

SECTION 3

Ventilation & Air Conditioning

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DIVISION 15**MECHANICAL WORKS****SECTION : 3.00****VENTILATION & AIR CONDITIONING INSTALLATION****3.01 GENERAL**

This Section of the Specifications covers Air Conditioning and Mechanical Ventilation Systems, comprising air handling units, fan coil units, extract fans, return fans, air outlets, dampers, attenuates etc. all as shown on the Drawings and as specified hereafter to form a complete installation.

The spaces shall be air-conditioned by means of central air handling units and fan coil units.

A various air distribution system shall be installed in accordance with the environmental conditions required in the served area.

3.02 BRITISH STANDARD AND CODES OF PRACTICE

Unless otherwise stated, the provisions of the latest revised editions of British Standards and Codes of Practice relevant to the particular installation or part thereof shall be held to be incorporated in the Specifications of materials and workmanship to do with that part of the works as specified herein. Other Standards, national or otherwise and Codes of Practice which are equivalent to the relevant British Standards and Code of Practice may be adopted subject to the approval of the Engineer.

3.03 INTERNAL DESIGN CONDITIONS

The room design temperature, relative humidities, air changes, fresh air requirement shall be as shown on the following table:-

Internal Design Conditions for Summer & Winter Season

Area	Summer		Winter		Fresh Air	
	DB (°C)	RH (%)	DB (°C)	RH (%)	L/S Person	AC/HR
Halls	23	50	20	45	10	-
Storage	23	50	20	45	10	-
Gallery	23	50	20	45	8	-
Offices	23	50	20	30	8	-
Library	23	50	20	45	8	-
Workshop	23	50	20	30	10	-
Cafeteria	23	50	20	30	10	-

3.04 HEPA FILTERS **(Not included in this Contract)**

The filter casing shall be constructed from stove-enamelled sheet steel with a secure, central, sealing and clamping device for the particular air filter cell.

The filter casing shall be complete with anodised aluminium fixed blade diffuser and pre-assembled pressure measuring points, with tubes run to immediately behind the diffuser face.

The diffuser shall be removable and the filter cell accessible from the space served and the casing shall be suitable for a ceiling mounted application.

The particulate air filter frame shall be constructed from a moisture proof fire resistant impregnated board, with fixed neoprene rubber sealing on one side.

The filter media shall be moisture proof glassfiber paper with aluminium corrugated spaces.

The filter unit shall be 99.997% efficient when tested in accordance with BS. 3928 (sodium flame) to meet the class (1) clear room requirements of BS. 5295.

The filter shall be suitable for operation in maximum conditions of 60 deg.C and 100% R.H.

3.05 AIR HANDLING PLANT CASES

3.05.1 General

- 1- A name plate shall be permanently affixed to every unit listing air volume, fan static pressure, coil duties and heat recovery equipment ratings.
- 2- The automatic control equipment required shall be supplied by the controls manufacturer and fitted by the equipment manufacturer, unless otherwise instructed.
- 3- Lifting rings shall be provided on all individual components of 35 kg mass and above for maintenance removal.
- 4- All bearings shall be supplied fully lubricated.
- 5- Spare drive belts shall be provided, in sets where applicable, for each drive in the assembly to a total of one complete change per drive.
- 6- Where serpentine averaging thermostat sensors required a full support system shall be provided.

3.05 AIR HANDLING PLANT CASES (CONT'D)

- 7- All access doors shall be insulated to the same standard as the unit casing open towards the high pressure side.
- 8- All components shall be inherently non flammable or be made permanently so by suitable treatment.
- 9- Any viscous liquid used shall have a flash point in excess of 177 C.
- 10- All electrical items of equipment cabling, wiring, and works shall comply with the latest edition of IEE Wiring Regulations & Electricity at Work Regulations 1989 or to equivalent UL requirement.
- 11- Test Points shall be provided to enable comprehensive air side and water side tests to be made on each air handling unit.
- 12- For hazardous or corrosive atmospheric applications, all materials including liners, fixing assemblies and paint schemes shall be selected to meet the detailed requirements and particular conditions. Appropriate IP ratings for electrical enclosures shall be provided.

The unit casings shall be made of (25 mm for inside and 50 mm for outside location) insulated double panels built into a post frame.

Each section of a unit shall have a post framework constructed of anodised aluminium section with cast aluminium corner pieces of smooth surface.

Frame posts and cross members shall be constructed to incorporate 25mm. nominal thickness thermal insulation which shall be sealed in position.

Lifting eye bolts shall be provided on the corners of the sections and shall be removed after installation, the holes being plugged off with suitably sized flush fitting brass plugs.

Insulation materials shall be tested to and comply with BS4765 part 7 and achieve class 1 ratings. Fiber glass mentioned.

Insulation shall have a thermal conductivity not greater than 0.04W/mk and have a minimum thickness of 50mm.

Insulates incorporating CFCs in their manufacture, woodwools slabs, polystyrene and urea formaldehyde shall not be used.

If mineral fibers material is used the density shall not be less than 80 kg/m³ and provisions shall be made to ensure that no settling in materials occurs

3.05 AIR HANDLING PLANT CASES (CONT'D)

Panels shall be formed from two sheets of 1.2 mm. thick outside and 0.7mm inside galvanized steel having 25 mm. returned edges riveted or spot welded together.

The insulated top and bottom panels of the units shall be designed to withstand the weight of a man and the necessary equipment for maintenance purposes.

Panels shall be adequately stiffened and braced to prevent flexing and drumming and as necessary to maintain rigidity.

All panels shall be of the bolted in removable type: panels fitting flush into frames and corner posts to give smooth external faces.

Joints between panels and framework shall be sealed air tight with non hardening plastic ribbon seal seating strip.

The completed air handling unit casings shall be designed and installed to reduce the fans sound power level radiated into the plant room, or roof level, by the amounts as specified in Schedule S3.01. The density and type of thermal and acoustic insulation to be sandwiched within the panels shall be selected to achieve the panel attenuation specified in Schedule S3.01.

Schedule S3.01

Frequency	HZ	63	125	250	500	1K	2K	4K
Power Loss	dB	22.5	28	27	30	35	27.5	29

Framework and panels shall be constructed so that bare metal bridges linking inside to outside will not occur as detailed on drawings for outdoor units. The units shall be designed to prevent condensation from occurring from any cool surface of the unit.

Individual panel sizes shall not be greater than 3.5m by 1.75 m. where sections are dimensionally larger, more than one panel shall be used.

All panels and section framework shall be of manageable proportions for transportation and shipment.

The air handling plants shall be painted at the manufacturer's works before dispatch and shipment internally with a complete corrosion resistant paint finish.

3.05 AIR HANDLING PLANT CASES (CONT'D)

The air handling plants shall be decoratively painted externally in accordance with the painting and decorating Clause of the Building Specifications. The final two coats shall be suitable for the weather conditions that prevail in Amman.

Doors in access sections and fan sections shall be suitably sized for man access into and for easy maintenance of the equipment. Each door shall be of double skin construction with an infill of thermal and acoustic insulation to provide acoustic properties equivalent to the unit panels. Doors shall be designed to be an airtight fit and match the unit panels. The doors shall be double hinged to ensure a good seal onto the gaskets and shall include chromium plated handles, seals and fasteners to hold the neoprene seals in compression. All doors shall be openable from outside or inside the section and shall be provided with door locks, which can be locked from outside the unit but which can still be opened from the inside (cast aluminium hinges and handles).

3.06 BAG FILTERS

Where indicated in the Equipment Schedules, bag filter sections shall be incorporated.

These can comprise a composite section of the air handling unit and shall be arranged to enable side withdrawal of the filter media from the unit.

Holding frames shall be constructed from galvanized sheet steel with suitable seals provided to prevent air bypass around the filters.

The filter media shall consist of high density glass micro fibre media with individual dust holding compartments, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average arrestance efficiency of not less than 98 % and atmospheric dust spot efficiency 80-90 % on ASHRAE test Standard 52-76 or to EU grade (EU -8).

The configuration of the dust holding compartments shall be controlled by means of progressive link stitching. The stitching shall be such that it forms a supported compartment resulting in uniform velocities in the passages of the air exit side of the filter.

The dust holding compartments shall be equipped with a minimum of 516 support points per square meter of the filter media.

All stitching points shall be sealed with a hot melt adhesive.

Each filter bank shall be fitted with an inclined tube manometer connected at the works by the manufacturer.

3.07 PANEL FILTERS (PREFILTERS)

The filter media shall be natural, synthetic or glass fibre or fabric fibrous material shall be covered with a final scrim backing. They shall be replaceable filter elements in either mat or pad form, suitable for attachment to the upstream face of the bag filter banks.

They shall be fixed in permanent holding frames, and clips to ensure quick and easy removal of pre filters. The arrangement of the prefilters shall not impair access to and serviceability of the bag filters. All frames and clips shall be galvanized steel or other acceptable corrosion resistant material.

All filter elements shall be bedded firmly into permanent frame seals and pressed firmly and continuously onto face of bag filter frame by a cam operated mechanism or a series of accessible clips for front withdrawal type to prevent air by passing.

Panel filter assemblies shall be 50 mm. thick unless otherwise specified and have efficiencies of not less than those given below for various types of media when tested, to BS 2831 Test Dust No. 2, or ASHRAE 52-76 test.

Typical performance requirements:

Media Volume Type	Nominal Face Velocity m/s	Pa	Initial PD BS2831- Ashrae 52-76	Efficiency	at	Design
1	2.0		70	92		83
2	2.0		80	96		86
Media						

No. Typical Construction

1. Laminated two stage glass filament media.
2. As type 1. followed with a synthetic scrim.

The filter media shall provide a normal servicing frequency of 4 months with a rise in pressure drop from clean to dirty of not more than twice the initial pressure drop.

Each filter bank shall be fitted with an inclined tube manometer connected at the works by the manufacturer.

3.08 PANEL WASHABLE TYPE FILTERS

The filter media shall be combined of expanded and slit aluminium, bonded together in various patterns to form a unique baffle design. This rust-proof aluminium should be easily washed.

