

DESIGN SERVICES FOR EMERGENCY CONSTRUCTION OF PATIENT WARDS AT KULHUDHUFFUSHI ISLAND IN MALDIVES

Specifications – Air Conditioning System

Prepared by:

URO Structural Consultants (Pvt) Limited,

No. 6/9, Third Lane, Nawala Road,

Rajagiriya, Sri Lanka

Tel: +94-114 502 472 / +94-117 220 698

Email - general@uro.lk, urostruct@gmail.com

Web - www.uro.lk



GENERAL TECHNICAL SPECIFICATION FOR VRV/VRF TYPE AIR CONDITIONING SYSTEM

1.0 INTRODUCTION

VRV/VRF type Air Conditioning System shall be provided for proposed emergency construction of patient wards at Kulhudhuffushi island in Maldives according to the following specifications.

This section consists of the general rules that apply to the design, manufacture, shop testing, delivery to site, erecting, commissioning, site testing, maintaining and handing over the material, equipment plant and services required for the air conditioning system of the building.

- **The manufacturer of the VRV/VRF air conditioning equipment shall have at least ten (10) years of experience in the design, manufacture, installation and commissioning and maintenance of HVAC equipment.**
- **Bidder should submit previous VRV/VRF installations references details for offered VRV/VRF make**

Bidder must submit documenting proof for the same with the bid documents. Bids without above documents will be rejected.

All equipment being supplied shall be suitable for operation under tropical conditions with ambient temperature up to 36°C and relative humidity up to 90%. All the outdoor units' components must be panel, brackets, nut & bolts, base pan, motor, heat exchanger and all the components of the outdoor unit's corrosion resistant coating & weather resistant coating.

1.1 LOCATION OF SITE

The site is located at Kulhudhuffushi island in Maldives.

1.2 SCOPE OF WORK

The scope of work consists of supply and installation of an air-cooled Variable Refrigeration Volume / Variable Refrigeration Flow (VRV/VRF) & Split type air conditioning system. The building will be air conditioned as indicated in the detailed technical specification and drawings. The system shall include ceiling suspended / Wall Mounted type indoor units. All components permanent and of temporary nature to successfully supply, install, test and commission the project shall be provided by the contractor.

1.3 STANDARD OF WORKS

1. ASHRAE : American Society of Heating, Refrigeration and Air conditioning Engineer.

Standard for the Installation of Air conditioning and Ventilation Systems ; ANSI/NFPA 90A-2015

Ventilation of Health Care Facilities ; ANSI/ASHRAE/ASHE Standard 170-2013

Safety Code for Mechanical Refrigeration Method of Testing General
Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size ;
ANSI/ASHRAE Standard 15-2013 52.2-2012

Design, Construction, and Operation of Sustainable, High-Performance Health
Care Facilities interactions Affecting the Achievement of Acceptable Indoor
Environments; ASHRAE Standard 189.3 Guideline 10-2011

2. IHVE : The Institute of Heating and Ventilation Engineers (UK)
3. ASME : American Society of Mechanical Engineers
4. ARI : Air conditioning Refrigeration Institute (USA)
5. ASTM : American Society of Testing and Materials
6. AWS : American Welding Society
7. DW142 : Specification for Sheet metal ductwork
8. SMACNA: Sheet Metal and Air-conditioning Contractor's National Association, Vienna
9. IEC/IEEE regulations for electrical system installation

1.4 AIR CONDITIONING SYSTEM

System Description:

Air Conditioning system consist of VRV/VRF System. Proposed system shall be having adequate capacity to meet building AC load.

All indoor units capacities will be rated at air on coil temperature of 27C DB,19C WB. Condensing unit capacities shall be rated at 35 C DB temperature.

VRV/VRF AIR CONDITIONING SYSTEM:

Each unit is equipped with modular condensing unit connected to several Indoor units. Condensing unit consist with DC Inverter type compressors and note that inverter driven high pressure chamber type Scroll type reputed brand compressors are preferable. Refrigerant shall be R410A or an equivalent environment friendly refrigerant. Compressors must have internal oil separator and external oil balancing lines between modules shall be avoided. Indoor unit must be consist with Electronic type expansion valve which also acts as a pilot valve.

All bidders must provide soft ware generated VRV unit selection data sheet along with the tender.

COP at full load – Shall fully comply with latest ASHRAE 90.1 energy minimum efficiency requirements(COP) and units with higher COP(Above 4.0) is preferred.

All selected units must suitable for tropical climate operation and special condensing protective hydrophilic/herasite coating shall be applied to the condenser fins for durability. Also there must be protective covering for condensers. Noise level of Condensing unit must be below 60dB(A) at 3m distance.

Condensing unit Refrigerant circuit designs with hard copper piping and brazed joints.

Crankcase heater, manual reset high low pressure cutout switch, to guard against compressor damage due to high discharge head and system leakages must be provided. Compressor motor winding shall be provided with Thermistor protection in addition to Thermal overload protection provided with contactor.

The air cooled condenser coils are of 3/8" OD seamless copper tubes arranged in staggered rows, mechanically expanded into die formed coated aluminum fins. The condenser fan is of high ESP (85Pa), high efficiency propeller type, direct driven by 3 phase IP 55, class F insulation condenser motor, suitable for outdoor application.

