

MATERIAL AND EQUIPMENT STANDARD

FOR

HUMIDIFICATION AND DEHUMIDIFICATION UNIT

AND SYSTEM

ORIGINAL EDITION

MAR. ۱۹۹۶

This standard specification is reviewed and updated by the relevant technical committee on May. ۲۰۰۰. The approved modifications are included in the present issue of IPS.

CONTENTS :

PAGE No.

١. INTRODUCTION	٢
١. SCOPE	٣
٢. REFERENCES	٣
٣. DEFINITIONS AND TERMINOLOGY	٣
٤. UNITS	٤
٥. CONFLICTING REQUIREMENTS	٤

PART ١ MATERIAL AND EQUIPMENT SPECIFICATION FOR HUMIDIFICATION UNIT AND SYSTEMS

١. HUMIDIFIERS	٥
١.١ Classification	٥
١.٢ Operation Limitations	٥
١.٣ Water Atomizing Humidifiers	٥
١.٤ Steam Grid Humidifiers	٧
١.٥ Jacketed Steam Humidifiers	٧
١.٦ Electric Steam Humidifiers	٨
١.٧ Area-Type Steam Humidifiers	٩
١.٨ Electrode Steam Generating Humidifiers	٩

PART ٢ MATERIAL AND EQUIPMENT SPECIFICATION FOR DEHUMIDIFICATION UNITS AND SYSTEMS

٢. DEHUMIDIFIERS	١٢
٢.١ Classification	١٢
٢.٢ Operation Limitations	١٢
٢.٣ Refrigerant Heat Pump Dehumidification Units	١٢
٢.٤ Desiccant Dehumidification System and Unit	١٥

PART ٣:

٨. GENERAL ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS	١٧
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PART ٤

٩. DATA SHEETS	٢١
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١. INTRODUCTION

In spite of the environmental technology being on the trend of continuous transition, efforts have been made to establish overall material and equipment specification required to control humidity for space, people and product and fulfill the requirements of equipment and systems involved.

Since this Standard represents varied range of equipment and system used for adding or reducing relative humidity, for ease of selection by the specifying engineers, it is hereby divided into the following parts.

- | | |
|-------------------|---|
| Part I : | Material And Equipment Specification For Humidification Unit and Systems. |
| Part II : | Material And Equipment Specification For Dehumidification Unit and Systems. |
| Part III : | General Administrative And Procedural Requirements. |
| Part IV : | Data Sheets. |

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.

۱. SCOPE

This Standard covers the material and equipment requirements for the updated version of the humidifier and dehumidifier equipment and system used for indoor or outdoor installation suitable for the humidity and environmental control of HVAC & R space applied in commercial, institutional, medical, industrial and large residential applications.

Note:

This standard specification is reviewed and updated by the relevant technical committee on May. ۲۰۰۰. The approved modifications by T.C. were sent to IPS users as amendment No. ۱ by circular No ۱۵۴ on May. ۲۰۰۰. These modifications are included in the present issue of IPS.

۲. 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.

ANSI/AHAM DH-۱-۱۹۹۲ "Dehumidifiers"

ANSI UL ۴۷۴-۱۹۹۳ "UL Standard for Safety Dehumidifiers"

ANSI/UL ۹۹۸-۱۹۹۳ "UL Standard for Safety Humidifiers"

ASHRAE ۳۵-۱۹۹۲ "Method of testing desiccant for refrigerant drying"

NFPA ۹۰A "Standard for the installation of air conditioning and ventilating systems"

NFPA ۹۰B "Standard for the installation of warm air heating and air conditioning systems"

ARI ۶۱۰-۱۹۹۶ "Central system humidifiers for residential applications"

۳. DEFINITIONS AND TERMINOLOGY

۳.۱ Activated Alumina Desiccant

A form of an aluminum oxide used as drying agent, which absorbs moisture readily.

۳.۲ Dehumidifier

An air cooler of an absorption, or an absorption or adsorption device used for lowering moisture content of the air

۳.۳ Desiccant

Absorbent or adsorbent, liquid or solid, that removes water or water vapor from material and/or air.

۳.۴ Humidifier

Device to add moisture to air or gases.

۳.۵ Humidistat

An instrument which measures changes in humidity and controls devices for maintaining a desired humidity.

٣,٦ Silica Gel Desiccant (Aerogel)

Form of silicon dioxide which absorbs moisture and may be used as a drying agent.

٤. UNITS

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

٥. CONFLICTING REQUIREMENTS

In 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 variations thereon.
- **Second Priority** : Data-requisition 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.

PART ١
MATERIAL AND EQUIPMENT SPECIFICATION
FOR
HUMIDIFICATION UNIT AND SYSTEMS

١. HUMIDIFIERS

١.١ Classification

Efforts have been made to classify the humidification equipment as a self-contained packaged equipment or incorporated as a separate entity into the following types:

- ١) Atomizing water humidifiers
- ٢) Steam grid humidifiers
- ٣) Jacketed dry-steam humidifiers
- ٤) Electric steam humidifiers
- ٥) Area type humidifiers
- ٦) Electrode steam humidifiers

Notes:

١) The specification mentioned in this Standard are intended to include equipment by all reputed manufacturers and are not intended to limit or restrict any renowned manufacturers from participating in the project.

٢) To control the water hardness, it is recommended that samples of water analysis be furnished to the participating manufacturers.

