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	CLIENT: MARLIM LESTE E SUL		SHEET: 1 of 88
	JOB: BASIC DESIGN – REVIT I		
	AREA: MARLIM SUL / MARLIM LESTE		
SRGE	TITLE: HVAC SYSTEM HVAC TECHNICAL SPECIFICATION		INTERNAL ESUP

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SUMMARY

1. INTRODUCTION

General

This Technical Specification is intended to define the HVAC Systems (Heating, Ventilation and Air Conditioning) Basic Criteria Design for REVIT I (MARLIM LESTE E SUL) - FPSO.

This specification associated with others Basic Design documents will support to produce a Detailed Engineering Design of the HVAC Systems and to procure all materials, equipment and installation, testing, commissioning all HVAC Systems. The HVAC System shall be completed and in full accordance with the requirements of this document.

In general terms, the HVAC Systems shall maintain all the designated criteria, ventilation rates, temperature, humidity, pressure etc.

The basic criteria presented here shall be complied with in all phases of design. Special cases such as revision of standards, technical difficulties in meeting any particular requirement, doubts regarding points not defined in the Basic Design, or modifications intended to upgrade the project shall be presented for analysis and approval by Petrobras.

The air conditioning and Ventilation Systems shall be designed to suit the site environmental conditions, all Brazilian Regulations and equipment Manufacturer's recommendations.

Abbreviations

The following abbreviations are used in this document:

- AEPR Automation & Electrical Panels Room
- AHU Air Handling Unit
- CCR Central Control Room
- CFC Chlorofluorocarbon (Refrigerant)
- COP Coefficient of Performance (Refrigeration Cycle)
- CS Classification Society
- CSS Control Safety System
- CDC Medium-Voltage Switchgears
- EFGS Fire and Gas System
- FEF Flexible Elastomeric Foam
- HCFC Hydrochlorofluorocarbon
- HFC Hydrofluorocarbon
- HFO Hydrofluoroolefin
- HMI Human – Machine Interface
- PSV Pressure Safety Valve
- PLC Programmable Logic Controller
- SOS Supervision and Operation System
- UAM Unit Alarm Malfunction
- UAS Unit Alarm Shutdown

2. REGULATION CODES AND STANDARDS

All work specified must be according to all applicable sections of the latest editions of the Codes and Standard (and their current amendments), listed below.

2.1. International Codes

a) IMO:
- SOLAS - Convention for the Safety of Life at Sea
- MODU CODE – Mobile Offshore Drilling Units
- RESOLUTION A.754 (18)

b) Classification Society.

c) MARPOL – International Convention for the Prevention of Pollution from Ships.

d) ISO (International Standard Organization):
- ISO 7547 - Ships and Marine Technology-Air-Conditioning and Ventilation of Accommodation Spaces-Design Conditions and Basis of Calculations;
- ISO 8861 – Shipbuilding – Engine-room ventilation in diesel engine ships – Design requirements and basis of calculations;
- ISO 8862 - Air-Conditioning and Ventilation of Machinery Control-Rooms on Board Ships-Design Conditions and Basis of Calculations;
- ISO 9099 - Air-Conditioning and Ventilation of Dry Provision Rooms on Board Ships-Design Conditions and Basis of Calculations- ISO 9943 Shipbuilding-Ventilation and air-treatment of Galleys and pantries with cooking appliances;
- ISO 15138 – Petroleum and Natural Gas Industries — Offshore Production Installations — Heating, Ventilation and Air-Conditioning.
- ISO 16890 – Air Filters for General Ventilation

e) IEC (International Electrotechnical Commission:
- IEC 61892-7 – International Standard – Mobile and Fixed Offshore Units – Electrical Installations;
- IEC 60092-502 – Electrical installations in ships - Part 502: Tankers - Special features.

f) Standards of AMCA (Air Movement Control Association):
- AMCA 99 - Standards Handbook;
- AMCA 201 - Fans and Systems;
- AMCA 202 – Troubleshooting;
- AMCA 203 - Fields Performance Measurements of Fan Systems.

g) Publications of ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers):
- ASHRAE Fundamentals Handbook;
- ASHRAE Systems and Equipment Handbook;
- ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

- ANSI/ASHRAE Standard 62.1-2019 Ventilation for Acceptable Indoor Air Quality.
- ASHRAE Laboratory Design Guide - 2nd Edition.

h) Publications by SMACNA (Sheet Metal and Air Conditioning Contractors' National Association):
- SMACNA HVAC System – Duct Design;
- SMACNA HVAC Duct Construction Standards – Metal and Flexible.

i) Industrial Ventilation – Manual of Recommended Practice for Design - ACGIH (American Conference of Governmental Industrial Hygienists)

j) NEEB (National Environmental Balancing Bureau): "Procedural Standards for Testing Adjusting and Balancing of Environmental Systems":
- CIBSE: Commissioning Code Series A - Section A.2.7;
- Air Balancing Council.

k) API (American Petroleum Institute): API RP 505.

l) ANSI/IEC 60529-2004 (American National Standards / International Electrotechnical Commission) - Degrees of Protection Provided by Enclosures (IP Code).

m) NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operation.

2.2. Brazilian Government Regulation

a) Brazilian Ministry of Labor Rule NR13 – Boilers, Pressure Vessels and Piping.

b) Regulation GM/MS Nº 3523/1998 - Ministry of Health.

c) Resolution RE-09: 2003 of ANVISA.

d) Resolution CONAMA – Nº 267.

e) Regulation NR-37 – Health and Safety in Oil Rigs and Offshore Platforms

2.3. Petrobras Specifications

a) DR-ENGP-M-I-1.3- Safety Engineering.

b) DR-ENGP-I-1.15 – Color Coding.

c) I-ET-3010.2Q-1200-200-P4X-002- Piping Specification for Hull.

d) I-ET-3010.2Q-1200-200-P4X-001- Piping Specification for Topsides.

e) I-ET-3010.00-1200-431-P4X-001 - Thermal Insulation for Maritime Installations

f) I-ET-3010.00-1200-251-P4X-001 - Bolt Materials.

g) I-ET-3010.00-1200-540-P4X-001 - Requirements for Pressure Vessels Design.

h) I-ET-3010.00-1200-956-P4X-002 - General Painting.

i) I-ET-3010.00-1200-310-P4X-003 – ASME B73 Centrifugal Pumps Specification.

j) I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements.

k) I-ET-3010.2Q-1200-500-P4X-002 – Material Specification for Hull Systems Pressure Vessels and Tanks.

l) I-ET-3010.2Q-1200-500-P4X-001 – Material Specification for Topside Systems Pressure Vessels and Tanks.

m) I-ET-3010.2Q-1200-450-P4X-001 – Material Specification for Heat Exchangers.

n) I-ET-3010.2Q-1400-196-P4X-001 - Ergonomic Requirements for Topsides.

o) I-ET-3010.2Q-1350-196-P4X-002 - Ergonomic Requirements for Hull.

p) I-RL-3010.2Q-1200-940-P4X-001 – General Specification for Available Utilities.

q) I-FD-3010.2Q-5400-947-P4X-001 - Safety Data Sheet – Topside.

r) I-FD-3010.2Q-5400-947-P4X-002 - Safety Data Sheet – Hull.

s) I-MD-3010.2Q-1200-947-P4X-003 – Descriptive Memorandum - SAFETY.

t) I-ET-3010.00-5140-700-P4X-002 - Specification for Electrical Material for Offshore Units.

u) I-ET-3010.00-5140-741-P4X-004 - Specification For Low-Voltage Generic Electrical Panels For Offshore Units

v) I-ET-3010.00-5140-700-P4X-007 - Specification For Generic Electrical Equipment For Offshore Units

w) I-ET-3010.00-5140-700-P4X-009 - General Requirements For Electrical Material And Equipment For Offshore Units

x) I-ET-3010.00-5140-700-P4X-003 - Electrical Requirements for Packages for Offshore Units.

y) I-ET-3010.00-5140-712-P4X-001 - Low-Voltage Induction Motors for Offshore Units.

z) I-ET-3010.00-1200-800-P4X-002 - Automation, Control and Instrumentation on Package Units.

aa) I-ET-3010.2Q-1200-800-P4X-014 - Automation Interface of Packaged Units.

bb) I-ET-3000.00-1200-940-P4X-001 – Tagging Procedure for Production Units.

cc) I-DE-3010.2Q-1350-960-P4X-003 – Freeboard Plan.

dd) I-ET-3010.00-1200-940-P4X-002 – General Technical Terms.

3. HVAC ENGINEERING DOCUMENTATION

3.1. Engineering

During the Detailed Engineering Design, the HVAC Systems shall be calculated based on more precise data as heat dissipation, thermal insulation etc. All values of flow, pressure, capacity etc, i.e., all performance data may be changed after analysis and approval by Petrobras.

Certain criteria and basic data of the HVAC System shall not be changed, except if approved by Petrobras, such as:

a) All criteria / requirements defined in this document;

b) Location of main equipment (chilled water units, chilled water pumps, fans, air conditioning units etc.);

c) Quantities and types of equipment;

d) Control and operation philosophy.

SI system must be used for calculations and document presentation:

a) Thermal Load – kW;

b) Airflow – m^3/h;

c) Water flow - m^3/h;

d) Velocity - m/s;

e) Temperature - °C;

f) Pressure – Pa;

g) Dimensions – mm;

h) Area – m^2;

i) Volume – m^3.

All HVAC equipment, accessories, ducts and fittings shall be tagged as per I-ET-3000.00-1200-940-P4X-001 – Tagging Procedure for Production Units.

3.2. Documentation

In the Detailed Engineering Design, at least the documents / information listed below shall be created and submitted to Petrobras for analysis and approval.

Documents shall follow an issuing order. Each document shall only be analysed after previous document approval, as established below:

a) Thermal Load Calculation Report;

b) D&ID (HVAC Ducting and Instrumentation Diagram);

c) P&ID (HVAC Piping and Instrumentation Diagram);

d) General Arrangement and Ducts and Piping Calculation Report, simultaneously;

e) Data Sheet and Material Requisition.

3.2.1. Calculation Reports

a) Thermal Load

– Calculation of the maximum thermal load for each room and the maximum simultaneous of all rooms served by the same system, including the supply flow rate of each room and the total flow rate of the air conditioning and ventilation systems.

b) Heat Dissipation Data List

It shall inform the Heat Dissipation of each equipment, component or item mentioned in the previous item a), considering “normal” and “emergency” operation modes (when the main power generation shuts down), also including the following information:

– The Demand Load Factor (operational electric current / rated electric current) considered for each electrical equipment;
– The Intermittency Factor (running time per day) for each equipment;
– The Demand Load Factors and the Intermittency Factors shall be consistent with operational condition considered in Electrical Load Balance List;
– The heat dissipation value of all electric equipment shall be consistent with the respective Demand Load Factor and Intermittency Factor;
– For redundant power transformers, heat dissipation calculation shall consider the biggest transformer of the room ON which a 125% load factor (forced ventilation active) and other transformer OFF; for further redundant transformers, heat dissipation calculation shall consider all transformers ON with 50% load factor.
– Heat dissipation of the space heaters for the unloaded and non-operational equipment;
– Heat dissipation of the space heaters for loaded and operant equipment, if the intrinsic heat dissipation of the equipment is not enough to increase the internal temperature and turn the space heaters off;
– Spare drawers in MCC and CDC or any spare loads shall not be considered;

– For current limiting reactors, the resistance considered shall be consistent with the resistance calculated in Short-Circuit Calculation Report;
– For VSD, the heat dissipation value shall be consistent to the operational condition (according to the Demand Load Factor). It is not expected a high Demand Load Factors for VSD, since this equipment are included only for the loads which are expected to operate below the rated point, for energy efficiency criteria;
– For soft-starters, only the heat dissipation related to space heaters shall be considered, since the soft-starters are bypassed after the equipment start;
– For redundant UPS and Battery Chargers, it shall be considered the operational condition with half consumers demand in each UPS and with batteries floating (not charging), since this is the prevailing condition. Attention: half consumers demand does not mean half of the rated load, but half of the current calculated consumer load plus the expected future (spare) load;
– For non-redundant UPSs and Battery Chargers, it shall be considered the operational condition with full consumers demand and with batteries floating (not in charging), since this is the prevailing condition. Full consumers demand does not mean rated load, but the actual calculated consumer demand, plus the expected future (spare) load;
– For lighting, it shall be considered total lamp power and reactor dissipation;
– For the electric cable thermal dissipation, the calculation criteria shall be submitted for Petrobras approval;
– If there is any spare or oversizing factor for heat dissipation, it shall be highlighted and informed;
– For Telecommunication and Automation equipment, the criteria shall be submitted for Petrobras approval. The criteria shall not consider simultaneity of the maximum equipment dissipations. The Demand Load Factors, Intermittency Factors and Simultaneity Factors shall be considered;
– The heat dissipation for all equipment shall be consistent to the informed efficiency rates;
– All information extracted from any third-party document, i.e. manufacturers document/catalogues shall be highlighted and informed as an External Reference Document, precisely identifying and describing the information source;
– All estimated data shall be clearly highlighted and identified as an estimative information;
– Each discipline Electrical, Automation and Telecommunication shall issue a specific calculation report for equipment heat dissipation with all information listed above to be used by HVAC discipline.

c) Ventilation.
– Air flow rates calculation for all areas and systems;
– Heat dissipation List for each equipment, component or item considered in calculation report.

d) Air Distribution Ducts.
– Pressure loss calculation of all HVAC air ducts, including all accessories and components and considering each room's differential pressure requirement;
– Static Regain shall be used for the air conditioning system dimensioning;
– Equal Friction Loss Method shall be used to size the Ventilation System;

– Each Pressure Loss Calculation shall include ducts and branches schematic drawings to improve the understanding of each calculated system.

e) Heat Transmission Coefficients.

