HVAC DESIGN CRITERIA

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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	50 °C
Summer coincident wet bulb temperature	25 °C
Summer design relative humidity	15.7%
Summer daily temperature range	25 °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 INDOOR DESIGN CONDITION

7.1 Pressurization

Buildings air conditioning will be provided at 25-50 Pa over pressure to ensure that dirt, dust, and sand are not ingested into the internal environment, except for toilets and battery room which will be kept at a slightly negative pressure with respect to adjoining areas.

7.2 Air Velocity in Manned Zones

Unless otherwise indicated, air speed in occupied areas shall not exceed 0.15m/sec.

7.3 Heat Transmission Coefficients (U Values)

The heat transmission coefficients shall be calculated according to ASHRAE calculation method and architectural components specifications. Heat transmission coefficients at walls, roofs with adequate thermal insulation will be considered as a basis for cooling & heating loads calculations. Heat transfer coefficient will be extract from public material property which has been issued by public reference such as Iran construction national regulations, 19th issue.

The values given below are the minimum U values to be used for heating and cooling loads calculation of air-conditioned areas shall be:

External insulated walls:	0.35 $W/m^2.°C$
External non insulated walls:	2.2 $W/m^2.°C$
Roof (with insulation):	0.3 $W/m^2.°C$
Windows:	2 $W/m^2.°C$
Doors:	4 $W/m^2.°C$
Floor (without insulation):	2 $W/m^2.°C$
Slab:	1.75 $W/m^2.°C$

- Color of buildings medium
- All mentioned values are the minimum accepted value and the exact value for U value shall be calculated from architectural detail drawing.

7.4 Heat gains

7.4.1 Heat Gains from Lighting & Office Equipment

Spaces	Lighting
Technical Rooms, cabinet room, operator room, office	10 W/m^2
Other Rooms, UPS room, Battery room, Switchgear room	15 W/m^2

Office Equipment	Heat gain
Desktop Computer	150 w

7.4.2 Heat Gains from People

People Activities	Heat gain
Sensible heat gain	71 w/person
Latent heat gain	60 w/person

7.4.3 Noise criteria

HVAC equipment sound pressure level shall not exceed 85 dB(A) beyond 1 m from equipment. The maximum allowable sound pressure level in control room, computer rooms and offices shall not exceed 50 dB(A).

Area Description	Maximum Allowable Sound Pressure Level
Office, control room	40 dB(A)
Laboratory Building	45 dB(A)
Substation/cable cellar	60 dB(A)
HVAC Room	85 dB(A)

If the noises generated by the equipment exceed the specified noise level, suitable sound attenuator shall be provided to achieve the noise level required. Anti-vibration mountings shall be provided to isolate all rotating equipment from the structure and flexible connections shall be provided between rotating equipment and ductwork/pipe work. Acoustical lining to be applied at first 1.5 meter of supply/return ductwork.

7.4.4 Filtration Efficiency

Sand:

To reduce the concentration of sand particles in the air to an acceptable level, sand trap louvers will be provided at each fresh air inlet as required.

Dust:

Efficiencies shall be as follows:

Pre-filter section:	EU2 (70% Arrestance) Aluminum Washable filter
First stage pleated filter:	(45% dust spot)
Second Filter section:	EU8 (95% dust spot efficiency) bag filter

Air filtration efficiencies for pre-filters and final filters, in accordance with ASHRAE standard 52.1 and AFI (American Filter Institute)

8 HAVC EQUIPMENT CHARACTERISTICS

8.1 Filters/ Sand Trap Louvers

A) **Filters**:

Filter assemblies shall comprise available bag and Aluminum filters for use in packaged or air handling units.

Aluminum filters shall be used as prefilters, pleated filter as secondary, bag filters shall be used as third stage filters. Filters shall be selected with a maximum front velocity of 500 fpm first stage and 350 fpm second and third stages.

Bag filters shall have a static pressure drop not exceeding 1 in.w.g when are dirty. For each filter differential manometer shall be provided.

Prefilter shall be made of aluminum, which is washable, by hot water and detergent with low resistance.

Bag filters shall be made of woven glass fiber. Frame shall be made of galvanized pressed steel.

B) **Sand trap louvers**:

Sand trap louvers shall be provided at unit fresh air inlets. They shall be as follows:

- Vertical slots to separate dust and sand from air stream.
- Sand discharge opening in the base,
- Bird wire meshes guard.

8.2 Packaged Units

Packaged units shall be direct expansion packaged type comprising manufacturer's standard components.

Each Packaged Units shall comprise but is not limited to the following components assembled and mounted on a common frame:

- Air Pre-filter Section
- Air Filter Section
- Direct Expansion Cooling Coil
- Self-draining, corrosion resistant condensate pans.
- Droplet eliminator
- Electric heating coil (if necessary)
- Humidifier (if necessary)
- Mixing box with motorized dampers
- Supply Fan driven by electric motor.
- Mounting brackets incorporating vibration isolation units.
- Compressor section

8.2.1 Casing

The casing of each air handling unit section shall be made of steel frame hot dipped galvanized steel sheet and double skin (50 mm minimum) plate panel. exterior sheet 1.5mm and Interior sheet shall be1mm.

