



Petrochemical Industries
Design & Engineering Co.

PROJ. NO. : 1203

SABALAN METHANOL PROJECT

COVER SHEET



OWNER :

SABALAN PETROCHEMICAL
INDUSTRIES CO.

PROJ. NO. : 89/S-G/102

CONSTRUCTION STANDARD SPECIFICATION FOR

Ducts and Accessories

DOCUMENT NO : **1203-00-HV-CSS-782**

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SABALAN METHANOL PROJECT

CSS For Ducts & Accessories

DOC. NO. : 1203-00-HV-CSS-782

Rev.: 01

OWNER :

**SABALAN PETROCHEMICAL
INDUSTRIES CO.**

PROJ. NO. : 89/S-G/102

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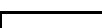
1. PURPOSE

This specification together with the referenced codes and standards define the minimum requirements for HVAC Duct Construction and Accessories for Sabalan Methanol Project in IRAN including the following buildings:

- Main Control Building
- Main Substation
- Laboratory
- Administration
- Analyzer

2. STANDARDS AND CODES

IPS	IRANIAN PETROLEUM STANDARD
IPS-M-AR-205-2001 IPS-E-AR-120-2004 IPS-E-AR-130-2002 IPS-E-AR-160-2004 IPS-C-AR-110-2003	Material And Equipment Standard For Fans, Filters And Air Distribution Units And Systems Engineering Standard For Building Air Conditioning Systems Engineering Standard For Humidification And Dehumidification System Engineering Standard For Venting, Ventilation And Pressurizing System Construction Standard For Installation, Testing, Adjusting And Commissioning Of HVAC&R Systems
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS
ASHRAE-2005 ASHRAE-2007 ASHRAE-2008 ASHRAE-2006	ASHRAE Handbook Fundamentals ASHRAE Handbook HVAC Applications ASHRAE Handbook HVAC Systems and Equipment ASHRAE Handbook Refrigeration Systems and Applications
ARI	AIR-CONDITIONING AND REFRIGERATION INSTITUTE
890-2001	Rating of Air Diffusers and Air Diffuser Assemblies
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
90A-2002	Standard for the Installation of Air-Conditioning and Ventilating Systems Life Safety Code
API	AMERICAN PETROLEUM INSTITUTION
API RP 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2
SMACNA	SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION
UL	UNDERWRITERS' LABORATORIES
UL 555	Fire Dampers
UL 181	Closure Systems for Use With Flexible Air Ducts and Air Connectors
ADC	AIR DIFFUSION COUNCIL
ANSI	AMERICAN NATIONAL STANDARD INSTITUTE

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ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
UBC	UNIFORM BUILDING CODE
INBC	IRANIAN NATIONAL BUILDING CODE

3. DUCTWORK

Galvanized steel sheet metal ducts

Galvanized steel sheet metal used for ducts shall conform to ASTM A653M, coating designation Z275, and to ASTM A924M. The following thicknesses, type of joints and bracing shall be used:

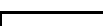
THCKNS. (US STD, GAUGE)	MAXIMUM SIDE	TYPE OF TRANSVERSE JOINT CONNECTION	BRACING
0.6mm (24 USG)	Up to 760mm (Up to 30")	S. drive pocket or Bar slips on 2390 mm (7.83') centers	25x25x3mm angles
0.76mm (22 USG)	785 to 1015mm (31" to 40")	Drive Pocket or bar slips on 2390mm (7.83') centers	25x25x3mm angle
0.76mm (22USG)	1040 to 1525mm (41" to 60")	40mm (1 1/2") angle connection or 40mm (1 1/2") pocket or 40mm (1 1/2") bar slips with 40 x3mm bar reinforcing on 2390mm bar reinforcing on 2390mm (7.83') centers	40x40x3mm angle
1.00 mm (20 USG)	1549 to 2286 mm (61" to 90")	40 mm (1 1/2") angle Connections, or 40mm (1 1/2") Pocket, or 40mm (1 1/2") Bar slips with 40x3 mm (1 1/2" x 1/8") Bar reinforcing on 1143mm (3.72') maximum centers	40x40x3mm diagonal angles, or 40x40x3 mm angle, 610 mm (2') from joint

Exhaust Ductwork for Kitchens shall be 1.50 mm (16 gauges) thick; and exhaust duct for air with Acid fumes shall be Acid resistant.

