MATERIAL AND EQUIPMENT STANDARD

FOR

FIELD-ERECTED AIR CONDITIONING SYSTEM

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0. INTRODUCTION

This Standard provides material specification for different types of air fans, air filters and air distribution outlet devices. The material description of units covers those that are manufactured by renowned international manufacturers, rated and tested by various authoritative international bodies. The description also incorporates ideas extracted through reams of magazine article and through accumulated knowledge and experience of the technical committee.

The body of the specifications allows the use of any equipment meeting the performance specifications. The specifications are intended to be inclusive of many components which may not be required, hence it is up to the discretion of the design or procurement engineer to eliminate those added items that may not be required for the specific needs of the project being addressed.

Since the type of controls are of several different standards used in the industry, recommendations by acceptable and approved manufacturers shall be used to meet differing requirements of the codes or the equipment.

1. SCOPE

This Standard covers the minimum requirements for specification of equipment and material, inspection, testing and shipment of field-erected air conditioning units and systems suitable for indoor and outdoor mount and for use in commercial, institutional, industrial, medical, oil, gas and petrochemical industries.

This Standard does not cover the requirements of scroll type compressors.

This Standard is divided into following Parts:

Part I: General Specification for Central Chiller Packages
Part II: General Specification for Air Handling Systems
Part III: General Specification for Air-Water Systems
Part VI: General Administrative and Procedural Requirements

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendors.

ASHRAE (AMERICAN SOCIETY OF HEATING, REFRIGERATING & AIR-CONDITIONING ENGINEERS)

ASHRAE 14-80	"Methods of Testing for Rating Positive Displacement Condensing Units"
ASHRAE 23-78	"Methods of Testing for Rating Positive Displacement Refrigerant Compressors"

ARI (AIR-CONDITIONING AND REFRIGERATION INSTITUTE)

ARI 550-92	"Centrifugal Water Chilling Packages"
ARI 410-87	"Forced-Circulation Air-Cooling and Air-Heating Coils"
ARI 560-82	"Absorption Water Chilling Packages"
ARI 110-80	"Air Conditioning and Refrigerating Equipment Nameplate Voltages"
ARI 370-86	"Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment"
ARI 450-87	"Water-Cooled Refrigerating Condensers, Remote Type"
ARI 460-87	"Remote Mechanical Draft Air-Cooled Refrigerant Condensers"

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)

ANSI/ASHRAE 51-85	"Laboratory Methods of Testing Fans for Rating"
ANSI/ASHRAE 83-85	"Capacity Measurement of Field Erected Compression Type Refrigeration and Air-Conditioning Systems"
ANSI/ASHRAE 15-1994	"Safety Code for Mechanical Refrigeration"
ANSI B 16.5	"Steel Pipe Flanges and Flanged Fittings"

ANSI/ARI 520-90	"Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units"
ANSI/ARI 590-81	"Reciprocating Water Chilling Packages"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME Section VIII, DIV. 1	"Unfired Pressure Vessel Code"

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

ANSI/NFPA 90A-89	"Installation of Air Conditioning and Ventilating Systems"
ANSI/NFPA 214-88	"Water Cooling Towers"

3. DEFINITIONS AND TERMINOLOGY

3.1 Air Handling Unit

A factory-made, encased assembly designed as a unit primarily to provide free delivery of conditioned air to an enclosed space or zone. It includes a prime source of refrigeration for cooling and dehumidification and means for circulating and cleaning air. It may also include means for ventilating and heating.

3.2 Chiller Package

A factory made package of the self-contained or condenserless type, for the purpose of cooling water.

3.3 Chiller, Absorption

A chilling system in which the refrigerant gas involved in the evaporator is taken up in an absorber and released in a generator upon the application of heat. These are packaged system using low pressure steam or hot water as the energy source.

3.4 Compressor, Hermetic Type

A combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, the motor operating in the refrigerant.

3.5 Compressor, Open Type

A refrigerant compressor with a shaft or other moving part extending through its casing to be driven by an outside source of power, thus requiring a shaft seal or equivalent rubbing contact between a fixed and moving part.

3.6 Compressor, Positive Displacement

A refrigerant compressor in which increase of refrigerant gas or vapor pressure is attained by changing the internal volume of the compression chamber.

3.7 Compressor, Rotary

A positive displacement compressor in which the change in internal wolume of the compression chambers is accomplished by the rotary motion of positive displacement member(s).

3.8 Condenser, Air-Cooled

A refrigerant condenser in which heat rejection is accomplished entirely by raising the temperature of the air used as a cooling medium.

3.9 Evaporator (Refrigerant)

A heat exchanger in which the liquid refrigerant, after reduction of its pressure (expansion), is evaporated by absorption of heat from the medium to be cooled.

3.10 Fan-Coil Unit

An air conditioning unit which consists of heating or cooling coils and positive (forced draft) ventilation.

3.11 Induction Unit

An air-conditioning device in which, high pressure primary air as discharged within the unit through nozzles, and induces room air across the heating or cooling coils.

3.12 Multi-Zone System

A constant volume, variable temperature system which is applied to areas of multiple spaces or zones. Each zone has individual mixing dampers and reheat coils.

3.13 Purger

A device for removing non condensable gas from refrigerant condensers or for removing low-concentrated solution from absorption system evaporators.

3.14 Water-Cooling Tower

An enclosed device for evaporatively cooling water by contact with air.

3.15 Unloader

A device on or in a compressor for equalizing the high and low side pressure for a brief period during starting in order to decrease the starting load on the motor, also a device for controlling compressor capacity by rendering one or more cylinders inactive.

3.16 Valve, Expansion

A device which regulates the flow of refrigerant from the liquid line in the evaporator to maintain a constant evaporator pressure.

3.17 Variable Air Volume (VAV)

A device to maintain room temperature by supplying a variable volume of constant temperature supply air, where:

- The volume is modulated by a damper in response to room temperature;
- the damper powered by duct pressure controls, pneumatic or electric controls.

4. CONFLICTING REQUIREMENTS

In the case of conflict between documents relating to the inquiry or purchase order, the following priority of documents shall apply:

First Priority:	Purchase order (including attachments) and variation thereon
Second Priority:	Data sheets and drawings
Third Priority:	This Standard specification

All conflicting requirements shall be referred to the company in writing. The company will issue confirmation documents if needed for clarification.

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

6. SYSTEM CLASSIFICATION

For ease of selection and application, air-conditioning equipment mentioned in this Standard according to the capacity limitation, the system classifications are recommended as follows:

a) Water Chilling Packages

1) Positive displacement (reciprocating or rotary or screw) compression water chilling package for capacities up to 1056 kW (300 TR).

2) For reciprocating packaged liquid chillers (water or air cooled) the following compressor cooling conditions and capacity are recommended:

i) Minimum capacity up to 15 TR;

ii) semi-hermetic compressors can be used up to 40 TR;

iii) number of cylinders for open compressors shall be limited to 8;

iv) maximum four compressor units shall be used on each liquid chiller package (irrespective of its cooling capacity);

v) compressors in excess of 80 TR shall be provided with unloaders.

The unloader can be electrically operated or electrically controlled and operated by suction gas or oil pressure.

3) Centrifugal compression water chilling package for capacities from 1056 kW (300 TR) and larger.

4) Absorption water-chilling package for capacities between 528 to 4224 kW (150 to 1200 TR).

b) All-Air Systems

1) Air handling units:

The capacity range and fan type for the single zone air handling unit should be as follows:

i) The total air capacity between 3380 to 55770 m^3/hr (2000 to 33000 cfm) when operating with following fan types at maximum indicated static pressure:

- Forward curved low pressure at 76 mm (3")
- Forward curved medium pressure @ 153 mm (6")
- Air foil at 153 mm (6")
- Air foil high pressure @ 203 mm (8")

ii) The type of configuration shall be either:

- Single zone draw-through suitable for horizontal or vertical arrangements.
- Multi-zone shall always be blow-through type.

2) Variable temperature constant volume system:

- Single-zone, capacity depending upon application.
- Multi-zone, capacity depending upon application.

3) Variable air volume system:

- Low velocity system arrangements 5 m/s (1000 fpm) for single zone packaged air-conditioning systems.

- High velocity system arrangement 12.5 m/s (2500 fpm) with individual terminal unit from 254 to 3380 m^3/h (150-2000 cfm) nominal capacity.

c) Air-Water Systems

1) Fan coil uints

The capacity limitation range for the chilled water type fan coil units should be as follows:

i) Floor mount with cabinet with ratings from 338 m^3/hr to 3380 m^3/h (200 cfm to 2000 cfm).

ii) Horizontally suspended ceiling mount direct drive with or without cabinet for ratings from 338 m^3/hr to 3718 m^3/h (200 cfm to 2200 cfm).

iii) The ceiling suspended belt-drive with ducts for ratings from 680 m^3/h to 7600 m^3/h (400 to 4000 cfm).