Insulated with 50 mm polyurethane foam injection or board with density in the range of 32 to 48 kg/m3 and thermal conductivity of 0.023 w/m.ºk.

The entire casing painted by 75-micron epoxy primer and 50-micron polyurethane topcoat.

The casing shall be stiffened and braced to eliminate distortion and drumming.

8.2.2 Filter Section / Mixing box

The air pre-filters and filters shall be in accordance with the international standards. Filters frames and filters shall be provided with each Air Handling unit. The filter section shall be V-bank type with side access for easy removal.

Air filters section shall comprise disposable panel pre-filters and filters for use in Air Handling units. Panels filters shall be mounted on stainless steel 316L guide rails and be easily removable. Filters shall have gaskets to prevent the bypass of unfiltered air.

Each filter shall be fitted with a differential manometer fitted with upstream/downstream pressure measure tubes.

Mixing box is equipped with two Aluminum opposed blade dampers for fresh-air and return-air. Dampers can be controlled manually.

Filters shall be washable Aluminum with 30% dust spot efficiency as pre-filter, first bed, pleated filter 45% dust spot efficiency as second bed and bag filter with Min. 85% dust spot efficiency as third bed.

Filters shall be selected with a maximum face velocity of 500 fpm for pre-filter and 350fpm for two other stages. For each filter, differential manometer shall be provided.

Filters sections shall be designed for easy withdrawal and replacement of filters. Hinged access door shall be situated on a vertical panel of the filters section to remove pre-filters or filters. Access door shall be airtight.

8.2.3 Cooling Coils

The coil shall consist of copper tubes with Aluminum fins, mounted in a steel sheet flanged frame suitable for mounting within a packaged unit.

Cooling coil section shall be provided with stainless steel condensate water basin and drain.

The following factors shall be considered for the selection of the cooling dehumidifying coils:

- Required capacity.

- Psychometric conditions of entering air
- Available cooling media and operating temperature
- Coil face air velocity (cooling coil face velocity shall be lower than 450 fpm)

All Copper/Aluminum alloy parts in contact with atmosphere shall be coated with "Bly-gold" or approved equal.

8.2.4 Self-Contained Electric Humidifier

The Electric Pan Type humidifier shall be connected to HVAC electrical panel and fed with potable water.

Electric Pan Humidifier comprise several perforated tubes or sheets which shall install internally or externally with heating elements in braze tubes.

Equipment shall be provided with the following control devices:

- On/ Off switch,
- Low water level switch
- Safety overflow
- Control circuit fuse
- High temperature cut-off,
- Proportional regulation
- Pilot lamps: on/off and fault
- Floater and Drain
- Air flow switch and high limit humidistat

At least two heating elements shall be provided. To avoid superheating, heating elements shall be fully immersed during operation.

In case of high-pressure feed water, a pressure-reducing device shall be provided. In case of low-pressure feed water, a pressure boosting installation and feed water tank installation are needed.

Humidifiers shall have water blow down capacity to minimize solids build up.

Steam spray pipes shall be fitted on the air duct by means of flanges.

Humidifiers shall be equipped with an earthing connection.

All components of humidifier casing are stainless steel.

8.2.5 Fans

Fan casing shall be made of galvanized steel sheet. Centrifugal fan impeller shall be backward curved blades made of high tensile steel, statically and dynamically balanced.

Axial fan impeller shall be multiplied type, made of Cast Aluminum alloy, statically and dynamically balanced.

All fans shall have non-overloading performance and power characteristics. The fan operating point shall be selected on a steep section of the fan curve, approaching a straight vertical line from minimum to maximum static pressures, to minimize variation in delivered air volume; due to change in external wind pressure and/or filters pressure loss.

Driven motors shall be in accordance with area classification, suitable for the environmental ambient conditions and designed according to relevant electrical specifications.

Fans shall be selected to meet the following criteria:

- Designed airflow and available static pressure.
- Noise level
- Efficiency
- Maximum fan speed, 1400 rpm
- Motors shall be selected according to:
    - Fans maximum power + 20% of margin
    - Starting torque
    - Starting time

- Ambient conditions
- Number of starts per hour.

Flexible connections shall be of non-combustible material.

Fan discharge velocity shall not exceed 2000 fpm and the fan motors shall have IP55 degree of protection with class F insulation.

Fan speed shall not be greater than 1200 rpm.

All Motors should be started with 80% nominal voltage (20% voltage drop)

8.2.6 Electric Heating Coils/Duct Heaters

Electric heating coils/duct heaters shall be mounted in a fire rated section and an anti-radiation shield installed to protect the nearest components.

Electric heating coils/heaters shall be provided with terminal box and as minimum the following prewired electrical control/safety components:

- Suitable disconnecting switch
- Contact for interlocking with the supply fan.
- Relay for remote alarms
- Automatic reset and manual reset thermal cut-outs.
- High temperature safety cut-out
- Earthing clamp on the casing and bolt in the terminal for connection of earthing cables

The heating element will be selected to limit terminal air reheat temperature below 50° F for each element.