- Where special rigidity or stiffness is required, ducts should be constructed of metal two (2) gauges heavier. All un-insulated ducts 450 mm (18") and larger shall be cross-broken. Cross breaking may be omitted on un-insulated ducts if two (2) gauges heavier metal is used.
- Other joint connections of equivalent mechanical strength and air tightness may be used.
- Longitudinal joints in all duct sizes may be flat lock joints.
- Lock joints shall be hammered airtight and shall be riveted in each corner.

The inside of the duct shall present a smooth surface to the flow of air.

All transitions or changes in duct size shall increase as gradually as space permits with a slope of not more than 1:3 where possible. Walk in type of plenum shall be made of 1.2 mm (no.18

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gauge) galvanized steel reinforced on a maximum of 760 mm (30") centers by 40x40x3 mm galvanized angles.

Where duct work passes through floors, walls, or ceilings, provide fitted sheet metal finishing flanges of sufficient sizes to cover rough masonry openings.

e) The material of all ductworks for battery rooms should be stainless steel UNS S31600.

4. DUCT SUPPORTS

Strap hangers shall be used for ducts up to 760mm (30") wide, and angle hangers for ducts over 760mm (30") wide, make strap hangers 25x3mm minimum extend down both sides of the duct and under bottom fastening to side and bottom with sheet metal screws. Angle hangers may be formed by extending the vertical bracing angles or by rods passing through the bottom bracing angles.

Hangers shall be spaced on centers not exceeding 2500mm, supporting angles shall be placed completely around ducts wherever possible.

5. SCHEDULE OF DUCT WORK SYSTEM, IDENTIFICATION

	Color	Band	Legend
Supply Ductworks	Green	Black	S.A.
Return Ductworks	Green	Grey	R.A.
Exhaust Ductworks	Orange	Red	E.A.
Fresh Air Intakes	Blue	Black	F.A.

6. VANES IN ELBOWS

Turning vanes shall be installed in elbows as following wherever the radius of turn is less than $1\frac{1}{2}$ x width of the duct.

A. Radius Elbows:

Width of duct	No. of vanes
- Up to 460mm (18")	1
- 460 to 915mm	2
- 915mm (36") and over	3

B. Rectangular Elbows:

- Provide double wall, factory fabricated, and closely spaced vanes in all rectangular elbows.
- Rectangular elbows are used where space limitation prevents the use of curved elbows and where square corner elbows are required.

7. FLEXIBLE DUCTS

Flexible ducts shall be listed as per UL 181 Class 1.

Flexible ducts shall be used for connecting air terminal boxes, diffusers and other air terminals to the air distribution ductwork. Flexible ducts used in return and exhaust systems shall be suitable for negative pressure.

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Flexible duct connectors

Flexible duct connectors shall be listed as per UL 181.

Flexible duct connectors shall be used as vibration isolation connection for ductwork to air moving equipment.

8. DAMPERS

All types of dampers shall constructed to withstand and / or close against an internal pressure of 2000 Pa and a duct velocity of 15 m/s. Fully open damper pressure loss at an approach velocity of 10 m/s shall not exceed 35 Pa. All remotely operated dampers must open and close within 5 seconds. The casing depth for all dampers shall be 300 mm flange to flange (otherwise specify) and manufactured from 2mm thick galvanized sheet metal. The frame shall be so designed as to eliminate all water traps and all welds will be continuous.

The damper's shaft shall be manufactured from 12mm 304L stainless steel. The shafts shall rotate in impregnated 304L stainless steel iolite bearings fitted to the outside of the frame.

Splitters

Splitters shall be 0.4 mm thicker than duct in which installed; minimum thickness shall be however not less than 0.8 mm when steel made or

1.5 mm if aluminum. Splitters shall be operated by 5 mm rod brought through the side of the duct with locking set screw and bushing.