The cabinet is constructed of heavy gauge galvanized steel, which provides a rigid structure. All outdoor units external exposed surface are coated with silk grey backed polyester based paint, providing high corrosion resistant. Outdoor noise level at 1m distance shall be less than 60dB(A).

Power supply of the unit will be 380-415 V, 3Ph, 50 Hz.

Unit shall be capable of Continuous capacity controlling(10%-100%) and must also include Internal motor protector to protect winding from over heating, as mentioned earlier. Mechanism must be in built to facilitate oil return especially at low load conditions. Also condensing units must be protected from over current, power surges, Phase failure and Phase sequence failure.

Installation:

AC Units & piping:

Piping layout and sizes given in the design drawings are for reference only and piping layout must be submitted with equipment manufacturer recommendations(Software generated piping layout is accepted).

All indoor units shall be fixed on to the concrete slab with 10mm Drop Anchor bolt ,vibration isolators for high capacity units and thread bars. Refrigerant piping will be properly anchored to the slab using hanger bars and hanging space shall be not more than 2m and where bends are to be installed must anchor from both end. Refrigerant gas line to be insulated with Closed cell Nitrile Rubber insulation(Armaflex or Aerofoam-NBR) and all the joints must apply adhesive tape.

All refrigerant piping shall be of Hard copper(Must be a reputed brand) and soldering shall be done with an inert gas(Nitrogen) to avoid oxidization. Refnet joints supplied by the manufacturer shall be used for pipe connections and no locally manufactured joints are allowed. Once soldering is completed system must be thoroughly flushed to remove impurities in piping. Pipe work shall be leak tested at a elevated pressure (1.5 times operating pressure) for a period of 12 hours before Vacuuming. System must be vacuumed as per Supplier's installation instructions.

Additional Refrigerant charge required for pipe work must be obtained from Supplier by submitting shop drawings of the installation. Refrigerant pipe sizes shall be based on each manufacturers specifications and only piping route is shown in the design drawings.

Drain piping shall be properly installed using hanger bands and must maintain adequate slope with U trap where necessary. Where ever drain lines are to connected to floor drains air gap must be maintained.

Since all condensing units shall be fixed on Roof slab adequate oil traps shall be installed in the compressor suction lines especially in Split Units.

1.5 DUCT WORK

The contractor shall provide and erect all ductwork including controls, isolating/balancing dampers, grilles, diffusers to form a complete air distribution system as indicated on the tender drawings. The contractor shall balance, test and commission all installations prior to the engineer issuing a completion certificate. Shop drawings shall be submitted to the engineer prior to the commencement of works.

G.I Steel Duct

The Contractor shall provide and erect all ductwork including controls, isolating/balancing dampers, grilles, diffusers and vapour proof insulation to form a complete air distribution system as indicated on the tender drawings. The Contractor shall balance, test and commission all installations prior to the Engineer issuing a Completion Certificate. Shop drawings shall be submitted to the Engineer prior to the commencement of works.

All sheet metal ductwork shown on the drawings, specified or required for exhaust air systems shall be fabricated and finished from best quality, cold rolled annealed galvanized mild steel sheets of soft bending quality especially suitable for air conditioning works. Materials used for ductwork, shall be free from blisters, pits and imperfections in coating.

Ductwork shall be so constructed that when erected, it shall be made airtight by tightly sealing after fabrication and free from movement, sagging or drumming under all operating conditions. It shall be true to size and accurately lined-up.

While the tender drawings shall be adhered to as closely as possible, runs and sizes of ductwork may be varied only by the Engineer, at no extra cost to the Employer, when deemed necessary for co-ordination purpose with other works.

All duct elbows having an inside radius smaller than the width of the elbow shall be equipped with approved vanes tightly riveted to the duct and in general as shown on the details of the tender drawings.

Approved duct-turn shall be installed in all cases where 90-degree square elbows are used and short take-offs are used on large ducts. Guide splitter vanes shall not be spaced more than 15 cm apart.

Take-offs from main ducts shall be conical. All take-offs and connections shall be constructed to minimise pressure loss. All raw edges of ductwork seams, rivets and areas where galvanizing has been destroyed shall be cleaned, prepared and painted with zinc rich paint at works and a further coat shall be applied after erection.

Allowances shall be made in ductwork construction for instruments and control connections and adequate local stiffening shall be incorporated to provide rigid mountings.

The fabrication of ductwork shall be carried out in accordance with HVAC/DW/142, ASHRAE or SMACNA standards.

Material

Galvanized Sheet

Hot dip galvanized steel shall be to ASTM-A527-87 standard, steel shall be of lock forming quality, zinc coating designation Z-27 or equivalent approved standard.

Duct Sealant Duct sealant shall be non hardening, non migrating mastic or liquid sealant as compounded and recommended by the manufacturer especially for sealing joint and seams in the duct.

Duct Hangers and Supports

Ductwork shall be supported by means of pre-galvanized fully threaded drop rods and also preferably galvanized mild steel angle/channel sections, with spacing between supports not exceeding 2.4 m and projecting 100 mm on either side to allow for proper insulation.

