



ICIC

شرکت سرمایه‌گذاری صنایع شیمیایی ایران  
IRAN CHEMICAL INDUSTRIES INVESTMENT CO

Completing the Remaining Documents of  
Design and Engineering Services for LAB2 Unit

### HVAC EQUIPMENT SPECIFICATION



شرکت طرح نواندیشان

Contract No.: 6258

Pro. Cod  
LRP

Cons.  
TNA

Discipline  
HV

Unit  
99

Type  
SPC

Serial  
0003

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# HVAC EQUIPMENT SPECIFICATION

00	13-Feb-2023	Issued for Approval	H.R	H.R	M. Mahmoodi
<b>REV</b>	<b>DATE</b>	<b>POI</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>



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## 1 INTRODUCTION

Iran Chemical Industries Investment Company (ICIIC) was established in 1984. The executive operation in the area of 3,420,000 square meters in the northwest industrial region of Isfahan began in 1990 to create a Linear Alkyl Benzene (LAB) Complex with 50,000 tons of LAB and 46,000 tons of normal paraffin capacity.

With the increase in domestic consumption and also the improvement of the consumer market in the region, the implementation of the company's development plan for the annual production of 75,000 tons of linear alkyl benzene and 140,000 tons of normal paraffin was strengthened. Utilizing the existing knowledge and applying the scientific and experimental skills of the specialized forces, this company succeeded in successfully completing its development plan in 2003. Iran Chemical Industries Investment Company to reduce the production of Heavy Alkylate By-product (HAB) and also to improve the quality and increase the production of alkyl benzene line (LAB) in cooperation with Sinopec company to successfully operate the selective Hydrogenation of Dyalphins (DSH) in 2008.

## 2 PURPOSE

The purpose of this specification is to define the minimum requirement and basis of design of the heating, ventilation, and air conditioning systems (HVAC) and plumbing systems of buildings in "LAB2 UNIT" in SHAHIN-SHAHR , ISFAHAN , IRAN:

- Maintain the required comfort conditions (i.e., temperature, humidity, air quality) for personnel.
- Create a satisfactory controlled environment for essential and non-essential electrical equipment, and instrumentation equipment installed in the buildings.
- Provide the minimum fresh air quantity for persons in mechanically ventilated areas.
- To extract, when necessary, fumes and products produced by equipment (battery rooms, kitchen, toilets etc.).
- Maintain the overpressure inside the buildings when required.

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This specification includes the following building:

- CHANGE HOUSE
- SUBSTATION NO.05
- PROCESS CONTROL BUILDING NO.03
- FIRE STATION NO.2

### 3 DEFINITION AND TERMINOLOGY

**OWNER:** IRAN CHEMICAL INDUSTRIES INVESTMENT COMPANY (ICIIC)

**CONTRACT:** Agreement between the OWNER and the ENGINEERING CONTRACTOR and includes documents referred to therein.

**MANAGING CONSULTANT (MC):** -

**ENGINEERING CONTRACTOR:** TARHE NO ANDISHAN Consulting engineers (TNA)

**PMT:** Project Management Team

**BEP:** Basic Engineering Package

**PDP:** Process Design Package

**CONTRACT NUMBER:** 6258

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## 4 CODES AND STANDARDS

ASHRAE:	American society of heating, refrigerating and air conditioning engineers guide and handbook.
SMACNA:	Sheet metal and air conditioning contractor's national association Inc.
NFPA:	National fire protection association
AMCA:	Air Moving and Conditioning Association
AFI:	American Filtering Institute (Filters)
ADC:	Air Diffusion Council (Air diffusion & tests)
NPC:	National plumbing code
ASTM:	American Society for Testing and Materials.
AHRI:	Air- Conditioning Heating and Refrigeration Institute
IPS:	Iranian petroleum standard
INBC:	Iranian National Building Code
	Publication No. 128 of Management and Planning Organization.

## 5 ORDER OF PRIORITY

When doubtful or conflicting interpretations arise, precedence shall be determined as follows:

- Purchase order
- MR
- Data Sheet or Duty Specification and Drawing
- Project Specification

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## 6 DESIGN CONDITION

**Note:** If safety studies will be requested by the client, this document will be reviewed and edited in accordance with the safety reports.

### 6.1 Site Information

Location	Shahin-shahr of IRAN
Elevation	Average 1685 meter above sea-level
Longitude	51° 40' E
Latitude	32° 36' N
Design wind pressure	100 kg/m <sup>2</sup> below 10 m 120 kg/m <sup>2</sup> below above 10 m below 20 m
Prevailing wind direction	From W
Rainfall value for sewer	30 mm/hr
Maximum relative humidity	63% at 45°C

### 6.2 External Design Conditions (for HVAC Design Calculations)

Summer design dry bulb temperature	36 °C
Summer coincident wet bulb temperature	17 °C
Summer design relative humidity	19%
Summer daily temperature range	15.6 °C
Winter design dry bulb temperature	-7.2 °C
Winter coincident wet bulb temperature	-9.5 °C
Winter design relative humidity	82%

Air cooled condensing units shall be designed with an external air temperature of 50°C.

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## 7 PACKAGED UNIT

A packaged unit is self-contained and consisting of following sections and related specifications,

- A. Compressors
- B. Condenser Coil
- C. Condenser Fan
- D. Casing / Structure
- E. Refrigerant Charge
- F. Refrigerant Piping
- G. Electrical and Control Panel
- H. Mixing Box/Filters (includes all washable , pleated and bag filter)
- I. DX-cooling coil with droplet eliminator
- J. Supply Fan
- K. Electric/Hot Water Heating Coil
- L. Electrical Steam Type Humidifier
- M. All HVAC Control Devices in Relation to HVAC System.
- N. Sound level shall be lower 85 DB @ one-meter distance.

### 7.1 COMPRESSOR

Compressor shall be of semi-hermetic screw or semi-hermetic reciprocating type according to data sheet.

#### A) FOR SCREW COMPRESSOR:

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- The compressor(s) shall be (accessible) semi-hermetic, refrigerant cooled, operating on 400V-3 $\phi$ -50Hz.
- The compressor(s) shall be equipped with an oil heater, oil charge, oil separator, oil filter, discharge gas temperature sensor, start unloading, capacity regulation – 4 step, capacity regulation – infinite, discharge and built-in check valve, electronic protection device.
- The compressor(s) shall be fitted with an oil-sight glass through which the quantity and the condition of the oil in the crankcase can be observed.
- For operating with R134a polyol-ester oil shall be consumed as per manufacturer recommendation.
- The oil heater shall be used during standstill in case of outdoor comp. installation, long shut-off periods, high refrigerant charge, and danger of refrigerant condensation into the comp.
- For the selection of contactor, cables and fuses the max. operating current shall be considered.
- Liquid injection shall be considered for screw compressors.

#### **B) FOR RECIPROCATING COMPRESSOR:**

- The compressor(s) shall be (accessible) semi-hermetic, refrigerant cooled, operating on 400V-3 $\phi$ -50Hz.
- The compressor(s) shall be equipped with an oil screen, an oil charge, discharge and suction shut-off valves with pressure gauge connections, a suction gas strainer.
- The compressor(s) shall be fitted with an oil-sight glass through which the quantity and the condition of the oil in the crankcase can be observed.
- Forced fed lubrication shall be performed by an oil pump with a suitable port for checking the oil pressure with facilities for connecting a mechanical differential oil pressure switch.
- All compressors shall be equipped with a pre-set internal pressure relief valve between the suction and the discharge chambers which will open if the permissible differential pressure is exceeded [set point approx. 30 bar  $\pm$  3bar (450 psig  $\pm$  45psig), fully open approx. 33bar (495psig)]

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- All compressors shall be fitted with standard crankcase heater sized appropriately (power-KW) to prevent the migration of refrigerant into the compressor during the OFF cycles.
- An oil balance (copper) tube shall be installed between the crank cases of 2 compressors sharing the same suction line. The balance line shall be fitted with sight glass and copper vibration absorber.
- Shall be equipped with at least one stage unloader.

## 7.2 Condenser Coil

- The coil frame shall be constructed of minimum 2.0mm galvanized steel sheet.
- The tube sheet shall have die-formed-drawn collars to support the tubes.
- An intermediate coil support shall be provided on coils with a finned length of more than 1m.
- Standard material for fins is Aluminium.
- Plate fins shall have full collars to allow for expansion and contraction of the fins.
- Maximum fin spacing shall be 10 FPI for fin corrugated plate type.
- Standard tubes shall be seamless drawn copper tubes alloy ASTM C12200 (Cu=99.9%) DHP according to ASTM B-68, condition light anneals (O50). Tolerances for diameter and wall thickness according to ASTM B-251. Grade SF-Cu according to DIN 1787, type ISO Cu-DHP.
- All return bends shall be brazed to tube ends with filler rods conforming to ANSI/AWS A 5.8-92 Standard-Classification BCUP-6 equivalent to DIN 8513 Part 2-Classification L-Ag 2 P and brazing procedures according to IN-DN-020 (Internal Document).
- Tubes shall be mandrel expanded to form fin bond.
- Bly-Gold or equal approved alternative anti-corrosion coating for coil protection

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### 7.3 Condenser Fans

Condenser fans shall be of propeller type Aluminium alloy blades, recessed below top of unit and one externally driven electrical motor. Motor is fitted with thermal protection device of the self-resetting type, to protect the motor from dangerous overheating. The motors are factory wired, using special silicon wires for high ambient operation. Condenser fans are individually statically and dynamically balanced at the factory. Complete fan assembly is provided with suitable acrylic coated fan guard made from heavy gauge galvanized wire. Class "F" insulation and class "B" temperature rise with IP55 shall be considered.