Manual Volume Dampers

Manual volume dampers shall be multi leaf opposed blade type; except that single blade type (butterfly type) may be used in rectangular ducts having height 150 mm and less and round ducts of diameter less than 400 mm. Damper casing and blades shall be 0.4 mm thicker than duct in which installed; however thickness shall not be less than 1.2 mm when steel made or 2 mm if aluminium. Damper blades shall be double skin and aerofoil section 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 stand-off mounting adapters to provide clearance from the insulation. Each manual damper shall be fitted with an external position indicator Dampers shall have nylon, PVC or bronze self-lubricating bushings.

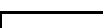
The allowable leakage rate for volume damper is 300 m³/m² h

Back Draft and Pressure Relief Dampers

Back draft and pressure relief dampers shall be gravity operated type, of a multi-blade design encased in a fabricated frame and shall have aluminium blades, 100 mm pitch maximum, with neoprene or polyester foam sealing strips and complete with nylon, PVC or bronze self-lubricating bushings. All blades shall be act in parallel and a single skin 0.7mm thick aluminum sheet metal. Pressure relief dampers shall be provided with adjustable counterweight for space pressure setting. The operational range of pressure relief damper should be 25 to 125Pa and suitable for maintaining an overpressure within a room / area of up to +70 Pa.

Fire Dampers

Fire dampers shall be single blade type or multi leaf parallel blade type, motorised, with 72°C fusible link, complete with open and closed position limit switch. Blade shall be of non-combustible materials asbestos free and bushings shall be stainless steel or bronze self-lubricating. Fire dampers shall conform to UL 555 with a rating generally corresponding to the one of the walls where they are installed, but however not less than 2 hours rating.

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Fire/Smoke Dampers

Combination of fire and smoke dampers are intended (1) to shut down in the event of fire to restrict its spreading and the spreading of smoke, or (2) in buildings that are protected by fire extinguishing gas, to shut down in case of discharge of the agent in order to contain it within the protected space and prevent its dispersion through the ductwork.

Fire/smoke dampers shall be single blade type or multi leaf parallel blade type, motorised, with 72°C fusible link, complete with open and closed position limit switch with an inspection hole or adequate-system for replacement of a fuse. The blades shall be formed from a double skin and aerofoil section. Each Skin shall be 1.6mm thick galvanized sheet metal. Dampers shall be low leakage rated (closed blade leakage less than 3 L/s per square metre of damper cross section with 100 Pa pressure differentials). Bushings shall be stainless steel or bronze self-lubricating. Fire/smoke dampers shall conform to UL 555 or UL 555S with a rating generally corresponding to the one of the walls where they are installed, but however not less than 2 hours rating.

Fire dampers shall be selected, manufactured and installed in accordance with the NFPA Standard No. 90A.

Fire dampers shall be suitable for both vertical and horizontal operation Horizontal fire damper shall be equipped with spring

Motorized Dampers

Motorized dampers shall be specifically designed 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 height 150 mm and less and round ducts of diameter less than 400 mm. Dampers shall be low leakage rated (closed blade leakage less than 3 L/s per square metre of damper cross section with 100 Pa pressure differential).

Damper casing and blades shall be 0.4 mm thicker than duct in which installed; however thickness shall not be less than 1.2 mm when steel made or 2 mm if aluminium. Dampers shall be fitted with mounting plate rigidly fixed to the casing to support the actuator and shall also be provided with position indicator. Bushings shall be nylon, PVC or bronze self-lubricating.

Actuators shall be suitable for operation by remote signal and shall be the electrical-actuated (24 VDC) type. Damper closing time, irrespective of type of actuator selected should be 5 sec.

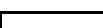
Dampers shall be equipped with external position indicators and shall be capable of electrically relaying the status of the damper blade to a remote source.

9. AIR DISTRIBUTION OUTLETS AND INLETS

Outlets, inlets and diffusing equipment shall be suitable to introduce and extract into and from a conditioned or ventilated space the quantity of air required to maintain the desired indoor conditions and shall be protected against corrosion and be provided in the fully furnished condition indicated.