Rectangular Duct

All channels and angles shall be preferably galvanized or mild steel, painted with one coat of zinc chromate paint prior to erection and a further two coats of gray paint on exposed metal parts after erection. Ductwork supports shall preferably be positioned close to dampers, diffusers and all similar equipment. Ductwork supports shall in general conform to HVAC/DW/142 or SMACNA standards. Galvanized serrated band with insulating band type supports shall also be acceptable up to duct size of 600 mm except in the Plant room.

Contractor to submit complete details for approval before fixing.

1.6 DAMPERS

Damper Quadrants

All dampers other than dampers behind registers shall be fitted with substantial locking cast metal quadrants. Quadrants shall be mounted outside the duct in an accessible position. On insulated ducts, the quadrants shall be fastened to bearing plates flush with the outside finish of the insulation.

Volume Control Dampers

Manual volume control dampers shall be provided as shown on the drawings or as required additionally for balancing purposes. The dampers shall have sturdy corrosion resistant construction. All dampers shall have multi-leaf double skin aerofoil section opposed blades. Individual blades should not exceed 1200 mm in length or 175 mm in width. Double skin blades shall be made out of minimum 22 gauge galvanized steel sheet. Damper frames shall be galvanized made out of 16 gauge steel sheet.

Single blade dampers with single skin blade section may be used for damper sizes up to 300 x 150 mm. Single skin blades shall be fabricated from 18 gauge galvanized steel sheet. The blades shall be securely bolted to plated steel spindles, the ends of which shall be extended to

the outside of the duct with a groove in line with the blade. Spindles shall be carried in brass or nylon bearings.

The control linkage shall be outside the air stream. Clear airflow area equal to the duct size shall be maintained within the damper frame. Maximum clearance between the blades and between the blades and the frame shall be limited to 3 mm. It should be noted that the dampers should be separate and independent from the dampers, hereafter specified to be set behind registers and diffusers.

1.7 FRESH AIR INTAKE LOUVRES

Fresh air inlet shall be fitted with insect wire meshes and filters.

Fresh air inlets shall be fitted with SS mesh bird screens and louvers in addition to 50 mm thick washable synthetic fibre filters. Filter media thickness shall not be less than 45 mm, having 60% efficiency .

1.8 FLEXIBLE CONNECTIONS

Flame-proof flexible connections shall be fitted on all intake and discharge connections of fans for preventing the transmission of vibration through the ducts to occupied spaces.

Flexible connections shall also be provided where ductwork passes across building expansion joints.

Flexible connections shall be factory fabricated from chemically impregnated canvas. Connections shall fit closely and be secured in airtight fashion to connections to ductwork, fans and apparatus.

The material shall have a penetration time of at least fifteen minutes when tested in accordance with BS 476 and shall remain flexible and without strain or distortion. Flexible connections shall be 150 mm minimum and 250 mm maximum in length.

1.9 GRILLES:

Supply/Return/Transfer Grilles shall be provided with face operated opposed blade volume control dampers.

All diffusers, grilles and registers shall be removable core type or mounted on a main frame work supplied by the maker of the diffuser such that the interior of the duct could be cleaned through the diffuser openings without removing the main frame work.

Grilles and frames shall be made of stamped, extruded or rolled steel or aluminium, welded and ground flush at the corners or provided with neat trim. All supply grilles shall have felt or sponge rubber sealing strips at all edges.

Exhaust and return grilles shall be similar in general appearance and construction to the supply grilles and shall have a single set of face bars or vanes without directional adjustment.

Grilles/diffusers shall be factory finished in baked enamel or other equally suitable finish, the colour to be to the approval of the Engineer.

1.10 EXHAUST/SUPPLY FANS

General

Fans shall be supplied and installed by the Contractor as shown on the drawings. Capacity, type and rating of the fans shall be as indicated in the schedule. The fan motors and switches shall be in accordance with this specification regarding electrical works. Fixing details shall be in accordance with manufacturer's recommendations.

1.11 FAN COIL UNITS

The fan-coil units shall be fabricated from minimum 1 mm thick electro-galvanized steel sheet and coated with oven-baked polyester paint finish. All casing panels and supports are formed or bent to provide a rigid construction which assures vibration free operation. The casing panels shall be internally insulated with acoustic liner to meet NFPA 90A and NTPA 90B standards or equivalent.

The condensate drain pans shall be constructed from minimum 1 mm thick galvanized steel, coated with oven-baked polyester paint.

The drain pan shall be externally insulated with fire-retardant polyurethane foam - insulation.

The fan wheel shall be light weight, double inlet forward curved centrifugal constructed from die form aluminium sheet or galvanised steel and dynamically balance to provide low sound levels.

The fan motor shall be of split capacitor type with built-in thermal overload protection. Vibration transmission shall be eliminated by the use of a resilient motor mount. Motors shall be supplied with permanently lubricated, maintenance free seated ball bearings. Motors shall be provided with at least 3 speed selections.

The cooling coil shall be seamless copper tubes mechanically bonded to aluminium fans to enhance the heat transfer surface. The chilled water coils shall be rated in accordance with SARL Standards. The coil shall be pressure tested for leak proof operation.