١.٢ Operation Limitations

The recommended operation limits shall be as follows:

١.٢.١ Water atomizing humidifiers capacity shall be from ٢,٧٢ kg/hr (٦ lb/hr) over to ٤٥٤ kg/hr (١٠٠٠ lb/hr), and the air flow at ١٣,٨ to ٤١٤ kPa (٢-٦٠ psig) shall be ١٢ cfm per ٤٠ kg/hr of water atomizing.

١.٢.٢ Steam grid humidifiers for room air conditioning systems shall be applicable for saturated steam between ٠,٢ and ٤ bar with the capacity up to ٧٥٠ kg/h.

١.٢.٣ Jacketed dry-steam humidifiers shall be suitable for steam pressure range from ١٣,٨ kPa (٢ psi) to ٣٤٥ kPa (٥٠ psi), steam capacity up to ٤٥٤ kg/hr (١٠٠٠ lb/hr), and valve size up to ٢".

١.٢.٤ Area type humidifiers shall be suitable for capacity up to ١٦,٥ kg/hr (٣٦ lb/hr), and air flow up to ١٧٠٠ m³/hr (١٠٠٠ cfm).

١.٢.٥ Electric humidifiers shall be acceptable for water flow range from ٢ kg/hr to ٦٠ kg/hr and electrical energy from ١,٥ kW to ٥٠ kW for suitable water quality.

١.٢.٦ Electrode steam humidifiers shall be designed for capacity from ٤ kg/hr (١٠ lb/hr) and networked into systems up to ٣٢٠ kg/hr (٨٠٠ lb/hr).

١.٣ Water Atomizing Humidifiers

1.3.1 General

The atomizing water humidifier shall be induct type suitable for atomizing humidification system. It shall comprise the minimum requirements of a complete system, including but not limited to the following:

1.3.2 Atomizing head manifold

- 1) Manifold shall be a factory assembled consisting of air, water piping and atomizing heads.
- 2) Atomizing head capacity shall be 2.5, 3.6, 4.5, 5.5 or 6.8 kg (5.5-15.2 or 10 pounds) of water per hour. Larger capacity heads will not be accepted. Heads shall be positioned to provide the maximum possible distribution.
- 3) Atomizing heads shall be machined solid brass and stainless steel construction, easily disassembled for servicing with self cleaning and purging feature to provide completely drip free operation. Maximum water droplet size produced by the heads will not exceed 10 microns at 100% output and vary down to sub-micron with modulation of the system.
- 4) Single manifold systems to have full modulation with 3:1 turn down ratio. Dual manifold systems to have full modulation on each manifold, staged with 3:1 turn down ratio. (Dual pneumatic type are ideal for humidifying contaminated atmosphere with large demand loads).
- 5) Manifold length shall be as indicated on the drawings or sized by the manufacturer to meet the calculated load.
- 6) Air consumption shall be a maximum of 12 SCFM free air per 100 pounds of water atomized per hour. Compressor size shall include an additional 20% safety factor.

Notes:

- 1) Water quality under 5 grains/gallons total dissolved solids can use untreated water.
- 2) Mist eliminators shall be furnished for removing water droplets over one micron.

1.3.3 Modulating control sections

- a) Each humidification system shall consist of two control sections; one for compressed air supply, the other for modulating water supply.
- b) The water section shall consist of gate valve, pressure regulator with strainer, pressure gages, water modulating valve (if used) and three way solenoid valve. Water pressure to the control section shall be 345 kPa (50 psi) and water pressure to the duct manifold shall be maintained at 275 kPa (40 psi) minimum.
- c) The air section shall consist of gate valve, pressure gage, two-way solenoid valve, primary and secondary regulator with gage and strainer, and an air pressure switch. Compressed air pressure to the control section shall be 414 kPa (60 psi) and air pressure to the duct manifold shall be maintained at 207 kPa (30 psi).
- d) All air and water piping shall be type "L" copper, pvc or stainless steel.

1.3.4 Control cabinet

- 1) Factory fabricated and tested steel cabinet enclosure shall be minimum 1 mm (10 gage) thick.
- 2) All internal components prewired and prepared to terminals, ready for field connections.
- 3) Auto-off-test switch with "power on" and "system on" lamps.
- 4) Panel mounted gages shall indicate relative humidity of the supply and return air in the system and output capacity.
- 5) Pressure electric switch or relay for each stage of control.
- 6) Controls shall incorporate a clean-out cycle timer to keep the heads clean and in working order.
- 7) The system shall incorporate, where specified, an automatic blow-down technique to empty the water lines of all liquid on shut down to prevent freezing.
- 8) Electrical compartment shall house electrical devices and shall be secured by a keyed panel.

1.4 Steam Grid Humidifiers

1.4.1 The pressurized steam humidifier shall be available for hygienic and odorless air humidification system suitable for in-duct, air handlers, or plenum operation, and include the minimum requirements of the following components as a complete unit.

1.4.2 The internal pipe shall be with uniform stainless steel steam distribution and condensate collection shall be by steam jacketed manifold in stainless steel material.

1.4.3 The steam flow shall be connected through the supply line by the seat type control valve with an integral orifice and sound absorber for low noise operation. Each orifice shall preferably be provided with stainless steel mesh. (Type of the control valve shall be as recommended by the manufacturer).

1.4.4 The condensate drain line shall be from the manifold (details as recommend by the manufacturer). The steam trap shall be thermostatic type in cast semi steel body with stainless steel internal parts.