2) Induction unit

Induction unit, where high windows are used for perimeter areas of the air conditioned space. The capacity limitation range for the induction units should be as follows:

i) Primary air capacity from 34 m^3/hr (20 cfm) through 255 m^3/h (150 cfm).
ii) The 1-Row coil capacity shall be between 500 to 1500 kcal/h (2000 to 6000 btuh).
iii) The 2-Row coil capacity shall be between 750 to 2000 kcal/h (3000 to 8000 btuh).

Notes:

1) Depending on local code ordinances the availability of equipment and system and the capabilities of local manufacturers, any deviation or exceptions shall remain permissible to the design engineer's discretion.

2) Equipment mentioned in this Standard shall meet the requirement of ANSI/ASHRAE 15-1994 Codes for safety provisions.

PART I
GENERAL SPECIFICATION FOR CENTRAL - CHILLER PACKAGES

7. COMPRESSION WATER-CHILLING PACKAGES

7.1 General

The compression water chilling packages shall cover the specification requirements of both open and hermetic centrifugal chilling units, and the liquid chilling units. Necessary arrangements shall be made available for interfaces to building management system, whenever specified.

7.1.1 The refrigeration chiller packages shall be either compression refrigeration type or absorption refrigeration system, as specified in relevant data sheets.

7.1.2 The compressor equipment for compression refrigeration system may be either positive displacement (rotary or reciprocating) type or centrifugal type, according to job requirements and as specified in data sheets.

7.1.3 Water-cooled or air-cooled condensers and heat rejection systems, based on condition at site, location and available facilities, may be selected.

7.2 Centrifugal Chiller Packages

7.2.1 Compressor and motor

7.2.1.1 Open type system

7.2.1.1.1 The compressor shall be a single or two-stage centrifugal type powered by an open-drive electric motor. The housing shall be fully accessible with the complete operating assembly removable from the compressor and scroll housing.

7.2.1.1.2 The rotor assembly shall consist of a heat-treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller.

7.2.1.1.3 The impeller shall be designed for balanced thrust, dynamically balanced and over speed tested for smooth, vibration free operation. Insert-type journal and thrust bearings shall be fabricated of aluminum alloy, precision bored and axially grooved.

7.2.1.1.4 Internal single helical gears with crowned teeth shall be so designed for even distribution of compressor load and quiet operation. Each gear shall be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces.

7.2.1.1.5 Capacity control shall be achieved by use of prerotation vanes to provide fully modulating control from 100% to 10% of full load. The unit shall be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550-92.

7.2.1.1.6 The lubrication oil shall be force-fed to all bearings, gears and rotating surfaces by an oil pump which operates prior to start-up, continuously during operation and during coastdown. Oil shall be filtered by an externally mounted replaceable cartridge oil filter equipped with service valves and cooled by a refrigerant-cooled oil cooler before entering the compressor. The oil piping shall be factory installed and tested, and an oil heater furnished in the oil reservoir.

7.2.1.1.7 The compressor motor shall be an open drip-proof squirrel cage induction type operating at 2975 rpm for 50 Hz operation. Motors mounting shall be provided with arrangements according to its power capacity, allowing the motor to be rigidly coupled to the compressor with factory alignment of motor and compressor shafts.

7.2.1.1.8 For units utilizing remote electro-mechanical starters a large steel terminal box with gasketed front access cover shall be provided for field connected conduit.

7.2.1.2 Hermetic type system

7.2.1.2.1 Each compressor, motor and transmission shall be hermetically sealed into a common assembly duly arranged for accessibility and easy servicing.

7.2.1.2.2 The compressor shall have a forced feed lubrication system to deliver oil under pressure to bearings and transmission gears; included in the system shall be:

a) Hermetic motor driven positive displacement oil pump

b) Refrigerant oil cooler

c) Oil pressure regulator

d) Oil strainer (filter)

e) Oil pump starter, factory mounted in the control panel and factory wired to pump motor and control circuit. The oil pump shall be provided with a separate 380 V three phase, 50 Hz power source.

f) Automatic water control valve.

g) Thermostatically controlled oil heater.

h) Oil reservoir with temperature gauge.

7.2.1.2.3 The compressor shall be supplied with modulating variable inlet guide vanes for capacity control.

7.2.1.2.4 Transmission gears shall be of the double helical type and must be arranged for visual inspection without disassembly or removal of compressor casing or impeller .

7.2.1.2.5 The impeller shall be statically and dynamically balanced and over-speed tested to a minimum of 15% above operating conditions at the factory.

7.2.1.2.6 Compressor motor shall be of direct drive accessible hermetic, single speed non-reversing, low-slip squirrel cage induction type, suitable for the voltage shown on the equipment data sheet.

7.2.1.2.7 Motor design speed shall be 2950 rpm at 50 Hz. The motor shall be directly connected to the compressor shaft with a flexible disc coupling.

7.2.1.2.8 Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized sub cooled refrigerant in contact with the motor windings and all internal motor components.

7.2.1.2.9 Motors shall be arranged for service or removal with only minor compressor disassembly and without breaking of main refrigerant piping connections.

7.2.1.2.10 Full load operation of the motor shall not exceed nameplate rating. The manufacturer shall submit for evaluation, the power required at 25, 50, 75 and 100% of rated equipment capacity.

7.2.1.2.11 An electrical interlock shall be provided to ensure that the main compressor drive motor will not start unless the auxiliary motors are running and safe operation conditions are established.

7.2.1.2.12 Low voltage motors shall be built for connection to combination star-delta starters, closed transition type in IP 54 or NEMA 1 enclosure. Subject to manufacturer's recommendation, use of reduced voltage auto transformer is acceptable. Overload relays shall be provided in each leg of the starter.

7.2.2 Cooler and condenser

7.2.2.1 Cooler and condenser may be unishell or separate horizontal shell and tube vessel, fabricated with integrally finned seamless copper tubing, steel shell and tube sheets and fabricated steel water boxes.

7.2.2.2 Tubes shall be rolled into the tube sheets and extended into support sheets and individually replaceable.

7.2.2.3 Cooler shall be flooded type or direct expansion type with refrigerant in tubes and liquid in the baffled shell. The refrigerant flow to the evaporator shall be controlled by fixed orifice with no moving part.

7.2.2.4 Shell shall be constructed of carbon steel plates and tested in accordance with the applicable sections of the ASME Code, incorporating minimum 5 or 7.5 cm (2" or 3") carbon rupture disc. The service access shall conform to ANSI/ASHRAE 15-1994.

7.2.2.5 Water boxes and nozzles connections shall be designed for maximum 1035 kPa (150 psig) design pressure and tested at 1550 kPa (225 psig).

7.2.2.6 Water boxes shall be provided with vents, drains and covers (plugs) to permit tube cleaning within the space shown on the drawings. Suitable toppings shall be provided in water boxes and nozzles for control sensors, gages and thermometers.

7.2.2.7 Tubes and water boxes shall be removable from either end of the heat exchanger without affecting strength and durability of the tube sheet and without causing leakage in adjacent tubes.

7.2.2.8 A thermal economizer shall be provided as part of the assembly to increase cycle efficiency.

7.2.2.9 The fouling factor in the evaporator and condenser and chiller performance shall be based on ARI Standard 550-92.

7.2.3 Purge system

A purge system shall be furnished for chillers operating under vacuum. System shall be self-contained thermal type, provided with all necessary devices for the evacuation of air and water vapor from the system and for condensing, separating and returning refrigerant to the system.

7.2.4 Insulation

a) The compressor motor purge chamber, and all miscellaneous piping, shall be factory-insulated by the manufacturer.

b) The evaporator (cooler), the suction elbow between the compressor and the evaporator, and the cooler water box covers shall be field or factory insulated, conforming to UL Standard 94 Classification 94 HBF.

c) Insulation shall be closed-cell, foamed, fireproof plastic, 20 mm (¾ inch) thick, with thermal conductivity as recommended by the manufacturer but not exceeding 0.0404 W/m. °C (0.28 Btu. in/h.ft²) to prevent condensation on the surface.

7.2.5 Control center

7.2.5.1 Each unit shall be furnished with a complete NEMA or IEC-rated electromechanical or microprocessor control center in a locked enclosure factory mounted, piped and wired as mentioned in the data sheet.

7.2.5.2 Starters shall contain in an IP 55 (NEMA) weather proof enclosure and shall be either factory installed on chillers or free standing mounted near the chiller as specified in the data sheet.