Frame, is of aluminium plain mill finish 24 gauge. Construction shall be of aluminium expanded media of 5/8 inch thick in one layer. Average dust arrestance 75% at 1.8 m/s, dust holding 400 Grms at final resistance of 125 Pa. this type of filters shall be used at fresh air inlet side

3.09 DAMPERS

All air regulating dampers shall be installed as indicated on the Drawings and as specified herein.

Air regulating dampers in air handling plant sections shall be assembled from individual dampers bolted together to form a multiple unit. The dampers shall be of the multi leaf opposed blade type. The assembled unit shall be bolted to angle and channel galvanized iron frame work built into the unit casings. Dampers shall be made of Anodised Aluminium sections geared together by plastic gears.

The multiple damper unit shall be sized for the full air handling unit area, without blanking plates. The face velocities shall be not greater than 5.08 m/sec. (1000 f.p.m.). Closed blade leakage should be <10 m³/h.m² with a 100 Pa pressure differential.

Complete damper assemblies shall be operated in vertical banks across the width of the unit. For the adjustment of vertical banks damper regulators with locking quadrants shall be installed inside the unit casing integral with the vertical bank.

Damper regulators shall be marked to indicate the damper position.

Dampers shall be designed, selected and installed such that they do not whistle, whine or produce any recognisable pure tone. The regenerated noise from dampers shall not exceed the induct sound power level at that point of the ductwork system, also the regenerated noise when combined with the induct sound power level at that point must not exceed the criterion in any room over which the duct passes subsequently or in a room which is subsequently served by that ductwork system.

Damper frames shall be fabricated from mild steel channel with all four corners of the frame braced, and shall be Electro galvanized after manufacture.

3.09 DAMPERS (CONT'D)

Damper blades shall not be greater than 250 mm. in width. Blades made from aluminium extruded sections. The blades shall have interlocking edges and cross connecting brackets. Each blade shall have neoprene edging inserted along its length to ensure an airtight seal and whistle free operation.

Damper sections shall be built to size using the lowest practicable number of equal width blades inter-connected on every other blade. Any resulting small air gap top and bottom between blades and channel frame shall be blanked off. Damper blade side stops shall be overlapped and designed to contact blade edges and reach the blade axles.

Damper blade axles and push rods shall be manufactured in stainless steel. Axle bearings shall be of the blind end type with the bearings mounted flush with the inside face of the damper frame. The bearing shall be pre packed with grease and the open end sealed with a rubber 'O' ring seal to prevent air leakage. The opposed blades action only, via gears, made from special anti-static plastic (ABC), temperature resistant to 100 C. Bearing seal achieved using a plastic elastomer on rear of gears between case and gear. Material: Perbunan.

3.10 AIR HEATING COILS

Air heating batteries contained within air handling plants shall be sectionalised. The whole air heater battery shall be made up of individual heater batteries having an overall area not greater than 2.0 square meters. The heaters shall be bolted onto a steel channel and angle iron framework built inside and bolted to the unit. The framework shall be protected against corrosion and all nuts and bolts shall be cadmium plated.

Airtight blanking plates shall be provided to seal the remaining portions of the cross sectional area of the air handling unit when the heater battery area is less than the cross sectional area of the unit. Sufficient space shall be left between the battery assembly and the top and bottom of the units for bolting the individual batteries in position in situ.

Each heater battery flow and return connection shall be extended through the unit side casings with puddle type black steel extension flanges ending to match flanged pipe joints. Adequate space shall be provided for the bolting of flanged joints within the units. Where two heater battery sections are mounted end to end across the width of the unit the primary flow and return connections shall be handed so that the coils can be connected to the service mains at each side of the unit.

Each air heater battery section shall be subject to an air under water test at a pressure equal to twice the working pressure as specified.

3.10 AIR HEATING COILS (CONT'D)

Heater battery coils shall be constructed from 16 mm. O.D solid draw copper tube mechanically expanded into heater spaced ribbed and punched Aluminium fins of maximum density 320 fin/meter (10 fins / inch). The fin and tube matrix shall be coated by acrylic layer after manufacture.

The fin and tube matrix shall be enclosed inside a galvanized sheet metal casing with flanges. Heavy gauge tube end plates shall have die formed extruded holes to support the coil tubes sizes to allow free expansion and contraction with minimum friction and minimum air leakage. The casings shall be painted after manufacture for protection against corrosion.

Heater battery return bends, distributor feeds, and primary feeds shall be of copper tube welded and silver brased to copper flow and return headers.

The flow and return primary feed connections to headers shall be located top and bottom on the same side of the coil and be flanged to match flange joints.

Flow and return headers shall be provided with a horizontal air vent box tapped 15mm nominal pipe diameter located above the last distributor tube and above the primary feed connection. Batteries shall be provided with 25mm drain connection Coil's in all AHU's should not contain more than three rows.

The heater batteries shall be selected and installed such that they do not whistle, whine or produce any recognizable pure tone.

The regenerated noise from heating batteries shall not exceed the induct sound level at that point of the ductwork system.

Alternatively, the regenerated noise, when combined with the induct sound power level at that point shall not exceed the criterion in any room over which the duct passes, subsequently, or in a room which is subsequently served by that ductwork system.

3.11 AIR COOLING COILS

Air cooler batteries contained within air handling plants shall be sectionalised. The whole air cooler battery shall be made up of individual cooler batteries having an overall area not greater than 2.0 square meters.

The coolers shall be bolted onto a steel channel and angle iron framework built inside, and bolted to the unit. The framework shall be protected against corrosion and all nuts and bolts shall be cadmium plated.

Airtight blanking plates shall be provided to seal the remaining portions of the cross sectional area of the air handling unit when the cooler battery is less than the cross sectional area of the unit. Sufficient space shall be left between the battery assembly and the top and bottom of the units for bolting the individual batteries in position in situ.

3.11 AIR COOLING COILS (CONT'D)

Each cooler battery flow and return connection shall be extended through the unit side casings with puddle type black steel extension flanges ending to match flange pipe joints within the units. Where two cooler battery sections are mounted end to end across the width of the unit, the primary flow and return connections shall be handed so that the coil can be connected to the service mains at each side of the unit.

Each air cooler battery shall be manufactured in accordance with the following Specification. Cooling battery coils shall be constructed from 16 mm. O.D solid drawn copper tube mechanically expanded into collar spaced ribbed and punched aluminium fins of maximum density 320 fin/meter (10 fins / inch). The fin and tube matrix shall be treated after manufacturing with corrosion protective layers such as acrylic coatings or other approved materials. Coil's in all AHU's should not contain more than five rows.

Each air cooler battery shall be provided with a galvanized steel drip tray at the base of each section of the battery. Each drip tray shall be tanked and sealed into the assembly. Each drip tray shall be fitted with air deflectors and 25 mm. pipe drain. Each intermediate drain pan shall be connected with a drain pipe feeding into the main air handling unit drain pan as specified in Section 3.13.

Drain pans shall be designed to minimize the risk of legionella.

The air velocity across the cooling coil shall not exceed 2.5 m/sec.

3.12 AIR HANDLING UNITS FANS

Supply air fans and recalculation air fans mounted within air handling unit sections shall be centrifugal casing type designed and manufactured as specified herein.

Fans shall be double inlet, double width centrifugal back ward curved, or forward blades.

Fans shall be suitable for indirect drive by matched V belts and pulleys. Where the system allows low flow, multi vane forward curved bladed fans may be used.

Fans shall be selected for slow speed running low sound level and high efficiency. All fans shall be selected to be capable of being operated by at least 10% in capacity over the design volume specified.

Fan casings and scrolls shall be fabricated from heavy gauge mild steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of with standing the pressures involved without leakage or distortion.

3.12 AIR HANDLING UNITS FANS (CONT'D)

Fan casings shall be continuously welded construction split as required to pass through available unit access doors.

Fan casings shall be bolted construction for ease of installation, the number of sections being dependent upon the size of the fan and access available for future removal and replacement.

Bearing blocks shall be carried on opposite sides of the fan casing on bearer bars forming a part of a rigid fabricated steel structure integral with the casing.

Ceiling hung fans shall be supported on spring hangers to eliminate vibration to the building structure.

3.13 FAN DRIVES

Fan drives for centrifugal fans shall be multiple V belts and variable pitch pulleys.

Pulleys of the taper lock type may be used for drives up to 30 KW output. The pulleys shall be keyed to the shafts after commissioning.

Alternatively, and where drives are above 30 KW out-put, the pulleys shall be secured to the fan and motor shafts by fitting into machined keyways. Keys shall be easily accessible so that they can be withdrawn or tightened and shall be accurately fitted so that the gibe head does not protrude beyond the end of the shaft.

Each fan set shall be supplied with initial sets of pulleys and drives to give the duties as designed.

Fans with standby motors if require shall be provided with two sets of pulleys, one on each side of the fan.

V belt drives shall comply with BS.3790 and shall be capable of transmitting not less than the rated wattage output of the motor with one belt removed.

Machined bolts, nuts and washers shall be used for the assembly of fans: all bearing surfaces for the heads of bolts of washers shall be counter faced.

All fan casings shall be fitted with bolted on air-tight inspection door and a drain plug.

Fan casing shall be fitted with flanged outlets for duct connections and shall have rigid spigot inlets truly circular and free from dents.

3.13 FAN DRIVES (CONT'D)

Inlet cones shall be manufactured to close tolerances to avoid turbulence at the air entry to the impeller. All internal and external exposed casing surface shall be zinc sprayed for protection against corrosion.

The fan impeller wheel and blades shall be robustly constructed from mild steel sheet with fabricated steel or cast iron boss with back plate when required. the boss shall be bored and keywayed for the shaft. Impellers shall be zinc sprayed against corrosion.

Impellers shall be rigidly braced to ensure concentricity and eliminate vibration and shall be certified as being statically and dynamically balanced on their shafts at the manufacturers works.

Fan driving shafts, of ample section for the loading, shall be of high tensile mild steel, precision turned, ground and polished.