Full perimeter of all air terminal devices located on walls or ceilings shall be provided with a resilient sealing strip and shall be fitted with non-combustible and smokeless sealing strip fitted behind the face which shall form an air-tight seal when fitted to ductwork. Each outlets, grilles, registers and diffusers shall have sponge rubber gasket around it and shall be installed with a moth-proof supportive wooden frame between the duct neck and air outlets.

Ceiling diffusers shall be of the round, square louver faced, perforated face or swirl type according to the air distribution requirements. Diffusers shall be manufactured from anodised extruded aluminium or painted steel and shall be complete with key-operated volume damper. Supply diffusers shall have and high induction rate. Ceiling diffusers may also be used for

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return and exhaust air when indicated. No fixing element shall appear outwardly. Each diffuser shall be provided with an airflow rate controller including opposed blade 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.

All diffusers connected to duct by flexible connection shall be provided with approved plenum boxes, secured to the diffuser and having top or side mounted spigots for the connection of flexible ducting.

All grilles and registers for supply air shall have two sets of adjustable blades, one set horizontal and one set vertical, and for extract air shall have a single set of adjustable blades either horizontal or vertical, or a lattice or egg crate front.

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

Supply registers shall be extruded aluminium of the double deflection type with opposed blade dampers, to regulate the volume and the pattern of the supply air.

Return and exhaust grilles shall be extruded aluminium of the single deflection type with opposed blade dampers.

Fresh air intake louvers and exhaust air louver shall be suitable for outdoor installation; louvers shall be complete with back-draft or pressure relief dampers and wire mesh screens as indicated.

Outlets and inlets shall ensure low pressure drop; the sound level shall not override the maximum permitted level and the room air velocity shall be kept within the prescribed limits.

The dimensions of diffusers, grilles and louvers shall be fully compatible with the type of structure and surface where installed.

Color of outlets and inlets shall be co-ordinated.

10. LOUVERS

A. General

A.1 Louvers is a device comprising multiple blades which when mounted in an opening, permits the flow of air but inhibits the entrance of other elements.

- Fixed louvers are those in which the blades do not move.
- Adjustable louvers are those in which the blades may be operated either manually or by mechanical means.

A.2 Louvers may be installed in exterior walls visible to the public. It may be produced in maximum single section sizes as dictated by shipping, handling or finishing limitations.

B. Louver Design

B.1 Frames

Louver frames can generally be classified as channel type or flange type fabricated smaller than the clear opening for ease of installation.

B.2 Basic Fixed Blades

These blades shall be plain or with center baffle positioned at various angles within the frame.

B.3 Drainable Fixed Blades

These blades shall be set from 30 to 45 angles with a gutter or rain trough at the lower edge.

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B.4 Adjustable Blades

These blades shall be capable to rotate within the louver frame anywhere from the full open to full closed position.

B.5 Sight proof Louver

The sight proof louvers may be installed with vertical or horizontal blades with Y, Z and V blades being the most common shapes. These louvers shall be used for ventilation, weather protection, and prevention of vandalism or insertion of foreign objects.

B.6 Acoustical Louver

These louvers shall be able to permit ventilation and decrease the transmission of sound by its special construction. Due to the task it requires to perform, pressure drop and free area may be sacrificed.

B.7 Sand Louver

These louvers shall be used in areas, which are subjected to sand storms and should be designed for 90% efficiency for particles from 150 to 700 μ m at 1 m/s

The main frame shall be 2mm thick, complete with mating flanges for fixing building frame or HVAC ductwork spool connection.

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 6mm thick. 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.

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.

B.8 Sun Screens/Sun Canopies

These louvers shall be attached to buildings to deflect direct sunlight. Special considerations shall be given to the structural support when a cantilever design is used.

B.9 Equipment Screen

These louvers may be used to screen HVAC electrical or mechanical equipment from view. Blade design may vary to meet specific free areas, degree of vision barrier requirements or to match adjacent walls.

C. Louver Free Area

C.1 The free area represents the minimum area through which the air can pass and varies with its size. The free area is the calculated louver free area divided by the louver gross area multiplied by 100. Air inlets sized on the basis of 70 percent free area louvers with a maximum velocity of 2 m/s. through the face area.(The maximum air pressure drop through any louver shall not be greater than 30Pa)

C.2 The louver free area percentage selected must be considered in relation to the:

- Air performance-pressure drop;
- Water penetration requirements;
- Air leakage;
- Sound transmission loss.

