Alpha
Engineering Consultant
2 ALEXANDRA ROAD, #03-03 DELTA HOUSE, SINGAPORE 159919
TEL: (65)6276 2228 FAX: (65)6276 9929 E-MAIL: aec@alpha.com.sg

Our Ref: OM-SC/020

9 September 2004

MEMORANDUM

To: All Staff

From: Andrew Loh

REVISION TO MASTER SPECIFICATIONS FOR AIR CONDITIONING & MECHANICAL VENTILATION INSTALLATION

The following clauses (see attached) have been included in Section 2 & 3 of the Master Specifications for Air Conditioning & Mechanical Ventilation Installation (DSC & NSC):

Section 2 – Air Handling & Cooling Equipment

Clause 2.5.2 Air-Cooled Packaged Air-Conditioner

Clause 2.7 Variable Refrigerant Volume (VRV) System Air Conditioner

Section 3 – Chillers, Cooling Tower and Pumps

Clause 3.3 Air-cooled Chillers

Andrew Loh

cc TLS/RT
cc Memo File

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BCA
ISO 9000
CERT. NO.: 236
SS ISO 9001 : 2000

FEEDBACK REPORT FORM

Alpha
Engineering Consultant

Ref No: 79-240804 (S)

To: LCT From: CLM 24/8/04

Job No./Project: Master Specs. *(where applicable)*

Source of feedback: _____

Scope of Feedback: *Quality System/Administrative/Contractual/Technical/Specification/Others

Section A : Problem & Cause

No specs for the following equipment in ACVI MASTER SPECS :-
1) Air-cooled packaged A/C
2) VRV system 3) Air-cooled chiller

Section B : Suggested Corrective Action

See attached for your comments. I prepare for 1399-ACVI Specs.

Section C: Approved Corrective Action

Approved By : _____ Date: 26/8

Section D : Action

Action By: NA hm

Targeted Completion: Sept '04

Actual Completion: 09/09/04 Verified By: _____

* *Delete as appropriate*

Distribution: | | | | | | |

This clause is meant for convention air-cooled packaged units as distinct from computer room
09/09/04

2.5.2 Air-Cooled Packaged Air-Conditioner

Air-cooled Packaged units shall be supplied and installed where required and as shown in the Specification Drawings. Each unit shall be complete with compressors, fans, condensers, evaporators, motors, filters and control system.

The unit shall provide the cooling capacities as detailed in the Schedule of Technical Requirements.

The unit shall be fitted with one or more compressors of the hermetic or semi-hermetic type. Lubrication system shall be of the forced feed type and compressors shall be fitted with gauge connections for reading oil, suction and discharge pressures and shall be fitted with oil sight glass. Compressors shall be driven by electric motors with suction gas cooled.

The refrigerant circuits shall be completely factory assembled, tested, dehydrated and charged, and shall include dual pressure control and rewired pump down circuit, suction and discharge valves, filter, drier, sight glass, solenoid valve and liquid line valves, and fully sealed oil and refrigerant charges.

The direct expansion evaporator coils shall consist of copper tubes with bonded copper or aluminium fins. Cooling coils shall be fitted with equalising type distribution headers. The face velocity of the air passing across the cooling coils shall not exceed 2.6 m/s. Coil fins shall not be more than 10 fins per 25 mm.

Fans shall be of the centrifugal type generally in compliance with the Specifications under centrifugal fans and shall be complete with motors and belt drive. Fans assembled on a single shaft may be used when forming portion of factory assembled equipment. Fans shall have wheels of the double-inlet type with forward curved blades matched with specifically designed scrolls to give high stable performance. All wheels shall be statically and dynamically balanced at the factory and fan speeds shall be below the critical speeds of the shaft and wheel assembly. Fan outlet air velocities shall not exceed 6 m/s.

Fans shall be driven by V-belt drive of minimum two belts of matched size, and designed for full motor horsepower plus an overload factor of 25 per cent. Fan shaft shall preferably be of tubular steel of large diameter with ends drawn down to size and ground for accurate fit of bearings and pulleys. Bearings shall be acoustic rubber pillar block self-aligning ball type or ring coiled sleeve type to meet noise level requirement. Fan and motor pulleys shall be "taperlock" type to facilitate site adjustment of air quantities.

Filters shall be provided as specified elsewhere in this Specification. Filters shall be easily accessible for inspection and replacement.

