


 <b>ICIIC</b> شرکت سرمایه‌گذاری صنایع شیمیایی ایران IRAN CHEMICAL INDUSTRIES INVESTMENT CO	Completing the Remaining Documents of Design and Engineering Services for LAB2 Unit							 شرکت طرح تواندیشان
	<b>MATERIAL REQUISITION FOR HVAC EQUIPMENTS</b>							
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## MATERIAL REQUISITION FOR HVAC EQUIPMENTS

Issued For :



- ☒ Inquiry  
☐ Purchase order

03	7-Feb-2023	AFP	H.R	H.R	R.JAVADZADEH
02	20-Oct-2023	AFP	H.R	H.R	AR. AHOOEI
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00	12-May-2023	IFA	H.R	H.R	AR. AHOOEI
<b>REV</b>	<b>DATE</b>	<b>POI</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>

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## 1 INTRODUCTION

Iran Chemical Industries Investment Company (ICIIC) was established in 1984. The executive operation in the area of 3,420,000 square meters in the northwest industrial region of Isfahan began in 1990 to create a Linear Alkyl Benzene (LAB) Complex with 50,000 tons of LAB and 46,000 tons of normal paraffin capacity.



With the increase in domestic consumption and also the improvement of the consumer market in the region, the implementation of the company's development plan for the annual production of 75,000 tons of linear alkyl benzene and 140,000 tons of normal paraffin was strengthened. Utilizing the existing knowledge and applying the scientific and experimental skills of the specialized forces, this company succeeded in successfully completing its development plan in 2003. Iran Chemical Industries Investment Company to reduce the production of Heavy Alkylate By-product (HAB) and also to improve the quality and increase the production of alkyl benzene line (LAB) in cooperation with Sinopec company to successfully operate the selective Hydrogenation of Dyalphins (DSH) in 2008.

## 2 PURPOSE

This Material Requisition is issued to obtain quotation for design, engineering, procurement and supply of materials, fabrication, quality control, inspection, test, packing and shipment of complete DX-Packaged Unit, Fans, Air handling unit & Fan Filter Unit in accordance with requirements of this requisition and all its attachments for "LAB2 UNIT" in SHAHIN-SHAHR , ISFAHAN , IRAN:- All documents attached hereto are an integral part of this Requisition and shall be taken into consideration.

This requisition includes the following building:

- CHANGE HOUSE
- SUBSTATION NO.05
- PROCESS CONTROL BUILDING NO.03

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- FIRE STATION NO.2

### 3 DEFINITION AND TERMINOLOGY

**OWNER:** IRAN CHEMICAL INDUSTRIES INVESTMENT COMPANY (ICIIC)

**CONTRACT:** Agreement between the OWNER and the ENGINEERING CONTRACTOR and includes documents referred to therein.

**MANAGING CONSULTANT (MC):** -



**ENGINEERING CONTRACTOR:** TARHE NO ANDISHAN Consulting engineers (TNA)

**PMT:** Project Management Team

**BEP:** Basic Engineering Package

**PDP:** Process Design Package

**CONTRACT NUMBER:** 6258

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## 4 CODES AND STANDARDS

ASHRAE:	American society of heating, refrigerating and air conditioning engineers guide and handbook.
SMACNA:	Sheet metal and air conditioning contractor's national association Inc.
NFPA:	National fire protection association
AMCA:	Air Moving and Conditioning Association
AFI:	American Filtering Institute (Filters)
ADC:	Air Diffusion Council (Air diffusion & tests)
NPC:	National plumbing code
ASTM:	American Society for Testing and Materials.
AHRI:	Air- Conditioning Heating and Refrigeration Institute
IPS:	Iranian petroleum standard
INBC:	Iranian National Building Code
Publication No. 128 of Management and Planning Organization.	

## 5 ORDER OF PRIORITY

When doubtful or conflicting interpretations arise, precedence shall be determined as follows:

- This Requisition
- Data Sheets
- Design Criteria for HVAC System
- Project Code & Standard List
- International Codes and Standards

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## 6 REFERENCE DOCUMENTS

For list of documents applicable to the scope of work, refer to clause-12 herein after.

### Note:

If safety studies will be requested by the client, this document will be reviewed and edited in accordance with the safety reports.



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## 7 SCOPE OF WORK AND SUPPLY

VENDOR'S scope of work and supply shall include but not limited to items in below tables under requirements stated in this requisition and all of its attachments. The scope of supply must include all necessary components and materials of ROOF TOP SELF CONTAINED PACKAGE UNIT, AIR HANDLING UNIT, FAN FILTER UNIT and ALL FAN TYPE in full compliance to this MR and its attachments, required for all modes of operation and safe and smooth operation of the plant.

### 7.1 Scope of Work

#### 7.1.1 Inclusion

Main Quotation	Optional	Description
✓	-	Planning, coordination and project control (covering all sub Vendors)
✓	-	Engineering, design and procurement of all material
✓	-	Data sheet and performance data
✓	-	Document control and submissions to Purchaser for review / comments / final filling and updating them progressively
✓	-	Manufacturing and assembling
✓	-	Surface preparation and Painting at shop including primer and finish coats
✓	-	Inspection and tests at shop
✓	-	All on skid wiring terminating at skid edge junction boxes
✓	-	Foundation loading diagram
✓	-	Insulation and personnel protection, if required
✓	-	Shipping and transportation according to delivery condition
✓	-	Packing including export and rust prevention for long term
✓	-	Units Assembly at Factory
-	✓	Supervision for Installation, Pre-Commissioning, Commissioning and Start-Up including time schedule & supervision stages
✓	-	Dimensional outline drawing and anchor bolts position
-	✓	Training (Syllabus, number of man days and duration to be specified in the quotation)

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Main Quotation	Optional	Description
✓	-	Mechanical Guarantee
✓	-	Performance Guarantee
✓	-	All Needed Work And Equipment To Set Up Equipment And Systems
✓	-	All technical data such as equipment manuals, catalogues, and other effective technical brochures.

### 7.1.2 Exclusion



In addition to exclusion items of data sheets, the following shall be considered as exclusion:

- Foundations design
- Civil works

## 7.2 Scope of Supply

### 7.2.1 Inclusion

Main Quotation	Optional	Description
✓	-	Mixing Box with washable filters
✓	-	Bag filter section
✓	-	Cooling Coil (DX, Chilled Water)
✓	-	Heating Coil (Hot water, Steam, Electric)
✓	-	Humidifier (Electric pan, Steam, Spray Nozzle)
✓	-	Supply Fan (Forward. Backward Type)
✓	-	Motorized dampers on (supply, return, outside air)
✓	-	Stainless Steel drain pan
✓	-	Both side condensate drains connection and trap.
✓	-	Safety devices (suction strainer, cut-out switches for high and low refrigerant pressure, high refrigerant temperature, low oil pressure and temperature)



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✓	-	A device to prevent compressor overloading on start up
✓	-	Unit mounted control panel
✓	-	Refrigerant and oil pressure gauge, sight glasses for levels of oil and refrigerant, and an oil heater
✓	-	Earthing lugs
✓	-	Delivery and suction stop valves shall be located in a readily accessible position and all refrigerant valves shall be fitted with seal caps. A liquid line drier shall be fitted to each unit and shall be complete with isolating valves and moisture indicator.
✓	-	Oil pumps shall be fitted with suction strainers. A crankcase heater and an oil separator shall be provided
✓	-	A liquid line drier shall be fitted to each circuit of unit and shall be complete with isolating valves and moisture indicator.
✓	-	A crankcase heater and an oil separator shall be provided
✓	-	Compressor shall be mounted on an anti-vibration base
✓	-	Condensers shall be of shell and tube type to suit the application, designed as per appropriate standards
✓	-	Condensers coils shall be suitably protected against corrosion
✓	-	Access doors shall be provided for easy maintenance. Each door shall have an airtight fit and be supplied complete with seals and fasteners. Access doors shall be provided on both sides of the unit in fan sections, automatic filter sections and for inspection of heater batteries and cooling coils.
✓	-	Liquid injection will all relates piping and instrument shall be Fitted in compressor.

### 7.2.2 Exclusion

The followings shall not be included in scope of supply:

- In addition to exclusion items of engineering data sheets, the following shall be considered as exclusion.
- Foundations design. (Foundation loading diagram and information shall be provided)
- Civil works except for anchor bolts.

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## 8 TECHNICAL NOTES AND SPECIAL CONSIDERATIONS

Unless otherwise stated in the specification and/or data sheet, the under mentioned shall be followed:

- Cooling coils in the direct exchange systems, they coincide with the evaporators of the refrigeration circuits.

**A)** In the other cases, they perform the exchange within the intermediate medium (e.g. chilled water) and air. The cooling coils shall have robust steel sheet airtight casing.



The cooling surfaces shall be made of solid drawn copper primary tubes brazed into flow and return headers. The tubes shall be fitted with flat aluminum fins mechanically bonded to the primary tubes. The fins shall be vertical to facilitated clearance of condensed moisture.

The cooling medium shall enter the coils on the air leaving side and shall leave the coils at the air entry side. Valves shall be provided to isolate and regulate the coils and a plugged drain connection fitted on each coil. The resistance of dirty filter to indicate when cleaning or replacement is necessary shall be shown by a differential pressure gauge. The air velocity across the face of the filters shall not exceed 2.5 meters per second. The units shall be fabricated such that there is no leakage around the cells and replacement, or cleaning of filter medium can be done easily. The type and efficiency of the filters shall be indicated.

**B)** Heating coils for low and average heating capacities they shall be designed for electrical heating. The coils shall operate at low temperature (black heat), be suitable for step control and be provided with thermostatic safety cut - outs to prevent overheating.

For high heating capacities, intermediate medium (steam or hot water) could be used. For hot water the characteristics are the same as the ones for chilled water, whereas for steam they could be in steel (tube) / aluminum (pins) or steel / steel. In the heating coils with steam the tubes shall have the necessary slope to convey the condensation and special expansion joints have to be provided to compensate the expansions for the high temperature of the steam.

**C)** Centrifugal fans comprise forward curved, backward curved or radial blade types, having single or double inlet.

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All moving and exposed parts, flexible couplings, belts, pulleys, drives etc., shall be adequately guarded to prevent personnel damaged. The rotating elements shall be statically and dynamically balanced using accurate balancing machines for balancing the rotating elements.

Huge fans shall operate below first critical speed; others shall be selected with a minimum margin of twenty (20) percent from first and second critical speeds.

D) All external surfaces of equipment shall be painted, pickled and passivated According to painting specification.

E) Spare parts shall be packed separately from the equipment, and labelled as commissioning and two years.

F) Tagging and numbering of the unit to be as per data sheets on engraved aluminium plate in compliance with project numbering procedure; sample to be provided prior to installation.



## 9 INSPECTION AND TESTING

Inspection and Test shall be carried out at Vendor's shop as per attached "Instruction to Vendor for Inspection", relevant ITP and applicable codes and standard.

## 10 PRESERVATION AND PROTECTION

VENDOR shall, upon receipt of PURCHASE NOTICE, send a sufficient number of qualified personnel to Client/Purchaser's office (in Tehran) at VENDOR's cost to hold the coordination meeting(s) according to following schedule:

Kick-Off Meeting	for (1) days , (2) weeks after Purchase Notice
Pre-Inspection Meeting	for (1) days as per schedule
Pre-FAT & IFAT Meetings	for (1) days as per schedule
Design Clarification Meeting	will be defined in Kick-Off Meeting (If required)

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## 11 CONFORMITY

VENDOR'S proposal shall be in strict conformity with PURCHASER'S requirements as stated in this Requisition and all its attachments. Any deviation or exception to Purchaser's requirements shall be raised to Purchaser to obtain prior Approval. Without such Approval any claims will be rejected, and Vendor shall correct the non-conformities at his own cost.

Purchaser Approval on Vendor documents shall in no way to relieve Vendor of any of his obligation, responsibility, or liability under the condition of this requisition.

## 12 REQUIREMENTS FOR DOCUMENTS (RFD FORM)

A) VENDOR shall provide list of drawings and documents by one week after order award.

B) VENDOR of equipment / material shall provide all documents and drawings listed in RFD and submit required number of copies.

C) All Vendor documents shall be categorized either "FOR INFORMATION", or "FOR REVIEW/COMMENTS" according to RFD. Purchaser will reply according to each category and return to Vendor documents and Vendor shall take necessary actions in accordance with the steps and manner as described in "INSTRUCTION FOR VENDOR DOCUMENTATION". All vendor's documents and drawings shall be submitted in both Native and PDF format upon each issue. Both Native and PDF files of documents shall be searchable.



D) Definition and abbreviations are as follows:

- **FINAL BOOK**

Means a collection of documents and drawings that convey the Project closing documentation requirements as defined by Purchaser.

- **REVIEW CYCLE**

Means the time duration required by the Purchaser to complete the review of the Vendor documents (10 calendar days from date of receipt). Vendor shall incorporate the comments, update and return the documents within 10 calendar days.

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These periods shall be considered in scheduling of documents, submissions and manufacturing activities. Status Review Codes are shown in the status review stamp in the documents.

E) Quantity, type, and submission date of documents to be as follows:

Description		Final Issue (No. of Weeks Upon NC/NR Status)	Final Book
No. of Copies	Hard Copy (H)		
	Soft Copy (S)		
Submission Date			
Vendor Documents Status Code:		NR: Not Reviewed NC: No Comment	



F) RFD form to be as follows:

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			Qty.	For Comment			Final Issue Rqd.	To Be Included in Final Book	
				Qty.	Sub. Date	Purpose			
				S	Week	I / R			
MANAGEMENT & SCHEDULING									
	1	Vendor Document List & Schedule (VDLS)	X	X	1	R	-	-	
	2	Organization Chart	X	-	-	-	-	-	



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			Qty.	For Comment			Final Issue Rqd.	To Be Included in Final Book	
				Qty.	Sub. Date	Purpose			
				S	Week	I / R			
	3	Monthly /Weekly Progress Report	-	X	-monthly	R	-	-	
	4	Engineering, Procurement , Fabrication, Testing and Delivery Schedule	X	X	-monthly	R	-	-	
	5	Deviation & Clarification List to Standards / Codes / All of Technical Specifications	X	-	-	- R	-	X	
	6	Vendor Catalogue	X	-	-	-	-	X	
	7	Final Book Index	-	X	-	R	-	X	
QUALITY INSPECTION & TESTING [PROCUREMENT]									
	1	Project Quality Assurance Plan	X	-	-	I	-	X	
	2	QC Inspection & Test Plan	X	X	4	R	X	X	
	3	Certification Dossier	-	-	-	-	-	X	
	4	Inspection & Test Report	-	X	*	R	X	X	* 1 week after test
	5	Vendor Quality Control Records	-	X	*	R	X	X	* 1 week after inspection
	6	Certificates of materials (including instrument devices)	-	X	*	R	X	X	* 4 weeks before inspection
	7	Instrumentation Certificates (including: ▪ Ex Classification, ▪ SIL (if any), ▪ Calibrations, ▪ Function Tests, ▪ Routine, Standard & NDT Tests (records), ▪ Inspection, ▪ Declaration of Conformity.	-	X	*	R	X	X	*: in due times before inspection





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			S	S	Week	I / R			
		<div><div></div><div>FAT &amp; SAT, Approvals)</div></div>							
	8	Certificates of calibrations	-	X	*	R	X	X	* During inspection
	9	Welders’ qualification records	-	X	*	R	X	X	* During inspection
	10	Statement of manufacturer’s testing capabilities	X	-	-	-	-	X	
	11	Hydrostatic test report	-	X	*	R	X	X	* 1 week after inspection
	12	Performance Test Report	-	X	*	R	X	X	* 1 week after inspection
	13	Certificate for explosion proof electrical equipment and devices	-	X	*	R	X	X	* During inspection
HSE									
	1	HSE Procedures / Policy	X	-	-	I	-	X	
ENGINEERING									
	1	Data sheets	X	X	4	R	X	X	
	2	Noise data sheets	X	X	7	R	X	X	
	3	Predicted SUPPLY FAN Performance curves	X	X	5	R	X	X	
	4	SUPPLY FAN Performance curves and data after test	-	X	4	R	X	X	
	5	P&ID and Schematic Diagrams for equipment and Auxiliaries (If any)	X	X	4	R	X	X	
	6	Dimensional outline drawing	X	X	4	R	X	X	
	7	Cross sectional drawings and bill of materials	-	X	10	I	X	X	

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				For Comment				Final Issue Rqd.	
			Qty.	Qty.	Sub. Date	Purpose			
			S	S	Week	I / R			
	8	Utility Consumption List	X	X	5	I	X	X	
	9	Lubricant List	-	X	18	R	X	X	
	10	Vibration analysis data	-	X	10	I	-	X	
	11	General Arrangement Drawing including Loading Table/ Information	-	X	4	R	X	X	
	12	Hydro-Test Procedures	-	X		R	X	X	
	13	AS Built Drawings	-	X		R	-	X	
	14	Name Plate Detail Drawing	-	X		R	X	X	
	15	Construction Forms		X		R	X	X	
	16	Cable Schedule		X		R	X	X	
	17	Control System Drawings		X		R	X	X	
	18	I/O List equipment Panel		X		R	X	X	
	19	MTO control System		X		R	X	X	
	20	Panel Logic Diagram		X		R	X	X	
	21	Wiring Diagram		X		R	X	X	
	22	HVAC Panel Single Line Diagram		X		R	X	X	
	1	FAT/SAT test Procedures	-	X	*	R	-	X	* 6 weeks before test
ELECTRICAL									
	2	Motor speed–torque curve	X	X	4	R		X	
	3	Motor speed–current curve	X	X	4	R		X	

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				Qty.	Sub. Date	Purpose			
				S	Week	I / R			
	4	Electrical load list	X	X	6	R	X	X	
	5	Electrical Final MTO	-	X	15	I		X	
	6	Electrical Signal List between package and MCC	-	X	10	R	X	X	
	7	Electrical Cable Lists	-	X	7	R	X	X	
	8	Single line diagram	-	X	10	R	X	X	
	9	Electrical Equipment List	-	X	15	I		X	
	10	Motor terminal box drawing	-	X	7	R	X	X	
	11	Local Push button station drawings		X	7	R	X	X	
PROCUREMENT									
	1	Sub-Vendor List (including all accessories & sub-ordered components)	X	-		-	-	X	
	2	Un-priced Copy of Final Technical Main Order and Sub-Orders	-	X		I	-	X	
	3	Detailed Packing List (	-	X		R	X	X	
TRANSPORTATION, INSPECTION, OPERATION AND MAINTENANCE MANUALS									
	1	Installation Procedure	-	X		I	-	X	
	2	Operation and Maintenance Instruction	-	X		I	-	X	
	3	List of special tools supplied and required for installation, calibration, configuration, site tests and maintenance	X	X		I	-	X	
	4	Spare Parts List (Installation, Pre-commissioning, Commissioning & Start-Up)	X	-		-	-	X	

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	5	Spare Parts List (Two Years Operation)	X	-		-	-	X	
	6	Spare Parts SPIR Form	-	X		R	X	X	
	7	Shipping Volume Information and arrangement	X	-		-	-	-	
	8	Shipping List	-	-		-	X	-	
	9	Trouble shooting diagram	-	X		I	X	X	
	10	Lifting, Loading, Unloading & Transportation Procedures Handling and Transport Protective Measures at Site	-	X		I	X	X	
	11	Preservation procedures [Long term storage procedure/ Preparation for storage at job site before installation/ Weather protection at job site]	-	X		I	X	X	

#### Notes:



- H= Hard Copy, S=Soft Copy
- R=Issued for Review/Comment, I=Issued for Information

### 13 LIST OF REFERENC DOCUMENTS (ATTACHED TO THIS MR)



No.	Doc. Title	Doc. Number
1	HVAC DESIGN CRITERIA	LRP-TNA-HV-99-SPC-0001

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No.	Doc. Title	Doc. Number
2	HVAC & PLUMBING DESIGN SPECIFICATION	LRP-TNA-HV-99-SPC-0002
3	HVAC EQUIPMENT SPECIFICATION	LRP-TNA-HV-99-SPC-0003
4	STANDARD DRAWING FOR HVAC & PLUMBING SYSTEM	LRP-TNA-HV-99-STD-0001
5	SYMBOL & ABBREVIATION FOR HVAC & PLUMBING SYSTEM	LRP-TNA-HV-99-STD-0002
6	SUBSTATION NO.05 HVAC CALCULATION	LRP-TNA-HV-19-CAL-0001
7	SUBSTATION NO.05 HVAC EQUIPMENT DATA SHEETS	LRP-TNA-HV-19-DSH-0001
8	SUBSTATION NO.05 HVAC ROOF PLAN	LRP-TNA-HV-19-DWG-0001
9	SUBSTATION NO.05 HVAC DUCTING PLAN AND SECTION	LRP-TNA-HV-19-DWG-0002
10	SUBSTATION NO.05 PLUMBING PLAN & ISOMETRIC	LRP-TNA-HV-19-DWG-0003
11	SUBSTATION NO.05 HVAC MATERIAL TAKE OFF	LRP-TNA-HV-19-MTO-0001
12	SUBSTATION NO.05 HVAC P&ID	LRP-TNA-HV-19-PID-0001
13	SUBSTATION NO.05 HVAC EQUIPMENT SCHEDULE	LRP-TNA-HV-19-LIS-0001
14	PROCESS CONTROL BUILDING NO.03 HVAC CALCULATION	LRP-TNA-HV-19-CAL-0002
15	PROCESS CONTROL BUILDING NO.03 HVAC EQUIPMENT DATA SHEETS	LRP-TNA-HV-19-DSH-0002
16	PROCESS CONTROL BUILDING NO.03 HVAC ROOF PLAN	LRP-TNA-HV-19-DWG-0004
17	PROCESS CONTROL BUILDING NO.03 HVAC DUCTING PLAN AND SECTION	LRP-TNA-HV-19-DWG-0005
18	PROCESS CONTROL BUILDING NO.03 PLUMBING PLAN & ISOMETRIC	LRP-TNA-HV-19-DWG-0006
19	PROCESS CONTROL BUILDING NO.03 HVAC MATERIAL TAKE OFF	LRP-TNA-HV-19-MTO-0002
20	PROCESS CONTROL BUILDING NO.03 HVAC P&ID	LRP-TNA-HV-19-PID-0002
21	PROCESS CONTROL BUILDING NO.03 HVAC EQUIPMENT SCHEDULE	LRP-TNA-HV-19-LIS-0002
22	FIRE STATION NO.2 HVAC CALCULATION	LRP-TNA-HV-15-CAL-0001



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No.	Doc. Title	Doc. Number
23	FIRE STATION NO.2 HVAC EQUIPMENT DATA SHEETS	LRP-TNA-HV-15-DSH-0001
24	FIRE STATION NO.2 HVAC ROOF PLAN	LRP-TNA-HV-15-DWG-0001
25	FIRE STATION NO.2 HVAC DUCTING PLAN AND SECTION	LRP-TNA-HV-15-DWG-0002
26	FIRE STATION NO.2 PLUMBING PLAN & ISOMETRIC	LRP-TNA-HV-15-DWG-0003
27	FIRE STATION NO.2 HVAC MATERIAL TAKE OFF	LRP-TNA-HV-15-MTO-0001
28	FIRE STATION NO.2 HVAC P&ID	LRP-TNA-HV-15-PID-0001
29	FIRE STATION NO.2 HVAC EQUIPMENT SCHEDULE	LRP-TNA-HV-15-LIS-0001
30	ALL BUILDING ARCHITECTURAL DRAWINGS	-
<b>*Note:</b> The last version and approved issue of all documents shall be considered by vendor.		

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## APPENDIX A1



### Equipment Specification

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• **SPECIFICATION NOTES**

- a) This equipment specification is for design, manufacture, testing, inspection and supply of all listed equipment, consisting or not limited the items and quantities listed within, complete with ancillary equipment and in full accordance with listed attachments.
- b) The supplier is responsible for ensuring that all listed equipment are suitable for the application and fit for the purpose for which they are intended, according to approved vendor list.
- c) Supplier must conform to all international codes and standards applicable in manufacturing the listed equipment.
- d) Supplier is responsible for and gives approval of satisfactory performance of listed equipment.
- e) Supplier is responsible to meet all capacities specified in data sheets for each listed equipment.
- f) After order placement, any amendment required conforming to specification and data sheet shall be at supplier's expense and responsibility.
- g) In the event of any problem being experienced with complete operating units once installed, it is supplier responsibility to identify the source and its resolution.
- h) The supplier must note the outdoor design condition listed in data sheets and design criteria.
- i) The supplier to provide HVAC control logic diagram, HVAC control signal layout, HVAC instrument schedule and electric power supply drawings.
- j) The supplier shall provide the following documents with his bid:
  - Vendor shall sign the letter of conformity and include in the quotation, listing any deviation to the requisition and its attachments, or confirm.
  - Dimensional outline drawings & footprints
  - Foundation load diagram
  - Installation recommendation
  - Data sheets and performance data/certificates
  - Technical specifications & related catalogues



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k) The following shall be included in the scope of vendor's supply:

- Packaged units
- Air handling units
- Condensing units
- Fan filter units
- Exhaust fans
- Electrical water heaters , Duct heaters
- Damper and louver and blast damper
- Spare parts for installation, commissioning & start up
- Spare parts for two years operation
- Special tools (if any)
- Initial charge for lubricant and refrigerant
- Anchor bolts & nuts, shim plates
- Required piping and accessories for split type equipment
- All HVAC control devices based on P&ID drawings same as motorized damper ,differential pressure switch for package filter, differential pressure switch for packaged evaporator fan, cooling and heating controller command, humidity controller, return air temperature and etc.

## 1 AIR HANDLING UNIT (AHU)

Air handling unit is self-contained and consisting following sections.

- a) Fan section. (Fan section inside panel shall be corrugated)
- b) Hydronic Cooling Coil
- c) Hydronic Heating Coil



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- d) Casing / Structure
- e) Electrical and Control Panel
- f) Electric Heating Coil (if any)
- g) Electrical Steam Humidifier
- h) Mixing Box/Filters (includes all washable, pleated and bag filter) according to data sheet.

## 2 PACKAGED UNIT

A packaged unit is self-contained and consisting of following sections.

- a) Compressors
- b) Condenser Coil
- c) Condenser Fan
- d) Casing / Structure
- e) Refrigerant Charge
- f) Refrigerant Piping
- g) Electrical and Control Panel
- h) Mixing Box/Filters (includes all washable, pleated and bag filter) according to data sheet.
- i) DX-cooling coil with droplet eliminator
- j) Supply Fan (fan section inside panel shall be corrugated.)
- k) Electric Heating Coil (if any)
- l) Electrical Steam Type Humidifier (if any)
- m) All HVAC Control Devices in Relation to HVAC System.
- n) Sound level shall be lower 80 DB @ one meter distance.

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#### ***D) Compressor***



Compressor shall be of semi-hermetic screw or semi-hermetic reciprocating type according to datasheet,

#### ***For screw compressor:***

- The compressor(s) shall be (accessible) semi-hermetic, refrigerant cooled, operating on 400V-3 $\phi$ -50Hz.
- The compressor(s) shall be equipped with an oil heater, oil charge, oil separator, oil filter, discharge gas temperature sensor, start unloading, capacity regulation – 4 step, capacity regulation – infinite, discharge and built in check valve, electronic protection device.
- The compressor(s) shall be fitted with an oil-sight glass through which the quantity and the condition of the oil in the crankcase can be observed.
- For operating with R134a polyol-ester oil shall be consumed.
- The oil heater shall be used during standstill in case of outdoor comp. installation, long shut-off periods, high refrigerant charge, and danger of refrigerant condensation into the comp.
- For the selection of contactor, cables and fuses the max. operating current shall be considered
- Liquid injection shall be considered for compressor.
- Hot gas bypass shall be considered.

#### ***For reciprocating compressor:***



- The compressor(s) shall be (accessible) semi-hermetic, refrigerant cooled, operating on 400V-3 $\phi$ -50Hz.
- The compressor(s) shall be equipped with an oil screen, an oil charge, discharge and suction shut-off valves with pressure gauge connections, a suction gas strainer.
- The compressor(s) shall be fitted with an oil-sight glass through which the quantity and the condition of the oil in the crankcase can be observed.

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- Forced fed lubrication shall be performed by an oil pump with a suitable port for checking the oil pressure with facilities for connecting a mechanical differential oil pressure switch.
- All compressors shall be equipped with a pre-set internal pressure relief valve between the suction and the discharge chambers which will open if the permissible differential pressure is exceeded [set point approx. 30 bar $\pm$ 3bar(450 psig $\pm$ 45psig), fully open approx. 33bar(495psig)]
- All compressors shall be fitted with standard crankcase heater sized appropriately (power-KW) to prevent the migration of refrigerant into the compressor during the OFF cycles
- An oil balance (copper) tube shall be installed between the crank cases of 2 compressors sharing the same suction line. The balance line shall be fitted with sight glass and copper vibration absorber.

#### ***a)Condenser Coil***

- The coil frame shall be constructed of minimum 2.0mm galvanized steel sheet.
- The tube sheet shall have die-formed-drawn collars to support the tubes.
- An intermediate coil support shall be provided on coils with a finned length of more than 1m
- Standard material for fins is copper.
- Copper plate fins shall be fabricated copper (Cu 99.98%) strip alloy ASTM B152 equivalent to DIN 1787, temper condition (O) soft anneal.
- Plate fins shall have full collars to allow for expansion and contraction of the fins.
- Maximum fin spacing shall be 10 FPI for fin corrugated plate type.
- Standard tubes shall be seamless drawn copper tubes Alloy ASTM C12200 (Cu=99.9%) DHP according to ASTM B-68, condition light anneals (O50). Tolerances for diameter and wall thickness according to ASTM B-251. Grade SF-Cu according to DIN 1787, type ISO Cu-DHP.

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- All return bends shall be brazed to tube ends with filler rods conforming to ANSI/AWS A 5.8-92 Standard-Classification BCUP-6 equivalent to DIN 8513 Part 2-Classification L-Ag 2 P and brazing procedures according to IN-DN-020 (Internal Document).
- Tubes shall be mandrel expanded to form fin bond.
- Bly-Gold or equal approved alternative anti-corrosion coating for coil protection

#### ***b)Condenser Fans (for packaged / condensing units)***

Condenser fans shall be of propeller type aluminum alloy blades, recessed below top of unit and one externally driven electrical motor. Motor are fitted with thermal protection device of the self-resetting type, to protect the motor from dangerous overheating. The motors are factory wired, using special silicon wires for high ambient operation. Condenser fans are individually statically and dynamically balanced at the factory. Complete fan assembly is provided with suitable acrylic coated fan guard made from heavy gauge galvanized wire. Class "F" insulation and class "B" temperature rise with IP55 shall be considered.



#### ***c)Casing / Structure***

The casing shall be constructed of hot dipped galvanized steel sheet panels (for both AHU & packaged units), painted with epoxy primes and polyurethane top coat, the density and thermal conductivity of thermal insulation is 50mm polyurethane foam or board factory assembled on a rugged steel channel base. The entire assembly shall be supplied with lifting holes to ease rigging for installation. Access panels are to be provided for easy service and maintenance on all different compartments.

The painting of casing shall consider the environment atmosphere conditions and direct sun exposure of 85°C, with maximum relative humidity of 95%.

Unit must be supplied with proper sized anchor-bolt and vibration isolators to be mounted on 200mm reinforced concrete pad and earthling clamp on the structure.

External and internal painting specification shall be as follow:

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- Primary zinc rich epoxy coating thickness: 70 microns
- Intermediate MIO epoxy high builds coating thickness: 100 microns
- Final aliphatic polyurethane coating thickness: 70 microns
- Total thickness (External) 240 microns
- Internal coating thickness shall be min. 100 microns

For AHUs casing shall be double skin with insulation by minimum internal panel sheet thickness of 1mm and external panel sheet thickness of 1.5mm.

Fan filter units are single skin and the thickness of panels shall be minimum 2mm.

### 3 FAN FILTER UNIT:

Fan filter units shall be equipped with:

- Sand Trap Louver Damper
- Washable 5 Layer Aluminum Filter
- Centrifugal Fan

The specification of above equipment shall be according to this document in related section.



### 4 REFRIGERANT CHARGE (FOR PACKAGED/CONDENSING UNITS)

The packaged unit shall come with a holding charge of R-134a refrigerant from the factory.

For cooling capacity lower than 10Kw refrigerant R22 is acceptable.

### 5 REFRIGERANT PIPING (FOR PACKAGED/CONDENSING UNITS)

The packaged units shall be fabricated with all internal piping of copper ASTM B288 type ACR/L between compressor condenser and evaporator. Unit shall be supplied with factory correctly sized thermostatic expansion valve, liquid line solenoid valve, liquid line sight glass, filter drier and shut-off valves, moisture indicator, gauge ports on suction and discharge compressor, high pressure gauge

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low pressure gauge and oil pressure gauge for reciprocating compressors And proper size suction line accumulator including liquid heat exchanger.

## 6 ELECTRICAL / CONTROL PANEL

HVAC/PLC control system with auto-change over from operating to stand by package unit shall be provided. Packaged unit shall be supplied with unit-mounted IP-55 electrical/ control panel enclosure designed for automatic operation and insuring safety, efficiency, sequence control for the fans. All wiring is sized as per applicable electrical code. The control panel is factory wired for 230 Volt, 1ph-50 Hz control power supply

Power supply, communication module and CPU shall be redundant.



Electrical power for HVAC control panel shall be considered from HVAC power panel emergency feeder (230VAC).

HVAC power panel feed from diesel generator.

Battery backup for control panel shall be supplied by vendor of HVAC.



An additional built-in 24 volts fused low voltage transformer, for case of connection to cooling thermostat. Packaged unit control panel shall have 20% spare space. The panel shall be fabricated at followings:

- Individual compressor and condenser fan motor contractors.
- Fuses for condenser fans.
- Individual condenser fan over current protection
- Low pressure safety switch
- anti-freeze protection
- High pressure safety switch
- Electrical Control panel shall be equipped with anti-condensate heater.
- Electrical Control panel shall be equipped with separate cooling system.

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- Oil failure switch for each reciprocating compressor
- Motor/compressor protection shall be provided to command the operation via compressor individual contactor.
- Head pressure control by fan cycling for low ambient operation.
- Suction pressure gauge.
- Panel shall be supplied with built-in internal electric heater to provide heating when the panel is out of service to provide rust protection due to high level of humidity.
- Panel shall be equipped with internal lighting when the panel door is wide open.
- Hardware is facilities required to data/command communication with F&G system control panels.
- Power supply, communication module and CPU shall be redundant.
- Electrical power for HVAC control panel shall be considered from HVAC power panel emergency feeder (230VAC) ,
- Backup battery should be considered for each HVAC control panel.
- All displays, lights (on, off, fault), push buttons and other operator interface which shall be needed, shall be mounted on the HVAC power-control cabinet.
- At least the running status and common fault should be transferred to the F&G via hard-wired I/O.
- The control system shall comprise locally mounted field instruments, which shall be connected to HVAC power- control cabinet.
- Controls and actuators including modulating valves and motorized dampers shall be electrically actuated.
- The HVAC control system shall be interlocked with the main fire protection system in accordance with the "Fire and Gas Cause and Effect for buildings.
- In buildings with split unit air conditioning system related power- control cabinet shall be capable for interconnecting with F&G system.



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- Pressure differential switches shall be provided in each pressurized system area to monitor the minimum positive pressure with respect to atmosphere.

## 7 MIXING BOX / FILTER SECTION

Mixing box is equipped with two aluminium opposed blade dampers for fresh and return air. Dampers shall be motorized controlled. Washable aluminium filters with 85% efficiency class 5cm thick with 7-V type net layers. Pleated with 60% efficiency and Bag filters section with 93% efficiency based on, ASHRAE 52-52.1 standard. Maximum face velocity of 500 fpm (2.54 m/sec) mounted in designated frame with filter clamp. Removable panels shall be provided on each for filter access.



The recommended static pressure drop of 250 Pa on bag filters when total static pressure of supply fan is determined.

On fresh air intake, section of mixing box a sand trap louver must be supplied with vertical slots to separate dust & sand from air stream in addition to insect wire mesh screen and sand discharge opening at the base of louver.

A differential pressure switch (manahelic gauge) must be supplied and set for alarm across the filter section and will operate the standby package unit.

## 8 COOLING AND DEHUMIDIFICATION DX/HYDRONIC-COILS

Provided cooling coil of scheduled capacity, mounted in unit in manner permitting removal. Direct expansion/hydrionic coil are constructed from seamless copper tubes and copper fins. Copper tubes are mechanically expanded into continuous copper fins. Direct expansion coils are equipped with properly sized distributor to ensure equal refrigerant feed to all circuits and hydrionic coils are equipped with proper size coil header for water inlet and outlet. The number of circuit is chosen to provide optimum heat transfer and reasonable refrigerant velocity and pressure drops so as not to trap any oil in the coil tubing for DX coils. Headers are made out of seamless copper pipe. All coils shall be designed to meet AHRI-410 standard and tested in accordance to ASHRAE standard 15 (safety code for refrigeration) coil section is provided with insulated drain pan with drain connection in order to hold and remove condensate formed during dehumidification.

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Drain pan is made of stainless steel 316L the pan itself must be insulated to prevent condensation from pan. In packaged or condensing units coil refrigerant piping and drain connections can be made on either side of unit as required refer to equipment arrangement drawing. Inlet and outlet connections are sealed against unit body by means of flexible closed cell gasket.

Coils are assembled in slide-in guides for easy removal for maintenance and replacement. Refer to data sheets and HVAC equipment arrangement drawings for capacities and proper coil pipe connection side.

Selected vendor must supply a computer generated coil selection with complete psychometrics.



Coil sections must be equipped with droplet eliminator made of removable Stainless steel 316L.

For variable flow air handling units the cooling coil shall be designed to adjust its performance during different air volumes to prevent coil freezing or the refrigeration cycle malfunction.

## 9 FAN

Fans are standard forward or backward curved blades or plug fan in other special cases as an alternative according to datasheet; all fans are belt-driven with belt guard. All fan wheel and shaft assemblies shall be statically and dynamically balanced. Fans are selected for best sound characteristics based on maximum efficiency in accordance to AMCA standard 210. Shaft to be of solid steel type stainless steel 316L with conformable and traceable mill or test certificate. All ball bearings are of self-aligning type, which greased for life. The complete fan and motor drive assembly is mounted on sub-base, in order to limit transmission of noise and vibration. The sub-base assembly is mounted on anti-vibration mounts.

Flexible connection shall be provided between fan discharge and casing to avoid transmission of noise and vibration to the connecting duct. A standard access door is to be provided on both sides of casing for servicing and maintenance of internal mounted motors. Each supply Fan of packaged unit shall be equipped by one airflow switch.

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Final alignment and belt adjustment shall be made after installation. Refer to data sheets and HVAC drawings for orientation of discharge and fan capacities. Class "F" insulation and class "B" temperature rise with IP55 shall be considered.

Fan also may be direct drive, as specified in the data sheet, and shall be factory assembled and aligned. An OSHA approved belt guards shall also be supplied by the Vendor.

Fan bearings shall be plumber block type.

Selected vendor shall specify following data:



- Design air flow and total static pressure
- Type of selected fans
- RPM of Fan& Motor : Max.1450 rpm
- Sound level (max. 85 dB @ 1 meter distance)
- Fan performance curve
- Physical data & origin
- Fan efficiency
- Motor protection class
- Test report from reputable laboratory containing the statically/dynamically balance test with accordance to applicable international code, regulation and certificate.
- The material and thickness of applied coating.

## 10 ELECTRIC HEATING COIL /DUCT HEATER

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

Electric heating coil/duct heater shall be provided with terminal box and as minimum the following rewired electrical control/safety components:

- Suitable disconnecting switch,

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

The heating element will be selected in order to limit terminal air reheat temperature below 10°C for each element.

Electric heating coil/duct heater shall be designed for 10% over capacity and according to speed of the airflow.

Electric heating coil/duct heater shall be suitable for installation within low velocity (i.e. less than 4 m/s). Air pressure drop shall not exceed 60 pas at the nominal flow rate.



Electric parts of electric heating coil/duct heater shall be at least IP55 for outdoor equipment, except for motors junction boxes that should be at least IP41 for indoor.

Heating coil/duct heater with more than 4 Kw heating capacity shall be rewired for thyristor control. For capacities, less than 4Kw, a step controller or a 3-Stage thermostat shall be used.

## 11 ELECTRIC STEAM HUMIDIFIER

An electric steam humidifier shall be supplied built-in with roof top packaged unit and be consisted of stainless-steel casing with at least two heating elements, to avoid super heating, heating elements shall be fully immersed during operation. Humidifier must have water blow down to minimize solids build up, also shall have earthing connection along with on/off switch, low water switch, high temperature cut-off, float and drain, air flow switch and high limited humidistat. A duct-mounted humidistat as indicated on drawing shall also be supplied.

All humidifiers shall be an immersed-electrode steam humidifier simply made up of a support system including comprehensive set of accessories such as steam distributors and hoses, dual-check fill valve, drain solenoid valve, connections and hoses, a disposable steam cylinder and some auxiliary

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components controlled by the dedicated controller and/or an external controller. No contactor, transformer, fuses are included. The humidifier shall evaporate water into steam in one or more disposable steam cylinders by heat that is provided by grid type electrodes. The operation of the humidifier shall be fully automatic and shall provide the following operations: Firstly monitor the conductivity of the water in the cylinder and secondly, maintain the desired conductivity rate by draining water with high content of dissolved solids. Finally control the steam generation by the room humidistat.

### COMPONENTS:

Each immersed-electrode steam humidifier shall be made up of the following components:

- Cylinder
- Plastic support with cylinder fastening strap
- Fill and drain valve/pump
- Conductivity meter
- Hoses
- Control card for proportional or ON/OFF external demand.
- Earth connection along with on/off switch
- Low water switch
- High temperature cut-off
- Float and drain.
- Air flow switch
- High limited humidistat
- Stainless steel/PVC casing

The frame of the humidifiers shall be of compact, open able, hot galvanized metal complete with handle and screw closing. The frame includes a case for housing the control board. The control board shall be microprocessor based, complete with software for immersed electrode humidifiers. The fill

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solenoid valve with 3/4" male connector shall be located on the frame, and shall be accessible for cleaning the filter on the solenoid valve when the unit is installed. Drain assembly shall be made up of a manifold and drain solenoid valve with 90° connector and min 32 mm diameters fitting, with the possibility to replace the drain with a straight pipe, supplied. Water circuit shall be consist of supply tank plus conductivity meter and cylinder fill, drain and overflow hoses, shall be made of polypropylene reinforced with fiberglass, cylinder secured by convenient strap closing system. The humidifier shall be fitted with a switch from turning the unit on/off and a button for the manual drain function.

The power cable shall be minimum 3 meters long, flame retardant and supplied with a rubber cable gland. One end has special cable terminals for connection to the cylinder, and the other end is free. Current transformer shall be fitted on the control board, and monitors one of the phases of the power supply to measure the current. The operation of the humidifier shall be displayed using a panel fitted with collared LEDs, with the following meanings:

The events shall be indicated by sequences of flashes.

#### **SAFETY:**

The potable water connection shall provide remote status of the steam humidifier complete with safety alarms.

All humidifiers shall be completed with self-cleaning system.



Humidifier shall have water blow down to minimize solids build up.

To avoid super heating, heating elements shall be fully immersed during operation.

A shut-off tap and a mechanical filter shall be installed to trap any solid impurities.

The drain water shall be connected using a section of rubber or plastic hose resistant to 100°C.

The drain connector shall be suitable for heat sealing with polypropylene drainpipes.

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## 12 COMPRESSOR

- Locate compressors in separate compartment so that they may be serviced during operation of equipment. Piping shall be type 1 copper.
- provide semi-hermetically sealed compressors with suction gas-cooled motor, rota lock service valves, vibration isolators, thermal overloads, oil sight glass, manual reset high pressure switch, pump down low pressure switch, suction line strainer, reversible oil pumps for forced feed lubrication and a maximum operating speed at 1,750 rpm. Hermetic compressors will be allowed for units 5 ton and smaller.
- Capacity control: four step compressor unloader, two steps per compressor.
- Provide compressor lock-out upon loss of flow.

## 13 CONDENSER



- Provide air cooled condenser for each circuit braced.
- Provide ASME stamped condensers for maximum refrigerant pressure of 400 psi at 95 degrees c.

## 14 ELECTRIC REHEATS (IF APPLICABLE)

Provide electric reheat coils, fin tubular type, with capacity and stages as scheduled on drawings. Provide unlisted safety lockout switches on reheat section to protect system from overheating.

## 15 HUMIDIFIER

Provide humidifier of infrared type consisting of high intensity quartz lamps mounted above and out of water supply. Evaporator pan shall be stainless steel and arranged to be serviceable without disconnecting water supply lines, drain lines, or electrical connections. Pre-pipe complete humidifier section, ready for final connection. Primary water supply from humidifier is condensate water from

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cooling coil, complete with programmable humidifier flush cycle. Provide capacity as scheduled on drawings.

## 16 FILTERS

- Media: pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded wire grid; enclosed in cardboard frame; 4-inch nominal thickness. Filters shall be serviceable from front or right side of unit.
- rating: ashrae 52; 45 percent dust spot efficiency, 90 to 92 percent weight arrestance; 500 feet per minute face velocity, 0.30-inch wg initial resistance. 1-inch wg recommended final resistance.
- Provide differential pressure switch to indicate filter status.
- Filters shall be removable from either end of unit by personnel standing on floor. filters located in 36-inch-high return air plenum will not be acceptable.



## 17 HEAT DETECTION ALARM

- Factory installed and wired heat sensor shall sense heat in return air. Upon detecting excessive heat, air conditioner shall automatically turn off and activate audible alarm on microprocessor indicator panel.
- Provide fire stat mounted in electrical panel with sensing element in return air.

## 18 SMOKE DETECTOR

- Smoke detector in return is factory installed and field installed in supply duct as provided by fire protection.
- Provide smoke detectors mounted in electrical panel with sensing elements in return air and in supply air duct.
- Smoke detectors shall shut down and alarm upon smoke detection.





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## 19 DISCONNECT SWITCH

- Provide non-locking type factory mounted and wired disconnect switch.

## 20 CONTROL SYSTEM



- Provide advanced microprocessor control system. As a minimum, display the following functions on an integral display panel.
  - High/low temperature set point.
  - Temperature sensitivity.
  - High/low humidity set point.
  - Humidity sensitivity.
  - Normal operating modes (heating, cooling, humidification, dehumidification).
  - Temperature anticipation.
- Monitor unit operation and activate and audible and visual alarm on the control panel in the event of the following factory present alarm conditions:
  - High temperature.
  - Low temperature.
  - High humidity.
  - Low humidity.
  - Changer filters.
  - Loss of air flow.
  - Humidifier problem.
  - High head.
  - Low suction pressure.
  - Loss of power.

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- Main fan overload.
- Smoke detected.
- Manual override.
- Short cycle.
- Failure of condensate pump.
- Provide following advanced microprocessor controls.
  - Temperature control with set point/sensitivity adjustment and anticipation.
  - Humidity control with set point/sensitivity adjustment and predictive humidity control.
  - Compressor short cycle control.
  - Automatic compressor sequencing.
  - Sequential load activation.
  - System diagnostics.
  - Shut down each unit, when a factory mounted, pre-wired firestat with sensing elements in return air temperature, exceeds a set point of 60 degrees c or when factory mounted smoke detector senses smoke.

## 21 UNIT HEATER



- The equipment materials shall be suitable for installation and operation within climate and environment condition specified in “HVAC Design Criteria”.
- Basic Unit Construction shall be heavy gage galvanized steel, welded and rigidly reinforced. Panels shall be acoustically and thermally insulated with aluminum covered polyurethane insulation.
- Provision for hanging the unit shall be provided by slots in the top wrap of the basic housing. Units shall be furnished with a removable bottom panel for access to motor blower assembly.

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- The motor blower assembly shall be designed for easy removal from the basic unit to provide easy servicing of these components. Removal of this assembly shall also provide access to the entering air face of the coil which will accumulate any dirt passing through the filter.
- Heating coils shall be copper tubes with mechanically bonded aluminum plate fins. All coils are to be factory leak tested at 350 psig and suitable for working pressure to 250 psig. Outlet and inlet connection to be furnished with manual air vent and drain.
- Motors are to be of the split capacitor type provided with three speed tapped windings. Sleeve bearings shall be self-aligning with wide permanent lubrication. Motors shall be for operation on 230V single phase 50cycle current with thermal protector.
- The fan assembly shall be consisted of one, two or four direct drive motor blower assemblies. Blower wheels shall be statically and dynamically balanced. Fans shall be centrifugal, forwardly curved double width type, constructed of plastic material. Fan scrolls shall also be of molded reinforced plastic for maximum corrosion resistance.
- Switches shall be Remote three speeds on and off.
- Systems shall be tested for proper air flow, etc. and reports shall be submitted to the Contractor for approval and acceptance of the systems. Contractor may choose to witness the test.

## 22 STEAM HEATING COIL

- Coils are constructed from Seamless Drawn Copper Tube to BS2871 mechanically expanded into aluminum fins with die formed self-spacing collars.
- Tubular copper headers are silver brazed into the tube ends. Flow and return connections are BSP(M).
- The coil casing is formed from heavy gauge galvanized sheet steel to BS 2989 to make a rigid assembly.
- Tube end plates have die formed collared holes to allow expansion and contraction of the tubes without damage.

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- All coils are pressure tested to 16 bar with dry compressed air under water.

## 23 EXHAUST FAN

### A) ROOF POWER VENTILATOR

A typical belt-driven centrifugal roof exhauster consists of the following section and related specification:

#### Roof Mounted Exhaust Units

The fans used in roof exhaust units shall meet the requirements of centrifugal Flow or Propeller Fans.

The cowls and bases shall be of materials which are resistant to the external environment and solar radiation appropriate to the location of the fans.

Casings shall be complete with integral weatherproofing provisions suitable for direct fixing to the building structure.



Adequate access to electrical supply terminals and lubrication points shall be provided by means of hinged cowls or other means as appropriate. Back draft dampers shall be included. Bird wire guards shall be provided as an integral part of the unit. Unless otherwise stated, selection of fans to be such that the operating point on the performance curves allows a minimum of 15% increases in duty. The motor is to be sized accordingly.

#### Testing and Commissioning

The supplier shall provide to the Contractor copy of the type certificate, certificate of conformity for these HVAC packages.

### B) CENTRIFUGAL FANS:

Each centrifugal fan shall be SWSI or DWDI as required, furnished completely assembled and fitted with electric motor, V-belt drive, belt guard, inlet guard, flexible connections and vibration isolating base.

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Fans shall be sized regarding to the performance requirements specified and shall be rated and certified in accordance with B.S. 848 Part 1; 1980. The vendor shall guarantee the fans performance will not be impaired when housed within the fan chamber of the air handling unit

#### **Efficiency:**

The Centrifugal Fans shall be suitable for continuous operation at the design duty selected, with an efficiency of at least 75%.

#### **Fan Discharge Velocity:**

Fan discharge velocity shall not exceed 10 m/s.

#### **Margin Factor:**

Fans shall be selected to give a margin for adjustment of +10% performances without reaching critical shaft or impeller speeds. Fan motor shall be selected for maximum power plus 20 % spare capacity.

#### **Vibration Isolators:**

The fan and motor shall be mounted on a common frame structural steel main chassis and shall be isolated from the casing with spring type vibration isolators with at least 95% attenuation. The fan anti-vibration mounting shall be supplied bolted to the support frame.



#### **Fan and Motor rpm:**

The motor shall operate at optimum rpm suitable for 400 volts, 3 phases or 230 volts, 1 phase and 50-cycle operation. Fan speed shall not exceed 1500rpm.

#### **Fan Impellers:**

For pressure drop up to 2.5 In.w.g impeller should be forward curved and for above this impeller shall be backward curved or airfoil blades if need . Any variation from this shall be agreed with contractor before manufacture and supply.

#### **Fan Blades:**

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Blades shall be of the non-overloading double thickness with non-overloading power characteristic. The blades shall be staggered on each side of the centre plate. The wheel shall be keyed to the stainless-steel shaft and the key secured with setscrew.

#### **Fan Shaft:**

The fan shaft shall be stainless steel grade 316L. The fan shaft shall be accurately turned ground polished and ring gauged for accuracy.

#### **Fan Bearings:**

Fan bearings shall be designed to give operation of 40,000 hours continuously rated. The fan bearings shall be split pillow block; grease lubricated spherical roller bearing type. Bearing shall be self-aligning grease lubricated double roll ball enclosed within two piece housing and supported on a pedestal either side of fan via a tubular arm assembly.

#### **Fan Housing:**

Fan housing shall be provided with an access door, bulkhead light, drain plug located at the bottom of the casing, and flanged inlet and outlet connections and an easily removable inlet cone. Centrifugal fans mounted in air handling unit enclosures will not have flanges on the inlet to the fan assembly. The access door shall be provided on a vertical panel of the fan section and shall be airtight. The fan section shall have bulkhead light fitting and 200 mm diameter double wall viewport. Light fitting wired to an external on/off switch mounted on unit.



#### **Fan Pulley:**

The fan pulleys shall be keyed and taper locked to the drive shaft.

#### **Fan Belts:**

The fan motors shall be mounted outside the housing on the skid base with the fans being driven by a multi-belt drive with not less than 2 belts on the drive. Fan(s) shall be belt driven with No. of belts=N+1. (N=No. of belts required). Belt tensioning and motor alignment facilities shall be provided.