1.5 Jacketed Steam Humidifiers

1.5.1 General

These units shall be capable to directly inject dry boiler steam into ducted air for humidification.

1.5.2 Separator

It shall be constructed of stainless steel with heli-arc welded seams, in centrifugal type for water/steam separation with an internal discharge tube extending into the center of the separator for separation of steam and condensate.

1.5.3 Dispersion tube

The steam jacketed dispersion tube shall be single or multi-bank, constructed of stainless steel heli-arc welded seams.

The design of the tube shall provide steam jacketing for an internal tube which is fitted with two rows of high temperature thermoplastic resin or stainless steel tubelets (nozzles). The single tube shall be factory assembled. The multiple tube with interconnecting piping can be acceptable for field assembly.

1.5.4 Steam valve

It shall be normally closed modulating type with modified linear flow characteristics and pneumatic actuator. The valve trim shall be in stainless steel and valve maximum flow rate shall not exceed specified humidifier capacity by more than 20%.

1.5.5 Controls

The following control options shall be made available by the manufacturer:

- High limit duct humidistat
- Paddle type, air flow proving switch
- Modulating electronic control valve
- On/Off electric valve
- Pneumatic temperature switch to prevent cold start-up of humidifier.

1.5.6 Steam trap

Unless otherwise mentioned a suitable float and thermostatic type steam trap for application up to 103 kPa (15 psi)

steam or an inverted bucket steam trap for applications above 103 kPa steam with a steam supply line strainer.

٦.٦ Electric Steam Humidifiers

٦.٦.١ General

٦.٦.١.١ The self contained cabinet type electric evaporative humidifier, shall be suitable for open area application not served by a central duct system.

٦.٦.١.٢ The humidifier used in packaged air conditioning unit shall be furnished without cabinet enclosure. The dispersion tube can be placed in duct.

٦.٦.٢ Material specification

The minimum requirements of the following components shall be included in each unit.

٦.٦.٢.١ Cabinet enclosure (for ductless type)

Cabinet enclosure shall be ١ mm (٢٠ gage) steel with enamel finish. Cabinet floor shall constitute a drip pan, with a threaded connection for drain piping. Electrical compartment shall house electrical devices and shall be secured by a keyed panel. Evaporator compartment shall house vaporizing chamber dispersion tube circulation blower and secured by a keyed panel. Front exterior shall contain three signal lights for "fill", "ready water" and "drain" and a humidistat set point dial wall hanging bracket shall be included, where required.

٦.٦.٢.٢ Cleanable vaporizing chamber

Vaporizing chamber and cover shall be stainless steel with heli-arc welded seams. Chamber shall be mounted on slide rails. All electrical and water fill line connections shall be flexible and mounted on the vaporizing chamber cover, allowing for convenient removal of the chamber for cleaning.

٦.٦.٢.٣ Immersion heater(s)

Heater(s) shall be incoloy alloy sheathed resistance type heater(s), and shall be factory mounted and wired to the vaporizing chamber's removable cover.

٦.٦.٢.٤ Water level control

Water level control system shall provide for automatic refill, low water cut off and periodic drain down of the unit. And shall consist minimum requirements as recommended by the manufacturer.

٦.٦.٢.٥ Surface skimmer

Surface skimmer shall be provided which has been factory set to provide the most effective mineral removal with minimum water waste.

٦.٦.٢.٦ Control system

Control system shall include step-down transformer, contactor, numbered terminal strip and suitable control board. All components shall be located in the electrical compartment, factory wired and tested.

٦.٦.٢.٧ Accessories (for humidifiers in packaged air conditioners)

The minimum requirements of the following accessories shall be made available:

- Vapor hose kit with clamps and escutcheon. As an option, a manifold tube bank with horizontal header and vertical dispersion tubes.
- Fan with relay, fan switch factory assembled.
- High limit duct humidistat.
- Air flow proving switch.
- Time proportional modulating control system.

1.7 Area-Type Steam Humidifiers

1.7.1 General

The area-type steam injection humidifiers shall be complete factory assembled used for discharge of boiler steam directly into the space to be humidified. The self-contained humidifier shall be dry type wherein the entrained condensate are removed from the steam by means of a centrifuge type, stainless steel, water-steam separator. The minimum requirements of the following components shall be inclusive.

1.7.2 Separator and distribution manifold

The water/steam separator shall be centrifuge type stainless steel, with an internal steam discharge tube. The condensate separator shall be directly mounted on distribution manifold. The distribution manifold shall be of stainless steel construction, unjacketed and allowed to cool to the surrounding air temperature during shutdown to prevent excessive heat gain in the surrounding air.

1.7.3 Dispersion fan

The commercial duty electric fan shall be suitable for operating at the condensing condition and able to disperse steam into the air surrounding the unit. A metal cabinet can be provided to house the entire unit including traps and blower.

1.7.4 Steam trap

A float and thermostatic steam trap shall be provided for use with the condensate separator for application below 103.4 kPa (15 psi) steam. Inverted bucket steam traps shall be provided for applications above 15 psi, complete with steam supply line strainer.

1.7.5 Metering valve

It can be modulating type, normally closed with an automatic actuator, to respond to variable signal from a compatible humidistat. In case of electric valve, it can be two positions solenoid operated on/off steam valve.