Fan coil units shall be provided with HEPA filter.

1.12 Filters

The filter section shall consist of pre filter and Bag filter. A set of HEPA filters shall be installed in the perforated face air diffusers at all patient rooms, isolation rooms, dialysis room and emergency room to maintain the required clean room condition.

Filters are to be fitted in supporting frames with suitable provision for holding the cells securely in place without permitting leakage of air and arranged for convenient insertion and removal of filters from the side or the front according to accessibility.

Filter section shall be provided with a differential pressure gauge and the means to give an electrical signal when the pressure differential reaches a pre-set value.

Filter must be capable of filtering particles which are greater than 0.5 micron.

Guidelines for filter installations

HEPA filters should be used on air supplies serving protective environment rooms for clinical treatment of patients with a high susceptibility to infection because of leukaemia, burns, bone

marrow transplant, organ transplant, or human immunodeficiency virus (HIV). HEPA filters should also be considered on discharge air from fume hoods or biological safety cabinets in which infectious, highly toxic, or radioactive materials are processed. Some health care facilities may also choose (or be required) to apply HEPA filters to exhaust originating from airborne infectious isolation rooms. When used, the filter system should be designed and equipped to allow safe removal, disposal, and replacement of contaminated filters.

Filter seals or gaskets should be installed to prevent leakage between filter segments and between the filter bed and its supporting frame. A small leak that allows any contaminated air to escape through the filter can reduce the usefulness of such filter. Maintaining the rated filtration efficiency over the entire installed service life of the filter should be considered if the removal efficiency is based on an initial electrostatic charge on the filter.

High-efficiency filters should be installed in the system, with adequate facilities provided for maintenance and in situ filtration performance testing without introducing contamination in to the delivery system or the area served. Keep in mind maintenance workers' safety.

High-efficiency filters are expensive. Energy costs associated with the pressure drop across high-efficiency filters can be the largest component of the total cost of ownership, so incorporate projections of filter bed life and replacement costs into the operating budget. Installing a manometer in each air filter system is recommended, to measure pressure drop across each filter bank. Control sequences to monitor and alarm, including ability to normalize or benchmark pressure drops and associated airflows, can enhance indication of filter loading when air handlers operate at less than design flow. Filter system life cycle costs can be calculated and various scenarios compared for overall optimization (Euro vent/CECOMAF 2005). Installing a lower-efficiency pre filter upstream of the high-efficiency filter can be a cost-effective strategy to extend the life of the high efficiency filter.

During construction, openings in ductwork and diffusers should be sealed in accordance with ASHRAE Standard 170 to prevent intrusion of dust, dirt, and hazardous materials. Such contamination is often permanent and provides a medium for growth of infectious agents. Existing or new filters as well as coils may rapidly become contaminated by construction dust.

1.13 SITE TESTING AND COMMISSIONING

On completion of the works all systems installed shall be tested in the presence of Engineer's representatives and other officials of the client. The contractor shall give adequate notice to the Engineer of the proposed dates for testing and shall provide all facilities required such as personal, instruments and equipment, access ladders for this purpose. The contractor shall rectify all works not conforming to the required specifications and tests be repeated after remedial measures at his cost.

The contractor shall commission and test the installation for a minimum period of seven (7) days to indicate to the engineer that the equipment installed achieves the minimum room conditions specified above. The tests shall be carried out during periods of maximum ambient temperature and loading. All conditioned areas shall be tested together.

1.14 Electrical Installation

The contractor shall undertake all the electrical work connected to the A/C system. The electrical work will conform to those set out in the BS 7671:1989.

The system electrical power supply 3 phase, 4 wire, 50Hz, 400V will be terminated on isolators closed to outdoor units. It will be the responsibility of the contractor, to provide all the

distribution and motor control equipment, as pertaining to the A/C system, and make all connections downstream from this point. The motor control panel shall be of the modular type incorporation short circuit over load and phase failure protection along with the contactors, timers as required to meet industry standard.

Timers shall be incorporate, as directed by the engineer to control the operating periods of the motors, fans etc.

The controls will have the same specifications as set out in the electrical specifications. All equipment's used shall be from a single manufacturer to ease future maintenance. All cable entrances to the main control panel and all other panels will be fitted with standard cable bushing to render the transition of the cable into the panel both dust and water proof.

Samples of all electrical equipment to be used shall be submitted to the engineer, for approval prior to their incorporation in the works.

1.15 Additional Information

All drawings are indicative of the system required. The contractor shall ascertain for himself that the equipment offered by him can be installed in the locations indicated.

The contractor shall make certain that the equipment offered by him will operate as indicated in the attached schematic.

The contractor shall obtain the engineer's approval for the indicated ranges of all instruments to be incorporated in the project, prior to their use in the works. This is applicable to all thermometers, pressure gauges, ammeters, etc.

1.16 Testing and Commissioning

The contractor shall commission and test the installation for a minimum period of seven (7) days to indicate to the engineer that the equipment installed achieves the minimum room conditions specified above. The tests shall be carried out during periods of maximum ambient temperature and loading. All conditioned areas shall be tested together.