Electric heating coils/ heaters shall be designed for 10% over capacity and according to speed of the airflow. In any case, the superficial exchanger temperature shall be lower than 90° F.

Electric heating coils/ heaters shall be suitable for installation within low velocity (i.e. less than 650 fpm). Air pressure drop shall not exceed 60 Pa at the nominal flow rate.

Electric parts of electric heating coil shall be at least IP55 for outdoor equipment, except for motors junction boxes that should be at least IP55 for indoor and outdoor installation.

Heating coils / heaters with more than 4 Kw heating capacity shall be prewired for thyristor control. For capacities less than 4 Kw, a step controller or a 3-stage thermostat shall be used.

8.3 Air-cooled Condenser Unit (ACCU)

Each Air-cooled condensing unit shall include compressor (should be finalized in detail design stage), air cooled condenser, microprocessor-based control panel, starter, thermal expansion valves. Air-cooled Condenser Unit skid mounted, factory wired, suitable for outdoor mounting. The units are factory assembled and mounted on a rugged steel channel base.

Each Air-cooled Condenser Unit shall comprise but is not limited to the following components assembled and mounted on a common frame:

- Compressor
- Condenser
- Control panel
- Starter
- Thermal expansion valves
- Fans

8.3.1 Compressor section

Components shall be skid mounted and housed within an insulated casing with removable panels to afford access for maintenance and inspection.

The casing shall be made of steel frame and double skinned panel of 50 mm thickness.

All component parts including the painting of the casing shall take in to account the environment atmosphere conditions.

Compressors can be semi-hermetic screw type. They shall be mounted on spring isolators.

Internal refrigerant pipes shall be made of hard copper, thermally insulated.

Refrigerant shall be R -134a.

Cooling units shall be electronically controlled.

Cooling coils and condenser coils shall be provided with Aluminum fins and Copper tubes. Shall be coated with "Bly-gold" or approved equal, only on exposed coils. Regarding to coated coil; modification factor and coil calculation shall be submitted by vendor.

Coils shall be selected according to:

- Cooling, dehumidifying capacity required to maintain balance with other system components
- Required capacity.
- Psychometric conditions of entering air
- Cooling media and operating temperatures
- Coil air face velocity

Drain pan shall be provided under entire cooling coil section. The pan shall be sufficient size to catch all condensation drip page from any part of the unit. Drain pan shall be of hot dipped galvanized steel sheet and shall be insulated to prevent condensation from the pan.

The compressor(s) shall be mounted on vibration free isolators and motor(s) shall be protected against overload, breakdown, and short cycling.

The compressor(s) shall be equipped with a 230V crank case heater (whenever required) and shall be equipped with electrical, or pressure actuated un-loader and oil sight glass (whenever applicable).

Refrigeration Circuit:

Refrigeration circuit shall include necessary Solenoid Valve, Expansion Valve, Filter Drier, Moisture Indicator, Sight Glass and Gage Ports, Liquid Injection and Accumulator.

8.3.2 Coil

Condenser coils are manufactured from seamless Copper tubes mechanically bonded to Aluminum fins. An integral sub cooling circuit is provided to increase the condenser cooling capacity, without additional operating costs. Here site or approved equivalent shall be applied for coil and fin of the unit.

8.3.3 Casing

The unit casing is made of hot dipped galvanized steel sheets conforming to ASTM A653. The entire assembly comes complete with lifting holes to ease rigging for installation. Access panels are provided for easy service and maintenance.

75-micron epoxy primer and 50-micron polyurethane topcoat shall paint the casing.

8.3.4 Fan

The condenser fans are propeller type. Aluminum alloy blades directly drive by electric motors. Motors are totally enclosed, class “F” insulation and minimum IP55 protection. The 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.

Electrical/Control Panels

The unit mounted IP-65 electrical control panel enclosure comprises all starting, operating and safety controls.

The following are the components used in panel:

- Individual condenser fan motor contactors,
- Fuses for condenser fans,
- Individual condenser fan over current protection,
- Compressor interlocks,
- Refrigerant flooding control method,
- Head pressure control by fan cycling for low ambient operation,
- Fan cycle control,
- Control disconnects toggle switch,
- Control circuit fuses,
- 24 volts low voltage fused transformer for thermostat,
- Volt free contact or terminals for indoor fan motor starter interlock,
- Power and control circuit's terminal blocks.

8.4 Air Extraction System (EF)

Ventilation fans shall be selected, considering suitable type, capacity, class, noise, etc. complying with the requirements for the HVAC system.

Exhaust fan shall have the capability of remote start/stop from control panel.

Exhaust outlets shall be in opposite direction to any fresh air intake (or however diverging from as much as possible) and shall discharge, whenever feasible, in the direction of the prevailing wind. They shall also be located so that exhausts do not enter the building doors and windows or present a danger to people.

Bearing and lubrication arrangements shall be suitable for the conditions.

Protectively coated fans shall meet the appropriate requirements of the proceeding clauses relating to fans and the form of protection shall be specified.

Centrifugal fans shall be skid-mounted assemblies, complete with suitable mounting steel channels and appropriate vibration isolators for minimizing vibration and vibration-induced noise.

Belt guards shall be provided for all centrifugal fans.