Keyways shall be provided for securing the impeller and riving pulley.

All fans shall be fitted with permanent type of bearings mounted in cast iron plumber blocks.

All V belts shall be of the anti static type suitable for operation in temperatures likely to prevail in the plant rooms.

Guards shall be provided for all open unprotected air inlets to centrifugal fans.

Fan and fan motor to be fixed on one steel shassy which is fitted with rubber anti vibration mounting and the fan outlet fitted with flexible canvas connection.

Drive and pulley guards shall be made to be readily removable to permit belts to be changed.

Adequate access panels shall be provided in the guard to allow tachometer readings of the shafts to be taken and the belt tension to be tested.

Allowance shall be made in the dimensions of the guard and the size and position of access panels for the adjustment of the motor on its side rails. Fans with standby motors shall be provided with two guards one on each side of the fan.

3.14 FAN MOTOR

Electric motors shall be continuously rated of metric frame construction and shall comply with BS.5000 and BS.2048.

Each motor shall be rated at 130 percent (%) of the fan's rating when running at the duties as designed. Fan motors shall be squirrel cage, total enclosed, fan cooled type wound for 380 volts, 3 phase, 4 wire, 50 hertz electrical supply. Motors of 5.6 KW and above shall be arranged for star delta starting. Motor insulations shall be to Class F.

Thermistor type overheating cut outs shall be provided in the motor windings.

All motors shall be suitable for horizontal foot mounting and be complete with slide rails and belt adjusting bolts.

Standby motors if require shall be complete as for duty driving motors with slide rails and shall be permanently mounted and wired within the air handling units so that in the event of failure of the duty motor the standby motor can be started without any belt changing, etc.

Each fan and motor assembly including standby motors shall be mounted on a fabricated and welded rolled steel channel iron base frame, suitably drilled for mounting upon antivibration mountings within the air handling unit fan section casing.

3.15 ANTIVIBRATION TREATMENT

All equipment containing moving parts generating noise or vibration shall be mounted or placed upon specially designed isolators. All connections to such equipment shall be fitted with flexible connectors to prevent transmission of such noise and vibration to the structure or to other areas of the building or to other pieces of equipment.

Each centrifugal fan and motor channel base frame shall be mounted on anti vibration mountings as specified herein.

The resilient material of the anti vibration mounting shall be rubber or neoprene for static deflections of less than 12 mm. and steel for deflection of greater than 12 mm. Steel springs shall contain a series of rubber or neoprene pads to contain and isolate the structural borne noise component. Anti vibration mounting shall be adjustable in height to level the machine foundation except where the static deflection of the mount is less than 6 mm.

Where practicable, anti vibration mountings shall be removed for shipment. Where impracticable anti vibration mountings must be provided with transit bolts and nuts to hold them rigid to the frame of the machine.

3.15 ANTIVIBRATION TREATMENT (CONT'D)

Flexible joints shall be provided on fan inlet and outlet connections as required.

Flexible joints and material shall be of, or be protected by, material having a fire penetration time of not less than fifteen minutes when tested in accordance with BS476, Part 1, Section 3.00. The material shall be of the glass fiber cloth type and waterproof. Canvas material will not be permitted.

The width of the joints from metal edge to metal edge shall not be less than 100 mm. and not greater than 250 mm.

All flexible joints shall be between flanged ends. The flexible material flange shall be backed by an angle or flat iron flange and the flexible material held securely between the metal faces of the steel section.

All electrical conduits and connections in contact with fans, bases, motors or supports shall be fitted with flexible sections to avoid nullification of the anti-vibration treatment provided.

Flexible conduit shall be watertight, PVC sheathed, spiraled metal type. The conduit shall be terminated at boxes and equipment with compression glands. An additional PVC insulated stranded tinned copper earthing conductor not less than 6 mm. diameter shall be drawn into flexible conduits and connected to the earth terminals at each end of the flexible run.

3.16 BULKHEAD LIGHTS

100 watt side entry bulkhead lights shall be provided in each section of the unit where access is available. The lights shall be wired back to surface mounted light switches located externally adjacent to the appropriate access door.

Bulkhead light fittings shall have a body in corrosion resistant aluminium alloy and a prismatic diffuser held firm in position by a hinged glazing ring, the rings seating onto a neoprene gasket. The interior of the fitting shall be painted white.

The bulkhead lights shall be drilled at their lowest point to prevent build up of condensation.

Single pole 15 ampere 240 volt light switches shall be galvanized weatherproof assemblies with two position semi rotating switch.

Switches shall be mounted on back entry galvanized steel boxes, surface mounted onto the unit. All conduits shall be welded mild steel heavy gauge to BS4568 galvanized after manufacture and jointed with galvanized solid screwed couplings.

3.16 BULKHEAD LIGHTS (CONT'D)

Conduits shall be fixed at intervals not greater than 1300 mm. Conduit systems shall be electrically and mechanically continuous and watertight after installation. All conduit systems shall be arranged wherever possible to be self draining to switch boxes and conduit outlet points for light fittings.

Each air handling compartment containing drive motors shall be fitted with a cable entry terminal box sized for the type and size of cables as specified in Schedule of Cable Sizes indicated in the Electrical Drawings. Each box shall be complete with gland plate and adequate space shall be provided within the box to easily permit cable cores to be spread and terminated.

3.17 TESTS AND PERFORMANCE CERTIFICATES

The Contractor shall submit for approval before placing his order for the AHU's the following information:

- a) A description of the actual test procedures used by the fan manufacturers.
- b) A laboratory test sheet showing results of a test for fans typical of the types that will be ordered.
- c) A fully documented list of total sound power levels in each of the second octave bands between the frequencies of 63 Hz and 4 KHz for each fan.

The Contractor shall provide the Engineer with fan performance certificates for each fan tested in accordance with the requirements of B.S.848, Parts I & II.

The characteristics of each fan's performance shall include curve relationships of volume, pressure, efficiency and power absorbed at constant speed.

The induct sound power levels shall be determined in accordance with the requirements of B.S.848, Part 11.

The Contractor shall provide the Engineer for approval with performance certificates showing the induct sound power level in the seven octave bands as specified above for each fan before placing his order with the manufacturer.

3.18 TEST HOLES

Tapped holes for testing purposes and for permanent instrumentation shall be provided as indicated on the drawings and Schedule. Suitably sized holes shall be formed in the inner and outer panel skins and steel hank bushes welded onto the inner faces.

Recesses hexagon brass plugs, threaded 15 mm. male shall be supplied and fitted into the female thread of the instrument ferrule.

The panel insulation shall be suitably cut to give a clear way for the instrument ferrule.

3.19 DRAIN PANS

Drain pans shall be fitted below all cooling coils as a continuous unit constructed from 2 mm. thick galvanized steel sheet steel. A 50 mm. galvanized drain complete with trap and clean out plug shall be provided. The drain shall be taken from the pan to terminate external to the unit to a glass trap for extension via a tundish to the nearest floor drain gully.

Secondary drain pans shall be installed under valves and strainers serving FCU's and under all valve stations.

They shall be same as drain pans of AHU's and shall extend via a tundish to the nearest floor drain gully.

3.20 SILENCERS (SOUND ATTENUATORS)

The degree of silencing for any fan and ductwork system is determined by the amount of silencing required to obtain the specified noise levels given as N.C. levels.

Silencers installed on the supply ductwork system side of fans shall include for the effects of regenerated noise, duct breakout noise, noise emanating from diffusers and noise from any other ventilation systems serving the area.

Silencers installed on the atmosphere connection side of fans and air handling equipment shall include for the effects of regenerated noise in the silencer and noise from other fans drawing or exhausting air to or from the atmosphere.

Silencers shall be of the splitter type, protected to ensure that erosion of the attenuating element does not occur. The materials and construction shall prevent carryover or migration of the material into the air conditioning distribution system. The regenerated noise of all silencers shall be predicted and shall not increase the induct sound power level at any point (i.e. shall be more than 10dB below the induct sound power level).

3.20 SILENCERS (SOUND ATTENUATORS) (CONT'D)

The regenerated noise, when combined with the induct sound power level at that point, shall not exceed the criterion in any room over which the duct subsequently passes, or in a room which is served by that ductwork system.

Prefabricated unit silencers shall be constructed with the silencer splitters inserted into unit casings secured by cadmium plated bolts through retaining angles.

Main air handling unit silencers shall be constructed with the silencer splitters in galvanized sheet steel casings constructed with a profiled galvanized steel frame bolted to angle frames with in the air handling unit casings. All retaining angles and framework shall be adequately protected against corrosion.

Noise levels within the conditioned space shall be no greater than those set out in Schedule below.

In his final assessment of conditioned space noise levels the Contractor shall make due allowance for the additive effect of all point sources of noise.

Standards of noise criteria to be maintained:-

Schedule of maximum allowable noise levels

Location	Noise level Criteria
Halls	NC35
Storage	NC35
Gallery	NC35
Library	NC30
Workshop	NC40
Noise to atmosphere	NC45 at 10 m. from building & 1.5 m. above ground level

Note:

- 1- Fan coil units shall be selected for NC 35 on medium sped and NC30 on low speed.
- 2- The air conditioning noise criteria given are the maximum noise levels permitted.

3.21 AIR HANDLING SYSTEMS IN FIRE MODE

All air handling systems shall be constructed and arranged to enable them to assist on smoke clearance purposes.

In the event of the a fire alarm within the building. All recirculation air plant dampers shall be closed.

Smoke detectors shall be fitted into the common extract ducts of individual recirculation air plants and shall shut off the supply fan and the recirculation damper while maintaining the exhaust fan on full operation.

Combined smoke and fire dampers shall be installed in all supply and extract ducts which shall be closed by the fire alarm system to prevent spread of smoke in to escape routes. The system shall be arranged that smoke dampers can be reset remotely.

3.22 LOUVERS AND PENTHOUSES

General

Louvers shall be of aluminium manufactured from HE 9th. quality extruded section to BS 1474 or from NS4, H3 or SIC/H quality aluminium sheet to BS 1470 alloy extruded sections.