Provision shall be provided for fan and motor speed checks via 50mm access holes, also a slot shall be provided so that belt tension checks can be made without the removal of fan belt drive guard.

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The fan motor shall be provided with an adjustable slide to accommodate belt adjustment.

#### **Motor Protection:**

The protection class shall be IP55.

#### **Hazardous Environment:**

Anti-spark and anti-static features should be provided on fans operating in an emergency, for smoke removal and/or to operate in a hazardous environment.

The supplier shall ensure the terminations have been completed and tested at his works, and the enclosures are securely fixed to the skid. These tests shall include the following:

- Insulation resistance tests shall be conducted prior to and after executing high voltage tests. Insulation resistance shall be measured by applying a D.C. test voltage from a “Meggar” insulation meter or equal and approved.

All terminal and junction boxes externally mounted shall be designed to shed rainwater and prevent the accumulation of standing water on any part of the enclosure.

#### **Materials of Construction**

The Contractor shall use the materials specified in referenced specifications and, where not specified, in selecting materials and designing the centrifugal fans the Contractor shall give special consideration to the operating and environmental conditions specified.

#### **Base Frame and Housing:**



the entire Base frame and housing shall be constructed from continuously welded mild steel plate with a minimum thickness of 2mm; the casing shall be hot dipped galvanised after manufacturing.

### **C)IN – LINE EXHAUST FAN**

#### **General Requirement**

##### **Efficiency:**

The mixed flow and axial flow fan shall be suitable for continuous operation at the design duty selected, with an efficiency of at least 75%.

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Fan Discharge Velocity: Fan air discharge velocity shall be a maximum of 10 m/s.

#### **Margin Factor:**

Fans shall be selected to give a margin for adjustment of +10% performances without reaching critical shaft or impeller speeds.

#### **Fan Impellers:**

Impellers for mixed flow fans shall be of non-overloading, non-stall characteristics with airflow at right angles to the direction of rotation. The fan shaft and impeller assembly to be statically and dynamically balanced to BS 686 Part I or equivalent standard subject to Contractor approval.

#### **Fan Belts:**

Mixed flow fans shall be driven by multi belt drive with not less than 2 belts on the drive, in line, cylindrical casing type with motor mounted external to air stream and suitable for either horizontal or vertical mounting.

#### **Axial Duct Fans:**

Axial flow fans shall be long casing complete with access panel for inspection/maintenance.

#### **Hazardous Environment:**

Anti-spark and anti-static features shall be provided on fans operating in an emergency, for smoke removal and/or to operate in a hazardous environment.

The Contractor shall ensure the terminations have been completed and tested at his works, and the enclosures are securely fixed to the skid. These tests shall include the following.



Insulation resistance tests shall be conducted prior to and after executing high voltage tests. Insulation resistance shall be measured by applying a DC test voltage from a “Meggar” insulation meter or equal, and approved.

All terminal and junction boxes externally mounted shall be designed to shed rain water and prevent the accumulation of standing water on any part of the enclosure.

Impellers shall be of steel, aluminum or plastic and shall secure to the hub.

Materials of Construction for Mixed Flow Fans.



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### Casing:

Casing shall be constructed from fully welded rolled tubular mild steel to BS EN 10130 with integral flanges rolled at each end for connection to the ductwork.

Fan casings shall be hot dipped galvanized after manufacture to BS EN ISO 1461.

### Access Doors:

Access doors shall only be provided on fans greater than 400 mm diameter, these should be air tight and of bolted construction.

### Impeller:

The impeller shall be constructed from mild steel to BS EN 10130 and painted to the Suppliers standard for H2S applications.

### Drive Guards:

Drive guards to be manufactured from galvanized mild steel complete with brass anti-spark track and removable inspection covers.

### Flexible Connections:

Flexible connections shall be complete with mating flanges to fans and ductwork. The minimum length of flexible connections shall be 200 mm.



### Vibration Isolators:

Anti-vibration mountings shall be totally enclosed and provide a minimum of 95% vibration isolation.

### Fan Frame:

The fan assemblies shall include an integral support frame. This frame shall be suitable for lifting and transportation without any permanent deflection. Lifting lugs or eyes shall be provided within the structural support frame.

An M10 earth boss shall be welded to the frame, complete with stud, nuts and a shake-proof washer.

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Brass rubbings strips shall be provided for fans 600 mm and above; smaller fan sizes shall have brass fairings.

Lubrication points shall be provided external to the fan assembly.



Belt tensioning and motor alignment features shall be provided.

Provision shall be made on the outside of the fan casing to monitor the fan bearings using a hand held shock pulse meter. Fans sizes up to 400 mm shall be fitted with tuned rods. Fans greater than or equal to 500 mm shall have flame proof transducers fitted to each bearing block with terminations on the fan casing.

#### **D)WALL MOUNTED AXIAL EXHAUST FAN**

A typical wall mounted axial exhaust fan shall consist of the following sections and related specification.

- For sizing and configuration, refer to data sheets and HVAC drawings.
- Fan wheels shall be statically and dynamically balanced. Should fan motor or fan bearing have appreciable noise or vibration, fan wheel, motor, bearings or all of them shall be replaced.
- Fan bearings shall be self-aligned and heavy-duty type for long life.
- Fan housing shall be constructed of steel sheet (St-37).
- Fans shall have louver shutter to open and close with fan operation. Louver shutter shall be rigidly constructed and free of vibration or rattle.
- Wall mounted fans shall have square panelled framework.
- Impeller shall be constructed of stainless steel sheet or aluminium or galvanized and equipped with side guard.
- Class "F" insulation and class "B" temperature rise shall be considered.
- Controller etc.

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## 24 ELECTRIC WATER HEATER

A typical electric water heater shall be met the following specification and for sizing and capacity refer to attached data sheets.

- Steel tank with thermal insulation inside cavity.
- Submerged anode rod to protect tank from corrosion.
- Nickel-chromium heating element separating water from electricity and preventing heating without water. Heating element shall be filled densely with magnesia powder and silicon to separate water and electricity utterly.
- The temperature / pressure (T&P) relief valve is rated @99 deg °C and 10.34 Barg.
- The water heater equipped with an adjustable thermostat to control water temperature. Thermostat shall be factory set @60 deg °C.

## 25 AIR DEVICES



### General requirements

All types of Dampers shall be constructed to withstand and / or close against an internal pressure of 2000 Pa and a duct velocity of 15 m/s. When in the fully open position, damper pressure loss at an approach velocity of 10 m/s shall not exceed 35 Pa.

All remotely operated dampers must open and close within 3 seconds. All dampers shall be suitable for mounting within ductwork and have purpose made flanges.

Dampers shall include two micro switches to indicate the fully open and fully closed status. Micro switches, which shall be single pole double throw sealed units with contacts, shall operate on a 24 V, D.C. supply. They shall have micrometer adjustment and should operate at less than 5% of the actuator travel.

The Supplier shall use the materials specified herein the referenced specifications and where not specified, the Supplier shall be responsible for the selection of materials of construction. In selecting

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materials and designing the dampers the Supplier shall give special consideration to the operating and environmental conditions specified.

The Supplier shall specify within the bid all proposed materials to be used. Final selection of materials will be subject to Contractor approval.

The frame shall be extremely rigid to keep the blade in proper alignment and prevent chattering and binding so as to ensures dependable damper operation. The blades shall be fixed to continuous shafts, which shall be manufactured from 12mm,304L stainless steel. The shafts shall rotate in impregnated 304L stainless steel oilite bearings fitted to the outside of the frame.

As indicated by the Contractor dampers located and / or operating under hazardous environment shall have junction boxes, micro switches and solenoid valves suitable to operate in such conditions.

Blade linkages shall be attached to extended spindles by pinning and arranged for operation on one side of the damper casing only. Linkage arrangement shall not prevent replacement of bearings.

For dampers in external side of buildings, frames shall be made of 1.5 mm stainless steel, 316L and blades from 1 mm stainless steel, 316L.



#### **SPLITTERS:**

Splitters shall be 0.4 mm thicker than duct in which installed; minimum thickness shall be however not less than 0.8 mm when steel made or 1.5 mm if aluminum. Splitters shall be operated by 5-mm rod brought through the side of the duct with locking setscrew and bushing.

#### **MANUAL VOLUME DAMPERS:**

Sufficient manually operated volume control dampers shall be installed in the ductwork where necessary, to regulate and balance the air distribution system. Air leakage past fully closed dampers shall not exceed 5% of the maximum design airflow in the duct. Each damper shall be fitted with a locking and position indicator device. All dampers shall be propriety units, and not manufactured by the sheet metal fabricator.

Manual volume dampers shall be multileaf opposed blade type; except that single blade type (butterfly type) may be used in rectangular ducts having 150 mm and less and round ducts of diameter

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less than 400 mm. Damper casing and blades minimum thickness shall be however not less than 1 mm when steel made or 2 mm if aluminium.

Dampers shall be operated by locking type quadrant operator; the quadrant operator for dampers installed in ducts to be thermally insulated shall be provided with standoff mounting adapters to provide clearance from the insulation.

