وزارة الاعلام

STATE OF KUWAIT

MINISTRY OF INFORMATION

SPECIFICATIONS FOR AIR HANDELING UNIT FOR ADMIN BUILDING SHUWAIKH

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CHAPTER – 1
GENERAL

وزارة الاعلام

SPECIFICATIONS FOR AIR HANDELING UNIT FOR ADMIN BUILDING SHUWAIKH

1. **General Conditions**:

1.1 This is a Turnkey project includes design, supply, installation, testing, commissioning and handing over to full satisfaction of the MOI's Engineer. Central station modular AHU's specified and mentioned in the scope of work. This project also includes all the related electrical, civil, control, 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 To contact project manager engineers use below numbers:

Eng: Hamad Alfarhan // 55118933

Eng: Mohammad Alyateem // 99810509.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 The contractor must keep the area cold during work on this project.

1.9 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.

1.10 All works must comply with Ministry of Public Works, Ministry of Electricity & Water and Kuwait Fire Service Directorate Codes and standards.

1.11 The contractor must train Ministry's engineers to operate and maintain the project.

1.12 All parts, material and drawings must be approved by MOI engineer prior to installations.

1.13 In case of working in a sound/noise sensitive area, like in studios, all sound and vibration levels generated by mechanical equipment must be silenced and accepted by the beneficiary department.

1.14 Cooling capacity in **CFM** stated in the BOQ (or in the scope of work) is the estimated capacity and it is for the contractor's reference only.

1.15 Replacing an existing AHU (or any HVAC system) could affect other areas nearby the location of this project. The contractor must maintain the amount of airflow and cooling needs for those places during the period of replacement.

CHAPTER – 2
SCOPE OF WORK

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Scope of Works:

1. Introduction:

The Ministry of Information (MOI) invites the tenderers to submit their offers for the removal of 2 Air Handling Units and supply and installation of 4 new Air Handling Units with complete chilled water connections and necessary duct connection to existing ductwork for the Admin Building located in Shuwaikh, in full compliance with the specifications, general conditions, special conditions, technical conditions and all other requirements stipulated in this document, on a turn-key basis.

These conditions, requirements and specifications represent the minimum needed to execute these works to the latest state-of–the-art technology. Any other works needed to fulfill this target, and not explicitly mentioned in this document must be stated and priced (in the BOQ) in the offer, otherwise it/they will be executed – free of any charge to MOI – by the Contractor, without any variation order.

2. Scope of work:

2.1 ***Dismantling and Removal and storing of 2 NOS Old AIR HANDELING UNITS AHU # 3 and # 4, in Government store and its valves, pips, connection duct, etc.***

2.2 ***Supply and installation of 2 AIR HANDELING UNITS and their connection duct with following capacities***

- ***for AHU # 3 28,000 CFM***
- ***for AHU # 4 28,000 CFM***

2.3 ***Supply and installation of HYDRONIC Piping of all new chilled water piping and connect to existing Supply and return Chilled water pipes including all accessories, insulation, cladding and other necessary pipe works.***

2.4 ***Supply and installation of chilled water valves for 2 AHU's***
Each AHU requires

- ***6 NOS Gate Valves***
- ***1 NOS Balancing Valve***
- ***1 NOS Y-Strainer***
- ***2 NOS Flexible Connection***
- ***1 check valve***

2.5 ***Supply and Installation of 3-way valve control complete with bypass on chilled water return pipe with bypass for maintenance for Each AHU.***

2.6 ***Supply and Installation of Thermometer and Pressure Gauges for each AHU on both the Supply and Return Pipes.***

2.7 ***All civil works required.***

2.8 ***All Electrical work required.***

2.9 ***Supply and Installation of Duct connection to existing air distribution system for all new Air Handling Units complete with insulation and supports.***

2.10 ***Supply and install BMS system that can allow to control the ALL AHUs by control room.***

2.11 ***Supply 6 fans motor assembly as spare parts.***

CHAPTER – 3
DETAILED TECHNICAL SPECIFICATION

SECTION-1 AIR-HANDLING UNITS

GENERAL INFORMATION

The purpose of this document is to define the minimum requirements of the ventilation and air conditioning systems employed within the building to achieve the necessary environmental criteria. For details on general configurations, performances, and required options, please refer to the equipment schedule here after.

The manufacturer as part of their tender submission shall submit full details on the air handling units, including scaled drawings, detailed performances, and prices. All deviations to these specifications will have to be clearly mentioned in the submitted offer. Failure to do so will result in the tender being disqualified.

The air handling units are to be manufactured in a plant certified in accordance with the ISO 9001 - 2015 quality standard and should consider the following harmonized Standards and Directives:

EN 13053-2006 Ventilation for Buildings - Air Handling units-rating and performance for units components and sections,
EN 1886- 2007 Ventilation for Buildings – Air Handling units-mechanical performance

The units design and the integrated components shall comply to the CE marking directives:

- Low Voltage Directive 2006/95/EC
- 2004/108/EC - EMC Directive – Conducted and Radiated Emissions
- 2006/42/EC – Machinery Directive
- Pressure Equipment Directive 97/23/EG

The units shall comply with EN 13053 requirements.
When the VDI 6022 hygienic standard is applicable, the necessary options for compliance need to be included.

PERFORMANCES

The air handling unit range and the related selection software shall be Eurovent certified and listed on the Eurovent-Certification web site.

The air handling unit manufacturer shall provide detailed technical data sheets with at least the following information:
Scaled drawings, dimensions and weight of each unit and every delivery modules

- Performances of every component
- The energy class as per Eurovent calculation
- Air pressure drops for each internal components
- Specific fan power of the unit
- Inlet, outlet and airborne sound power and sound pressure levels
- List of selected controls components

The maximum velocity through the coils finned surface area shall not exceed the values indicated in the detailed description and in any case 3,0 m/s.
The fans and motors shall be selected with medium filter pressure drops.

ENERGY EFFICIENCY CLASS

As part of the Eurovent certification program, the Efficiency Class of each fan motor set and the whole unit shall be provided. The technical data sheets shall clearly provide:

- The Energy Efficiency Class of each fan-motor set and of the complete unit
- The Specific Fan Power of each fan-motor set and of the compete unit

- The air velocity through the coils finned areac

CONSTRUCTION

The equipment shall be suitable for indoor or outdoor installation, as listed in the data sheets.
The air handling units shall be of robust design and manufactured to withstand maximum fan pressures with closed dampers, without permanent deformation.
All sections of the air handling unit shall be constructed to conform to the pressure characteristics of the system under all operating conditions to prevent drumming, distortion and vibration when tested to a pressure differential of **2500 N/m².**

The casing construction shall be made with 50 mm thick self-supporting panels, assembled together without any vertical members. To avoid dust traps, supporting or assembly frames inside the air stream are not permitted.

The panels are assembled together with concealed internal fixings from the edge of the panels. Screws or bolts crossing the panels shall be avoided to ensure completely closed panels, avoid humidity migration inside the panels, fiber carry over into the air stream and long lasting air tightness. Proper sealants shall be fitted between the panels to guaranty long lasting casing air and water tightness.
The outer skin shall be mechanically fixed to the inner skin in order to get all panels easily removable.

The unit construction shall be silicone free.
Screws or bolts protruding inside the air stream are not permitted.

To minimize internal air pressure drops and the on-site foot print, the internal dimensions of the units shall be based on the universal filter frame dimensions. Therefore, internal dimensions shall be multiple of 305 mm in the height and in the width, and 152,5 in length providing a neat exterior along the length of the unit and a clean interior appearance to ensure even distribution of air across the face of all components without blanking plates.