Calculation and / or indication, according to the corresponding reference, of the transmission coefficients of each partition for all air conditioned and ventilated rooms, to be used in the Thermal Load Calculation Reports.

3.2.2. D&ID and P&ID

At least the following information shall be indicated:

a) airflow for each room and the total for the system;
b) fire, gas tight, modulating, non-return, shut-off and balancing dampers;
c) air filters and distribution devices (diffusers, grille, louvers);
d) chilled water flow for every branch of chilled water piping;
e) valves, control valves, filters and instruments for chilled water piping;
f) solenoid valve for control of fire and tightness dampers;
g) fire integrity class of the bulkheads and decks.

3.2.3. HVAC General Arrangements.

a) Location of HVAC equipment and layout of the HVAC machinery rooms, with cross-sectional drawings, details etc.
b) The fire integrity class of the bulkheads and decks shall be indicated in the arrangement. The dampers panels shall be located in the drawing.
c) Location and dimensions of ducts, with location of accessories such as supporting members, diffusers, filters, dampers, ducts material with thickness and classification, penetration pieces, insulation details and thickness etc. Location of ducts to include elevation of the lower face in relation to the floor.
d) Location of control sensors of HVAC System.
e) Location of HVAC equipment maintenance area.

3.2.4. Materials Requisitions and Data Sheets.

a) Containing all information on equipment, accessories and instruments, documentation, tests, spare parts etc. Spare part shall be detailed with a view of further purchase. All the tests / inspections shall be listed on an Inspection Test Plan to be submitted to Petrobras approval.
b) Data sheets shall be fulfilled according to models in the APPENDIX, item 11.

3.2.5. Typical Construction and Installation Details

a) Containing all information on mounting details, insulation, ducts penetration on bulkheads indicating the penetration pieces, water-piping connections, fire and tightness dampers mounting details, grounding details etc.

3.2.6. NR-13 Documentation

a) All documents required by NR-13 shall be included in fabrication documents.

3.2.7. Documents Numbering.

a) All documents emitted by HVAC or documents emitted by correlated area for HVAC Systems (such as electrical, instrumentation or safety) shall be numbered according to the general requirements established in contract. Documents numbering shall comply with the structure of coded number required on N-1710. HVAC documents shall be numbered as follows:

Group 3 (Activities Areas): 5250
Group 4 (Class of services, equipment and materials): 942 for master and arrangement plans; and 944 for engineering flowcharts (D&ID's and P&ID's).

3.2.8. Other Documents and Information

a) Detailed Overall Description of the HVAC System.
b) Ventilation Inlet & Outlet plan showing all details of Main Inlets & Outlets necessary for Area Classification Drawing.
c) Electrical Diagram and Cause & Effect Matrix may be executed by others disciplines but shall be supported by HVAC discipline.
d) Installation, operation and maintenance manuals in Portuguese language.
e) If any information required for the development of the HVAC design is not found in this technical specification, ISO 15138 and ASHRAE literature shall be consulted.

4. DESIGN PARAMETERS

4.1. External Design Condition

The Air Conditioning and Ventilation Systems shall be calculated to suit the following conditions:

a) Summer

Outside:
Dry bulb temperature: 32º C
Relative humidity: 61 %
Daily temperature range: 3.6º C

b) Winter

Outside:
Dry bulb temperature: 18° C
Relative humidity: 75 %

The winter conditions shall not be considered for the Thermal Load Calculation and HVAC System dimensioning.

4.2. Internal Design Condition

HVAC System shall be designed for the internal conditions indicated in Table 2 – Design Requirements for Ventilated and Air Conditioned Rooms. The system also shall be designed to suit the room conditions according to the Equipment Manufacturer's recommendations, if applicable.

Specified air change rate per hour for each room shall be maintained according to the Table 2 in the item 6.1 and furthermore specified. Considering both situations above mentioned, the maximum calculated value for the air flow rate shall be considered.

4.3. Noise Levels

HVAC Rooms shall be located and treated to avoid noise propagation to the nearby areas.

For rooms and HVAC System noise levels, see the following documents I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements .

If the system does not comply with the noise limit:

a) a Sound Attenuator shall be installed according to the System demand, in order to meet the noise level requirement;

b) the system pressure loss shall be recalculated and all affected documents shall be corrected;

c) all equipment shall be designed, selected and supplied considering the correct pressure loss calculation.

All equipment shall individually generate a noise level not higher than 5 dB(A) below the maximum noise level allowed for the room where it is installed.

All dynamic HVAC equipment shall be provided with anti-vibration devices, in order to reduce vibration levels transmitted to structure. These devices shall comply with the same material requirements applied to the equipment serviced. If it is installed outdoors, these devices cannot accumulate water.

4.4. Motions and Accelerations

HVAC System design shall comply with the general classification rules. All equipment shall be capable of operating at the slope angles defined in I-DE-3010.2Q-1350-960-P4X-003 – Freeboard Plan.

4.5. Area Classification

HVAC design shall consider hazardous area classification as mentioned in DR-ENGP-M-I-1.3 - Safety Engineering, and I-DE-3010.2Q-1200-94A-P4X-001 – Area Classification – General.

The enclosure protection and the electrical installation requirements for the electrical equipment shall comply with I-ET-3010.00-5140-700-P4X-002 - Specification for Electrical Material for Offshore Units. and ANSI/IEC 60529.

4.6. FPSO Life Cycle

The FPSO life cycle is 30 years. All supplied equipment and materials shall be suitable to withstand the FPSO life cycle and shall be suitable for the environment where it is installed, based upon regular maintenance and servicing according to the Manufacturer’s recommendation.

4.7. Heat Transmission Coefficients for Partitions

The Overall Heat Transmission Coefficients for each partition shall be calculated based in architecture and arrangement documentation.

Partitions shall be specified in order to avoid exceeding the maximum values shown in Table 1 - Maximum Overall Heat Transmission Coefficients for Partitions.

Type of Partition	Vicinity of Air Conditioned Room	Overall Coefficient (U) (W/m².K)
Internal Partitions	Rooms with temperature of 40°C	0.6
	Rooms with temperature of 35°C	0.8
External Partitions	Bulkheads	0.7
	Ceilings	0.5
	Floors	0.8

Table 1 - Maximum Overall Heat Transmission Coefficients for Partitions

To comply with the internal temperature limits (see Table 2 – Design Requirements for Ventilated and Air Conditioned Rooms), some ventilated rooms need external partitions insulation. In this case, the maximum coefficient in the Table 1 shall be used.

Rooms attended by Ventilation Systems, with external bulkheads subjected to insolation, shall be insulated according to the Table 1 – external partitions.

5. UTILITIES

5.1. Electrical Power

See I-ET-3010.00-5140-700-P4X-003 - Electrical Requirements for Packages for Offshore Units.

5.2. Instrument Air

See I-RL-3010.2Q-1200-940-P4X-001 – General Specification for Available Utilities.

5.3. Fresh Water Cooler

For the freshwater, see I-FD-3010.2Q-5120-456-P4X-001 - Engine Room Central Fresh Water Cooler.

6. HVAC SYSTEM DESIGN BASIS

6.1. Design Requirements for Ventilated and Air Conditioned Rooms

Table 2 – Design Requirements for Ventilated and Air Conditioned Rooms

AMBIENT	EXAMPLES	INTERNAL TEMPERATURE – Max. Dry Bulb (°C)	RELATIVE HUMIDITY (%)[1]	MINIMUM AIRFLOW (ch/h) [2]	FRESH AIR FLOW CALCULATION CRITERIA [3]		EQUIPMENT CONFIGURATION[4]
					Min Air ch/h	l/s per person	
Manned areas – sedentary work	Control Room, Radio Room [5] [6]	24	50		1.5	8	2x100%
Living quarter areas	Changing Room with toilet	35	n/a	15	n/a	n/a	2x100%
	Laundry	24	55	6	n/a	n/a	2x100%
	Restroom/WC	35	n/a	15	n/a	n/a	2x100%
	Mess Room [7]	24	55		1.5	8	2x100% [8]
	Library, Offices Music Room, Kiosk, Coffee Shop, Phone Cabin, Meeting Rooms	24	50		1.5	8	1x100% [8]
	Dry Provision Store [9]	24	50		1.5	-	1x100%
	Gymnasium	24	50		1.5	8	1x100% [8]
	Games Room	24	55		1.5	8	1x100%
	Cinema, TV/Video Room, Briefing Room	24	55		1.5	8	1x100%
	Cabins[10]	24	50		1.5	8	1x100%
	Galley	24	55	30	100% fresh air	8	2x100%
	Corridors [11]	26	n/a		1.5	8	2x100%[12]
	Stairways [13]	35	n/a	6	n/a	n/a	2x100%
	Medical Unit [14]	23	50		12	8	2x100%

[1]) A variation of 5% (45% to 55%) is acceptable.
[2]) Air renovation per hour, enough to keep gas and vapor concentration rates below 20% LEL for compartments with flammable gases or vapors, considering the maximum possible leakage during normal operational conditions, whichever is higher.
[3]) The biggest airflow shall be considered.
[4]) For rooms not described in Table 2: standby equipment requirements are applicable for essential areas, classified areas and wherever continuous operation is necessary.
[5]) When the main power generation is not operational, Hull Essential Panel Room, M-17 Topside Automation and Electrical Panels Room, M-16B Automation Panels Room and M-13 Generators Control Panels Room shall have only Ventilation System, with the maximum internal temperature of 40°C.
[6]) The Central Control Room, Radio Room, Telecom Room and UPS Room shall have a dedicated Air Conditioning System, independent of any other HVAC System.
[7]) The Mess Room air may be partially exhausted through the Galley Exhaust System.
[8]) If there is no AHU HVAC System, each conditioned compartment/room shall have, at least, one fan-coil unit (FCU). For big compartments or rooms with a high human concentration (such as Recreation Room, Mess Room), more than one fan-coil shall be provided to guarantee a correct air distribution.
[9]) No recirculation air to the Central Air Conditioning unit is permitted.
[10]) The air exhaust shall be through a duct grille or a door grille. When there is an associated WC, the air may be partially or totally exhausted through a door grille to the WC.
[11]) The air from Corridors also may serve as a complementary supply air for other rooms.
[12]) The operational configuration is also valid for the exhaust fans.
[13]) The stairwell pressurization system shall be designed in accordance with NFPA 92. The pressure differences across doors shall not cause the maximum force permitted to begin opening the door to exceed the value stipulated in NFPA 101 or local codes and Classification Society. The air shall be supplied at the lower part of the stairway through grille(s). The air exfiltration shall be located on the upper part of the staircase compartment. There shall be a dedicated ventilation system for the stairways. The staircase compartment shall have positive pressure compared to any adjacent environment.
[14]) 100% fresh air supply shall be considered. All the room air shall be exhausted and not be mixed or recirculated to any other HVAC System.

Light manual work	Laboratory [1]	21	50	30	100% fresh air	8	2x100% [2]
	Tools Room, Electrical, Instrumentation and Mechanical Workshops	24	50		1.5	8	1x100%
Light manual work	Welding room [3]	40	n/a	30	n/a	n/a	1x100%
	Paint Shop [4]	40	n/a	12	n/a	n/a	2x100%
	Warehouse/Store	35	n/a	6	n/a	n/a	1x100%
Unmanned without electrical equipment	Inert Gas Generator Room	40	n/a	30	n/a	n/a	2x100%
	Paint Store	35	n/a	12	n/a	n/a	2x100%
	Inergen / CO_2 Room	35	n/a	12	n/a	n/a	2x50%
	Garbage Room	35	n/a	12	n/a	n/a	1x100%
	Purifier Room	40	n/a	12	n/a	n/a	2x50%
	Machinery Room (FPSO) [5]	40	n/a	6	n/a	n/a	2x50% [6]
Unmanned with electrical equipment – without critical instrument	Transformer room	40	n/a	6	n/a	n/a	2x100%, 3x50%, 4x33% or 5x25%
Unmanned with electrical equipment	Normal Electrical Panels Rooms [7], Essential Electrical Panels Rooms [8], UPS/Battery Charges Room [9], Telecom Room	24	50		1.5	8	2x100%, 3x50%, 4x33%, 5x25% or 6x20%
Equipment rooms with temperature-critical instruments	Battery room (Valve-regulated Battery) [10]	24	50	12	12	-	2x100% [11]
Equipment rooms without temperature-critical instruments	Battery room (Vented battery) [12]	35	n/a	30	n/a	n/a	2x100%
Unmanned	Production Modules	40	n/a		n/a	n/a	
	Utilities Room [13]	40	n/a	6	n/a	n/a	2x50%

[1]) 100% fresh air supply shall be considered. All the room air shall be exhausted and not be mixed or recirculated.
[2]) Configuration also valid for exhaust fans.
[3]) These values apply for normal ventilation of the rooms. Specific ventilation for room operation shall be included in scope of supply.
[4]) These values apply for normal ventilation of the rooms. Specific ventilation for room operation shall be included in scope of supply.
[5]) Machinery rooms are rooms containing only equipment (pumps, compressors etc.) and their drivers/push buttons.
[6]) Machinery room where any unit fed by emergency generator is installed, minimum 2 x 50% configuration shall be used.
[7]) Relative Humidity shall be greater than 30%.
[8]) Relative Humidity shall be greater than 30%. In emergency condition, the maximum temperature of 40°C shall be adopted, without air-conditioning system, which can be obtained from AHU or through a Ventilation System back-up if applicable.
[9]) In emergency condition, the maximum temperature of 40°C shall be adopted, without air-conditioning system, which can be obtained from AHU or through a Ventilation System back-up if applicable.
[10]) In emergency condition, the maximum temperature of 40°C shall be adopted, without air-conditioning system, which can be obtained from AHU or through a Ventilation System back-up if applicable. The minimum airflow shall be also calculated for the H_2 dilution as defined in IEC 61892-7: Safety requirements compliance. Valve-regulated Battery shall also have an exhaust system, which shall comply with Battery Rooms requirements established in the item 7.2.2. Battery Room must have a dedicated exhaust system.
[11]) Configuration also valid for exhaust fans.
[12]) The minimum airflow shall be also calculated for the H_2 dilution as defined in IEC 61892-7. Battery room must have a dedicated exhaust system. Supply system shall only be installed in case battery room location jeopardizes the direct fresh air intake with not suitable air admission risk.
[13]) Ventilation System for Utilities Room shall be according to the IMO MODU CODE, Petrobras Safety Philosophy and Classification Society.