7.2.5.3 The safety and operating controls to be OSHA-oriented and be furnished with following minimum requirements:

a) Chilled water temperature controller with control point adjustment.

b) Evaporator freeze protection and evaporator limit control.

c) Compressor start-stop/reset push button and operating signal light.

d) Motor current controller with load limiting selector switch.

e) Manual reset protective controls with indicating lights for high oil temperature, high motor temperature, high discharge temperature, high and low refrigerant pressure, low oil pressure, low leaving chilled water temperature.

f) Chilled water flow and power failure indication lights.

g) Dial pressure gages for refrigerant evaporator, condenser pressure and oil pressure.

7.2.5.4 The factory furnished controls shall be pre-piped and pre-wired with connections to a terminal strip for interlock with other equipment.

7.2.6 Piping and appurtenances

7.2.6.1 Water connections to oil cooler and other water supply, drain and vent connections as required by equipment drawings shall be provided.

7.2.6.2 The refrigerant circuit shall be complete with discharge line muffler, insulated suction line and liquid line including shut-off valve with charging connection, cartridge type replaceable filter-drier, and sight glass as moisture indicator.

7.2.6.3 The Vendor shall furnish flanged piping connections on the water boxes in accordance with ANSI B 16.5.

Note:

The refrigerant relief lines shall be extended vertically upward outside the mechanical equipment room.

7.2.7 Supports

7.2.7.1 The Vendor shall furnish for field installation on a concrete base a soleplate package consisting of soleplates, jacking screws, and leveling pad constructed of molded neoprene.

7.2.7.2 Spring vibration isolators for the desired degree of isolation, shall be furnished for chiller not installed on concrete base. The isolators shall be selected by the manufacturer for the conditions involved to prevent noise and vibration transmission to the structural base.

7.3 Liquid Chiller Packages

7.3.1 Compressor

7.3.1.1 Reciprocating compressor

The reciprocating compressor shall be semi hermetic type with specified capacity control and refrigerant. (For further information, reference is made to IPS-M-AR-185.)

7.3.1.2 Rotary screw compressors

The rotary screw compressor(s) unit shall meet specified requirements. Compressor casing shall be gray cast iron. The steel rotors in combination with an integral gear drive shall be supplied. The compressor shall incorporate a complete anti friction bearing design for reduced power consumption. (For additional information reference is made to IPS-M-AR-185.)

7.3.2 Condensers

7.3.2.1 Water-Cooled condensers

7.3.2.1.1 The water-cooled condenser shall be of the horizontal shell and finned type design, fabricated so each tube can be individually replaced.

7.3.2.1.2 Compact water boxes shall be provided and furnished with removable cover plates having integral water connections, permitting direct access to tubes for inspection and maintenance. Water connections shall be pipe stubs for welding with raised face flanges in accordance with ANSI standard B 16.5.

7.3.2.1.3 Shell shall be designed for a working pressure on the refrigerant side suitable for the relevant refrigerant used, and constructed and designed to meet the requirements of ASME Unfired Pressure Vessel Code Section VIII Division 1.

7.3.2.1.4 Relief device(s) shall be provided for the refrigerant side in accordance with ANSI B 9.1 safety code. (Multiple relief devices shall be brought to a common connection.) Refrigerant flow control device(s) shall be factory installed and piped.

7.3.2.2 Air-Cooled condenser

7.3.2.2.1 The vendor shall furnish air cooled condenser unit as specified in data sheet.

7.3.2.2.2 Fan shall be propeller type and direct driven by electric motor, suitable for outdoor installation. The fan blades shall be made of heavy gauge aluminum alloy, highly resistant to environmental corrosion. Each fan shall be statically and dynamically balanced at the factory. For application in hazardous area, spark resistant fan and explosion proof motor shall be provided.

7.3.2.2.3 The motor shall be totally enclosed fan cooled (TEFC), wiring insulation class "F". Motor shall be suitable for outdoor installation and having IP 54 enclosure protection according to IEC Standards.

7.3.2.2.4 Condenser coils shall be made of seamless copper tubes expanded into aluminum fins for optimum heat transfer. The headers shall be brazed on to the coils using silver solder.

7.3.2.2.5 The unit casing shall be made from zinc coated galvanized sheet, protected by proper coating and finished by resin coat baked. Access panels shall be provided for ensuring ease of inspection and maintenance. All components shall be supported by a strong structurally designed support frame.

7.3.2.2.6 Electrical panel shall be factory wired and mounted with all safety components including, but not limited to, fan motor contactor, fuses and compressor interlock.

8. ABSORPTION WATER CHILLING PACKAGES

8.1 General

8.1.1 The vendor shall furnish absorption water chilling package in compliance with ARI Standard 560, completely assembled, leak tested and evacuated in the factory.

8.1.2 Each unit shall consist of evaporator, absorber, generator, condenser, solution and baffled heat exchanger, solution pump, refrigerant pump, purge unit, necessary interconnecting piping, refrigerant and purge piping, automatic crystallization control panel, spare parts and special tools.

8.1.3 Approval on renouned manufacturer's standard equipment which meets the priority requirement of specification mentioned in this Standard shall be given due consideration.

8.1.4 The Vendor shall furnish initial charge of lithium bromide solution with necessary chromate inhibitor.

Note:

All shells shall be completely assembled under vacuum. Where upper and lower shell assemblies are shipped separately, these shall be maintained under nitrogen pressure.

8.2 Specification Requirements

8.2.1 Generator

8.2.1.1 Steam or hot water shall be supplied to the generator as the heating medium as specified in the data sheet.

8.2.1.2 The generator shall have shell and tube construction. Generator tube bundles shall be of U-bend design, secured at one end only, reducing tube wear and tube bundle failures. The generator shall be hydrostatically tested at 1½ times the design working pressure. The pressure shall be maintained for at least 30 minutes.

8.2.1.3 The construction of generator shall be in accordance with ASME Unfired Pressure Vessel Code Section VIII Division 1. The hot water units shall be supplied with a 103 kPa (15 psig) bursting disc on the shell side.

8.2.2 Evaporator, absorber and condenser

8.2.2.1 Evaporator, absorber and condenser shall have shell and tube construction. All tubes shall be individually replaceable at either end of the machine with the tube ends rolled into annular grooves in the tube sheet.

8.2.2.2 The absorber, generator and the evaporator tube material shall preferably be of cupro-nickel. The condenser tube material shall be of copper.

8.2.2.3 Absorber and evaporator shall be suitable for a fouling factor equal to 0.0005 and the condenser for a fouling factor of 0.001 on the water side of the tubes.

8.2.2.4 All headers shall be hydrostatically tested at 1½ times the design working pressure. The pressure shall be maintained for at least 30 minutes. Headers shall be removable for free access to the tube bundles.

8.2.3 Solution and refrigerant pumps

8.2.3.1 Pumps shall be of the self-contained hermetic type, without pump seals or external seal water system. Lubrication and cooling of the solution pump shall be accomplished by lithium bromide solution.

8.2.3.2 The refrigerant pump shall be lubricated and cooled by the refrigerant. Mechanical-magnetic strainer assembly shall be installed in the pump-motor cooling circuit.

8.2.3.3 Pump motors shall be operated on 3 phase, 380 volts, 50 Hz power supply. The pump motor shall be factory mounted and wired. It shall be removable without breaking vacuum or removing solution from the machine.

8.2.4 Purge system

8.2.4.1 Unless otherwise specified, purging shall be by a system consisting of an electric motor driven vacuum pump. It shall require no external water supply. A self-contained automatic motorless purge system may be provided as an approved alternate.

8.2.4.2 The system shall have sufficient capacity to purge the unit of non-condensable gases in a period of not more than one hour per week during normal machine operation.

8.2.4.3 The machine shall be automatically protected against re-entry of non-condensable gases providing a positive seal. The purge system shall not eject solution from the machine.

8.2.5 Decrystallization device

The unit shall be provided with any suitable automatic decrystallization device, which may consist of heated solution or a steam jacket or electric element around the heat exchanger, to eliminate any crystallization that may occur.

8.2.6 Capacity control

Capacity control shall be provided by an automatic pneumatic system capable of governing operation at all conditions of load and entering condenser water temperature. The control system shall ensure safe and stable machine operation at varying conditions of load and entering condenser water temperature. Chilled water shall be controlled by a valve which regulates the supply of the heating medium.

8.2.7 Control panel

8.2.7.1 Each unit shall have a completely factory assembled and mounted electro-pneumatic control panel. A clearly marked terminal strip shall be provided for ease of external wiring connections.