1.7.6 Control system

It shall consist the minimum requirements of transformer, contactor, terminal strips, fan fuse, fan control relay and electronic/ electric control boards. All components shall be located in the electrical compartment, factory wired and tested.

1.8 Electrode Steam Generating Humidifiers

1.8.1 General

1.8.1.1 The electrode steam humidifier uses its water as the heating element to create steam. Its pure and contaminated free steam eliminates the environmental concerns associated with chemically treated feed water for boiler systems.

1.8.1.2 As pure steam is produced all the minerals from the water are left behind on the two or more electrically conductive (A.C. voltage) electrodes mounted in a cylinder which is immersed by water. These minerals are collected in the steam cylinder. Once the cylinder becomes filled with minerals, the humidifier signals that the cylinder should be changed.

1.8.1.3 Utilizing the conductivity of the water, an A.C. voltage is applied to the electrodes causing current to pass directly through the water. The current produces the heat necessary to boil the water and produces steam in controlled capacities to meet the humidity requirements of the space.

1.8.1.4 The self-contained electrode steam humidifiers shall be capable of operating on water with conductivity from 10 to 1500 microhms per centimeter automatically. It shall be sufficiently versatile

to meet the humidification needs of computer rooms, telecommunication switchgear facilities, cleanrooms, hospital applications etc.

1.8.1.5 The unit shall be suitable for floor mount, wall mount or ceiling suspended as specified in the data sheet. The electrode steam generating humidifier shall include minimum requirements of 1.8.2 to 1.8.6:

Notes:

For a given cylinder size electrode configuration and voltage, the amount of current that will flow depends on:

- a) The conductivity of the water in the cylinder.
- b) The level of water immersing the electrodes.
- c) The spacing of the electrodes.

1.8.2 Control system

A humidity control system utilizing any one of the following control modes:

- On/Off (humidistat)
- Proportional (transmitter or single-ohms)
- Proportional + integral (sensor or signal).

1.8.3 Input devices

The input devices shall be control input device (or signal), high limit humidistat, air proving switch, or proportional high limit device (signal). It shall be able to enable modulating control systems to adapt the capacity setpoint in response to varying psychrometric conditions, such as VAV* systems, applications with high percentage of outdoor air etc.

Note:

VAV: "Variable air volume systems"

1.8.4 Distribution system

A steam distribution system operating at atmospheric pressure consisting of :

- a) Stainless steel steam distributing pipes (for horizontal or vertical integral or on duct installation) with integral pitch; or with blower pack room distribution unit (remote or unit mounted) with adjustable speed control.
- b) Steam hose or insulated copper pipes in suitable lengths, for connection between the unit and the steam distribution system.

1.8.5 Cylinders

Disposable polypropylene cylinders shall be provided with a stand-by replacement for each unit. The multiple cylinder humidifiers shall be with separate microprocessor control, with fill and drain provisions. Each unit shall be capable of common or independent control.

1.8.6 Heater element

The ultra-sonical-rod electrically conductive heater element mounted in a cylinder shall be applicable for mineral free deionized water for protection against contaminants and bacteria. An integral microprocessor control, monitor and diagnostic system featuring an LCD display, user-friendly programming, system diagnostics and the flexibility to utilize on/off, proportional or proportional plus integral control.

For applications larger than 50 kg/hr (110 lbs/hr) systems shall be networked in a master/slave relationship to a personal computer or a Building Management Control System (BMCS) utilizing an RS-485 communications network link. This link shall be able to allow up to 1230M (4000 ft) distance between the master and slave units.

1.8.7 Steel cabinet

A full front access painted steel lockable cabinet for cylinder replacements, with side and front access doors for electric controls. The cabinet shall be constructed of 1.0 to 1.2 mm (16 and 18 Ga) steel finished with polyurethane-based enamel. All piping and wiring shall be routed through the bottom behind the integral skirt to maintain smooth lines on terminal connections. A system on/off switch shall be externally available. A door interlock switch shall prevent operation when the access door is open.

1.8.8 Accessories

The manufacturer shall have the minimum requirements of the following accessories available:

- a)** Built-On or remote factory built blower packs to meet UL requirements suitable for operation with the specified humidifiers. The built-on type shall be internally powered by the humidifier's primary circuit and the remote type shall be of the same voltage as the humidifier's primary circuit.
- b)** Following controls in accordance with the manufacturer's recommendation shall be made available:
 - Wall mounted or duct mount on/off humidistat.
 - Proportional modulating control package, with wall mounted sensor and built-in set point.
 - Fan speed control for blower pack (room distribution unit)
 - Remote high or low humidity alarm kit for duct and/or space sensing.

PART ٢
MATERIAL AND EQUIPMENT SPECIFICATION
FOR
DEHUMIDIFICATION UNITS AND SYSTEMS

٢. DEHUMIDIFIERS

٢.١ Classification

The dehumidification equipment is classified as a self-contained equipment, or incorporated as a separate entity, into the following types:

- ١) Refrigerant heat pump dehumidification system.
- ٢) Desiccant dehumidification system and units.

٢.٢ Operation Limitations

٢.٢.١ Heat pump refrigerant systems are recommended to cover the following requirements:

- a) Heating capacity up to ٣٠٠٠٠ kcal/h and reheat up to ٧٠٠٠٠ kcal/h.
- b) Airflow from ٨٥٠ m³/h (٥٠٠ cfm) to ٢٥٠٠٠ m³/hr (١٥٠٠٠ cfm).
- c) Compressor, reciprocating or scroll types up to ٥٠ HP.
- d) Blower, centrifugal type up to ١٥ HP.