- In battery room, where fans duty + stand-by are required to handle toxic, corrosive, flammable, explosive gases, materials of construction shall be as specified, and all relevant safety regulations shall apply.
- Impellers shall be PVC anti- spark Aluminum casing.
- Fan motor shall be explosion proof EEx 'd'-IIC - T3.
- Motors are totally enclosed, class "F" insulation and minimum IP55 protection.
- Operation of this fan will be manually, after an event is finished.

8.5 HVAC Electrical and Control Panel

Air conditioning, ventilation and pressurization system shall be monitored by HVAC automatic control system. The HVAC electrical and control panel shall be installed in HVAC room.

The HVAC control system shall equipment be microprocessor based and designed especially for use with HVAC equipment.

Electrical power shall be provided individually from the panel to each equipment (such as air handling units, air-cooled condensers, fans, etc.)

Supply power to HVAC Control Panel shall be nominal 400V-3PH-50HZ.

Manual operating devices and indicating equipment shall be installed in front of the control panel and shall comprise:

- Push buttons, switches for start/stop, open/closed functions, etc…
- Signal lights: on/off, open/closed, fault.
- Alarm lights with pushbuttons for acknowledgement and tests, including alarm lights for:
    - Filters fouling (pressure drop)

- Emergency shut down device.
- Lamp test push-button
- General switch

- Automatic change over between duty and standby units
- 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 main filter shall be provided with a pressure differential switch high to provide an alarm.
- Fan discharge flow switch, which is set at a predetermined setting point, shall send a no airflow alarm signal.
- Ability to shut down from a received signal from toxic gas and flammable gas detectors.

The HVAC electrical & control panel shall have the facilities for receiving signals from the fire and gas control system to protect concerned building. On receiving these signals, the panel shall shut down all HVAC equipment, motorized dampers and fire dampers and send a signal to F & G control panel. The system shall be started by manual switch only; however, DCS shall receive such signal. Other status monitoring signals shall be sent via Modbus RTU serial link to control system.

Control cabinet shall have 20% spare space.

Controls shall be electronic and electric. All alarm and maintenance information shall be completely independent from controls. Alarm electrical interface shall be realized by means of potential free switches.

All considered free voltage contact shall be d-energized to open to interface with other systems.

The panel shall be completely factory wired and tested.

Refer to Specification for Electrical Requirement for Package Unit.

8.6 REFRIGERANT PIPING

Each air-cooled condenser unit will be connected to each Air handling unit by appropriate refrigeration lines.

Piping shall be typing "L" hard drawn copper with wrought copper fittings. Connections shall be silver soldered (45% minimum silver solder). Flux containing ammonia and acid shall not be used.

Joints shall be brazed while dry gaseous nitrogen is continuously being released / circulated in the piping and past the joint.

The refrigerant piping systems shall include, but not be limited to:

- manual shut off valves.
- charging valves
- gauges (oil, discharge, and suction pressure)
- expansion valves
- relief valves
- sight glasses and gauge glasses
- strainers and filters
- vibration isolators
- flexible connectors

The refrigerant hot gas lines should not be insulated. Liquid lines do not require insulation unless they pass through an area of higher temperature or exposed to the direct rays of the sun for a considerable distance. The suction line shall be insulated to prevent capacity loss and possible sweating.

Refrigerant piping shall be designed according to procedures as outlined in the ASHRAE handbooks and good engineering practice.

Design should be such that oil migration through the system is kept to a minimum.

All copper/aluminum alloy parts in contact with atmosphere shall be coated with suitable resistance to UV-radiation and corrosive Environment.

9 CALCULATION

9.1 Cooling and Heating Loads Calculation

Calculation method shall be developed by using a computer program (HAP 4.5) based on ASHRAE methods or similar.

20% safety factor is considered for both cooling/heating in HAP software.

9.2 Air Flow Calculation

Airflow quantity shall consider:

- Indoor overpressure with respect to outdoor
- Minimum fresh air quantity in respect with rooms occupancy and equipment requirements
- Exhaust air requirements
- Total sensible heat gains

9.3 Ductwork Calculation

Calculation shall be prepared using established design methods as given in ASHRAE handbook fundamentals or similar approved method. Duct design shall be based on equal friction method for constant volume system (or static regain method according to SMACNA standard recommendation).

All duct works shall be constructed straight, smooth on the inside with neatly finished joints, air tighten according to leakage limit with fiber gasket, and free from vibration under all operating conditions. The duct work 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 main duct work systems shall be as equal as possible.

Flexible duct connections shall be provided on supply and return side of all fans of the air handling units, which are connected to the ducting systems. Duct liner for sound absorption in the interior surface of duct near HVAC equipment shall be applied up to 2 meters in length with required

thickness and shall not support heat and absorb moisture. Flexible connection shall not pass through any fire rated wall and shall be air tighten with a maximum length of 50cm.

Duct work shall be supported adjacent to flexible connections and axial stops shall be provided to accommodate the thrust forces at flexible joints. Fasteners such as nuts, bolts, screws, etc. shall be galvanized steel and shall be compatible with the duct work material.