8.2.7.2 The pneumatic control system as a minimum requirement shall consist of chilled water temperature controller, pressure switch, solenoid air valve, temperature gauge, display lights indicating operational status of machine and purge.

8.2.7.3 The electrical control system as a minimum requirement shall consist of control transformer and separately fused single phase control system, motor temperature cutout and low temperature cutout, time delay for dilution cycle, motor starter, purge motor fuse, 3 phase overload protection, external lights to indicate operation of the unit, pumps and purge system.

8.2.7.4 A Direct Digit Control (DDC) panel consisting of all safety and operation requirements will be given serious considerations.

8.2.8 Piping and appurtenances

8.2.8.1 Where required, the following accessories shall be provided by the Vendor.

8.2.8.2 Gage cocks and thermometer wells shall be provided for temperature and pressure readings at the inlet and outlet of the evaporator, at the inlet an outlet of absorber, and at the outlet of the condenser and at the inlet of the hot water or steam piping as shown on the plans.

8.2.8.3 The steam control valves shall be either cage or butterfly type with low thrust and equal percent characteristic.

8.2.8.4 The hot water control valves shall be 3 way diverting type double seated with balanced stems.

8.2.8.5 A flow switch in the chilled water circuit to be interlocked with the electrical control circuit of the unit, so that the unit is allowed to operate only when there is flow in the circuit.

8.2.8.6 Safety relief valves shall be provided for upstream from the control steam or hot water valve.

Note:

Materials supplied for field installation shall be clearly identified.

8.2.9 Insulation

8.2.9.1 Factory insulation, minimum 19 mm (¾") thick flexible closed cell plastic type, shall be provided on evaporator shell surfaces. (Refrigerant pump, and piping shall be field insulated. Chilled water headers and water boxes shall be field insulated after piping has been completed.)

9. PERFORMANCE TESTS

9.1 Centrifugal water chilling packages shall be performance tested in accordance with ARI Standard 550-88.

9.2 Liquid chiller packages shall be performance tested in compliance with ANSI/ARI Standard 520.

9.3 Absorption water chilling packages shall be performance tested according to ARI Standard 560.

9.4 Remote type water-cooled refrigerant condenser shall be performance tested in accordance with ARI Standard 450.

9.5 Mechanical draft air-cooled refrigerant condenser shall be performance tested in compliance with ARI Standard 460.

PART II
GENERAL SPECIFICATION FOR AIR-HANDLING SYSTEMS

10. AIR HANDLING UNITS

10.1 General

10.1.1 The Vendor shall furnish complete knocked down or in modular component, single or multi-zone air handling unit(s) suitable for indoor mount of the size and type as shown in the data sheet and plan drawings.

10.1.2 The central air handling unit shall be certified in accordance with ARI Standard 430, and assured performance through ARI Standard rating procedures.

10.1.3 The construction arrangement shall be available for vertical or horizontal assembly suitable for floor or ceiling mount. The unit can be either draw-through or blow-through configuration.

10.1.4 For outdoor mount units the gasketed panels and the components shall be weatherproofed and well protected.

Note:

A weatherproof overhead shading protection shall be provided for outdoor mount units.

10.2 Specification Requirements

10.2.1 Casing construction

10.2.1.1 The central air handling unit shall be of panelized construction with all metal parts fabricated of heavy gauge zinc coated steel. The coil and fan sections shall be insulated to prevent heat loss and condensation forming during cooling operation.

10.2.1.2 Fiber glass insulation shall be bonded to internal side of the panels insulation. It shall be coated by suitable material for best acoustical performance.

10.2.1.3 Unit shall be equipped with rigid base frame bolted to unit casing for site installation on leveled foundation. It shall be provided with factory drilled holes or lifting lug facilities for site fixing/suspension.

10.2.2 Mixing box

10.2.2.1 The mixing box unit shall be constructed of heavy gage galvanized steel and fitted with a damper system, designed to combine precise ratios of recirculated air and fresh air intake sections.

10.2.2.2 Full-width gasketed flanges shall be included on all inlets providing convenient installation and air-tight seal with the mixing box providing a combined filtering and mixing function. Filter shall be of cleanable type as specified in the data sheet. Hinged and latched access door shall be provided on each filter box.

10.2.3 Damper sections

10.2.3.1 Face and bypass damper sections shall be available for bypass purpose. Economical and accurate control of heating or cooling shall be achieved with the use of face and bypass damper. The dampers shall be multi-leaf and the damper blades shall be interlocked providing one control point.

10.2.3.2 Construction shall be a frame design, consisting of galvanized steel angles, securely bolted and braced to form a rigid and durable structure.

10.2.3.3 The damper blades shall preferably be suitable to rotate in nylon bearings providing a smooth-action and requiring no lubrication.

10.2.4 Fan and drive

10.2.4.1 Fan(s) and shaft(s) shall be selected to operate below the first critical speed, which shall be at least 25% above operating speed. Fan shaft shall be factory coated after assembly with anti-corrosion coating. The fan wheel shall be constructed of galvanized steel or aluminum, statically and dynamically balanced.

10.2.4.2 Units furnished with multiple fans shall have adjustable outlet damper on each fan to insure stable operation of parallel fans.

10.2.4.3 Fan section shall be constructed of reinforced channels mounted externally on the unit casing. Heavy duty mounts with additional supports and isolators shall be included.

10.2.4.4 Grease fittings and extended lubrication lines shall be provided for easy maintenance.

10.2.4.5 Fan may be direct drive or V-belt drive, as specified in the data sheet, and shall be factory assembled and aligned. An OSHA approved belt guards shall also be supplied by the Vendor.

10.2.4.6 Electric motor drives shall be selected for 120% of nominal motor horsepower. Motors shall be either open or TEFC (totally enclosed fan cooled) type and enclosure protection according to IP 54 class of IEC Standards. Insulation shall be class "F" and suitable for 220/380 volt, single or three phase and 50 Hz electrical supply as indicated in the data sheet.

10.2.5 Filter section

10.2.5.1 The unit shall be available with possibility for various filtration requirements to fulfill the dust spot method and dust arrestance method and meet the requirements of ASHRAE 52-76 and DIN 24185.

10.2.5.2 The filter sections to required thickness shall either be for panel or V-bank arrangements provided with side access.

10.2.6 Coil sections

The drain pan shall be extended beyond the coil section, providing complete condensate drainage. Heavy gauge galvanized steel construction, with welded joints shall be provided with full insulation.

10.2.6.1 Water coils (cooling and heating)

10.2.6.1.1 Water coil capacities and pressure drops shall be certified in accordance with ARI standard 410. All coils must be circuited to operate at design loading with water velocity within the ARI range of certified rating conditions.

10.2.6.1.2 Primary surface shall be copper or aluminum tubes, preferred to be staggered in direction of air flow. Tubes shall be expanded to form fin bond and provide hardened interior surface. Return bends shall be die-formed and silver-brazed to tubes.

10.2.6.1.3 Headers shall be of heavy seamless copper/aluminum tubing, silver brazed to tubes. Connections shall be with male pipe threads, silver brazed to headers. Plugged vent or drain tap shall be provided on each connection. Headers shall be hydrostatically tested before assembly. Header cross section shall be tapered to assure uniform water distribution to all tubes.

10.2.6.1.4 Extended surfaces shall consist of die-formed, continuous copper or aluminum fins with formed channels and surface treatment to minimize moisture carry-over.

10.2.6.1.5 Structural galvanized steel casing shall protect coil during shipment and provide for stacking of coils. The sheets on each end shall have drawn collars to support tubes.

10.2.6.1.6 All water coils shall be circuited to provide free draining and venting, through one vent and drain on each coil, with connections arranged for counterflow of air and water. Pressure drop shall not exceed more than specified value in the data sheet. Closed water circulating system shall have water pressure relief valve to avoid exceeding coil design pressure due to thermal expansion.

10.2.6.1.7 Freeze protection for coil must be used on installation where any part of water coil is subjected to air temperature of 0°C or lower.

10.2.6.1.8 Coils used in dehumidifying duty must have drain trough installed for each coil. Tubing should be provided to drain the upper pans into main drain pan.

10.2.6.1.9 When coil surfaces are sprayed to provide winter humidification, provisions shall be made for blow-down or water treatment to avoid build up of chemical deposits on coil fins.

10.2.6.2 Direct expansion coils

10.2.6.2.1 The coils which provide cooling by direct expansion of refrigerant inside the tubes, capacities and pressure drops shall be in accordance with ARI Standard 410.

10.2.6.2.2 The refrigerant shall be distributed from the multi-outlet venture type distributor to the coil circuits through seamless copper tubing.

