

وزارة الاعلام

Air Distribution and New Ducting Layout for Government Printing Press Zone 2



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General Conditions



1. <u>General Conditions</u>:

- 1.1 This is a Turnkey project includes design, supply, installation, testing, commissioning and handing over to full satisfaction of the MOI's Engineer. This project also includes all the related electrical, civil, control, plumbing works to complete it in a perfect condition
- 1.2 All tenderers wishing to participate in this tender must visit the site to have full idea about all works before submitting their offers as no variation claims shall be entertained.
- 1.3 Specifications described hereunder are brief and therefore the tenderer shall include all equipment material, labor and whatever required for the entire installations and to ensure best workmanship and operating conditions to the satisfaction of the MOI Engineer whether detailed under the specifications or not, any additional works which may deem necessary to complete the work shall be made by the contractor without any right of variation claims of cost or time.
- 1.4 The Contractor shall take all necessary precautions not to damage any exiting services and must fix any damage done by him during the course of installation of equipment, at no extra cost.
- 1.5 The Contractor shall ensure that all mechanical, electrical and civil works shall be supervised by qualified engineers of the respective specialization and experience and all installations shall be made with special companies working in the Air Conditioning field and approved from the Engineering Services Department before the installation works start.
- 1.6 The contractor shall ensure cleanliness and safety of the site throughout the execution of the project and shall remove all waste materials. Scrap materials are not allowed to accumulate in the work site. Short intervals cleaning up are required to avoid mishap, accident or inconvenience to site users.



- 1.7 The contractor shall guarantee and maintain all the works for a period of two years including supply to the spare parts, guarantee and maintenance shall start from the date of handing over of the project.
- 1.8 All works must comply with Ministry of Public Works, Ministry of Electricity & Water and Kuwait Fire Service Directorate Codes and standards.
- 1.9 All parts, material and drawings must be approved by MOI engineer prior to installations.
- 1.10 The Contractor shall add labels or tags to all appliances that may need identifying.



SCOPE OF WORK





Scope of Work

- **1.** Design, supply, installation, , commissioning with two years guarantee and maintenance the following:
- 2. Design, supply and installation of new Ducting layout with all duct work and accessories including insulation, acoustic lining, supports, cladding, dampers, air inlets and outlets according to new layout plan and other necessary equipment to have an efficient air distribution system as specified.
- 3. Dismantling, removal and shifting of existing ductwork and Chilled Water pipe and connections to Ministry Of Information Store
- 4. Two years guarantee and maintenance of all works.
- 5. Replacement of Chilled water piping with insulation, cladding for both AHU connection on the rooftop
- 6. Supply and Installation of pressure gauges and thermometers for the supply and return Chilled water pipes
- 7. Replacement of existing AHU Valves and strainers for AHU number 7 and 8
- 8. Installation of 3-way control valve on Chilled water inlet and outlet on AHU number 7 and 8 complete with bypass and thermostat
- 9. Supply and Installation and Replace of both AHU Washable Air Filters
- 10.Supply and Installation washable Fresh Air Filter
- 11.Supply and installation of Chilled Water Cooling Coils for both Air Handling Units
- 12.All Builders work required including openings and supports.



DETAILED TECHNICAL SPECIFICATION



AIR-HANDLING UNITS COIL

PART - 1 GENERAL

1.01 SECTION INCLUDES

Air-Handling Units Coil

1.02 DESCRIPTION

A. General:

• Extent of Work: The extent of air handling unit is, by requirements of this section of the specifications, and is hereby defined to include, but not by way of limitation, chilled water coils, water proof drain pan, drive, removable panels, mixing boxes (as required) filter panel(s) and bag(s) vibration isolators and any other appurtenances necessary for satisfactory operation.

1.03. QUALITY ASSURANCE

- A. Manufacturer's: Firms regularly engaged in manufacture of air conditioning units, of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. NFPA Compliance: Provide air-handling unit thermal insulation with flame-spread rating of 25 or less, fuel-contributed of 50 or less, and smoke-developed rating of 50 or less.
- C. AMCA Standards: Comply with Air Movement and Control Association standards as applicable to testing and rating fans, and testing louvers, dampers and shutters.
- D. Damper Air Leakage Rate: Except where more stringent limitation is indicated, provide dampers with leakage limited to 100 LPS per square meter at 1 KPA static pressure.



- E. SMACNA Compliance: Comply with Sheet Metal and Air Conditioning Contractors National Associated ductwork construction standards as applicable to air-handling units.
- F. Industry Standards: Except as otherwise indicated, comply with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) recommendations pertaining to air handling units and chilled water coils.
- G. ARI Compliance Comply with Air-conditioning and Refrigeration Institute (ARI) 410, "Standard for Forced Circulation Air Cooling and Air Heating Coil".
- H. ARI: Provide ACHV coils bearing Air-conditioning and Refrigeration Institute (ARI) certification labels.
- I. ARI Certification: Provide central station packaged air-handling units which comply with Air-conditioning and Refrigeration Institute Standard 430 and display ARI'S certification symbols.

1.04 SUBMITTALS

- A. Manufacturer's data: Submit manufacturer's data on air handling units as follows:
 - i. Supply and return fan (where fitted) performance curves showing air quantity, static pressure, brake kw, efficiency, tip speed and rpm.
 - ii. Cooling coils performance data indicating air quantity, rows deep fin spacing, face velocity, air side pressure drop, entering air dry bulb, entering air wet bulb; leaving air dry bulb, leaving air wet bulb and coil capacity, entering and leaving water temperature and water side pressure drop.



- iii. Complete dimensions of each unit and all accessories including location and sizes of all piping, electrical, support and access areas required.
- iv. Shipping and operating weights of each unit and all accessories.
- v. Complete description of construction materials of each unit and all accessories including internal insulation, filters, dampers, isolators and special coatings.
- vi. Characteristics of each fan motor including type enclosure, nameplate kw, voltage, phase, cycles, full load amps and rpm.
- B. Shop Drawings: Submit dimensioned drawings of installed air-handling units and components Show accurately scaled units' layout and special relationship to surrounding environment; and show electrical power feeder connections, duct connections and equipment supports.
- C. Spare Part List: Submit with the System Operation and Maintenance Instructions specified in Clause 1.01 of this Section. Spare parts list for all the Air Handling Units and accessories covered by the Specification (chapter 6). Include in the submittal a description, number and price for each part.
- D. Installation, Operation and Maintenance Instructions: Submit manufacturer's recommended installation, operation and maintenance instructions for Air Handling Units, and accessories covered by this Specification. The instructions shall be sufficiently detailed so that the average mechanic can install, operate and perform minor maintenance operations when necessary.



E. Fans: Submit for each of the air handling unit fan(s) pressure drop calculations and noise levels which should be based on shop drawings and actual equipment selected.

1.06. PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver air handling units with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.
- B. Handle air-handling units carefully to avoid damage to components, enclosures and finish. Do not install damaged components; replace and return damaged components to equipment manufacturer. Avoid crushing or bending coils and fins and prevent dirt and debris from entering and settling on coils.
- C. Where possible, store equipment inside and protect from the atmosphere and construction worker traffic. When necessary to store outside, take the same precautions and store above ground and enclose with waterproof wrapping.



PART – 2 PRODUCTS

2.01 MANUFACTURERS

Provide package factory assembled, double skin air handling units from the following manufacturers or approved equal:

• Complied with this specifications document.

2.02. GENERAL:

The air handling unit shall consist of the required number of different factories assembled sections, described below to handle each air handling unit's specific demands. Unit fan and coil performance shall be certified in accordance with the ARI standard for fans and coils or other approved standard which requires no lower quality than mentioned.

The design shall allow access of the housed components from the inspection side of the unit. The various unit sections shall be all made in a right-hand or left-hand version with respect to inspection panels as seen in the direction of the air flow.

The air handling unit shall be mounted on a common, concrete base of height not less than 6 inches and high enough to enable easy mounting of the water trap for draining the condensate from the air cooler. The bottom frames of the unit sections shall rest on rubber pads in contact with the concrete base. The width and length of the base shall be selected to suit the size and combination of unit sections of the relevant unit. The water trap shall be fitted and installed at the base.

The contractor must calculate the system static pressure and provide the required fans and motors HP.



2.03 COOLING COIL SECTION

The coil shall be constructed from seamless copper tubes of 5/8" with copper fins spaced at not more than 10 fins/inch. The headers and water connections shall be made of copper.

Plugged tapping for venting and drainage shall be fitted on the coil. Venting and drainage connection to be executed as specified elsewhere in the specifications.

Cooling coils shall be drainable and shall have entrapped circuits. An internal condensate pan of stainless-steel sheet with drain connection to the inspection side of the unit shall be provided. The drain line shall be provided with a "U" trap suitable for the operating static pressure of the fan.

The coil shall be designed to operate with a face velocity up to max. 500 ft/min., and number of rows shall not exceed 6.

Maximum pressure drop on the water side shall not exceed 16 feet and scheduled valves on the air side (but not more than 0.4 inches w.g.).

Where coil height exceeds 40" it shall be split into two coils with intermediate drain pans with drop tubes at either end to drain condensate to the main drain pan without flooding the lower coil.

The sides of the units shall be removable for withdrawal of the coil.

The coil shall be designed for a maximum working pressure of 150 psi. Each coil shall be factory tested at a minimum pressure of 300 psi.

The coils shall be designed and tested in accordance with the American National Standards Institute safety code for mechanical refrigeration (ANSI B9.1).



PART - 3 EXECUTION

3.01 INSPECTION

A. The Contractor shall examine the substrate and conditions under which units are to be installed and correct unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02. INSTALLATION

- A. Install units in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Coordinate with other work, including ductwork, floor construction and piping, as necessary to interface installation of units with other work.
- C. Install units on vibration isolators and comply with manufacturer's installation requirements.
- D. Temporary Closure: Upon completion of installation, provide protective covering on air-conditioning unit ductwork connection openings to prevent entrance of dust and debris into equipment.

3.03. INSTALLATION OF COILS

- A. General: Install coil products in accordance with the manufacturer's written instructions, the applicable portions of NFPAN Standard No. 90A, and in accordance with recognized industry practices to ensure that products serve the intended functions.
- B. Comb out damaged fins when bent or crushed before bolting coil section to unit.



C. Clean dust and debris from coil section as it is installed to ensure its cleanliness.

3.04. GROUNDING

A. Provide positive equipment ground for limit components.

3.05. TESTING

A. Upon completion of installation of unit and connection to completed air distribution system, start-up and test equipment in accordance with ARI Standards; operate unit to demonstrate capability and compliance with requirements. Where possible, field-correct malfunctioning unit, then retest to demonstrate compliance.

3.06. FIELD QUALITY CONTROL

- A. Repair or replace coils as required, following purging and tightness testing of coils and piping to eliminate leaks and retest as specified to demonstrate leakproof performance.
- B. Coils with heavily damaged fins shall be replaced.
- C. Upon completion of installation of unit start-up and operate equipment demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.
- D. Except as otherwise indicated, test units in accordance with ARI Standard 430.



SECTION - AIR-DISTRIBUTION

PART-1 GENERAL

1.01 SECTION:

- A. Duct work
- B. Duct work accessories

1.02 DESCRIPTION

- A. Extent of ductwork and accessories is in the scope of work, and the requirements of this section.
- B. Types of ductwork required include the following:
 - Closed loop high speed, high pressure ducts.
 - Air-conditioning supply and return air ducts.
 - Outdoor air supply systems.
 - Mechanical exhaust systems.
- **C.** Types of duct accessories required include, but not limited, to the following:
 - Dampers.
 - Fire dampers.
 - Elbows.
 - Duct fittings.
 - Duct access doors.
 - Housing access doors.
 - Casing or housing.
 - Flexible connections.
 - Hangers and supports.
 - Sealants.
 - Duct connection to equipment.
 - Turning vane extractor.
 - Duct hardware.
 - Duct lining.