A chart indicating the temperatures, humidity and the air flow at all supply air diffusers, against the time of day, shall be prepared for each area, and submitted to the engineer on completion of the tests, prior to the application for the practical completion certificate for the system.

All controllers and thermostats shall be adjusted so that they operate correctly.

1.17 Makes of equipment offered

Makes of equipment offered shall have been commonly used in Maldives and have workshop facilities, experienced technical personnel operating in Maldives. Prior approval of the Engineer shall be obtained before placing orders for the supply of equipment.

1.18 Free Maintenance & Guarantees

The contractor shall maintain the complete system for a period of 12 months from the date of takeover of the system for beneficial use.

Any equipment which may prove defective during this period shall be replaced or repaired free of charge during this period.

Items of equipment repaired or replaced, during this period, shall be guaranteed for a further period of one (1) year from the date of repair or replacement.

PART 2 - DETAILED TECHNICAL SPECIFICATION

1.0 SCOPE

This section specifies the detailed requirements of the design, manufacture, supply, delivery, installation, testing, commissioning and maintenance during the defects liability period of the Air Conditioning System for the proposed patient wards at Kulhudhuffushi island in Maldives. The system shall consist of the marine treated Variable Refrigerant Volume/ Flow (VRV/VRF) type air conditioners in combination 4-Way ceiling mounted cassette type & ceiling concealed ducted type indoor units and accessories suitable for coastal area.

VRV/VRV Air Conditioners

- Supply and installation of following indoor units, with grouping outdoor units:

Outdoor Unit VRV-OU-01

Indoor Unit Type	Cooling Capacity/ (TR)	Quantity
Fan coil unit	0.8	1
Fan coil unit	1.1	1
Fan coil unit	1.5	2
Fan coil unit	2	2
Fan coil unit	2.2	12
Fan coil unit	2.3	1
Fan coil unit	2.4	1
Ceiling Cassettes	0.8	4
Ceiling Cassettes	1.1	2
Ceiling Cassettes	1.5	3

Total Cooling Capacity for Specified Area = 50 TR

Outdoor Unit VRV-OU-02

Indoor Unit Type	Cooling Capacity/ (TR)	Quantity
AHU	35	2
Ceiling Cassettes	1.5	3
Ceiling Cassettes	2.5	2

Total Cooling Capacity for Specified Area = 80 TR

- Supply and installation of condensate drainage pipe work with all the insulations and accessories.
- Supply and installation of all the required sensors, thermostats and controls for indoor units.
- Supply and installation all the electrical power cables (indoor units & outdoor units) and supply from the main air conditioning distribution board.

2.0 BASIS OF DESIGN

- 2.1 It is required to maintain condition of comfort in the given specific areas under normal load conditions and average lighting limits.

The outside conditions are assumed as follows:

Dry bulb temperature	-	33°C
Relative humidity	-	80%.

Inside conditions to be maintained:

Dry bulb temperature	-	24 °C - 25 °C
Relative Humidity	-	55%-60%
Sound level	-	40 dBA
System Minimum Efficiency	-	Comply ASHRAE 90.1- 2019

3.0 SYSTEM DESCRIPTION

The entire building areas to be air conditioned with VRV/VRF air conditioners.

Three phase electrical power supply to air conditioners shall be obtained from the dedicated MCCBs & Socket outlets. The air conditioning contractor shall carry out all wiring of outdoor units from the MCCBs & indoor units from socket outlets.

Condensing water pipe lines from indoor units shall be installed to the nearest drain point as recommended by the manufacturer, taking care not to allow air to enter the lines. Refrigerant pipes & Condensing water piping where exposed outside the building shall be vapor sealed and clad using Al sheet. Insulated pipe system complete with all accessories of suitable diameter to meet the requirement of the proposed units with lengths to suit the locations of the units as shown in the drawings shall be designed and supplied by the contractor.

4.0 SELECTION OF AIR CONDITIONING UNITS

The minimum capacities of the units shall be as per the schedules given in the drawings.

The air conditioning units should be capable of achieving following functional requirements with specified equipment.

- Air cooled outdoor units designed for variable refrigerant flow systems.
- Broad outdoor temperature operating range with 43°C DB maximum.
- Cooling capacity control capability ranging from 10% - 100% to suit the demand
- Use of high efficient inverter controlled permanent magnet scroll compressors
- Inverter frequency control range from 30Hz – 100Hz in 1Hz incremental steps
- Refrigerant circuit with super coolers and sub coolers to improve performance
- System reliability achieved by emergency operation of compressors and outdoor units
- Computer controlled network system integrated with outdoor units and indoor units.
- Fine control of indoor temperature achieved through electronically controlled expansion valves which control refrigerant flow to suit the demand

- Simultaneous operation of 100% loaded compressors with capacity controlled compressors to suit the demand.

Both Indoor & Outdoor units shall be mounted in an anti corrosive rust resistant and Marine treated casing.