10.2.6.2.3 Refrigerant coils shall be hydrostatically tested by water followed by thorough cleaning process, dehydration and dry nitrogen charging and sealing before shipment.

Note:

Thermostatic expansion valves with external equalizers shall be field connected to suction line. Proper expansion valve operation is necessary for full coil capacity.

10.2.6.3 Steam coils

10.2.6.3.1 Steam coil capacities and pressure drops shall be certified in accordance with ARI Standard 410.

10.2.6.3.2 Steam distributing coils shall be of a non-trapping, condensate drainable design, facilitating complete gravity drain.

10.2.6.3.3 Casing, extended surfaces, headers, primary surfaces shall be similar to those mentioned for water coils.

10.2.6.3.4 Complete coils, including headers, connection and return bends shall be tested with compressed air. Coils shall be designed for operation at saturated steam pressure as specified in the data sheet.

10.2.7 Add-On accessories

10.2.7.1 Humidifiers

The humidifier shall be either water spray, steam pan or steam grid type. (The selection of a humidifier shall depend upon the media available, the amount of humidity that is required, and the accuracy of control that is necessary.) A suitable selection shall be provided (by the agreement between the Vendor and Company) as specified in the data sheet.

10.2.7.2 Electric heater

Where required, the unit shall be equipped with electric heating battery composed of finned tubular enclosed heating elements. Standard elements shall be of galvanized steel construction (stainless steel as option). Manufacturer's standard unit shall be subject to the engineer's approval.

10.2.7.3 Vibration isolators

The vibration isolators shall be either integral rail type, rubber-in-shear or spring type isolation suitable for floor or suspended mount or mounted on fabricated steel support or platform (by others) as specified in the data sheet.

10.2.7.4 Speed controller

Where motor speed controller is specified for air volume controlling instead of mechanical vanes or dampers, the motor speed controller (air-modulator) shall conform to the following:

a) The manufacturer shall supply a variable frequency, AC, solid state, induction motor speed controller. The speed controller shall be self-contained, totally enclosed in a NEMA-1 cabinet capable to operate on 50 Hz frequency.

b) The motor speed controller shall be automatically controlled by either a pneumatic or electric control signal. Manual operation capability must be provided.

c) Motor speed controller must be provided for a slow speed start (soft start) with adjustable starting frequency allowing minimum and maximum speed adjustment.

d) The motor speed controller shall provide simple connections for time clock control, fire, smoke and freeze detectors. A visible indicator light must indicate if fire, smoke, or freeze conditions have shut-down unit.

e) Unit shall shutdown if power fails, but shall be capable to automatically restart when power is reapplied.

11. MULTI ZONE UNITS

11.1 Multi zone unit shall have individual mixing damper for each zone, which shall be thermostatically controlled to maintain the desired conditions in the zone area.

11.2 Each zone shall have a heating coil with heated air plenum and cooling coil with cooled air plenum in a parallel arrangement.

11.3 Any zone shall be supplied with heated and/or cooled air by proper positioning of its zone dampers as specified. The zone shall be able to be switched from heating to cooling or vice versa without thermal lag.

11.4 Zone damper shall be positioned at the factory for vertical, horizontal, or angular discharge. The number of blades for each unit shall be listed in the data sheet. Damper blades may be inter-connected for the specified zones at the factory. Each zone shall be provided with a duct collar ready for attaching ductwork in the field. Blades shall be supported on shaft by specified bearings.

11.5 Zone dampers must close tight to prevent overheating. To preclude any possibility of overheating or cooling, dampers shall be gasketed in their entire length between the blades and sealed between blade and frame.

11.6 Construction of the zone dampers shall be of high gauge galvanized steel of sufficient thickness to provide a rigid unit and conversely light enough to provide ease of operation.

11.7 The damper blades shall be securely mounted on a common steel rod and positioning at 90° angle in relation to each other.

11.8 Dampers shaft shall be furnished with nylon bearings at each end providing smooth operation and maintenance free performance.

Notes:

1) For dual duct systems, where warm air and cold air flow in individual duct and mixing takes place at each individual outlet, zone dampers, as multi zone systems are not required.

2) Cold or warm air damper in each terminal shall be thermostatically controlled. A constant volume compensator in the terminal unit shall maintain a constant supply air quantity by controlling the cold and warm dampers.

3) Overall specification of air handling unit shall comply with multi-zone units.

12. VARIABLE AIR VOLUME SYSTEM

12.1 General

a) The system uses conditioned air supplied from single zone packaged air conditioning unit and distributes the air through a single main supply air duct.

b) Control terminal units are connected to main supply by flexible ducts. Air from the control terminal units can be supplied to air diffusers through flexible duct-work between the control terminal unit and the diffusers.

12.2 Terminal Units

12.2.1 Two kinds of terminal units may be applied:

a) Terminal units which supply conditioned air to T-bar slot or perimeter diffusers through flexible ducts.

b) Self-contained terminals which consist of a combination air-inlet chamber and T-bar slot air diffuser. The terminal unit shall be set over the ceiling framework.

12.2.2 The terminal unit designated shall be of the sizes shown on the system drawing and shall have factory catalog rating not to exceed the static pressure and sound level shown on the manufacturer's schedule for the required volume of air.

12.2.3 Terminal units shall have self-contained damper control consisting of a bladder actuating a pivoted drive plate which is linked to a throttling damper. The damper shall be actuated thermostatically by an electric motor.

12.2.4 Damper operator shall be a 220 volt, AC, 50 Hz blade. The assembly shall be permanently lubricated. The drive coupling shall be stainless steel with thrust bearing. A cover for damper operating motor shall be provided.

12.2.5 Terminal units shall be fabricated of steel-coated material and shall have a factory-applied enamel finish. The interior surfaces shall be acoustically and thermally insulated with glass fiber, surface treated to prevent erosion. The insulation material shall meet the requirements of NFPA Standard No. 22.

12.2.6 In heating or cooling systems, if specified, an electric reheat coil shall be used before or after terminal units with respect to type of terminal unit.

12.2.7 Performance of the units shall be based on tests conducted in accordance with the requirements of ASHRAE Standard 36 B.

12.3 The following additional items of variable air volume system required for connection to the terminal units shall be as specified by approved manufacturers and acceptable by the design engineer:

a) Air diffuser arrangement
b) Wall or integral thermostat
c) Amplifying relay
d) Control center
e) Any item not mentioned.

PART III
GENERAL SPECIFICATION FOR AIR - WATER SYSTEMS

13. AIR FAN-COIL UNITS

13.1 General

13.1.1 The basic elements of system shall consist of water chiller package, water heater (boiler), chilled water pump, secondary water pump. Three way control valve, secondary water thermostat, fan-coil units and room thermostats as a minimum requirement.

13.1.2 The fan-coil unit shall meet the sensible and total load requirements of the room. Capacities shall confirm that design conditions can be met with the design water temperature.

13.1.3 The introduction of fresh air into the conditioned space shall be required to meet minimum circulation requirements, and the unit capacity shall be based on the mixed air temperature.

13.1.4 The fan-coil conditioners shall be certified in compliance with the ratings of ARI Standard 440.

13.1.5 The ducted belt drive fan coil unit shall be available with motor-blower assembly and coil, enclosed in a heavy gauged galvanized steel cabinet for a total static pressure of 38 mm (1.5 inches).

13.2 Specification Requirements

13.2.1 Basic unit construction

13.2.1.1 The basic unit shall be fabricated of galvanized steel. Interior surfaces of floor and lowboy models shall be coated with glass fiber insulation meeting NFPA-90 A requirements.

13.2.1.2 Baked enamel finish, of color selected, shall be provided when specified.

13.2.1.3 Exposed floor and lowboy models shall have an easily removable front panel for complete serviceability. Stamped supply grilles and recessed access door for control and piping compartments shall be provided in the top panel. Lowboy model shall have a return air grille stamped into the front panel.

13.2.1.4 Ceiling exposed and conceal models shall have a removable bottom panel with stamped return air grille and provision for integral filter. Ceiling exposed models shall be furnished with integral stamped supply grilles on the front panel.

13.2.2 Coil section

13.2.2.1 All coils shall be rated in accordance with ARI Standard 410. Coils shall have copper/aluminum fins, mechanically bonded to the tubes and fitted with manual air vents.

13.2.2.2 Coils shall be factory leak tested by pressurized air under water. The hydrotest pressure shall be 1½ times the working pressure maintained for at least half an hour.

13.2.3 Fan and motor

13.2.3.1 Fan(s) shall be of the double inlet, centrifugal forward-curved type. Fan wheels shall be statically and dynamically balanced. Fan wheel and housings shall be galvanized steel.