D. Classification:

The Duct Work shall be classified into two groups:

- i. Low Pressure
- ii. Medium and High Pressure

The following table shows pressure-velocity classification:

Duct Group	Duct Class	Static	Pressure	Velocity FPM.
	II' 1 D			4000 0 1
Medium and	High Pressure	10'	Positive	4000 & above
High Pressure				
	Medium pressure	6"	Positive	4000 & above
	Medium Pressure	4"	Positive	4000 & above
	Medium Pressure	3"	Pos. or	3999 & below
			Negative	
Low Pressure	Low Pressure	2"	Pos. or	2500 & below
Duct			Negative	
	Low pressure	1"	Pos. or	2500 & below
			Negative	
	Low pressure	1/2"	Pos. or	2500 & below
	_		Negative	

1.03. QUALITY ASSURANCE

- A. SMACNA Standards: Comply with SMACNA "Low Pressure Duct Construction Standards" and SMACNA "High Pressure Duct Construction Standards" for fabrication and installation of low and high pressure ductwork comply with SMACNA "Low Pressure Duct Construction Standards" and SMACNA "High Pressure Duct Construction Standards" for fabrication and installation of low medium and high pressure ductwork.
- B. NFPA Compliance: Comply with ANSI/NFPA90 A "Standard for the Installation of Air-conditioning and Ventilating Systems" and APNSI/NFPA 90 B "Standard for the Installation of Warm Air Heating and Air-conditioning Systems.



- C. Field Reference Manual: submit at project field office, copy of SMACNA "Low Pressure Duct Construction Standard and SMACNA "High Pressure Duct Construction Standards."
- D. Frame-Smoke Ratings: Duct liner shall have flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84-75.

1.04. SUBMITTALS

- A. Product Data Submit manufacturer's specifications on manufactured products and factory fabricated ductwork, used for work of this Clause.
- B. Shop Drawings: Submit dimensions layouts of duct work showing both the accurately scaled ductwork with its accessories and its relation to space enclosure. show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed ductwork, duct accessories, and outlets and inlets.
- D. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory, include this data in Maintenance Manual.



1.05. DELIVERY, STORAGE AND HANDLING

- A. Protect shop-fabricated and factory-fabricated duct work, accessories and purchased products from damage during shipping, storage and handling. Prevent damage and prevent dirt and moisture from entering ducts and fittings.
- B. Store ductwork and ductwork accessories inside and protect from weather. Where necessary to store outside, store above ground and enclose with waterproof wrapping.

PART - 2 PRODUCTS

2.01. DUCT MATERIAL:

- A. Sheet Metal: All ducting shall be made of galvanized steel sheet to ASTM A525, Lock-forming quality, having zinc coating of 1.25 Oz. per sq. ft. (382 g/sq.m) for both sides in conformance with ASTM A90 of tensile strength in range of 28/33 tons per square inch.
- B. Stainless Steel Sheet: Provide stainless steel complying with ANSI/ASTM A 167; ISI Type 316 with No. 4 directional polish where exposed to view in occupied spaces. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

2.02. FABRICATION

- A. Shop fabricate ductwork in 1, 2, 3 or 4 meter lengths, unless otherwise required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field disassembled systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark actions for reassembly and coordinated installation.
- B. Shop fabricate ductwork of gauges (thickness) and reinforcement complying with SMACNA "Low Pressure Duct Construction



Standards" and SMACNA "High Pressure Duct Construction Standards".

- C. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centre-line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
- D. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.
- E. Duct dimensions shall be clear inside dimensions.
- F. Ductwork shall be fabricated from galvanized steel sheet metal having a thickness and appropriate joints and reinforcement as recommended by SMACNA STANDARDS and as listed hereunder:
 - i. Low Pressure Rectangular Duct Work:

Gauges of G.I. Sheeting, type of joints, bracing etc,. used for the manufacture of low pressure. Ducting shall be as per the following schedule:

Max. Sida	US/Std.	Transverse Joints and bracing		
Inches	Gauge			
Up to 12"	24	³ / ₄ " Pocket or slip Joint at 8 ft. center		
13"-18"	22	1" Pocket Joint at 4. ft. centers with		
		cross breaking		
19" – 30"	22	1" Pocket Joint at 4. ft. centers with		
		cross breaking		
31"-42"	22	1 ¹ / ₂ Pocket Joint at 4 ft. centers with		
		across breaking and 1/2" x 1/2" x 1/8"		
		angle girth at 8 ft. centers bolted to the		
		pocket joints.		
43" – 54"	20	1 ¹ / ₂ Pocket Joint at 4 ft. centers with		
		across breaking and 1 ¹ / ₂ " x 1 ¹ / ₂ " x 3/16"		
		angle girth at 8 ft. centers bolted to the		
		pocket joints		
55" – 72"	20	1 ¹ / ₂ Pocket Joint at 4 ft. centers with		
		across breaking and 1 ¹ / ₂ " x 1 ¹ / ₂ " x 3/16"		
		angle girth at 8 ft. centers bolted to the		
		pocket joints		
73" and	18	$2 - 1 \frac{1}{2}$ " x 1 $\frac{1}{2}$ " x 3/16 angles at 4 ft.		
above		centers bolted to the duct with 3/8"		
		bolts at $1\frac{1}{2}$ centers and fastened		
		together with 3/8' bolts at 2" centers		



with rubber gasket between the 2
angles and cross breaking.

All transformation pieces of ducting shall have slope of 1 in 7, where it is not possible to maintain this, a maximum slope of 1 in 4 shall not be exceeded.

All the side outlet take off (outlet collars) shall have a throat radius of not less than the width of the take off and to be fitted with fixed turning vanes.

All Tees, bends and elbows shall be constructed in such a way that the radius will not be less than 1-1/2 times width of duct on centerline. Where this is not possible turning Vanes shall be provided.

Duct sizes shall be increased gradually, not exceeding 15 Deg. wherever possible. Divergence upstream of equipment shall not exceed 30 degrees,

convergence downstream shall not exceed 45 degrees.

ii. Low Pressure Round Duct

Low pressure Round Duct shall be constructed generally according to the following schedule:

Duct	Negative P	gative Pressure Positive Pressure		
diameter in inches	Spiral Seam gauge US	Longitude. Seam gauge US	Spiral Seam gauge US	Longitude. Seam gauge US
3"thru 8"	28	24	30	28
9" thru 14"	26	24	28	26
15"thru 26"	24	22	26	24
27"thru 26"	22	20	24	22
27"thru 50"	20	18	22	20
61"thru 84"	-	16	-	16

1" W.G. Maximum Negative Pressure.



iii. Medium and High Pressure Duct Work:

Medium and High Pressure Duct shall be of round Construction.

Fabrication and Construction shall be in accordance with SMACNA high pressure duct construction Standards.

The Spiral Ducts shall be externally seamed so that the inside surface of the ducts is smooth.

Gauges of G.I. sheeting, type of joints, bracing etc. used for the manufacture of medium and high pressure round duct work shall be as per the schedule:

Duct	Galv. Steel		Girth Reinforcing		Girth Joints*			
Diameter	Gau	ıge (U.S.)						
mm	Spiral lock	**	***	Between Joint		Between Joint		
	Seam Duct	Longit	Sound	Angle Size & Ma				
		udinal	Duct	Longitudinal				
		Seam	Fitting	Spacing				
		Duct						
Up thru 200				22	None Required	50 mm long		
225 - 350	26	24	26	20		Slip Joint		
375 - 650	24	22	24	20	None Required	50 mm. Ditto		
675 - 900	22	20	22	20	None Required	50 mm. Ditto		
925 - 1250	20	20	20	18	None Required	40x40 mm		
					_	Angle flanged joint		
1275 - 1500	18	18	18	18	None Required	Ditto		
1525 - 2100			18	18	None Required	Ditto		



* Recommended Joint Listed; However, 50 mm. Slip Joint or Draw Band is acceptable thru 1500 mm. size.

** Slip or Draw Band Joint.

*** Flanged Joint.

All Tees, Bends and Elbows shall be constructed with radius of not less than 11/2" times diameter of duct on centerline. Where not possible and where rectangular elbows are used, airfoil turning vanes shall be provided. Transformation of duct sizes shall be gradual, not exceeding 15 degrees divergence and 30 degrees convergence.

Round duct fittings shall be of welded type construction. For ducts of diameter up to and including 12", one piece smooth 90 Deg. elbows shall be used. Over 12" 0 they shall be 5 pieces welded.

2.03. STAINLESS STEEL DUCTWORK:

Provide stainless steel ductwork for all kitchen hoods up to five (5) meters away from hood. Fabricate entire length of ductwork using stainless steel type 316, thickness 0.7 mm.

2.04. FLEXIBLE DUCTS:

For connections between branches, risers or mains to mixing units, air outlets and inlets or terminal units or for combination lighting air distribution units. Flexible ducts to be manufactured from vinyl or anisole bonded to glass fabric zinc-coated flexible metal or constructed of two-element spiral construction composed of a corrosion-resistant metal, supporting spiral and coated fabric approved equal materials with a mineral base.

2.05. DAMPERS

A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "Low Pressure Duct Standards". These dampers are for use in balancing air flow in duct systems.



- B. Control Dampers: Provide dampers with parallel blades for 2-position control or opposed blades for modulating control. Construct blades of 1.6 mm thick steel to provide heavy-duty molded self-lubricating nylon bearings, 13mm diameter steel axles spaced on 230 mm centers. Construct frame of 50mm x 13mm x 3.2 mm steel channel for face areas 2.3 sq. meter and under; 100mm x 32mm x 1.6mm thick channel for face areas over 2.3 sq. meters. Provide galvanized steel finish with aluminum touch-up.
- C. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 1.6mm thick aluminum, provide 13mm diameter ball bearings, 123 mm diameter steel axles spaced on 230 mm centers. Construct frame of 50 x 13 x 3.2 mm steel channel for face area 2.3 sq. meters and under; 100 x 32 x 1.6mm channel for face areas over 2.3 sq. meters. Provide galvanized steel finish or frame with aluminum touch-up.

2.06. TURNING VANES/AIR EXTRACTORS

A. **Turning Vanes**:

- Shall be fabricated in accordance with SMACNA Standards.
- Turning Vanes shall be as follows: Factory fabricated vane spacing rails. Turning Vanes shall be provided in all square elbows, take-off or extension collars to supply outlets and tap-in branch take-off connections.
- B. Actuation Mechanism: Devices shall be equipped with both motorized and the fusible links. The fusible links shall be rated and marked for 72 degrees C. Fire dampers shall be suitable for horizontal or vertical mounting and shall be interlocked with fire alarm system.
- C. Free Areas: Unless otherwise noted, fire dampers for use in ducted applications shall be constructed so that in the open position, the damper has a clear opening equal dimensionally to the duct size. Fire



dampers for use in no ducted applications must have at least 75% free areas

D. Fire Rating: All dampers shall not permit the passage of flame when exposed to the time/temperature curve of BS 476, Part 8 for a period of two (2) hours. The damper blades, gearing, mechanism and inner casting shall be easily removable to facilitate maintenance, replacement or repair. To facilitate reset and manual resetting of the blades, a short extension spigot shall be fitted to the damper blade assembly with a manual lever fitted to the spigot and linked to the damper blade gearing assembly. Indication shall be provided when the damper is in the open or closed position. An internal rachet mechanism shall hold the damper in the open position. Fire damper assembly shall be tested by an approved authority and the contractor shall provide test certificates from the authority. An inspection hatch shall be provision for remote close or open signaling and shall be connected with fire alarm system.

2.08. ELBOWS

- A. Rectangular Ducts:
 - i. Radius Elbows: Radius elbows shall be fabricated in accordance with Figure 2-1 of the SMACNA L.P Duct Manual. Wherever possible, the throat radius of the elbow shall be equal to duct width. Where throat radius must be less than duct width, elbow shall be constructed with one vane as shown in Figure 2-1.
 - ii. Square Elbows: Double thickness turning vanes as shown in Figure 2-3 of the L.P Duct Manual shall be used in square

Туре	Space Between Vanes	Radius	Gauge
Small	1 1/2"	2"	24
Large	3 1/4"	4 ¹ / ₂ "	22

B. Air Extractors:

Provide air extractors in sub-branch supply ducts to control air flow quantity to branch. Construct extractors of Galva steel or aluminum in accordance with SMACNA "Low Pressure Duct Standards".