Unmanned with diesel engines	Fire Fighting Pump – in operation	40	n/a	To be defined by manufacturer	n/a	n/a	2x50%
	Fire Fighting Pump – not operating	35	n/a	6	n/a	n/a	1x100%
	Diesel Auxiliary/Emergency Generation – in operation	40	n/a	6	n/a	n/a	note [1]
	Diesel Auxiliary/Emergency Generation – not operating	35	n/a	6	n/a	n/a	note [2]

[1]) Engine radiator shall be mounted on an external bulkhead of the room (direct driven fan by engine). The necessary engine cooling and combustion air shall be supplied by radiators fan.
[2]) One ventilating fan (1x100%) shall be supplied for operate when generator is not running and guarantee 6 air changes/hour in the room.

Table 3 – Air Filter Class

AMBIENT	EXAMPLES	FILTER CLASS [1 2 3]
Manned areas – sedentary work	Control Room, Radio Room	Coarse (80%) + ePM1 (75%)
Living quarter areas	Changing Room with toilet	Coarse (80%)
	Laundry	
	Restroom/WC	
	Mess Room	Coarse (80%) + ePM1 (75%)
	Library, Offices Music Room, Kiosk, Coffee Shop, Phone Cabin, Meeting Room	
	Dry Provision Store	
	Gymnasium	
	Galley (air-conditioning system)	
	Cinema, TV/Video Room, Briefing Room	Coarse (80%) + ePM1 (75%)
	Cabins	
	Galley (Ventilation System)	Coarse (80%)
	Corridors and Stairways	Coarse (80%)
Living quarter areas	Medical Unit	Coarse (80%) + ePM1 (90%)
Light manual work	Laboratory	Coarse (80%) + ePM1 (75%)
	Tools Room, Electrical, Instrumentation and Mechanical Workshops	Coarse (80%) + ePM1 (75%)
Light manual work	Welding room, Blasting Room, Paint Shop	Coarse (80%)
	Warehouse/Store	
Unmanned without electrical equipment	Inert Gas Generator Room	
	Paint Store	
	Inergen / CO_2 Room	
	Garbage Room	
	Purifier Room	Coarse (80%)
	Machinery Room (FPSO)	
Unmanned with electrical equipment – without critical instrument	Transformer room	
Unmanned with electrical equipment	Normal Electrical Panels Rooms, Essential Electrical Panels Rooms, UPS/Battery Charges Room, Telecom. Room	Coarse (80%) + ePM1 (75%)
Equipment rooms with temperature-critical instruments	Battery room (Valve-regulated Battery)	Coarse (80%) + ePM1 (75%)
Equipment rooms without temperature-critical instruments	Battery room (Vented Battery)	Coarse (80%)
Unmanned	Production Modules	
	Utilities Room (machinery room for FPSO)	
	Cargo Pump Room (for FPSO)	
Unmanned with diesel engines	Fire Fighting Pump – in operation	
	Fire Fighting Pump – not operating	
	Diesel Auxiliary/Emergency Generation – in operation	
	Diesel Auxiliary/Emergency Generation – not operating	

1) The requirement for installation of coarse filters shall be required only when the emergency/auxiliary generator is open type (IP23) or when other electrical equipment that required air filtration are installed inside these ambient, such as electrical panels, transformers etc.
2) For comfort systems composed by small capacity equipment which cannot handle filters demanded on Table 3, e.g. Fan-Coil Room, the Coarse (80% efficiency) can be acceptable.
3) Filters are selected according to ISO16890 standard.

7. HVAC SYSTEM REQUIREMENTS

7.1. General requirements

Air intake ducts shall comply with the following requirements:

a) It shall be fitted with gas detectors according to the document DR-ENGP-M-I-1.3- Safety Engineering.;

b) It shall have drop eliminators with filters. The maintenance space shall be allocated for the filter element removal;

c) It shall be installed in a safe area, located, at least, 3.0 meters away from classified areas limits;

d) It shall be minimum 4.5 meters away from the exhaust of the Ventilation Systems, from combustion gas discharge, from “vents” and where the prevailing winds are favourable. Gas dispersion study shall be developed to confirm the HVAC air intakes position properly.

HVAC Rooms shall be located and treated to avoid noise propagation to nearby areas.

Wherever there is a modulating damper installed on the supply duct, another modulating damper shall be installed on the return and/or exhaust duct to avoid pressure unbalancing in the room.

The demand for fire damper or tightness damper installation shall comply with the requirements established in other items of this document, in SOLAS/ IMO MODU CODE and in Classification Society Rules. All compartments protected by Fire-fighting Extinguishing System (CO_2 / Inergen - Fixed gaseous protection systems (clean agent – IG-541) shall have tightness dampers, to ensure tightness in the ducts and/or on the room’s ventilation openings, to prevent leakage and preserve the bulkhead integrity level.

All hand valves responsible for closing pneumatic dampers, including the valves installed in the pneumatic damper panels, must be identified with the pneumatic damper tag number(s) which will be closed, the room(s) protected by the damper(s) and the air duct service, such as ventilation or air conditioning and supply, exhaust, relief etc.

A QEV (quick exhaust valve) shall be installed as close as possible to each fire and tightness pneumatic damper.

Manual closing appliances shall be provided for all ventilation air inlets and outlets located up to 4.5 m above freeboard deck or decks of enclosed superstructures. For essential equipment rooms, these air inlets and outlets shall be located in such positions that closing appliance will not be necessary. Changes in coaming height or position needed in order to attend any studies, such as damage stability or movements, shall be implemented.

The minimum HVAC air renovation of closed or semi-open compartments with flammable gases or vapours shall be 12 changes per hour or enough flow to keep gas and vapour concentration rates below 20% LEL, considering the maximum leakage possible in normal operational conditions, whichever is higher. For more details, see Table 2 – Design Requirements for Ventilated and Air Conditioned Rooms to verify other compartments specific requirements.

For other compartments without flammable gases or vapours, the minimum supply air changes (considering recirculation) shall be 6 changes per hour.

More details concerning safety requirements for minimum air changes shall be verified in Safety Requirements for Heating Ventilation and Air Conditioning Systems (HVAC) of DR-ENGP-M-I-1.3- Safety Engineering.

In case of main ventilation loss of classified areas, the stand-by equipment shall be automatically started-up.

The air distribution shall be designed to avoid areas with low air speed inside the room, to prevent build-up of heat or gases. Supply and Return/Exhaust terminals shall be located on opposite sides of the room to provide a better air circulation inside the room and to avoid short-circuit.

Closed compartments with openings located closer than 3.0 m distant from classified area limit shall be positively pressurized and monitored. Closed compartments with internal sources of flammable gases or vapours shall be negatively pressurized and monitored, compared to neighbour compartments.

The operational conditions of the Ventilation Systems and the Air Conditioning Systems shall be continuously monitored. Any failure shall activate a remote signal in the CCR.

All fans shall provide the design airflow when the pressure loss in the system is at a maximum. Maximum pressure loss shall be calculated assuming that the filters are at the end of the respective campaign period (prior to maintenance), the modulating dampers, the fire dampers, the tightness dampers and the balancing dampers are fully opened and considering the wind direction, speed etc. Electrical motor shall be specified for the filter condition at the beginning of the respective campaign period.

The Ventilation Systems shall not connect rooms of different area classifications, such as:

a) Systems that involve rooms with the possibility of odour occurrence, e.g. WC, Galley etc, with other Systems that serve manned areas;

b) Battery Room and Laboratories Exhaust, increasing the contamination risk with other compartments;

c) Areas of different classification of electric equipment installation;

d) The Ventilation System of WC may be connected to the material stores, as an exception.

Skid mounted equipment shall comply with following terms:

a) The skid shall be designed to accommodate the entire equipment within the scope of supply. The skid shall be composed by a rigid construction, which shall not distort during hoisting, operation and shipment and shall withstand all moments and forces due to the vessel motion.

b) Lifting facilities shall enable the equipment to be lifted by crane as a single point lift for transportation and installation. The design and manufacture of the lifting

lugs shall be certified. The arrangement of equipment, piping and superstructure shall be such that the center of gravity (COG) coincides approximately with the geometrical center of the skid. When lifting the skids, complete with all equipment mounted, beam deflection shall not exceed 1/400 L.

c) The skid shall resist all sling forces, including both horizontal and vertical components of the applied sling angle (sling angles shall be within between 50 and 90 degrees with the horizontal plane).

d) Lifting beams, spreader bars, slings, shackles etc are within the PACKAGER' scope of supply.

e) Drip trays with drain connections shall be provided underneath equipment where severe spillage may to occur. Drainage outlets shall be provided on both sides, with water seat (the air does not pass through). Drip tray height shall consider the Unit motion (pitch, roll) and accelerations, and submitted for Petrobras approval. Alternatively, a central conical skid drain may be supplied. A 2% minimum slope shall be considered.

f) The skid shall be welded to the supporting structures.

g) The floor shall be made of plate material with a raised on-slip tread.

h) Welds underneath skid beams shall be ground flush.

i) Skid shall have 2 (two) diagonally opposed electrical grounding bosses.

j) Welding shall be carried out with procedures and operators qualified according to the ASME section IX. Welding shall not be performed before all necessary documents, e.g. Qualified Welding Procedure, are approved. Intermittent fillet welds are not allowed.

Equipment, accessories, piping and structure shall be electrically grounded according to the requirements of IEC 61892-6 and IEC 60092-502. In addition, the grounding installation in hazardous area shall comply with the IEC 61892-7.

Safety signs shall be in Portuguese language.

7.2. Ventilation System Requirements

Supply and exhaust terminals shall be fitted with grilles.

Unless otherwise specified, ventilated rooms do not need to be dehumidified.

7.2.1. Transformer Room

Air shall be supplied into the room at the floor level, to improve the fresh air entry into the transformers.

Air shall be exhausted at the upper part of the room, to improve the hot air removal. When mechanical exhaust is adopted, the exhaust system grilles shall be installed immediately above the transformers or, at least, above the larger transformers, to improve heat removal.

Flanged and dismountable exhaust and supply air ducts shall be provided over and near the transformers to enable access for maintenance and/or removal of equipment's components.

7.2.2. Battery Room

a) General Remarks

The Battery Room Ventilation System shall comply with IEC 61892-7 standard and the specific guidelines of the Classification Society, if applicable.

The Exhaust System shall be exclusive to the Battery Room.

Exhaust fans shall be installed outside the room, as close as possible to the air outlet, to reduce the air ducts length with positive pressure. The air discharge shall be, at least, 3 meters far from any electric motor, instruments, actuators or any other electrical item.

If the fans are located inside a HVAC room, the HVAC Room shall be considered as the same hazardous classification of the Battery Room as per Classification Society rules.

The Exhaust System fan shall be centrifugal type, single inlet, internally protected against corrosion (rotor, casing, shaft) and shall have non-sparking construction as per AMCA requirements and approved by the Classification Society.

Ducts shall not pass through any other compartment, especially where operations involve flames, e.g. Galley, Welding Room etc.

Hydrogen detectors shall be installed as defined in the DR-ENGP-M-I-1.3- Safety Engineering.

The exhaust air duct shall be built air-tight over its positive pressure part (downstream from the fan).

Welded penetration sleeves shall be installed wherever the air ducts pass through bulkheads or decks, even if it is not required by the safety classification, in order to render these penetrations air-tight.

The pressure in the room shall be monitored at 50 Pa negative comparing to adjacent areas. In case of differential pressure drop or an increase gas concentration inside the room, the stand-by fan shall start automatically.

If supply fans are necessary, the exhaust fans and associated dampers shall be electrically interlocked for automatic start-up and shutdown (opening / closing) according to the supply fans and associated dampers serving the room. Supply fans cannot operate without the simultaneously exhaust fans operation.

b) Air Distribution

The air shall be supplied at room floor level and exhausted at the upper part of the room to improve the removal of the hydrogen, released by the batteries, and to avoid the hydrogen gas accumulation on the room's ceiling.

The exhaust duct outlet shall be located at a safe distance and in a safe direction to prevent possible contamination of the surrounding air intakes of other systems by hydrogen gas.

7.2.3. Diesel Auxiliary/ Emergency Generator Rooms

As engine radiator is mounted on an external bulkhead of the room (direct driven fan by engine), the Ventilation System shall be composed by one supply fan (1 x 100%) to operate when the Diesel Generator is not running and guarantee 6 air changes per hour in the room.