All louvers shall be provided with an epoxy based powdered coating suitable to resist corrosion.

All louvers and cowls shall be rigid in construction and shall not rattle or flex.

The free area of louvers shall not be less than 45%.

Unless otherwise specified, wall louvers shall be based on the following maximum intake and discharge velocities, provided the specified noise levels are not exceeded.

<u>Type</u>	<u>Intake</u>		<u>Exhaust</u>	
	<u>Max.Vel.</u>	<u>Max.Pr</u>	<u>Max.Vel.</u>	<u>Max.Pr</u>
	<u>m/s</u>	<u>Pa</u>	<u>m/s</u>	<u>Pa</u>
Single blade	2.0	35	2.5	60
Double blade	2.0	50	2.0	80
Triple blade	2.3	70	2.0	140

The louvers and cowls shall be constructed from aero dynamic designed extruded section to provide low resistance to air flow and maximum resistance to rain penetration.

3.22 LOUVERS AND PENTHOUSES (CONT'D)

Before manufacture, the exact size of opening into which louvers and cowls must fit shall be checked by site measurement.

Louvers shall be in multi bank form

a) Wall Louvers

Louvers shall be provided with subframe suitable for bolting into a prepared opening in the building structure.

Special finishes shall be applied to match with the frames of the windows.

Louvers shall have a maximum module size of 2 m.x 2 m. Louvers in excess of this size shall be constructed by bolting modules together. Vertical mullions shall be provided at not more than 1 meter centres.

Box section louver frames shall be provided with all joints and connections.

All louvers shall be provided with flashings, top covers, cills, clips, shims, fastening devices separating panels, anchors and all other items required for a complete installation. All fastenings shall be non-ferrous, or zinc/cadmium plated.

All louvers shall be furnished with bird screens of 12 mm. diamond or square mesh, 2.0 mm. galvanized steel wire in folded frame complete with fixing lugs. All steel parts shall be hot dipped galvanized after manufacture.

Where blank off sections in louvers are indicated, they shall be constructed from two 1.0 mm. thick sheets of galvanized steel with 50 mm. of mineral wool insulation between, then primed and painted matt black on louver side.

b) Penthouse louvers

Penthouse louvers of the size and performance indicated in schedules shall be provided.

The units shall be constructed in extruded aluminium alloy. The louvers shall be a minimum of 100 mm. wide.

All joints shall be mounted and blades shall be mechanically fastened to the main frame with stainless steel screws.

The effective pressure area must not exceed 50% of the blade area.

3.22 LOUVERS AND PENTHOUSES (CONT'D)

All penthouse units shall have a roof panel of 12 gauge aluminium.

The base of the units shall be constructed for curb mounting and the units shall be securely fixed to the curb to ensure stability under all weather conditions and provide a completely weatherproof enclosure.

Each unit shall be fitted internally with bird screens, mesh size shall be a minimum of 12 mm. x 12 mm. and manufactured from 2.0 mm. diameter wire hot dipped galvanized after manufacture. The screens shall be fitted direct to the main louver between the screen frame and penthouse mounting angles. All fixings shall be non ferrous or zinc/cadmium plated.

c) Low profile terminal discharge cowls

Units shall be manufactured in non rusting aluminium alloy or glass reinforced plastic to form a weatherproof housing. The unit bases shall incorporate integral weatherskirts and air inlets/outlets complete with bird screens. All fixings and fasteners shall be in stainless steel or zinc plated mild steel.

Unit constructed from natural aluminium shall have an epoxy resin powdered coating finish.

The units shall be suitable for mounting onto flat roofs with upstand curbs or pitched roofs as indicated on Mechanical Services Drawings.

3.23 SAND TRAP LOUVRES

Units shall be constructed of aluminium extruded sections. They shall separate sand from intake air and shall include self-emptying sand drain holes. The finish shall be syntha pulvin powder coated M4 L009 (BS 00 A 05) or otherwise to withstand the humidity and temperature conditions prevailing in Amman. The colour shall be decided by the Engineer at the time of submittal and order.

They shall be provided with bird screens galvanized 12 x 12 x 1 mm.

The blades shall be 0.9 mm. thick and the casing shall be 2.0 mm. thick.

The units shall be supplied complete with builders cleats.

3.23 SAND TRAP LOUVRES (CONT'D)

Sand rejection at 1 m/s. face velocity shall not be less than the following:

<u>Particle size (in microns)</u>	<u>Efficiency %</u>
150 - 700	90
75 - 700	60

3.24 TOILET EXTRACT FANS

Toilet extract fan units shall be of twin centrifugal cabinet type. with one fan on duty and the other fan as stand by. Fan operation shall be controlled by built in controller to alternate operations and to operate the standby fan, should the on duty fan fails, provided all in accordance with the following requirements, as scheduled on the Contract Drawings and in the positions shown on the Drawings. All fans shall be of belt driven motors.

The housing of units shall contain all components of the unit except the terminal box for electrical connections. The housing shall be provided with dust-protected access covers to IP54 of BS5490 for inspection, and replacement, of all components. No electrical component shall be fixed to or supported by any access cover. A galvanized mild steel terminal box shall be securely fixed to the outside of the casing in a suitable position. Units to be located in plant rooms may be supplied in chassis form, where specified. Unless otherwise specified the fans shall be arranged for automatic changeover.

Housing and cowls of externally mounted units shall be weatherproof and manufactured from galvanized mild steel or aluminium alloy sheets, or glass reinforced plastics to BS 3532, assembled with compatible and non-corroding nuts, bolts, washers and ancillary items.

Discharge outlets shall be weatherproof and include guard screens to IP20 of BS5490, to prevent finger contact with electrical and moving parts. Each fan damper shall close when the fan is de-energised. All items shall have a non-corroding finish.

Except where otherwise specified dual fans and motors shall be fitted on a common baseplate supported on anti-vibration mountings.

Backdraught dampers shall have edge seals and shall open and close fully. All blades shall be mechanically linked or close by gravity or light springs and be galvanized mild steel except where specified otherwise.

Fan failure in units of less than 500W fan shaft power shall be sensed and indicated from switches operated by damper blade movement, except where specified to be otherwise. Double throw airflow switches shall be used in units above 500W shaft power.

3.24 TOILET EXTRACT FANS (CONT'D)

The unit casing shall be manufactured in aluminium alloy of rectangular section and shall house twin independent removable fan assemblies comprising direct driven double inlet forward curved centrifugal impellers running in metal scrolls. The discharge outlet shall incorporate backdraft shutter. The fans shall be fitted with air flow sensors and shall discharge into a common outlet plenum chamber through a linked shutter system. Motors to BS 5000 shall have ventilated enclosures and sealed for life sleeve bearings. Motors shall be held to scroll frames through resilient mounts. Motors and flow switches shall be pre wired to an electrical isolator casing accessible from external to the unit.

A rectangular inlet spigot shall be fitted to the base complete with flexible connector.

The unit casing shall be closed by a top cover, easily removable for access to the fans for servicing and maintenance purposes. The units shall be acoustically lined and non rusting fasteners shall be used throughout.

3.25 CENTRIFUGAL TUBULAR FANS

Tubular centrifugal type fan shall be back ward curved or airfoil blades design with non overloading operating characteristics and high efficiency. The fan shall include a flat wheel backplate with cast iron or fabricated steel hub and accurately formed spun shrouds. The wheel shall be dynamically balanced to commercial tolerances.

Fans shall be suitable for indirect drive by matched V belts and pulleys. Where the system allows low flow.

Fans shall be selected for slow speed running low sound level and high efficiency. All fans shall be selected to be capable of being operated by at least 10% in capacity over the design volume specified.

Fans shall be provided with 1 speed 2 speed or 3 speed motors as indicated on the equipment schedule with Class "F" insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.

Fan casings and scrolls shall be fabricated from heavy gauge mild steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of with standing the pressures involved without leakage or distortion. Fan casings shall be continuously welded construction split as required to pass through available unit access doors.

Fan casings shall be bolted construction for ease of installation, the number of sections being dependent upon the size of the fan and access available for future removal and replacement.

3.25 CENTRIFUGAL TUBULAR FANS (CONT'D)

Bearing blocks shall be carried on opposite sides of the fan casing on bearer bars forming a part of a rigid fabricated steel structure integral with the casing.

Fans shall be complete with:

- a) Backward curved / or airfoil blades
- b) Inlet cone
- c) All welded fan casings with reinforced outlets
- d) Side support frames
- e) Polished high grade steel fan shaft on with lubricating roller bearings
- f) TEFC electric motor rated for continuous operations in ambient temperature up to 50°C
- g) V belt drive
- h) Galvanized wire mesh guards constructed and fitted to satisfy all relevant safety legislation
- i) Rolled steel channel base frame
- j) Antivibration mountings
- k) Flexible inlet and outlet flexible connections

Laundry Exhaust fans components shall be constructed to operate continuously at not less than 200°C.

All fan sets shall be finished with one priming coat and two coats of gloss. The impeller shall be finished in a contrasting colour. All fan sets shall be tested at Works and installed strictly in accordance with the manufacturer's instructions.

3.26 Roof Extract Fans

Roof extract fans shall be curb mounted type and shall be belt driven with a mixed flow or backward curved impeller. They shall include a stand by motor.

Dual speed units shall be provided if required and mentioned.

The weather cap, motor compartment and base shall be of moulded polyester resin, glass reinforced with an additive rendering it fire retardant to BS.476 : Part 7.

The fans shall be mounted on concrete curbs. The curbs shall be constructed under civil works.

3.26 Roof Extract Fans (cont'd)

The fans shall include :

- Anti back draught shutters.
- Resilient mounts
- motors as indicated on the equipment schedule with Class "F" insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.
- Electric isolator switch.
- Prelubricated motor bearings. manufactured to BS5000 Class B insulation, with sealed for life bearings.
- Inlet guards

The fans shall be mounted on concrete curbs. The curbs shall be constructed under civil works.

3.27 AXIAL FANS

Axial fans shall be belt driven with the electric motor outside the casing. The fans shall be hung on spring hangers to eliminate the transmission of vibration to the building structure.