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D. System Effects

System effects influences the final performance of the louver and can be categorised as inlet conditions, outlet conditions, screens and wind velocities.

E. Louver Selection

E.1 Permitting airflow into or out of structure, a correctly sized and fabricated louver shall be expected to function the following:

- Look aesthetically attractive and complement the surrounding architecture.
- Inhibit undesirable elements from entering the structure.
- Offer low air resistance so those fan power is conserved for the rest of the system.
- Minimise energy losses into or out of the structure.

Notes:

- A louver size shall normally specify width (first) followed by height. The free areas are listed in manufacturer's tables.
- For construction of louver construction and materials, reference is made to IPS-M-AR-225.

11. CONSTRUCTION AND INSTALLATION

Sheet metal duct construction shall comply with SMACNA HVAC Duct Construction Standards - Metal and Flexible. For each ductwork system the applicable static pressure construction class for a maximum level not less than the maximum operating static pressure of the system (see SMACNA page 1-6), shall be determined. Seal classes to be used shall be as indicated in SMACNA Table 1-2 "Duct Sealing Requirements". However ducts shall not be constructed to a pressure class lower than 500 Pa with seal class B.

Installation of fire dampers and fire/smoke dampers shall comply with SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.

Ductwork construction and installation shall also conform to NFPA 90A, 90B and 91.

Duct elbows in rectangular ducts shall be long radius type with a centreline radius not less than 1.5 times the width of the duct. Where space does not permit the use of long radius elbows, short radius or square elbows with turning vanes may be used. Turning vanes shall be single vane type in short radius elbows and double wall type in square elbows; vanes shall be constructed as detailed in SMACNA standards.

Duct elbows in round ducts shall be long radius types with a centreline radius not less than 1.5 times the diameter of the duct. Where space does not permit the use of long radius elbows, short radius elbows with minimum centreline radius equal to diameter. Segmented elbows shall be 5-piece types for 90° long radius elbows, 4-piece for 90° short radius, 3-piece for 60° and 45° and 2-piece for 30° elbows.

Branch take-off in rectangular ducts shall be 45° entry shoe piece type; round branch connections to rectangular ducts shall be bell mouth type.

Transitions shall have a maximum included angle of 45° for diverging airflow and 60° for converging airflow.

Plenum boxes shall be of 1.6 mm minimum sheet thickness.

Ducts connected to blast protection valves shall be of 2 mm minimum sheet thickness, for a length up to 2 m.

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Manual volume dampers and splitters shall be fitted in each branch from a main or sub-main duct and elsewhere indicated on drawings or however necessary for system balancing.

Flexible ducts shall be 1 m long maximum.

Duct access doors shall be double skin types, hinged, sealed to prevent air leakage and shall be as large as practical for the required service. Smaller size doors shall be provided with cam locks; doors 600 x 600 mm shall be provided with double-sided lock operating handles. Doors in insulated ducts shall be double skin internally insulated types. Duct-access doors shall be provided at all type of dampers and all other apparatus requiring service and inspection; at in-duct coils the access doors shall be provided both upstream and downstream.

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.

Test holes shall be of rigid metal construction, complete with leak proof heavy duty metal caps. Hole ports shall be provided wherever required for testing and balancing.

All ducts passing through walls and slabs shall be installed through framed prepared openings; installation frames shall be fabricated from galvanised sheet metal 1.6 mm minimum thickness, unless otherwise indicated. Clearance between ducts and framed prepared openings shall be 25 mm and shall be packed with fire resistant insulation material sealed at both ends with fire resistant mastic; sealant for sleeves in slabs and in exterior walls shall be both fire resistant and waterproof. Closure collars (retaining angles) of galvanised sheet metal not less than 50 mm wide and 1.6 mm minimum thickness, unless otherwise indicated, shall be provided on each side of wall and slab penetrations; roof penetrations by ducts shall be provided with water-shedding external flashing. Details of fire dampers and fire/smoke dampers shall conform to the requirements of SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems and UL 555; dampers and frames shall not be supported by adjacent ductwork. Duct penetrations, fire dampers and frames shall always be set perpendicular to the plane of wall or slab.