### 7.4 Casing / Structure

The casing shall be constructed of hot dipped galvanized steel sheet panels, painted with epoxy primes and polyurethane topcoat, the density and thermal conductivity of thermal insulation is 50mm polyurethane foam or board factory assembled on a rugged steel channel base. The entire assembly shall be supplied with lifting holes to ease rigging for installation. Access panels are to be provided for easy service and maintenance on all different compartments.

The painting of casing shall consider the environment atmosphere conditions and direct sun exposure of 85°C, with maximum relative humidity of 95%.

Unit must be supplied with proper sized anchor-bolt and vibration isolators to be mounted on 200mm reinforced concrete pad and earthing clamp on the structure.

External and internal painting specification shall be as follow as project "ENGINEERING SPECIFICATION FOR PAINTING".

### 7.5 Refrigerant Charge

The packaged unit shall come with a holding charge of R-134a refrigerant from the factory.

For indoor mounted split units R410a is acceptable.

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## 7.6 Refrigerant Piping

The packaged units shall be fabricated with all internal piping of copper ASTM B288 type ACR/L between compressor condenser and evaporator. Unit shall be supplied with factory correctly sized thermostatic expansion valve, liquid line solenoid valve, liquid line sight glass, filter drier and shut-off valves, moisture indicator, gauge ports on suction and discharge compressor, high pressure gauge low pressure gauge and oil pressure gauge for reciprocating compressors and proper size suction line accumulator including liquid heat exchanger.

## 7.7 Electrical / Control Panel

HVAC/PLC control system with auto-change over from operating to stand by package unit shall be provided. Outdoor packaged unit shall be supplied with unit-mounted IP-55 electrical/ control panel enclosure designed for automatic operation and insuring safety, efficiency, sequence control for the fans. All wiring is sized as per applicable electrical code. The control panel is factory wired for 230 Volt, 1ph-50 Hz control power supply.

Power supply, communication module and CPU shall be redundant.

Battery backup for control panel inside unit shall be supplied by vendor of HVAC.

An additional built-in 24 volts fused low voltage transformer, for case of connection to cooling thermostat.

Packaged unit power & control panel shall have 20% spare space. The panel shall be fabricated as followings:

- Individual compressor and condenser fan motor contractors.
- Fuses for condenser fans.
- Individual condenser fan over current protection
- Low pressure safety switch
- Anti-freeze protection
- High pressure safety switch

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- Outdoor power & Control panel shall be equipped with separate cooling system.
- For compressor protection, provide over heating instrument and safety signal.
- Head pressure control by fan cycling for low ambient and part load operation.
- Suction and discharge pressure gauge.
- Electrical and control panel shall be supplied with built-in internal electric heater to provide heating when the panel is out of service to provide rust protection due to high level of humidity.
- Panel shall be equipped with internal lighting when the panel door is wide open.
- Electrical and control panel shall be interlocked with F&G system control panels.
- Power supply, communication module and CPU shall be redundant.
- Electrical power for HVAC control panel shall be considered from HVAC power panel emergency feeder (230VAC).
- Backup battery should be considered for each HVAC unit local PLC control panel.
- All displays, lights (on, off, fault), push buttons and other operator interface shall be mounted on the HVAC power-control cabinet.
- At least the running status and common fault should be transferred to the F&G via hard-wired I/O.
- The control system shall comprise locally mounted field instruments, which shall be connected to HVAC power- control cabinet.
- Controls and actuators including modulating valves and motorized dampers shall be electrically actuated.
- The HVAC control system shall be interlocked with the main fire protection system in accordance with the Fire and Gas Cause and Effect for buildings.
- In buildings with split unit air conditioning system related power- control cabinet shall be capable for interconnecting with F&G system.

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- Pressure differential switches shall be provided in each pressurized system area to monitor the minimum positive pressure with respect to atmosphere.
- The split packaged unit shall be supplied with variable speed driver for fan electrical motors and relate instrumentation and electrical panel.
- Duct mounted differential pressure switch shall be supplied by vendor to control the fan speed for maintaining constant volume of air in discharge of packaged units.

## 7.8 Mixing Box / Filter Section

Mixing box is equipped with two aluminum opposed blade dampers for fresh and return air. Dampers shall be motorized controlled. Washable aluminum filters with 85% efficiency class 5cm thick with 7-V type net layers. Pleated with 60% efficiency and Bag filters section with 93% efficiency based on, ASHRAE 52-52.1 standard. Maximum face velocity of 500 fpm (2.54 m/sec) mounted in designated frame with filter clamp. Removable panels shall be provided on each for filter access.

The recommended static pressure drops of 250 Pa on bag filters when total static pressure of supply fan is determined.

On fresh air intake, section of mixing box a sand trap louver must be supplied with vertical slots to separate dust & sand from air stream in addition to insect wire mesh screen and sand discharge opening at the base of louver.

A differential pressure switch (magnehelic gauge) must be supplied and set for alarm across the filter section and will operate the standby package unit.

## 7.9 Cooling and Dehumidification DX-Coils

Provided cooling coil of scheduled capacity, mounted in unit in manner permitting removal. Direct expansion coil is constructed from seamless copper tubes and aluminium fins. Copper tubes are mechanically expanded into continuous Aluminium fins. Direct expansion coils are equipped with properly sized distributor to ensure equal refrigerant feed to all circuits. The number of circuits is chosen to provide optimum heat transfer and reasonable refrigerant velocity and pressure drops so as not to trap any oil in the coil tubing. Headers are made of seamless copper pipe. All coils shall be

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designed to meet AHRI-410 standard and tested in accordance with ASHRAE standard 15 – 1992 (safety code for refrigeration) coil section is provided with insulated drain pan with drain connection to hold and remove condensate formed during dehumidification. Drain pan is made of stainless steel 316L the pan itself must be insulated to prevent condensation from pan. Coil refrigerant piping and drain connections can be made on either side of unit as required refer to equipment arrangement drawing. Inlet and outlet connections are sealed against unit body by means of flexible closed cell gasket.

Coils are assembled in slide-in guides for easy removal for maintenance and replacement. Refer to data sheets and HVAC equipment arrangement drawings for capacities and proper coil pipe connection side.

Selected vendor must supply a computer-generated coil selection with complete psychometrics.

Hot gas bypass control shall be provided for eliminating DX cooling coil freezing.

Coil sections must be equipped with droplet eliminator made of removable Polypropylene.

For variable flow air handling units, the cooling coil shall be designed to adjust its performance during different air volumes to prevent coil freezing or the refrigeration cycle malfunction.

## 7.10 Fan

Fans are standard forward or backward curved blades or plug fan in other special cases as an alternative according to datasheet. All fan wheel and shaft assemblies shall be statically and dynamically balanced. Fans are selected for best sound characteristics based on maximum efficiency in accordance with AMCA standard 210. Shaft to be manufactured by CK45 material.. All bearings are of self-aligning type, which greased for life. The complete fan and motor drive assembly is mounted on sub-base, to limit transmission of noise and vibration. The sub-base assembly is mounted on anti-vibration mounts.

Flexible connection shall be provided between fan discharge and casing to avoid transmission of noise and vibration to the connecting duct. A standard access door is to be provided on both sides of casing for servicing and maintenance of internal mounted motors. Each supply Fan of packaged unit shall be equipped by one airflow switch or differential pressure switch.

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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.

For variable air volume application, the fan shall be centrifugal backward type with variable speed driver to adjust the required system air volume with fan speed. Fan bearings shall be plumber block type.

Selected vendor shall specify following data:

- Design air flow and total static pressure
- Type of selected fans
- RPM of Fan& Motor: Max.1450 rpm (In some cases that 1450 rpm is out of fan performance curve, 2900 rpm is acceptable by contractor approval)
- Sound level (max. 85 dB @ 1meter distance)
- Fan performance curve
- Physical data & origin
- Fan efficiency
- Motor protection class
- Test report from reputable laboratory containing the statically/dynamically balance test with accordance to applicable international code, regulation, and certificate.
- The material and thickness of applied coating.

## 7.11 Electric Heating Coil /Duct Heater

Electric heating coil/duct heater shall be provided with terminal box and as minimum the following rewired electrical control/safety components:

- Suitable disconnecting switch,
- Contact for interlocking with the supply fan,

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- Relay for remote alarms,
- Automatic reset and manual reset thermal cut-outs,
- High temperature safety cut-out,
- Earthling clamps on the casing and bolt in the terminal for connection of earthling cables.