The necessary engine cooling and combustion air will be supplied by radiators fan.

Engine exhaust gases shall be discharged directly to the outside through dedicated exhaust ducts.

Air intakes and exhaust ducts shall be correctly designed in order to avoid the entrance of water inside the rooms.

7.2.4. Painting Shop and Painting Store

Ventilation Systems for the Paint Shop and Paint Store shall have a dedicated Mechanical Supply/Exhaust Systems. All HVAC equipment shall be installed outside the room.

7.2.5. Galley

HVAC System for Galley shall be according to the following criteria:

- Negative pressure inside the Galley compared to the adjacent rooms, in order to avoid any odour spread;
- The air exhaust shall be done through the hoods;
- A Mechanical Ventilation System shall be installed to supply an additional air flow. It shall supply the air next to the hood to not overload the cooling capacity of the existing Air Conditioning System;
- Air conditioning system shall be 100% fresh air, without air return;
- Air conditioning, supply and exhaust ventilation systems shall be dedicated to the Galley only.

Exhaust fans shall be located and installed outside the compartment, as close as possible to the air outlet to atmosphere.

The exhaust shall be through the hood and follow ASHRAE design criteria.

The hood exhaust fans shall be centrifugal type and single inlet to avoid the risk of contact between the hood exhaust air and the fan electric motor. It also shall have inspection hatch and a drain on the lower part of the fan casing.

The minimum air speed in the exhaust ducts shall be 7.5 m/s.

Exhaust duct must follow the shortest route to outside. Horizontal portions must have a 3% minimum slope down, from the fan towards the hood, in order to improve the grease drainage. Depending on ductwork arrangement more drainage points might be necessary. These additional drainage points (minimum dia. 100 mm) shall be provided along the ductwork considering 2 meters from nearest access hatch.

If the exhaust duct path is external to Galley but internal to accommodation area, the ducts shall be constructed and installed as per item 8.13 - Air Ducts. No duct branch shall be installed inside a shaft.

Fire dampers shall be the automatic type and shall be installed:

- On each hood connection flange, between the hood and the exhaust air duct;
- On the exhaust air duct, where it penetrates the bulkhead leaving the Galley, as required by IMO MODU CODE and Classification Society;
- Close to the exhaust fan air intake.

The Fixed Fire-fighting Extinguishing System serving the Galley hoods and exhaust air ducts shall serve the grease exhaust air duct and hoods. If there is another duct branched off (wet and/or dry) from the grease duct, they must be isolated with remote controlled fire damper prior to Fire-Extinguishing System release.

When a Fire-fighting Extinguishing System in both hood and exhaust duct (between two fire dampers) is supplied, if there is fire, the Fire-Extinguishing System shall automatically shut down all the fans and close the fire dampers in the Exhaust System.

All HVAC systems must have push button switches installed in their respective rooms to shut down all the running equipment in case of emergency. The interlock between the air exhaust and supply equipment of the system must be observed.

7.2.6. Laundry

Air conditioning system shall be 100% fresh air, without air return. Mechanical ventilation shall be used for exhaust air. HVAC systems shall be dedicated to the Laundry only.

The fans shall be located outside the Laundry. The exhaust fans shall be installed as close as possible to the air outlet to the atmosphere or in the drier itself.

The exhaust ducts from the drier shall be routed directly to the outside of the Laundry, preferably following a straight line, observing the maximum allowable pressure loss required by the drier fans. If it is not possible, the Laundry Exhaust System shall be able to exhaust the air from these equipment.

The ISO 15138, “Laundry Systems” topic shall be followed for drying machines.

The air distribution inside the Laundry shall be designed to avoid uncomfortably zones to the occupants.

Two (02) sets of filters with high efficiency and high accumulation capacity, disposable or easily cleanable, shall be installed in the drier exhaust duct. One set shall be installed inside the drier (originally supplied by the equipment manufacturer), and the other set shall be installed as close as possible to the Laundry Room partition.

7.2.7. Welding Room

The Ventilation System calculation shall consider all welding equipment installed inside the room for the thermal load and the airflow calculation besides other criteria of minimum ventilation airflow. It is not acceptable to consider only the minimum flowrate criteria.

Ventilation shall be capable of extracting the welding smoke from the room. Two (02) articulated flexible arm ducts attached to their respective centrifugal fans, shall be installed. One (01) articulated flexible arm duct shall be installed to attend the welding workbench for smoke and soot extraction and another (01) articulated flexible arm duct shall be installed to attend the cutting table.

Each articulated flexible arm duct shall have a manual shut-off damper installed on the suction air opening.

The gas cylinders for the welding operation shall not be installed inside the room.

7.2.8. Other Areas

For rooms not mentioned in this document, the Ventilation System shall comply with the design criteria of Classification Society, IMO MODU CODE and with a similar room in this Technical Specification and approved by Petrobras.

7.3. Air Conditioning Requirements

For occupied rooms where the air conditioning is used for comfort purposes, it is recommended that temperature differential between the room occupied zone and the air supply temperature shall be 10 K. Temperature gradients within the room shall be minimized.

For proper comfort conditions the maximum air velocity shall not exceed 0.25 m/s in the occupied zone.

The return grilles shall be sized considering maximum air speed as per Table 4 – Air return maximum velocity.

Table 4 – Air return maximum velocity

Grille Location	Air velocity (m/s)
Cabins	1.5 to 3.0
Other Rooms	1.5 to 4.0

7.3.1. Laboratory

Air conditioning system shall be 100% fresh air, without air return. Mechanical exhaust air shall be used for hoods and bonnets. HVAC systems shall be dedicated to the Laboratory only.

Hoods and bonnets maximum opening areas shall comply with the values laid out on I-DE-3010.2Q-5250-944-P4X-003 - HVAC SYSTEM - M-15B - LABORATORY - D&ID general notes. The recommended face speed (0.51 m/s) for air flow calculation shall be according to ASHRAE Laboratory Design Guide 2nd Edition.

The Laboratory main supply AHU shall have VSD to comply with all internal operation conditions.

After been removed the moisture of the fresh air in the cooling coil, the air shall be reheated to be supplied to the ductwork of the Laboratory.

All HVAC systems must have push button switches installed in their respective rooms to shut down all the running equipment in case of emergency. The interlock between the air exhaust and supply equipment of the system must be observed.

7.3.2. Electrical Room / Automation Room / Control Room

Air conditioning systems for the essential rooms shall be independent from those provided to the regular rooms.

During an emergency condition, the backup equipment for Central Control Room, Telecom Room and Radio Room shall be provided by one package unit (self-contained unit) and shall be considered as an essential safety service.

7.3.3. Galley

See item 7.2.5.

7.3.4. Accommodation

Accommodation shall be slightly pressurized and designed to operate without build-up of high pressure by providing pressure relief dampers where necessary. The system design shall include suitable quantity of fresh air to maintain a positive pressure in the building and to meet the air change requirements of designated POB.

Openings used for air balance or return air in the bulkheads are not allowed. It shall be considered door grille according to IMO MODU CODE 2009 and Classification Society requirements.

In corridor bulkheads “B” Class Divisions, ventilation openings may be permitted only in and under the doors of cabins, public spaces, offices and sanitary spaces. The openings should be provided only in the lower half of the door. Where such an opening is in or under a door, the total net area of any such opening(s) is not exceed 0.05 m^2. When such an opening is cut in a door it should be fitted with a grille made of non-combustible material.

7.3.5. Other Areas

If any room is not specified in this document, the design criteria shall be based on a similar room and approved by Petrobras.

7.4. Interface with other systems

7.4.1. General Remarks

For HVAC essential loads definition, see DR-ENGP-M-I-1.3- Safety Engineering., chapter 7.8.2 – Emergency Loads.

7.4.2. HVAC Machinery Room

The drains for HVAC rooms shall be fitted with siphoned outlets. For dimensioning siphoned outlets height, it shall be considered the differential pressure between ambient and drain piping outlet. The room floor shall be suitable for withstanding dripping and eventual floods (water piping leakage).

HVAC machinery room shall have a draining system with enough capacity to sustain any liquid leakage (chilled water and cooling water systems) inside the room.

Except for the HVAC air inlets and outlets, any other opening in closed rooms such, e.g. cable and piping orifices, shall be fully closed up and sealed, to avoid air infiltration or leakage.

Machinery Rooms shall have acoustic treatment (acoustic insulation partitions) in order to guarantee noise levels below the maximum acceptable in the neighborhood areas.

7.5. Application of Dampers

7.5.1. Fire and Gas Dampers

a) Criteria for Application

Application and installation of dampers shall be based on the recommendations of IMO MODU CODE and Classification Society requirements.

Wherever classified fire bulkheads are penetrated by ducts, fire-proof dampers shall be provided according to IMO MODU CODE and Classification Society.

All fire and gas dampers shall fulfil the tightness damper requirements.

b) Installing Fire Dampers

Dampers shall be installed on the side of the partition that is not subject to fire hazards.

The inspection opening shall be externally protected but easy to open, and its location shall be clearly indicated.

Standard dimensions dampers shall preferably be used.

7.5.2. Balancing Dampers

These dampers are intended to regulate the airflow and may be installed in the main ducts and/ or in the branches.

They are to be installed in readily accessible locations and shall be hand-controlled. They shall have devices for fixing the units in any intermediate position.

7.5.3. Non-Return Dampers

Intended to allow the airflow in only one direction. They shall be gravity type actuated by the weight of their own blades which close with the airflow in the opposite direction. Normally used at the fan and air conditioning units outlets, to avoid short-circuiting of air between the operating and the stand-by equipment.

7.5.4. Tightness dampers

Intended to ensure tightness of air ducts and openings.

7.5.5. Modulating Dampers

These dampers control quantities of supply and recirculated air in recirculation HVAC Systems.

7.5.6. Pressure-Relief (manual) and Pressure-Control (mechanical) Dampers

These dampers are supposed to maintain internal pressurization of the various compartments at the desired levels and to offset increased pressure loss occurring in all filters.

Pressure relief dampers should have parallel action blades controlled automatically by tension spring or counterbalanced weight, set to restrict blade opening until pre-set pressure is exceeded. The pressure relief set point should be site-adjustable.

7.6. Filters and Drop Eliminators

7.6.1. Filters

The filtering systems shall be composed of one or two stages depending on the required filtration level for the respective rooms. See Table 3 – Air Filter Class.

Filters efficiency shall comply with requirements of ISO16890.

The fresh air filters shall be installed in the HVAC Systems air intake downstream of the Drop Eliminators and upstream of dampers and fans.

The filters shall be selected for maximum surface speed of 2.5 meters per second.

The maximum pressure loss for clean and dirty coarse filters shall be 60 Pa and 180 Pa, respectively.

Maximum pressure losses for clean and dirty fine filters shall be 190 Pa and 450 Pa respectively.

7.6.2. Drop Eliminators

Drop Eliminators shall be installed in all fresh air intakes, upstream of the filters, to reduce the mist concentration with high humidity and salinity, reduce water aspiration and soaking of air filter, thus increasing the duration and extending the period of the respective campaigns of the filters.

Drop Eliminators shall have 96% efficiency according to requirements of ISO 15138 - Petroleum and Natural Gas Industries — Offshore Production Installations — Heating, Ventilation and Air-Conditioning Second Edition, ANNEX A – Equipment and Bulk Selection, item A.3.2.

The airflow speed through the Drop Eliminator shall be 1.5 to 4.0 m/s, and the maximum air pressure shall be 60 Pa.

7.6.3. Sound Attenuators

Sound Attenuation along the ductwork, if necessary, shall be made through the insertion of a pre-manufactured Sound Attenuator. No Sound Attenuator shall be installed for the Galley exhaust system.

The Sound Attenuators shall be used for the noise control on the suction/discharge of fans and air conditioning units until the noise level comply with I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements.

The Sound Attenuators shall be installed as close as possible to the fans.

7.7. Controls

7.7.1. Control Panels

The control operations shall be performed by two (2) panels and shall comply with the following requirements:

a) CSS (Control and Safety System).

Located in the CCR/AEPR. The CSS is not included in the scope of supply of the HVAC System Packager.

This station performs the safety interlock functions and the resetting of the HVAC System.

b) Field Panel

Field panels shall be located close to the respective equipment.

All data and information from the field panel, as indicated in the I-DE-3010.2Q-5250-944-P4X-001 – HVAC System – Typical Schemes, I-ET-3010.00-1200-800-P4X-002 - Automation, Control and Instrumentation on Package Units. and I-ET-3010.2Q-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS shall be updated at Topsides SOS, in a time period not longer than two seconds. The unit field control panel shall also recognize commands from Topsides CSS in a time period no longer than one second.

Proper field operation facilities shall be foreseen on the panel for field operation and monitoring.

Outdoor field control panel cabinet shall be made of AISI 316L - painted (electrostatic or liquid epoxy), including the control system box.

All instrumentation and control signals shall be installed on the field control panels, which shall be interconnected within the skid limits by Packager.

All devices, equipment and accessories mounted inside the panel shall be installed with easy access for tests, calibration and maintenance, without using special tools and allowing proper air circulation among all items to avoid over-heating. The identification tags of the terminal connectors shall be clearly visible. The minimum free space between PLC/electronic components and cable trays shall be of 60 mm.

The field panel shall be provided interconnected to all instruments, sensors and final devices regarding the Unit, including provision for interconnection to the electrical system. Back up equipment shall have independent control panels.