Sound attenuators shall be installed in ducting where it is necessary to eliminate the noise level in different spaces to a specified level. These silencers fabrication and installation standard shall be the same as the ducting system.

Air velocities in “HVAC” systems shall not exceed the followings rates:

SPACE	Maximum Allowable Velocity m/s
Unmanned Area	
Main and Branches Ducts	10
Supply grilles	4
Return or Exhaust grilles	3
Manned Area	
Main Ducts	6
Branch Ducts	4
Supply grilles	2
Return or Exhaust grilles	2
General Equipment	
Cooling coils	2.8
Heating coils	3.8
Exhaust Louvers	3.5
Inlet Louvers	2.5
Door or Wall louver	1.5
Fresh air intake louver	1.5 ~ 2

The sheet metal gage used in the ducts and the reinforcing required depend on the pressure conditions of the system and the ducts size (aspect ratio shall not exceed 1:4).

Rectangular ductwork shall be constructed as here in after specified and shall meet ASHRAE codes and standards.

All sheet metal work shall be constructed of prime quality galvanized sheet metal according to ASTM A 653A.

The following gauges shall be applied for the rectangular ducts regarding to the duct size:

U.S.std. Gauge (mm)	**Max. Side** (cm)
24 (0.6mm)	up to 45
22 (0.75mm)	46 to 105
20 (1mm)	106 to 150
18 (1.25mm)	151 and up

Supply and Return and Fresh air ducts shall be insulated with rock/glass wool blanket or elastomeric insulation (EPDM type) or equivalent with maximum thermal conductivity of 0.04 W/m.k @ 20°C, non-flammable & vapor barrier, covered with aluminum jacketing. The insulation shall be continues thought floors, walls, partitions etc.

9.4 Pipe Work Calculation

Calculation shall be developed using established design methods as given in ASHRAE Handbook Fundamentals or similar approved method.

9.5 PLUMBING

Plumbing consists of all piping, fixture, appliances, and appurtenances in connection with any of the following:

- domestic cold and hot water
- sanitary sewage
- battery room drainage
- venting system

Estimated demand load for fixtures is based on flush tank system. A minimum pressure 0.54 Bar should be allowed for each fixture.

For service cold and hot water and drinking water pipes sizing, pressure drop shall be less than 4 m. per 100 m. of pipes.

The water velocity in pipes for main lines under 8fps (6 is recommended) and 1.2 m/s for branches.

Domestic Cold and hot water supply Fixture Unit considered on following table:

Fixture Type	Total "F.U."	Fixture Unit Cold water supply	Fixture Unit hot water supply
Water Closet	5	5	0
Toilet Mixing Valve	2	1.5	1.5
Lavatory	2	1.5	1.5
Pantry sink	3	2.25	2.25
Shower	4	3	3
Battery Room Sink	2	1.5	1.5
Laboratory Sink	2	1.5	1.5

Electrical water heater generates required domestic hot water supply (60 °C) in buildings based on the following table:

Fixture	**Hot Water flow rate** (L/h)	**GPH**
Lavatory (public)	45.5	12
Pantry sink	76	20
Laboratory sink	38	10
Battery room sink	38	10
Shower	850	225
Demand factor for industrial Plant	0.4	
Storage capacity factor*	1	

Note:

This table value is based on ASHRAE Handbook, HVAC Applications.

9.5.1 sewage piping

Sanitary sewage piping diameter and venting system are based on the following table:

Fixture Type	**Fixture Unit**	**Trap Size** (IN.)	**Pipe Size** (IN.)
Water Closet	5	4	4
Lavatory	2	2	2
Shower	4	3	3
Pantry sink	4	2	2

9.5.2 Materials

SANITARY SEWAGE:

A) Material of sanitary sewage and its venting pipes of buildings (embedded) shall be Polypropylene according to Iranian National Building code 16, EN 1451(Part 1&2) with rubber ring for connection or equal acceptable standard.

B) Material of sanitary sewage pipes of outside of building (sewage collection) shall be Heavy density polyethylene according to Iranian National Building code, EN 1519(Part1&2) or equal acceptable standard.

C) Material of expose sanitary sewage pipes shall be cast iron according to Iranian National Building Code 16, ISIRI 1547 or equal acceptable standard.

DOMESTIC WATER:

A) Domestic cold and hot water pipes material shall be PEX/AL/PEX up to 11/4 in. according to Iranian National Building code 16, ASTM F1281/F2262 or equal acceptable standard.

B) Domestic cold and hot water pipes material for greater than 11/4 in and shall be galvanized steel, conforming to ASTM A53/A53M or equal acceptable standard.

DRAINPIPE:

A) Drainpipe work from condensate drain pans of cooling coils and drainpipes from packaged units up to building drainage system shall be galvanized steel piping for above ground installation and high-density polyethylene (HDPE) piping for underground installation.

NOTE:

All Connection types and materials should be considered in accordance with related acceptable codes and standards of pipe material.

9.5.3 Pipe work Calculation

Calculation shall be developed using established design methods as given in ASHRAE handbook fundamentals or similar approved methods. As for refrigerant; piping shall be in accord to ASHRAE 15 standard.