### **BACK DRAFT AND PRESSURE RELIEF DAMPERS:**

Back draft dampers shall be gravity shut-off types such that in the event of fan failure, the damper closes automatically. Blades shall act in parallel and have flexible tip seals manufactured from a suitable material. The blades shall be a single skin 0.8mm thick aluminum sheet metal. A strip of flame-retardant PVC shall be bonded to the back of each blade to form a seal between the adjacent blades.



Mechanical pressure control dampers shall be the gravity operating type having fully interlocked blades arranged to give parallel action. The backpressure exerted by the dampers shall be by means of an adjustable spring to weights.

### **FIRE DAMPERS:**

Fire dampers shall be selected, manufactured, and installed in accordance with the relevant Code and Standards. Curtain type dampers (where automatic remote opening and closure is not necessary) shall be arranged to spring close tight when released by the fusible link. Dampers shall be equipped with external position indicators and shall be capable of electrically relaying the status of the damper blade to a remote source. Fire damper shall have as the minimum the same fire resistance as the wall or slab in which it is located and shall be in accordance with NFPA 90A requirements.

All fire dampers shall be fail-closed types. Fusible link shall be set for 70° C and be an approved pattern. An inspection hole or adequate system shall allow easy replacement of a fuse.

Fire dampers shall have frames and blades manufactured from sheet steel hot dip galvanized. The blades shall be formed from a double skin, aero foil section. Each Skin shall be 1.00mm thick hot deep galvanized sheet metal. Bearings shall be of the sealed for the lifetime of the equipment and without lubrication. The damper assembly shall be internally wired by the Supplier and terminate at the Supplier junction box.

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Fire dampers shall be electrically actuated. Each damper shall be complete with micro-switches, which shall indicate the damper in open and closed position or fault.

When in the closed position fire dampers shall be airtight and leakage rate shall not exceed 0.03 m<sup>3</sup>/s.m<sup>2</sup> area of damper at 2000 pa differential pressure.



Resetting shall be possible without any special tools. An inspection hole or an adequate system shall allow easy replacement of a fuse.

#### **GAS TIGHT DAMPER (IF APPLICABLE):**

- Construction shall be stainless steel fully welded.
- All electrical components shall be certified for use in zone 1 hazardous area.
- No insulation required.
- Damper construction shall be such that leakage rate are substantially improved to limit gas ingress.
- Closure of gas dampers shall be achieved within 2 sec. (to be confirmed)

#### **Motorized Dampers:**

Motorized dampers shall be specifically for automatic control applications and shall be multileaf opposed blade type; except that single blade type (butterfly type) may be used in rectangular ducts having 150 mm and less and round ducts of diameter less than 400 mm. Damper shall be low leakage rated (closed blade leakage less than 3 L/s per m<sup>2</sup> of damper cross section with 100 Pa pressure differential). Damper casing and blades minimum thickness shall be however not less than 1 mm when steel made or 2 mm if aluminium. Motorized dampers shall have frames and blades manufactured from sheet steel hot dip galvanized. The blades shall be formed from a double skin, aerofoil section. Each Skin shall be 1.00mm thick hot deep galvanized sheet metal. Bearings shall be of the sealed for the lifetime of the equipment and without lubrication. The damper assembly shall be internally wired by the Supplier and terminate at the Supplier junction box. Dampers shall be fitted with mounting plate rigidly fixed to the casing to support the actuator and shall also be provided with position indicator. Dampers shall have nylon, PVC or bronze self-lubricating bushings. Each motor controlled isolating damper shall be complete with micro-switches which shall indicate the damper

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in open and closed position or fault. The motorised control and isolating dampers shall be driven by the HVAC control system. It shall also be possible to drive manually each automatic damper.

Damper shall be sized to accept a differential pressure of 4000 Pa without buckling.

### **DIFFUSERS:**

Unless otherwise indicated on the air terminal devices data sheet, each diffuser shall be provided with an airflow rate controller and a means of altering the discharge airflow pattern.

All controllers shall be adjustable from the front of the diffuser. Where a diffuser is directly connected to a stub duct, which has a straight length of less than two equivalent diameters, an equalizing deflector shall be used.

Cone type diffusers shall be provided, where indicated, with finish as indicated on the air terminal devices data sheet.

Circular diffusers, with adjustable airflow pattern, shall have the cone retained by a screwed spindle fitted with upper and lower stop pins or other approved method. All diffusers shall be provided with approved plenum boxes, secured to the diffuser and having top or side mounted spigots for the connection of flexible ducting.

Where diffusers are intended to be less than 4 way throw, the Supplier shall ensure the correct orientation.



Supply diffuser shall be sized for maximum air velocity of 2 m/sec for manned and 3 m/sec for unmanned area.

### **GRILLES AND REGISTERS:**

Grilles and registers for supply air shall have two sets of adjustable blades, one set horizontal and one set vertical. Unless otherwise indicated on the Contractors air terminal devices data sheet.

The airflow rate controller for supply air registers shall be a damper of the opposed blade multi-leaf type or rhomboidal type.

Grilles and registers for extract air shall have a single set of adjustable blades either horizontal or vertical, or a lattice or egg crate front as indicated on the Contractors air terminal devices data sheet.

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

Return or exhaust grill shall be sized for maximum air velocity of 2 m/sec for manned and 3 m/sec for unmanned area.

### FLOOR GRILLES:

Grilles or other terminal devices shall be sufficiently robust to withstand loadings associated with normal use of the occupied space and shall be interchangeable with floor tiles.

Floor tiles to be supported by adjustable pedestal via under floor structure.

Floor tiles shall have soft sealing edges to prevent air leakage.

Floor tiles to be constructed from iron extrude, and nylon coated where applicable.

Approximate air supply for a perforated floor grill of 600mm x 600mm is about 500 m<sup>3</sup>/hr.

### DOOR GRILLES:

These should be of the non-vision, door-mounted type having a fixed core of inverter "V"-blades.

Maximum air velocity for door or wall grills shall be 1.5 m/sec.

### LOUVERS:

Louver shall be sized for maximum face velocity of 2 m/sec for inlet, 3 m/sec for exhaust and, based on 45% free area. Over sizing shall be 15%.



All inlet and outlet louvers shall be supplied complete with bird/insect wire mesh guards and designed to minimize the penetration of wind driven dust, sand, and moisture into the system.

All external inlet/outlet louvers and external sand trap filters shall be fabricated throughout from stainless steel 316L.

Bird screens shall be 12 x 12 mm mesh, 1.2 mm diameter; insect screens shall be 1 x 1 mm mesh; 0.4 mm diameter.

All intake and discharge louvers should be weather tight under the prevailing local weather conditions.



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The maximum air pressure drop through any louver should not be greater than 30Pa.

### SAND TRAP LOUVERS:

Sand Trap inlet louver in naturally ventilated areas shall be of the inertia separation type consisting of vertical channel separator vanes mounted in an enclosure frame having self-emptying sand/moisture discharge openings in base.

%90 efficiency for particles from 350 to 700  $\mu\text{m}$  and %80 efficiency for particles from 75 to 700  $\mu\text{m}$  at 1 m/s.

The complete assembly of sand trap louver shall be stainless steel grade 304L.

The main frame shall be 1.5mm thick, complete with mating flanges for fixing to Building frame or HVAC ductwork spool connection.

The sand trap louver shall have vertical vanes of 1mm thick for sizes up to 1000mm x 1000mm, 2mm thick up to 4000mm x 4000mm and for above this the vertical vanes shall be 3mm thick.

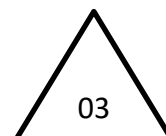
The sand trap louver shall be designed to remove the average solids of 26 mg/m<sup>3</sup> during wind speeds at ground level of 3 to 4 m/s. The design shall be suitable for these values at a duration not exceeding 6 hours.

The sand trap louver blades shall be in labyrinth form, arranged to allow passage of air but resist the entry of airborne sand into the HVAC intake and or exhaust ductwork.



The sand trap louver shall be complete with deflector plate at the bottom of the vertical vanes.

Sand removal shall be in front of the louver face via the inlet hopper. For sand trap louver sizes up to 1000mm x 1000mm there shall be a minimum of 2 discharge points and 4 discharge points above this size.

## 26 VRF SYSTEM



- All instrument loose items required to control the air conditioner systems( Outdoor and indoor units) properly according to D& ID description.

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	<b>MATERIAL REQUISITION FOR HVAC EQUIPMENTS</b>							
	Pro. Cod	Cons.	Discipline	Unit	Type	Serial	Rev	
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- Refrigerant piping with thermal insulation, run between outdoor unit and indoor units including pipes, insulation, supports, cladding...
- Electrical Cabling between Outdoor and indoor units
- Refrigerant for full load performance at site
- Spare parts for erection, pre-commissioning, commissioning and start-up
- Spare parts list for two (2) years operation (As an Option)
- Packing and Marking
- Special tools for Erection and Maintenance
- Supply of all materials required for transportation and field erection (i.e., lifting lugs, lifting beam, spreader beam etc.) if required.
- Mounting steel structure
- Name plate and its brackets.
- Other Accessories required for safe operation (Not Referred in this MR.)
- Vendor's Standard Accessories