All instrumentation and panels related to HVAC Packages shall fully comply with requirements of I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-ET-3010.2Q-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS.

As a minimum, in addition to signals foreseen in P&IDs, D&IDs and this Technical Specification, all interface signals required in I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-ET-3010.2Q-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS shall also be foreseen in field panels.

> Note: Interface signals contact types shall comply with requirements of I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.
> Interposing relays shall be installed on the HVAC Package System Side.

All devices, components and accessories shall be adequate to operate with the following power supply specification:

- Maximum voltage: 24 Vdc + 10 %
- Minimum voltage: 24 Vdc – 15 %
- Internal lighting: 220 Vac ± 10 %, 60 Hz

The external power supply shall be according to I-ET-3010.00-5140-700-P4X-003 - ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

Portuguese language shall be used in all controllers` HMI screens.

7.7.2. Fans

The start-up/stop logic for the fans shall be as follows:

1. Manual start-up of one of the fans with automatic opening of all fire and tightness dampers of the system.
2. If the airflow is still low after the elapsing of approximately ten (10) seconds from start-up of the main fan, it shall be automatically switched off and the stand-by fan (if it exists) shall start up automatically.
3. If the airflow is still low after the elapsing of approximately thirty (30) seconds from start-up of the second fan (stand-by), this fan shall also be automatically

disconnected, an alarm must be sent to SOS-HMI and all the fire and tightness dampers shall be automatically closed.

4. During normal operation, if the air flow is low for approximately ten (10) seconds, the fan shall be automatically switched off, the stand-by fan (if it exists) shall start up automatically and the logic implements the “step 3” above.

Pressure switches (PSL or PSH) for operation confirmation shall be installed on the discharge duct in an easily visible and accessible position.

7.7.3. Air Handling Units

The control function for each unit shall be executed at the Field Control Panel.

The start-up/stop logic for the fans shall be as follows:

1. Manual start-up of one of the fans with automatic opening of all fire and tightness dampers of the system.
2. If the airflow is still low after the elapsing of approximately ten (10) seconds from start-up of the main fan, it shall be automatically switched off and the stand-by fan (if it exists) shall start up automatically.

If the airflow is still low after the elapsing of approximately thirty (30) seconds from start-up of the second fan (stand-by), this fan shall also be automatically disconnected, an alarm must be sent to SOS-HMI and all the fire and tightness dampers shall be automatically closed.

The fan operation shall be independent of chilled water flow operation, i.e. the air conditioning unit shall be able to be used for ventilation alone.

The temperature control for the served rooms shall be accomplished by means of a temperature indicating transmitter (TIT), installed in the return air duct of the air handling unit or in the supply duct, if the system operates with 100% fresh air. To control the temperature, the TIT will actuate a proportional electric 2-way valve.

For module M-16B`s AHUs, 3-way mixing valves shall be used for room temperature control, instead of 2-way valves.

Pressure switches (PSL or PSH) for operation confirmation shall be installed preferably inside equipment`s cabinet, where feasible, or equipment discharge duct in an easily accessible position.

Room Fan-Coil Unit

In case of room fan-coil, a digital thermostat, with 3 speed selector, temperature display and temperature setting button, installed in the ambient will actuate a 2-way ON-OFF solenoid valve. Room fan coils do not have Field Control Panels by Automation discipline, and do not interact with the supervisory system of the Unit (SOS).

7.7.4. Self-Contained Air Conditioning Units (DX Air Handling Units)

The control function for each unit shall be executed at the Field Control Panel.

The temperature control for the served rooms shall be accomplished by means of a thermostat, installed in the return air duct. The thermostat will actuate on the compressor's capacity.

The minimum devices and the start-up/stop logic for the fans shall be the same as described in the fan description item.

There shall be a control logic interlocking arrangements between the fan(s) and the compressor(s), to make sure that the compressor(s) is(are) not started up or operating without the fans also running. This condition shall be verified also during the normal operation.

For water-cooled air conditioning units, there also shall be a control logic interlocking device to make sure that the compressors cannot be turned on unless there is water flowing through the condensers. The interlocking arrangement shall consist of a flow switch installed in the cooling water line, at the outlet from the condensers. The control of the cooling water flow shall be effected by a regulating valve, which will adjust the flow of the water to keep condensing pressure constant.

The Field panel shall also contain the following:

- General circuit-breaker (panel supply);
- Power Indicator light;
- Complete electrical functional unit (starter) for each motor;
- Air conditioning unit shutdown with visual alarm of high pressure at compressor discharge (manual resetting);
- Air conditioning unit shutdown with visual alarm of low oil differential pressure at the compressors (manual resetting);
- Air conditioning unit shutdown with visual alarm of low cooling water flow (manual resetting);
- Shutdown of refrigeration (compressors) and visual alarm of overload on the respective motors (manual resetting);
- Shutdown (optional) of compressors by the action of a pressure switch;
- Shutdown of refrigeration with visual alarm of low suction pressure of compressors (automatic resetting);
- Selection of automatic/manual mode;
- Compressors and fans operation indicator;
- Indication if the oil heaters of the compressor crankcase are turned on during the periods in which compressors are turned off (when applicable).

The fans control shall be independent of the compressors control, i.e. the air conditioning unit may also be used for ventilation only, through a remote signal from CSS, if necessary.

There shall be a minimum interval of five (5) minutes between shutdown and start-up of the same compressor.

The SOS-HMI shall contain the indication of the units operation, normal shutdown and shutdown caused by failure (without the cause indication), from the field panel.

7.7.5. Fire Dampers

Dampers control, according to the SOLAS rules, shall be effected by means of:

- Field manual operation from both sides of the partition (for tests and regular operation), marked with reflective red paint;
- Field automatic action through the effect of a thermal fuse, set off at a temperature of 74°C (144°C for Galley dampers), provided the ambient air or temperature conditions do not call for a higher triggering temperature. In such cases the triggering temperature shall be, at least, 20°C higher than the respective maximum operational air temperature or ambient temperature.

There shall be an air back-up cylinder with enough air capacity to perform two operations of each pneumatic fire-damper. At the bottom of the cylinder it shall be installed a valve to provide manual bleed of compressed air condensate trapped at this cylinder.

The instruments for the damper field operation (solenoid valve, compressed air regulating filter and valves) shall be installed on a Field Panel for suitable protection of these items. This panel shall be installed on the partition side that is not exposed to fire hazards, and shall be as close as possible to the fire damper.

Fire dampers with simultaneous operation may have a common panel/valve set.

The field manual control on the partition side that is exposed to the fire hazard may be attached to the bulkhead itself. The site and the device itself shall be marked with reflective red paint.

It is advisable to use a single control and operation system to operate all fire and tightness dampers in the same safety zone.

The fire dampers shall also have automatic remote control from the CSS-FGS. The units actuating the damper shall be designed in such a manner that it is not possible to re-open the sealing element by remote control if the damper is being closed down by the effects of the thermal fuse.

The signalling of the damper actuator position on the Field Panel shall imply effective closing of the damper blade (through a signal by the magnetic limit switches) and not mean that the signal to close was transmitted to the damper.

There shall be logical interlocking arrangements between the fans start-up and shutdown and the respective fire dampers, closing the dampers when the fan stops and opening the dampers when the fan is requested to start-up. When the dampers are confirmed open, then the fan shall be commanded to start.

7.7.6. Gas Tight Dampers

The gas tight dampers shall be automatically and manually remote closed in case of fire or gas detection. Additionally, it shall be manually controlled on site for tests and regular operation.

There shall be logical interlocking arrangements between the fans start up and shutdown and the respective gas tight dampers, closing the dampers when the fan stops and opening the dampers when the fan is requested to start-up. When the dampers are confirmed open, then the fan shall be commanded to start.

The instruments for field operation of the damper (solenoid valve, compressed air regulating filter and valves), shall be installed on a Field Panel for a proper protection of these items.

7.7.7. Modulating Dampers with Electrical Control

The damper control shall be proportional, effected by an electrical operating device. The opening degree shall depend on a differential transmitter signal sent to an indication and control unit, which operates the activating device. The dampers also shall have devices allowing manual adjustment.

The control instruments are to be installed on a field panel supplied by the manufacturers of the HVAC System.

7.7.8. Chilled Water Units

The control of the Chilled Water Units shall be carried out in one or more Local Control Panel. It shall be a P2 package.

This (these) panel (s) shall contain, at least, the following:

- General switch (panel supply);
- Power Indicator light;
- Unit shutdown and visual alarm in case of high pressure at the compressors discharge (manual resetting);
- Unit shutdown and visual alarm on low suction pressure of compressors (automatic resetting);
- Unit shutdown and visual alarm in case of low oil pressure differential at the compressors (manual resetting);
- Unit shutdown and visual alarm in case of compressor motors overload (manual resetting);
- Unit shutdown and visual alarm in case of low chilled water temperature at the unit outlet (manual resetting);
- Unit shutdown and visual alarm in case of low chilled water flow (manual resetting);

- Unit shutdown and visual alarm in case of low cooling water flow (manual resetting);
- Manual start-up/ shutdown of compressors;
- General Chilled Water Units control shall establish the automatic start-up and shut-down order according to the system requirements. It shall allowed to an operator to locally change the start-up and shut-down sequence. It is not necessary to establish a stand-by mode for a Chilled Water Unit;
- Compressor running indication;
- Indication of the operating point (capacity control - 100%, 75%, 50% etc.);
- Indication that the oil heater in the compressor crankcase is turned on during periods when the unit is turned off;

There shall be an interval of, at least, five (5) minutes between shutdown and the next start-up of the same compressor.

Electrical interlocking arrangements shall be provided on the Local Panel, so as to prevent start-up of the unit being the chilled water pump out of operation and without having water flow through the condenser and evaporator.

The local panel shall have a sequenced control system establishing the order of start-up and shutdown of the units. The operator shall be capable of locally changing this start-up/ shutdown sequence.

7.7.9. Chilled Water Pumps

The Local Control Panel for the pumps may be the same as for the chilled water units or else may be an independent one. Either way, it is in Chilled Water Unit scope of supply to provide this panel, interconnect it with the Chilled Water pumps, and to provide the logic of the whole Chilled Water System (Chilled Water Pumps + Chilled Water Units).

The primary chilled water pumps shall be interconnected with the chilled water units, so that any unit can only start-up if a chilled water pump is running.

The local panel shall have a sequenced control system establishing the order of start-up and shutdown of the pumps. The operator shall be capable of locally changing this start-up/ shutdown sequence.

The local pump panel shall display the pump operation indication.

8. HVAC EQUIPMENT DESIGN

8.1. General Remarks

All equipment shall be delivered fully assembled and tested, ready to be installed, with the water, gas, oil, refrigerant etc initial loads.

An Operation and Maintenance (O&M) manual shall be supplied with all equipment. The package shall make the applicable recommendations to optimize operation and maintenance, considering the location and conditions. All equipment shall be supplied with all required components and accessories for safe, economical and efficient operation and maintenance.

All equipment and devices shall have the required maintenance area, not occupied by other items, which will vary according to the items, maintenance routine and equipment parts to be removed during the maintenance procedure.

All static equipment shall comply with NR-13 requirements, whenever it is applicable.

All dampers and actuators (fire dampers and gas tight dampers) shall have suitable access to operation and maintenance.

Ergonomic aspects shall follow requirements of I-ET-3010.2Q-1400-196-P4X-001 - Ergonomic Requirements for Topsides. The recommended mounting heights shall comply with the images 1, 2 and 3 of the same document. Also, the I-ET-3010.2Q-1350-196-P4X-002 - Ergonomic Requirements for Hull shall be considered. Access stairways shall be designed to achieve recommended mounting heights, if necessary. Fire and Tightness dampers shall be classified as Category 2, while non-return and manual dampers shall be classified as Category 3.

All utilities that feed HVAC Systems (compressed air, cooling water and chilled water) shall follow the established requirements in their respective P&IDs.

Aluminium materials shall be ASTM B211 either for drawing or swage, and either ASTM B26 or B108 for casting.

All carbon steel bolts, nuts and washers located at outside areas shall be 8-12% Ni balanced Zn coated, according to ASTM B841, class 1, type B/E, grade 10. For indoor areas (air treated by HVAC Systems), they may follow the equipment, component or duct material specification, such as hot dip galvanized steel, stainless steel (316 L) etc. Whenever applicable, the baking treatment to remove hydrogen prior to service is mandatory, with effectiveness according to ASTM F 1940.

HFC or non-flammable HFO refrigerant fluids shall be used. HFC Global Warming Potential (GWP) shall not exceed 1500. Non-flammable (Ashrae Safety Group A1) HFO blend refrigerant fluids shall be preferably used due to its low GWP (not exceeding 600) and HFC future phase down.

All equipment shall be suitable to operate in a marine atmosphere.

Air cooled equipment (chillers, self-contained, condensing units etc.) shall not be used, neither cooled by means of sea water.

All equipment, component and device installed outdoors shall be prepared to avoid water accumulation.

All equipment`s data/identification plates shall be positioned to allow an easy reading of all information without scaffolding or ladders.

All rotating equipment shall have flexible connections at its inlet and discharge to minimize vibration transfer to other systems' components.

All AHU, fan and fan box shall have shut-off dampers for maintenance of the respective equipment.

All pressure vessels shall be designed according to I-ET-3010.00-1200-540-P4X-001 - Requirements for Pressure Vessels Design.