2.07. FIRE DAMPERS

- A. Damper Frame: Frame shall be fabricated of no less than 1.7 mm thick (minimum galvanized steel, roll-formed for structural rigidity and equipped with slots or holes for mounting to wall sleeve. Damper frames designed to function as a wall sleeve are not acceptable. Separate wall sleeves must be furnished.
- B. Damper Blades: Damper blades shall be mounted in the air stream and be opposed - blade arrangement. The blades shall be interlocking, be constructed from not less than 0.7 mm thick (minimum) galvanized steel, or not less than 0.5 mm thick stainless steel and have hollow section profile. The blades shall normally be parallel with the air stream and be closed by internal spring's operating rack and pinion mechanism, or gearing, to interlink the damper blades. The gearing shall have low torque characteristic and be constructed in zinc plated steel. The fire damper blades and holding casting shall be fitted in the fire wall or floor and be designed to accommodate thermal expansion during fire condition to prevent jamming and distortion of the blades and maintain integrity to the fire seal.
- C. Wall Sleeves: Contractor-fabricated sleeves shall be furnished for all fire damper installations. Sleeves shall be fabricated of not less than 3mm thick, (minimum) galvanized steel and equipped with 38 mm x 38mm x 3.2mm (or larger) angle iron frames to secure the sleeve in the wall or floor. Angle iron frames shall be provided on both sides of the wall or floor and shall be welded or bolted to the wall sleeve along the entire perimeter of the sleeve.
- B. Round and Oval Ducts:

Elbows for round ducts may be smooth, machine stamped elbows or mitred elbow, with throat radius equal to or greater than the duct diameter. All mitred elbows shall be fabricated according to the following schedule:

Elbow Angle	Number of Cores
Up through 35 degrees	2
36 degree thru 71 degree	3



2.09. DUCT FITTINGS

A. Rectangular Duct:

All changes in duct sizes or elevation, tee connections, connection for grilles, registers or diffusers, transitions for elbows, casings, etc. shall be in accordance with Figures 2-2, 2-7 through 2-10 of the L.P. Duct Manual, SMACNA. Unless otherwise noted, no mitred fittings will be allowed.

B. Round and Oval Ducts:

All changes in duct size or elevation, the connections and branch laterals shall be made with separate fittings of all welded construction. All 90 degrees tees and 45 degree branch laterals up to 300 mm diameter tap size shall have a radiused entrance into the tap, reduced by machine or press forming; field-made connections are not acceptable. For duct with tap sizes larger than 300 mm diameter, these fittings shall be of the conical design. Welded seams must be ground free of any weld build-up, burrs or irregularities and coated with a corrosion resistant aluminium paint.

2.10. ACCESS DOORS

- A. General: Access doors are to be installed in ducts, casings and housing as specified below. Unless otherwise noted, access doors are to be made of the same material as ducts, casings, or housing in which they are installed. Insulate access doors with an equal ductwork or housings in which they are installed.
- B. Access doors are to be installed in ducts at each vaned elbow or tee, splitter damper, volume damper, fire damper, duct-mounted coil, fan, humidifier, air flow measuring station and any duct mounted instrumentation.
- C. Air tight access doors with rubber linings shall be installed in all ducts at fans, filters, heaters, fire dampers and volume dampers for inspection, cleaning and maintenance purposes.



C. The opening in the ductwork shall be properly stiffened at the edges, with frames riveted or welded to the duct. The access door shall be as follows:

All Access Doors mounted on insulated ducts shall be of sandwich type, having the same insulation thickness as that of duct, with Cam Lock Handles.

MSX DIM	NO. OF HINGES	NO.OF HANDLING	DOOR	GAUGE BACK	FRAME
12x12	2	1	26	26	24
16x20	2	2	24	26	22
24x24	2	2	22	26	22

2.11. FLEXIBLE CONNECTIONS

Flexible connections shall be fitted on all suction and discharge connections of fans and air conditioning units, for preventing transmission of vibration through the ducts to occupied spaces.

Flexible connections shall be flame proof factory fabricated from chemically impregnated canvas. Connections shall fit closely and be secured in an air-tight fashion to duct work, fans and apparatus by means of angle iron or flat iron frames. The un-clamped section of the flexible connection between the apparatus and the ductwork shall be not less than 6" in length. Flexible connections shall not be painted.

2.12. SUPPORTS AND HANGERS

Refer to "Supports and Anchors" spec's in section "12". Installation of supports and hangers shall be as follows:

- A. Supports and hangers shall be attached only to structural framing members and concrete slabs. They shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking.
- B. Supports shall generally comprise galvanized steel sections, and where heavy item of equipment occur within ductwork additional supports shall be provided as necessary.



- C. Duct work hung from inserts or from clip angles shall be secured with expansion bolts in shear.
- D. Supports for horizontal ducts shall be as follows:

LENGTH OF LONGER SIDE	DROP ROD DIAMETER	BEARING MEMBER	MAXIMUM SPACING
mm	Mm	Mm	mm
Up to 300	8	20x3 FLAT	3000
Over 300	8	25x25x4 angle	3000
Over 600	10	40x40x4 angle	2500
Over 1000	10	50x50x5 angle	2500
Over 1600	15	75x75x6 angle	2500

i. Rectangular Duct

Design of Supports for vertical ducts will be dictated by site conditions and spacing may be greater than for horizontal ducts.

Supports for vertical ducts shall be angles and channels made of galvanized or painted black steel.

Vertical duct shall be fastened with a minimum of 2 supports at each floor.

- **DUCT DIAMETER STRAP HANGERS** MAXIMUM SPACING Up thru 26" One 1" x 22 ga. 12 ft 27" thru 36" One 1" x 18 ga 12 ft One 1" x 16 ga 37" thru 50 12 ft 51" thru 60" Two 1"x 18 ga 12 ft 61" thru 84" Two 1"x 16 ga 12 ft
- ii. Hangers Sizes for Round Duct:



2.13. SEALANTS:

- A. All joints and seams in ductwork and casing are to be thoroughly sealed to prevent air leakage. This applies to all transverse joints between duct sections, duct taping, branch duct connections or access door installations. Longitudinal seams need not be sealed unless the duct or casing section contains more than two seams along its perimeter.
- B. Sealant is to be a fast-setting, thixotropic paste that remains flexible after drying.

2.14. DUCT CONNECTIONS TO EQUIPMENT:

- A. Duct connections to air conditioning equipment shall be angle reinforced, flanged connections secured by 6 mm dia. bolts on 200 mm centers (maximum). Joints are to be gasketed with red rubber or high-density neoprene and sealed airtight.
- B. Ducts connection to transmitters shall be carried out to manufacturer recommendations and approved of the engineers.

2.15. DUCT HARDWARE:

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on product.
- B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as required, duct test holes, consisting of slot and cover, for instrument tests.
- C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and test holes, consisting of slot and cover, for instrument tests.

2.16. DUCT LINING:

Duct lining shall be 25 mm thick, 24 Kg/m3 density, coated with black-pigmented fire-resistant coating on the side towards the airstream.



PART - 3 EXECUTION

3.01 INSTALLATION OF DUCTWORK:

A. General:

Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight (5% leakage) and noiseless (no objectional noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 3 mm misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling.

- B. Seal ductwork, after installation, to seal class recommended and method prescribed in SMACNA "Low Pressure Duct Construction Standards 5th Edition.
- C. Install concrete inserts for supports of ductwork in coordination with formwork, as required to avoid delays in work.
- D. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- E. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Or if not otherwise in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead constructions, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 13 mm furring where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 25 mm clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.



- F. Electrical Equipment Spaces: Unless otherwise indicated, do not run ductwork through transformer vaults and their electrical equipment spaces and enclosures.
- G. Where ducts pass through interior partitions, conceal space between construction opening and duct or duct-plus-insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 38 mm.
- H. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- I. Support ductwork in manner complying with SMACNA "Low Pressure Duct Construction Standards 5th Edition" hangers and supports section.
- J. Exposed Ductwork Materials: Where ductwork to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting, exposed duct color and finish shall be subject to M.O.I's engineers approval.
- K. Duct Lining: All portions of duct designated to receive duct liner shall be completely covered with 2.5 mm thick duct liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black coated surface of the duct liner shall be adhered to the sheet metal with 100% coverage of adhesive, and all exposed leading edges and all transverse joints coasted with adhesive.

The duct liner shall be additionally secured with mechanical fasteners which shall compress the duct liner sufficiently to hold it firmly in place.

Duct Liner shall be cut to assure overlapped and compressed longitudinal corner joints.

Fasteners shall start within 70 mm of the upstream transverse edges of the duct liner and 70 mm from the longitudinal corner joints.



Fasteners shall start within 70 mm of the upstream transverse edges of the duct liner and 70 mm from the longitudinal joints and shall be spaced at a maximum of 300 mm around the perimeter of the duct, except that they may be a maximum of 300 mm from corner break. Elsewhere they shall be placed not more than 150 mm from a longitudinal joint of the liner nor 300 mm from a corner break.

3.02. INSTALLATION OF FLEXIBLE DUCTS:

Install flexible ductwork in accordance with SMACNA Flexible Duct Performance Standards and Flexible Duct Installation Standards - 15d".

3.03. INSTALLATION OF KITCHEN EXHAUST DUCTS:

A. General:

Fabricate joints and seams with continuous welds for watertight of ductwork through 1000 Deg. C temperature range. Install without dips or traps which may collect residues, except where traps have continuous or automatic residue removal. Provide access openings at each change in direction, located on sides of duct 38 mm minimum from bottom, and fitted with grease tight covers of same material as duct.

3.04. INSTALLATION OF DUCT ACCESSORIES:

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90 degree in supply and exhaust air systems.
- C. Install access doors larger than 400 mm x 400 mm to open against system air pressure.
- D. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.



- E. Manual dampers shall be provided to all branches for air balancing.
- F. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where duct work is to be painted, might interfere with painting or cause paint deterioration.
- G. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.
- H. Temporary Closures: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris into unit at time connections are to be completed.

3.05. BALANCING:

Refer to "Testing, Adjusting and Balancing" for air distribution balancing of pressure ductwork. Seam and leaks in ductwork that become apparent in balancing process.



SECTION - AIR OUTLETS AND INLETS

PART-1 GENERAL

<u>1.1 DESCRIPTION:</u>

A. Scope:

1. Supply and Install Air outlets and inlets compliance in accordance with the requirements of the Contract Documents. This Section relates to supply and installation of air outlets and inlets for the HVAC Installation.

- 2. Types of outlets and inlets required include the following:
 - a. Ceiling air diffusers
 - b. Registers and grilles.
 - c. Louvers
- B. Related Work Specified Elsewhere and Forming Part of This Contract: Refer to other Sections of the HVAC installation for Ductwork and Duct Accessories required in conjunction with outlets and inlets.

<u>1.2</u> QUALITY ASSURANCE:

- a) Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- b) All manufacturers will be approved as subject to compliance will specifications.
- c) Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- d) Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the engineer for a complete written summary of the manufacturer's proposed products


- B. Regulatory Requirements
 - IDC Test Code: Test and rate air outlets and inlets in certified laboratory under the requirements of Air Diffusion Council (ADC) Equipment Test Code 1062 "Certification, Rating and Test Manual".
 - 2. ANSI/NEPA Standards: Install air outlets and inlets in accordance with National Fire Protection Association (NFPA) Standard 90A "Installation of Air Conditioning and Ventilating System".

1.3 SUBMITTALS:

Product Data: Submit manufacturer's data on outlets and inlets including the following:

- 1. Schedule of outlets and inlets indicating drawing designation, room location, and number furnished, model number, size, and accessories furnished.
- 2. Data sheet for each type of outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
- 3. Performance data for each type of outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, static pressure drop and noise criteria ratings at the required cfm. Indicate selections on data.

Samples: Submit samples of each type of finish required.

<u>1.4 PRODUCTS DELIVERY, STORAGE AND HANDLING:</u>

- A. Delivery outlets wrapped in factory-fabricated fiberboard type containers. Identify on outside container type of outlet or inlet and location be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.



PART 2 – PRODUCTS

2.1 GENERAL:

All air inlets and outlets shall be made of extruded aluminum alloy, polyester powder coated, oven baked and with a suitable color to the satisfaction of the Engineer. All air inlets and outlets shall be tested by an approved laboratory and certified by ADC (Air Diffusion Council) or an approved equivalent Authority.

Air Velocities in Press Hall not exceed 0.5 m/sec and also pressure in the Press Hall must be controlled to be lower than pressure in the adjacent Rooms in order to avoid ink smell, which is spreading from Press Hall to rest of the other building.

2.2 GRILLES AND REGISTERS:

They shall be furnished with sponge rubber gaskets or foam tape behind the frame to eliminate air leakage and with nylon bushings or PVC at the blades connection to the frame to eliminate corrosion and vibration. Free cross-sectional area shall be at least 65 percent.

Supply air registers and grilles shall have individually adjustable horizontal front blades and vertical rear blades.

Supply air register shall be equipped with key operated, opposed blade volume control damper.

Return and exhaust air registers and grilles shall have fixed single deflection blades set at an angle 35°.

Return and exhaust air registers shall be with key operated, opposed blade volume control damper.