Top and side panels shall be fixed together with heavy duty 1,5 mm thick profiles. These profiles shall be made:

- In aluminum, protected with an anti-corrosion powder coating.
- In Stainless steel 304

The bottom panels shall be integrated into a “C” shaped bolted base frame in galvanized steel to facilitate reinforce the casing stability and facilitate the unit handling.

The air handling units shall be delivered in one piece or with separate modules to be connected together on site. The assembly between the delivered modules shall ensure perfect continuity of the air passage and a smooth interior finish without any rough points or cavities at joining surfaces to prevent any dust build-up encouraging microbial growth.

All internal electrical components and the entire unit shall be earthed.

The mechanical characteristics of the casing shall be tested by an independent laboratory and be Eurovent certified. They must be equal or better than the following values (based on EN 1886).

Casing strength / Maximum relative deflection 1000 Pa:	D1
Casing air leakage -400 Pa:	L1
Casing air leakage 180 / 002 +700 Pa:	L1
Filter bypass leakage rate:	F9
Casing thermal transmittance:	T2
Thermal bridging factor:	
TB2	

Casing acoustical execution:

Frq. Hz	125	250	500	1000	2000	4000	8000
Attenuation dB	15	23	31	33	35	36	45

PANELS

The panels must be self-supporting, sandwich panels with a thickness of min. 50mm, perfectly closed and thermally and acoustically insulated between inside / outside with a special min. 8 mm thick PVC-strip in between the inside to the outside panel. The panels must have a smooth inside with no gaps and screws to prevent dust accumulation and facilitate cleaning.

The panels must be made of the following material:

Galvanized steel, according to EN 142-79 as a minimum quality

The internal guides shall be in galvanized steel
The internal guides shall be in stainless steel 316

The external panel must be made of
galvanized steel sheet (based on EN 142-79) with a UV, weather and scratch resistant PVC coating (PVC coating should be tested 500h based on ASTM B 117-95 and 1000h based on ASTM D 2247-94). The external PVC coating must be made in a neutral color and should have a thickness not less than 120 µm.

The panels shall be insulated with a 50 mm thick non combustible mineral fiber infill insulation having a thermal conductivity of 0.59 W/m²K maximum according to DIN 4108.

Isolation 20 Kg/m³

The panel insulation shall comply with the following fire protection class:

- Class 0 according to ISO 1182.2
- Class A1 according to DIN 4102
- A1 according to EN 13501-1:2007

The insulation must be completely separated from the air flow.

The panels shall provide a high degree of noise attenuation to minimize noise breakout, and shall be sufficient to achieve the following reduction:

casing execution: (1.00/1.00 mm)

Certification proving noise reduction of the panels shall be provided with the tender.

ACCESS DOORS

Adequate access with hinged doors shall be provided to ensure that all components can be cleaned, inspected or serviced easily. Doors shall be made with the same construction as the casing panels, 50 mm thick, completely closed, internally and externally flush mounted. Hinged doors shall be provided in all sections where regular maintenance is required, such as fan, filter or humidifier sections.

Hinged doors shall be mounted on Aluminium frames, with adjustable heavy duty aluminum hinges and fastened with reinforced PA6 handles.
Hinged doors provided on positively pressurized sections shall be with inward opening or equipped with safety chains.

The door frames shall have thermal welded rubber seals designed to ensure the optimum air tightness for the life of the units.
The locking system of the handles of shall be made of wear-resistant plastic roller bearing to prevent scratching or damage to the door frame.

The hinged doors provided on fan sections shall be lockable with a key.

Removable inspection panels shall be provided on narrow sections or where regular access is not needed.

UNIT BASE FRAME

For rigidity and stability reason, each delivery module shall be supported with a continuous built heavy gauge base frame:

Base frame shall be In C type, made from galvanized steel, with height not less then 200 mm with a min thickness of 4mm

The unit base frame shall be provided around the entire perimeter of the air handling unit and wherever a joint occurs between the sections. Lifting lugs shall be provided to facilitate the onsite lifting.

PACKING

Prior to dispatch, each section of air handling units shall be provided with a packing to prevent damages during transit, storage and installation.

- On pallet, with shrink wrapping and heavy duty polythene sheeting

UNIT CONFIGURATIONS

The air handling units configuration shall comply with the attached project specification: Horizontal in line.
[

ErP compliance according EU regulation no. 1253/2014

The European directive 2009/125/EC establishes Ecodesign requirements and relating regulations for the implementation for different technical products
The product on this data sheet may be a non-residential ventilation unit according to the implementation regulation of the European Union No. EU 1253/2014.
The compliance check for this product according to No. EU 1253/2014, resulted ”**Not compliant**” to the requirements valid from 01.01.2018
A not compliance is allowed, if a ventilation unit is covered by the exemptions, stated in regulation No. EU 1253/2014 and the later official interpretations.
In some cases it may be possible, that the conformity is only given, after the integration of the product into a complete system, so only the complete systems forms a compliant ”ventilation unit” according the regulation.
The product on this datasheet is a customized product and the layout is done according the customers requirements. the manufacturer is not informed about the exact scope and use of the product and the manufacturer has no information, if an exemption as per regulation No. EU 1253/2014 can be applied.
For this reason the manufacturer assumes that an exception to this Regulation has been checked by the customer.
So by ordering this product, the client accepts the following clauses:

- The product is sold by the manufacturer as ”**out of scope**” of the regulation No. EU 1253/2014
- A declaration of conformity and a CE - marking according the regulation No. EU 1253/2014 by the manufacturer is not possible for that reason.
- It is the clients obligation to check the need of conformity of the installed product in the completed plant to European or national legislation.

In this case, the obligations given by the relevant legislation are to be fulfilled by the installer of the product.

In case of doubts, the manufacturer recommends to clarify the need of ErP - compliance - before placing the order - with the consultant, who designed the relating air treatment plant and who issued the related product specification

COMPONENTS DESCRIPTION

Single mixing box sections

Single mixing box sections shall include a return air dampers and a fresh air dampers. The dampers shall be properly sized for the nominal air flows, made with the materials and positioned as indicated in the schedule. The single mixing box length shall be defined to ensure an optimum mixing of the return and fresh air streams.
When the mixing box is used to access a front removal filter set, it shall be provided with a hinged door.
When possible, the dampers shall be linked together with a linkage for an operation with one single actuator or manual lever.

Hinged doors, inspection windows, wired lights, or drain pans shall be provided as indicated in the detailed description.

Dampers

Dampers shall be provided as inlet/outlet shut off devices, with ON/OFF control or as mixing or dividing devices with modulating control. They shall be controlled with either manual levers or electric motors as indicated in the detailed description.

Dampers shall be made with double skin airfoil section blades, made of galvanized steel, aluminium or stainless steel.

The blades interconnection mechanisms shall be made with gears made of either glasfiber reinforced PP, suitable for temperature up to 110°C or Ryton material, suitable up to 160°C.
They shall provide opposed rotating blade to blade interaction without slippage, and a smooth operation with minimum torque.

Aluminium blades shall be provided with edge seals in neoprene, and comply to Class 2 according to EN 1751.

The shaft shall be with a square section, suitable for standard actuator fitting and shall be fitted on low friction bearings made of
reinforced glass fiber.

The damper frames shall be made with galvanized steel, aluminium or stainless steel and shall include flanges on each side with holes in the 4 corners for an easy connection to the ductwork.

Dampers longer than 1525 mm or/and higher that 1220 mm shall be sectionized in equal sized dampers.

Dampers provided on external units shall be either weatherproof or installed inside the units.

For hygienic applications, opposed rotating dampers shall comply to DIN 1946-4 and Class 4 as per EN 1751. The damper blades shall be made with double skin airfoil aluminium section, with edge seals. The blades interconnection mechanisms shall be made with gears made in fiber glass reinforced PP installed out of the air flow. Bonded aluminium profiles with special seals shall be provided between the blades and the frame, inside the air stream to ensure long lasting air tightness. The damper frames shall be made in galvanized steel or in stainless steel as indicated in the detailed description.