The electric motors shall be carried on a support frame which is extended to one side of the fan casing.

The belts shall be enclosed by a sheet metal housing.

Impellers shall be die cast in aluminium.

The fan casings shall be hot dipped galvanized steel.

The electric motors shall be totally enclosed fan cooled squirrel cage induction type rated for continuous operation in ambient temperature up to 40°C.

The fans shall be selected for maximum efficiency and low noise levels. The casing shall be externally sound isolated.

Fans of car park shall be of dual type and shall be scheduled to operate on two stages. The first fan to operate in low parking periods, while the second to operate on peak time periods.

The fans shall be provided with matching flanges on both ends.

Supply air fans or exhaust air fans shall be of double inlet, double width centrifugal back ward curved or air foiled for capacities above 1000 L/s and forward curved for lower capacities, non overloading operating characteristics with high efficiency.

3.28 CENTRIFUGAL FANS

Supply air fans or exhaust air fans shall be of double inlet, double width centrifugal back ward curved or air foiled for capacities above 1000 L/s and forward curved for lower capacities, non overloading operating characteristics with high efficiency.

Fans shall be suitable for indirect drive by matched V belts and pulleys. Where the system allows low flow, multi vane forward curved bladed fans may be used.

Fans shall be selected for slow speed running low sound level and high efficiency. All fans shall be selected to be capable of being operated by at least 10% in capacity over the design volume specified.

Fans shall be provided with 1 speed 2 speed or 3 speed motors as indicated on the equipment schedule with Class "F" insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.

Fan casings and scrolls shall be fabricated from heavy gauge mild steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of with standing the pressures involved without leakage or distortion. Fan casings shall be continuously welded construction split as required to pass through available unit access doors.

Fan casings shall be bolted construction for ease of installation, the number of sections being dependent upon the size of the fan and access available for future removal and replacement.

Bearing blocks shall be carried on opposite sides of the fan casing on bearer bars forming a part of a rigid fabricated steel structure integral with the casing.

Fans shall be complete with :

- a) Backward/ Forward curved blades
- b) Inlet cone
- c) All welded fan casings with reinforced outlets
- d) Side support frames
- e) High grade steel fan shaft on roller bearings
- f) TEFC electric motor rated for continuous operations in ambient temperature up to 50°C
- g) V belt drive
- h) Galvanized wire mesh guards constructed and fitted to satisfy all relevant safety legislation
- i) Rolled steel channel base frame
- j) Antivibration mountings

3.28 CENTRIFUGAL FANS (CONT'D)

- k) Flexible inlet and outlet flexible connections
- l) Laundry Exhaust fans shall be components shall be constructed to operate continuously at not less than 200°C.

All fan sets shall be finished with one priming coat and two coats of gloss. The impeller shall be finished in a contrasting colour. All fan sets shall be tested at Works and installed strictly in accordance with the manufacturer's instructions.

3.29 PROPELLER FANS

Shall include multi blade steel blades with steel hub. Safety guards shall be provided on motor and on fan side. Mounting frames shall be predrilled at Works. Fan panels and frames shall be bonderized and finished in baked enamel.

The wheels shall be precision balanced and die formed. The electric motors shall be totally enclosed with prelubricated bearings for long service life. The Units shall be selected for maximum efficiency and low noise levels.

**3.30 SMOKE CLEARANCE INLET FANS
(Not Included in This Contract)**

Single stage axial smoke clearance fans, all in accordance with the following requirements, the accompanying schedules and as shown on the Drawings shall be provided.

Each fan shall comprise an aerofoil impeller direct driven by a totally enclosed motor and enclosed in a galvanized casing.

**3.31 SMOKE VENTILATION FANS
(Not Included In This Contract)****General**

Fans to be used for smoke extract ventilation application shall be of bifurcated and of all steel construction with fire rated flexible connections, and motors, electrical cabling and components suitable for continuous operation at elevated temperatures. Fans shall be constructed to operate continuously at highest smoke temperatures envisaged and not less than 300°C for one hour. The smoke extract fans shall be fitted with suitably constructed non return dampers.

Motors shall be rated for fans to pass the hot gas volume of air at NTP.

Impeller/casing clearances shall be satisfactory at the intended operating temperatures.

Units shall be type tested to the standards of the Smoke ventilation Association.

3.32 STAIRCASE PRESSURIZATION SYSTEM (Not Included In This Contract)

General

Stair case pressurization system shall be designed to maintain 0.1 kpa water gage static pressure in the stairwell with all doors closed.

With the three doors furthest from the point where the pressurization air is introduced into the stair enclosure open, the system should be capable to maintain 0.013 kpa static pressure. If unable to maintain static pressure with the doors open, the minimum velocity through the door openings should be 2.0 m/sec

The system shall comprise:

- Stair Case Pressurization Fan
- Smoke Relief Vent
- Emergency Relief Vent

3.33 STAIRCASE PRESSURIZATION FAN (Not Included In This Contract)

The fan shall comprise of galvanized steel with non-rusting fixings. Unit cases shall be of square section, weather-proof and shall be manufactured in galvanized steel. Inlets and outlets shall be flanged and drilled for connection into compatible ducting. Removable panels shall be bolted to one side of the casings to provide quick and easy access to the unit interiors for wiring, cleaning, inspection and maintenance purposes.

Fans shall be of single inlet, twin high performance mixed flow impellers manufactured in aluminium and dynamically balanced after manufacture.

Motors are manufactured to BS 5000, with class F insulation to IP54.

Electrical isolators shall fitted as standard. The isolators are rotary type units, locable on pattern to IP 54. The isolators are pre wired to the motors via cabling protected inside flexible conduit. Six pole isolators are fitted to all units.

Fans shall be provided with auxiliary contacted shall be and differential pressure switch, (DPS).

Fans shall provided with guards for inlet and outlet fitting.

Fans shall be provided with resilient mounting kit containing a set of four mountings matched to the particular unit or unit/silencer combination, plus a set of four purpose designed mounting feet manufactured in galvanized steel.

3.33 STAIRCASE PRESSURIZATION FAN (CONT'D) **(Not Included In This Contract)**

The kit is provided with the necessary fixings to assemble the resilient mountings and feet to the unit/silencers.

Fan inlet shall be provided with aluminium fresh air louver and wire mesh.

Fans shall be provided with flexible connectors which shall be of square section with a square end flange to match the units.

The flexible duct material incorporated into the connectors shall be of flameproof and shall have a tensile strength of 227 kg x 204 kg with a tear strength of 22.7 kg x 22.7 kg. and shall be of heat resistance to 132° with continuous resistance to chemicals, ozone, oil and grease. The connectors are airtight and waterproof and have been tested to BS 476 Part 7.

Controls

The pressurization fan starter and controller shall be accommodated in a dedicated control panel protected to IP65. It shall be independently and directly fed from the essential power source.

The fan shall be activated by smoke detectors in corridors, suppression system activation or by 1 fire alarm station.

Starters for fan shall be of "hand-off-automatic" type with spring return.

A smoke detector is also to be fitted in the intake of the fan. this shall shut off the fan or reverse the flow, if smoke is detected.

Control Panels shall be interfaced and connected to the main alarm systems. Units feature auto changeover, a test facility and condition indication.

3.34 STAIRCASE PRESSURISATION ANCILLARIES **(Not Included In This Contract)**

Pressure Relief Vent

A 800x400mm (N. & W. shaft) & 700x350mm (E. & S. shaft) relief vent shall be provided from the stair enclosure into the service lobby of each floor so as to maintain the desired static pressure when the doors are closed. The relief vent shall be balanced to open at a pressure of 100 kPa and be capable of passing 2200 L/S (N. & W. shaft) & 1500 L/S (E. & S. shaft) when it opens.

The relief vent shall contain a barometric back draft damper, a fire damper, and a protection air louver.

Barometric Back Draft Damper

3.34 STAIRCASE PRESSURISATION ANCILLARIES (cont'd)
(Not Included In This Contract)

A horizontal operatable shutter balanced to open at 0.1 kPa static pressure. The frame & blades shall be of extruded aluminium anodized finish. A 1/8" thick, 3/8" wide foam tape shall be installed on the blades to insure a good seal by overlapping.

Fire Damper

A thin line static type fire damper with no flanges shall be installed. Blades are 24 gage ultra slim galvanized steel curtain type, mill finished. The damper shall be 1½ hour rating with a 74°C fusible link.

Protection Air Louver

The louver shall be made of heavy gage extruded anodized finish aluminium bars. The blades & frame shall be mechanically supported to provide rigid and mitered joints.

3.35 EMERGENCY RELIEF VENT
(Not Included In This Contract)

The automatically controlled emergency relief vent shall be 700x250mm and shall be normally closed and opens automatically when subjected to a temperature of 57°C or to a rise in temperature at the rate of 10°C per minute. It shall discharge to the outside of the building by means of a duct work from the stair enclosure to the atmosphere. It shall contain an automatic damper and an air louver.

3.36 KINETIC FLOATING FLOORS

Floor mounted air conditioning plants and extract fans shall be installed on a kinetic floating floor which shall be generally constructed as detailed below:

- a) Isolation panels consisting of Aircor glass fiber support isolators individually coated with a moisture impervious acrilontrite membrane, factory bonded to 15 mm. thick 'plywood' former. Isolator points are at 300 mm. centres and isolator density and quantity shall be selected such that floated slab under the influence of equipment loads shall be controlled to within the bending limited of the concrete.

The space between the support isolators shall be filled with low density thermal grades glass fibre of a minimum density of 24 Kg. per m³.

- b) Steel junction plates shall connect Panels at all junctions.
- c) 500 gauge polyethylene sheet waterproof membrane with suitable tape.

3.37 AIR OUTLETS

a) General Requirements:

Material : Powder Coated aluminium colors as approved by Engineer unless other wise specified.

Size : as indicated on Drawings.

Manufacturer: as far as practicable air outlets are to be the products of one manufacturer.

Approval : Approved manufacturers does not necessarily constitute approval of their products. The Contractor shall submit for approval a complete list of proposed air outlets, indicating manufacturer, catalogue number, details of construction and performance.