Each packaged unit cabinet shall be fabricated of heavy gauge galvanised steel panels formed for close fit and structural rigidity. Framework shall be of steel angle members all galvanised, securely bolted and braced. All panels, framework, bolts, etc shall be hot-dipped galvanised. Panels shall be designed for easy removal for inspection, servicing and maintenance.

All interior surfaces of the casing enclosure including the framing angles shall be thermally and acoustically insulated with minimum 25mm thick layer of at least 32 kg/cu m density fibre glass with neoprene or similar facing. The insulation shall be applied onto the casing using suitable adhesive and held in place by proper pins and washers fixed at centres not exceeding 300mm. The condensate drain pan shall be of

the double-bottom type and adequately insulated in an approved manner. All surfaces subject to condensation shall be treated with at least 3 mm mastic compound to guard against corrosion. Unless otherwise indicated, drain lines shall be run to the nearest gully or floor waste and in accordance with the requirements of the local Authorities; the drain lines shall terminate visibly approximately 80mm above the grating.

Each packaged unit shall be complete with controls to provide proper sequence operation of the fan and compressors, time delays between starting of each motor and safety controls including cut-outs for high an low refrigerant pressures and low oil pressure. Manual re- sets shall be provided for safety cut-outs.

Vertical-coil air-cooled condensers shall be supplied as integral parts of the air cooled packaged unit. The condenser shall be complete with fan, motor, condensing coils, discharge shields, etc. and shall be suitable for the working conditions. The air-cooled condensers shall provide the heat rejection for the maximum rated cooling capacity of the offered air cooled packaged unit based on outdoor air conditions of 33 deg. celsius dry bulb, 27 deg. celsius wet bulb.

Condenser coil shall be of staggered coil and finned type; coils shall be constructed of copper tubes with mechanically bonded aluminium or copper fins. The condenser shall be cleaned, dehydrated, scale and leak tested at the Manufacturer's premises before delivery to site.

Fans shall be of the propeller type fabricated from aluminium alloy or other approved corrosion resistant materials, and shall be complete with non-corrodible bird screens on the discharge outlet. The fan motor shall be of the totally enclosed fan-cooled weather-proofed type. A minimum of two V-belts of matched size shall be provided for each fan/motor assembly.

This clause is meant for the conventional split units as distinct from the computer room
30/11/95

2.6 Air-Cooled Air Conditioning Split Units

2.6.1 Air Cooled Condensing Unit

Air cooled condensing unit shall be supplied and installed generally as shown on the Drawing. The condensing unit shall be complete with compressors, fans, condenser coil, motors and control system. The condensing unit shall be suitable for outdoor (exposed to weather) installation.

The air cooled condensing unit shall provide the minimum cooling capacities as detailed in the attached Schedule.

The air cooled condensing unit shall be fitted with reciprocating or rotary compressors of the hermetic or semi-hermetic type and each compressor shall have its own refrigerant lines and independent control/power wiring. Lubrication system shall be of the force feed type and compressors shall be fitted with gauge connections for reading oil, suction and discharge pressure and fitted with oil sight glass to manufacturer's recommendation. Compressors shall be driven by electric motors designed for single phase, 50 cycle operation; motors shall be suction gas cooled. Compressor motor shall have both thermal and current overload protection devices.

The condensing unit shall be fitted with condenser-coils in the compressor compartment of the unit. The condenser coils shall be of the coiled tube type with copper tubes of the external finned type. A fusible plug or safety valve shall be fitted to the condenser coil to protect the unit in the event of failure of the High or Low pressure cut-outs. A sight glass shall be fitted near to the condenser.

Each cassette fan coil unit shall be internally insulated in accordance with manufacturer's standard and adequate to avoid condensation. Where cassette fan coil units are found to be unduly noisy, these shall be replaced at the instruction of the Architect. Prior to placing of order for manufacturer, the Contractor shall submit sound power level ratings to the Architect for review.

Each cassette fan coil unit shall be equipped with a built-in condensate drain pump and condensate drain pan. The condensate drain pan shall be of heavy gauge galvanised sheet steel insulated in the same manner for the casing and pitched for positive drainage by the drain pump.

Filters shall be of the washable type mounted on frames designed for quick attachment for servicing.

The decorative panel shall consist of supply air diffusers and return air grilles. The supply air diffusers shall be the adjustable type.