To ensure long lasting operation, interconnecting mechanisms with levers or rods are not permitted.

Panel pre-filters

The panel pre-filters shall be 48 or 98 mm thick, and G2, G3, G4 or F5 rated according to EN 779:2002, as specified in the schedule hereafter.
The filters consist of metallic or synthetic pleated media fitted in galvanized steel headers.
The filters shall be suitable for 70°C in continuous service.

The pre filters shall be installed in rails, on universal frames or in clamping slide channels as specified.
When the pre filters are fitted on universal frames, the optimum airtightness between the filter cells and the frames shall be insured with continuous rubber seals compliant to the VDI 6022 recommendations.

To optimize maintenance and storage costs, the filter dimensions shall comply with the Eurovent 2/2 recommendations as follows:

592mm x 592mm x 48 mm or 592mm x 592mm x 98 mm
592mm x 287mm x 48 mm or 592mm x 287mm x 98 mm

Other filter dimensions are not permitted.

The designed pressure drop used for the fan selection shall be the mid life pressure drop at nominal air flow.

Performances, accessories and options as indicated in the detailed description shall be provided.

High efficiency bag filters

High efficiency filters shall be bag type, rated from F5 to F9 according to EN 779:2011, as specified hereafter. The rigid bag filters shall be Eurovent certified, feature low air pressure drops and long operating life cycle.

They shall be made with glass fiber or synthetic media fitted in 25 mm thick headers. They shall be lightweight and easy to install.

The filters shall be suitable for 70°C in continuous service.

To optimize maintenance and storage costs, the filter dimensions shall comply with the Eurovent 2/2 recommendations:

592mm x 592mm x 535mm
592mm x 287mm x 535 mm

Other filter dimensions are not permitted.

Filters shall be fitted into the units on universal holding frames which shall be screwed and properly sealed to the casing. The optimum airtightness between the filter cells and the frames shall be insured with continuous rubber seals compliant to the VDI 6022 recommendations.

The designed pressure drop used for the fan selection shall be the mid-life pressure drop at nominal air flow.

The filter bypass leakage shall not exceed 0.5% of the nominal air flow at the nominal operating condition, Class F9 as per EN 1886.

Performances, accessories and options as indicated in the detailed description shall be provided.

Inspection windows (Portholes)

Inspection windows (portholes) shall be provided as indicated in the detailed description.

Inspection windows shall be made of polycarbonate with sealing gaskets.
The fastening system made with locking screws only shall the polycarbonate structure, and not the panels to avoid thermal bridges. A thick and continuous internal-external gasket shall be fitted to ensure highest air tightness. The windows shall be round, 200mm diameter as a minimum and double wall construction. Single wall inspection windows will not be accepted.

Bulkhead lights

Bulkhead lights shall be provided in access sections as indicated in the detailed description.
Bulkhead lights shall be made with a PVC bodies and clear polycarbonate lens.
They shall be corrosion resistant and watertight, IP44.
They shall be suitable for 60W bulbs under 24V or 230V and pre-wired as specified.

Chilled water coils

Chilled water coils shall be easily demountable with removable, fitted on rails with removable front panel. The air velocity through the finned block area shall not exceed 2,5 m/s.

Coil performances shall be in accordance to AHRI Standard 410-2001.
Chilled water coils shall be designed for a maximum operating pressure of 16 bars, and factory tested at 30 bars.

The coils shall be made of seamless copper tubes, 0,35 mm (for 9mm tubes) and 0,42 mm thick for 16mm tubes as a minimum and 0,12 thick aluminum fins. The coil frame shall be made of galvanized steel and the header shall be made of painted mild steel. Coil headers shall be equipped with drain and air vent. Other materials for the fins, frames or headers or special treatment shall be provided as specified in the detailed description.

The fins shall be flat to avoid fouling and allow a proper cleaning.
The minimum fin spacing shall not be lower than 2,5 mm and not lower than 3,0 mm when the sensible heat ratio is lower than 0,7.
Coil connections shall be threaded and capped prior shipment.

EUROVENT certified data (“Rating Standard 6/C/005-2011”), capacity, air and water side pressure drop.

To avoid risk of water carry over, cooling coils shall be provided with droplet eliminators when the air velocity trough the finned block exceeds 2,49 m/s and/or when the sensible heat ratio is below than 0,9.

The droplet eliminators shall be made of polypropylene blades having a minimum width of 110mm. The blades shall be mounted in a galvanized steel or stainless steel frame. If the AHU internal height is max. 915mm the droplet separator should be in frameless execution.

A properly sized drain tray, with 3 slopes shall be incorporated in the bottom panel of the cooling coil section, with a 32 mm diameter drain located on the side of the unit.

Coil connections shall be capped prior shipment.

Performances, accessories and options as indicated in the detailed description shall be provided.

EC Plug Fans

Single inlet, backward curved motorized impeller, energy-optimized for operation without a volute casing with a rotating diffuser (without blade) for high efficiency and good acoustic performance. The impeller is made of aluminum or plastic. The radial impeller with external rotor motor is statically and dynamically balanced to ISO 1940 Part 1 and designed for mounting in horizontal and vertical position. Impeller with rotating diffuser and 7 backward curved airfoil blades. Galvanized inlet ring with flow-measuring device. The centrifugal fan has integrated electronic device. The electronic is protected by an over-temperature protection with active temperature management. IP54, Thermal Class 155 and designed for an ambient temperature of -25 ° C to +60 ° C. The fan characteristics should be measured on a test station according to DIN 24163 Part 2 and ISO 5801. The performance should be on accuracy class 2 according to DIN 24166 and the efficiency class of the motor should be not less then IE4.

Cable glands through casing for motor power cable shall be provided.
Performances, accessories and options as indicated in the detailed description shall be provided.

Supply air

Position No.:	**002**
Identification:	**AHU-03 TO 04 (FAN ARRAY)**
Quantity:	2
Casing type and size:	**Supply air unit:** **Indoor Unit** **External dimensions WxHxL:** **2845 x 2385 x 3202.5 mm** **Air flow:** **28,000 cfm**

Eurovent EEC

Unit:

Performance data:

Efficiency class		D
SFP class		SFP1
SFP value	W/(m³/s)	1,398
Design temperature	gF	42.60
Density	kg/m³	1.20

Technical data of unit sections in direction of air flow

M1 - Simple mixing section

Section length:	mm	762.5
Section pressure loss:	Pa	15
Opening	Size	2,685.0 mm x 702.5mm
	Direction	Top
Damper	Frame	galvanized steel
	Fins	galvanized steel
	Sealing	No
	Gears	PPGF
	Drive	Suitable for actuator - External, in air dir. right
Opening	Size	2,685.0 mm x 702.5mm
	Direction	Frontal top horizontal
Damper	Frame	galvanized steel
	Fins	galvanized steel
	Sealing	No
	Gears	PPGF
	Drive	Suitable for actuator - External, in air dir. right

FTH - Bag Filter section with prefilter

Section length:	mm	610.0
Section pressure loss:	Pa	230

CFH - Panel filter

Technical data:

Filter manufacturer		Camfil

Filter type		AeroPleat ECO / 48
Air volume	cfm	28,000
Filter class (EN779)		G4
Class ISO 16890		Coarse 65%
Initial pressure	Pa	66
Final pressure	Pa	116
Design pressure	Pa	91

Filter qty and sizes:

12 x 596.0 mm x 596.0 mm x 48.0 mm
3 x 596.0 mm x 290.0 mm x 48.0 mm
4 x 596.0 mm x 290.0 mm x 48.0 mm

Filter frames or guide shell be execute in galvanized steel

CFT - Bag Filter

Technical data:

Filter manufacturer		Camfil
Filter type		Standard-Flo-F7
Air volume	cfm	28,000
Filter class (EN779)		F7
Class ISO 16890		ePM1 50%
Filter length		520.0
Filter surface		57.00
Initial pressure	Pa	89
Final pressure	Pa	189
Design pressure	Pa	139

Filter qty and sizes:

12 x 592.0 mm x 592.0 mm
3 x 592.0 mm x 287.0 mm
4 x 592.0 mm x 287.0 mm

Filter frames or guide shell be execute in galvanized steel

- Accessories / Execution / Indications

1 Pcs Door lock

Inspection window

Illumination		Bulkh.light Plast. LED wired
		Protection type IP44
	Voltage [V]	230
	Capacity [W]	8

K - cooling coil

Section length:	mm	762.5
Section pressure loss:	Pa	142

CK1 - Cooling coil H2O / Glycol

Materials:

Fins	copper tinned
Tubes	copper
Frame	Stainless steel 304
Header	copper

Technical data:

Inlet connection		DN 100
Outlet connection		DN 100
Air volume	cfm	28,000
Air velocity	fpm	512
Air on temp	gF	79.98

Air on hum	gF	66.99
Air off temp	gF	54.98
Air off hum	gF	54.69
Capacity	BTUH	1,085,105
Pressure loss	Pa	123
Medium		Water
Medium quantity	l/s	13.6200
Medium velocity	fpm	274
Entering temp	gF	43.98
Leaving temp	gF	53.99
Pressure loss	kPa	43.28
Content	Liter	194.900

- Accessories / Execution / Indications

1	Pcs	Drain / air vent
1	set	Flange with counterflange steel, supplied loose
1	Pcs	Coil easily removable

Drain pan	Material	Stainless steel 304
	Dimensions	762.5 x 2,745.0 Ø1"
	Type	inclined
Drop eliminator	Frame	Stainless steel 304
	Blades	PPTV

VF - Plug fan

Section length:	mm	1,067.5
Section pressure loss:	Pa	15

High performance impeller with backward inclined blades, statically and dynamically balanced

Technical data fan:

Manufacturer			ebmpapst
Fan type	x 6		K3G400-PA27-62
Air volume	x 6	cfm	4,666.67
External static pressure		Pa	500
Dynamic pressure		Pa	96
Total pressure		Pa	1,016
Total Efficiency		%	75.78
Absorbed power	x 6	kW	2.953
Nominal speed		1/min	2,686
Sound power level		dB(A)	92.9

Frq.Hz	63	125	250	500	1000	2000	4000	8000
Okt.dB	76.3	77.9	83.7	83.9	85.3	87.7	81.9	82.3

- Accessories / Execution / Indications

Motor data:

Manufacturer		ebmpapst
Motor type		M3G150FF
Protection class		IP55
Insulation class		F
Connection / Voltage		3x400 / Default
Nominal power	kW	3.650 / /
Nominal speed	1/min	2,800 / /
Nominal current	A	5.80 / /
Efficiency		89.06
El. absorb power		3.32
Motor efficiency class		analog to IEC60034: IE 5

- Accessories / Execution / Indications

1	set	Motor precabeled
1	set	Gland for power cable

- Accessories / Execution / Indications

1	Pcs	Door lock
1	Pcs	Safety catch lock

Opening

Size	2,685.0 mm x 702.5mm
Direction	Top

Unit sound levels Supply air

	Unit sound levels Supply air	Tot dB (A)	63	125	250	500	1000	2000	4000	8000
1	Sound power level casing +/- 4 dB	**69.7**	72.6	67.7	65.1	63.5	63.3	65.3	57.1	57.7
2	Sound power level air inlet +/- 4 dB	**77.9**	70.4	80.6	80.9	76.4	70.5	65.4	63.7	65.5
3	Sound power level air outlet +/- 4 dB	**99.8**	83.3	85.7	91.5	91.7	93.1	95.5	89.7	90.1
4	Sound pressure 1 m appart of AHU	**51.6**	54.4	49.5	46.9	45.3	45.1	47.1	38.9	39.5
5	Sound pressure 1 m appart from air inlet	**72.4**	63.0	73.9	74.9	70.9	65.2	60.2	58.8	60.6
6	Sound pressure 1 m appart from air outlet	**94.6**	75.9	79.0	85.5	86.2	87.8	90.3	84.8	85.2

Calculated sound pressure levels are indicative only. It corresponds to: free field hemispheric sound radiation from the unit casing (4), the inlet (5) and the outlet (6) opening. Other sound sources, acoustic character of the room, air flow noise, duct connections and vibrations can influence the sound pressure in dependence. In practice, therefore measured values on site may be different from the calculated ones.

1	Pcs	Panel insulation mineral wool
1	set	Base frame BF3 - 200
1		Plug in profiles in PVC
1		Truck - Transport
1	Pcs	Nylon Wrapping
1	Pcs	Front side covering

SECTION 2 - 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	Pressure	Velocity FPM.
Medium and High Pressure	High Pressure	10’	Positive	4000 & above
	Medium pressure	6”	Positive	4000 & above
	Medium Pressure	4”	Positive	4000 & above
	Medium Pressure	3”	Pos. or Negative	3999 & below
Low Pressure Duct	Low Pressure	2”	Pos. or Negative	2500 & below
	Low pressure	1”	Pos. or Negative	2500 & below
	Low pressure	1/2"	Pos. or Negative	2500 & below

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. Side Inches	**US/Std. Gauge**	**Transverse Joints and bracing**
Up to 12”	24	¾” 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 ½ Pocket Joint at 4 ft. centers with across breaking and ½” x ½” x 1/8” angle girth at 8 ft. centers bolted to the pocket joints.
43” – 54”	20	1 ½ Pocket Joint at 4 ft. centers with across breaking and 1½” x 1½” x 3/16” angle girth at 8 ft. centers bolted to the pocket joints
55” – 72”	20	1 ½ Pocket Joint at 4 ft. centers with across breaking and 1½” x 1½” x 3/16” angle girth at 8 ft. centers bolted to the pocket joints
73” and above	18	2 – 1 ½” x 1 ½” x 3/16 angles at 4 ft. centers bolted to the duct with 3/8” bolts at 1 ½” 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 diameter in inches	**Negative Pressure**		**Positive Pressure**	
	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 Diameter mm	**Galv. Steel Gauge (U.S.)**			**Girth Reinforcing**		**Girth Joints***
	Spiral lock Seam Duct	**** Longitudinal Seam Duct**	***** Sound Duct Fitting**	**Between Joint Angle Size & Max. Longitudinal Spacing**		
Up thru 200 225 – 350	26	24	26	22 20	None Required	50 mm long 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 1275 – 1500 1525 - 2100	20 18	20 18	20 18 18	18 18 18	None Required None Required None Required	40x40 mm Angle flanged joint **1)Ditto** **2)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 provided on each side of the damper. Fire damper shall have provision for remote close or open signaling and shall be connected with fire alarm system.

2.07. 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

Type	Space Between Vanes	Radius	Gauge
Small	1 ½”	2”	24
Large	3 ¼”	4 ½”	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".

2.08. 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.

D. 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:

i. Rectangular Duct

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

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.

ii. Hangers Sizes for Round Duct:

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
37” thru 50	One 1” x 16 ga	12 ft
51” thru 60”	Two 1”x 18 ga	12 ft
61” thru 84”	Two 1”x 16 ga	12 ft

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.

SECTION 3 - 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. NFPA National 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	1"
Supply & Return air ducts exposed to outside ambient temperature.	3"

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.

SECTION 4 - 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 product.

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.