The heating element will be selected to limit terminal air reheat temperature below 10°C for each element.

Electric heating coil/duct heater shall be designed for 10% over capacity and according to speed of the airflow.

Electric heating coil/duct heater shall be suitable for installation within low velocity (i.e., less than 4 m/s). Air pressure drop shall not exceed 60 Pa at the nominal flow rate.

Electric parts of electric heating coil/duct heater shall be at least IP55 for outdoor equipment, except for motors junction boxes that should be at least IP41 for indoor.

Heating coil/duct heater with more than 4 kW heating capacity shall be rewired for thyristor control. For capacities, less than 4kW, a step controller or a 3-Stage thermostat shall be used.

## 7.12 Sound Attenuator

Acoustic silencer to be designed to attenuate sound power generated from roof top packaged units (according to data sheets and HVAC drawings). It should be made of sound absorbing material with galvanized steel housing located on supply ducts as shown on drawing. Sound attenuator shall be of parallel baffle type. The absorbed sound level and pressure drop must be designated on all sound attenuators. For sizing, refer to schedule drawing.

All materials shall be in accordance with ISO 5660 Part 3 i.e. non-combustible and non-smoke producing.

All sound attenuators shall be provided with lifting lugs or removable eyes at both ends of the assembly.

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Galvanized steel sound attenuators shall be suitable for a maximum duct static pressure of 1500 Pa and a leakage of 0.009 l/s per m<sup>2</sup>.

Sound Attenuators shall have flanged connections, suitable for mounting within ductwork systems, with a minimum flange thickness of 2mm.

Sound Attenuators shall be selected to achieve the sound reductions specified and have a low resistance to air flow. The attention material shall possess, in addition to the above, the following properties:

- Adequate strength and cohesion to prevent sagging.
- Resistance to erosion
- Prevent disintegration and migration of sound attenuating materials.
- Odor free
- Non-dust producing
- Non-hygroscopic
- Not support mild growth
- Asbestos free
- Rot and vermin proof.
- Fireproof
- Maximum air pressure drops across Sound Attenuator shall not exceed 50Pa.

#### **Materials of Construction:**

Sound attenuators located internally shall be constructed from galvanized steel sheet.

Sound Attenuators within enclosed areas shall be constructed from 2.0mm thick galvanized steel casing with 1.2mm thick galvanized mild steel internal splitters, as necessary.

The internal splitters shall be perforated and riveted for galvanized materials.

The splitters shall encase an infill of inorganic mineral fibre packed to a density of 48 kg/m<sup>3</sup>. A melinex polyester film sheet minimum thickness 23µm (microns) which shall be flame retardant to

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ISO 5660 Part 3, shall be fitted between the infill and perforated steel sheet to prevent particles of sound absorbent medium migrating into the air stream.

The entry and exit from the sound attenuators shall be aerodynamically shaped to minimize the static pressure losses.

Circular sound attenuators shall have an inner cone if the performance requirements necessitate this. The cones shall be securely fixed to the outer cylinder by supporting rods, the inner cone and caps shall be 2mm thick and of the same material as the casing.

All angle shaped attenuators shall have guide vanes at the bends. The guide vanes shall be the same material as the casing and should have a minimum thickness of 1.6 mm; depending on the materials being used, they should be either riveted or welded to the inner face of the casing.

### 7.13 Electric Steam Humidifier

An electric steam humidifier shall be supplied built-in with roof top packaged unit and be consisted of stainless-steel casing with at least two heating elements, to avoid super heating, heating elements shall be fully immersed during operation. Humidifier must have water blow down to minimize solids build up, also shall have earthing connection along with on/off switch, low water switch, high temperature cut-off, float and drain, air flow switch and high limited humidistat.

According to calculation and building characteristics, maybe the designer uses a duct-mounted humidistat in the HVAC air distribution system.

All humidifiers shall be an immersed-electrode steam humidifier simply made up of a support system including comprehensive set of accessories such as steam distributors and hoses, dual-check fill valve, drain solenoid valve, connections and hoses, a disposable steam cylinder and some auxiliary components controlled by the dedicated controller and/or an external controller. No contactor, transformer, fuses are included. The humidifier shall evaporate water into steam in one or more disposable steam cylinders by heat that is provided by grid type electrodes. The operation of the humidifier shall be fully automatic and shall provide the following operations: Firstly, monitor the conductivity of the water in the cylinder and secondly, maintain the desired conductivity rate by

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draining water with high content of dissolved solids. Finally control the steam generation by the room humidistat.

### Components:

Each immersed-electrode steam humidifier shall be made up of the following components:

- Cylinder
- Plastic support with cylinder fastening strap
- Fill and drain valve/pump.
- Conductivity meter
- Hoses
- Control card for proportional or ON/OFF external demand.
- Earth connection along with on/off switch
- Low water switch
- High temperature cut-off
- Float and drain.
- Air flow switch
- High limited humidistat
- Stainless steel/PVC casing

The frame of the humidifiers shall be of compact, open able, hot galvanized metal complete with handle and screw closing. The frame includes a case for housing the control board. The control board shall be microprocessor based, complete with software for immersed electrode humidifiers. The fill solenoid valve with ¾” male connector shall be located on the frame and shall be accessible for cleaning the filter on the solenoid valve when the unit is installed. Drain assembly shall be made up of a manifold and drain solenoid valve with 90° connector and min 32 mm diameters fitting, with the possibility to replace the drain with a straight pipe, supplied. Water circuit shall be consisting of supply tank plus conductivity meter and cylinder fill, drain and overflow hoses, shall be made of

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polypropylene reinforced with fiberglass, cylinder secured by convenient strap closing system. The humidifier shall be fitted with a switch from turning the unit on/off and a button for the manual drain function.

The power cable shall be minimum 3m long, flame retardant and supplied with a rubber cable gland. One end has special cable terminals for connection to the cylinder, and the other end is free. Current transformer shall be fitted on the control board and monitors one of the phases of the power supply to measure the current. The operation of the humidifier shall be displayed using a panel fitted with collared LEDs, with the following meanings: The events shall be indicated by sequences of flashes.

#### **Safety:**

The potable water connection shall provide remote status of the steam humidifier complete with safety alarms.

All humidifiers shall be completed with self-cleaning system.

Humidifier shall have water blow down to minimize solids build up.

To avoid super heating, heating elements shall be fully immersed during operation.

A shut-off tap and a mechanical filter shall be installed to trap any solid impurities.

The drain water shall be connected using a section of rubber or plastic hose resistant to 100°C.

The drain connector shall be suitable for heat sealing with polypropylene drainpipes.

## **8 AIR HANDLING UNIT**

Equipment shall be capable of operating both in enclosed environments neither heated or cooled.

Air handling units shall include:

- Air Intake
- Mixing box (if any)
- Prefilter section
- Main filter section

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- Cooling coil
- Heating coil
- Humidifier (if any)
- Supply fan

The unit shall be completely weatherized for outdoor installation to suit corrosive and coastal environment and properly reinforced and brazed.

Steel sheet panels shall be zinc-coated with mineral wool insulation of 50mm and galvanized by the hot-dip process, followed by baked-on electrostatic polyester dry powder coat. The frame shall be fabricated with anti-coroidal tubes, fastened with screws and suitable nylon glass joints. Casing shall be completely disassembled and reassembled, connected to a galvanized press – formed sheet metal base.

The access panels shall be removable, for inspection to all internal parts.

Pre-filter and main filter shall meet the air filtration efficiencies as specified here below. Filtering media shall be of self-extinguishing type.

Filters provided in AHU shall have efficiency as follows:

- Prefilter: efficiency F5 (60% opacimetric)
- Final filter: efficiency F7 (90% opacimetric)

Air filtration efficiencies for pre-filters and final filters, in accordance with ASHRAE standard 52.1 “Opacimetric and Dust-Spot procedures for Testing Air Cleaning Devices used in General Ventilation for Removing particulate matter” shall be as follows:

Average arresstance of inertial filters shall be 80% in accordance with Arizona Dust Fine method, 92% in accordance with Arizona Dust Coarse method.

Cooling coils shall be of the cartridge type, removable from coil connection side of casing as well as from the opposite side, supported in tracks over the entire length of the coil.

Cooling coils shall have Aluminium fins mechanically bonded to seamless copper tubes.

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Standard coils can be used only if protected by a suitable anti-corrosion treatment in accordance with actual environmental conditions. The expected coil treatment shall be previously submitted for approval.

The drop eliminator shall be Polyethylene. Each coil shall have inclined condensing dip tray.

The fan section shall house a centrifugal fan, carbon steel welded impeller wheel, with backward curved blades, statically and dynamically balanced, self-aligning shaft with radial ball and Plummer block housing, V belt transmission with cast iron pulley, electric motor, common base for motor and fan; vibration elimination device shall be applied as requested by statical and dynamical loads.

The maximum air velocity through filter shall not exceed 2m/sec and maximum pressure drop across filter shall be as follows:

- Pressure drop clean filter: max. 100 pa
- Pressure drop dirty filter: max. 250 pa

Filter section shall have local pressure drop.