This clause is meant for the VRV split units as distinct from the computer room
09/09/04

2.7 Variable Refrigerant Volume (VRV) System Air Conditioner

2.7.1 General

Each variable refrigerant volume (VRV) air conditioning system shall consist of one outdoor air cooled condensing unit connected via refrigerant piping to multiple indoor fan coil units as shown in the Specification Drawings. The capacities of condensing unit and fan coil units are shown in the Schedule of Technical Requirements. The type of refrigerant use shall be environmental friendly.

The condensing unit and each of the associated fan coil units shall operate independently and automatically as a system as well as a unit. The system shall operate such that when one or more fan coil units is started, the associated condensing unit and fresh air supply fan shall commence operation and vice versa. All control system shall be included.

The condensing unit shall be equipped with inverter controller, enable it to reduce minimum load down to 8% of the total load. The system must be able to reduce to its minimum load without having to utilise any hot gas by pass system.

The condensing unit shall be suitable for mix-match connection of ceiling mounted cassette type, ceiling concealed ducted type and wall mounted type of fan coil units.

The VRV system shall be capable of operating with refrigerant piping connected up to 100 meter in length and 50 meter level difference without any oil traps.

All indoor and outdoor units shall be assembled, tested and charged with refrigerant at the factory. Quality assurance certificates by the factory shall be submitted for verification. All refrigerant piping work shall be supervised by the manufacturer's representative who is trained and well verse in VRV system installation. Certificate of compliance shall be endorsed by the manufacturer before testing and commissioning.

2.7.2 Air-Cooled Condensing Unit

The air-cooled condensing unit shall be a factory assembled unit housed in a sturdy weatherproof casing constructed from rust-proof mild steel panels coated with a baked enamel finish. The condensing unit shall be designed to operate safely when connected to multiple fan coil units which have a combined operating nominal capacity varying from 5% to 130% of nominal compressors capacity. The noise level shall not be more than 62 dBA measured horizontally 1 m away and 1.5 m above ground. The

condensing unit shall come equipped with two numbers of hermetically sealed scroll compressors for units exceeding 5 HP.

The condensing unit shall be modular in design and should be allowed for side by side installation.

a. Compressor

The compressor shall be of highly efficient hermetically sealed scroll compressors and equipped with inverter control capable of changing the speed linearly in accordance to the room load requirement.

b. Condenser Assembly

The air-cooled condenser shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The condenser shall have large face area to minimize noise and give a high EER for heat transfer. Condenser should be of waffle lourve fins and Hi-X tubes design for high efficiency performance. The condensing unit shall come with standard chemically coated anti-corrosion P.E. fins. The thickness of the coating must be between 2.0 to 3.0 microns.

c. Condenser Fan and Motor

The condenser fan shall be of multi-blade low speed noise level type made from pressed out aluminium and dynamically and statically balanced for minimum noise and vibration. The condenser fan shall be directly coupled to an induction motor. The axial of the fan shall be perpendicular to the face of the condenser to ensure smooth air floor. The condenser fan and motor shall be of the high efficiency type with minimum power consumption. The fan motor shall be equipped with pole-change control so that it can be stepped down to low speed when requirement is low.

d. Refrigerant Circuit

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves solenoid valves and an electronic expansion valve. All necessary safety devices should be provided to ensure the safety operation of the system.

e. Accumulator

The cylindrical accumulator shall be constructed from mild steel plates pressed into shape. The accumulator shall have sufficient capacity to prevent any liquid refrigerant from flowing back into the compressor suction.

f. Safety Devices

The following safety devices shall be part of the condensing unit:

(i) High Pressure Switch

(ii) Fuse

(iii) Crankcase Heater

(iv) Fusible Plug

(v) Overcurrent Relay for Compressor

(vi) Thermal Protectors for Compressor and Fan Motors

(vii) Recycling Guard Timer

g. Oil Recovery System

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping up to 100 m. Piping installed with oil traps are not acceptable.

2.7.3 Fan Coil Units

Fan coil units shall be supplied and fitted generally as shown on the accompanying drawings. Each fan coil unit shall be complete with fans, motors, filters, direct expansion coil, controls and all accessories.

The type of fan coil units (ceiling mounted cassette type, ceiling concealed ducted type or wall mounted type) shall be as shown in specification drawings.

Each fan coil unit shall be equipped with a self diagnosis remote controller and having features of setting room temperature with digital indicator of room set temperature, timer, air discharge direction, fan speed selection, self diagnosis circuit with malfunction code display.

Coils shall be of the extruded surface plate fin and staggered tube type and constructed of seamless copper tubing and aluminium fins and be complete with manual air vent and drain plug. Coil shall be suitable for the operating pressure and tested to 1.5 times the working pressure.