5.0 REFRIGERANT PIPING

- Long refrigerant piping lengths should be possible with these Variable Refrigerant Flow Air Conditioning units, reducing restrictions during installation.
- Maximum pipe length shall be as per equipment manufacturer recommendations
- Pipework Class and material

The types and quality of all pipework used shall comply with the following schedule unless otherwise shown on the Drawings or specified elsewhere in the Specification: -

Refrigerant pipework shall be of Copper to B.S. 2871.

- All pipe works shall be so installed and supported so that it is free from excessive stressing due to its own weight and its contents, equipment vibration or movement, and thermal movement.
- Care shall be taken to achieve a neat installed appearance. All pipes and fittings shall be cleaned before erection and free from scales, burrs, sand and other foreign matters.
- Sufficient unions or flange joints shall be allowed for satisfactory removal and reassembly of equipment, valves fittings for inspection or repair.

Joints - Copper

- For refrigerant use may be of compression type of ASA B16-26-1958 and brazed type to ASA B9-1 code for size up to 40mm diameter. Only brazing rod containing 45% silver may be used and shall be thoroughly cleaned and washed to remove all traces of flux before installation.
- Copper pipework 50mm diameter and above shall be joined by means of brazing connections. At terminals joints to equipment, flanged joint shall be used to facilitate maintenance, dismantling and repair for water service and drains shall be joined by solder, using special capillary fittings.

Fittings - Copper

- For refrigerant circuit, fittings to be of copper or brass specially manufactured for refrigerant use, no fabricated fittings shall be accepted.
- Small size may be joined by compression fittings to ASA B16.26. Larger size fitting to be of brazed type to ASA B9.1. Flanges to be used in equipment locations.

Anchors, Expansion Joints and Welding

- a. Wherever possible, advantage shall be taken of changes in direction of pipes to take up expansion and contraction due to temperature changes of the pipe and its contents.
- b. All anchors shall be securely mounted to structure with suitable neoprene pads or approved equal. All pipes shall be anchored to control the movement of pipes due to thermal movement. Anchors shall be fitted to resist the attempted movement due to expansion and the weights of pipe and contents.
- c. All oxy-acetylene welding shall be in accordance with B.S. 2640:1982.

Pressure Test

Refrigerant piping shall be tested by filling the system with dry nitrogen to the required pressure and all joints inspected with a halide torch to check for leaks. A test pressure

of 1.5 times the maximum service pressure shall be maintained for 24-hours. Pressure drop of more than 2% over the 24-hours shall not be accepted.

Insulation and Painting

Thermal Insulation

All insulation work shall be carried out by skilled and experience craftsmen and special attention paid to the final coating of insulation that will be on view; all plane surfaces shall be trowelled to a truly smooth surface and all pipe insulation shall be finished using purpose made metal former as necessary for a clean, smooth unlined surfaced to the approval of the Engineer.

All cold valves, strainers, flanges, pump volutes and other fittings shall be insulated as necessary as detailed for the pipe insulation and securely held in position by purpose made galvanised sheet steel or aluminium split case boxes with non-corrodible screws. A sample of one of these boxes shall be submitted to the Engineer for approval before final manufacture is commenced.

All insulation shall be applied as whole continuous pieces to the approval of the Engineer. The Engineer reserves the right to order the partial or complete replacement of any section of insulation or call for further skin-finishing coats where in his opinion the work is of sub-standard nature. This work shall be carried out by the Contractor at no extra cost.

All insulation work shall be carried out after the particular section or run of the pipework has been successfully tested and the Tenderers attention is called to the correct choice of Flintcote materials, its adaptability and correct method of usage when combined with other materials. Samples of the typical finished insulation on sheets of 300 mm x 300 mm x 2 mm steel plate shall be submitted to the Engineer for approval before insulation work is carried out. All internal insulation to ductwork shall be fabricated off site, unless otherwise approved.

The following items shall be insulated as specified later.

- a. Factory Assembled Plant.
- b. Refrigerant and Condensate Pipework.
- c. Air-Conditioning Supply and Return Ductwork.
- d. MV duct passing through air-conditioned area.

All refrigerant suction lines shall be insulated using vapour sealed closed cell elastomeric foam type insulation having a K factor not higher than 0.038 W/m/°C @ 0°C, and an average water absorption of not more than 0.9% by volume over 28 days. Insulate all fittings in the pipework.

Insulation shall be fire and flame propagation tested to BS 476 Pt 7:1990 and exhibit Class O performance, and BS 476 Pt 6:1989 and exhibit a Total Index of Performance of less than 12. Insulation thickness shall be in accordance with the following table depending on the installation practice:

Description of Installation	Minimum Thickness of Insulation Required
Concealed in brickwork with plaster	9mm (Insulation to be protected against deformation prior to plastering)
Running through aircon space	13mm
Running through non-aircon space	19mm

Running through bathroom ceiling space	25mm
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Jointing of lengths of preformed insulation shall not be by means of adhesive tapes which deforms the insulation. Such joints shall be by proper gluing of mating faces of each length using glue and method recommended by the manufacturer.

Factory Assembled Plant

The factory assembled plant shall be insulated as recommended by the manufacturers and as specified earlier. This insulation shall be applied at the manufacturer's factory, and only as necessary on site during or after installation. Should this insulation appear inadequate in the opinion of the Engineer, he reserves the right to call for its partial or complete removal and repair or replacement by the Contractor at no extra cost to the Employer.