All equipment and materials shall be painted according to:

a) I-ET-3010.00-1200-540-P4X-001 - Requirements for Pressure Vessels Design.
b) I-ET-3010.00-1200-956-P4X-002 - General Painting.
c) DR-ENGP-I-1.15 – Color Coding.

For control stations and service spaces, paints, varnishes and other finishes used on exposed interior surfaces shall comply with Classification Society Rules.

8.1.1. Identification

All HVAC equipment shall have nameplates. This plate shall be stainless steel AISI 316 made with a 1.5 mm minimum thickness and shall be fixed by stainless steel bolts or fasteners at a visible and accessible site. It shall include, at least, the following information (in Portuguese and in English):

- Petróleo Brasileiro S.A. – Petrobras;
- Manufacturer' s name;
- Serial number;
- Manufacture Year;
- Main data for design, operation and testing (Power, Pressure, Volume, Temperature, Rotation, Flow rate, Filter Class etc.), where applicable;
- Specific requirements;
- Installation identification;
- Equipment TAG;
- Purchase Order Number;
- Empty Weight;
- Hydrostatic test water requirements - when applicable;
- Potential Risk Group Category as per NR-13 (for pressure vessels and shells of Shell & Tube Heat Exchanger identification must be painted on body of the vessels and shall be visible at a distance of at least 5.0 m);
- Equipment Datasheet document number;
- Electrical Data.

8.2. Air Handling Unit - AHU

Units shall be draw-thru type.

Start-up shall be manual and automatic.

Units shall be supplied with the following accessories:

- Integrated electric and control panel;
- Anti-vibration devices for fans and electric motors;
- Inspection doors for filters, cooling coil and fan;
- Belt stretchers;

- Air filter pressure drop sensor with indication (magnetic type, one for each filter section);
- Lighting inside each AHU section for maintenance.
- All equipment doors shall have magnetic limit switch to shut down the equipment as soon as the door is opened

All Air Handling Units shall have Ultraviolet Germicidal Irradiation (UVGI) lights inside that use short-wave ultraviolet (UV-C) energy to inactivate viral, bacterial, and fungal organisms. The UV-C effectiveness irradiance and exposure time (UV-C dose) shall comply with germicidal purpose for airstream disinfection.

It shall be provided safety devices to avoid human exposition to ultraviolet light. The installations shall comply with the following items:

- The UVGI can only operate if the equipment is running;

- There shall have an outside and visible nameplate, attached to the equipment external casing and in Portuguese language, warning the UV-C light human exposition. This nameplate shall follow the same requirements of all equipment nameplate, specified in the item 8.1.1;
- There shall have an indicator informing if the UVGI have malfunctioning, to avoid unnecessary human exposition to ultraviolet lights only to ensure the proper operation of the banks of UVGI;
- The technical criteria and all operational information, e.g. the air exposition time, maximum air speed etc, shall be informed and approved by Petrobras;
- The UVGI shall be installed in the cooling coil section in order to reduce the growth of bacteria and mold-contained biofilms on damp or wet surfaces such as cooling coils, drain pans, plenum wall, fans and filters;
- The material and components exposure to UV-C light irradiance shall be suitable for this work, in order to avoid material degradation.

8.2.1. Composition

The Air handling unit is basically composed of the following sections:

- Filter and air mixing section;
- Water cooling coil, UV-C lights, drop eliminator and drip tray;
- Electric motor and fan section, built on a galvanized steel frame.

8.2.2. Filter requirements

See chapter 7.6 and chapter 8.12

8.2.3. Casing

The casing shall consist of removable sandwich panels, built of steel sheet, provided with attachment devices to ensure complete tightness and access doors. For units installed in open areas, the casing shall be built in stainless steel AISI 316L. For sheltered areas, the external casing shall be built in galvanized steel. The internal sheet of all units shall be made of stainless steel AISI 316L, regardless of the equipment location.

Structural frames shall be built in AISI 316 for equipment installed in open areas.

For equipment installed in sheltered areas frames shall be built in anodized aluminium.

The minimum thickness for the external sheet shall be gauge 22 and for the internal sheet shall be gauge 16. The upper panels shall be reinforced to not be easily damaged during the construction, assembly and maintenance stages.

Internal thermal-acoustic insulating material shall be at least 50 mm thick, of non-combustible type, CFC and HCFC free, not releasing toxic gases when in the presence of flames and with a thermal conductivity of at most 0.04 W/m.K (0.034 Kcal/h.m°C).

The drip tray shall be built of gauge 14 stainless steel AISI 316 sheet, insulated with FEF 25 mm thick on the outside to avoid condensation. Drainage outlets shall be provided on both sides of the Unit, in such a way that air does not pass through it (water seal). Drip tray height shall consider Unit motions (pitch, roll) and accelerations, and submitted for Petrobras approval. Alternatively, a central conical skid drain may be supplied.

The drain pipe shall be insulated (minimum thickness 15 mm) and routed to the nearest drain point. There shall be two drain pipes at opposite sides of the unit, each one with a siphon for water sealing. Drain insulation shall follow the same criteria of chilled water piping.

Collecting trays shall be built in stainless steel AISI 316 and shall be installed under valves and hydraulic connections. The water shall be leaded to the drainage network.

Equipment shall be externally painted according to I-ET-3010.00-1200-956-P4X-002 - General Painting.

The bottom of the Air Handling Unit (AHU) is positioned on a steel skid frame and shall be bolted on top of another frame, which is welded on the deck. If the equipment arrangement demands an AHU installed above another AHU, then a proper structure shall be installed to withstand the weight forces of the upper AHU. The bottom AHU shall not be used as the upper AHU structure.

8.2.4. Cooling and De-Humidifying Coil

It shall be built of seamless copper tubing according to ASTM B111 or ASTM B68, with the fins made of copper. To make sure that the tubes are in full contact with the fins, the tubes shall be mechanically swaged after the fins have been assembled in the correct position.

The headers shall be built in copper, with the holes for insertion of the tubes pressed and spun to avoid shearing.

The refrigerant feed and discharge manifolds (DX AHU) shall be built in copper, welded to the coil tubes and located on the same side; they shall be fitted with breathers and drainage connections.

The air speed on the face area of the tubes shall not exceed 2.5 meters per second. There shall not be drop eliminators downstream of the cooling coil.

A maximum 6 rows coils is allowed. Two chilled water cooling coils shall be installed in series if were necessary more than 6 rows coils. Spaced each other for at least in 800 mm to provide easy cleaning access.

The chilled water cooling coil shall be selected with minimum and maximum pressure drop respectively 10 kPa and 30 kPa.

The two-way proportional temperature control valve shall have authority upon to hydraulic system for a suitable chilled water flow control.

It shall be avoided horizontal chilled water piping branches with high and low points layout, to avoid trapped air. If it is not possible, vents shall be installed in the high piping points to purge all trapped air, with access for maintenance.

AHU that treats and delivers 100% of fresh air shall have to remove humidity and reheat the air. After the fresh air moisture removal, the air shall be reheated to be supplied to the ductwork. A group of 3 electrical resistances, staggered in series and controlled by TRIAC Solid State Relays (SSR), shall be installed after cooling coils.

A manual vent shall be mounted externally and on the highest point of the cooling coil to perform the air purging.

8.2.5. Fan

The fans shall be centrifugal and limit load type, double inlet.

The fans shall be V-belt driven (115% capacity) and motors shall be installed inside the fan compartment.

The remaining characteristics shall be according to the centrifugal fans item 8.10, except the casing thickness, which can be supplied with 1.5 mm thickness.

The fans shall allow 15% variation of the rated airflow by pulley adjustments. The electric motor shall be suitable to this condition.

Maximum discharge speed shall be limited to 10 m/s.

Items 8.10 or 8.11 requirements shall be followed, whichever is applicable.

8.2.6. Inspection and Tests

There shall have Inspection Reports for the manufacturing stages, static and dynamic balancing, performance tests and final manufacture's inspection. Petrobras shall be invited to all inspection stages.

8.3. Self-Contained Units – SCU (DX Air Handling Units)

Self-contained units supply requirements are shown in the item 8.2, since these equipment shall be treated as a composition of an Air handling unit (with refrigerant gas cooling coil) with a Condensing unit.

8.3.1. Compressors

Compressors shall be hermetic or semi-hermetic, scroll type with COP shall have a minimum value of 3.5.

When applicable, the compressors shall be fitted with automatic capacity control, arranged for unloading start-up.

The capacity control shall be by continuous unloading system.

Service valves in the suction and discharge sides shall be provided. An oil level sight glass and a crankcase heater shall be provided.

Compressors connected in parallel should be equipped with oil-equalizer and crankcase pressure-equalizer lines, to maintain lubrication under all operating conditions.

There shall be an automatic device for receiving the gas when the compressor is shutdown.

Means shall be provided to ensure proper lubrication during pitching and rolling and permanent list and trim. The lubricating system may be of the forced-feed type or using high-to-low-side pressure differential to provide lubrication oil feed. The compressor oil sump shall be electrically heated to minimize the accumulation of refrigerant in the oil during off-cycles.

An accumulation tank shall be installed at compressor suction.

A high efficient vertical oil separator shall be installed at compressor discharge.

If the cooling capacity is bigger than 26 kW, multi-circuit refrigeration system (two or more independent circuits) shall be specified.

Due to voltage drop limits during motor start, the maximum acceptable rated power for each individual motor using direct-on-line start is 55 kW. This limitation shall be considered to define the quantity of compressor units. It is acceptable alternative solution using soft-starter, included in Manufacturer's scope of supply and with liability confirmed by Electrical Studies.

Transmissions shall be direct type.

8.3.2. Condensers

The condensers shall be shell-and-tube type and the cooling fluid shall be fresh water (closed circuit).

A 2-way globe proportional temperature control valve (TCV) shall be supplied and installed in the fresh water piping outlet side controlled by a water temperature indicating transmitter (TIT) in order to avoid low temperature at inlet side. This 2-way valve shall be normally closed when equipment is not operational.

Condensers shall be designed with the water flowing inside the tubes (with maximum speed of 2.4 meters per second) and allow suitable sub-cooling of the refrigerant at the outlet. Pressure loss in the water circuit shall be kept as minimum as possible. It shall never exceed 50 kPa.

A minimum fouling factor of 1.7×10^{-4} m^2 K/W shall be considered.

The condensers shall be sized to operate with 5.5 K maximum cooling water temperature differential.

Construction shall comply with ASME and API STD 660 standards, built in the following materials:

- Tubes: seamless copper according to ASTM standard B111, with integrated fins.
- Shell and covers: ASTM A 106 grade B carbon steel or ASTM A-285 grade C carbon steel.

The unit shall have a safety valve, service valves in the gas and liquid lines, draining and purging valves, side covers removable for cleaning purposes and a laterally inserted coupon type sacrificial anode. Tube spool type sacrificial anodes shall not be used.

The condensers PMTA shall be compatible with the cooling water pump shut-off pressure.

8.3.3. Refrigerant Lines

Each refrigerant line shall be built in copper, according to ASTM B88.

All refrigerant piping shall be properly insulated to prevent water condensation or undesirable heat transfer. Piping insulation shall be properly protected against moisture by the application of a suitable sealing material. An external mechanical protection built in stainless steel AISI 316 shall be provided.

Flexible connection shall be installed between inlet piping flanges, shell flanges and outlet piping flanges.

Each circuit shall have, at least, the following components (if applicable for the compressor type):

- expansion valve:
  - To maintain proper refrigerant flow;
  - To be built so as to permit dismantling for repair or replacement of internal components without need for disconnection from the refrigerant line;
- solenoid valve:
  - To be open when energized and closed when de-energized;
  - To be designed to be opened by hand in case of a breakdown in power supply;
- liquid level sight glass with humidity gauge;
- drying filter (threaded connection);
- suction and discharge pressure indicators (for each compressor);
- oil differential pressure indicator (for each compressor);

- high and low side pressure relief devices.
- service valves, in suction and discharge sides of compressors;
- service valves, in liquid lines;
- high refrigerant pressure gauge, with Ø 100mm analogic display;
- low refrigerant pressure gauge, with Ø 100mm analogic display;
- DoP (difference of potential) 3-phase electricity tension Volt gauge (Voltmeter), with Ø 100mm analogic display;
- 3-phase electric current Ampère gauge (amperemeter), with Ø 100 mm analogic display.
- Flow-switch at the cooling water inlet.

8.4. Refrigeration Condensing Units Racks (Cold Storage Rooms)

It shall be supplied two (2) refrigeration condensing unit racks (2 x 100%) for cold storage rooms.

The cooling water system (fresh water) shall have the same operation mode (normal and/or essential loads electric distribution) as the refrigeration system.

18 hours cool down time shall be factored into the cold storage rooms cooling capacity sizing.

8.4.1. Compressors

One compressor shall be installed for each refrigeration rack.

Compressors shall be hermetic or semi-hermetic, reciprocating type.

If the cooling capacity is bigger than 18 kW, multi-circuit refrigeration system (two or more independent circuits) shall be specified.

When applicable, the compressors shall be fitted with automatic capacity control, arranged for unloading start-up.

The capacity control shall be by continuous unloading system, depending on the compressor type. Automatic capacity control at the compression system shall be supplied. For reciprocating compressor unloading solenoid valve at compressor header shall be used. If scroll compressor is used, vendor shall detail the capacity control capacity for PETROBRAS approval.

An oil level sight glass and a crankcase heater shall be provided (if applicable).

Compressors connected in parallel should be equipped with oil-equalizer and crankcase pressure-equalizer lines, to maintain lubrication under all operating conditions.

There shall be an automatic device for receiving the gas when the compressor is shutdown.