Fan coil units shall be selected based on medium speed operation of the fan and under this condition the coil face velocity shall not exceed 2.6 m/s.

Fans shall be of the double inlet, double width type with forward curved wheels of aluminium construction. Fan wheels shall be statically and dynamically balanced for true operation. Fans shall be direct driven by two-bearing, three speed motor with nominal speed not exceeding 1000 rpm.

Fractional horsepower motors shall be permanent split capacitor type. Motors shall be equipped with sleeve bearings with oilers, inherent thermal protection with automatic reset. Fans and motors shall be mounted on galvanised steel fan deck with the assembly easily removable from the basic unit.

Each fan coil unit shall be internally insulated in accordance with manufacturer's standard and adequate to avoid condensation. Where fan coil units are found to be unduly noisy, these shall be replaced at the instruction of the Architect. Prior to placing of order for manufacture, the Contractor shall submit sound power level ratings to the Architect for review.

Condensate drain pans shall be of heavy gauge galvanised sheet steel designed for quick detachment from the base unit for servicing. Drain pans shall be insulated with minimum 15mm thick rigid insulation. Furthermore, the Contractor shall supply and install a secondary drain pan for the entire fan coil unit; this drain pan shall be constructed of minimum 18 B.G. galvanised sheet steel and suitably insulated, and hinged for easy access to the fan coil unit. The drain pans shall connect to insulated condensate drain pipes to discharge to condensate drain pipe.

Filters shall be suitable for washing. Filters shall be supported on frames designed for quick detachment for servicing.

Each fan coil unit shall be provided with a thermostatic liquid expansion valve and a solenoid operated valve or motorised valve with spring loaded return, and built into the unit casing during or after assembly at the manufacturer's works. The valves shall be positioned in the pipe section and arranged such that it is not disturbed during the periodic removal for adjustment and cleaning. The automatic control and adjusting box shall be fitted in an accessible position near one of the inspection covers within easy reach for control and adjustment.

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2.8 Room Air Conditioners

Room air-conditioners shall be supplied and installed generally as specified. They shall be suitable for mounting through walls and shall be complete with 4-way adjustable grilles, heavy gauge zinc coated stove enamelled sheet steel casing with a single or two colour decorative finish.

The motor/compressor shall be of the hermetic type, fitted with resilient mountings and complete with thermal overload protection.

The evaporator shall be manufactured of copper tube with aluminium fins mechanically bonded. The evaporator fan shall be of double inlet double width type and complete with continuously rated totally enclosed electric motor.

The filter shall be of the washable and replaceable nylon type, suitably positioned for easy access for cleaning. Automatic control by means of an integral thermostat shall be provided together with the safety control to prevent excessive cooling.

Condenser cooling fan shall be internally mounted with totally enclosed motor.

The unit shall be supplied as a whole and be suitable for removal and repositioning as may be instructed by the Employer.

Controls shall be factory wired and completely enclosed within the unit. Controls shall be located on the front of the unit. Fan controls shall be a 2 position switch for high and low fan speeds for cooling. Exhaust vent control shall be 2 position control to close vent or introduce fresh air to room.

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2.9 Heat Recovery Wheel (HRW)

Heat Recovery Wheel shall be supplied and installed as shown in the Specification Drawings. The wheel shall be made of stiff alternating layers of flat and corrugated untreated aluminium foils, bonded together into a rigid transfer media forming a multitude of narrow flutes in the axial direction of the wheel.

All surfaces shall be evenly coated with solid, silica gel desiccant. The flow through the wheel shall be laminar and dry solid particles up to 500 microns in size shall pass through the wheel.

The transfer media shall exchange sensible and latent heat with equal effectiveness and not support the growth of bacteria.

The transfer media shall, when operated in accordance with Schedule of Technical Requirements, run dry and not require any condensate drain.

The casing shall be constructed of heavy gauge steel and be equipped with air tight removable side panels to provide easy access to internal parts. All steel parts shall be coated with a primer. Rotor shall be supported by two grease lubricated sealed ball bearings.

Each refrigeration machine shall be mounted as specified. The condenser and compressor shall be rigidly connected on a common base before connection to the vibration isolators.