Refrigerant and condensate Pipework

The whole of the condensate and refrigeration pipe lines including gas suction line, all fittings, valve and strainer bodies, flanges, etc., on the refrigeration equipment shall be insulated with 25mm thick thermal insulation. Thermal conductivity shall not exceed 0.0039 W/M degrees C for a mean temperature of 24 degrees C.

All surfaces over which the insulation is to be applied shall be dry and grease free. Exposed pipe work will be provided with two layers of 25mm thick insulation. Suitable weather proof paint as per manufacturer's recommendation shall be applied.

6.0 ELECTRICAL WORKS

The system electrical power rating is 3 phase, 50Hz, 400 V. 3 phase, 50Hz, 400V electrical power supply for outdoor units shall be obtained from the isolator provided within each floor level near to outdoor location. Control panel for air conditioning equipment, switch gear, all electrical & control wiring for indoor units shall be provided by the air conditioning contractor. All necessary control wiring in-between indoor and outdoor units have to be carried out by AC contractor.

The Contractor shall supply and install electrical distribution and control panels, switchgear including circuit breakers, other electrical equipment and wiring necessary for the operation of the air conditioning equipment as specified. All equipment supplied and install by the contractor shall suit the above power rating of 400 / 230 V, 50 Hz.

This work shall be carried out by a Contractor who has specialized in this type of work and shall meet the requirements of the 17th edition of IEE regulations latest amendment, local supply authority's requirements and conform to best trade practices.

All signals of indication and faults displayed in the local control panels of equipment shall be duplicated on this Main Control Panel.

7.0 MATERIALS

Test reports on materials used tested according to the relevant standards shall be provided if called for by the Engineer.

8.0 TEST EQUIPMENT, SPECIAL TOOLS AND RECOMMENDED SPARES

Bidder shall submit with the Bid a complete itemized list of test equipment, special tools and recommended spares needed to enable the user to carry out maintenance work. All test equipment, special tools and recommended spares shall be on site when the commissioning work is completed and shall be handed over with the system to the Engineer.

9.0 SUBMISSIONS

The Contractor shall submit for approval the following documents and samples in quantities as indicated.

9.1 Shop Drawings

Shop drawings of all piping systems, electrical circuit and wiring diagram and any other drawings necessary for fabrication and installation of the system.

9.2 Technical Literature of Equipment

Technical literature of all equipment proposed to be used in the system inclusive of dimensional drawings, capacity, tables, test reports and other relevant information shall be supplied in triplicate for the Engineer or determine the adequacy and suitability of the equipment for the proposed air-conditioning system.

9.3 Operation and Maintenance Manuals

The Contractor shall furnish three (03) copies of an operation and maintenance manual which shall contain complete instructions for overall operation of the facility and its component parts. The manual shall also include the operation and maintenance charts specified above. Drawings to be photo-reduced for incorporation into the Manuals to facilitate reference and reduction in volume. Manuals shall be complete, detailed guides for the maintenance and operation of equipment and systems and shall include complete information necessary for start-up, adjustments, maintaining continuous operation for long periods of time and dismantling and re-assembling of the complete units and sub-assembly.

9.4 Samples

Samples of all materials to be supplied under the contract such as pipes, insulating materials and multiple fittings such as valves, strainers, electric components shall be supplied to the Engineer for approval. Such samples shall be kept with the Engineer until completion of the Works and same will be released to the Contractor on completion of work. The items of supplies used for the project shall be at least equal in quality to the approved sample.

9.5 As-built drawings

On completion of the installation, the Contractor shall prepare a set of As-built drawings incorporating all changes made to the original design and drawings, which drawings shall represent an accurate description of the installed systems. These drawings shall be bound with covers in to an album and handed over to the Engineer.

9.6 Handing over documents

The final handing over documents to be submitted by the Contractor on completion of the installation shall comprise the following:

- a) Operation and maintenance manuals (03 copies)
- b) Commissioning sheets (03 copies)
- c) Test reports (03 copies)
- d) As built drawings (03 copies)

These documents should be supplied to the Engineer within 30 days on issue of taking over certificate.

10.0 TRAINING OF OWNER'S STAFF

Bidders shall submit with the Bid, a full proposal of the recommended training necessary for the owner's personnel to attend to routine testing, maintenance service and minor repairs including an indication of the duration of such training. The number of persons required to be trained shall be determined jointly by the Engineer, and the contractor.

The scope of training shall include on-site training and such training shall be prior to hand-over of the system. Technical training and system operation instructions to the owner's personnel shall also be provided during the commissioning and performance tests phases of the system.

System operation instructions shall be given by an experienced and competent representative of the Contractor who is thoroughly conversant with the air conditioning system installed

11.0 SITE TESTING AND COMMISSIONING

Bidders shall submit with the Bid, a complete proposal with time schedule for testing and commissioning of the air conditioning system. The program shall include a trial operation of all main equipment with any necessary adjustments to ensure that the system is working correctly. The Contractor shall provide all instruments and equipment together with commissioning engineers and adequate assistance for carrying out the commissioning and testing activity, which shall be done in accordance with the recommendations of relevant standards. If any portion the works fails to pass the tests, the Contractor shall, at his own expense carry out such alterations or replacements as are required to the satisfaction of the Engineer. The Engineer shall be at liberty to call for further commissioning when such alterations have been completed to their satisfactory. The Contractor shall provide commissioning spares at his own expense.

