- (f) Pipe work
- (g) Pipe Insulation
- (h) Painting
- (l) Commissioning and Balancing

EQUIPMENT/MODEL FOR THE SUPPLY OF THE FOLLOWING

	Manufacturer	Model
(a) ACU/CU-1
(b) ACU/CU-2
(c) ACU/CU-3
(d) ACU/CU-4
(e) TEF-1
(f) TEF-2
(g) TEF-3
(h) EF-1
(i) EF-2
(j) EC-1

- (k) Diffusers
- (l) Controls

TENDERER:

SIGNATURE:

NAME:(Please Print)

DATE: