HVAC & PLUMBING DESIGN SPECIFICATION

00	13-Feb-2023	Issued for Approval	H.R	H.R	M. Mahmoodi
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1 INTODUCTION

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.

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

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

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^2 below 10 m 120 kg/m^2 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.

7 HVAC CONTROL SYSTEM

The air conditioning, ventilation and pressurization systems shall be monitored by HVAC control system and supplied by vendor.

Power supply, communication module and CPU shall be redundant.

Electrical power for HVAC control panel shall be considered from HVAC power panel emergency feeder, also backup battery should be considered for each HVAC control panel by vendor.

The conversion of 400 volt to 110 volts inside the HVAC electrical panel is by vendor.

The HVAC control system shall drive such function of the buildings as:

- Pressurization and ventilation.
- Normal starting sequence of each system.
- Maintenance of internal temperatures and psychrometric conditions.
- All the running conditions: on, off, fault, for each part of equipment
- Automatic change over to stand by equipment.
- All alarms.
- Emergency operation including the shutdown and restart of the HVAC after an emergency.

Fresh air, return air and fan discharge motorized dampers shall close when the respective fan stops and open when the respective fan starts.

Each pre-filter and filter shall be provided with a pressure differential switch high to provide an alarm.

Fan discharge flow switch is set at a predetermined setting point shall send a no air flow alarm signal. The operating system shall stop, and the standby system shall automatically start.

The HVAC panels shall have the facilities for receiving signals from the fire and gas control system to protect each concerned area. On receiving these signals, the panels shall take the shutdown actions for packaged unit and associated motorized dampers shall be closed. The system shall be started by manual switch only.

Each HVAC electrical & control panel shall send HVAC status signal to fire & gas system.

A HVAC control and electrical panel is required in each packaged unit. Each panel shall include 2 separated parts: one for the control system and the other one for the electrical part. This panel shall be made by vendor and assembled on each unit.

Backup battery for HVAC control panel should be supplied by vendor.

8 PIPE AND DUCT WORK

8.1 Pipe Work

- Gate and globe valves size 2 in. and smaller shall be bronze body, union bonnet type, threaded ends, class 150.
- Check valves size DN50 and smaller shall be bronze body, swing or ball type, threaded ends, class 150.
- Flanges at battery limit connection points shall match the class of the flanges of the incoming utility piping.
- Drain piping for condensate from all air-cooling evaporators shall be provided with a trap; the trap shall be sufficient depth to prevent air of unit fan from entraining water in the air stream due to improper coil drainage.
- Condensate drains from packaged units shall be taken to discharge on the nearest floor drain in HVAC room or on the roof.
- Pipe support system shall consist of hangers, supports, anchors and guides and shall be of correct size and strength to withstand all static and dynamic conditions, allowing for proper expansion, contraction and anchoring of the piping system; vertical risers and drops shall be properly restrained and supported.

Individual horizontal piping shall be suspended by clevis type or swivel ring type hangers; multiple pipes in rack may be suspended by trapeze hangers with U-bolts.

Vertical piping shall have riser clamps securely bolted with end extensions bearings on the building structure.

Hanger and supports for steel piping shall be ferrous; hanger and supports for copper piping shall be non-ferrous or have a liner to prevent electrolytic action.

Threaded rods used shall be hot-dip galvanized; steel hanger and support elements shall be hot-dip galvanized.

Maximum hanger spacing and rod size for horizontal piping shall be as indicated in below table here below.

Where two or more pipes are to be carried by a single support, the support spacing shall be for the shorter interval.

Vertical piping shall be supported or guided at intervals not exceeding 3m and shall be supported at the base of the riser.

Maximum hanger spacing		
PIPE SIZE (IN.)	MAX.SACING (M)	ROD SIZE (MM)
1/2 -1	2	6
11/4 - 2	2.5	10
21/2 - 3	3	10
4 -5	3.5	13
6	4.5	13
8 - 10	6	16
12	7	22

The interior of pipes shall be thoroughly cleaned, fittings, valves, and other devices from any foreign matter before installation; dirt and foreign matter shall be excluded from installed pipes by closing open ends with appropriate covers.

8.1.1 Piping insulation

All condensate piping, refrigerant gas piping shall be insulated in accordance with the following requirements:

- All insulation material including jackets, facings, adhesives, coatings, tape, and accessories shall be listed and fire hazard rated.
- All pressure and leakage tests shall be completed and approved before application of insulation.

Piping insulation materials shall be in accordance with the following standard:

- Insulation shall be fire resistant.
- Refrigerant gas minimum 10 mm of closed cell elastomeric type
- Condensate pipes 9 mm of telomeric material. (Just for exposed pipe)

Vapor barrier permeability shall be no more than 0.05.

8.1.2 REFRIGERANT PIPES

Refrigerant pipe Insulation shall be closed-cell elastomeric pipe insulation suitable for refrigeration applications, 10 mm thick minimum.

Pipe work insulation in HVAC plantroom and outdoor shall be covered with Aluminum sheet metal.

8.1.3 COLD & HOT WATER PIPES

All insulating materials used shall:

- Be non-combustible.
- Not emit toxic fumes or smoke when heated.
- Be inorganic and non-hygroscopic.
- Be chloride free.
- Be asbestos free.

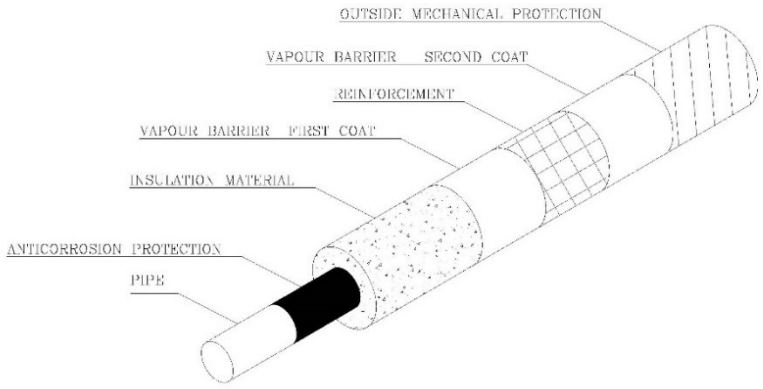
Insulated piping shall be provided with saddles at hanger points and hardwood plugs or blocks at hanged points to prevent compression of insulation.

Vapor barriers shall form a complete seal to prevent condensation occurring on the exterior surface of the pipe.

All penetrations through the vapor barrier shall be sealed by wrapping.

All hot water concealed pipe inside wall or floor shall be covered 9mm telomeric material.

8.1.4 DOMESTIC COLD-WATER PIPES (outside the building)



Pipe	Gal. Carbon steel
Insulation material	2” Mineral wool (slag wool or rock wool) pipe warp -be applied dry or Polyisocyanurate
Vapor barrier	First and second coats: monolar mastic
Reinforcement	OPEN woven glass cloth dipped in vapor barrier
Outside mechanical protection	Stainless steel 316L 0.4 mm thickness.

8.1.5 DOMESTIC HOT & COLD-WATER PIPES (inside the building)

A)DOMESTIC HOT WATER:

For hot water pipes exposed:

Pipe	Gal. Carbon steel
Insulation material	Elastomeric insulation, λ=0.035 w/m.k . (1” or 30 mm)
Vapor barrier/mechanical protection	Vapor barrier plus Aluminum cover (minimum 130 micron)

For hot water pipes located inside the internal walls:

Pipe	Galvanized Carbon Steel
Insulation material	wrapping with 20% overlap + Elastomeric insulation, λ=0.035 w/m.k . (9 mm)

B)DOMESTIC COLD WATER

For exposed piping, located in pipe chases at exterior walls or passing through electrical equipment rooms:

Pipe	Galvanized Carbon Steel
Insulation material	Elastomeric insulation, λ=0.035 w/m.k . (9 mm)
Vapor barrier/mechanical protection	Vapor barrier plus Aluminum cover (minimum 130 micron)

For cold water pipes located inside the internal walls:

Pipe	Galvanized Carbon Steel
Insulation material	wrapping with 20% overlap

All pipe insulation shall be extended through sleeves.

C)HOT WATER (SUPPLY & RETURN) PIPES

Hot water above ground pipes inside buildings shall be insulated as:

Pipe	Carbon steel
Anticorrosion protection	MIO 165 or Hempalin Red Lead12370- Primer
Insulation material	1” Mineral wool (slag wool or rock wool)pipe warp -be applied dry or Polyisocyanurate
Vapor barrier	First and second coats: monolar mastic
Reinforcement	OPEN woven glass cloth dipped in vapour barrier

All pipe insulation shall be extended through sleeves.

8.2 Duct Work

Duct work shall be constructed in accordance with SMACNA, ASHRAE, and NFPA 90A, 90B and 91.

There are three classes of duct construction to correspond with the three pressure classifications:

Class A: Low pressure ducts suitable for a maximum positive operating pressure of 500 Pascals and a maximum negative pressure of -500 Pascals.

Class B: Medium pressure ducts suitable for a maximum positive operating pressure of 1000 Pascals and a maximum negative pressure of -750 Pascals.

Class C: High pressure ducts suitable for a maximum positive operating pressure of 2000 Pascals and a maximum negative pressure of -750 Pascals.

8.2.1 Duct Work Design Principles

Ductwork dimensions shown on the relevant layout drawings represent the nominal inside dimensions.

Ductwork shall be true rectangles, squares, or circulars as the case may be and being without deformation. Duct work shall be constructed straight, smooth on the inside with neatly finished joints, airtight in accordance with leakage limit, and free from vibration under all operating conditions.

The ductwork shall be completed with providing all connections to ductwork for instrumentation provided by others.

The design of ducts at structural joints in buildings shall be such that the joint is not affected by ductwork.

Where possible ductwork shall be concealed above false ceilings, the ductwork design shall ensure that the air velocities are uniform across the duct section and that eddies in the duct are avoided. The pressure drops through each branch of the main ductwork systems should be as equal as possible.

Fasteners such as nuts, bolts, screws etc, Shall be cadmium coated stainless steel.

To prevent air leakage, sealant gaskets and tapes should be applied.

Duct sealing material and gaskets shall be non-combustible materials in addition; exterior duct sealant shall be weather resistant to provide watertight seal.

Sufficient hand holes and clean out openings shall be provided in the ductwork systems for access, maintenance, cleaning and adjustment of all control equipment.

The connection with equipment shall be designed so that the performance of the equipment is not affected by the ductwork.

To prevent contact between the metals and reduce noise, the joints of dissimilar metal in a ductwork shall be insulated with fiber gaskets, and bolts with fiber ferrules and washers.

All slip joints shall be made in the direction of flow, all elbows shall have a centerline radius equal to 1-1/2 times the width of the duct.

The ventilation facilities (fan/ductwork systems) shall be designed to handle necessary volume of the conditioned air to always maintain the room design condition.

The air distribution system shall be routed from the HVAC room to other air-conditioned spaces by means of the most convenient routes available with respect to other services in building.

All devices mounted on ductwork shall be accessible for maintenance and inspection.

All supply and extract diffusers/grilles provided shall be selected with limited pressure drop, limited noise level and allow free air distribution within the area.

Applicable Software: The applicable software for detail design of HVAC system is last version of carrier E20 and HAP load calculation.

Sufficient hand holes and clean out openings shall be provided in the ductwork systems for access, maintenance, cleaning and adjustment of all control equipment.

To prevent contact between the metals and reduce noise, the joints of dissimilar metal in a ductwork shall be insulated with fiber gaskets, and bolts with fiber ferrules and washers.

8.2.2 Duct Sizing

Duct work shall be sized considering the velocity and friction rate design limits suggested by ASHRAE. The design of the duct system shall consider the space available, allowable noise levels, Duct leakage, thermal and noise insulation, effect of air contaminants on duct materials, fire and smoke control and pressure losses due to friction and turbulence.

The common methods of air duct system design which are recommended for use are as follows:

8.2.2.1 Equal Friction Method

In the equal friction method, ducts are sized for a constant pressure loss per unit length. When energy cost is high and installed ductwork cost is low, a low friction rate design is more economical. For low energy cost and high duct cost, a higher friction rate is more economical. After initial sizing, calculate the total pressure loss for all duct sections, and then resize sections to balance pressure losses at each junction. This method is used for exhaust and return air ducts design.

8.2.2.2 Static Regain Method

In this method the static pressure increase (static regain) at each take-off, offsets the pressure loss of the succeeding sections of ductwork. This method is especially suited to supply systems having long runs with many registers and diffuser located at take-offs. With this design procedure, approximately the same static pressure exists at the entrance of each branch, simplifying outlet selection. This method is used for supply air duct design.

8.2.2.3 Constant Velocity Method

This method is generally applied to exhaust systems.

8.2.3 Duct work Material and Coating

The outdoors & internal ductwork could be constructed from prime quality galvanized sheet metal according to ASTM A653 and coating designation Z275 and ASTM 924M.

Outdoor duct installation shall be protected from oxidizing. If outdoor galvanized ducts have not been weather proofed, stainless steel 316L material shall be considered. Minimum thickness for outdoor galvanized ductwork shall be 1.2 mm.

All connection flanges shall be constructed from galvanized angle; hence, all welding points shall be coated by cold galvanized painting.

Outdoor supports for ducts, dampers, etc. shall be made of galvanized steel. Otherwise, supports shall be painted and protected against corrosion according to the relevant painting specification.

Recommended minimum zinc coating requirement on each standard 1000×2000mm galvanized sheets shall be per the following schedule:

- 0.26 kg/m2 for 0.5 mm thick sheets
- 0.315 kg/m2 for sheets 0.6 mm to 1 mm thick
- 0.375 kg/m2 for sheets 1.20 to 1.25 mm thick

The supply and exhaust air ducts and louvers shall be of stainless steel 316L material construction in battery rooms.

All ductwork materials and supports installed in the buildings shall be Galvanized steel except the followings:

- Kitchen hood(s) exhaust duct, which shall be constructed with stainless steel 304L.
- Dishwasher hood(s) exhaust duct, which shall be constructed with stainless steel 304L.
- Battery rooms duct (supply and exhaust) which shall be constructed stainless steel 316L.
- ASTM A167 for stainless steel ductwork shall be considered.

As an option, pre-insulated duct (For example Polyisocyanurate Foam (PIR)) with aluminum cladding can be used in projects.

8.2.4 Sheet Metal Gauge

The sheet metal gauge used in the ducts and the reinforcing required depend on the pressure conditions of the system. Rectangular ductwork shall be constructed as here in after specified and shall meet ASHRAE codes and standards.

The following recommended fabrication schedule for galvanized sheet metal ducting shall be used in low pressure system:

Duct Dimension	Thickness
UP TO 450 mm or Ø<450	0.6 mm (24 gauges)
450 ~ 1050 mm or Ø<910	0.75 mm (22 gauges)
1050~ 1500 mm or Ø<1320	1.0 mm (20 gauges)
Above 1525 mm or Ø>1320	1.25 mm (18 gauges)

Ductwork inside mechanical rooms or roof shall not be less than 20 gauges (1.0mm thickness).

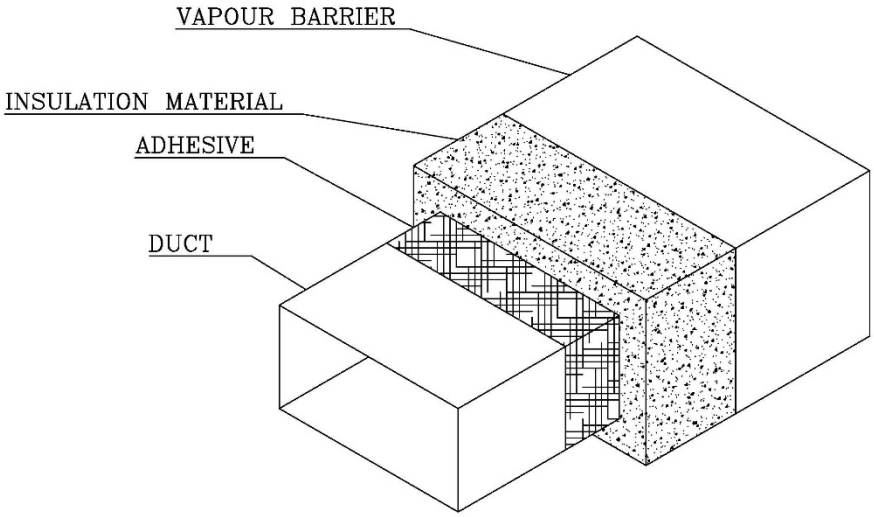
8.2.5 Duct Insulation

Thermal insulation

As general requirement, all insulating materials shall be non-combustible as defined by NFPA 220. No insulation utilizing CFC's in manufacture or having asbestos content shall be used.

Thermal insulation for ductwork shall be a minimum of 25 mm for mineral wool and 19 mm for Elastomeric (EPDM type) insulation thick for internal ducts, having thermal conductivity "k" of 0.035 W/m K or less, at a mean temperature of 24°C and a minimum of 80 mm thick (mineral wool) for external ducts.

Duct insulation materials shall be in accordance with the following standard:



INSIDE DUCT

- Duct: Galvanised steel (or stainless steel in case of wall penetration)
- Adhesive: Special adhesive for elastomeric insulation
- Insulation material: Elastomeric insulation (EPDM type), λ=0.035 w/m.k
- Vapor barrier/mechanical
- Protection: Aluminum cover (minimum 130 micron)

OUTSIDE DUCT

- Duct: Galvanized steel (or stainless steel in case of wall penetration)
- Adhesive: Special adhesive for elastomeric insulation
- Insulation material: Elastomeric insulation (EPDM type (UV and radiation resistant)), λ=0.035 w/m.k
- Vapor barrier/mechanical
- protection: Aluminum cover (minimum 400 micron)

All supply & fresh ducts shall be insulated and return ducts in unconditioned spaces shall be insulated.