3.2.7 Installation and Commissioning

A fully trained and authorised commissioning engineer from the refrigeration machine manufacturer shall supervise all tests including the pressure testing, evacuation, dehydration, charging, and initial start-up commissioning of the machines to the entire satisfaction of the Architect; the commissioning engineer shall submit proper records and reports on the commissioning tests. This representative shall attend to the machines as and when required by the Architect during the Contract period. The representative shall also instruct the Employer's operating personnel on the proper operation of the machines.

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3.3 Air-cooled chillers

Air-cooled chillers shall be supplied and installed generally as shown in the Specification Drawings. The chillers shall provide cooling capacity as shown in the Schedule of Technical Requirements and be capable of working at reduced load conditions down to 10% of its specified cooling capacity under specified operating condition.

The type of refrigerant shall be of non-CFC refrigerant and suitable for installation in building as approved by the local Authorities.

Each chiller shall be a self-contained unit complete with compressor, air cooled condenser, evaporator, refrigerant circuit, control system, a complete set of safety devices and all necessary components for the complete and efficient operation. It shall be internally wired and charged with refrigerant at the factory. A remote controller shall be provided for monitoring and control of the air cooled chiller. (remote controller to be located in the pump room)

The chillers shall be arranged to allow any of the machines to lead in the sequence of operation.

The chillers shall be arranged with isolating valves which will allow any of the chillers to be isolated without interrupting the operation of the other machines.

a) Compressor

The compressor shall be compact, highly efficient and durable and is hermetically sealed scroll type with minimum moving parts, 2-pole electric motor, cooled by suction gas with overload protection through an internal thermostat and/or thermal relay. Oil level sight glass and polyester synthetic oil charge shall be provided.

b) Evaporator

The evaporator shall be of stainless steel plate heat exchanger with welded copper connections. Anti-freeze protection shall be provided during operation and shut down.

c) Air Cooled Condenser

The air cooled condenser shall be of coils with slotted aluminium fins expanded into grooved copper tubes. The coil protection grille shall be made of steel wire, coated in polyethylene.

Low-noise axial fan shall be of minimum 10 blades and the rotating shroud shall be made of a composite material. The fan shall be driven by two-speed motor with insulation class F, protection category IP 55 and overload protection by thermal relay.

The air flow shall be preferably vertical with protection grille made of steel wire, coated in polyethylene.

d) Refrigerant Circuit

There shall be minimum two refrigerant circuits for each chiller. Each circuit shall includes liquid line valve, moisture sight glass, thermostatic expansion device, pressure and temperature sensors, manually reset high pressure switch. All components of the refrigerant circuit shall be welded for total and lasting leak-tightness.

e) Control and power circuit control box

The control box shall be accessible via a hinged door. The box shall includes a main isolator switch, fuses and circuit breakers, compressor/fan contactors, thermal relays, low-voltage control circuit transformer (24V control circuit) and the control system.

The whole unit shall be supplied by a single power connection point.

f) Safety devices

Each unit shall be complete with safety devices such as overcurrent relay, overheat protection for discharge gas, high pressure switch, freeze-up protection thermostat, crankcase heater, reverse phase protector, fan motor thermal protector and other necessary safety devices to ensure a long life and trouble free operation.

g) Casing

The casing shall be made of galvanized sheet steel and painted with oven-baked polyester powder paint. The casing shall be completely weather proof.

Select only the type/types of cooling towers required
09/09/04

3.4 Cooling Towers

3.4.1 Induced Draught Cooling Towers

Mechanical induced draught cooling towers shall be supplied and fitted generally as shown in the Specification drawings. Each tower shall have a cooling capacity as detailed in the Schedule of Technical Requirements. The cooling tower complete with basin, fan, motor, tower in-fill, etc shall be suitable for the required working conditions.

The design, construction and installation of the cooling towers shall be strictly in accordance with the manufacturer's recommendation and comply with the Code of Practice for the Control of Legionella Bacteria in Air-Conditioning Cooling Towers in Singapore published by the Ministry of the Environment (ENV).

All parts of cooling tower shall be prefabricated and supplied with detailed erection drawings to facilitate field assembly.

Each cooling tower basins shall be fitted with electrode type level sensing switches for connection to a buzzer and indicator light in the Main Supervisory Control Panel and Computer-based Control System to alarm in case of low water level. Electrodes shall be properly secured in the basin to prevent swaying.

Cooling towers floor supports shall be mounted on steel springs with travel limit stops in series with 2 layers of 8mm thick neoprene waffle pads as specified in the Schedule of Vibration Isolation Equipment. The isolators shall be galvanised by the manufacturer to prevent rusting in an exposed environment. Cooling towers sump shall