SECTION 5 -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 specifiedherein.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 6 - ACHV VALVES AND ACCESSORIES

PART 1 GENERAL

1.01. SECTION INCLUDES

A. Gate Valves
C. Check Valves
E. Drain Valves
F. Commissioning Valves
G. Strainers
H. Automatic Air Vents

1.02. 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.

ii. 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.

iii. 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 ValvesCheck 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, aluminium 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.

Screen preparation shall be as follows.

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

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 7 -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 :**

1. At suction side of pumps : Vacuum – 60 psi (Vacuum – 4 bars)

2. 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.

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 ANDCOMPOUND 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 central station 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 8 - 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

A. 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 9 -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 fibre 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 aluminium 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.

3.03 INSULATION SCHEDULE FOR PIPING

Piping	Type	Pipe Size Inch(mm)	Thickness Inch(mm)
Domestic hot water supply return piping In partition walls or chases All other areas	 C A	 All sizes 2 (50) and under 2 ½(65) and over	 1/4 (6) 3/4 (19) (25)
Domestic cold water supply piping in ceiling spaces used as ACHV return plenums	B	All sizes	1/2 (12)
Stom water draining in ceiling spaces used as ACHV return plenums	B	All sizes	1/2 (12)
Soil and waste piping in ceiling spaeces used as ACHV return plenum	B	All sizes	1/2 (12)
ACHV chilled water supply and return piping/valves and fittings	A	2 (50) and under 2 ½(65) and over	(25) 2 (50)
ACHV chilled water supply and return piping/valves and fittings	A	2 (50) and under 2 ½(65) and over	(25) 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)

3.04 INSULATION SCHEDULE FOR EQUIPMENT

EQUIPMENT	TYPE	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.

C. ACHV chilled water piping exposed to outdoor on roof : shall be provided with aluminium cladding.

SECTION 10 -MECHANICAL IDENTIFICATION

PART -I GENERAL

1.01 SECTION INCLUDES

A. Identification of mechanical products.

1.02 REFERENCES

A. BS 1710 Scheme for identification of piping systems.

B. ANSI A 13.1 Scheme for identification of piping systems.

1.03 SUBMITTALS

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

B. Submit coordinated color schemes, valve schedules indicating service, location and tag number; legend chart for stenciling etc.

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:
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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 COLORS

A. Conform to reference standards unless otherwise indicated.

B. Coordinate with all other, similarly identified services and agree on a schedule which avoids confusing repetitions.

C. Comply with prevailing governmental requisitions, where appropriate like for fuel/gas pipe work.

2.03 SELF ADHESIVE PLASTIC PIPE MARKERS FOR PLUMBING SERVICES

A. Two ply self adhesive vinyl tapes applied around the pipes with 12mm over lap. Use 15 cm. wide (total) tapes of colors, as scheduled below:

1. City water	White/Navy Blue/White
2. Filtered City Water	White/Sky/Blue/White
3. Cold Water Supply	White/Moss Green/White
4. Irrigation Supply	White/Bottle Green/White
5. Soil and Waste Pipes	White/Black/White
6. Vent Pipes	White/Yellow/White

7. Rain Water Pipes White/Brown/White.

B. Two-ply, self adhesive vinyl strip markers of 5x15cm. size (minimum) with white arrows on contrasting background shall bused to indicate flow direction in pipe work.

2.04 SELF ADHESIVE PLASTIC PIPE MARKERS FOR FIRE PROTECTION SERVICES.

A. Two ply self-adhesive vinyl tapes applied around the pipes with 12mm overlap. Use 15 cm. wide (total) tapes of colors as scheduled below:

1. Sprinkler Systems White/Safety Red/White.
2. Wet stand pipe systems White/Crimson/White & Fire Hose Reel System.

B. Two ply self-adhesive vinyl strip markers of 5x15cm size (minimum) with white arrows on contrasting background shall be provided to indicate direction of flow in pipe.

2.05 SELF ADHESIVE PLASTIC PIPE MARKERS FOR ACHV SERVICES.

A. Two ply self-adhesive vinyl tapes applied around the pipes with 12mm overlap. Use 15 cm. wide (total) tapes of colors as scheduled below:

1. Refrigerant liquid Line White
2. Refrigerant Suction Line Navy Blue
3. Chilled Water Supply Navy Blue/Whit/Sky Blue.
4. Chilled Water Return Sky Blue/White/Sky Blue.
5. Condensate Brown/White/Brown.

B. Two ply self adhesive vinyl strip markers of 5x15cm. size (minimum) with white arrows on contrasting background shall be provided to indicate direction of flow in pipe.

2.06 STENCILS

A. Use clean cut stencils of appropriate size, for making identification wordings. The paint used shall be semi-gloss enamel.

B. Identification numbering of ACHV, Plumbing and Fire protection equipment shall be stenciled on contrasting background.

2.07 PLASTIC NAME PLATES

A. Three ply rigid plastic name plates with black engraved lettering on light contrasting background shall be used for identifying electrical control panels, technical cupboards, plant rooms and equipments. Fix these labels by adhesive or by metal screws lettering shall not be smaller than 10mm & 6mm in size.

2.08 SIGNAGE (FIRE PROTECTION)

A. Aluminum plates, with painted lettering (backed enamel) shall be used for identifying Fire Protection Equipment. Fix these to equipment / walls by screws.

2.09 VALVE IDENTIFICATION TAGS

A. Three ply rigid plastic tags with black engraved lettering on light contrasting background shall be used for identifying valves. Each tag shall be minimum four (4) cm. diameter in size and shall have a drilled hole for attaching to valves with corrosion resistant metallic chain.

2.10 WARNING GRIDS FOR BURIED SERVICES (TRACER TAPES)

A. Use colored (as coded) continuously printed vinyl tapes at midway between the surface and pipe crown, each grid shall be minimum 15cm. wide. Use metal coated tapes for non-metallic pipes.

PART - 3 EXECUTION

3.01 PIPE WORK IDENTIFICATION

A. Provide pipe markers at valves and similar control gear, equipment, junctions, access doors etc. The distance between pipe markers on exposed straight runs shall not exceed six (6) meters.

B. Provide directional arrows adjacent to pipe markers.

C. Furnish pipe work identification chart in frame and install as directed.

3.02 VALVES IDENTIFICATION

A. Establish a pattern and assign coded numbers to all valves. These numbers shall be included in as-built drawings and manuals.

B. Furnish valve identification chart in frame and install as directed.

3.03 EQUIPMENT IDENTIFICATION

A. All equipment shall be numbered and these numbers should be included in as-built drawings and manuals.

3.04 MISCELLANEOUS

A. Provide name plate on door of all technical premises.

B. Stencil identification codes/numbering on all places of equipment not covered otherwise.

C. Provide warning signs at controls as appropriate Eg. Do not operate, Operate in the event of, etc.

SECTION 11 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1-GENERAL

1.01 SECTION INCLUDES

A. The works in this section include: Supports, anchors and seals complete in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
4. Building Attachments.
5. Saddles and Shields.
6. Spring Hangers and Supports.
7. Miscellaneous Materials.
8. Anchors.
9. Equipment Bases.

1.02 SUBMITTALS

A. Product Data: Submit catalogue cuts, specification, installation instructions and dimensioned drawings for each type of support, anchor and seal. Submit pipe hanger and support schedule showing manufacturers figure number, size, location and features for each required pipe hanger and support.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualification: Firms regularly engaged in manufacture of supports and anchors, of type and size required whose products have been in satisfactory use in similar service for not less than ten (10) years.

1.04 MOCK-UP

A. The contractor shall provide mockup samples as required and shall obtain approval by the Engineer

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.06 COORDINATION

A. Inspect and discuss space availability and adequacy withall other trades.

B. Verify that equipment operation is consistent with system description.

C. Review coordination of interlocked equipment specified in this Section and elsewhere.

D. Review required testing, inspecting, and certifying procedures.

1.07 CLOSE-OUT REQUIREMENTS

A. WARRANTY

A. Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, workmanship and the system performance for a period of not less than two (2) years from date of acceptance by the owner shall be provided by the contractor.