Noise level : Size air outlets for minimum noise levels. Not to exceed the allowable noise level at the specified air quantity, as measured on the A scale of a standard noise level meter unless specified otherwise.

Gaskets : To be fitted at factory on all air outlets to prevent air leakage around them and dust streaking of walls and ceilings. To be felt by sponge rubber.

Screws : All screws used in fixing air outlets to be chrome or cadmium plated.

Finish : Shall be powder coated and as agreed upon with Engineer at time of order. They shall be factory coated of colour approved by the Engineer.

b) Ceiling diffusers:

They shall be of the louvred face pattern. Select to give required throw to nearest wall. Terminal velocity is not to exceed 50 feet per minute at specified air quantity. Velometer velocities through diffuser are not to exceed 500 feet per minute.

They shall be flanged suitable for flush mounting to false ceiling and round or square neck sized to fit over the duct. They shall be complete with volume control damper accessible from face of diffuser and equalizing deflectors to provide an even air discharge pattern.

Square and rectangular ceiling diffusers shall be two piece design consisting of mounting frame and removable core attached with spring lock and safety chain.

3.37 AIR OUTLETS (CONT'D)

c) Linear diffusers

Linear diffusers shall be continuous, single or multiple slot type, with individually adjustable supply air pattern and volume control blades on each slot. Air supply pattern is to be adjustable in 6" lengths through 180 degrees from diffuser face with two way incremental capability from multiple slots.

Noise level is not to exceed 25 NC at specified air quantity measured at vertical position.

Linear diffusers to be of total length, number of slots and cfm per linear foot run as indicated on Drawings.

Linear diffusers shall be without face flange screw holes, and shall be suitable for ceiling mounting air supply and for air return. Diffusers shall be supplied in standard lengths up to 60 inches. Where longer lengths are specified, multiple lengths shall be joined with special key strips supplied with the diffusers.

Linear diffusers shall be complete with end caps on end sections and one piece diffusers, grid pattern air straighteners and concealed mounting brackets for easy installation without need for special tools.

d) Air register.

Air register supply and return shall be selected for correct deflection to suit shape of room. Terminal velocity at end of throw to opposite wall is not to exceed 50 feet per minute at specified air quantity. Velometer velocities through register or grille are not to exceed 500 feet per minute.

Return/Extract air grilles, fixed blade type with blades set at 45 degree deflection parallel to long dimension. Grille net free area is to be not less than 70 % of gross face area. They shall include volume dampers of the opposed blade type.

e) Transfer grilles

Transfer grilles to be of the fixed blade type, with blades set at 45 degree deflection parallel to the long dimension. Grille net free area not to be less than 70 per cent of the gross face area. They shall include double frames.

f) Fan Coil Units Return Grilles

FCU access panel with return Grilles. Grille face is to be hinged to provide easy access to filter and have a knurled knob. Area

3.37 AIR OUTLETS (CONT'D)

g) Return /exhaust air registers

Registers are to have fixed, 1" wide, horizontal louvers set at 45 degree deflection, spaced at 3/4" centres and equipped with vertical, opposed blade, key operated volume control dampers accessible through the face of the register.

h) Door grilles

Door grilles no vision, V-shaped louver type. Grille net free area is to be not less than 70% of the gross face area.

Grilles shall be installed in an approved, neat, level, square, tight manner.

i) Outlets

Outlets that are installed directly on ducts shall fit to an appropriate sheet metal flange formed integrally from the duct and be fixed with sheet metal screws.

Outlets installed in walls shall be fixed to an appropriate wooden frame provided around the opening. Fixing to frame shall be with chrome plated or cadmium plated wood screws.

Duct collar to finish flush with external surface of frame shall be provided and shall be nailed to the frame to make a tight connection. The frame shall be of a size to be completely concealed by the air outlet flange.

3.38 MANUAL VOLUME CONTROL DAMPER

Provide dampers of a proprietary manufacture mounted in a flanged or folded section galvanized zinc spray coated steel frame.

Construct damper frames and blades to ensure rigidity and prevent distortion and jamming in operation.

Provide for low velocity air systems, single thickness damper blades. Provide for high velocity air systems, double thickness, streamline pattern damper blades. The edges of the blades shall be folded and left smooth. Dampers located inside aluminium duct shall contain blades made from aluminium extruded sections.

Each blade shall be securely bolted to solid spindles mounted in low friction sealed for life ball bearings or self lubricating for life, special plastic bearings (Pocan) suitable to withstand temperatures up to 120 degrees C.

3.38 MANUAL VOLUME CONTROL DAMPER (CONT'D)

Provide single bladed dampers for ducts up to 150 mm. in height and multi bladed dampers, not more 150 mm. wide generally, for ducts and apertures in excess of 150 mm. in height.

All blades of multileaf dampers shall be rigidly fixed to their spindles and inter linked to ensure that one movement of the operating handle shall move each blade an equal amount and differential blade movement does not occur.

Provide all dampers with external indication of blade position.

Dampers shall be rigid in construction and free from vibration in any position. Casings shall be air tight. Dampers shall be accurately installed in relation to their quadrants so as to permit free movement of 90 degrees.

Dampers greater than 1200 mm. in height or width shall be built up in two or more sections, suitably interconnected with air tight seals between sections, and mounted into a framed casing having additional bracing members as necessary to avoid flexing large installations shall be site assembled.

Provide accessibly located and external to dampers a substantially constructed, rigid mounting bracket to which a cast quadrant with lockable cadmium plated screws, nuts and washers. The quadrant shall be clearly marked "open" and "shut".

Dampers shall be provided where required for the proper regulation of the ventilation systems. In general, the dampers shall be provided as follows, and at such other points indicated on the Drawings:

- 1 In all branches serving more than 3 Nos. supply and return registers
- 2 In all branches serving fresh air to spaces
- 3 In all main fan supply, recirculation and extract ducts.
- 4 In all connections to grille and diffuser plenum boxes.

Scribe or indelibly mark the final setting on all dampers and adjusting devices after balancing.

Standard dampers must always be installed with the blade axles horizontal.

3.39 FIRE DAMPERS

Automatic fire dampers shall be provided at each fire compartment where shown on the building drawings and each slab level and be complete with access doors for maintenance purposes. Fire dampers shall be operated by fusible links actuation with failure indication connected to the indication lamp.

3.39 FIRE DAMPERS (CONT'D)

Fire dampers shall be of the shutter type. They shall comprise continuous folded interlock blades contained within and arranged to close the opening of a surrounding frame. The blades frame and component parts shall be constructed from 1.2mm. strip mill cold reduced sheet steel continuously hot dipped galvanized to B.S.2989, Group 2, Class B, with all cut edges protected with zinc chromate prime. The shutter shall be held in the open position out of the airstreams by a fusible link set to release at 72°C. The closing action of all shutter type dampers shall be actuated by means of two constant force coiled band springs. Shutter type fire dampers shall be sized to suit adjacent ductwork sizes and shall be manually reset.

Where fire dampers incorporate short lengths of ductwork between the damper and the protected wall, such short lengths of ductwork shall be constructed to the same fire rating as the fire damper.

Fire damper shall have a minimum fire rating of two hours. Access shall be provided for inspection and testing.

3.40 SMOKE DAMPER

Smoke Damper shall be installed as depicted on drawings. Frame shall be a minimum of .125" aluminium formed into a structural hat channel shape with corner braces for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. The blades shall be airfoil shaped double skin construction. Blade edge seals shall be silicone rubber designed to withstand 450°F and jamb seals shall be aluminium flexible metal compression type. Blade action must be parallel blade or opposed.

Each smoke damper shall be classified by underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S. The leakage rating under UL555S shall be leakage Class I (4 cfm/ft. at 1" w.g.).

Dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressure of at least 4" w.g. in the closed position, and 4000 fpm air velocity in the open position.

In addition to the leakage ratings already specified herein, the smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250°F depending upon the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and alarm.

3.40 SMOKE DAMPER (cont'd)

Blade Position Indicator: Each smoke damper shall be equipped with Switch Package. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

Openings sizes shall be restricted so as to require the minimum of infill material which shall be keyed in to provide a homogeneous construction and maintain the fire resistance integrity of the structure.

Smoke dampers and frames shall not be supported by adjacent ductwork.

Smoke dampers and frames shall always be set parallel to the plane of the wall or floor.

Access doors shall be provided adjacent to smoke dampers for inspection and be of sufficient size for single-handed resetting.

Access to smoke damper assemblies shall also be maintained through builders work elements.

3.41 COMBINED FIRE SMOKE DAMPER

Combined fire smoke damper shall be installed as depicted on drawings. Frame shall be a minimum of 16 gage (1.52) galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. The blades shall be airfoil shaped double skin construction with 14 (1.90) gage equivalent thickness. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in blade edge (adhesive or clip fastened seals not acceptable) and shall withstand 450°F. Jamb seals shall be stainless steel flexible metal compression type. Blade action must be parallel blade.

Each combined fire smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, classified by underwriters laboratories as a leakage rated damper for use in smoke control systems under the latest version of UL555S. The leakage rating under UL555S shall be no higher than leakage Class I (4 cfm/ft. at 1" w.g. and 8 cfm/ft. at 4" w.g. or. 02 m³/s/m² at 249 Pa or.04 m³/s/m² at 996 Pa).

Dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressure of at least 4" w.g. (996 Pa) in the closed position, and 4000 fpm (20.32 m/s) air velocity in the open position.

3.41 COMBINED FIRE SMOKE DAMPER (cont'd)

In addition to the leakage ratings already specified herein, the combination fire smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 121°C depending upon the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity. Manufacturer shall provide factory assembled sleeve of 16" (406) minimum length. Factory supplied caulked sleeve shall be 20 gage (.91) for dampers through 84" (2134) wide and 18 gage (1.21) above 84" (2134) wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation.