Electrical equipment of units shall be according to IEC codes and have IP54 class F built in thermal protection PTC as minimum. For motor requirements refer to relevant electrical specification and motor data sheets.

For heating, cooling, humidification and dehumidification process of air handling units, the following functions shall be provided by control devices:

- Control system energizes when fan is turned on.
- Manual positioning switch determines minimum outdoor air damper position.

## 9 AIR COOLED CHILLER

The Air-cooled chiller shall be manufactured with semi hermetic screw type compressor, consisting of twin screw compressor, squirrel cage induction motor, closed transition star-delta starter, air cooled condenser, shell and tube evaporator refrigerant piping, and all related components and equipment, electronic expansion valve, solenoid valve, suction filter, filter drier, solenoid valve,

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liquid sight glass , charging valve and ready for operation, microprocessor control, HP/LP switch all mounted on a steel frame and control power wiring/cabling.

Screw compressors shall be rated at 100%, 75%, 50%, and 25% load relative to the full load.

Factory run-tested shall be in accordance with AHRI 550-590.

Rating Net Refrigerating Capacity (AHRI) Cooler (Chiller) shall be tested and stamped in accordance with ASME Code.

Noise level Shall not exceed 80 dBA measured at distance of 1m from outline of equipment.

## 9.1 COMPRESSORS

- The compressor(s) shall be (accessible) semi-hermetic, refrigerant cooled, operating on 400V-3 $\phi$ -50Hz.
- The compressor(s) shall be equipped with an oil heater, oil charge, oil separator, oil filter, discharge gas temperature sensor, start unloading, capacity regulation – 4 step, capacity regulation – infinite, discharge and built-in check valve, electronic protection device.
- The compressor(s) shall be fitted with an oil-sight glass through which the quantity and the condition of the oil in the crankcase can be observed.
- For operating with R134a polyol-ester oil shall be consumed as per manufacturer recommendation.
- The oil heater shall be used during standstill in case of outdoor comp. installation, long shut-off periods, high refrigerant charge, and danger of refrigerant condensation into the comp.
- For the selection of contactor, cables and fuses the max. operating current shall be considered.
- Liquid injection shall be considered for screw compressors.

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## 9.2 SHELL AND TUBE EVAPOEATOR

The chiller shell shall be formed of carbon steel, provided with cast iron tube having standard flange type connections. Evaporator tube shall be provided with drain connections and shall be easily openable for tube cleaning. The evaporator shall be design according to the ASME standard.

A thick steel tube sheet shall be welded to each end of the shell and shall be drilled to accommodate tubes. Annular grooves in the tube sheets shall prevent leakage at the tube sheet bond. Tube support sheets shall be placed along the length of the shell to avoid relative motion between the tubes.

Seamless copper tubing shall be used for evaporator surface. Tube shall be expanded into the tube sheets and shall pass through supports and baffels so that the refrigerant side of the evaporator shall be leak free and there shall be no relative motion between tubes and tube supports. Each tube shall be individually replaceable.

## 9.3 REFRIGERANT

The refrigerant to be used in the chiller shall be R-134a. The manufacturer shall supply a full charge of refrigerant for installation. The refrigerant shall meet the ARI 700-95, ANSI/Ashrae standards for purity.

## 9.4 REFRIGERANT PIPING AND COMPONENTS

Refrigerant piping and fittings interconnecting compressor, condenser and chiller shall be all copper and valves shall be brass/ gunmetal.

The unit shall be fabricated with all internal piping of copper ASTM B288 type ACR/L between compressor condenser and evaporator. Unit shall be supplied with factory correctly sized Electronic expansion valve, liquid line solenoid valve, liquid line sight glass, filter drier and shut-off valves, moisture indicator, mechanical gauge on suction and discharge compressor, high pressure gauge low pressure gauge and isolating valve for suction and discharge compressor and refrigerant charging valves a minimum requirement.

Suction line shall be completely isolated by thermal isolator.

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## 9.5 Condenser Coil (FOR AIRCOOLED CHILLER)

- The coil frame shall be constructed of minimum 2.0mm galvanized steel sheet.
- The tube sheet shall have die-formed-drawn collars to support the tubes.
- An intermediate coil support shall be provided on coils with a finned length of more than 1m.
- Fin shall be made from corrugated Aluminum plate.
- Maximum fin spacing shall be 12 FPI for fin corrugated plate type.

Standard tubes shall be seamless drawn copper tubes alloy ASTM C12200 (Cu=99.9%) DHP according to ASTM B-68, condition light anneals (O50). Tolerances for diameter and wall thickness according to ASTM B-251. Grade SF-Cu according to DIN 1787, type ISO Cu-DHP.

## 9.6 Condenser Fans (FOR AIRCOOLED CHILLER)

Condenser fans shall be of propeller rotorex type Aluminium alloy blades with coating, installed below top of unit and externally driven electrical motor. Motor are manufactured with thermal protection device of the self-resetting type, to protect the motor from overheating. The motors are factory wired, using special wires for high ambient operation. Condenser fans shall be statically and dynamically balanced. Fan shall be installed with suitable fan guard made from heavy gauge galvanized wire. Electrical motor shall be Class "F" insulation and class "B" temperature rise with IP55 protection completely suitable for outdoor operation.

## 9.7 Electrical / Control Panel (FOR AIRCOOLED CHILLER)

**HVAC/PLC** control system with auto-change over from operating to stand by package unit shall be provided. Outdoor packaged unit shall be supplied with unit-mounted IP-54 electrical/ control panel enclosure completely suitable for outdoor operation, designed for automatic operation and insuring safety, efficiency, sequence control for the fans. All wiring is sized as per applicable electrical code. The control panel is factory wired for 230v-1ph-50Hz control power supply.

An additional built-in 24v fused low voltage transformer, for case of connection to cooling thermostat.

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- Individual compressor and condenser fan motor contractors.
- Fuses for condenser fans.
- Individual condenser fan over current protection
- Low pressure safety switch
- Anti-freeze protection
- High pressure safety switch
- Outdoor power & Control panel shall be equipped with separate cooling system.
- For compressor protection, provide over heating instrument and safety signal.
- Head pressure control by fan cycling for low ambient and part load operation.
- Suction and discharge pressure gauge.
- Electrical and control panel shall be supplied with built-in internal electric heater to provide heating when the panel is out of service to provide rust protection due to high level of humidity.
- Panel shall be equipped with internal lighting when the panel door is wide open.
- Control panel shall be manufactured by proper HMI suitable for outdoor installation to show all important chiller operation values (supply/return temperature, suction/discharge pressure, compressor running and sequencing).

## 10 EXHAUST FAN

### 10.1 ROOF POWER VENTILATOR

A typical belt-driven/direct drive centrifugal roof exhauster consists of the following section and related specification:

#### 10.1.1 Roof Mounted Exhaust Units

The fans used in roof exhaust units shall met the requirements of centrifugal flow or propeller fans.

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The cowls and bases shall be of materials which are resistant to the external environment and solar radiation appropriate to the location of the fans.

Casings shall be complete with integral weatherproofing provisions suitable for direct fixing to the building structure.

Adequate access to electrical supply terminals and lubrication points shall be provided by means of hinged cowls or other means as appropriate. Back draft dampers shall be included. Bird wire guards shall be provided as an integral part of the unit. Unless otherwise stated, selection of fans to be such that the operating point on the performance curves allows a minimum of 15% increases in duty. The motor is to be sized accordingly.

#### **Testing and Commissioning:**

The supplier shall provide to the Contractor copy of the type certificate, certificate of conformity for these HVAC packages.

## **10.2 Centrifugal Fans**

Each centrifugal fan shall be SWSI or DWDI as required, furnished completely assembled and fitted with electric motor, direct drive/V-belt drive, belt guard, inlet guard, flexible connections and vibration isolating base.

Fans shall be sized regarding to the performance requirements specified and shall be rated and certified in accordance with B.S. 848 Part 1. The vendor shall guarantee the fans performance will not be impaired when housed within the fan chamber of the air handling unit.

#### **Efficiency:**

The Centrifugal Fans shall be suitable for continuous operation at the design duty selected, with efficiency as per ASHRAE or AMCA standards recommendations. (Fan working point shall be located on the most efficient area as per vendor performance curve.)

#### **Fan Discharge Velocity:**

Fan discharge velocity shall not exceed 10 m/s.

#### **Margin Factor:**

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Fans shall be selected to give a margin for adjustment of +10% performances without reaching critical shaft or impeller speeds. Fan motor shall be selected for maximum power plus 20% spare capacity.

#### **Vibration Isolators:**

The fan and motor shall be mounted on a common frame structural steel main chassis and shall be isolated from the casing with spring type vibration isolators with at least 95% attenuation. The fan anti-vibration mounting shall be supplied bolted to the support frame.

#### **Fan and Motor rpm:**

The motor shall operate at optimum rpm suitable for 400 volts, 3 phases or 230 volts, 1 phase and 50-cycle operation. Fan speed shall not exceed 1500rpm.

#### **Fan Impellers:**

It shall be according to related HVAC equipment data sheets.

#### **Fan Blades:**

Blades shall be of the non-overloading with non-overloading power characteristic. The blades shall be staggered on each side of the center plate. The wheel shall be keyed to the carbon steel shaft and the key secured with setscrew.

#### **Fan Shaft:**

The fan shaft shall be CK 45. The fan shaft shall be accurately turned ground polished and ring gauged for accuracy.

#### **Fan Bearings:**

Fan bearings shall be designed to give operation of 40,000 hours continuously rated. The fan bearings shall be split plumber block; grease lubricated spherical roller/ball bearing type. Bearing shall be self-aligning grease lubricated double roll ball enclosed within two-piece housing and supported on a pedestal either side of fan via a tubular arm assembly.

#### **Fan Housing:**

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Fan housing shall be provided with an access door, bulkhead light, drain plug located at the bottom of the casing, and flanged inlet and outlet connections and an easily removable inlet cone. Centrifugal fans mounted in air handling unit enclosures will not have flanges on the inlet to the fan assembly. The access door shall be provided on a vertical panel of the fan section and shall be airtight. The fan section shall have bulkhead light fitting and 200 mm diameter double wall viewport. Light fitting wired to an external on/off switch mounted on unit.

#### **Fan Pulley:**

The fan pulleys shall be keyed, and taper locked to the drive shaft.

#### **Fan Belts:**

The fan motors shall be mounted outside the housing on the skid base with the fans being driven by a multi-belt drive with not less than 2 belts on the drive. Fan(s) shall be belt driven with No. of belts=N+1. (N=No. of belts required). Belt tensioning and motor alignment facilities shall be provided.

Provision shall be provided for fan and motor speed checks via 50mm access holes, also a slot shall be provided so that belt tension checks can be made without the removal of fan belt drive guard.

The fan motor shall be provided with an adjustable slide to accommodate belt adjustment.

#### **Hazardous Environment:**

Anti-spark and anti-static features should be provided on fans operating in an emergency, for smoke removal and/or to operate in a hazardous environment.

The supplier shall ensure the terminations have been completed and tested at his works, and the enclosures are securely fixed to the skid. These tests shall include the following:

Insulation resistance tests shall be conducted prior to and after executing high voltage tests. Insulation resistance shall be measured by applying a D.C. test voltage from a “Meggar” insulation meter or equal and approved.

All terminal and junction boxes externally mounted shall be designed to shed rainwater and prevent the accumulation of standing water on any part of the enclosure.

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### Materials of Construction

The Contractor shall use the materials specified in referenced specifications and, where not specified, in selecting materials and designing the centrifugal fans the Contractor shall give special consideration to the operating and environmental conditions specified.

Spark proof fans shall be constructed according to AMCA 99-401 types A for ferrous or non-ferrous metals.

### Base Frame and Housing:

The entire Base frame and housing shall be constructed from continuously welded mild steel plate with a minimum thickness of 2mm; the casing shall be from carbon steel.

## 10.3 IN – LINE EXHAUST FAN

General Requirements are as below:

### Efficiency:

The mixed flow and axial flow fan shall be suitable for continuous operation at the design duty selected, with an efficiency of at least 60%.

Fan Discharge Velocity: Fan air discharge velocity shall be a maximum of 10 m/s.

### Margin Factor:

Fans shall be selected to give a margin for adjustment of +10% performances without reaching critical shaft or impeller speeds.

### Fan Impellers:

Impellers for mixed flow fans shall be of non-overloading, non-stall characteristics with airflow at right angles to the direction of rotation. The fan shaft and impeller assembly to be statically and dynamically balanced to BS 686 Part I or equivalent standard subject to Contractor approval.

### Axial Duct Fans:

Axial flow fans shall be long casing complete with access panel for inspection/maintenance.

### Hazardous Environment:

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Anti-spark and anti-static features shall be provided on fans operating in an emergency, for smoke removal and/or to operate in a hazardous environment.

The Contractor shall ensure the terminations have been completed and tested at his works, and the enclosures are securely fixed to the skid. These tests shall include the following.

Insulation resistance tests shall be conducted prior to and after executing high voltage tests. Insulation resistance shall be measured by applying a DC test voltage from a “Meggar” insulation meter or equal and approved. All terminal and junction boxes externally mounted shall be designed to shed rainwater and prevent the accumulation of standing water on any part of the enclosure.

Impellers shall be of steel, Aluminium or plastic and shall secure to the hub.

Spark proof fans shall be constructed according to AMCA 99-401 types A for ferrous or non-ferrous metals.

#### **Casing:**

Casing shall be constructed from fully welded rolled tubular mild steel to BS EN 10130 with integral flanges rolled at each end for connection to the ductwork.

Fan casings shall be hot dipped galvanised after manufacture to BS EN ISO 1461.

#### **Access Doors:**

Access doors shall only be provided on fans greater than 400mm diameter, these should be airtight and of bolted construction.

#### **Impeller:**

The impeller shall be constructed from mild steel to BS EN 10130 and painted to the Suppliers standard for H2S applications.

#### **Drive Guards:**

Drive guards to be manufactured from galvanised mild steel complete with brass anti-spark track and removable inspection covers.

#### **Flexible Connections:**

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Flexible connections shall be complete with mating flanges to fans and ductwork. The minimum length of flexible connections shall be 200 mm.

#### **Vibration Isolators:**

Anti-vibration mountings shall be totally enclosed and provide a minimum of 95% vibration isolation.

#### **Fan Frame:**

The fan assemblies shall include an integral support frame. This frame shall be suitable for lifting and transportation without any permanent deflection. Lifting lugs or eyes shall be provided within the structural support frame.

Lubrication points shall be provided external to the fan assembly.

Belt tensioning and motor alignment features shall be provided.

Provision shall be made on the outside of the fan casing to monitor the fan bearings using a handheld shock pulse meter. Fans sizes up to 400 mm shall be fitted with tuned rods. Fans greater than or equal to 500 mm shall have flame proof transducers fitted to each bearing block with terminations on the fan casing.

### **10.4 WALL MOUNTED AXIAL EXHAUST FAN**

A typical wall mounted axial exhaust fan shall consist of the following sections and related specification.

- For sizing and configuration, refer to data sheets and HVAC drawings.
- Fan wheels shall be statically and dynamically balanced. Should fan motor or fan bearing have appreciable noise or vibration, fan wheel, motor, bearings, or all of them shall be replaced.
- Fan bearings shall be self-aligned and heavy-duty type for long life.
- Fan housing shall be constructed of steel sheet (ST-37).

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- Fans shall have louver shutter to open and close with fan operation. Louver shutter shall be rigidly constructed and free of vibration or rattle.
- Wall mounted fans shall have square panelled framework.
- Impeller shall be constructed of Aluminium or galvanized and equipped with side guard.
- Class "F" insulation and class "B" temperature rise shall be considered.
- Controller etc.

## 11 AIR DEVICES

General Requirements are as below:

- All types of dampers shall be constructed to withstand and/or close against an internal pressure of 2000 Pa and a duct velocity of 15 m/s. When in the fully open position, damper pressure loss at an approach velocity of 10 m/s shall not exceed 35 Pa.
- All remotely operated dampers must open and close in opposed blade position. All dampers shall be suitable for mounting within ductwork and have purpose made flanges.
- The Supplier shall use the materials specified herein the referenced specifications and where not specified; the Supplier shall be responsible for the selection of materials of construction. In selecting materials and designing the dampers the Supplier shall give special consideration to the operating and environmental conditions specified.
- The Supplier shall specify within the bid all proposed materials to be used. Final selection of materials will be subject to Contractor approval.
- As indicated by the Contractor dampers located and/or operating under hazardous environment shall have junction boxes, micro switches, and solenoid valves suitable to operate in such conditions.
- Blade linkages shall be attached to extended spindles by pinning and arranged for operation on one side of the damper casing only. Linkage arrangement shall not prevent replacement of bearings.

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### 11.1 Manual volume dampers:

Sufficient manually operated volume control dampers shall be installed in the ductwork where necessary, to regulate and balance the air distribution system. Air leakage past fully closed dampers shall not exceed 5% of the maximum design airflow in the duct. Each damper shall be fitted with a locking and position indicator device. All dampers shall be propriety units, and not manufactured by the sheet metal fabricator.

Manual volume dampers shall be multi-leaf opposed blade type; except that single blade type (butterfly type) may be used in rectangular ducts having 150 mm and less and round ducts of diameter less than 400 mm. Damper casing and blades minimum thickness shall be however not less than 2 mm and blade material shall be from Aluminium profile.

Dampers shall be operated by locking type quadrant operator; the quadrant operator for dampers installed in ducts to be thermally insulated shall be provided with standoff mounting adapters to provide clearance from the insulation.