All opposed blade volume control dampers shall be polyester coated oven baked with black color finish.



2.3 DIFFUSERS:

Diffusers shall be suitable for ceiling installation and duct work application as shown on project drawings. They shall be provided with rubber gasket or foam tape at the outer edge of the frame to produce a positive air seal at the mounting surface. They shall be produced with removable core and provided with equalizing grids. Face plates shall be furnished with concealed hinges and clips. Duct collars connecting duct of diffuser shall be air tight and not interfere with the volume control damper. Supply air diffuser shall be equipped with opposed blade volume damper adjustable from the face of the diffuser without removing the core.

2.4 DOOR GRILLES:

The frame shall be separated from the blades by an extruded rigid PVC track which shall be an integral part of the frame. The blades shall be of V-shape; mounted in the PVC track and spaced 12.5mm on centers. Door grills shall be provided if necessary even not shown on drawings.

Note: All Toilet door are to be provided with DUC /Door grilles.

2.5 LOUVERS

Louvers shall be suitable for installation into masonry work or directly connected by duct work to air handling equipment and shall be as follows: -

Frame and blades shall be made of extruded aluminum alloy, polyester powder coated, oven baked with a suitable colour to the satisfaction of the Engineer.

Each blade shall be held to the frame by aluminum angle brackets, which slip into a groove on the interior blade face and riveted to the frame.

The blades shall be spaced 2 1/4" on center and set at 45 degree to the horizontal.

Edges of louver blades shall be baffled to exclude driving vain.

Louver shall be furnished with an expanded aluminum bird screen, attached to the interior face of the louver.

For fresh air intake, louver shall be provided with insect screen, filters and control damper. Control damper shall be manual or motor operated as required.



PART 3 – EXECUTION

3.1 GENERAL:

- A. Provide all grilles, registers or diffusers which are suitable for installation in the ceiling, wall or floor finishes. Provide all required accessories to facilitate installation.
- B. Provide all air distribution devices from one manufacturer unless otherwise noted.

3.2 INSPECTION:

Examine areas and conditions under which outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.3 INSTALLATION:

- A. General: Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

3.4 SPARE PARTS:

Furnish to the Engineer, with receipt, 3 operating keys for each type of outlet and inlet that require them.

20% of special displacement outlets from Total quantity.



SECTION - INSULATION

PART -1 GENERAL

1.01 DESCRIPTION

- A. Extent of Work: The extent of insulation work is as per the requirements of this section.
- B. Insulation material shall be applied to the following:
 - i. Chilled water piping, condensate water piping, valves and accessories.
 - ii. Supply & return ductwork.
 - iii. Cold surfaces of ACHV equipment

1.02 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of pipe and ductwork insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Code and Standards: Comply with applicable requirements of NFPA, ASTM and BS standards as follows:
 - i. BS British Standard BS 542, BS 2972, BS 5970 and BS 476.
 - ii. ASTM American Society for Testing and Material, ASTM E-84.
 - iii. NFPANational Fire Protection Association, NFPZ 225.



1.03 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data on all types of insulation specified hereinafter.
- B. Certification: Provide certificates or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.04 PRODUCT DELIVERY, STORAGE & HANDLING

- A. Product insulation against dirt, water and chemical and mechanical damage. Do not install damaged insulation; remove from project site.
- B. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory fabricated containers with the manufacture's stamps, or label, affixed showing fire hazard ratings of the products.
- C. Store insulation in original wrappings and protect from weather and construction traffic.



PART - 2 PRODUCT

2.01. GENERAL REQUIREMENTS

- A. Insulating materials shall be selected for use in accordance with, and comply with all applicable requirements of BS 5422 and BS 5970.
- B. Thermal insulation shall be of an approved material with thermal conductivity no higher than 0.29 Btu/hr. Ft 2. Deg.F. inch measured at an average temperature of 100 F. The thermal insulation shall be non-corrosive to the metal, water repellent, fire retardant, sustenance to vermin and easily cut and fitted to shape during application.

The insulation shall be provided with approved fire retardant vapour barrier jacket to prevent moisture penetration to the insulation. Vapour barrier shall also be applied to all joints and edges.

The insulation shall be fixed into the material surface by means of an approved adhesive compound that has no corrosion effect on the metal, and thoroughly applied to the metal surface and insulation.

- C. All materials, including fixing and finishing materials, shall be rated Grade "P" when tested for ignitability in accordance with BS 476; part.5.
- D. Materials shall be rated "low flammability" as defined in BS 2972.

2.02 MANUFACTURERS:

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed product.



2.03. PIPE WORK INSULATION

A. Chilled Water, Refrigerant Pipes, Valves, Strainers, etc., and fittings shall be insulated with rigid fibre glass of not less than 6 lb/ft3 density or equivalent, performed sectionally and split longitudinally into two valves with factory applied reinforced aluminium foil coating with following thickness.

PIPE SIZE SERVICE

Upto 2" 21/2" - 6" 8" & above

- 1. Chilled Water Pipes exposed to Sun. 1" 2" 3"
- 2. Chilled Water Pipes in non A/C Areas. 1" 11/2" 2"
- 3. Chilled Water Pipes in A/C areas 1/2" 1" 11/2"
- 4. Condensate Drain Pipe 1/2" 1/2"
- 5. Refrigerant (Suction Pipe Only) inside building 1" 1"
- 6. Refrigerant (Suction Pipe Only) exposed to Sun 11/2" 21/4"
- B. Insulation jacket to be white Kraft paper bonded to aluminum foil, reinforced with glass fiber yarn. The Kraft paper shall be permanently treated to assure permanent fire and smoke safety and to prevent corrosion of foil. An adhesive shall be used to seal the insulation jacket. The longitudinal lap of the jacket shall have pressure sensitive tape closure system. The tape shall be protected by a strip of release paper which is pulled off prior to application to pressure sensitive tape. Butt strips shall also be furnished in order to totally seal the system.



C. Chilled water pumps, valves, strainers and fittings requiring periodic maintenance shall be insulated with removal and replaceable covers of 1 mm. thick galvanized sheet metal jacket lined with 2" thick rigid fiberglass insulation. All voids between insulation and cold equipment surfaces shall be filled with fiber glass blanket insulation.

Joints of the metal cover shall be vapour sealed with vapour barrier coating after the covers are in place.

- D. On chilled and condensate pipes, longitudinal jacket laps shall be sealed with adhesive and butt joints and wrapped with 3 inch wide strip of jacket material and sealed with adhesive. Fitting cover edges to be sealed with vapor barrier adhesive and circumferential edges to be covered with vapor barrier tape over-lapping a minimum of 2 inch on each side of joint.
- E. Runout to air handling units to be insulated with 1/2 inch thick flexible foamed plastic insulation, having an average thermal conductivity of 0.04Wm Deg.C. at a mean temperature of 24 Deg.C. When necessary to cut insulation and at all butt joints, joint insulation by sealing with waterproof vapor barrier adhesive.
- F. All insulated pipes running inside A/C plant room or inside they are exposed to view, shall be cladded with anodized 0.4 mm. thick aluminum sheets neatly installed. No painting is required above the aluminum cladding. Colored arrows and indications shall be used as specified elsewhere.

All insulated pipes inside tunnels, shafts, and above false ceiling shall be cladded with 0.3 mm. thick smooth PVC sheet.

Pipes running underground or in trenches below ground level, whether back-filled or not, shall be specially treated for moisture and water-proofing. The whole insulation shall be tightly wrapped with 3/4" galvanized wire mesh and coated with approved bitumastic compound thickly applied to cover the mesh completely. Alternatively, the insulation may be wrapped completely with dense taps over-lapped or equal and approved moisture proofing material.



Un-insulated pipes burried underground shall protected against water and soil corrosion.

2.04 DUCT WORK INSULATION

Thermal insulation shall consist of an inorganic blanket of fiber glass or equivalent with reinforced aluminum foil external coating, factory applied with resin bonded internal layer to give flat and resilient surface. The insulation for all duct work exposed to outside and those in plant rooms shall be rigid slab type and for remaining ducting flexible blanket type.

The density of insulation shall be minimum 1.5 1b/cu.ft. for flexible blanket type and 3 1b/cu.ft. for rigid slab type and thickness as below:-

Supply air duct in non air-conditioned areas	2"
Supply air duct in air-conditioned areas	1"
Return air duct in non air-conditioned areas	1"
Return air duct in air-conditioned areas	Nil
Fresh air duct in air-conditioned areas	
Supply & Return air ducts exposed to outside	
ambient temperature.	

Insulation shall be secured to duct work 2" x 2" G.I. sheet metal strips of 22 gauge fixed to corners and tightened with wire 6" intervals. The strips may be suitably grooved to take the wire fasteners. Transfers duct connections such as pocket joints and flanges shall be additionally insulated with 4" wide, 1" thick insulation and covered with 8" wide, 8 OZ canvas equally overlapped on either side and finally coated with 2 coats of approved paint.

All duct work exposed to outside, shall be covered with 0.6 G.I. sheeting and shall be treated for water-proofing prior to cladding i.e. wrap the insulation with 0.5.mm. thick polyethylene sheet and secure with adhesive. All duct work insulation exposed to view shall be finished with 8 OZ canvas finished with 2 coats of fire retardent and water proof paint.



2.05. ACOUSTIC DUCT LINING

Internal duct lining for acoustic insulation where applicable shall not be less than 1" thick fibre glass mat faced, flexible blanket of fine fibres with securely bonded surface mat coated with clean or black neoprene or approved equal. Lining to be applied with 100% coverage of fire resistive approved adhesive compound and mechanical fastenings according to the manufacturer's instructions. Acoustic lining shall be cleared 20cm. Duct lining density shall be 1.5 Lb/Ft.3.



PART -3 EXECUTION

3.01. INSPECTION

A. The Contractor shall examine the substrate and the conditions under which insulation

is to be installed and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02. INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with the manufacture's written instructions, and in accordance with recognized industry practices to ensure that the insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to testing and acceptable of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapour barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Contractor's option) except where a specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.



- I. In addition to the insulation specified above, pipes that are exposed in traffic areas such a mechanical rooms and pipes exposed to outdoor conditions such as those installed on roofs shall be cladded with aluminum sheet. Cladding shall be strapped at not more than 400 mm on centers.
- J. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 75 mm wide vapor barrier tape or bank over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 75 mm wide vapor barrier tape or band.

3.03. INSTALLATION OF DUCTWORK INSULATION

- A. Install insulation products in accordance with the manufacturer's written instructions, and in accordance with recognized industry practices to ensure that the insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces
- C. Clean and dry ductwork prior to insulating, Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapour-barrier on ductwork insulation and protect it to prevent puncture and other damage.
- E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- F. Apply insulation with edges tightly butte. Impale insulation on pins welded to the duct and secure with speed clips. Cut the protruding ends of the pins flush after the speed clips have been applied. Seal the vapour barrier facing with a vapour barrier mastic or tape where the pins have pierced through. Space the pins as required to hold insulation firmly against duct surface but not less than 10 pins per square meter. Seal all joints with 75 mm wide pressure sensitive tape to match the facing.



3.04. INSTALLATION OF EQUIPMENT INSULATION

- A. **General:** Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapour-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Aluminum sheet metal cladding shall be neatly cut, fixed with self-tapping aluminum metal screws and arranged for easy removal and reinstallation.
- E. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- F. **Equipment Exposed to Weather:** Protect outdoor insulation from weather installation of weather-barrier mastic protective finish, or jacketing, as recommended by manufacturer.

Protection: The Contractor shall provide protection, as required for insulation work during remainder of construction period, to avoid damage and deterioration

3.05 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protect insulation work during the remainder of the Construction period, to avoid damage and deterioration.



SECTION - HYDRONIC PIPING

PART - 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping Materials
- B. Piping Accessories

1.02 DESCRIPTION

All water pipes, pipe fittings, valves, strainers, flexible connections, expansion joints and all other accessories etc., for chilled, and the associated make up drain water piping shall be supplied and installed as mentioned in the Scope of Work..

1.03 QUALITY ASSURANCE

- A. All pipes and fittings shall be brand new stamped clearly at factory indicating size, make and standard to which they are manufactured. Pipes shall be provided with plastic caps at both ends.
- B. Welding: Qualify welding procedures, welders and operators in accordance with BS 2971 for shop and project site welding of piping work.
- C. Certification of Welders: No certifications shall be more than two years old. The Engineer may accept or reject any certification. Any certification tests required will be conducted at a place and time convenient to both the Contractor and the Engineer.
- D. Brazing: Certify brazing procedures and operators in accordance with BS 1723 for shop and job-site brazing of piping work.
- E. Testing: Radiographic (X-ray) method of fusion welded steel pipe joints shall comply with BS 2910.