Fire Stat: Each combination fire smoke damper shall be equipped with a UL classified Fire Stat. Fire Stat shall electrically and mechanically lock damper in a closed position when duct temperatures exceed (74°C) and still allow appropriate authority to override Fire Stat and operate damper as may be required for smoke control functions.

Damper must be operable while temperature is above (121°) Fire Stat package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when damper is fully open; the other switch shall close when damper is fully closed. Fire Stat and position indicator switches shall be capable of interfacing electrically with building fire alarm systems. Fire Stat shall be equipped with High Limit Temperature Sensor that meets all requirements of NFPA92A by returning damper to fire protection mode when temperatures reach (121°C), which is the operational limit of the damper and actuator assembly.

Electric Fuse Link: Each combination fire smoke damper shall be equipped with an Electric Fuse Link which shall activate at 165°F, (74°C) causing damper to close and lock in a closed position, and can be reset when damper cools to 135°F. Damper shall also be furnished with an EP switch if pneumatic actuator is specified.

Blade position indicator (included with Fire Stat): Each combination fire smoke damper shall be equipped with Switch Package. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

Fusible Link: Each combination fire smoke damper shall be equipped with a fusible link which shall melt at 74°C causing damper to close and lock in a closed position.

Openings sizes shall be restricted so as to require the minimum of infill material which shall be keyed in to provide a homogeneous construction and maintain the fire resistance integrity of the structure.

3.41 COMBINED FIRE SMOKE DAMPER (cont'd)

Smoke dampers and frames shall not be supported by adjacent ductwork.

Smoke dampers and frames shall always be set parallel to the plane of the wall or floor.

Access doors shall be provided adjacent to smoke dampers for inspection and be of sufficient size for single-handed resetting.

Access to smoke damper assemblies shall also be maintained through builders work elements.

3.42 FAN COIL UNITS

The design construction, materials and finishes of all units shall be suitable for the locations and operating conditions indicated in these Specifications and Drawings.

A customary auxiliaries deemed necessary, shall be provided by the manufacturer for the safe controlled automatic operation of the equipment which shall be pre-wired and tested.

Units shall be of the room cabinet or basic chassis type, suitable for floor or ceiling location as shown on Drawings.

All units shall be provided with easy access to fans, controls, filters, coils, vents, drain and valve connections.

Discharge grilles shall be provided with hinged sections for access to controls on wall or floor mounted furred in or cabinet type units.

Units shall be selected with sound levels at least 3db below required room specified sound levels at design speed.

All units shall be complete with the following basic components:-

- Air filters
- Flexible rubber connectors
- Electrical junction box
- Fan assembly
- Coil section

The chassis shall be fabricated from at 1.6mm thick galvanized sheet steel to form a rigid unit fully sealed to eliminate extraneous air leakage free from sharp edges and complete with fixing lugs.

Thermal insulation of 12 mm. minimum thickness shall be applied to all sides of coil sections, and beneath all cooling coil drip pans.

3.42 FAN COIL UNITS (CONT'D)

All insulation must be non flammable, nontoxic, and possess minimum smoke propagation qualities.

Acoustic treatment shall be supplied to casings as required to meet the room specified sound levels.

Reinforced sheet steel enclosures shall be provided for room mounted units to form a rigid cabinet that will not flex or vibrate during unit operation. There shall be space within each cabinet for piping connections and valves.

Panels shall be bonded plastic coating or be treated with corrosion resistant baked on primer and stove enameled or equal finish.

Access shall be provided in cabinets to fans, coils, filters and electrics. Access to control switches and coil connections shall be through hinged flaps on the top panel discharge grille. Front panels shall be secured with positive locking tamper proof fasteners, hinged for horizontal units. All flow grilles shall have adjustable discharge.

The design of the enclosures shall enable air filters to be serviced without having to remove any of the unit paneling.

When specified or shown on drawings, return air plenums shall be provided to suit particular manufacturer's standard model type.

Resiliently mounted, direct driven centrifugal double width, double inlet fans, shall be used with impellers and scroll made in shockproof material to guarantee maximum stability during transport and installation.

Impellers shall be statically and dynamically balanced for quiet operation.

The fan and motor assembly shall be removable on a slide out arrangement. For changeover systems, the motor shall be positioned below the unit coil to eliminate damages due to excessive heat and air temperature.

Maximum motor speeds shall not to exceed 24 rps.

Coils shall be of copper construction with aluminium fins mechanically bonded to seamless copper tube coils all joints brazed arranged for On Site handling

Each coil water and electrical connections shall be handed to suit Site requirements, but connections shall be adaptable for Site reversal.

3.42 FAN COIL UNITS (CONT'D)

Units shall be complete with a one piece drip pan, extending beyond the cooling coil sections to cover return bends and shall have a second deep flanged drain pan fitted outside of unit chassis having 22 mm. OD outlet to cover where necessary random condensate from valves, fittings and coil drip pan outlet.

Drip and drain pans shall be zinc coated and treated both sides with a protective coating of mastic. Both pans shall be reversible for left or right hand location. The outer surface of all condensate drain pans shall be adequately treated/insulated to prevent secondary condensation occurring.

All drip and drain pans shall be designed to reduce to the absolute minimum the formation of legionella by careful detailing of both pans and pipework connections.

The protective mastic coating shall be suitable for the frequent application of disinfectant when maintenance engineers flush through drip/drain pans and fan coil drainage pipework.

Cooling coil face velocities shall be sufficiently low to prevent moisture carry over beyond the condensate drip tray, and to limit noise generation.

All coils shall be complete with air vent and drain cock.

All units shall have air filters on the inlet side prior to coil and fan sections.

Filters shall be of throw away type readily accessible for inspection, removal and replacement.

The media shall be vermin and rot proof and shall not break up in the air stream.

Filter media shall be non flammable and shall not produce smoke or large volumes of noxious products when exposed to fire.

Bonding agents shall have a flash point of not less than 163°C.

The Contractor shall ensure all control valves can open and close against the maximum system differential operating pressures.

All units shall be provided with manual isolating and commissioning set (double regulating and testing valves, in addition to the proportion three way valve or two way valve and other fitting as shown on the drawings or mentioned in the specs or the BOQ, and required.

3.42 FAN COIL UNITS (CONT'D)

Concealed units shall be selected for operation with sufficient fan and motor power to provide the required air flow rates at the operating resistance of the air distribution systems.

Fans and motors shall be resiliently mounted.

Final electrical connections to the units shall be flexible.

The contractor shall provide flexible sleeves, between unit spigots and connected ductwork of heavy quality glass fibre reinforced canvas having a minimum length of 150 mm. securely fixed and sealed to minimize air leakage. Maximum flame spread rating 25.

Support rails and vibration isolators shall be provided for horizontal units.

The Contractor shall select units to ensure that the room sound levels in Specifications are not exceeded.

Room Thermostat

The fan coil unit shall be controlled by a wall mounted sensor with recessed housing and over lapping cover plate. The housing shall have conduit entry provision and shall be handed to the electrical Sub Contractor with instructions for fixing at the time that conduits are installed.

Interconnecting cables shall terminate at a fixed terminal strip within the housing and all connections to the components mounted on the fascia.

The sensor shall be connected to the 2-line DDC bus connection to BMS.

Facilities on the sensor shall include :

- Fan high, medium and low speed selector
- ON/OFF switch
- Temperature setpoint
- Temperature digital readout
- Power 'ON' indicator
- Set back default setting (economy / normal)
- Reverse auctioning of the temperature controls depending on the temperature of the water supplied to the coil.

Drawings

Detailed drawings of the complete installation including the housing, fans, filters and structural arrangements, together with detailed circuit diagram and control panel arrangement shall be submitted to the Engineer prior to ordering.

3.42 FAN COIL UNITS (CONT'D)

These drawings are for approval prior to manufacture and similar 'as fitted' details are to be provided in the service manual.

3.43 VARIABLE AIR VOLUME TERMINAL BOX (VAV)

The VAV terminal box shall comprise of :-

- A Supply air volume controller unit
- Hot water coil
- Inside terminal box Sound attenuator
- Single or multiple outlet plenum
- Microprocessor Application Specific Controller (ASC).

The air terminal shall be of the independent pressure type, single duct with ARI Certified performance data. The air terminal shall be constructed of coated steel of minimum 1mm thickness suitably stiffened to prevent drumming and shall be internally insulated with non inflammable, non -toxic and face with neoprene to prevent erosion by air stream.

The box shall have circular spigot connection and shall provide a minimum lapped joint of 38mm. The inlet shall have a round (or oval) damper operating within a round (or oval) chamber enclosed by an insulated sheet metal casing.

The damper seal shall be provided by a flexible gasket mounted in the damper blade without adhesives. The damper shall be a double thickness of 24 gauge steel and leakage around the damper shall be less than 1% of maximum flow at 3" static pressure. Construction to be minimum 24 gauge steel for the Air Terminal casing and inlet plate. The universal control mounting panel and damper cylinder shall be constructed of minimum 20 gauge steel. The VAV box shall be insulated with 1" minimum thick 1.5 pcf density fibrous glass, lined with neoprene to prevent air erosion up to 6000 FPM surface velocity. All raw edges shall be coated with adhesive to seal loose fibres. Insulation, adhesive and gasket materials shall meet NFPA90A.

The air terminal shall be provided with control linkage design that allows the damper to be repositioned without the use of tools so that damper can be switched from normally open to normally closed, or vice versa, without removing or relocating the damper actuator. The air terminal with the multiport velocity sensor and flow sensing device shall be provided with a quick release access door to permit damper inspection and removal of the air flow sensor. Each air terminal shall have a control wiring diagram specific to that air terminal affixed to the control mounting panel and shall be marked with specific setting and location tagging.

The electric or electronic actuator shall be fitted with an end switch which shall be connected to the BMS (Building Management System) to indicate the position of the damper.

3.43 VARIABLE AIR VOLUME TERMINAL BOX (VAV) (CONT'D)

Attenuators: Where the selected terminal unit has at NC level which does not conform to that specified for the area under consideration, a terminal box attenuator shall be employed to reduce the unit noise level even further.