### 11.2 Back draft and pressure relief dampers:

Back draft dampers shall be gravity shut-off types such that in the event of fan failure, the damper closes automatically. Blades shall act in parallel and have flexible tip seals manufactured from a suitable material. The blades shall be a single skin 0.8mm thick Aluminium sheet metal. A strip of flame-retardant PVC shall be bonded to the back of each blade to form a seal between the adjacent blades.

Mechanical pressure control dampers shall be the gravity operating type having fully interlocked blades arranged to give parallel action. The backpressure exerted by the dampers shall be by means of an adjustable spring to weights.

### 11.3 Fire Dampers:

Fire dampers shall be selected, manufactured, and installed in accordance with the relevant Code and Standards. Curtain type dampers (where automatic remote opening and closure is not necessary) shall be arranged to spring close tight when released by the fusible link. Dampers shall be equipped with

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external position indicators and shall be capable of electrically relaying the status of the damper blade to a remote source. Fire damper shall have as the minimum the same fire resistance as the wall or slab in which it is located and shall be in accordance with NFPA 90A requirements.

All fire dampers shall be fail-closed types. Fusible link shall be set for 70°C and be an approved pattern. An inspection hole or adequate system shall allow easy replacement of a fuse.

Fire dampers shall have frames and blades manufactured from sheet steel hot dip galvanized. The blades shall be formed from a double skin, aerofoil section. Each Skin shall be 1.00mm thick hot deep galvanized sheet metal. Bearings shall be of the sealed for the lifetime of the equipment and without lubrication. The damper assembly shall be internally wired by the Supplier and terminate at the Supplier junction box.

Electrically actuated fire damper shall be complete with micro-switches, which shall indicate the damper in open and closed position or fault. Resetting shall be possible without any special tools.

An inspection hole or an adequate system shall allow easy replacement of a fuse. Fire dampers shall be tested according to UL or ISO 10294 (or another equal standard)

#### 11.4 Smoke Dampers:

- Damper shall be designed for air flow isolation to prevent smoke migration into supply air system.
- Damper shall comply with underwriters' laboratories (UL) standards UL 555S
- Leakage class I, 8 CFM/ft<sup>2</sup> @ 4" w.g.
- Temperature rating of 250°F to 350°F
- Frame: 12 gage galvanized steel channel
- Blade: Aluminum air foil 0.08 thick double-skin type, opposed blade action
- Position: Vertical or horizontal position whichever applies.

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## 11.5 Motorized Dampers:

Motorized dampers shall be specifically for automatic control applications and shall be multi-leaf opposed blade type; except that single blade type (butterfly type) may be used in rectangular ducts having 150 mm and less and round ducts of diameter less than 400 mm. Damper leakage class shall be class I according to AMCA standard 511 (or related equivalent standard) Damper casing and blades minimum thickness shall be however not less than 1 mm when steel made or 2 mm if aluminium. Motorized dampers shall have frames and blades manufactured from sheet steel hot dip galvanized. The blades shall be formed from a double skin, aerofoil section. Each Skin shall be 1.00mm thick hot deep galvanized sheet metal. Bearings shall be of the sealed for the lifetime of the equipment and without lubrication. The damper assembly shall be internally wired by the Supplier and terminate at the Supplier junction box. Dampers shall be fitted with mounting plate rigidly fixed to the casing to support the actuator and shall also be provided with position indicator. Dampers shall have nylon, PVC, or bronze self-lubricating bushings. Each motor controlled isolating damper shall be complete with micro-switches which shall indicate the damper in open and closed position or fault. The motorized control and isolating dampers shall be driven by the HVAC control system. It shall also be possible to drive manually each automatic damper.

Damper shall be sized to accept a differential pressure of 4000 Pa without buckling.

## 11.6 Blast Dampers (If required):

Blast Dampers shall be of a parallel rotation, multi-blade design, of exceptionally rigid construction, which will withstand an explosion blast force of 1.0 bar.g without damage.

Material shall be stainless steel grade 316.

All frame members shall be formed from 5mm thick material. The frame members have integrally formed external flanges around the duct aperture. Frame members shall be welded together at duct corners and across flanges.

The casing flanges shall be 55mm wide and 5mm thick.

Bearing housings shall be fully welded to the drive side (control enclosure end) and non-drive side (idle end) frame members. Each bearings housing carries a Zeron duplex stainless steel bearing bush

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with thrust face. The Zeron bushes must be highly resistant to corrosion and form a non-galling bearing pair with a stainless-steel shaft.

Blade shafts are of the stub type design. Each shaft shall have a machined flat at its inner end for direct attachment to the blade and be secured with two locked bolts.

In a multi-bladed Damper, slave shafts at the drive side shall be linked to the drive shaft and transmit motion to the other blades.

The blades consist of a single thickness of 5mm plate with lips formed at the leading and trailing edges. This lip strengthens the blades and additionally provides a measure of protection from direct weather/storm impingement.

In the closed position the blade 'lipped edges' clip together and engage with top and bottom duct stops to form a sealed fire barrier.

These profiled stainless-steel seals are continuously welded to the entire duct perimeter. The Blast Damper blade shall be designed to close by the blast pressure present in the duct and aided by gravity. The blades shall be normally secured in the open position by the tension. The design shall facilitate the adjustment to release the Damper blades from the 'open' position for various explosion pressures, thus shutting down the duct and protecting the system.

When in the 'open' position the blade is held at 40 degrees by cam and roller mechanism, which breaks under explosive pressure. The blades then remain closed until the explosion forces have decayed.

Applying torque to the external reset shaft of the Damper will then manually reset the blades.

Blast dampers shall be ATEX certified.

## 11.7 Diffusers:

Unless otherwise indicated on the air terminal devices data sheet, each diffuser shall be provided with an airflow rate controller and a means of altering the discharge airflow pattern.

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All controllers shall be adjustable from the front of the diffuser (equipped with adjustable volume damper). Where a diffuser is directly connected to a stub duct, which has a straight length of less than two equivalent diameters, an equalizing deflector shall be used.

Cone type diffusers shall be provided, where indicated, with finish as indicated on the air terminal devices data sheet.

Circular diffusers, with adjustable airflow pattern, shall have the cone retained by a screwed spindle fitted with upper and lower stop pins or other approved method. All diffusers shall be provided with approved plenum boxes, secured to the diffuser, and having top or side mounted spigots for the connection of flexible ducting.

Where diffusers are intended to be less than 4-way throw, the Supplier shall ensure the correct orientation.

Supply diffuser shall be sized for maximum air velocity of 2 m/sec for manned and 3 m/sec for unmanned area.

## 11.8 Grilles and Registers:

Grilles and registers for supply air shall have two sets of adjustable blades, one set horizontal and one set vertical. Unless otherwise indicated on the Contractors air terminal devices data sheet.

The airflow rate controller for supply air registers shall be a damper of the opposed blade multi-leaf type or rhomboidal type.

Grilles and registers for extract air shall have a single set of adjustable blades either horizontal or vertical, or a lattice or egg crate front as indicated on the Contractors air terminal devices data sheet.

The blades of all grilles and registers shall be adjustable from the front and shall have a friction device to retain set positions. The air flow rate controller of all registers shall be adjustable from the front.

Return or exhaust grill shall be sized for maximum air velocity of 2 m/sec for manned and 3 m/sec for unmanned area.

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## 11.9 Door Grilles:

These should be of the non-vision, door-mounted type having a fixed core of inverter "V"-blades.

Maximum air velocity for door or wall grills shall be 1.5 m/sec.

## 11.10 Louvers:

Louver shall be sized for maximum face velocity of 2 m/sec for inlet, 3 m/sec for exhaust system.

All inlet and outlet louvers shall be supplied complete with bird/insect wire mesh guards and designed to minimize the penetration of wind driven dust, sand, and moisture into the system.

Bird screens shall be 12 x 12 mm mesh, 1.2 mm diameter; insect screens shall be 1 x 1 mm mesh; 0.4 mm diameter.

All intake and discharge louvers should be weather tight under the prevailing local weather conditions.

The maximum air pressure drop through any louver should not be greater than 30Pa.

## 11.11 Sand Trap Louvers:

Sand Trap inlet louver in naturally ventilated areas shall be of the inertia separation type consisting of vertical channel separator vanes mounted in an enclosure frame having self-emptying sand/moisture discharge openings in base.

Sand traps shall have 90% efficiency for particles from 350~700 $\mu$ m and 80% efficiency for particles from 75~700 $\mu$ m at 1 m/s.

The complete assembly of sand trap louver shall be made of ST-37 material.

The main frame shall be 1.5mm thick, complete with mating flanges for fixing to Building frame or HVAC ductwork spool connection.

The sand trap louver shall have vertical vanes of 1mm thick for sizes up to 1000mm x 1000mm, 2mm thick up to 4000mm x 4000mm and for above this the vertical vanes shall be 3mm thick.

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The sand trap louver shall be designed to remove the average solids of 26 mg/m<sup>3</sup> during wind speeds at ground level of 3~4 m/s. The design shall be suitable for these values at a duration not exceeding 6 hours.

The sand trap louver blades shall be in labyrinth form, arranged to allow passage of air but resist the entry of airborne sand into the HVAC intake and or exhaust ductwork.

The sand trap louver shall be complete with deflector plate at the bottom of the vertical vanes.

Sand removal shall be in front of the louver face via the inlet hopper. For sand trap louver sizes up to 1000mm x 1000mm there shall be a minimum of 2 discharge points and 4 discharge points above this size.

**Materials:**

Supply diffuser, Register Grilles, Door Grilles and Louvers shall be made of Hot deep galvanized steel sheet painted with suitable color for site conditions, unless other material selected in the datasheet.

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## 12 CAST IRON BOILER

Boilers are cast-iron, designed to burn fossil fuels and transfer the released heat to water. Boiler designs provide for connections to a piping system, which delivers heated fluid to the point of use and returns the cooled fluid to the boiler.

Boilers construction shall meet ASME Boiler and Pressure Vessel Code. Boilers are equipped with heat exchangers for domestic water service.

Boiler is rated for a maximum working pressure that is determined by the applicable boiler code under which it is constructed and tested. When installed, it also must be equipped at a minimum with operation and safety controls and pressure temperature-relief devices. The maximum working pressure shall be 4 bar.

Cast-iron sectional boilers are designed according to ASME SCIV requirements and range.

Boiler controls shall provide automatic regulation of burner and boiler performance to ensure safe and efficient operation. Boilers shall meet The National Fire Protection Association (NFPA) Code85, Boiler and Combustion Systems Hazard Code (NFPA 2007), Chapter 17 and Chapter 14 of Iran Construction Engineering shall be applicable for combustion.

## 13 DOMESTIC HOT WATER TANK

The Hot water Tank shall be water to water vertical and consisting of domestic cold-water line, recirculation pump line, inclined thermometer, drain valve, ASME relief valve with discharge pipe to hub end drain and tube, manhole, temperature controller, steel angle legs and base plate and heat exchange tube bundle with all related controllers and equipment such as 3-way control valve, balance valve, gate valve and temperature controller. vertical Hot water Tank shall be made of ST37.2 -in accordance with DIN standard- or Copper-Silicon. Shell Material shall be hot-galvanized steel with three-layers of epoxy coating. Copper coil with 1mm thickness shall be used. The design pressure of the Vessel shall be 125 psig as a minimum. Water pressure and temperature relief valves shall be in accordance with ASME standard. The Tank shall be coated with three layers of epoxy-coated colors with heat resistance for use in sanitary applications.

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THE Vessel shall be specified to be ASME constructed, inspected, and stamped.

## 14 EXPANSION TANK

An expansion tank must be included to allow fluid expansion and contraction. It consists of vent, floating valve, drainpipe, cold water make-up, gate valve and all other necessary connections and proper operation component.

Expansion Tank use on hot water heating and chilled water-cooling closed system piping to eliminate the air found in the system and protect it from excessive pressure. The expansion tank shall be located on the suction line of the pump and close to the circulating. Open expansion tank shall be placed on the top of the buildings.

The expansion valve shall be used with safety valve. There should not be any valve between safety valve and expansion tank. Open expansion tank shall be made in accordance with DIN standard. ASME standard shall be used in construction of open expansion tank.

## 15 PUMP

### 15.1 CIRCULATING BASE –MOUNTED PUMPS

Supply and Install factory assembled and tested (original manufacturer's test reports) packaged pump set suitable for Boiler hot water and chiller chilled water HVAC services.

Vendor shall furnish a complete pumping set, i.e. pump, driver, base plate and auxiliaries (such as flexible coupling and guard, on skid piping and valves, lubrication system, controls, etc.) as required, and shall be responsible for the satisfactory operation and compatibility of all components.

#### **Pump H(Q) curve (characteristic curve)**

The manufacturer/supplier shall make available the characteristic curve which shall indicate the allowable operating range of the pump as supplied. Characteristic curves of the smallest and largest impeller diameter shall be plotted on the performance chart for pumps conforming to ISO 2858 and for other pump types when requested by the purchaser.

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Unless otherwise specified, the rated flow shall be within the region of 70-120% of Best Efficiency Point of the furnished impeller. Performance curves shall be extended to at least 120% of capacity at peak efficiency.

Pumps with a stable characteristic curve are preferred.

If specified by the purchaser, it shall be possible for pumps that are to be used with constant speed drives to increase the head by approximately 15% at rated conditions by installing new, larger, or different impeller or purchaser.

The position of the duty points in the flow range relative to the best efficiency point should be decided by the purchaser as a function of the specific application and anticipated variation in flow for optimum operation.

## 15.2 Horizontal pumps

Unfiltered vibration shall not exceed the vibration severity limits as given in below Table when measured on the manufacturer/supplier's test facilities.1) These values are measured radially at the bearing housing at a single.

operating point at rated speed ( $\pm 5\%$ ) and rated flow ( $\pm 5\%$ ) when operating without cavitation.

### Vibration:

Maximum allowable vibration severity			
Pump arrangement	Pump type	Maximum values of r.m.s Vibration velocity mm/s	
		h<225	h>225
Pump with rigid support	Horizontal pumps	3.0	4.5
Pump with flexible support	Horizontal pumps	4.5	7.1
All	Vertical pumps	7.1	

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### Pressure/Temperature Rating

The maximum allowable working pressure of the pump at the most severe operating conditions shall be clearly defined by the manufacturer. In no case shall the maximum allowable working pressure of the pump casing and cover including shaft seal housing and gland follower/end plate) exceed that of the pump flanges.

For pumps complying to ISO 2858 the following shall apply:

- a) the basic design pressure of the pump shall be at least a gauge pressure of 16 bar at 20 °C when made of cast iron, ductile iron, carbon steel or stainless steel.
- b) for materials, the tensile requirements of which do not permit the 16-bar rating, the pressure/temperature rating shall be adjusted according to the stress temperature rating for the material and shall be clearly stated by the manufacturer/supplier.

### Impeller design

Impellers of closed semi-open or open designs may be selected according to the application. Cast or welded impellers shall consist of one piece, excluding wear rings.

Impellers shall be secured against circumferential and axial movement when rotating in the intended direction.

If field adjustment of impeller axial clearance is required, external means shall be provided. If adjustment is seal(s).

Fabricated impellers are not accepted. Single piece cast impellers could be machined for exact geometries and shall be machined for keyway and secured to shaft.

Spare impellers shall always be proposed and supplied at maximum diameter. Pinning of the impeller is not acceptable. All impellers shall be keyed to their shafts. Impellers for multistage pumps shall be individually secured against axial movement in either direction along the shaft.

### Shafts and shaft sleeves

The surface roughness of the shaft or shaft sleeve at the stuffing box, mechanical seal, and lubricant seal. if provided. shall be not greater than 0,8  $\mu\text{m}$  Ra unless otherwise required for the seal.

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Consideration should be given to the use of lower levels of surface roughness (e.g. 0,4  $\mu\text{m}$  Ra) for mechanical seals using axially dynamic shaft or sleeve seals. Measurement of surface roughness shall be in accordance with ISO 3274.

Shaft sealing shall be mechanical seal type.

Axial movement of the rotor permitted by the bearings shall not adversely affect the performance of the mechanical seal.

### Lubrication

The operation instructions shall include information on the type of lubricant to be used and the frequency of application.

### Coupling

The pump shall normally be coupled to the drive by flexible coupling. The coupling shall be sized to transmit the maximum torque of the intended driver. The speed limitation of the coupling shall correspond to all possible operating speeds of the intended pump driver.

A spacer coupling shall be provided where required to permit the pump rotor to be dismantled without moving the drive. Coupling spacer length is dependent on the distance required between shaft ends for dismantling the pump. The distance between the shaft ends should be in accordance with an International Standard where possible.

A limited end float coupling shall be used if the drive has no thrust bearing.

Coupling halves shall be effectively secured against circumferential and axial movement relative to the shafts.

Shaft ends shall have threaded centre bores, or other means shall be provided to ensure proper coupling assembly.

Couplings shall be of two-piece, flexible, spacer type, permitting change of flexible membrane without disturbing the alignment of shafts.

Coupling service factor shall be at least 1.5 on motor nameplate for centrifugal pumps directly driven by electric motors, unless a more stringent limit is specified by the coupling technical bulletin.

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Coupling guard shall be made of non-sparking material unless otherwise specified in the datasheet.

Assembly of pump and driver on baseplate

Single pump-motor baseplates shall be supplied with motor, coupling, auxiliaries, and pump assembled on it and ready to operate.

### 15.3 BOOSTER PUMP

The booster pump shall be multistage to provide high water pressure for buildings and the more stages the pump has the higher the final discharge pressure. The pump shall be of robust construction with all rotating parts carefully balanced to prevent undue vibration. The pump set shall be designed for installation in horizontal or vertical position the pump shall have stable characteristics and shall be capable for continuous operation at any flow rate over the specified operating range. The booster pump shall be bolt to a rigid foundation. For service convenience a gate valve and union shall be installed in the inlet and discharge line.