1.04 SUBMITTALS

- A. Shop drawings: Submit shop drawings for all ACHV piping network including schematic drawings as required.
- B. Required Data : The submitted shop drawings shall include but not be limited to the following information regarding ACHVS piping and accessories :
 - i. Pipe and tube sizes, location, elevation and slopes.
 - ii. Pipe fittings, accessories, valves, meters, gauges and controls.
 - iii. Equipment connections and drain connections.
 - iv. Support hangers, etc
- C. Product Identification: Submit with the shop drawing a list of equipment, accessories, gauges, supports etc., giving each item a design code number and manufacturer number. The code number shall be identified by number on the shop drawings submitted.



PART - 2 PRODUCTS

2.01 PIPING MATERIAL

- A. Unless otherwise specified, pipes for chilled water shall be seamless black steel pipe to ASTM B 53 Schedule 40 or equal standard.
- B. Equipment and condensate drain and make-up water pipes shall be galvanized steel pipe to ASTM B 53 Schedule 40 or equal.
- C. Pipe fittings for chilled water pipes shall be factory made wrought steel, seamless, butt welding fittings to ASI B 16, 9 or equal.
- D. Pipe fittings for equipment and condensate drain and make up water pipes shall be malleable iron threaded fittings to ANSI B 16.3 or equal.

2.02 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Insulating (Dielectric) Unions : Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance) prevent galvanic action and stop corrosion.
- B. Welding Materials: Except as otherwise indicated, provide welding materials that comply with installation requirements.
- C. Soldering Materials: Provide jointing materials as required to comply with installation requirements. For pipe size to 54mm capillary fittings shall be tin-lead solder alloy to BS 219, Grades F & G.
- D. Brazing Materials: For pipe size of 67mm and above provide brazing materials that comply with BS 1845



2.03 PIPING ACCESSORIES

A. **General**: Provide factory fabricated piping accessories as specified herein. Provide products of the type and pressure-rating for each service or provide proper selection as required to comply with installation requirements. Provide sizes and connections matching pipe, tube, valve and equipment connections.

B. Flanges:

- i. Flanges shall be required for pipe size 2 inches and larger.
- ii. Flanges shall match class, material, grade and facing of connecting flange.
- iii. Screwed flanges shall be standard or heavy cast iron as required.
- iv. Flanges shall be furnished with gaskets of the one-piece ring type, compressed type or stainless steel wound type, suitable for temperature, pressure and service of system.
- v. Flanges shall be made to B.S 4503-NP 16/11 or ANSI-125 or equivalent and drilled to suit the mating flange.
- vi. Flanges on Black steel pipes shall be black forged steel of welding neck or slip on type.
- vii. Flanges shall be assembled with steel, square head machine bolts and hexagonal nuts. The bolts shall be of diameter and length to suit the flanges and to allow the nuts to utilize the full length of their thread. Bolts and nuts shall be stainless steel to ASME G E 316.



C. Unions

- i. Unions shall be required for pipe sizes 11/2 inches and smaller.
- ii. Unions shall be of wrought copper, suitable for the System test pressure and working temperature.

D. **Dielectric Unions and Flanges**

- i. Joints between dissimilar metals shall be made through dielectric unions or flanges to pelectrolytic interaction and corrosion. This applies particularly to joints between ferrous and non-ferrous piping.
- ii. Dielectric unions shall be used on 11/2 inches pipes and smaller and flanges on 2 inches and larger. Flanges shall be fitted with a set of gaskets and Teflon sleeves and washers between flanges nuts and bolts.
- iii. The entire joints including the dielectric material shall be suitable and capable to withstand the temperature, pressure and all other operating conditions of the service for which they are used.
- E. **Flexible Connections** shall be used to connect pipes to equipment to provide piping flexibility to permit isolators to function properly, protect equipment from strain from misalignment and expansion or contraction of piping and to attenuate noise and vibration transmission along the piping. Spherical connections shall be used for chillers, pumps air-handling units and other isolated equipments. It shall be constructed of one or more large radius arches of either rubber or Teflon with metal or fabric reinforcement. Flexible connections upto 11/2 inches shall be provided with unions while 2 inches and above with Flanges. Metallic flexible hose connections shall be generally used for refrigerant lines. Rubber flexible hose connections shall be used for chilled and hot water lines to take up lateral movement with practically no axial movement. The flexible connections shall be suitable for the test pressure and working temperature of the circulating medium.



F. <u>Expansion joints</u>.

- i. Expansion joints shall be fitted where expansion not taken up by the piping off-sets and change in direction of piping and where pipes cross the expansion joints of the building. The Contractor shall submit to the Engineer for approval the calculation of the system expansion and contraction together with the selection and location of expansion joints.
- ii. Expansion joints shall be suitable for system test pressure and working temperature.
- **G.** Steel pipe Sleeves: Fabricate from galvanized steel pipe to BS 1387
- H. Iron Pipe Sleeves: Fabricate from cast iron pipe.
- I Sheet Metal Pipe Sleeves:

Fabricate from galvanized sheet metal closed with lock-seam joints. For following pipe sizes provide gauge indicated : 80 mm diameter pipe and smaller, 20 gauge, 100 mm to 150mm diameter pipe 16 gauge, over 150mm diameter pipe, 14 gauge.

J. Pipe sleeve caulking by means of oakum and lead, except where another caulking system or material is indicated.



PART - 3 EXECUTION

3.01 PIPE INSTALLATION

A. General:

In general refer to attached section TESTING, ADJUSTING AND BALANCING. Install pipe, tube and fitting in accordance with recognized industry practices which will achieve permanently leak-proof piping system, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and coupling, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections with in 11/2 mm misalignment tolerance.

- B. All piping circuits shall have means for complete drainage at all low points and means for venting at all high points.
- C. All branches of water piping circuits shall be provided with isolating valves, permit closing off any section of the circuit for maintenance and repair without interrupting other parts of the system.
- D. Pipe fittings shall be factory fabricated or size and type to match the pipe, tube, valve or equipment connection.
- E. All change in direction, change in pipe size, branching and jointing of pipes shall be made with regular pipe fittings, such as Elbows, Reducers, Tees, Couplings, Unions, Flanges, etc. Bending of pipes for elbows and field fabricated fittings such as mitred elbows, tees or reducers shall not be accepted.
- F. Reducers shall be of the concentric or eccentric type to suit the application.
- G. For branch connections where branch pipe size is less than half the main pipe size, cutting through shall be accepted to make the connection using factory fabricated saddles.



- H. **Unions or Flanges** shall be required on both sides of each piece of equipment in the system, such as chillers, pumps, strainers, valves, etc., to facilitate its removal for repair or maintenance.
- I. Locate piping runs, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lies.

Locate runs and run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls overhead construction columns and other structural and permanent-enclosure elements of the building, limit clearance to 12mm enclosure or concealment of piping and allow for insulation thickness, if any. Where possible, locate insulated piping for 25mm clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings, do not encase horizontal runs in solid partitions, except as indicated or directed by the Engineer.

- J. **Electrical equipment Spaces**: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures.
- K. **Piping system joints**: Provide joints for the type specified hereinbefore to each piping system, and as follows:
 - i Thread pipe in accordance with BS 3643 cut threads full and clean using sharp dies, Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 - ii. Weld pipe in accordance with BS 2971.
 - iii. Braze copper tube and fitting joints, in accordance with BS 1723.



- iv. Flanged Joints: Match flanges within piping system and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets. Comply with BS 4504.
- v. Solder copper tube and fitting joints in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas to both tubes and fittings. Insert tube full depth into fitting and solder in a manner which will draw solder full depth and circumstance of joint. Wipe excess solder from joint before it hardens.

L. Cooling Coil Condensate Piping:

Install piping pitched to drain with a minimum of 1% run in the direction of floor drain.

M. Buried Pipe Installation:

Pre-insulated pipe work shall be installed in buried condition to the levels and extent required.

3.02. INSTALLATION OF PIPE ACCESSORIES:

A. **Expansion Compensators:**

Install expansion compensators where indicated and all building expansion joints for adequate expansion of the piping system. Install in accordance with manufacturer's instructions.

B. Strainers:

Install strainers at inlet of pumps and elsewhere as indicated. Install strainers in accordance with manufacturer's instructions.

C. Install escutcheon plates at pipe sleeves where piping is exposed to view in occupied spaces of the building, on the exterior and elsewhere .

D. Drip Pans:



Install drip pans under pipes which pass over or close to electrical equipment. Support with bars or angles and brace to prevent sagging or swaying.

E. **Pipe Sleeves:**

Install pipe sleeves of the types indicated wherever piping passes through walls, floors, ceilings, roofs and structural members of the work. Provide sleeves of adequate size, accurately centered on pipe runs. Size sleeves so that piping and insulation will have free movement in the sleeve, including allowance for thermal expansion. Where insulation includes a vapor barrier covering provide sleeve with efficient clearance for installation of a vapor barrier, but not less than 2 pipe sizes larger than piping run, install length of sleeve equal to thickness of construction penetrated, except extend floor sleeves 6.3mm above floor finish and where floor surface drains to a floor drain, extend floor sleeve 19mm above floor furnish.

Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering pipe sleeves.

- i. At interior partitions and ceilings install sheet-metal sleeves.
- ii. At exterior penetrations install iron pipe sleeves, both above and below grade.
- iii. Except as otherwise indicated, install steel pipe sleeves.
- iv. Caulk pipe sleeves at exterior penetrations and at other locations where indicated. Provide sufficient quantities of oakum and lead to make permanent whether-tight closure between sleeve and piping, slightly recessed at exposed surface.

3.03 CLEANING, FLUSHING, PURGING, INSPECTING.

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings (if any). Inspect each run of each system for completion of joints, supports and necessary items.
- B. Clean and flush, with clear water, of all dirt, metal chips, sand, and foreign matter. After flushing remove, clean and replace all strainer



baskets or screens. Inspect each run of each system for completion of joints, supports, accessory items and obvious leaks.

3.04. PIPING TESTS

A. **General:** In general, refer to Testing Adjusting and Balancing. Provide temporary equipment for testing, including pumps and gauges. Test piping system before insulation is installed and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Required test period shall be a minimum of 2 hours at the conditions specified.

Unless otherwise specified test each piping system at 150% of operating pressure indicated but not less than 2 bar test pressure.

Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

Repair piping systems sections which fail require piping test. By disassembly and re-installation. Using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Re-tests shall have to be carried out after completion of remedial work arising from initial test failures to the satisfaction of the Engineer. The Engineer shall be notified at least 24 hours before performing tests.

B. Chilled Water: Pressure test the system as a whole or in sections in compliance with CP 341.300 - 307 and BS 806.

Drain test water from piping systems after testing and repair work that has been completed.



SECTION - ACHV VALVES AND ACCESSORIES

PART 1 GENERAL

1.01. SECTION INCLUDES

- A. Gate Valves
- B. Globe Valves
- C. Check Valves
- D. Butterfly Valves
- E. Drain Valves
- F. Commissioning Valves
- G. Strainers
- H. Automatic Air Vents

1.03. DESCRIPTION

A. General

All Valves shall be factory fabricated.

Valves shall be marked with name of manufacturer, trade mark, nominal size and the class number, all cast on the valve body.

Valves where possible, shall be of the same manufacturer. Valves shall be designed for saturated steam working pressure of 125 psi and cold water non-shock working pressure of 200 psi., unless otherwise specified in the project documents and shall be manufactured and factory tested in accordance with the latest relevant British Standard or an equivalent. Test certificate shall be submitted for all valves.

Seating surfaces of valves shall be machined and finished to ensure tightness against leakage for the service specified and shall set freely.

Handwheels of valves shall be of suitable diameter to allow tight closure by hand with reasonable force without additional leverage and without damage to stem, seat or disc.

Valves located 8 feet or more above operating floor or platforms in plant rooms shall be provided with a chain operated handwheel.



Flanged valves shall have flanges conforming to B.S.4504-NP 16/11 or ANSI 125 or equivalent.

Cast iron body gate, globe and butterfly valves shall be provided with position indicator.