Spare parts earmarked for maintenance shall not be used during this period.

12.0 MAINTENANCE CONTRACT

Bid shall submit the terms and charges for service and maintenance contract along with the Bid.

DATA SHEET OF HVAC SYSTEM

Note: Bidders shall provide all necessary information of their proposed product under the column 'As Offered' under this returnable schedule. Bids with incomplete returnable schedule will be rejected.

Item	Description	As Specified
1.00	Air conditioners	
	Air-cooled Variable Refrigerant Volume/Flow air conditioners	
	Make	
	Type	Top Discharge
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Method of demand control	
	Method of refrigerent flow control	
	Control System: Central / Network etc.	Central
	Max. No. of indoor units connectable to	
	Control interface	
	Refrigerant	R-410A
	Maximum pipe length / (m)	1000
	Pipe length between first branch and lowest indoor unit / (m)	
	Height difference between highest and lowest indoor unit / (m)	
	Height difference between outdoor and lowest indoor unit / (m)	
1.1	Outdoor Unit	
	VRF / VRV	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Year of manufacture	

	Minimum Cooling Capacities / (kW)	
	COP / (%)	4.5
	Working range / (oC)	
	Refrigerent	R-410A
	Refrigerent charge / (kg)	
	Sound pressure level / (dB) A scale	65
	Casing material	Compatible for Maldives Environment
	Compressor :	
1.20	Inverter controlled compressors	(If Applicable)
	Type	
	No. of compressors	2
	Capacity control steps	5
	Electrical Rating	
	Full load compressors	
	Type	
	No. of compressors	2
	Electrical Rating	
1.30	Fan :	
	No. of Fans	2
	Air flow rate	
	Blade material	Compatible for Maldives Environment
	Electrical Rating	
	Dimensions :	
	H x L x W / (mm)	
	Operating weight / (kg)	
	Refrigerent piping Liquid/Gas / (mm)	
	Min. Capacity of indoor units connectable	
	Max. No. of indoor units connectable	
	Total capacity of indoor units connectable	
	Indoor Units	
1.4	Ceiling mounted four way cassettes	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan

	Country of Manufacture	Korea or Japan
	Year of manufacture	
	Minimum Cooling Capacities / (kW)	As per the drawing
	Air flow Rate / (cfm)	
	Power Input / (kW)	
	Air outlet , Evaporator : / (oC, rh%)	
	Air inlet, Evaporator : /(oC, rh%)	
	Refrigerent	
	Sound pressure level / (dB) A scale	35
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
	Connections: Liquid/Gas /(mm)	
	Codensate drain	PVC type 1000
1.5	Fan coil unit :	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Year of manufacture	
	Minimum Cooling Capacities / (kW)	
	Air flow Rate / (cfm)	
	Power Input / (kW)	
	Air outlet , Evaporator : / (oC, rh%)	18
	Air inlet, Evaporator : /(oC, rh%)	27
	Refrigerent	R-410A
	Sound pressure level / (dB) A scale	35
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
	Connections: Liquid/Gas /(mm)	
	Codensate drain	
1.6	Air Handling unit :	
	Make	
	Model	
	Type	

	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Year of manufacture	
	Minimum Cooling Capacities / (kW)	
	Air flow Rate / (cfm)	
	Power Input / (kW)	
	Air outlet , Evaporator : / (oC, rh%)	18
	Air inlet, Evaporator : /(oC, rh%)	27
	Refrigerent	R-410A
	Sound pressure level / (dB) A scale	40
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
	Connections: Liquid/Gas /(mm)	PVC type 1000
	Codensate drain	
1.7	Hepa filter :	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Year of manufacture	
	Sound pressure level / (dB) A scale	30
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
	Minimum Airbone partical size	0.3micron
	Clean Air Delivery Rates (l/s)	
1.8	Refrigerant Pipework & Fittings	
	Make	
	Model	
	Type	copper
	Country of Origin	
	Country of Manufacture	
1.90	Insulation for Refrigerant Pipework	
	Make	
	Model	

	Type	NBR
	Country of Origin	
	Country of Manufacture	
	Thermal properties	
2.00	Fans	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	
	Year of manufacture	
	Sound pressure level / (dB) A scale	30
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
	Air flow Rates	
2.10	Brackets & Hangers	
	Make	
	Model	
	Type	Marine resistance
	Country of Origin	
	Country of Manufacture	
2.20	Air Terminal Units	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan
	Year of manufacture	
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	
2.30	Air Recovery Ventilator	
	Make	
	Model	
	Type	
	Country of Origin	Korea or Japan
	Country of Manufacture	Korea or Japan

	Year of manufacture	
	Sound pressure level / (dB) A scale	30
	Dimensions: H x W x D / (mm)	
	Weight / (kg)	