13.2.3.2 All unit shall be provided with an OFF-HI-MED-LO fan speed switch unit mounted or loose for field installation, on a factory furnished wall plate with respect to unit model.

13.2.3.3 Motor shall be split capacitor and 3-speed (unless specified) type, with thermal overload protection. The motor and thermal overload combination shall be certified at locked rotor conditions. Motor bearings shall be the sleeve type with oil tubes and reservoirs.

13.2.4 Controls

A unit mounted modulating thermostat (for exposed floor models), or a wall mounted thermostat (for concealed and ceiling models) shall be provided to permit room temperature control by cycling two-position, 3 way diverting motorized, hot and chilled water control valves to maintain the desired room temperature.

13.2.5 Drain pan

13.2.5.1 Floor and lowboy models shall have a combination drain pan and fan deck assembly, fabricated of galvanized steel. Drain pan shall have a 19 mm (¾") NPT drain connection, with interior surfaces insulated and sealed.

13.2.5.2 Ceiling models shall have a drain pan fabricated of galvanized steel lined on the interior surfaces. An overflow secondary drain connection shall be provided.

13.2.6 Filter

All units shall be furnished with washable filters. All filter panels shall be easily removable for cleaning.

14. INDUCTION UNITS

14.1 General

14.1.1 The Vendor shall furnish high pressure induction heating/cooling room units as indicated on plan drawings. The Vendor shall furnish primary air transition pieces and/or plugs as required.

14.1.2 Unit shall meet capacity requirements, and coil flowrate and pressure drop, nozzle static pressure, and sound level shall not exceed maximum values specified on induction unit data sheet.

14.1.3 The performance requirements shall conform to the requirements of ARI Standard 445.

14.2 Specification Requirements

14.2.1 Induction unit shall consist of primary air intake and transition pieces and/or plugs, primary air plenum, internal plenum damper, multistage nozzles, secondary water coil, drain pan, and screen filter.

14.2.2 Cabinet models shall consist of temper proof discharge grilles, two access doors, and end pockets large enough for easy piping and control package installation.

14.2.3 Primary air plenum shall be of galvanized steel with all joints spot welded and sealed. Plenum shall be lined with high density insulation board. Portion of unit plenum visible through discharge opening shall be painted with enamel.

14.2.4 Internal primary air balancing damper shall be of full length multiple slot design.

14.2.5 Multistage nozzles shall be in vertical strips molded from high heat resistant thermoplastic material, with high nozzle coefficient. Nozzle strips shall mechanically lock to nozzle frame and be bedded in a mastic sealer.

14.2.6 Secondary water-coil shall be one row (mono coil) or two row (twin coil) deep as specified in the data sheet, in direction of air flow. Fins shall be of aluminum, mechanically bonded to copper or aluminum tubes. Supply and return connections shall be made flare couplings, with return connector fitted with manual (or automatic) air vent. Coil circuiting shall be single or multiple tube serpentine to produce allowable specified pressure drop with nominal flow rate.

14.2.7 Drain pan shall be of not less than 1.30 mm (20 U.S gauge) galvanized steel, suspended below unit coil and screen filter, with built-in pitch to drain connection. Drain connection, where required, may be ½" OD copper tube.

14.2.8 Throwaway filter (permanents galvanized steel filter or aluminum mesh lint screens) shall be provided for attachment ahead of secondary water coil. Filters shall have dirt holding characteristics.

14.2.9 Cabinet shall be of not less 1.25 mm (than 18 U.S gauge) steel, bonderized and finished in a baked-on enamel. A hinged access door shall be provided over each end pocket and recessed to fit flush with discharge grille section. A front panel or recirculated air grille shall be removable for access to filter and controls. On horizontal models, the bottom panel shall be hinged at the rear and secured to the cabinet with fasteners.

14.2.10 On vertical models, top cabinet panel shall be fitted with metal grille segments. Grille segments shall be fixed securely in top panel discharge slot. Each segment shall be inserted and removed only by sliding grille from discharge slot into access opening over each end pocket.

14.2.11 Units shall be equipped with automatic air-flow regulator to maintain constant preset plenum pressures. Regulators shall be selected in proper size and spring type to maintain primary air flow, and equipped with a solder coupling for connection to the primary air distributing system.

14.2.12 The dampers shall be equipped with air type servo-motor responsive to pneumatic pressure. The pneumatinc thermostat for actuating servo-motor shall preferably be of direct action type and provided by the Vendor.

PART IV
GENERAL ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

15. GENERAL CONDITIONS

15.1 Labeling

15.1.1 All units on order shall be suitably labeled engraved on non corrosive alloy nameplate, showing all data as called for in the relevant standards and order including the following:

- Manufacturer's name and fabrication date
- Type, size and serial number
- Power supply characteristics
- Input/output characteristics
- Rating and class of insulation
- Purchase order number and date.

The name plate shall be fixed in an easily visible and non removable part of the frame. A second plate reserved for purchaser shall be screwed to the unit engraved as following:

For example:

+ NIOC No	**————————— +**

15.2 Inspection/Quality Control and Quality Records

15.2.1 Inspection/Quality control and test

15.2.1.1 The purchaser's inspector, or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment, to carry out necessary inspection at any stage of work.

15.2.1.2 Approval by the purchaser's inspector or assigned representative shall not relieve the vendor of his commitments under the terms of this specification or any associated order.

15.2.1.3 The supplier shall make available technical data, test facilities and samples that the purchaser's representative may require for verification in conjunction with pertinent equipment.

15.2.1.4 The equipment should be replaced if measurement, data and inspection reveal any discrepancies between quoted figures resulting in purchase order and those measured physically.

15.3 Inspection and Certification

15.3.1 Test certificates and test reports shall refer to the serial number of the equipment tested and bear the purchaser's name, and seal.

15.3.2 Completed coils, including headers, connections and return bends shall be leak tested with compressed air under water. The hydrotest pressure shall be 1½ times the coil working pressure and maintained for at least half an hour.

15.3.3 The fan wheel shall be dynamically and statically balanced, and tested in accordance with the requirements of ARI Standard 430 and ANSI/ASHRAE Standard 51.

15.3.4 Air filter shall be performance tested in accordance with the requirements of UL-900.

15.3.5 Manufacturer's standard for finishing and painting shall be specified and certified.

15.3.6 Third party inspection when required, shall confirm the following:

a) Visual and dimensional check
b) Sound level test
c) Operation and performance test of complete unit in accordance with relevant ARI Standard.
d) Painting and finishing check.
e) Packing of the equipment.

15.4 Packing and Shipping

15.4.1 Due attention must be given to protection against corrosion during transit; silica gel or similar dehydrating compound shall be provided.

15.4.2 The purchased equipment shall be suitably packed for overland transportation. Details of packing of the unit, including weight and dimensions, shall be submitted for the company's approval.

15.4.3 The method of cleaning, preserving and the details of packing including moisture elimination, cushioning, blocking and crating shall be such to protect the product against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open air storage.

15.4.4 After cleaning, leak test and vacuuming of pressure vessels, its refrigerant side connecting ends and tube chamber connections shall be plugged or welded as required.

15.5 Preparation for Transportation

15.5.1 All resilient mounted components to be secured by wedges or suitable clamps before packing, to prevent movement and consequential damage during transportation.

15.5.2 Refrigerant coils shall be dry nitrogen charged and sealed before transportation.

15.5.3 Wiring conduits and piping connections within the confines of the unit skid shall be braced and protected against damage during transportation and job site handling.

15.5.4 Spare parts shall be carefully clamped inside a container and protected against impact or damage.

15.6 Vendor's Data

15.6.1 Drawings and data

The supplier shall provided the purchaser, drawings and data in the English language at no extra cost to the purchaser.

15.6.2 Technical documents

The technical documents shall be furnished according to following stage:

15.6.2.1 At quotation stage

a) Comprehensive catalogs, technical data, outline drawings, applicable performance curves, proposed test procedures, service facilities, etc. of equipment offered and its components.

b) Reference list showing the continuous operation for at least three years and the location of equipment offered in major international installations.

15.6.2.2 At ordering stage

a) Piping connections and wiring diagrams, dimensional and installation drawing.
b) Service, operation and maintenance manual.
c) Commissioning and two years spare parts list.

15.7 Guarantee

15.7.1 The equipment must carry the manufacturer's one year guarantee on all parts and further four year's guarantee on compressors 12 months after installation and/or 18 months after shipment.

15.7.2 Replacement of defective parts

All defective parts shall be replaced by the supplier in shortest possible time free of recharge including dismantling, reassembling at site and all transportation cost. The above mentioned period shall not be later than 18 months from the date of dispatch from manufacturer's works.