Reheater: Terminal reheater shall be manufactured from galvanized mild steel sheet, contain either single or double row coils. The coils shall be constructed from copper tube, pressure bonded on to aluminium plate fins, spaced at 12 fins per 25mm.

No solder bonding to be used in the construction and all copper-to-copper joints shall be manufactured using high temperature silver brazing. The copper tubing used has walls which are not less than 0.04" O.D. thick. Both the single and double row coils shall terminate on the outside of the reheat section with 50mm. long tails, and shall be manufactured from BS2871/1X copper tube. The coils shall be tested to 300psi (21kg/cm²) pressure and are designed for 150psi (10.5kg/cm²) working pressure.

The differential pressure sensor, the pressure shall be measured at the pressure sensor and sent to BMS via a controller to the multi-controller .

3.44 VARIABLE AIR CONTROLLED VOLUME DAMPER (CVD)

The controlled Volume unit shall be mounted on return duct in areas were supplied by VAV and shall be rectangular, with opposed rectangular blade (hollow) connected by internal gear wheels at both ends, volume flow control unit for variable volume return air system, shall consist of electronic devices, receivers & sensors. The Case shall be stable shape, multi-profile frame, suitable for attachment of angle flanges, bearing casing penetration sealed with lip seals. This unit should be able to be mounted in any position, operating temperature 10 - 50 C, maintenance free.

MATERIAL:

- Casing, shaft and rod in galvanized steel.
- Blades and pressure sensor of extruded aluminium sections.
- Plastic gear wheels (ABC)

5.45 HUMIDIFIER

The humidifiers shall be self generative electrode type having cleanable steam cylinder, large area replaceable stainless steel electrodes, drain/blowdown pumps and steam manifold. The control system shall incorporate electronic supervision of the blowdown process as well as conductivity limits.

5.45 HUMIDIFIER (cont'd)

The unit shall be capable of operating on ordinary mains water and incorporate a potentiometer which allows the rated output to be adjusted anywhere between 10% and 100%. The steam cylinder shall incorporate filling through the cylinder foot, mixing the cylinder and water deposits so that more deposits are lowdown.

The humidifier shall be provided with microprocessor control fully proportional and includes built-in P+1 controller and integral interface for connecting to BMS.

3.46 ROOFTOP AIR-CONDITIONING UNIT (Single Zone)**1. General:**

Each single zone rooftop unit shall be completely factory assembled, piped, wired, tested and shipped in one piece with a single point power connection. Outside air system, return air system, filters, switches, supply air fan system and all standard operating and safety controls shall be furnished and factory installed. Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet.

Units shall be available for direct expansion and heat pump; units shall be shipped fully charged with Refrigerant 22.

All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the dead front cover in the main control panel. Electrical wiring diagrams shall be attached to control panels. Installation and maintenance bulletins shall be supplied with each unit.

Each unit shall be provided with the following components:

2. Cabinet, Casing and Frame:

The frame and unit base shall be 14 gauge-galvanized steel. The unit base shall overhang the roof curb for water runoff and shall have a formed recess that seats on roof curb gasket to provide a positive weather tight seal.

Exterior panels shall be constructed of 18 gauge-galvanized steel. Access doors downstream of the supply air fan section shall include 20 gauge galvanized steel door liners. Side access doors shall seal to vinyl, dual durometer gasketing.

Unit cabinetry shall incorporate a standing top seam and channelled surfaces at all joining section. Top panels shall be cross-broken for water drainage. Unit cabinet shall be designed to operate at external static pressures up to 5 inches w.g.

3.46 ROOFTOP AIR-CONDITIONING UNIT (Single Zone) (cont'd)

Exterior surfaces shall be phosphatized and coated with baked-on light grey enamel. Hinged side panels with flush-mounted, single lever latching mechanisms shall provide access to each cabinet section from both sides of the unit. Condensing unit section access doors shall have Southco type quick turn latches.

Unit shall be completely insulated with one-inch thick neoprene coated glass fibre secured to side, top and end panels with adhesive and mechanical fasteners. Lifting brackets with lifting holes shall be provided on the unit base to accept cable or chain hooks.

3. Condensing Section:

Compressors shall be heavy duty, reciprocating, semi-hermetic type with reversible, positive displacement oil pump, suction and discharge line service valves, crank case heater and inherent solid state thermal overload protection. Each compressor shall have its own completely independent refrigeration circuit including sight glass, filter-drier, manual shutoff valve and spring-type high-pressure relief valve. Compressors shall be isolated on neoprene impregnated fibreglass kinetic blocks. Compressor capacity reduction shall be accomplished with cylinder unloading, and/or hot gas bypass.

The condensing unit section shall be open on the sides and bottom to assure complete access to and airflow through the coils. Condenser coils shall be multi-row type fabricated from 3/8" O.D. seamless copper tubing mechanically bonded to rippled and corrugated aluminium fins. Condenser coil for each refrigerant circuit shall be provided with an additional circuit for a minimum of 15 degrees of sub cooling. Each condenser coil shall be factory leak tested at 315 psig under water.

Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge. Fan blades shall be constructed of steel and riveted to an Iridite dipped steel center hub.

Condenser fan motors shall be heavy duty, inherently protected, three phase non—reversing type with permanently lubricated ball bearings and integral rain shield.

4. Cooling Coil Section:

Evaporator coils shall be multi-row type fabricated from 5/8" O.D. seamless copper tubing mechanically bonded to rippled and corrugated aluminium fins. Two-row evaporator coils shall have a maximum of twelve fins per inch and three, four and five-row coils shall have a maximum of eight fins per inch. Coils shall be factory leak tested at 315 psig under water. The evaporator coil circuiting shall be fed with an adjustable thermal expansion valve (one per refrigerant circuit) with an external equalizer. The evaporator coil shall be circuiting for a combination row/ Face split.

3.46 ROOFTOP AIR-CONDITIONING UNIT (Single Zone) (cont'd)

A mastic coated primary drain pan shall be provided with the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall be connected to a threaded drain connection extended through the unit base. Units shall be provided with a secondary mastic coated drain pan connected to the primary drain pan.

5. Heating Section (Hot water heat): (Not Applicable)

Hot water coils shall be one or two-row type fabricated from 1/2" O.D. seamless copper tubes mechanically bonded to rippled and corrugated aluminium fins. Control of the hot water coil shall be accomplished by factory installed control package including a three-way modulating control valve, piping and a spring return valve operator.

6. Supply Fan Section:

Supply fans shall be double width, double inlet centrifugal type, forward curved. All fans shall be statically and dynamically balanced for quiet operation. The forward curved fan wheel and housing shall be fabricated from painted cold rolled steel.

Units shall have solid steel fan shafts mounted in heavy-duty 200,000-hour relubricatable ball bearings.

Fan motors shall be heavy duty, 1450 rpm, and open drip-proof type with relubricatable ball bearings. The motor shall have a variable pitch sheave and an adjustable base for proper alignment and belt tension adjustment. The entire fan assembly shall be completely isolated from the unit bulkhead with neoprene gasketing and mounted on double deflection rubber-in-shear or spring isolators.

7. Filter Section:

The filter section shall be supplied complete with galvanized steel filter racks as an integral part of the unit. Filters shall be accessible from both sides of the unit. The filter section shall be provided with panel.

Panel filters shall be 2-inch thick, permanent cleanable wire mesh type mounted in a galvanized steel filter frame. The panel filter section shall be designed for face velocities not to exceed 335 fpm.

8. Electrical:

Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with NEC requirements and shall conform to all applicable U.L. Standards. All wiring shall be number coded per the electrical wiring diagrams.

All electrical components shall be labelled according to the electrical diagram and be U.L. recognized where applicable.

3.46 ROOFTOP AIR-CONDITIONING UNIT (Single Zone) (cont'd)

Each unit shall have a 230-volt control circuit transformer 230-volt receptacle, return air fire stat, supply air fire stat, system service switch, and control circuit fuse.

The supply air fan, compressor and condenser fan motor branch circuits shall be individually fused. Contactors and inherent thermal overload protection shall be furnished for each compressor and condenser fan motor.

The supply air fan motors shall have contactors and external overload protection, Main control panel shall be of weatherproof construction with a dead-front cover over the main power circuit controls.

A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. A separate key-locked control panel shall house all controls for the condensing section.

9. Refrigeration Controls:

Each compressor circuit shall include a liquid line solenoid valve, oil pressure switch, high pressure switch, low pressure switch, compressor control circuit switch and pump down switch. Each refrigeration circuit shall have at least one condenser fan controlled from an ambient thermostat for positive head pressure control. An ambient thermostat shall prevent the refrigeration system from operating below 50 F.

10. Temperature Controls:

Units shall be provided with electro-mechanical, solid state on discharge air temperature control systems. All temperature control system components shall be completely factory wired and tested with the wall thermostat.

11. Electro-Mechanical Controls:

Electro-mechanical. controls shall be provided on wall thermostat applications for direct expansion cooling. Control of the mechanical cooling shall be by a 24 volt, mercury bulb type thermostat. Additional steps of compressor capacity control shall be by suction pressure unloaders. Automatic changeover of heating and cooling functions shall be provided on units.

12. Solid State Controls:

Solid-state controls shall be provided for wall thermostat and return air thermostat applications when the unit manufacturer provides all temperature control components including the thermostat, hot water.

3.46 ROOFTOP AIR-CONDITIONING UNIT (Single Zone) (cont'd)

The solid state control system shall provide two or three stage cooling; modulating cooling; two, three six or eight stage heating ; modulating heating ; and automatic changeover of the cooling and heating functions. The solid-state control system shall include a solid-state thermostat, discharge air sensor, and central processor

The central processor shall integrate the continuous input signals from the thermostat and discharge air sensor and translate them into the appropriate cooling and heating.

13. Roof Curb:

A prefabricated 12 gauge galvanized steel mounting curb designed and manufactured by the unit manufacturer shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a perimeter type with complete perimeter support of the air handling section and rail support of the condensing unit section. The curb shall be a minimum of 12 inches high and include a nominal 2 x 4 inch wood nailer strip. Gasketing shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the Structural Engineer.

END OF SECTION