٢.٢.٢ Desiccant dehumidification units and system are recommended to cover the following requirements:

- a) Process air volume suitable from ٨٥٠ m³/hr (٥٠٠ cfm) to ٣٤٠٠٠ m³/hr (٢٠٠٠٠ cfm). The custom-built model shall be available up to ١١٨٣٠٠ m³/h (٧٠٠٠٠ cfm).
- b) Reactivation air volume from ٦٠٠ m³/hr (٣٥٠ cfm) to ١١٠٠٠ m³/hr (٦٥٠٠ cfm).
- c) Process fan from ٢ HP to ٢٥ HP.
- d) Reactivation fan from ¾ HP to ١٥ HP.
- e) Maximum moisture removal from ٩ kg/hr (٢٠ lb/hr) to ٣٠٥ kg/hr (٦٧٠ lb/hr).

Notes:

- ١) The above limitations are based on manufacturer's standard requirement. It does not cover for custom-built equipment which shall depend on job to job basis.
- ٢) The dehumidification equipment shall be delivered to the jobsite either completely assembled or as a package of modular components ready for field assembly keeping the installation costs at a minimum.

٢.٣ Refrigerant Heat Pump Dehumidification Units

٢.٣.١ General

٢.٣.١.١ It shall include material production based on refrigerant dehumidification suitable for indoor mount and for both air cooled and water cooled systems. The unit can be self-contained packaged or with remote condenser.

٢.٣.١.٢ The modes of operation can represent the following system:

- Dehumidification and air heating
- Dehumidification and cooling
- Dehumidification and water heating (for pool, spas etc.).

4.3.2 Material specification

The minimum requirement of applicable feature shall not be limited to the following specified features.

4.3.2.1 Compressor

The compressor shall be a heavy duty hermetic or semi-hermetic reciprocating type with service valves, oil sight glass, crankcase heater to protect against liquid slugging, complete with start up kit. It shall be equipped with low and high pressure safety switches, and internally protected from overheating and shall be vibration isolated internally and/or externally. The scroll compressors shall be also provided with internal and discharge thermal protection.

4.3.2.2 Panel enclosure housing

The frame, panels, removable access panels, and top panels shall be constructed of 1.0 or 1.2 mm (16 or 18 gage) steel. Base panel shall be 11-gage steel with welded 1/2" steel angle supports on the underside for maximum rigidity. All cabinet panels shall be phosphated for maximum coating adhesion. Coating shall consist of a solid based baked enamel with impact resistance to 22 kg (10 lbs.) minimum. Removable panels shall be provided to allow easy accessibility to internal parts within each section. The electrical control panel shall be in its own separate compartment.

4.3.2.3 Insulation

The thermal and sound insulation shall be odor-free flame attenuated, glass fiber, bonded with a thermosetting resin. The air stream surface shall be faced with a black coated mat and shall be fire resistant to 121°C (250°F) and rated to withstand air velocities to 20 m/s (400 fpm). Insulation shall be securely fastened by mechanical means and meet the following requirements;

Flame Spread	- 20
Smoke Developed	- 10
Fuel Contributed	- 0
NFPA 90 and 90 B/ASTM-C 1071.	

4.3.2.4 Blower assembly

The blower housing shall be galvanized steel, double inlet, double width, full width blower wheel, mounted on permanently lubricated sealed ball bearings, selected for approximately 20,000 hours of average life. It shall be forward curved, centrifugal, low RPM type fan, dynamically and statically balanced. The blower housing shall be vibration isolated. The motor pulley and the blower pulley shall be machined cast iron. The motor sheave shall be variable pitch type to allow for field adjustment of required air volume and external static pressure and shall be made with a keyed shaft. Pulleys shall be dynamically and statically balanced. Blower belts shall be V-belt and the drive overload service factor shall be 1.0 minimum.

4.3.2.5 Blower motor

The blower motor shall be open drip proof, continuous duty, with automatic overload protection. It shall have permanently lubricated ball bearings, keyed shaft, and be resilient mounted. Thermally protected with automatic reset, at safety factor of 1.25. Motor shall meet the requirements UL, CSA or authoritative international bodies. The insulation class shall be as mentioned in the data sheet.

4.3.2.6 Dehumidifier coil assembly (evaporator)

4.3.2.6.1 Fins for the coil shall be die-formed, plate type, tempered aluminum for easy cleaning and be damage resistant. Extruded fin collars shall be provided for maximum heat transfer, and accurate fin spacing, which may be at 10 fin per inch spacing.

4.3.2.6.2 The coil shall be fabricated from 1/2" OD seamless drawn copper. The tubes shall be hydraulically expanded into the fins to form a permanent metal to metal bond for maximum heat

transfer and stability. The coil shall be of suitable rows and vapor degreased to clean and dry them internally and externally. It shall be leak tested under pressure with 289 kPa (42.0 psig) nitrogen.

4.3.2.3 All manifolds, headers and connecting tubing shall be made with heavy wall seamless copper tubing. The casing shall be galvanized steel, 1.0 mm (16 gage), with end plates. The joints shall be brazed with silver-bearing brazing.