B. The warranty shall be direct from the system manufacturer and supported by the local certified contractor and installer. Acceptance shall be deemed as beneficial use by the number.

C. The warranty shall include system performance, applications assurance, material defects and workmanship.

B. **OPERATION & MAINTENANCE MANUAL**

A. The handbooks covering all facilities and equipment shall be printed books of all the necessary texts, charts, tables of materials, schematic diagrams, block diagrams, and other data that may be needed by the client's engineering and/or operation staff, to facilitate understanding the general theory of equipment operation, practical operation of the equipment, preventive maintenance daily/weekly/monthly checks (if required), fault finding and correction, repair and maintenance functions.

B. All handbooks delivered shall be bound in binders suitable for heavy usage. The handbook title, volume number, book number and publisher's name shall be printed on the spine. Major sections of the handbooks shall be separated and tabbed by numbers or letter dividers.

C. The engineer shall have the right to comment and ask for any modification and/or addition to these handbooks with no extra charge to the client.

C. **AS BUILT DRAWINGS**

1. As-built packages shall include, but not be limited to:
    a. Index Sheet that shall:
        i. Define each page to include facility name, building name, floor, and sheet number.
        ii. Reference all general notes that are utilized

A. Floor plans, site plans, and enlarged plans shall:
    a. Include a title block as defined above.
    b. Define the drawings scale in both standard and metric measurements.
    c. Provide equipment identification and location.

B. A riser drawing for each applicable system shall:
    a. Indicate the sequence of operation.
    b. Relationship of integrated components on one diagram.
    c. Include the number, size, and identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

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 with specifications and Engineer's approval.
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

2.02 SYSTEM / ASSEMBLIES

A. When the equipment is shipped in parts, the contractor shall provide professional team, with all required tools to carry out the assemblies under the supervision of the engineer and wherever applicable.

2.03 MATERIALS

A. Horizontal – Piping Hangers and Supports

1. General: Except as otherwise indicated, provide hot dipped galvanized factory fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.

B. Adjustable Steel Clevises: MSS Type 1. For suspension of non-insulated or insulated stationary pipelines; 13mm to 750mm (½" to 30").

C. Alloy Steel Pipe Clamps: MSS Type 2. For suspension of high temperature pipe requiring up to 100mm (4") of insulation; 100mm to 400mm (4" to 16").

D. Steel Double Bolt Pipe Clamps: MSS Type 3. For suspension of pipe requiring up to 100mm (4") of insulation and where flexibility of clamp is desirable; 19mm to 600mm (3/4" to 24").

E. Steel Pipe Clamps: MSS Type 4. For suspension of cold pipe lines or hot pipe lines where little or no insulation is required; 13mm to 600mm (½" to 24").

F. Pipe Hangers: MSS Type 5. For suspension of piping when off-center closure allowing installation of hanger before erection of piping is desired; 13mm to 100mm (½" to 4").

G. Adjustable Swivel Pipe Rings: MSS type 6. For suspension of non-insulated stationary pipe lines; 19mm to 200mm (3/4" to 8").

H. Adjustable Steel Band Hangers: MSS Type 7. For suspension of non-insulated stationary pipe lines; 13mm to 200mm (½" to 8").

I. Adjustable Band Hangers: MSS Type 9. For suspension of non-insulated stationary pipe lines; 13mm to 200mm (½" to 8").

J. Adjustable Swivel Rings, Band Type: MSS Type 10. For suspension of non-insulated stationary pipe lines; 13mm to 50mm (½" to 2").

K. Split Pipe Rings: MSS Type 11. For suspension of non- insulated stationary pipe lines; 10mm to 200mm (3/8" to 8").

L. Extension Split Pipe Clamps: MSS Type 12. For suspension of non-insulated stationary pipe lines; 10mm to 75mm (3/8" to 3").

M. U-Bolt: MSS Type 24. For support of heavy loads; 13mm to 750mm (½" to 30").

N. Clips: MSS Type 26. For support of uninsulated piping not subject to expansion or contraction.

O. Pipe Slides and Slide Plates: MSS Type 35. For support of piping where horizontal movement resulting from expansion and contraction takes place and where coefficient of friction low is desired. Include one of the following plate types:
   1. Plate: Unguided type.
   2. Plate: Guided type.
   3. Plate: Hold-down clamp type.

P. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast-iron floor flange. To support pipe from floor stanchion, using floor flange to secure stanchion to floor; 100mm to 1200mm (4" to 36").

Q. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange. Equivalent to Type 36 except U-bolt provided for retaining pipe

R. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange. For stanchion type support where vertical adjustment is required; 63mm to 1200mm (2½" to 36").

S. Single Pipe Rolls: MSS Type 41. For suspension of pipe from two rods where longitudinal movement due to expansion and contraction may occur; 25mm to 750mm (1" to 30").

T. Adjustable Roller Hangers: MSS Type 43. For suspension of pipe from a single rod where horizontal movement may occur because of expansion or contraction; 63mm to 500mm (2½" to 20").

U. Pipe Roll Stands: MSS Type 44. For support of pipe where longitudinal movement resulting from expansion and contraction may take place, but vertical adjustment is unnecessary; 50mm to 1050mm (2" to 42").

V. Pipe Rolls and Plates: Type 45. For support of pipe where small horizontal movement due to expansion and contraction may occur and where vertical adjustment is unnecessary; 50mm to 600mm (2" to 24").

W. Adjustable Pipe Roll Stands: MSS Type 46. To support pipe lines where vertical and lateral adjustment during installation may be required in addition to provision for expansion and contraction; 50mm to 750mm (2" to 30").

2.04 VERTICAL-PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with ANSI/MSSSP-58, of one of the following types listed, selected by the Contractor and approved by the Engineer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical-piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.

B. Two-Bolt Riser Clamps: MSS Type 8. For support and steadying of pipe risers; 19mm to 500mm (3/4" to 20"). Also supports pipe covering or insulation.

C. Four-Bolt Riser Clamps: MSS Type 42. When longer ends are required for riser clamps.

2.05 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated provide factory- fabricated hanger-rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

B. Steel Turnbuckles: MSS Type 13. To provide adjustment up to 150mm (6") for heavy loads.

C. Steel Clevises: MSS Type 14. For use on high temperature piping installations.

D. Swivel Turnbuckles: MSS Type 15. To be used with split pipe rings, MSS Type 11.

E. Malleable Iron Sockets: MSS Type 16. For attaching hanger rod to various types of building attachments.

F. Steel Weldless Eye Nuts: MSS Type 17. For use on high temperature piping installations.

2.06 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated building attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.

B. Concrete Inserts: MSS Type 18. For upper attachment for suspending pipe hangers from a concrete ceiling.

C. Top Beam C-Clamps: MSS Type 19. To be used under roof installations with bar joist construction, for attachment to top flange of structural shape.

D. Side Beam or Channel Clamps: MSS Type 20. For attachment to bottom flange of beams, channels, or angles.

E. Center Beam Clamps: MSS Type 21. For attachment to center of bottom flange of beams.

F. Welded Attachments: MSS Type 22. For attachment to bottom of beams where loads are considerable and rod sizes are large.