All cast iron valves shall be fitted with Cast Iron indexed handwheel clearly marked "Open" and "Close" with an arrow to indicate the direction of rotation.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of valves, of types and sizes required, and which have been in satisfactory use for not less than one year in similar service.
- B. Inspection of Castings : Provide valve bodies, bonnets and discs which have been inspected in accordance with manufacturer's standard written quality control procedure.
 - I. Marking of Valves: All valves shall have the manufacturer's name, material designation, pressure rating and size clearly marked on the outside of the body. In addition, all globe and check valves shall have arrow indication of flow direction.
 - II. Valve Types: Provide valves of same type by same manufacturer.
- C. Hydrostatic Testing of Valves: Provide valves which have been tested in accordance with manufacturer's standard written test procedure and the applicable BS or ANSI Code.



1.04 SUBMITTALS

A. Manufacturer's Data, Valves

- i. Submit manufacturer's product data including dimensions, sizes, and connections, weights, and installation instructions.
- ii. Include instructions on repacking and repairing valves.
- iii. Include data indicating Code compliance and optional features.
- iv. Include required reports as prepared by manufacturers of valves.

1.05. PRODUCT DELIVERY, STORAGE AND HANDLING.

Provide manufacturer's standard temporary protective coating on cast iron and steel valves, and provide factory-applied end-caps on valves. Maintain coating and end-caps through shipping, storage and handling, in adequate condition to inhibit corrosion, prevent damage and eliminate dirt and moisture from inside of valves. During transportation and delivery, handle valves with care using adequate lifting equipment. Do not drop or abuse valves. Store valves inside and protect from weather. Where coating has been removed or damaged, and where valves are in environment which could reasonably be expected to cause rusting, protect valves with separate, durable waterproof wrapping.



PART 2 PRODUCTS

2.01 MANUFACTURERS

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.02 VALVE TYPES AND SIZES

A. General: Except as otherwise indicated, provided factory-fabricated valves of the type, body material and pressure class for use in service indicated. Where type or body material is not indicated, provide proper selection as determined by installation requirements, with pressure class selected from BS standards based on the maximum pressure and temperature in the piping system. Except as otherwise indicated, provide valve sizes and connections which properly mate with pipe, tube and equipment connections.

B. Gate Valves

- i. Gate valves shall be used for isolating purposes, such as inlets and outlets of chillers, pumps and at all branches from mains or risers.
- ii. Gate valves shall not be used for throttling purpose, such as regulating, balancing or control.
- iii. Gate Valves shall be of double facade solid wedge disc type giving straight line flow.



- iv. Gate valves of sizes 11/2 inches and smaller shall be of all bronze construction type with inside screw non-rising spindle, screwed bonnet, and screwed ends to ASTM B6 1/B 62 or gunmetal to BS 1400-LG 2.
- V. Gate valves of sizes 2 inches and larger shall be of flanged bonnet and flanged ends, outside screw rising spindle type. Body, wedge & cover in cast iron. Wedge facing rings & stem nut in gunmetal.

Spindle in aluminium bronze. Stem seal packing shall be of high quality suitable for Kuwait tropical climate.

vi. Gate valves of sizes 8" and larger shall be equipped with bevel gear unit.

C. Globe Valves

- i. Globe valves shall be used for throttling purposes to control the flow rate from full flow to complete shut-off.
- iv. Globe valves of sizes 1-1/2 inches and smaller shall be of all bronze construction with inside screw rising spindle, screwed bonnet and screwed ends.
- v. Globe valves of sizes 2 inches and larger shall have cast iron body, with outside screw aluminum bronze rising spindle, renewable gunmetal or bronze disc, with gunmetal or bronze seat ring, flanged bonnet and flanged ends. Globe valve disc shall be of the bevelledor parabolic shape to allow throttling.
- D. Check Valves: Check valves shall be silent, spring actuated lift type used to prevent automatically reversing of flow at pump outlets, in vertical lines and as required elsewhere. Check valves of sizes 11/2 inches and smaller shall be of bronze construction, screwed ends. Check valves of sizes 2 inches and larger shall be cast iron body, wafer type, stainless steel or bronze disc, stainless steel spring, renewable seats.



E. **Butterfly Valves:** The butterfly valves shall be used for shut-off or throttling purposes. The butterfly valves shall be of rubber lined tight shut-off type, having modular cast iron body, aluminum bronze disc, high grade stainless steel shaft, bronze bearings, monel taper pins, bunan seat liner vulcanized to the body. The butterfly valves shall be wafer type or flanged type. The butterfly valves of 21/2 " and larger shall have manual gear operator. All butterfly valves shall be supplied with locking device and position indicator.

F. **Drain Valves**

- i. Threaded ends 50mm and Smaller: Nominal pressure PN 16, Series A, bronze body, screwed bonnet, rising stem, composition disc, complying to BS 5154, threads to BS 3643.
- ii. Soldered Ends 50mm and Smaller: Nominal pressure PN 16, bronze body, screwed bonnet, rising stem, composition disc, complying with BS 5154, ends to BS 864, Part 2.

All valves 21/2" and above shall be of Butterfly valve with manual gear operator as explained in item e. (Butterfly Valves)

G. Commissioning Set shall be provided on the return pipe of each water cooling coil of A.H.U.'s and chiller return pipe to facilitate balancing procedure.

Commissioning Set shall consist of a double regulating valve for flow regulation and isolation and metering orifice station for measuring the pressure drop.

The metering station shall have an integral square-edged orifice plate fitted with a pair of pressure test plugs which can be connected to a manometer to measure the head loss. Bronze metering station shall have cast-in flow direction marking, threaded ends. The cast iron metering station shall be supplied complete with 2 correctly sized gaskets and one set of flange bolting.



The double regulating valve shall be of the Y-pattern (oblique) globe type having parabolic disc allowing regular variation of the valve opening. The variation of the opening is step controlled by a graduated adjustable sleeve fitted with the valve to control the lift of the disc. Each opening position is indicated by a marked number on the sleeve. At any pre-set position, the valve opening can still be regulated from fully-closed to a maximum opening at the pre-set position. The regulating sleeve is locked in the set position to prevent undesirable interference with the setting but remaining capable of being closed.

For sizes 11/2 inches and smaller Commissioning Set shall be of all bronze or gunmetal construction screwed ends and rising stem double regulating valve, fitted with numeric indicator.

For sizes 2 inches and larger Commissioning Set materials shall be as follows:

- H. Metering Orifice Station Cast iron body, stainless steel orifice plate, gunmetal retaining bush, brass test plugs.
- I. Double regulating valve, Cast iron body, stainless steel or bronze rising stem, gunmetal or cast iron disc, gunmetal rings, anodized aluminium indicator plate and flanged ends.
- J. Strainers shall be provided at the Suction Side of each water circulating pump.

Strainers shall be of Class 150 saturated steam working pressure, unless otherwise specified in the project documents.

Strainers shall be either y-type or basket type .

Strainers shall be full-size of the connecting pipe. Strainers for 11/2 inches pipe size and smaller shall be bronze body with stainless steel screen and screwed ends.

Strainers for 2 inches pipe and larger shall be cast iron body with stainless steel screen and flanged ends.



Pipe Size (inch)	Preparation size (inch)	Number of preparations per sq.inch
Upto 1-1/2	1/32	414
2 and larger	1/16	150

Screen preparation shall be as follows.

K. Automatic Air Vents Automatic air vents shall be provided at all high points of water piping system.

Automatic air vents shall be of the float type, and construction shall be as follows:

Body and guide cross of cast iron.

Valve Seat, guide bush, upper and lower guide connecting rod, valve and guide cone or brass or stainless steel. Float ball of stainless steel.

All automatic air vents shall be installed with a suitable size shut off valve.



PART-3 EXECUTION

3.01. INSTALLATION

- A. General: Except as otherwise indicated, comply with the following requirements:
 - i. Install valves where required for proper operation of piping and equipment.
 - ii. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

iii. Install globe valves on stem system for isolation purposes.

- B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation
- C. Applications Subject to Shock : Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
- D. Applications Subject to Corrosion : Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
- E. **Mechanical Actuators**: Install mechanical actuators with chain operators where indicated, and where valves 100mm and larger are mounted more than 2.1m above floor in mechanical rooms, boiler rooms; and where recommended by valve manufacturer because of valve size, pressure differential or other operating condition making manual operation difficult.



- F. Valve Stem: Select and install valves outside screw and yoke stems, except inside screw nonrising stem valves where headroom prevents full opening of OS&Y valves.
- G. **Non-Metallic Disc:** Limit selection and installation of valves with non-metallic discs and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
- H. **Renewable Seats:** Select and install valves with renewable seats, except where otherwise indicated.
- I. **Fluid Control:** Except as otherwise indicated, install gate, ball or globe valves complying with the applicable BS. Where throttling is indicated or recognized as principal reason for valve, install globe valves.
- J. Installation of Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.



SECTION - METERS AND GAUGES

PART - 1 GENERAL

1.01 WORK INCLUDED:

- A. Thermometers and fittings
- B. Pressure gauges and fittings
- C. Air flow measuring stations
- D. Water flow meter

1.02 QUALITY ASSURANCE

A. Provide from specialized manufacturer whose products have been in satisfactory service for minimum five years.

1.03. SUBMITTALS

A. Submit product data, samples and manufacturer's installation instructions.

1.04 DELIVERY, STORAGE AND HANDLING.

- A. Deliver products to site, store and protect products.
- B. Keep items in shipping containers until time of installation.
- C. Store factory calibrated items which are dropped or subjected to shock otherwise, in separate containers with appropriate labels till completion of works. Keep a record of the same for inspection by the Engineer.


PART - 2 PRODUCTS

2.01. THERMOMETERS - ACCEPTABLE MANUFACTURERS

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.02. GLASS THERMOMETERS

- A. **Construction:** Baked enamel finished, die cast aluminum case, Mercury in glass capillary, V-shaped painted aluminum dial and spring secured glass front.
- B. **Connection:** Straight form or 90 deg. Back angle form.
- C. **Stem:** Brass or copper plated steel for separable socket, length to suit installation.
- D. Scale: Permanetched black lines and numerals on white non-reflective back ground, 9 inches long.
- E. **Calibration:** Dual (Deg. F and Deg. C) with 20 deg F (10 deg C) maximum figure intervals and 2 deg F (1 deg. C) smallest graduations.
- F. Accuracy + or one scale division
- G Range : As follows:
 - 1. Chilled water : 32 to 180 Deg. F (0 to 82 Deg. C)



2. Hot Water : 32 to 240 Deg. F (0 to 114 deg. C)

2.03 DIRECT MOUNTED DIAL THERMOMETERS

- A. **Construction:** Gas filled type with phenol turret case, stainless steel movement, painted aluminum dial and spring secured shatter proof glass front.
- B. **Connection:** Bottom or back as required
- C. **Bulb:** Rigid stainless steel with union, for separable socket, length to suit installation.
- D. Scale: Permanently etched black lines and numerals on white non-reflective background 31/2 inches diameter.
- E. **Calibration:** Dual (deg. F and deg. C) with 20 deg. F (10 deg. C) maximum figure intervals and 2 deg. F (1 deg. C) smallest graduation.
- F. Accuracy: + or one scale division.
- G. Range: As follows:
 - 1. Chilled water : 32 to 180 Deg. F (0 to 82 Deg. C)
 - 2. Hot Water : 32 to 240 Deg. F (0 to 114 deg. C)

2.04 REMOTE READING DIAL THERMOMETERS.

- A. **Construction:** Gas filled type with phenol turret case, stainless steel movement, painted aluminum dial and spring secured shatter proof glass front.
- B. **Connection:** Bottom or back as required
- C. **Bulb:** Rigid stainless steel with union for separable socket, length to suit installation.
- D. **Capillary:** Stainless steel with union for separable socket length to suit installation.



E. Accuracy: + or - one scale division

F. Range: As follows:

- 1. Chilled water : 32 to 180 Deg. F (0 to 82 Deg. C)
- 2. Hot Water : 32 to 240 Deg. F (0 to 114 deg. C)

2.05. THERMOMETER WELLS

A.Welding type of carbon steel construction, pressure rated at three times the system working pressure. Select length to suit the pipe diameter and provide lagging extension where required. Provide brass cap and chain attached to the well.

2.06. PRESSUREGAUGES-ACCEPTABLE MANUFACTURERS

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.07 PRESSURE AND COMPOUND GAUGES

- A. **Construction:** Phenol turret case, phosphor bronze bourden tube, bronze/nickel silver/stainless steel movement, painted aluminum dial and spring secured shatter proof glass front.
- B. **Connection:** 1/2 inch nominal size bottom or back as required.
- C. **Scale:** Permanently etched black lines and numerals on white non-reflective background 31/2 inches diameter.