4.3.2.4 Condenser coil

4.3.2.4.1 The fins shall be die-formed, plate type, tempered aluminum for easy cleaning and be damage resistant. Extended fin collars shall be maximum heat transfer, and accurate fin spacing which may be 12 FPI. The coil shall be fabricated from 1/2" OD seamless drawn copper. The tubes shall be hydraulically expanded into the fins to form a permanent metal to metal bond for maximum heat transfer and stability. The coil shall be of suitable rows and sized for full system capacity. The descriptions of clause 4.3.2.1 shall apply.

4.3.2.4.2 Where water cooled condensers are included in the system, it shall preferably be double wall vented coaxial type with cupro-nickel inner tube and steel shell. The condenser shall be adequately sized with a 10% margin of safety for efficient heat rejection.

4.3.2.5 Condensate drain

The condensate drain pan shall be stainless steel positioned under the dehumidifier coil. It shall be attached securely to the evaporator and plates to avoid shifting. Drain pans shall preferably be fitted with a 25mm (1") size plastic drain connection.

4.3.2.6 Electrical control panel

The electrical control panel shall be easily accessible on one side so that all services can be performed from the side of the unit. It shall be of adequate size so as to house all electrical controls and devices. The electrical controls shall include IEC starters for compressor and blower motor, low voltage transformer to supply 24-volt control power with circuit breaker, or fuse, clearly labeled high and low voltage terminal strips, high and low pressure control with manual reset of the high pressure cut out, and automatic reset of low pressure cut out. Anti-short cycling timer, to protect against compressor cycling. The indicating lights for system, compressor and blower shall be made available.

4.3.2.7 Receiver

The receiver shall meet the requirements of UL and ASME pressure vessel code, adequately sized to hold the total charge. For the outdoor condenser, the receiver shall be suitable for connection of refrigerant lines for up to 10 m (30 ft) distance.

4.3.2.8 Accessories

Minimum requirements of the following accessories shall be made available, when specified:

a) Electric controlled evaporator

Electrically controlled evaporator to maintain optimum coil temperature under varying load conditions and electrically controlled damper assembly shall be mounted on the evaporated coil.

b) Low ambient control

The low ambient valve to control discharge pressure regardless of ambient air temperatures. The hot gas bypass valve will prevent coil freeze up and the need for defrost cycles regardless of entering air temperatures.

c) Air filter

It shall be disposable or cleanable type and meet the requirements of Underwriter's Laboratories Inc, as to the flammability, Class 2500-A UL.

4.1 Desiccant Dehumidification System and Unit

4.1.1 General

4.1.1.1 It shall be designed according to factory proven method and state-of-the-art components shall preferably be in a modular arrangement to permit straight through air processing. The reactivation and dry air fans shall be so arranged as to provide a counter-flow between both air streams.

4.1.1.2 The unit shall be packaged self-contained including reactivation (gas, steam or electric) heaters, roughing filter, reactivation fan/motor, desiccant rotor drive unit, access panels, microprocessor controller with display, energy modulation, silica desiccant rotor and necessary hardware rigidly mounted on channel steel skids. It shall have a ceramic, rotary, desiccant structure, suitable for continuous operation.

4.1.2 Rotor

The dry cell rotor shall be ceramic structure impregnated with a nongranular, non-metallic, non-corrosive, silica gel or other suitable desiccant.

4.1.3 Reactivation fans

The process and reactivation fans shall be centrifugal, direct or V-belt driven with totally enclosed fan cooled motors. The reactivation energy shall be provided by electric, steam, direct or indirect natural gas heating modules.

4.1.4 Panel enclosures

The panel shall be constituted of heavy gage steel or aluminum all welded for combination of strength and corrosion protection. Between modules faceplate neoprene rubber gaskets shall be used to provide a full airtight, rain-proof seal. A polyurethane based enamel paint shall preferably be applied to the panel to provide further protection from wind, rain and rust. The interior of the panel shall be protected from condensation with suitable insulating material.

4.1.5 Filters

The process filters shall be disposable type with 99% efficiency rating. The reactivation filters shall be permanent clean type with aluminum wire mesh housed in a suitable frame. The thickness of filters shall be identified by individual manufactures.

4.1.6 Control

Automatic operation shall be controlled and monitored by the microprocessor unit housed in a weathersafe NEMA4 enclosure. The motor start protectors shall be used for all motor services. The dehumidifier shall preferably include the following dampers:

- a) A manual bypass made of galvanized steel or aluminum duct with butterfly damper.
- b) An outlet damper module consisting of a round galvanized steel duct with manual butterfly damper.

4.1.7 Accessories

- The dehumidifier unit shall be supplied with minimum requirements of the following features:

- a) A post cool module, of suitable capacity shall include connections for coil inlet/outlet, coils with 16 mm (5/8 inch) copper tubes, aluminum fins 10 fins per inch.
- b) A post heat module steam or electric coil heater, steel or aluminum housing and interior 38 mm (1.5 inch) foil backed fiberglass insulation.
- c) A suitable capacity steam post humidification module, canister type in steel housing.

- d) A ۵۰%, ۸۰% and ۹۰% prefiltration module with steel housing, access door and filter.
Also a ۵۰%
and ۸۵% post filter module with steel housing, access door and filter.
- e) A mechanical or microprocessor controller to allow control of dehumidifier functions, bypass functions, pre/post conditioning functions etc.