Means shall be provided to ensure proper lubrication during pitching and rolling and permanent list and trim. The lubricating system may be of the forced-feed type or using high-to-low-side pressure differential to provide lubrication oil feed. The compressor oil sump shall be electrically heated to minimize the accumulation of refrigerant in the oil during off-cycles.

An accumulation tank shall be installed at compressor suction.

Due to voltage drop limits during motor start, the maximum acceptable rated power for each individual motor using direct-on-line start is 55 kW. This limitation shall be considered to define the quantity of compressor units. It is acceptable alternative solution using soft-starter, included in Manufacturer's scope of supply and with liability confirmed by Electrical Studies.

Transmissions shall be direct type.

8.4.2. Cooled Water Shell and Tube Condensers

The condensers shall be shell-and-tube type and the cooling fluid shall be fresh water (closed circuit).

A 2-way globe proportional temperature control valve (TCV) shall be supplied and installed in the fresh water piping outlet side controlled by a water temperature indicating transmitter (TIT) in order to avoid low temperature at inlet side. This 2-way valve shall be normally closed when equipment is not operational.

Condensers shall be designed with the water flowing inside the tubes (with maximum speed of 2.4 meters per second) and allow suitable sub-cooling of the refrigerant at the outlet. Pressure loss in the water circuit shall be kept as minimum as possible. It shall never exceed 50 kPa.

A minimum fouling factor of 1.7×10^{-4} m^2 K/W shall be considered.

Construction shall comply with ASME and API STD 660 standards, built in the following materials:

- Tubes: seamless copper according to ASTM standard B111, with integrated fins.
- Shell and covers: ASTM A 106 grade B carbon steel or ASTM A-285 grade C carbon steel.

The unit shall have a safety valve, service valves in the gas and liquid lines, draining and purging valves, side covers removable for cleaning purposes and a laterally inserted coupon type sacrificial anode. Tube spool type sacrificial anodes shall not be used.

The condensers shall be sized to operate with 5.5 K maximum cooling water temperature differential.

The condensers PMTA shall be compatible with the cooling water pump pressure.

8.4.3. Refrigerant Lines

Each refrigerant line shall be built in copper, according to ASTM B88.

All refrigerant piping shall be properly insulated to prevent water condensation or undesirable heat transfer. Piping insulation shall be properly protected against moisture by the application of a suitable sealing material. An external mechanical protection built in stainless steel AISI 316 shall be provided.

Flexible connection shall be installed between inlet piping flanges, shell flanges and outlet piping flanges.

Each circuit shall have, at least, the following components (if applicable for the compressor type):

- Expansion valve:
  - To maintain proper refrigerant flow;
  - To be built so as to permit dismantling for repair or replacement of internal components without need for disconnection from the refrigerant line;
- solenoid valve:
  - To be open when energized and closed when de-energized;
  - To be designed to be opened by hand in case of a breakdown in power supply;
- liquid level sight glass with humidity gauge;
- oil level sight glass at the low side of the compressors;
- drying filter (threaded connection);
- service valves;
- suction and discharge blocking/service valves;
- suction and discharge pressure indicators (for each compressor), with Ø 100 mm view display;
- cooling water pressure indicators (for entering and leaving side of the condenser), with Ø 100 mm view display;
- oil differential pressure indicator (for each compressor), with Ø 100 mm view display;
- electrical indicators measures (current and voltage), with Ø 100 mm view display;
- high and low side pressure relief devices;
- pressostats / pressure switches (suction, discharge and oil differential pressure) shall be installed;
- Suction pressure regulators to equalize pressures from cold chambers to freeze chambers;
- Manual purging oil points with blocking valves and subsequent screwed plugs (double blocks) shall be installed bellow suction, liquid and manifold headers.
- Flow-switch at the cooling water inlet.

The return (suction) header from the (5) evaporators shall have an inverted U 180° trap interconnecting the vertical header to the horizontal compressors suction header. At each 3,5 meters of falling vertical suction pipe shall be installed a S-Trap.

The horizontal header for feeding liquid refrigerant shall have an inverted U 180° trap interconnecting the vertical header to liquid supply of the (5) evaporators. An inlet pipe with edge shall be penetrated at the horizontal header. The purpose is to deliver any remaining oil, that was not separated at the discharge oil separator, in gush to the evaporators. It shall be installed points of collecting trapped oil on the horizontal headers.

After the condensers, at the vertical liquid pipe, it shall be installed a check valve to prevent hydraulic chocks during off period.

A pipe trunking, near the (5) cold/freeze chambers, shall contain both horizontal liquid and suction manifold headers. Access to the (5) solenoid valves, blocking and service valves shall be installed. External (5) HMI/TIT, one for each evaporator for each cold/freeze chamber, shall be installed.

Equalizer valves shall be installed to equalize pressure between low temperature and medium/high temperature suction lines.

8.4.4. Lubricating system prevention against 6 types of ship motions at sea

A high efficient vertical vortex oil separator shall be installed at each compressor discharge. Equalizing oil systems shall be installed integrating both compressor of the respective refrigeration rack.

The whole refrigerant systems, specially lubricating systems, shall be sized to support and have continuous operations at those six conditions: Heaving, pitching, surging, rolling, yawing and swaying.

Units shall be prepared to operate under all types of ship motion according to I-RL-3010.2Q-1350-960-P4X-002 – Motion Analysis.

8.5. Room Fan-coil Unit - FCU

The casing shall consist of removable sandwich panels of galvanized steel panels (minimum thickness of 0.95 mm) painted externally according to item 8.1. Casing shall be thermally and acoustically insulated with non-combustible and non-toxic material, CFC and HCFC free, with a thermal conductivity of at most 0.04 W/m.K. The fan/motor assemblies shall be mounted on heavy gauge galvanized structure.

Panels shall cover all sides of the unit and shall be designed to allow easy access to the filters, drain pans, fans and motors.

These removable panels shall be supplied with devices to ensure anchorage to structure and equipment tightness. Equipment shall have inspection doors for every section to allow a proper maintenance.

Fans and electric motors shall be mounted on galvanized steel structure correctly dimensioned to withstand equipment operation. All dynamic equipment must be supplied on anti-vibration devices.

Fan-coil unit systems require frequent maintenance, which is done in occupied areas. Unit accessibility is very important when performing routine maintenance such as filter replacement (require frequent changing to maintain air volume), coil and drain pans cleaning and motor lubrication. Water valves, controls and dampers should also be checked for proper calibration, operation, and needed repairs. FCU shall be selected and located with consideration for required maintenance.

The suitable FCU ceiling access hatch (ceiling inspection doors) shall be considered to allow a full FCU inspection and maintenance space (cooling coil, drain pans, UV-C light, control panel, junction box, fan motor, pipe and valves assembly etc).

FCU air filter shall be installed attached to return grilles to allow easy filter replacement.

Air filter dimensions shall be clearly informed in equipment data sheet.

The drain pans shall be made of stainless steel AISI 316 plate, with minimum thickness of 1.2 mm, with fully welded corners and shall be provided with two drain connections. The drain pans height shall be calculated considering the Unit motions and submitted for Petrobras approval. The minimum height shall be 50 mm. The drain pans shall be externally insulated with FEF (minimum thickness 25 mm). Alternatively, a central conical drain may be supplied.

The drain pipe shall be insulated and routed, inside the compartment bulkheads, to the nearest drain point. There shall be two drain pipes at opposite sides of the unit, each one with a siphon for water sealing. Drain insulation shall follow the same criteria of chilled water piping. Drain insulation thickness shall be at least 15 mm.

Collecting trays shall be supplied under valves and hydraulic connections and the water shall be lead to the drainage network.

The cooling coil shall be built of seamless copper tubing according to ASTM B111, with fins made of copper. To make sure that the tubes are in full contact with the fins, the tubes shall be mechanic ally swaged after the fins have been assembled in place.

All Fan-Coil Units shall have Ultraviolet Germicidal Irradiation (UVGI) lights inside that use short-wave ultraviolet (UV-C) energy to inactivate viral, bacterial, and fungal organisms. The UV-C effectiveness irradiance and exposure time (UV-C dose) shall comply with germicidal purpose for airstream disinfection.

It shall be provided safety devices to avoid human exposition to ultraviolet light. The installations shall comply with the following items:

- The UVGI can only operate if the equipment is running;
- There shall have an outside and visible nameplate, attached to the equipment external casing and in Portuguese language, warning the UV-C light human exposition. This nameplate shall follow the same requirements of all equipment nameplate, specified in the item 8.1.1;

- There shall have an indicator informing if the UVGI have malfunctioning, to avoid unnecessary human exposition to ultraviolet lights only to ensure the proper operation of the banks of UVGI;
- The technical criteria and all operational information, e.g. the air exposition time, maximum air speed etc, shall be informed and approved by Petrobras;
- The UVGI shall be installed in the cooling coil section in order to reduce the growth of bacteria and mold-contained biofilms on damp or wet surfaces such as cooling coils, drain pans, plenum wall, fans and filters;
- The material and components exposure to UV-C light irradiance shall be suitable for this work, to avoid material degradation.

Fan and motor assemblies shall be high quality and low noise and vibration levels. The fan shall be double inlet, double width, and centrifugal type. Three main speeds motor shall be used. The fan housing shall be made of heavy gauge galvanized steel plate. The forward curved rotor shall be statically and dynamically balanced for smooth and quiet operation.

Supply grilles shall be installed on vertical surfaces. When supply air is made through ceiling void, diffusers shall be used. The number of outlet ways of the diffuser shall be selected according to the design HVAC arrangement, to avoid air draft or uncomfortably zones in the room. The maximum air velocity shall not exceed 0.25 m/s in the occupied zone.

The temperature and the fan speed control shall be made with a digital thermostat, installed inside the attended room.

The chilled water cooling coil shall be selected with minimum and maximum pressure drop respectively 10 kPa and 30 kPa.

The two-way on/off temperature control valve shall have authority upon to hydraulic system for a suitable chilled water flow control.

A vent piping shall be mounted externally and on the highest point of the cooling coil to perform the air purging.

It shall be avoided horizontal chilled water piping branches with high and low points layout, to avoid trapped air. If it is not possible, vents shall be installed in the high piping points to purge all trapped air, with access for maintenance.

8.6. Chilled Water Unit

Basically, the unit shall be a self package liquid chiller unit, including compressor(s), motors, shell-and-tube water-cooled condensers, shell-and-tube evaporators, electrical panel control & instrumentation, HMI, piping etc.

Each package unit shall be mounted on individual support base frames, complete with anti-vibration mountings and compressor acoustic enclosures.

Condensers and evaporators shall be fixed tube sheet, shell & tube heat exchangers type. Maintenance for both exchangers shall be on the same side.

The Chilled Water Units (liquid chiller) shall operate automatically and shall be capable of both continuous and intermittent duties with long idle periods. They shall be suitable for full-load operations and complete with integral automatic capacity control to maintain the desired capacity at any operating conditions.

The HMI shall show at least refrigerating parameters (pressure, temperatures, subcooling, superheater, compressor in operation, percentage of refrigeration) and electrical parameters (tensions and currents). Alarms, failures shall be showed. The HMI shall be maritime atmosphere protected.

Blocking valves shall be installed upstream of PIs.

8.6.1. Compressors

Compressors shall be hermetic or semi-hermetic, screw type and COP shall have a minimum value of 3.5. Manufacturer shall inform the performance at partial loads during the technical proposal phase.

When applicable, the compressors shall be fitted with automatic capacity control, arranged for unloading start-up.

The capacity control shall be by continuous unloading system, depending on the compressor type.

Service valves in the suction and discharge sides shall be provided. An oil level sight glass and a crankcase heater (if applicable) shall be provided.

Compressors connected in parallel should be equipped with oil-equalizer and crankcase pressure-equalizer lines, to maintain lubrication under all operating conditions.

There shall be an automatic device for receiving the gas when the compressor is not running.

Means shall be provided to ensure proper lubrication during pitching and rolling, and permanent list and trim, if the unit is a ship. The lubricating system may be of the forced-feed type or using high-to-low-side differential pressure to provide lubrication oil feed. The compressor oil sump shall be electrically heated to minimize the accumulation of refrigerant fluid in the oil during off cycles.

An accumulation tank shall be installed at compressor suction.

A high efficient oil separation scrubber shall be installed at compressor discharge.

If cooling capacity is greater than 35 kW, multi-circuit refrigeration system (two or more independent circuits) shall be specified.

Due to voltage drop limits during motor start, the maximum acceptable rated power for each individual motor using direct-on-line start is 150 kW. This limitation shall be considered to define quantity of compressor units. It is acceptable as an alternative solution using a soft-starter, included in Manufacturer's scope of supply and with liability confirmed by Electrical Studies.

8.6.2. Condensers

The cooling fluid shall be fresh water (closed circuit).

Condenser control valve shall be mounted on the water outlet of the condenser. The valve shall be controlled by the condensing pressure in the condenser and shall be interlocked with chiller operation (closed when compressor is off).

The condensers PMTA shall be compatible with the cooling water pump shut-off pressure.

8.6.2.1. Fresh water cooled condensers

They shall be designed with the water in the tubes (at a maximum speed of 2.4 meters per second) and allow suitable sub-cooling of the refrigerant at the outlet. Pressure loss in the water circuit shall be kept in a minimum and in any case shall exceed 50 kPa.

A minimum fouling factor of 1.7×10^{-4} m^2 K/W shall be considered.

The condensers shall be shell-and-tube type.

The condensers shall be sized to operate with 5.5 K maximum cooling water temperature differential.