10 SYSTEM DESCRIPTION

The systems applications described hereafter generally provide for one basic arrangement. which may satisfy a particular application; it is recognized that more than one arrangement? may be successfully applied to any requirement.

No	BUILDING		HVAC SYSTEM SUMMARY						
			Air conditioning system	Reserve	Cooling	Heating	Ventilation	Emergency Power	Remark
1	SUBSTATION NO.05	Switchgear And Related Spaces	ACPU + ACCU	1+1	DX	HOT WATER	EF	YES	-
		Cable gallery	-	-	-	-	EF	YES	-
2	PROCESS CONTROL BUILDING NO.03	Manned space and related spaces	ACPU + ACCU	1+1	DX	HOT WATER	EF	YES	BLAST PROOF
		Cabinet room and related spaces	ACPU + ACCU	1+1	DX	-	EF	YES	
5	FIRE STATION NO.2	Manned space and related spaces	ACPU + ACCU	1	DX	HOT WATER	EF	NO	-
		Fire Engine	UNIT HEATER	-	-	HOT WATER	EF	NO	-
7	CHANGE HOUSE-01&02	Inside Of Building	Existing HVAC System						
		Outside Of Building	FFU (1+1) for each CHANGE HOUSE building						

Note:

ACPU: Air Conditioning Package Unit
ACCU: Air Cooled Condensing Unit
EF: Exhaust Fan
RAC: Room Air Conditioner
FFU: Fan Filter Unit
FFU Fan Filter Unit

11 HAZARDOUS AREAS / BLAST PROOF BUILDINGS

The HVAC Electrical equipment shall satisfy to the project requirements regarding safety and hazardous areas (explosion proof and non-sparking equipment).

The air inlet and air discharge of blast proof buildings shall be fitted with explosion proof dampers/valves.

12 INTERFACE WITH FIRE AND GAS DETECTION SYSTEMS

The contractor shall provide F&G cause and effects which shall indicate the actions required of the HVAC systems in the event of an emergency and integrate with F&G signals. The following indicates the minimum actions that shall be performed by the HVAC systems.

In the event of Fire

Fire detection systems shall be interlocked with HVAC control systems to ensure safety for occupants in a fire alarm mode. Upon detection of a fire alarm within any of the buildings the HVAC controls shall deactivate the HVAC plant and equipment in the building which has the fire alarm signal from the fire control panel. On fire detection relevant fire dampers will be closed to isolate the effective room or building.

In the event of Gas

In the event of pre-determined levels of gas being detected in the HVAC air intakes, the HVAC systems affected shall automatically shut down. The fresh air and exhaust fire/gas dampers shall fail-safe closed.

However, the exception to this action is the HVAC system serving the control room, and electrical substations. The HVAC inlet and exhaust motorized gas dampers shall close shut, and the HVAC air system shall continue to operate in a full recirculation mode. The HVAC system shall continue to provide cooling facilities to these buildings.

13 INDOOR DESIGN PARAMETER

Air conditioning system & airflow ventilation rate should be sufficient to satisfy not only air removal specification, but also to maintain overpressure and temperature specifications. It should be also capable to avoid wind penetration to meet the requirements of a conditioned space, simultaneous control of temperature, humidity, cleanliness, contamination, and air distribution should be considered in design & selection of HVAC equipment. Indoor design conditions and air change rate for specific areas shall be indicated in the following table:

Room	Design Conditions				Fresh Air Mini		Min Exhaust Air	Over Pressure Value
	Summer		Winter					
	DB °C	RH %	DB °C	RH %	ac	l/s	ACH	
SUBSTATION NO.05								
01-DIESEL GENERATOR ROOM	NC	NC	NC	NC	NC	NC	30	-
02-CAPACITOR BANK	NC	NC	NC	NC	NC	NC	NC	-
03-TRANSFORMER ROOM	NC	NC	NC	NC	NC	NC	NC	-
04-BATTERY ROOM	<32	NC	NC	NC	-	-	10	Neg.
05-UPS ROOM	25 ±2	50±5	22 ±1	45±5	1	-	-	Pos.
06-SWITCHGEAR ROOM	32	NC	22 ±1	45±5	10% of Supply air		-	Pos.
07-PLATFORM	NC	NC	NC	NC	NC	NC	NC	-
08-CABLE GALLERY	NC	NC	NC	NC	-	-	2	Pos.
PROCESS CONTROL BUILDING NO.03								
01-CONTROL ROOM	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.
02-CABINET ROOM	25 ±2	50±5	NC	NC	2	10	-	Pos.
03-ENGINEERING ROOM	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.
04-INSTRUMENT UPS	25 ±2	50±5	NC	NC	1	-	-	Pos.
05-BATTERY ROOM	<32	NC	NC	NC	-	-	10	Neg.
06-HVAC ROOM	32	NC	NC	NC	1	-	-	Pos.
07-MANAGER OFFICE	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.