Notes:

- ۱) The drycell desiccant dehumidifier shall be suitable for commercial uses of dry air, critical storage areas, hygroscopic material in pharmaceuticals, chemicals, agricultural seed storage, water treatment plants etc.
- ۲) The desiccant dehumidifier may also be required for use for dry cooling when combined with air conditioning systems.

PART ٣**٨. GENERAL ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS****٨.١ Labeling**

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

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

٨.١.٢ The name plate on the units (where applicable) 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. ----- +

٨.٢ Inspection/Quality Control and Quality Records**٨.٢.١ Inspection/Quality control and test**

٨.٢.١.١ 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.

٨.٢.١.٢ 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.

٨.٢.١.٣ 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.

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

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

٨.٢.٢ Quality control records

The suppliers shall maintain appropriate inspection and test records to substantiate conformance

with specified requirements. Preference shall be given to those suppliers that apply ISO-٩٠٠٠ version of quality management and quality assurance.

٨,٢,٣ Test method

The following inspection and tests shall be executed for the fans of the units at the factory:

- Performance test.
- Vibration and balancing test.
- Sound level test

Notes:

١) **Subject to engineer's approval the humidistats, humidity controllers and sensing elements, may be furnished, by leading control manufacturers.**

٢) **All proprietary items shall be clearly identified.**

٨,٣ Packing and Shipping

٨,٣,١ Due attention must be given to protection against corrosion during transit, and trays of renewable desiccant (silica gel) or similar dehydrating compound shall be provided.

٨,٣,٢ 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.

٨,٣,٣ Accessory items forming an integral part of the equipment should be wrapped in polyethylene sheathing and packed preferably in separate boxes and shipped loose to prevent damage. Alternatively the ancillary items shall be fixed securely to the solid top skid of equipment and adequate precautions taken to ensure that the items do not loosen in transit.

٨,٤ Vendor's Data

٨,٤,١ Drawings and data

The supplier shall provide the purchaser relevant drawings and technical datas in the English language at no extra cost to the purchaser.

٨,٤,٢ Technical documents

The technical documents shall be furnished according to the following stages:

٨,٤,٢,١ At quotation stage

Comprehensive catalogs, technical data, outline drawings, proposed test procedure, service facilities, etc., of equipment and its components offered. All ratings shall be at site conditions.

٨,٤,٢,٢ At ordering stage

Suppliers shall provide the following in quantities and at times as detailed on the order.

- a) Equipment connections and wiring diagrams, dimensional and installation drawings for humidification and dehumidification units.
- b) Service, operation and maintenance manual.
- c) Reference list showing the successful continuous operation for at least three years and the location of the equipment offered, in major international installations, preferably in the Middle East.
- d) Commissioning and two years spare parts list.
- e) Test certificates per specified conditions.

٨,٥ Guarantee

٨,٥,١ Clearance of defect

٨,٥,١,١ The equipment must carry the manufacturer's one year performance guarantee, on all parts and further four years guarantee on electric motors. The manufacturer shall guarantee the capacity efficiency and unit capabilities for the job site conditions.

٨,٥,١,٢ The equipment or devices must carry manufacturer's following warranty protection period, on all parts and components.

a) Full two-years warranty

Supply of parts, repair and replacements of any item and section of equipment which may fail due to manufacturing defects.

b) Full five-years warranty

Supply of parts, repair and replacement of sealed items such as, compressors, electric motors, trim mounts, structural items etc., which may fail due to manufacturing defects.

٨,٥,٢ Replacement of defective parts

All defective parts shall be replaced by the supplier in the shortest possible time free of charge including dismantling, reassembling at site and all transportation cost. The above mentioned period shall not be later than ١٨ months from the date of dispatch from manufacturer's works.

٨,٥,٣ After sale technical services

٨,٥,٣,١ Commissioning

٨,٥,٣,١,١ 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 for the humidification and dehumidification equipment and system at site on a per diem basis.

٨,٥,٣,١,٢ 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 data within a minimum of four weeks advance notice by the Purchaser.

۸.۶ Spare Parts

۸.۶.۱ 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.

۸.۶.۲ The Vendor shall guarantee the provision of spare parts for a minimum period of ۱۰ years from the date of dispatch of materials and/or equipment.

۸.۶.۳ The spare parts shall be preserved to prevent deterioration during shipment and storage in tropical climate.

۸.۷ Coordination Responsibility with Others

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

۸.۷.۲ 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.

۸.۷.۳ Copies of all correspondence shall be furnished to the Purchaser.

۸.۸ Languages

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

PART ۴**۹. DATA SHEETS****۹.۱ General**

The specification of this Standard is in abridged short form due to the limited nature of the size of the unit and/or system involved. Descriptions shown or implied are to be performed in workmanlike manner, and all materials are to be first-line quality of the proper type, required capacity and size needed to make a complete and proper operating system ready for the owner's beneficial use, including the furnishings of strategic optional items and all utility connections required for the system and/or equipment.

Based on the available and accumulated knowledge, the following data sheets have been prepared but it is the participating manufacturer's responsibility to fill-in all data necessary to comply to the codes and regulations which are in effect during the manufacturing stage:

- Site conditions
- Humidifiers
- Refrigerant dehumidifiers
- Desiccant dehumidifiers

۹.۲ Data Sheet for Site Conditions**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 m(ft)..... above sea level
- Site Latitude

b) Wind Velocitykm/h (miles/h)**c) Environment: b Dusty, b Saliferous, b Hazardous****d) Available Service:**

- Power Supply.....VoltPhase
Hz
- Cooling Water Sources:
b From City Water b From Treated Water b From Untreated Water

e) Area Classification:**f) Job Description:****g) Other Conditions:****Note:**

Earthquake belt of Iran is located in UBC zone ۳.