General Requirements are as below :

- To avoid medium flowing back through the pump a non-return valve shall be installed on the discharge line.
- Each pump shall have its own inverter.
- All hydraulic parts of the pump shall be made of stainless steel.
- Booster pumps shall be protected by a low-pressure cut-off switch to shut-off the pump(s) if the suction pressure drops to an unsafe value
- A pressure relief valve shall be installed on systems where the discharge line can be shut off or obstructed
- The efficiency at the specified duty point shall be the maximum value and for pumps, which driver is medium voltage motor best efficiency point shall be at least 80%
- The limiting sound pressure level for the pump set shall not exceed 85 dBA at any point 1 m from the pump set.

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- Material of construction shall be as per ASTM standards. In special cases DIN, BS or any other well-known international materials as substituted materials to ASTM ones can be selected, after granting Purchaser's approval, if they are equivalent or superior to ASTM ones
- Pump chamber shall be stainless steel-304.
- Cooling water, gland oil, lube oil and recirculating piping systems, including all accessories such as gauge, orifice, and valves, shall be supplied and furnished by the pump manufacturer fully assembled and installed on the pump.
- When special tools and fixtures are required to disassemble, assemble, or maintain the unit, they shall be including in the quotation and furnished as part of the initial supply of the machine.
- Pumps shall be capable of at least 5% head increase at rated conditions by replacement of the impeller(s) with one(s) of larger diameter or different hydraulic design.
- If parallel operation is specified, the head rise from rated point to shutoff shall be at least 10 %.
- Vent and drain connections shall be flanged and valves shall be provided. Drains shall be piped to the edge of the base plate.

### **Pump Casing**

The pump casing shall be fitted with replaceable wear rings. Delivery flanges shall be provided for installation pressure gauges.

### **Pump Shaft**

The pump shaft shall be protected from wear by replaceable sleeves as appropriate. The pump shall be fitted with mechanical seals suitable for use with a pressure greater than the sum of the closed valve head of the pump and the maximum suction head. Mechanical seal shall comply with the API 682 standard. Pump shaft shall be made of stainless steel-431. Axial movement of the rotor permitted by the bearings shall not adversely affect the performance of the mechanical seal.

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Measurement of surface roughness shall be in accordance with ISO 3274. The diameter of the portions of the shaft or shaft sleeves in contact with the shaft seals shall be in accordance with ISO 3069 where practicable.

### **Pump Impellers**

The impellers shall be designed with sufficient strength to withstand all possible stresses imposed by the drive. The impellers shall be machined to close limits inside the pump casing and dynamically balanced. The direction of rotation of the impeller(s) shall be clearly marked on the casing by permanent means. The pump rated impeller shall not be the maximum or minimum size impeller for the pump casing. Impellers for multistage pump shall be individually secured against axial movement in either direction along the shaft. The impellers shall be made of stainless steel-304.

### **Pressure Gauges**

Suction and delivery pressure gauges of suitable range and graduated in both kPa and metres head of water shall be provided. The gauge complete with isolating cock shall be mounted at the tapings adjacent to the pump suction and delivery flanges.

### **Bearings and Bearings Housings**

The radial and thrust bearings shall be preferably of rolling element type. Vertical pumps with motor greater than 37 kW, shall be provided with separate thrust bearings.

Bearing housing shall be arranged so that the bearing can be replaced without disturbing pump driver or mounting. Bearing housing for horizontal pumps shall be equipped with replaceable oil seals on shaft passages to effectively retain the oil inside the housing and prevent entry of foreign material into the housing.

These bearings shall conform to the relevant ISO or other equivalent standards.

### **Couplings**

Couplings shall be of two-piece, flexible, spacer type, permitting change of flexible membrane without disturbing the alignment of shafts. Coupling shall be of stainless-steel flexible element with steel coupling hubs provided with spacer.

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Coupling service factor shall be at least 1.5 on motor nameplate for centrifugal pumps directly driven by electric motors, unless a more stringent limit is specified by the coupling technical bulletin.

Coupling guard shall be made of non-sparking material unless otherwise specified in the datasheet.

### **NPSH**

The curve of NPSH required by the pump shall be submitted for assessment. The NPSHA shall exceed the NPSHR by at least 0.6 m at the rated flow.

### **Motor**

The pump shall normally be directly driven at standard electric motor speeds, unless otherwise stated in the data sheet. For motor IP55 shall be considered.

### **Controls and Instrumentation**

- Electric motors shall be designed, manufactured, and tested in accordance with “Technical Specification for MV Motors” and “Technical Specification for LV Motors” in accordance with project MDL.
- All instruments and controls, when applicable to the pump skid, shall be fitted for purpose, suitable for the climate, hazardous area, and environment for which they are intended according to the same standards and requirements applicable for this project.
- Manufacturer shall ensure that the equipment is properly certified for the specified classification
- All vibration detection and temperature sensor devices on the equipment shall be suitable for prevailing temperatures. When applicable, field amplifiers, transducers, etc., shall be installed as per Manufacturer practices, according to the area classification to protect them against mechanical damage.
- All wiring within the limits of the enclosure shall be clearly marked on the wire and at the terminal.
- All cabling between the driver and the local gauge board shall be furnished.
- All cables and cable routes shall contain at least 20% of the extra capacity.

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- The minimum alarm and shutdown functions shall be as required in the technical data sheet.
- All the sensors elements for monitoring shall be supplied by pump manufacturer with electric connection to the junction box supplied inside pump skid.
- Manufacturer must consider that sensors shall be connected to Machinery Monitoring System, so that, they must be specified for it.

### Pump Tests

Inspection and tests should be performed according to the Purchaser's relevant Datasheets and Inspection and Test Plan Vendor shall submit procedure for each test for Purchaser's approval. Purchaser's personnel or representative have the right to inspect manufacturing and tests of pump units and their assembly.

All hydrostatic, performance and NPSH tests shall be in accordance with API 610 For performance test, tolerances shall be in accordance with table 16 of API 610 11th editions. The pump performance test shall be carried out at the rated pump speed. Certified test curves are required, curves shall be drawn from the test data (at least 5 points) obtained for the purchased pump and shall include head, efficiency, NPSH and brake horsepower recalculated to the proper specific gravity plotted against capacity. During shop test, operation of the pump with acceptable vibration levels shall be demonstrated from minimum continuous stable flow to maximum allowable flow.

All pump components subject to pressure shall be hydraulically tested to a pressure of at least 1,5 times the maximum allowable working pressure of the pump.

## 16 CONTROL VALVES

Control valves are used to maintain space temperature conditions by altering the flow of water to the cooling coil. Two-way valves shall be used to control the flow in variable flow systems. The valve shall pass the maximum flow when about 90% open.

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- Control valves shall have actuators with enough force to open and close under the maximum pressure differential in the system. The control valve should have a pressure drop through the valve equal to at least 10~30% of the static pressure drop of the distribution system
- All control valve bodies shall be suitable for the static and dynamic pressures of the system.
- Valves serving heat exchange coils and heat exchangers shall have equal percentage flow characteristics. Closed system temperature or pressure bypass valves shall have equal percentage or linear control characteristics. Open system temperature bypass valves shall have linear control characteristics.
- Unless otherwise specified, control valves 2 inches and smaller shall have cast iron or bronze bodies with screwed NPT connections. Valves between 2½ inch and 6 inches shall have cast iron or bronze bodies with flanged connections.
- All automatic control valves shall be installed by the mechanical trade. All control valves shall be sized by the control vendor.

### Body Ratings

Inlet pressure ratings shall be in accordance with ANSI/ASME standards. Pressure/Temperature rating curves or tables shall be submitted in accordance with "Manufacturer's Standard" ratings.

### Materials

The material of valves shall be according to ASME Standard B16.34.

In selecting proper valve materials, the valve body-bonnet material shall be selected first and then the valve plug and seat trim.

### Testing and Examination

- All completed valve assemblies shall meet the pressure test and examination requirements of API 598 unless approved otherwise by the Purchaser. Valves which contain elastomeric O-rings (e.g., Neoprene, Viton, etc.) are provided from stock, and are older than 5 years from the date of manufacture shall be retested.
- All ball valves 2" and above shall meet the pressure test requirements of API 6D.

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- All pressure containing welds shall be considered as a part of the valve assembly and shall be subject to all applicable design, fabrication, material, examination, testing, and inspection requirements.
- The type and/or style of stem packing used during the pressure test shall be the same as that final packing supplied with the valve.
- When specified, fire testing shall be in accordance with API 607. Ball valves 2” and above shall meet the fire test requirements of API 6FA.

#### Valve Tagging Requirements

- The Manufacturer shall attach to each valve a metal nameplate or tag of corrosion resistant metal stamped with characters approximately 5 mm high with the manufacturer's name and model number, and the size and style of valve.
- All valves having a preferred direction of flow shall be marked by permanent means with a flow arrow or bridge wall marking to indicate the direction of flow, which results from pressure under the valve seat or disc. The preferred method of marking is for arrows to be cast or forged into the valve body. Use of stamping or another method shall not affect the required pressure thickness. Stamping shall be with “low stress” steel.