G. C-Clamps: MSS Type 23. For attachment to structural shapes.

H. Top I-Beam Clamps: MSS Type 25. For attachment to top of beams when hanger rod is required tangent to edge of flange.

I. Side I-Beam Clamps: MSS Type 27. For attachment to bot-tom of steel I-beams.

J. Steel I-Beam Clamps with eye Nut: MSS Type 28. For attachment to bottom of steel I-beams for heavy loads.

K. Steel WF-Beam Clamps with eye Nut: MSS Type 29. As Type 28 with link extensions.

L. Malleable Beam Clamps: MSS Type 30. For attachment to structural steel.

M. Steel Brackets: One of the following for indicated loading. To be used for support from below, or by using clip and rod for suspending from above. Light duty: 340 Kg. (750 lbs.), Medium: 680 Kg. (1500 lbs.), Heavy: 1360 Kg. (3000 lbs.).

1. Light Duty: MSS Type 31.
2. Medium Duty: MSS Type 32.
3. Heavy Duty: MSS Type 33.

N. Side Beam Brackets: MSS Type 34. For use on sides of steel or wooden beams.

O. Plate Lugs: MSS Type 57. For attachment to steel beams where flexibility at the beam is desired.

P. Horizontal Travelers: MSS Type 58. For supporting piping systems subject to linear horizontal movements where head room is limited.

2.07 SADDLES AND SHIELDS

A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory- fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

D. Thermal Hanger Shields: Constructed of 360‘insert of high density, 690 KPa (100 psi), waterproofed calcium silicate, encased in 360‘sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.08 SPRING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with ANSI/MSS SP-58 of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit piping systems, in accordance with MSS SP-69 and manufacturer’s published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading. All hangers, supports serving the main piping headers, connections to main equipment such as chillers, pumps, cooling towers, air separators, sand separator etc. shall be spring roller type.

B. Restraint Control Devices: MSS Type 47. To control piping movement.

C. Spring Cushion Hangers: MSS Type 48. For light loads where vertical movement does not exceed 32mm (1¼”).

D. Spring Cushion Roll Hangers: MSS Type 49. For equipping Type 41 roll hanger with springs.

E. Spring Sway Braces: MSS Type 50. To retard sway, shock, vibration, or thermal expansion in piping systems.

F. Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25%. To absorb expansion and contraction of piping system from hanger.

G. Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25%; include load flange. To absorb expansion and contraction of piping system from base support.

H. Variable Spring Trapeze Hangers: MSS Type 53; preset to indicated load and limit variability factor to 25%. To absorb expansion and contraction of pipe system from trapeze support.

I. Constant Supports: Provide one of the following types, selected to suit piping system.

Include auxiliary stops for erection and hydrostatic test and field load-adjustment capability:

1. Horizontal Type: MSS Type 54.
2. Vertical Type: MSS Type 55.
3. Trapeze Type: MSS Type 56.

2.09 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of one (1) part cement to three (3) parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe Guides: Provide factory-fabricated guides, of cast semi steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.01 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated work, the Contractor shall meet at project site with inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this Section, and the Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.02 ADJUSTING

A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.03 PROTECTION OF WORK

A. The contractor shall be fully responsible to receive, check, unload, store, and adequately protect equipment and materials to be Installed as part of the contract.

3.04 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer’s written instructions, to

limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacing's: where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 EQUIPMENT BASES

A. Construct suitable concrete bases for the elevated support of all floor mounted equipment. Furnish, for the Engineer's approval, scaled layouts of all required bases, with dimensions and location to column center lines, and templates, anchors bolts and accessories, necessary for base construction.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of approved structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.06 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in Drawing MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping. Provide concrete inserts, where required to be installed before structural concrete is placed.

3.07 INSTALLATION OF HANGERS AND SUPPORTS

A. General

1. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing's complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized approved methods.

B. Provisions for Movement

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

   Contractor to check and confirm that loads from equipment, piping etc can be safely accommodated by structure.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Pipe Slopes: Install hangers and supports to provide required pipe slopes and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Insulated Piping

1. Comply with the following installation requirements.

a) Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

b) Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 200mm (8") and over, install wood insulation saddles.