08-SUPERVISOR OFFICE	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.
09-ENGINEER ROOM	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.
10-CORRIDOR	25 ±2	50±5	22 ±1	45±5	1	10	-	-
11-W/C. SHOWER	NC	NC	NC	NC	-	-	15	Neg.
12-LOCKER ROOM	NC	NC	NC	NC	-	-	15	Neg.
13-PANTRY	25 ±2	50±5	22 ±1	45±5	-	-	10	-
14-INSTRUMENT OFFICE	25 ±2	50±5	22 ±1	45±5	2	10	-	Pos.
FIRE STATION NO.2								
01-FIRE ENGINE	NC	NC	+7	NC	-	-	6	Neg.
02-WORK BENCH	25 ±2	50±5	22 ±1	45±5	2	10	-	-
03-OFFICE	25 ±2	50±5	22 ±1	45±5	2	10	-	-
04-LOCKER	25 ±2	50±5	22 ±1	45±5	-	-	15	Neg.
05-TOILET	NC	NC	NC	NC	-	-	15	Neg.
06-PANTRY	25 ±2	50±5	22 ±1	45±5	-	-	10	-
07-STORE	NC	NC	NC	NC	-	-	6	Neg.
CHANGE HOUSE NO.2								
ALL INTERNAL SPACES	Existing HVAC System							

Abbreviation:

AC = Air Change

NC = Not Control

POS. = Positives

NEG. = Negative

14 SYSTEM DESCRIPTION

The systems applications described hereafter generally provide for one basic arrangement.

which may satisfy a particular application; it is recognized that more than one arrangement,

may be successfully applied to any requirement.

14.1 SUBSTATION NO.05

In the Substation Buildings there will be two separate HVAC/ventilation systems. One system for cable gallery (Ventilation system) and one for Switchgear, Battery Room, and HVAC room (HVAC system).

14.1.1 Cable Room

For cable room only mechanical ventilation shall be considered. Mechanical ventilation shall be provided via the supply & exhaust fans (Fan Filter Unit) connected with ducts and fitted with motorized dampers. Both fans are located on the roof.

Also, these fans will be used for CO_2 purging.

14.1.2 SWITCHGEAR ROOM

This space will be conditioned using an “Air Conditioning Package Unit” and air distribution system.

The following equipment shall be included as part of the HVAC system:

- The system shall be composed by two 100% “Air Conditioning Package Unit” coupled with two 100% “Air-Cooled Condensing Unit”. One unit is on duty and the second is in standby.
- The outdoor air is taken in with sand filter with bleed fan.
- The air is returned from rooms to the Air Conditioning Package Unit. The ACPU operates at a fixed constant volume and a variable temperature.
- The room temperature could be controlled by room thermostat.
- The RH will be controlled by Electrical Pan Humidifier.

- The air-cooled condensing units (one unit 100% standby) will be positioned in an electrically safe area. The units will have the relevant power/control panel.
- All necessary fire dampers shall be installed to maintain fire integrity of the building firewalls.
- The battery room is provided with hazardous rated twin duty/stand by exhaust fan. Air is exhausted into the outdoor atmosphere.
- Room pressure will be controlled by a pressure switch and motorized damper.
- Air handling units should be equipped with hot water heating coil. This heating coil will be supplied from PROCESS CONTROL BUILDING NO.03 Mechanical Room.

Battery Room:

The battery room shall be equipped with hazardous rated twin duty/standby explosion proof-anti spark exhaust fan. This fan shall be work only during boost charge of battery.

Therefore, fan shall have an interlock with battery system for running during boost charge of battery. During boost charge, air shall be transferred to battery room through a motorized damper and this damper shall have an interlock with exhaust fan.

Battery room sewage system should be equipped with a Neutralizing tank Before attachment into the site sewage system.

This shall be considered by substation building electrical team.

Diesel Generator Room:

The diesel room doesn't need to condition with any HVAC equipment. This room shall be ventilated with two set exhaust fans. one set for generally needed ventilation and the second set for supplying the Air required for the combustion of diesel generator.

diesel generator room sewage system should be equipped with a grease trap and after separating pollution be transferred into the site sewage system.

Emergency Power:

During an emergency, the HVAC supply air fans and battery room exhaust fan shall operate on emergency power supply. Change over from normal power to emergency power shall be done automatically.

Mechanical room

Substation building heating loads should be provided with PROCESS CONTROL BUILDING mechanical room.

14.2 PROCESS CONTROL BUILDING NO.03

In this building two air condition system should be consider:

A) Equipment and UPS spaces:

02-CABINET ROOM	04-INSTRUMENT UPS	05-BATTERY ROOM

B) manned and service spaces:

01-CONTROL ROOM	08-SUPERVISOR OFFICE	12-LOCKER ROOM
03-ENGINEERING ROOM	09-ENGINEER ROOM	13-PANTRY
06-HVAC ROOM	10-CORRIDOR	14-INSTRUMENT OFFICE
07-MANAGER OFFICE	11-W/C. SHOWER	

A)ACPU-01&02

The Cabinet Room, Instrument UPS, and Battery Room are spaces that contain equipment that require cooling. Two ACPU (one duty and one reserve) are installed for these spaces. Each ACPU is connected to a separate ACCU.

The AHUs that supply air to these spaces do not have heating coils and can provide free cooling when the outdoor temperature is low enough.