15.7.3 After sale technical services

15.7.3.1 Commissioning

15.7.3.1.1 The supplier shall quote if required for the services of competent engineer(s) and/or technician(s) to assist in installation, commissioning and test-run of the equipment and system at site on a per diem basis. This includes the training period required for the Owner's operating personnel.

15.7.3.1.2 The quoted rates shall be irrespective of duration and frequency and the supplier shall guarantee the services of the engineer(s) and technician(s) on the specified date within a minimum of four weeks advance notice by the purchaser.

15.8 Spare Parts

15.8.1 The spare parts shall comply with specification and tests of the original equipment and shall be fully interchangeable with the original parts without requiring modification at site.

15.8.2 Spare parts shall be preserved to prevent deterioration during shipment and storage in tropical climate.

15.9 Coordination Responsibility with Others

15.9.1 In case the equipment ordered should be mounted on, aligned, connected or tested with the equipment of other manufacturer(s), the supplier shall coordinate with the participating manufacturer(s) and obtain all dimensional and technical information allowing for any interconnecting equipment and tests that may be required.

15.9.2 The supplier shall be responsible for correct and timely communication with the participating manufacturer(s) and for any delay and/or cost claims arising from such communications.

15.9.3 Copies of all correspondence shall be furnished to the purchaser.

15.10 Languages

All correspondence, submittals, layouts, documents, certificates including testing procedures and edited specifications shall be submitted in English and/or Persian Language.

16. DATA SHEETS

Information in data sheets provided herein shall be inserted by projects engineer and suppliers in the space provided. The supplier is responsible to complete where required, the following data sheets and forward to the Company.

- Site data sheet.
- Data sheet for centrifugal chiller package.
- Data sheet for compression chilling package.
- Data sheet for absorption chilling package.
- Data sheet for air handling unit.
- Data sheet for multi-zone system.
- Data sheet for air fan coil unit.
- Data sheet for variable air volume (vav).

16.1 Site Data Sheet

a) Ambient temperature:

- Summer max.————°C (°F) DB ————°C (°F) WB
  min. ————°C (°F) DB ————°C (°F) WB
- Winter max.————°C (°F) DB ————°C (°F) WB
  min. ————°C (°F) DB ————°C (°F) WB
- Site elevation ..... meter above sea level
- Site latitude .....

b) Wind velocity ..... km/h

c) Environment: b Dusty, b Saliferous, b Hazardous

d) Available service :

- Power supply ———————— Volt ———————— Phase,———————— Hz
- Cooling water sources

b From treated water b From city water

e) Area classification: .....

f) Job description: .....

g) Other conditions: .....

Note:

Earthquake belt of Iran is located in zone 3.

16.2 Data Sheet for Centrifugal Chilling Package

Project ..... Service Duty .....Model/s. No. .....
Manufacturer ..... Year Built .....
Order No. ..... Supplier ..... Customer .....
Refrigerant ..... Refrigerant Charge .....

Package shall be in accordance with ARI Std. 550.

+ Performance Data:

+ Cooling capacity ..... kcal/h, ...Tons ..... kWr
* Chilled water flow rate ..... m^3/hr, ... gpm
* Chilled water inlet temp. .....°C (°F), Outlet temp. ..... °C (°F)
* Condensing water flow rate ..... m^3/h, ... gpm
* Condensing water inlet temp.....°C (°F), Outlet temp. ..... °C (°F)

* Compressor/Starter:

Type ..... Stages ..... Manufacturer .....
Factory installed ..... Remote mounted .....
Type of starter .....
Supplied by ..... Manufacturer ..... Others
Electrical data ..... Volt ..... Phase ..... Hz

* Condenser:

Max. pressure drop ..... m of water, Fouling factor .....
Design pressure ..... kPa (bar), Hydrotest pressure ..... kPa (bar)
Condenser passes .....
Condenser flange size and rating .....
Connections ..... Standard ..... Marine box .....

* Cooler (Evaporator):

Shell side design press. ..... kPa (bar), Hydrotest press. .....
Tube side-design press. ..... kPa (bar), Hydrotest press. ..... kPa (bar)
Passes .....

* Pumps:

Purge pump: Flow rate ..... m^3/h, Head ..... m
Type ..... , Lubrication and cooling system .....
Pump speed ..... rpm, Motor nameplate ..... kW, Motor speed ..... rpm
Refrigerant pump: Flow rate ..... m^3/h, Head ..... m
Type..... , Lubrication and cooling system .....
Pump speed ..... rpm, Motor nameplate ..... kW, Motor speed ..... rpm

Control System:

Capacity control system .....
Chilled water control system .....
Pump starter .....
+ Electrical data ..... Volt ..... Phase ..... Hz
Control panel components .....

Data Sheet for Centrifugal Chilling Package (continued)

* Miscellaneous:

+ Nozzle type ..... Arrangements .....
Standard..... Cooler ..... Condenser .....
Marine box option..... Cooler ..... Condenser .....
Recovery/Storage system ..... Type ..... Capacity .....
Systemoperation.....
Vibration isolators ..... Type.....Qty.
Painting: Prime coat ..... Final coat ..... Color .....
Insulation: Material ..... Thickness ..... mm (inch)
Overall dimensions (L × H × W) ..... m
Safety features .....
Weight kg (lbs)..... Dry ..... Operating

Notes:

+ Filled by the Company.
*** Filled by the Manufacturer.**

16.3 Data Sheet for Compression Chilling Package

Project ..... Service Duty ..... Model/s. No. .....
Order No. ..... Supplier ..... Customer .....
No. of Packages ..... Refrigerant .....

- Compressor Data:

Type: * No. of compressors per package .....
Reciprocating b
Rotary screw b
No. of cylinders (for recip. comp.) .....

+ Compressor Construction: Open b Semi-hermetic b Hermetic b
+ Compressor, Rated power (each) ..... kW, Rated speed ..... rpm

- Performance Data:

+ Chilling capacity ..... kcal/h, ... Btuh ..... kWr
* Chilling water flow rate ..... m^3/h, ...

gpm
* Feed water temp..... °C (°F) Chilled ..... °C (°F) condens-ing
* Max. pressure drop in cooler ..... m of water
+ Cooler design pressure ..... bar, Hydrotest pressure ..... bar

* Construction:

Cooler construction .....
Shell material ..... Tube material .....
Water coller fouling factor .....
Lubrication system: Oil pump type ..... Oil pump power consumption ..... kW
Oil cooler : Water cooled b Refrigerant cooled b
Type of compressor drive .....
Type of purge system .....
Type of capacity control .....

Electric Motor Data:

+ Motor: ..... Volt ..... Phase ..... Hz
+ Enclosure protection....., Insulation class .....
* Full load current ..... A, power factor ....., Name plate power ..... kW
* Motor starter..... , Speed ..... rpm

*Condenser:

a) Water-cooled condenser :

Condenser water flow rate ..... m^3/h ..... gpm
Condenser water inlet..... °C (°F) outlet ..... °C (°F)
Condenser water max. pressure drop ..... bar
Condenser design pressure ..... bar, Hydrotest pressure ..... bar
Condenser fouling factor .....
Condenser construction .....
Condenser water pump: Flow rate..... m^3/h, Head ..... m

b) Air-cooled condenser:

Air flow rate ..... m^3/h ..... cfm
Air inlet temp. (dry) ..... °C (°F), Air outlet temp. (dry) ..... °C (°F)
No. of fans ..... Type of fans ..... Fan speed ..... rpm
Fan arrangement .....

Fan drive ..... Power consumption ..... kW
Motor nameplate power ..... kW, Motor speed ..... rpm
Casing construction ..... Coating .....
Coil material ..... Fin material .....
Desing pressure ..... bar, Hydrotest pressure ..... bar
Overall dimensions (L × H × W) ..... m, Dry weight ..... kg
Motor starter ..... Enclosure protection .....
Accessories .....

* Control Center:

Type of system: Microprocessor b Electromechanical b

Compressor protection system & control .....
Electric motor protection .....

* Miscellaneous:

Expansion valve: Size ..... Type .....
Painting: Prime coat ..... Final coat ..... Color .....
Type of insulation ..... Insulation thickness on water boxes,..... mm
Isolators: Type ..... , Quantity .....
Overall dimensions (L × H × W) ..... m
Weight kg (lbs) ..... Dry ..... Operating

Notes:

+ Filled by the Company.
*** Filled by the Manufacturer.**

16.4 Data Sheet for Absorption Chilling Package

Project ..... Service Duty ..... Model/s. No. .....
Order No. ..... Supplier..... Customer .....
Manufacturer ..... Year Built .....
No. of Packages ..... Absorbent Liquid .....