Duct sealing materials and gaskets shall be non-combustible materials meeting the requirements of NFPA 90A, 90B and 91; in addition, exterior duct sealant shall be weather resistant to provide watertight seal, it shall have an appropriate service temperature range and shall be suitable for direct sunlight exposure.

Hangers and supports shall conform to the requirements of SMACNA HVAC Duct Construction Standards - Metal and Flexible. Threaded rods used shall be hot-dip galvanised; steel hanger and support elements shall be hot-dip galvanised or field painted as specified. Maximum spacing between hangers shall not exceed 2 m. Hangers for ducts to be thermally insulated shall provide clearance for insulation to be applied and finished; high density insulation inserts shall be provided in order to withstand the support compression.

Ductwork shall be installed in a manner to allow service access without disturbing and without interference with other equipment or pipes. Ducts to be thermally insulated or otherwise covered shall be fixed to permit the application around the full perimeter. Ducts to be concealed shall be installed neatly and as close as possible to the building structure, allowance shall be made for supports, brackets, adjacent services and thermal insulation. No joints shall be formed within walls or slabs or in positions inaccessible after completion.

Ductwork shall be protected from dust and dirt during transport, storage on site and installation; dust and debris shall be prevented to enter from open ends of ductwork when installed.

12. SOUND ATTENUATION

Sound attenuators shall be of the factory fabricated type, constructed of galvanised steel sheet. The outer casing shall be not less than 0.8 mm thickness. Control plates on surface of splitters shall be made from galvanised steel sheet. Absorption material shall be fibrous glass, moisture

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repellent and abrasion-proof up to at least 20 m/s velocity. Sound absorbing material shall meet the fire hazard rating required for the duct insulation material. Perforated steel sheet shall be applied to avoid undesirable diffusion of fibrous glass material.

The net noise reduction values shall be selected in order that the radiating sound shall result within the sound level requirements. The sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated airflow conditions. The noise reduction data shall include the effects of planking paths and vibration transmission.

The attenuators shall be constructed to be airtight when operating at the static pressure of the duct system but in no case less than 500 Pa. Attenuators shall be insulated to prevent sweating.

Duct internal acoustic lining shall not be used for hygienic reasons

13. BLAST PROTECTION VALVES

Blast protection valves shall consist of a spring and spindle mechanism made of stainless steel, corrosion protected, within a modular cast iron body. Valves shall close in one direction in response to the positive phase of the blast wave and in the opposite direction in response to the negative phase. Valves shall be designed for mounting in factory fabricated casings.

Blast protection valve assemblies shall be selected to a maximum pressure drop of 150 Pa.

Blast protection valves shall be installed at HVAC openings/penetrations of perimeter walls and roof slabs in the Blast Proof buildings.

14. DUCTWORK THERMAL INSULATION

As general requirement, all insulating materials shall be non-combustible as defined by NFPA 220 and have a flame spread rating of not more than 50 as defined by UL Standard Test Method of Fire Hazard Classification or approved equal. No insulation utilizing CFC's in manufacture or having asbestos content shall be used.

Thermal insulation for ductwork shall be rock wool, 24 kg/m³ density minimum, having max thermal conductivity "k" of 0.04 W/m K or less, at a mean temperature of 24°C.

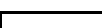
As minimum requirement, the indoor ducts concealed or exposed in general areas shall be insulated with blanket type fibre-glass insulation 25 mm thick complete with aluminum foil reinforced Kraft facing with integral vapour barrier jacket. Insulation shall be attached to the ducts with mechanical fasteners such as insulation pins and washers; additional retaining galvanised steel net shall be applied if necessary for protection and to maintain insulation firmly in place.

In HVAC plant-room the ductwork shall be insulated as described above, but covered with aluminium sheet metal 0.6 mm thick. Insulation of exposed ducts in general areas, at low level, shall also be covered with aluminium sheet metal 0.6 mm thick, up to a height of 2.2 m from the floor, for protection from damages. Outdoor ducts shall be insulated in the same way as the ductwork in plant-room, but thickness shall be 50 mm; in addition, aluminium cladding shall be sealed with weather resistant mastic to provide watertight seal.