- D. **Calibration:** Shall be dual on the pressure side (Bars and Psi) as well as vacuum side (cms and inches or mercury). Figure intervals shall be at 10 to 20 psi (1 Bar) and smallest graduation shall not be more than 2 psi (0.1 Bars).
- E. Accuracy: + or one percent.
- F. Range : As follows :
- At suction side of pumps : Vacuum 60 psi (Vacuum 4 bars)
 At discharge side of pumps : 200 percent of pump shut off head, but limited to 300 psi.

2.08. DIFFERENTIAL PRESSURE GAUGES FOR AIR

- A. **Construction:** Diaphragm actuated, magnetic drive type with die cast, aluminum case, clear plastic facial, painted aluminum dial, rubber pointer stops, over pressure restrictors, external, pointer zero adjustment etc.
- B. Connection: 1/8 inch high and low pressure taps at side or back as required.
- C. Scale: Permanently etched/printed black lines and numerals on white non-reflective background, 31/2 inches diameter (minimum).
- D. **Calibration:** Shall be in inches of water, figure intervals shall be at 0.2 to 4 inches and smallest graduation shall not be more than 0.05 inches.
- E. Accuracy: + or 2% of full scale.
- F. Range : As follows :
 - 1. Across air filters : 0 to 2 inches

G. Accessories

- 1. Static pressure tips (2 nos)
- 2. 5 feet long 1/4 inch aluminum tubing (2 nos)
- 3. Vent valves (2 nos)
- 4. Surface mounting bracket.



2.09 DIFFERENTIAL PRESSURE GAUGES FOR WATER

- A. **Construction:** Diaphragm actuated, magnetic drive type with forged brass case with separation between dial chamber and fluid, painted aluminum dial, clear plastic facia, rubber pointed stops, over pressure restrictor, external, pointer zero adjustment etc.
- B. **Connection:** 1/8 inch high and low pressure taps at bottom (duplicated at top for air, gas)
- C. **Scale:** Permanently etched/printed black lines and numerals on white non-reflective background, 31/2 inches diameter (minimum).
- D. **Calibration:** Shall be in feet of water, figure intervals shall be at 5 feet and smallest graduation shall not be more than 1.0 feet.
- E. Accuracy: + or 3% of full scale.
- F. Range: As follows :
 - 1. Across water coils and water filters : 0 to 35 feet

G. Accessories

- 1. Copper capillary tubing with compression fitting
- 2. Isolating cocks (2 nos)
- 3. Bleed fittings (2 nos)
- 4. Surface mounting bracket

2.10 PRESSURE GAUGE ACCESSORIES

- A. Cocks: Bronze bar stock needle valves with female threaded ends.
- B. **Snubbers**: Filter type, of brass/stainless steel construction with porous metal disc.
- C. **Siphon tubes:** Straight coil constructed of schedule 40 steel, size and length as required.



2.11 DIRECT READING AIR FLOW MEASURING STATION

- A. The air flow measuring devices shall be designed and built to comply with and provide results in accordance with accepted practice as defined or system testing in the ASHRAE systems hand book.
- B. Air flow measuring station shall be fabricated of heavy gauge galvanized steel welded casing with 90 degrees connecting flanges in configuration and size equal to that of the duct it is mounted into. Each station shall be complete with an air directionalizer and parallel cell profile suppressor across the entire stream and mechanically fastened to the casing, equal area and equal weighted averaging total pressure sensors and manifold, bullet nose shaped static piping and external transmitter parts. An identification label shall be placed on each unit casing listing model number, size area and specified flow capacity.
- C. The maximum allowable pressure loss through the unit shall not exceed 0.1 inch at 1000 fpm, or 0.3 inch. w.g. at 2000fpm. Each unit shall be capable of measuring air flow rate within an accuracy of 2% as determined U.S.G.S.A. or equal and approved certification tests and shall contain a minimum of one total pressure sensor per thirty six square inches of unit measuring area.
- D. Stations shall be installed in strict accordance with the manufacturer's published requirements. These stations shall be serving as primary signals for the airflow control systems. It shall be the responsibility of the Contractor to verify location and installation to assure that accurate primary signals are obtained.
- E. The units shall have a self-generated sound rating of less than NC 40 and the sound level within the duct shall not be amplified nor additional sound be generated.
- F. Measured air flow shall be displayed on a digital meter and Building Automation system.



2.12 MANOMETRIC TYPE WATER FLOW METER

Manometric type water flow meters shall be provided to each A.H.U. cooling coil and each chiller water supply or return pipe . Meter size shall be matching with pipe diameter.

2.13 WALL OR CABINET MOUNTED TEMPERATURE AND RELATIVE HUMIDITY GAUGE:-

The gauge shall be at least 6" in diameter comprising Display Panel for zone or air stream dry bulb and percentage of relative humidity.

The gauge shall be provided to the following:-

- Each supply air to transmitter
- Each return air to transmitter
- Central control room
- Tx's Hall (2 Nos.)
- Combiner hall
- Each EVR room or room containing equipment
- Each Entrance to buildings
- ACHV plant
- Each office
- D/G plant
- Control room for utility building
- Two Nos. spare gauges

Temperature scale shall extend from o - 80 degree C at least.

Relative humidity scale shall be from 0 - 100%

Gauges serving transmitters shall have remote sensors (at two meter from the gauge)



PART - 3 EXECUTION

3.01 SELECTION AND INSTALLATION OF THERMOMETERS

- A. Install dial type thermometers at the following locations. At the inlet and outlet of central station air handling units, chilled water coils and water chillers.
- B. Install thermometers with the dial in vertical upright position and tilted to give maximum readability.

3.02 SELECTION AND INSTALLATION OF PRESSURE AND COMPOUND GAUGES.

- A. General: In pressure gauges in piping tee with gauge cock, at most readable position. Select gauges with bottom, side near inlets as appropriate.
- B. **Locations:** Install gauges at the following locations and elsewhere as indicated.
 - 1. Install compound gauges at the following locations.
 - a. At the discharge manifolds of packaged pump sets.
 - b. At the suction/suction header of unit pumps
 - 2. Install pressure gauges at the following locations.
 - a. At the suction manifolds of packages pump sets.
 - b. At the discharge of unit pumps
 - c. At the inlet and of hot water circulating pump sets, pressure reducing stations.
 - d. At the inlet and outlet of chilled water circulating pumps, water chillers, chilled water coils of air-handling units.
- C. Install snubbers on all pressure gauges installed in close proximity of pump discharge.



- D. Range of pressure gauges shall be 160 to 200 percent of the system working pressure, as appropriate..
- E. Provide red set hands to indicate normal or critical pressure in gauges subjected to variable pressures.
- F. Use remote reading type pressure gauges with armoured capillary tubes, when installed above 7 feet from FFL.

3.03 SELECTION AND INSTALLATION OF DIFFERENTIAL PRESSURE GAUGES.

- A. **General:** Install differential pressure gauges on custom fabricated brackets attached to the equipment assembly.
- B. **Locations**: Install gauges at the following locations and elsewhere as indicated.
 - 1. Across central water filters.
 - 2. Across air filter sections pre-filter and bag filter of central station airhandling units
- C. All tap off shall have snubbers.
- D. Provide red set hands to indicate limiting values.
- E. Provide snubbers on all water type gauges.
- F. Select gauges with adjustable switches for interconnection with Building Automation System, where required.

3.04 SELECTION AND INSTALLATION OF AIR FLOW MEASURING STATIONS

A. Install air flow measuring stations and related accessories in each Central Station Air Handling Unit supply air duct and at other location in drawings.

B. Stations shall be installed in strict accordance with the manufacturer's published requirements.



3.05 Installation of water flow measuring stations:-

- A. Install water flow meters (In USGPM) in each A.H.U. chilled water supply piping to chillers.
- B. Stations shall be installed in strict accordance with the manufacturer's published requirements.



SECTION - CONTROL SYSTEMS

PART - I GENERAL

1.01 DESCRIPTION

- A. Supply and install electrical/electronic control systems complete in accordance with the requirements of the Contract Documents. This Section relates to the supply and installation of automatic control systems for the ACHV Installation.
- B. Control wiring including power necessary for electronic digital temperature control systems, 3 way valves dampers and actuators, etc, is including in this Section.
- C. Automatic temperature control systems to be provided shall include all relays, switches, dampers, valves, thermostats, transformers, humidistats, controllers and all other control devices required to maintain the specified conditions. Control devices shall be connected complete so as to perform the functions in a required sequence. Thermometers, indicators and all other necessary accessories shall be included as required in related section.
- D. All sensors, actuators and field items should be able to give and/or receive signals from building automation system.

1.02. QUALITY ASSURANCE

- Manufacturers: Firms regularly engaged in the manufacture of electric/ electronic controls equipment instrumentation of type and size as specified hereafter and who shall submit a list of at least five (5) similar installations provided by them in the Middle East area and which have been in satisfactory use for not less than 3 years.
- B. The manufacturer shall have facilities in the Middle East area capable of providing locally, technical assistance and maintenance. The Contractor's trained staff shall be readily available and shall be fully capable of system engineering supervision, start-up commissioning, personnel training and emergency service.



- C. Any components of the system related to fire or smoke control shall have been tested, and listed by Underwriters Laboratories Inc. (UL). The system shall be supplied with all hardware and installed as to comply with all requirements of NFPA Standards for Local Protective Signaling System.
- D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project.
- E. All systems and components shall have been thoroughly tested and proven in actual use.
- F. The systems must be a standard with the manufacturer to ensure spare parts, availability and trained technical support.
- G. Electrical Standards: Provide electrical products which have been tested, listed and labelled by Underwriter's Laboratories (UL) and comply with Kuwait regulation.

1.03. SUBMITTALS

A. **Engineering Submittal for approval**: The intention of the engineering submittal is to provide sufficient information to allow the Engineer to evaluate the manufacturer's compliance to specification, system capability and reliability in order to grant approval.

The engineering submittal shall include:-

- List of all system "local control loops" related to all mechanical installations independent of size of complexity.
- Complete detailed control diagrams for each of the listed "local control loop" accompanied by wiring/connection diagrams. All control equipment, system components or devices shall be identified by a reference number.
- Technical specification data sheets for each system component identified by the reference number given in the control diagrams.



-A proposed spare parts list to cover basic parts to be used by the Employer to provide a reliable and trouble-free operations.

B. After installation the Contractor shall keep records of all changes and adjustments and shall incorporate them into his final submission. This submittal shall include:-

- Complete "As-Built" drawings comprised of system diagrams, plans, etc.

- Complete system description.

-Manufacturer's catalogs with technical data for all devices and equipment.

- Operation instructions for each system.
- Maintenance instructions for each item.
- -Parts list of submittal items.
- Required copies of all above submittals shall be provided in sets of book form with hard cover all as specified.

1.04 PRODUCT, DELIVERY, STORAGE AND HANDLING

- A. Provide factory shipping cartons or crates for each piece of equipment. Maintain these through shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment.
- B. Store equipment and materials inside and protect from weather. Where necessary to store outside, elevate well above ground and enclose with durable waterproof wrapping.
- C. System component shall be capable of withstanding high ambient temperatures and adverse dust conditions during shipment and on site storage.



PART - 2 PRODUCTS

2.01. MANUFACTURERS

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.02. CONTROL VALVES

- A. **General:** Provide factory-fabricated electrical control valves of type, body material as specified hereinafter. Class of valves shall be based on maximum pressure and temperature rating of piping system. Unless otherwise indicated, provide valves which mate and match material of connecting piping. Equip valves with proper shut-off rating for each individual application.
- B. Electrical Characteristics: All valves motors shall be suitable to work on low voltage. Motors must be suitable to receive 4-20 mA control signal.
- C. Control valves of sizes 50 mm and below shall have threaded connection to BS.3643 complete with pipe coupling pieces. Valves 65 mm and above shall be flanged connections to BS 4504.
- D. Valves shall be sized to have a full pressure drop equal or greater than the pressure drop of the water coils being controlled, but not more than 65 KPa.
- E. Three port valves shall have a close off capability equal to or greater than the combined full flow pressure drops of the coil plus the valve itself.
- F. Three port valves shall be piped for mixing service.



- G. Valves shall be designed for pressure rating of 10 bars.
- H. All valves shall be closed when the spindle is in the up position. Two port modulating valves(when used) shall have an equal percentage control characteristic. Three port modulating valves shall have an equal percentage characteristic on the through port and a Linear characteristic on the bypass port.