+ Performance Data:

+ Cooling capacity ..... kcal/h, ... Tons..... kWr
* Chilled water flow rate ..... m^3/hr, ... gpm ..... L/s
* Chilled water inlet temp. ..... °C (°F), Outlet temp. ..... °C (°F)
* Condensing water flow rate ..... m^3/h, ... L/s (gpm)
* Condensing water inlet temp. .....°C (°F), Outlet temp..... °C (°F)

* Generator:

+ Heating medium: Steam b Hot water b
+ Steam press. at generator ..... bar, max. steam consumption ..... kg/hr (lbs/hr)
* Hot water inlet temp. ..... °C (°F), Hot water press. at generator ..... bar
* Hot water flow rate ..... kg/hr, max. press. drop..... kPa (bar)
* Generator design press..... kPa (bar), Hydrotest press. ..... kPa (bar)
* Generator tubes .....

* Absorber/Condenser:

Max. pressure drop ..... m of water, Fouling factor .....
Design pressure ..... kPa (bar), Hydrotest pressure ..... kPa (bar)
Absorber/Condenser passes ..... , Absorber flange size & rating .....
Condenser flange size and rating .....
Absorber/Condenser tubes .....

* Chiller:

Max. pressure drop ..... kPa (bar), Fouling factor .....
Chiller design press. ..... kPa (bar), Hydrotest press. ..... kPa (bar)
Chiller passes ..... , Chiller flange size and rating .....
Chiller tubes .....

* Pumps:

Solution pump: Flow rate ..... m^3/h, Head ..... m
Type ....., Lubrication and cooling system .....
Pump speed ..... rpm, Motor nameplate ..... kW, Motor speed ..... rpm
Refrigerant pump: Flow rate ..... m^3/h, Head ..... m
Type ..... , Lubrication and cooling system .....
Pump speed ..... rpm, Motor nameplate ..... kW, Motor

* Control System:

Capacity control system .....
Chilled water control system .....
Pump starter .....
+ Electrical characteristics ..... Volt ..... Phase ..... Hz
Control panel components .....
+ Nozzle arrangements .....
Purge System: Motorless b with Elec. motor b
System Operation .....

Data Sheet for Absorption Chilling Package (continued)

* Miscellaneous:

Painting : Prime coat ..... Final coat ..... Color .....
Insulation: Material ..... Thickness ..... mm (inch)
Overall dimensions (L × H × W) ..... m
Weight kg (1bs) ..... Dry ..... Operating

Notes:

+ Filled by the Company.
*** Filled by the Manufacturer.**

16.5 Data Sheet for Air Handling Units

Project ..... Service Duty ..... Model/s. No. .....
Order No..... Supplier ..... Customer .....
Type .....No. of Units ..... , Designation .....

+ Unit arrangement: Floor mounted b Ceiling mounted b
+ Discharge arrangement: Front b, Top b , Rear b
+ Total flow rate ..... cfm, *Outside flow rate ..... m^3/h (cfm)
+ Outside temp. ..... °C (°F) DB, ... °C (°F) WB
* Recirculation flow rate ..... m^3/h (cfm) At ..... °C(°F) DB, ... °C (°F) WB

Fan Data:

Type and class: ..... Material
No. of wheels and diameter ..... Standard air
Outlet velocity ..... m/s (fpm), Total static pressure ..... bar
External static pressure ..... bar, Speed ..... rpm
Bearings: b Sleeve b Ball
b Internal b External
Drives: b Fixed drive b Variable drive
Speed range for variable drive.....
Electric motor: Type ..... , Nameplate power ..... kW
Insulation class ..... , Starter system .....

Cooling Coil:

Medium.....Refrigerant.....Water.....Brine
Cooling load ..... kcal/h ..... Tons
Entering air temp. ..... °C (°F) DB..... °C (°F) WB
Leaving air temp. ..... °C (°F) DB ..... °C (°F)

WB
Air flow rate ..... scfm, Face velocity..... m/s (fpm)
Face area ..... m²
Max. press. drop in coil ..... bar
Coil ..... Series ..... Rows ..... Fins per mm (inch)
Material/Thickness ..... Tube ..... Fin

Data Sheet for Air Handling Units (continued)

Preheat Coil:

Total load ..... kcal/h, ... mbh
Air flowrate ..... m³/h (cfm), Air inlet temp. ..... °C (°F)
Face Velocity ..... m/s (fpm)
Standard steam b Steam pressure ..... bar, Flow rate ..... kg/h (lbs/hr)
Hot water b Flow rate ..... gpm, Inlet temp. ..... °C (°F), Outlet temp. ..... °C (°F)
Max. pressure drop ..... bar, Face area ..... m² (ft²)
Coil ..... Series ..... Rows ..... Fins per mm
Material/Thickness.....Fin.....Tube

Preheat Coil:

Total load ..... kcal/h, ... mbh
Air flow rate ..... (cfm), Air inlet temp. ..... °C (°F)
Face velocity .... m/s, Face area ..... m² (ft²)
Standard steam b, Steam pressure ..... barg, Flow rate ..... kg/h (lbs/hr)
Hot water b, Flow rate ..... gpm, Inlet temp ..... °C (°F), Outlet temp..... °C (°F)
Max. pressure drop bar Coil ..... Series ..... Rows ..... Fins per mm (inch)
Material/Thickness ..... Fin ..... Tubes

* Humidifier:

Capacity ..... kg/h Water spray b Steam grid b
Water/System pressure ..... bar Material .....

* Accessories:

Filter section: High velocity b Low velocity b
Throw-away b Cleanable b

Mixing box: With damper b Less damper b Opening .....
Internal face & bypass damper .....
Eliminators: Type ..... Material .....
Isolators: Type ..... Quantity.....
Control valves: .....
.....
Overall dimensions (L × H × W) ..... m
Weight kg (lbs) ..... Dry ..... Operating

Remarks:

* Multi-zone system data sheet:

Multi-zone model .....
With zone dampers b Base unit damper less b
Zone unit accessories:

b Fan .....
b Cooling coils .....
b Reheat coils .....
b Filters .....

Data Sheet for Air Handling Units (continued)

+ Air Distribution:

Zone No.	(cfm per zone) m³/hr per zone
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Notes:

+ Filled by the Company.
*** Filled by the Manufacturer.**

16.6 Data Sheet for Air Fan Coil Units

Project ..... Service Duty ..... Model/s. No. .....
Order No. ..... Supplier ..... Customer .....

Capacity rating kcal/h ..... Sensible ..... Total

Fan coil unit:
b Exposed floor, Designation ..... , Qty..... (cfm) m³/h
b Lowboy, Designation ..... , Qty..... (cfm) m³/h
b Ceiling concealed, Designation ..... , Qty..... (cfm) m³/h
b Ceiling exposed, Designation ..... , Qty..... (cfm) m³/h
b Concealed floor, Designation ..... , Qty..... (cfm) m³/h
b Concealed floor, Designation ..... , Qty..... (cfm) m³/h
b Ducted unit, Designation ..... , Qty..... (cfm) m³/h

+ Medium ..... Refrigerant ..... Chilled water
Tube material/size ..... Fin material/thickness .....

* Fans:
*Type ..... Construction .....
+ Filters: Type ..... Material ..... Thickness .....

* Motors:

Speed range ..... Type .....
Protection ..... Bearing ..... Lubrication system .....
Power supply: ..... Volt ..... Phase ..... Hz

* Construction: Panel material ..... Coating .....
Insulation: Thickness ..... mm ..... inch

* Overall dimensions (L × B × H) ..... m
Weight kg (lbs) ..... Dry..... Operating

Notes:

+ Filled by the Company.
*** Filled by the Manufacturer.**

16.7 Data Sheet for Variable Air Volume (VAV)

+ General:

Project ..... Location .....
Manufacturer ---------- Year Built .....
Order No. ..... Supplier ..... Customer .....
System supply ..... Variable volume ..... Variable temperature
Air handling unit ..... Low velocity ..... Hi-velocity
Source of conditioning ..... Cooling/Heating ..... Heating only
Duct Fabrication ..... Rectangular ..... Round

* Performance Data:

Air volume ..... m^3/h (cfm)
Area served ..... Interior ..... Perimeter
Outlet Nr. .....
Type .....
Size .....
Max. design velocity ..... m/s (fpm)
Max. design volume ..... m^3/h

(cfm)
Classification ..... Furred-in ..... In false ceiling
Minimum design air flow ..... m^3/h (cfm)
Thermostat.....Wall.....Integrated
Total Pressure ..... Drop ..... Throw
Type of control ..... Integrated .....- Duct pressure
+Overall dimensions (L × H × W) ..... m
+ Weight kg (lbs) .....
Special features .....
.....