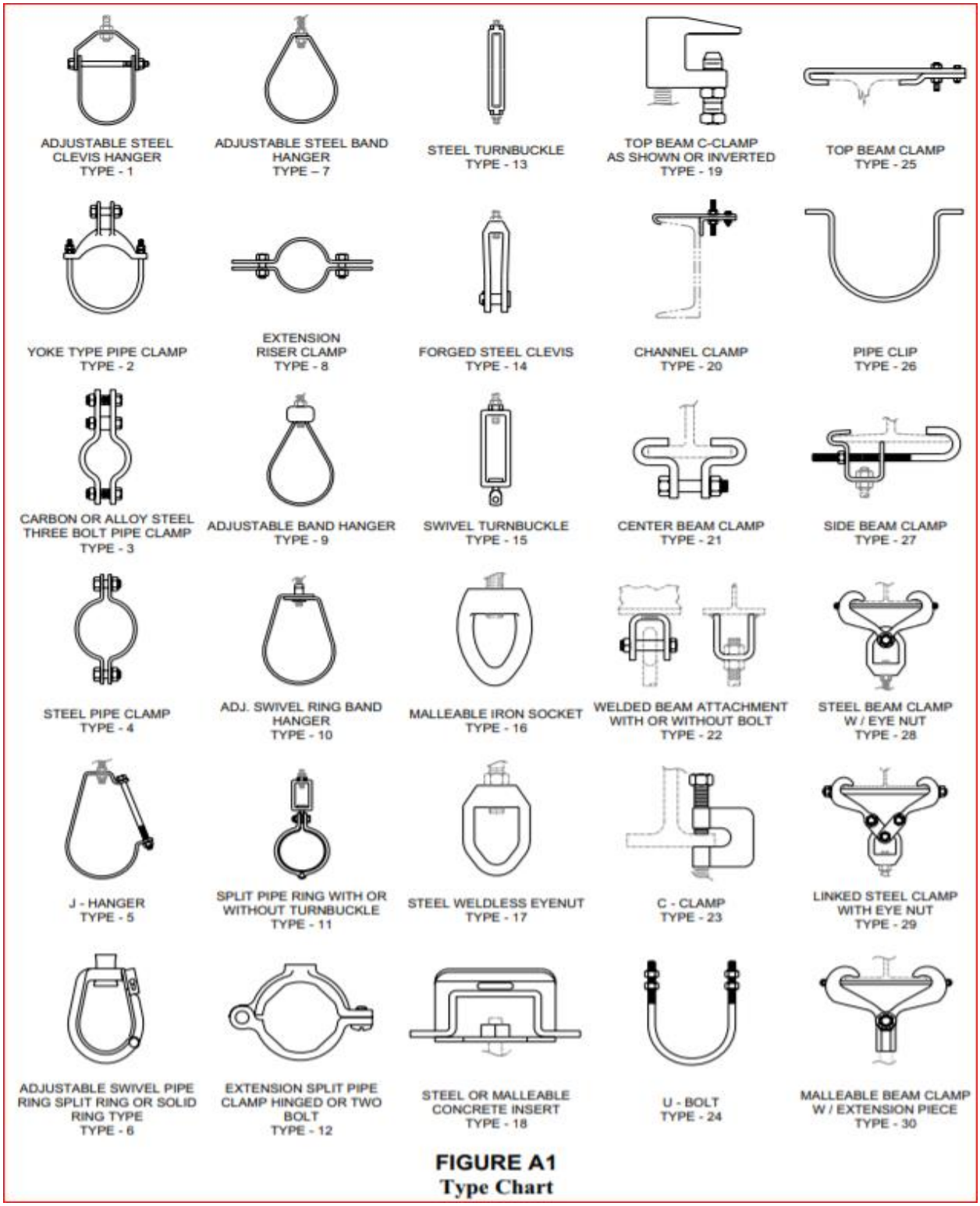

FIGURE A1
Type Chart

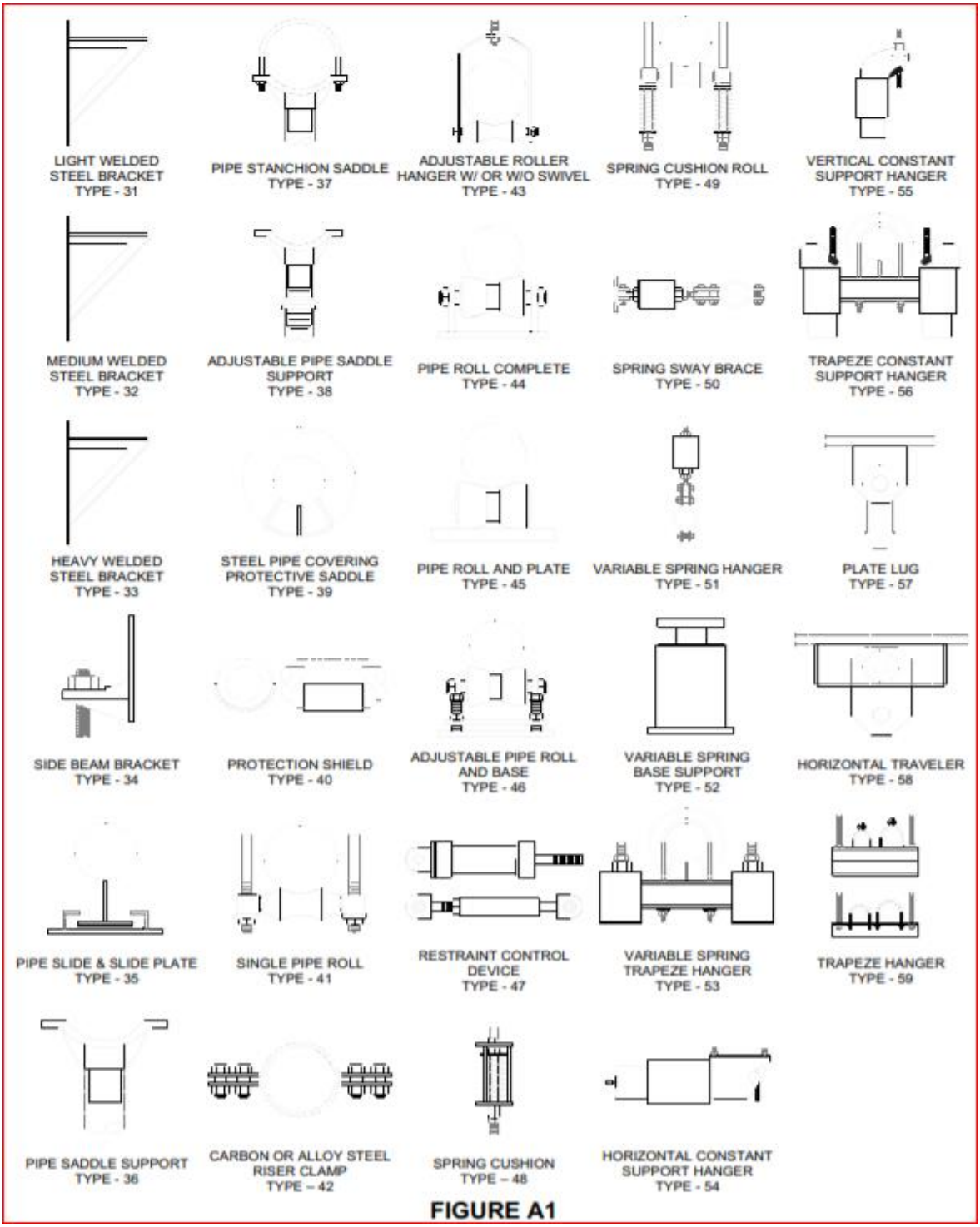

FIGURE A1

END OF SECTION

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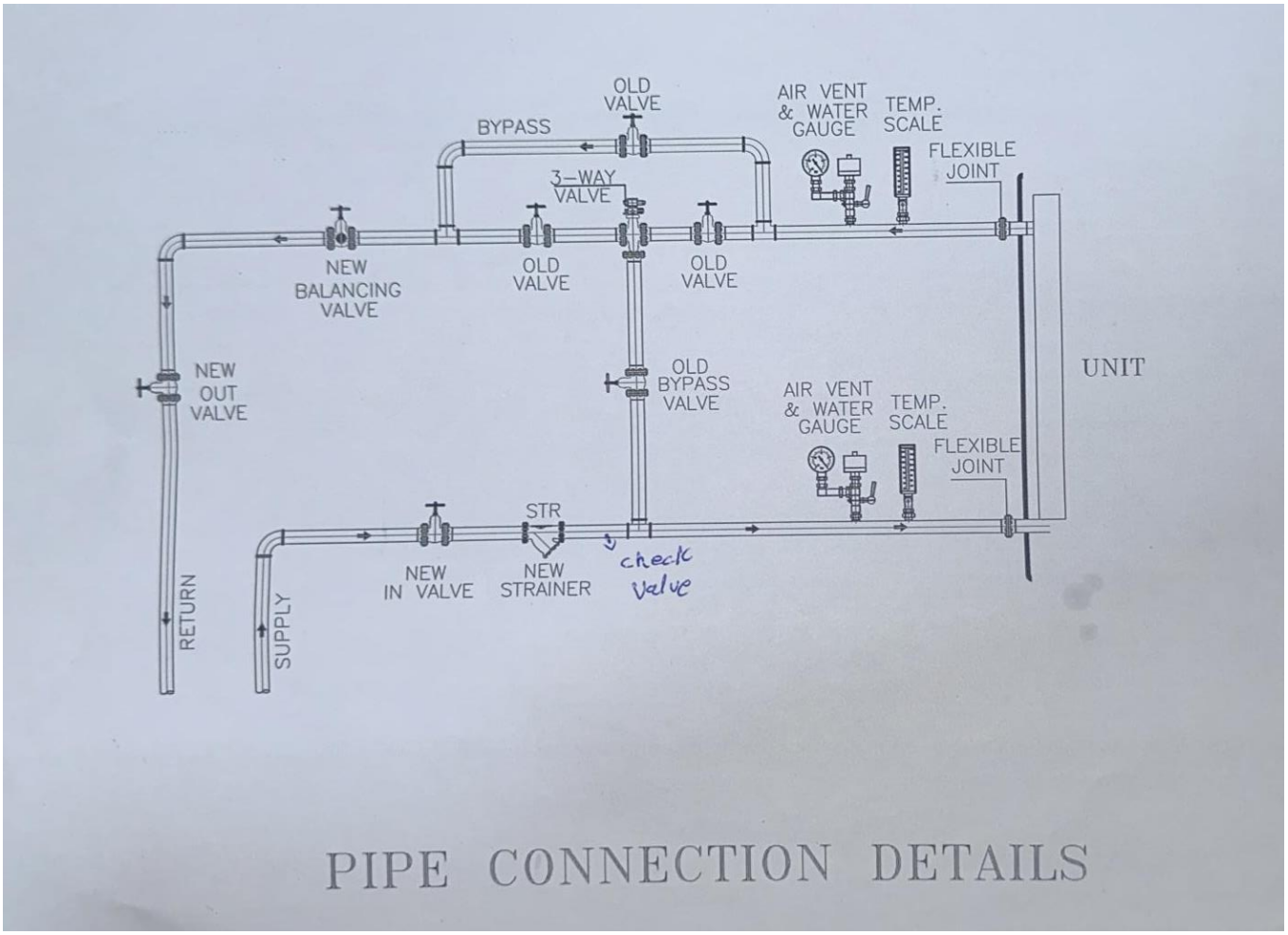
Pipes and Valves diagram



Note:

- **All Valves,Pipes,Gaguges,etc must be new.**