I. Valve Construction:

- Threaded valves shall be of brass or gunmetal body with bronze or stainless steel seats.
- Flanged valves shall be of cast iron body with bronze or stainless steel seats.
- Valves trim and stems shall be polished stainless steel.
- Valves shall have performed, spring loaded, self adjusting packing of teflon.

2.03 DAMPERS AND VALVE MOTORS

- A. Size each motor to operate damper or valve with sufficient reserve power to provide smooth modulating action or 2-position action as specified.
- B. Provide Permanent Split-Capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, in operational sequence, with integral spiral-spring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
- C. Equip motors for outdoor locations and or outside air intakes with "O-Ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at ambient condition in Kuwait.
- D. Furnish non-spring return motors for dampers larger than 25 square metres for valves larger than 50 mm, sized for running torque rating of



150 inch-pounds, and break-away torque rating of 300 inch-pounds. Size spring-return motors for running torque rating of 150 inch- pounds, and breakaway torque rating of 150 inch-pounds.

E. Motors to be connected to BAS, should be suitable for 4-20 mA signal, if modulating type.

In case of the ON/OFF type motors should be suitable for 240V, 50Hz.

2.04. ROOM THERMOSTATS

Provide electronic room type thermostats for the control of the 3-way valves as necessary. The thermostat shall be of solid state integrated circuit construction with accessible set point adjustment. It shall also include an internal direct/reverse action selector switch and adjustable throttling range. It shall provide proportional control 3-way valves.

The room thermostats shall be complete with locking covers, and with concealed or readily accessible adjustment devices.

2.05 IONIZATION SMOKE DETECTORS

For each air handling unit, provide UL-listed ionization smoke detectors in main supply and return air ducts, and where indicated. connect detectors into control circuits to stop fans in event of presence of smoke.

2.06 ELECTRONIC SENSORS

Provide electronic temperature and or relative humidity sensors of supersensitive resistance type, which are vibration and corrosion-resistant, and of wall mounted immersion, duct mounting, averaging or bulb type as required for application including controllers.

2.07 WATER FLOW SWITCHES

Provide water flow switches of stainless steel paddle types. Where flow switches are used in chilled water applications, provide vapor-proof type to prevent condensation of electrical switch. Provide pressure-flow switches of bellows actuated mercury type or snap-acting type, with appropriate scale range and differential adjustment for service indicated.



SECTION - PIPING AND EQUIPMENT INSULATION

PART - 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 REFERENCES

- A. ASTM C 195 Mineral fiber thermal insulation cement.
- B. ASTM C 547 Mineral fiber pre-formed pipe insulation.
- C. ASTM C 522 Cellular glass block & pipe thermal insulation.
- D. ASTM B 209 Aluminium & aluminium alloy sheet & plate.
- E. ASTM E 84 Surface burning characteristics of building materials (also NFPA 255 and UL 723)

1.03 QUALITY ASSURANCE

- A. **Applicator:** Company specialized in piping insulation application with three years minimum experience.
- B. Materials: Shall have self extinguish characteristics and shall not release toxic by-products in combustion; flame spread/fuel contributed/smoke developed rating in accordance with ASTM E84, NFPA 255 and UL 723.

1.04 SUBMITTALS

- A. Submit product data.
- B. Include product description, list of material and thickness for each service, and locations.
- C. Submit manufacturer's installation instructions.
- D. Submit maintenance data and replacement material lists for each type of insulation. Include this data in the maintenance manual.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and protect products.



PART - 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.02 INSULATION

- A. Type A: Pre formed glass fiber sectional insulation; 'K' value of 0.24 at 75 degrees F ('ksi' value of 0.035 at 24 degrees C) noncombustible; density 4 lbs/cu.ft. (64 kg/cu.m.), complete with factory applied kraft reinforced aluminum foil vapor barrier, with self sealing adhesive joints.
- B. Type B: Pre formed plastic cellular foam sectional insulation, 'K' value of 0.28 at 75 Degree F ('Ksi' value of 0.035 at 24 degrees C).
- C. Type C: Aluminum foil backed, foamed plastic, self-adhesive insulation tapes; 'K' value of 0.28 at 75 degrees F ('ksi' value of 0.04 at 24 degrees C).
- D. Type D : Flexible, expanded, elastomeric plastic tubing.
- E. Type E : Formed in place, cellular fiberglass insulation, extending under coil and fan section.
- F. Type F : Formed glass blocks, having conductivity less than 0.4 at 75 degrees F and permeability of 0.00 perms.
- G._Type G: Performed calcium silicate sections of 2 inch thickness applied one over the other to make 4 inches overall thickness.



2.03 VAPOUR BARRIER JACKETS

A. Kraft reinforced aluminum foil vapour barrier with self sealing adhesive joints.

2.04 PROTECTIVE JACKETS

- A. **Canvas:** UL listed treated cotton fabric, 8 oz/sq.yd. (250 g/sq.m) weight.
- B. Aluminum jackets: ASTM B 209, 0.020 inch (0.51mm) thick; smooth finish.

2.05 ACCESSORIES

- A. **Insulation Bands:** Kraft reinforced aluminum foil tapes of minimum 2 inch (50 mm) width, with self sealing adhesive.
- B. Metal Jacket Bands: 3/8 inch (10mm) wide; 0.015 inch (0.38mm) thick aluminum.
- C. **Canvas adhesive coating:** Compatible with insulation, non-flammable type, tough, vapour barrier, abrasion resistant, applied by brush or spray.



PART - 3 EXECUTION

3.01 PREPARATION

- A. Install materials after piping has been tested and approved and painted with two coats of approved primer, where applicable.
- B. Clean pipe work of all dirt prior to installation.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapour barrier through penetrations.
- C. In exposed piping, locate insulation cover seams in least visible locations.
- D. On insulated piping with vapour barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. On insulated piping without vapor barrier and piping conveying fluids of 140 degrees F (60 Degrees C) or less, do not insulate flanges and unions at equipment, but level and seal ends of insulation at such locations.
- F. Provide an insert, not less than 6 inches (150mm) long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches (50 mm) diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cellular glass or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts shall be used.
- G. Where glass fiber rigid sectional insulation is specified, insulate fittings flanges and valves by applying mineral wool cement, maintaining thickness of insulation same as for adjoining pipe. Finish with asbestos cement and jacketing as specified.



- H. Neatly finish insulation at supports, protrusions, and interruptions.
- I. Provide mitered bends on insulation shells at pipe fittings and finish neatly.
- J. Use adhesives at joints of cellular plastic insulation.
- K. For insulation of fan coil units drain pans, cut glass fiber insulation to shape of equipment with mitered corners. Use adhesives or galvanized wires (at 12 inches spacing maximum) to hold the insulation in position. Cover insulation with glass cloth and tack coat of mastic so that no fabric is visible.
- L. For diesel generator exhaust piping, apply the calcium silicate shells in staggered layers, secure with adhesive or outward clinch staples on maximum 6 inch centers.

Piping	Туре	Pipe Size Inch(mm)	Thickness Inch(mm)
Domestic hot water supply return piping			
In partition walls or chases	C	All sizes	1/4 (6)
All other areas	A	2 (50) and	3/4 (19)
		under 2 ½(65)	(25)
		and over	
Domestic cold water supply piping in ceiling	В	All sizes	1/2 (12)
spaces used as ACHV return plenums			
Stom water draining in ceiling spaces used as	B	All sizes	1/2 (12)
ACHV return plenums			
Soil and waste piping in ceiling spaces used as	В	All sizes	1/2 (12)
ACHV return plenum			
ACHV chilled water supply and return	A	2 (50) and	(25)
piping/valves and fittings		under 2 ½(65)	
		and over	2 (50)
ACHV chilled water supply and return	A	2 (50) and	(25)
piping/valves and fittings		under 2 ½(65)	
		and over	2 (75)
Condesate drain piping	B	All sizes	3/4 (29)
Refrigerant suction/refrigerant liquid	D	All sizes	1 (25)
Emergency Generator Exhaust including Muffler	G	All sizes	4 (100)

3.03 INSULATION SCHEDULE FOR PIPING



3.04 INSULATION SCHEDULE FOR EQUIPMENT

EQUIPMENT	ТҮРЕ	THICKNESS	
		INCH	MM
Drain Pan	E	1	(25)
Expansion Tank/Air Separator	F	1	(25)
Chilled Water pumps	F	1	(25)

3.05 PROTECTION JACKETS

- A. Domestic hot water supply and return piping in plant areas : Canvas jacketing with adhesive coating.
- B. ACHV chilled water piping exposed to view in mechanical equipment rooms and in finished areas shall be provided with aluminium cladding.
- B. ACHV chilled water piping exposed to outdoor on roof : shall be provided with aluminium cladding.



SECTION - AIR-FILTER

PART - 1 GENERAL

1.01 DESCRIPTION

A. Extent of Work: The extent of air filter work is shown on other section and by requirements of this section.

1.02. QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of air filters, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. NFPA Compliance: Comply with applicable provisions of National Fire Protection Association (NFPA) 90A and 90B.
- C. UL Compliance: Comply with Underwriter's Laboratories (UL) Standards pertaining to safety performance of air filter units.
- D. ASHRAE Compliance: Comply with the provisions of American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Standard 52/76 for dust spot testing, and for recording and calculating air flow rates.
- E. ARI Compliance: Comply with provisions of Air Conditioning and Refrigeration Institute (ARI) Standard 850 pertaining to test and performance of air filter units.
- F. British Standards Institution Codes and Standards (BS): Comply with provisions of BS 2831, Methods of Test for Air Filters Used in Air Conditioning and General Ventilation.



1.03. SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's data on air filters, including, but not limited to dimensions, clearances, access, flow-through capacity, media fire classification, and filter media efficiency, and pressure drop (clean and dirty).

1.04. PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air filter products wrapped in factory fabricated fiber board type containers.
- B. Do not install damaged products; damaged units shall be replaced.
- C. Store air filters in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.



PART - 2 PRODUCTS

2.01. MANUFACTURERS:

- 1 Except where specifically stated to the contrary, approved manufacturers for equipment and/or materials under this section are as follows:
- 2 All manufacturers will be approved as subject to compliance with specifications and Engineer's approval.
- 3 Manufactured units will be considered if they are produced by, specialized manufacturers whose units are equal in every respect and have been in similar service for not less than five years.
- 4 Approval of the manufacturer does not necessarily constitute approval of its products as equal to the start of construction submit to the Engineer for a complete written summary of the manufacturer's proposed products

2.02. TYPE

A. Type (E3) Dry Type Cleanable (washable) Panel Filters: Shall be of metallic type, constructed of galvanized steel and designed to provide maximum arrestance, large dust holding capacity and low resistance.

The filter media shall be constructed of layers of crimped corrugated wire screen and expanded galvanized steel to provide large filtering area and shall be held in a heavy gauge galvanized steel frame capable to withstand shock and abuse. The filter shall be sized for maximum air velocity of 350 fpm with initial press drop of not more than 0.1" WG and average arrestance of 75%.

Return air filters shall be 2" thick and fresh air filters 4" thick.

This type of filters may be used as a pre-filter to a higher efficiency filter.

B. Type 3 Bag Filters: It shall be of dry, extended surface pocket type consisting of 16 gauge galvanized steel holding frame and replaceable filter. Holder frames shall be installed to provide service from the dirty air side. Holding frames shall be equipped with factory installed special high temperature gaskets and heavy duty rotary spring type latches



which fasten across the corners of the filter to force the filter firmly against the gaskets. Replaceable air filters shall consist of rigid rust-resistant metal headers to which individual pockets of filter media are attached. The media shall be made from ultra-fine fiber glass supported on the air leaving side by a protective media backing.

The bag filter shall be designed for a face velocity of 500 fpm.

PART - 3 EXECUTION

3.01. INSTALLATION

- A. General : Comply with installation requirements as specified elsewhere in these specifications pertaining to air filter housing, casings and associated supporting devices.
- B. Install air filters and holding devices in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes. Comply with applicable provisions of NFPAN 70, 90A and B, pertinent to installation of air filters.
- C. Locate each filter unit accurately in position indicated in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.
- D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters proper with other work.
- E. Install filters in proper position to prevent passage of unfiltered air.
- F. Install air filter gauge pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Adjust and level inclined gauges for proper readings.

3.02. FIELD QUALITY CONTROL

A. Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to



demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.

B. At the date of substantial completion, replace the disposable filters by permanent washable filters as specified.