- The PROCESS CONTROL BUILDING equipment spaces requires two HVAC systems. These HVAC systems should regulate the temperature and humidity of the occupied spaces and related service spaces. The HVAC systems should be controlled independently and have different set points and parameters. The HVAC system shall be composed by two 100% "Air Conditioning Package Unit" coupled with two 100% “Air-Cooled Condensing Unit”.
- One unit is on duty and the second is in standby.
- Air handling units don’t have equipped with any heating coil.
- All HVAC opening should be equipped by the blast damper.
- The air is returned from rooms(except Battery Room) to the ACPU. The ACPU operates at a fixed constant volume and a variable temperature.
- The room temperature could be controlled by room thermostat.
- The RH will be controlled by duct mounted electrical pan humidifier.
- The Air-Cooled Condensing Units (one unit 100% standby) will be positioned in electrically safe area. The units will have the relevant power/control panel.

Battery Room:

- The battery room shall be equipped with hazardous rated twin duty/standby explosion proof-anti spark exhaust fan. This fan shall be work only during boost charge of battery.
- Therefore, fan shall have an interlock with battery system for running during boost charge of battery. During boost charge, air shall be transferred to battery room through a motorized damper and this damper shall have an interlock with exhaust fan.
- Battery room sewage system should be equipped with a Neutralizing tank Before attachment into the site sewage system.
- This shall be considered by control room electrical team.

B)ACPU-03&04

The Control Room, and Engineering Room and other offices shall be conditioned using “Air Conditioning Package Unit” supplying conditioned air to the space.

The following equipment shall be included as part of the control room HVAC system:

- The PROCESS CONTROL BUILDING manned and service spaces requires two HVAC systems . These HVAC systems should regulate the temperature and humidity of the occupied spaces and related service spaces. The HVAC systems should be controlled independently and have different set points and parameters. The HVAC system shall be composed by two 100% "Air Conditioning Package Unit" coupled with two 100% “Air-Cooled Condensing Unit”.
- One unit is on duty and the second is in standby.
- Air handling units should be equipped with hot water heating coil. This heating coil will be supplied from Mechanical Room.
- All HVAC opening should be equipped by the blast damper.
- The air is returned from rooms to the ACPU. The ACPU operates at a fixed constant volume and a variable temperature.
- The room temperature could be controlled by room thermostat.
- The RH will be controlled by duct mounted electrical pan humidifier or a steam humidifier.
- The Air-Cooled Condensing Units (one unit 100% standby) will be positioned in electrically safe area. The units will have the relevant power/control panel.

Office

Each office room located in this building shall be equipped with "Air Conditioning Package Unit" to provide suitable environment for employee.

Air shall be exhausted from shower and toilets areas. Exhaust fan shall extract air to provide a low pressure. Suitable exhaust fan shall be considered to extract air from this building to outside.

Also, in Mechanical Room domestic hot water should be generated with suitable equipment.

Emergency Power:

During an emergency, the HVAC system and exhaust system of battery room shall operate on emergency power supply. Change over from normal power to emergency power shall be done automatically.

Mechanical Room:

A mechanical room is a suitable option for supplying all the heating load required for heating coils and domestic hot water in Substation and Control Building. The Substation and Control Building share a mechanical room. This room supplies hot water for heating coils and domestic hot water.

14.3 FIRE STATION

The Fire Station manned spaces shall be conditioned with “Air Cooled Condensing Unit” that supply cooling and heating loads in the summer and winter seasons.

Unmanned space (only FIRE ENGINE) should be heated by hot water unit heaters.

Suitable exhaust system should be considered for FIRE ENGINE salon. This exhaust system provides fresh air for dilute parking smoke and other pollutants.

Air shall be exhausted from shower and toilet areas. Exhaust fan shall extract air to provide a low pressure. Suitable exhaust fan shall be considered to extract air from this building to outside.

Emergency Power:

Emergency power supply not required for HVAC system.

Mechanical room:

A mechanical room should be considered for this building to provide heating loads for unit heaters, the AHU heating coil, and required domestic hot water. One of the possible options for the design of the building is to place the mechanical room in the store space. This would allow for easy access to the equipment and reduce the need for additional piping and ductwork.

14.4 CHANGE HOUSE NO1 & NO.2

In these buildings used the existing HVAC system. To ensure thermal comfort and proper ventilation in the relevant areas, each of these buildings has two Fan Filter Units installed. One of them is active and the other is a backup.

- The system shall be composed by two 100% "Fan Filter Unit". One unit is on duty and the second is in standby.
- According to the client's opinion, fan filter units will be installed in a safe area (Due to the possibility of the existence of HF gas) on top of a suitable elevated structure. So, Fan filter units should be redesigned for every two buildings.
- The outdoor air is taken in with sand filter with bleed fan.
- Due to the long distance between the building and the installation location of the fan filter unit, the ductwork should be from galvanized steel pipe with the right diameter. This pipe should be installed in an underground trench.
- Fresh air will be heated by the steam heating coil.
- Steam heating coil should be installed on the main duct at the entry of the building.

Electrical water heater shall be considered to provide hot water for showers, pantry, and toilet.

Emergency Power:

To ensure optimal performance and safety, all Fan Filter Units (FFUs) must be connected to an emergency power supply (EPS) at all times.