High density compression resistant, non-combustible insulation inserts shall be provided at duct hangers and supports. Inserts shall be of the same thickness as the specified insulation and shall be covered with vapour barrier jacket.

All flexible ducts required to be insulated shall have factory-applied thermal insulation.

Supply air and all the outside air ducts shall be insulated. Return, and exhaust air ducts running inside the building, shall be generally not insulated, unless necessary in order to prevent condensation.

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Duct internal insulation shall not be used for hygienic reasons.

In brief, the insulating thickness shall be used as the following table:

Location Of Duct	Supply Air	Fresh Air	Return Air	Exhaust Air
Air Conditioned Areas	25 mm	25 mm	Not Insulated	Not Insulated
Suspended Ceiling Void Above Air Conditioned Areas	25 mm	Not Insulated	25 mm	Not Insulated
Non-Air Conditioned Areas	25 mm	Not Insulated	25 mm	Not Insulated
Exposed To Ambient Air Conditions	50 mm	Not Insulated	25 mm	Not Insulated

15. AIR DISTRIBUTION OUTLETS AND INLETS

Outlets, inlets and diffusing equipment shall be suitable to introduce and extract into and from a conditioned or ventilated space the quantity of air required to maintain the desired indoor conditions.

Ceiling diffusers shall be of the round, square louver faced perforated face or swirl type according to the air distribution requirements. Diffusers shall be manufactured from anodised extruded aluminium or painted steel and shall be complete with key-operated volume damper. Supply diffusers shall have a high induction rate. Ceiling diffusers may also be used for return and exhaust air when indicated. No fixing element shall appear outwardly.

Supply registers shall be extruded aluminium of the double deflection type with opposed blade dampers, to regulate the volume and the pattern of the supply air.

Return and exhaust grilles shall be extruded aluminium of the single deflection type with opposed blade dampers.

Fresh air intake louvers and exhaust air louver shall be suitable for outdoor installation; louvers shall be complete with back-draft or pressure relief dampers and wire mesh screens as indicated.

Outlets and inlets shall ensure low pressure drop; the sound level shall not override the maximum permitted level and the room air velocity shall be kept within the prescribed limits.

The dimensions of diffusers, grilles and louvers shall be fully compatible with the type of structure and surface where installed.

Color of outlets and inlets shall be co-ordinated.

16. EARTHING

Bonding of the ducting and equipment to earth shall be carried out during installation.

To satisfy the continuity of earthing between flanged joints or ductwork and equipment, star washers are to be used on such joints. Earthing straps are to be installed across flexible connections and other breaks in continuity. For general information see related project specification.

17. CLEANING AND PROTECTION

All ductwork, fittings and equipment shall be cleaned before erection. All protective covers on equipment shall be left in place as long as possible during erection and shall be adequately protected against damage during construction.

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All duct elements shall be supplied with dust blinds immediately after fabrication. Dust blinds shall remain in place until the duct elements are actually required for installation.

Ductwork terminated for later hook-up shall be equipped with a blind on the open end immediately after installation. When the duct system is finally installed and ready for mechanical completion, the system shall be internally clean along the complete run.

Stainless steel ductwork and equipment shall be kept externally covered to avoid contamination from other sources.

18. PRESSURE TESTING

General Requirements

The ductwork inclusive equipment shall be pressure tested after installation. All materials such as duct, stiffeners, gaskets, bolting etc., intended as part of the final installation, which are damaged during testing shall be replaced.

Preparation for Pressure Test

The section of the ductwork to be tested shall be prepared by blanking off duct outlets etc. All dampers in the tested ductwork shall be left in open position. Testing shall be satisfactory completed before insulation and before terminal units are fitted.

Test Requirements

All ductwork shall meet the requirements for Air Tightness Class B.

A minimum of 10% of the ductwork shall be tested, and it shall be selected by the company. If this ductwork does not pass the test, then the whole ductwork system shall be tested to the satisfaction of the company. All test devices shall be removed after the tests have been performed.