۱,۳ Data Sheet for Humidifiers

a) General:

Project :..... Location.....
 Order No.:..... Customer.....Factory
 Manufacturer..... Model No.....Serial No.
 Site Hazard Class:..... Fabrication Date.....
 Mountings.....In-Duct..... Air HandlersOpen Space
 Space Application
 Commercial.....Residential.....Industrial

b) Specified Requirements:

۱) Water atomizing humidifiers:

Water Content.....kg (lb)
 Water PressurekPa psi
 Power Consumption.....kW

۲) Steam jacketed humidifiers:

Capacity of Steam Separator:kg/hr (lbs/hr)
 Strainer capacity:kg/hr (lbs/hr)
 Type of ActuatorPneumatic
Electric
Electronic
 Jacketed Dispersion Tube Length.....mm
Qty.
 Steam Trap Type.....Float and Thermostatic
Inverted Bucket

۳) Electric steam humidifiers:

Power Consumption kW
 Control SystemMicroproces
 Sor.....Mechanical
 Steam Output Condition.....kPa (psi)..... °C
 (°F)
 Water Capacity Storage.....Lt (lbs)
 * Minimum Duct Dimensions mm
 (Inch).....Width.....Depth
 * Pan Dimension.....
 L.....W.....H
 * Heater Power Rate..... kWPhase
 * Fan Conditions..... m³/hr
 (cfm).....Type.....HP
 * Auxiliary Items

۴) Steam grid humidifiers:

Humidifier Capacity kg/h
 (lb/hr).....
 Available Steam ConditionkPa (psi)..... °C
 (°F)

Distribution Tube Lengthmm.....Qty.
 Steam Trap.....Type.....kg/hr
 (lb/hr)
 Steam Inlet Size.....mm (Inch)
 Insulation Material:.....TypeTemp. Range °C (°F)
 Electrical Characteristics:.....V.....Phase-
 Hz

***) Electrode steam humidifiers:**

Rate of Humidification:..... kg/hr (lb/hr)
 Rate of Power Input: kW
 Unit Net Heating Capacity: kW
 Cylinders:
 Type.....Quantity
 Water Capacity: Lt (lb)
 Electrodes
 Length.....Spacing
 Type of Controls.....On/Off ... Proportional.....Proportional+Integral
 Control SystemMicroprocessorMechanical
 Blower Fan m³/h (cfm).....HP
 Blower Package Mount Factory.....Remote
 InsulationMaterial.....Temp. Range °C (°F)
 Electrical Characteristics V.....pHHz

c) Salient Features:

d) Physical Data:

Overall Dimension, mm (Inch).....Height.....LengthWidth
 Shipping Export Data, kg (lbs).....Gross Weight.....Net
 Weight

۹,۴ Data Sheet for Refrigerant Dehumidifiers

a) General:

Project: Location
 Order No.: Customer:Factory
 Manufacturer Model No.Serial No.
 Site Hazard Class: Fabrication Date.....
 Type of Unit Packaged
Modular
 Space Application Commerical-
 Residential.....Industrial

b) Capacity Requirements:

Rate of Dehumidification: kg/hr (lb/hr)
 Refrigerant Charge kg
 (lb).....Type
 Unit Net Heating Capacity kW
 * Unit Flow m³/hr
cfm
 External Static Pressure (inch-
 H₂O).....

Compressor
 HP.....Type
 Blower Conditions
 HP.....Size
 Inlet/Outlet Air Temp.°C
 (°F)
 Air Inlet Size
 Width.....Height
 Air Outlet Size
 Width.....Height
 Water Source O.D Inlet.
Outlet
 Water Flow L/s (GPM) Pressure Drop.....
 Condensate Drain (fpt).....Type
 Electrical Characteristics V.....pH.....Hz

c) Physical Data:

Overall Dimension, mm (inch).....Height.....Length.....Width
 Shipping Export Data, kg (lbs).....Gross Weight.....Net
 Weight

* Based on return air (°C), water temp. (°C), and relative humidity (%) to be specified by the purchaser.

1.0 Data Sheet for Desiccant Dehumidifiers

a) General:

Project Location.....
 Order No.: Customer:Factory
 Manufacturer Model No.Serial No.
 Site Hazard Class Fabrication Date.....
 Type of Unit Pack-
 aged.....Modular
 Desiccant Type Hours of Operation.....

b) Capacity Requirements:

Rate of Dehumidification kg/hr (lb/hr)
 Reactivation Heaters
 Electric.....Steam.....Gas
 Heater Capacity: kW
 Air Volume, m³/hr (cfm) Reactivation
 Filter TypeWashable.....Permanent
 Filter Rating Efficiency.....DOP Test
 Type of ControlsMicroprocessor.....Mechanical
 Insulation Material.....Temperature Range °C(°F)
 Fan HPz..... DesiccantReactivation
 Media Drive Motor HP.....Full Load Amp.
 Electrical Characteristic: VoltPhase
Hz

c) Salient Features:

.....

.....
d) Physical Data:

Overall Dimension, mm
 (inch).....Height.....Length.....Width
 Shipping Export Data, kg (lbs).....Gross Weight.....Net
 Weight