Construction shall comply with ASME and API STD 660 standards, with the following materials being used:

- Tubes: seamless copper according to with ASTM standard B111, with integrated fins.
- Shell and covers: ASTM A 106 grade B carbon steel or ASTM A-285 grade C carbon steel.

The unit shall have a refrigerant pressure relieve safety valve PSV, service valves in the gas and liquid lines, draining and purging valves, side covers removable for cleaning purposes and a laterally inserted coupon type sacrificial anode. Tube spool type sacrificial anodes shall not be used.

8.6.3. Evaporators

The Evaporators shall be designed to support refrigerant expansion, which will circulate inside the tubes, while the water circulates in the shell.

The shell shall be fitted with baffles to increase heat transfer as much possible.

The Evaporators shall be externally insulated to avoid condensation. The insulation material shall be made of non-inflammable material, and it shall have a vapour seal and an external mechanical protection of stainless steel AISI 316 sheet.

The Evaporators shall have drain and purge valves in the shell, removable side covers for cleaning and a side insertion coupon type sacrificial anode. Tube spool type sacrificial anodes will not be acceptable.

If not specified, a fouling factor of 0.9×10^{-4} m^2K/W shall be considered. Pressure loss in the water circuit shall be kept as minimum as possible and in shall never exceed 60 kPa.

The evaporator chilled water leaving and entering temperatures shall be respectively 6ºC and 12ºC.

The Evaporators shall be built in the following materials:

- shell and covers: ASTM A 106 grade B carbon steel or ASTM A285 grade C carbon steel;
- tubes: Copper, according to ASTM B 111;
- tubesheet: Carbon steel ASTM A-516;
- baffles: steel ASTM A 36.

8.6.4. Refrigerant Lines

Each refrigerant fluid line shall be built in copper according to ASTM B88.

All refrigerant fluid piping shall be properly insulated where required to prevent condensation or undesirable heat transfer. Piping insulation shall be properly protected against moisture by application of suitable sealing material. An external mechanical protection built in stainless steel AISI 316 shall be provided.

Flexible connection shall be installed between inlet piping flanges, shell flanges and outlet piping flanges as well.

Each circuit shall have, at least, the following components (if applicable for the compressor type):

- electronic expansion valve:
  - To maintain proper refrigerant flow;
  - To be built so as to permit dismantling for repair or replacement of internal components without need for disconnection from the refrigerant line;
- solenoid valve:
  - To be open when energized and closed when de-energized;
  - To be designed to be opened by hand in case of a breakdown in power supply;
- liquid level sight glass with humidity gauge;
- drying filter (threaded connection);
- service valves;
- suction and discharge pressure indicators (for each compressor);
- oil differential pressure indicator (for each compressor);
- high and low side pressure relief devices;

A high efficient vertical vortex oil separator shall be installed at each compressor discharge. Equalizing oil systems shall be installed integrating both compressor of the respective refrigeration rack.

The hole refrigerant systems, specially lubricating systems, shall be sized to support and have continuous operations at those six conditions: Heaving, pitching, surging, rolling, yawing and swaying.

Units shall be prepared to operate under all types of ship motion according to I-RL-3010.2Q-1350-960-P4X-002 – Motion Analysis.

Easy access for oil collection (oil preventive analyses), with pipes and valves, shall be installed.

Preventing long time storage between purchasing and start-up, the oil shall be exchanged if the liquid chiller equipment (CHILLER) stay stopped for a year or more.

8.7. Chilled Water Piping

Chilled water piping insulation material shall be Flexible Elastomeric Foam (FEF) according to the requirements of item 6.2 of the I-ET-3010.2Q-1200-200-P4X-001-Piping Specification for Topsides.

To avoid condensation on the pipe supports or penetration pieces, it shall be installed an insulated prefabricated pipe supports, or the vapor barrier shall be extended up to a minimum length of 3 times the insulation thickness on the support area. Thermal insulation shall not be sectioned for piping supporting.

The installation of automatic vents at all high points and drains at all low points is mandatory for any piping, if those showed on the P&IDs are not sufficient/suitable.

It shall be avoided horizontal chilled water piping branches with high and low points layout, to avoid trapped air. If it is not possible, vents shall be installed in the high piping points to purge all trapped air, with access for maintenance.

8.8. Chilled Water Pumps

They shall be centrifugal type, with scroll ("volute"), a closed-in rotor, a cast-iron casing and directly driven by an electric motor drive.

Pump shall comply with the requirements of ANSI B73-1 Standards.

For more details, see I-ET-3010.00-1200-310-P4X-003 – ASME B73 Centrifugal Pumps Specification.

The secondary circulation pumps systems shall be driven by VSDs.

8.9. Expansion Tank

The atmospheric expansion tank shall be considered. It shall be installed at least 1.0 meter above the highest point of chilled water system.

The minimum volume of the tank shall be equal to 6% of the total water volume in the chilled water system.

At least the following accessories shall be included in the tank:

- Reflex type level sight glass;
- One Level indicator transmitter (LIT) to monitor the expansion tank water level and operate the water feed solenoid at 60% (open water feed solenoid) and 80% (close water feed solenoid). LIT shall alarm at 30% (LAL), 90% (LAH) and 95% (LAHH). To detect leaks in the chilled water system, if the expansion tank water feed solenoid valve opens twice within 24 hours, a leak warning should be indicated in the CSS.
- A second Level indicator transmitter (LIT) to ensure operational continuity. LIT shall alarm at 20% (LALL) and shutdown the chilled water system at 10%.
- Fresh water feed point with solenoid valve and by-pass with globe valve;
- Drain point with gate valve;
- Drainage piping at high point (overflow device).

For tanks material, see the I-ET-3010.2Q-1200-500-P4X-001 – Material Specification for Topside Systems Pressure Vessels and Tanks.

8.10. Centrifugal Fans

8.10.1. General Remarks

Fans shall be V-belt driven (unless otherwise specified) by electrical motor, limit load, and shall have non-sparking construction, according to AMCA requirements and approved by the Classification Society. Fans located in classified areas or handling potentially explosive or flammable particles, fumes or vapours shall comply with AMCA 99 requirement type B and CS requirements. For other fans, type C may be used.

Equipment shall have inspection doors to improve the maintenance.

The fans shall be fitted with a grease inlet and outlet nipple for each motor and fan bearing. It shall be possible to inject grease from outside the equipment.

Belts and pulleys must be protected with belt guards, easily removable. The belt guard shall have an opening for tachometer use.

Impellers shall be protected by an inlet screen, easily removable.

Fans shall have V-belt pulleys balanced with the minimum of 2 and the maximum of 3 V-belts per drive.

The centrifugal fans shall be designed to operate continuously.

Fan bearings shall have a design life of at least 40,000 hours.

Fan bearings shall have heavy duty housing and heavy duty self-aligning ball or spherical roller bearings pillow block type with grease lubrication.

For accessibility, the lubrication fittings shall be mounted on the support gussets. Lube lines of nylon or copper tubing shall be run to the bearings.

The centrifugal fans and electric motor shall be assembled on the same steel frame. The steel frame shall be mounted with anti-vibration devices, helical spring type with a minimum efficiency of 80%.

The centrifugal fans shall have flexible coupling installed wherever any connection flange is attached to a rigid structure, e.g. air duct, fan box, plenum box etc.

Equipment shall be static and dynamic balanced.

The electric motor shall be mounted on steel guide rails to allow belt tension to be adjusted.

Discharge speed shall not be higher than 10 m/s.

The efficiency shall be equal or higher than 70%.

The fan start-up shall be manual and automatic.

8.10.2. Fan box

The fan box casings shall consist of removable panels built of steel sheet, provided with attachment devices to ensure the complete tightness and access doors. The casing shall be built in stainless steel AISI 316L, regardless of the equipment location.

Structural frames shall be built in AISI 316L for equipment installed in open areas.

The minimum thickness for the sheet shall be gauge 16.

Fan box shall be supplied with filters, according to item 8.12.

Lighting inside for each section for maintenance shall be indicated.

8.10.3. Fan Casing

The fan casing shall be built of shall be built in carbon steel ASTM A 653 with 3 mm thickness, supported by a steel frame cabinet made of ASTM A 653. An exception shall be considered to Laboratory exhaust fans, which shall be made of polypropylene (other polymeric material or stainless steel AISI 316 may be used, conditioned to the Classification Society approval).

The fan casing shall be fitted with a drain at the lowest point and an inspection opening. The air ducts, dampers or other devices which should connect to the fan suction or discharge shall have steel flanges for the respective attachments.

8.10.4. Impeller

The blades shall be built in carbon steel, ASTM A 653, or cast Aluminium, ASTM B26 or B108, according to AMCA and Classification Society requirements (non-sparking classification), backward inclined type. An exception shall be considered to Laboratory Exhaust fans, which shall be made of polypropylene (other polymeric material or stainless steel AISI 316 may be used provided that Classification Society approves). It shall be statically and dynamically balanced for the maximum efficiency and silent operation according to ISO 1940 and ISO 14694. Fans with driver power equal to or less than 37 kW (BV-3) shall meet balance quality grade G 6.3, while fans with driver power higher than 37 kW (BV-4) shall meet balance quality grade G 2.5.

8.10.5. Shaft

The shaft shall be built in ASTM A322 Gr. 4140 steel.

8.10.6. Surface Treatment

The casing, impeller (except if aluminium is used) and base shall be protected against corrosion and the marine atmosphere by pickling and hot galvanization.

8.10.7. Inspection and Tests

There shall be provided Inspection Reports of the dimensional inspection and balancing (static and dynamic).

8.11. Vane-Axial and Tube-Axial Fans

8.11.1. General Remarks

Fans shall be direct driven by electric motors and shall have non-sparking construction approved by Petrobras, AMCA and the Classification Society. Fans located in classified areas or handling potentially explosive or flammable particles, fumes or vapours shall comply with AMCA 99 requirement type B and Classification Society requirements. For others fans, type C may be used.

The fans shall be designed to operate continuously.

The fans and the electric motor shall be assembled on the same steel frame. The steel frame shall be mounted with anti-vibration devices, helical spring type with a minimum efficiency of 80%.

Equipment shall be static and dynamic balanced.

Minimum efficiency of 70% shall be guaranteed.

The fan start-up shall be manual and automatic.

8.11.2. Casing

It shall be built of welded carbon steel sheet at least 3 mm thick.

The fan casing shall be provided with inspection openings and support for electric motor.

The fans shall be fitted with a grease inlet and outlet nipple for each motor bearing.

The casing shall be fitted with a mushroom when it is vertically and outdoor installed. The mushroom shall be built in the same material as the casing.

Flanges shall be provided at the suction and discharge openings.

It shall be provided counter flange with wire guard mesh in stainless steel AISI 316 in the axial fan air inlet to avoid the suction of flexible connection in case of damage.

8.11.3. Impeller

The blades shall be built in carbon steel, ASTM A 653, or cast Aluminium, ASTM B26 or B108, according to AMCA and Classification Society requirements (non-sparking classification). It shall be statically and dynamically balanced for maximum efficiency and silent operation according to ISO 1940 and ISO 14694. Fans with driver power equal to or less than 37 kW (BV-3) shall meet balance quality grade G 6.3, while fans with driver power higher than 37 kW (BV-4) shall meet balance quality grade G 2.5.

8.11.4. Shaft, Surface Treatment and Identification

The same requirements for centrifugal fans shall be applied.

8.11.5. Inspection and Tests

There shall be provided Inspection Reports of the dimensional inspection and balancing (static and dynamic).

8.12. Air Filters and Drop Eliminators

8.12.1. Air Filters

8.12.1.1. General Remarks

All filter casings shall be built in stainless steel AISI 316, except those installed inside the air handling units and fan-coil units, which shall be built in the same material of air handling units interior.

Each filtering element shall be attached to a metal frame, which shall be built in stainless steel AISI 316.

Each frame shall be designed to permit an inter-connection with other frames and an erection frame to form a complete filtering panel and to permit an easily replacement of the filter element.

The sealing material of all gaskets shall be non-toxic and fireproof or self-extinguishing.

Air filters shall be provided with dimensions according to usual international/Brazilian market standards.

8.12.1.2. Pre-Filters

In the filtering system selection, the following premises shall be considered:

- The filtering elements shall be disposable type. The useful life shall be specified by manufacturer;

- The filtering elements shall be made of fire-retarding or self-extinguishing material, not releasing toxic gases in the presence of flames and not releasing fibres.

When installed in ducts, the filter panels shall be of drawer type, to permit an easily replacement of the filter element, without removing air ducts and/or inspection doors.

When installed in the air ducts or boxes, there shall be an inspection door for replacement, maintenance and cleaning procedures.

8.12.1.3. Fine Filters

These filters may be panel type or bag type and shall be installed in frames similar to those used for the coarse filters. It also shall be installed downstream of the coarse filters.

In the filtering system selection, the following premises shall be taken into account:

- The filtering elements shall be disposable type. The useful life shall be specified by manufacturer.
- The filtering elements shall be made of fire-retarding or self-extinguishing material, not releasing toxic gases in the presence of flames and not releasing fibres.

When installed in the air ducts or boxes, there shall be an inspection door for replacement, maintenance and cleaning procedures.

8.12.2. Drop Eliminators

The Drop Eliminator shall consist of crimped vertical plates, spacers, body, flange connection to connect to the bulkheads, air filtration systems or air ducts) and drip tray.

It shall be easily accessible for cleaning and maintenance and each Drop Eliminator shall have the following maximum dimensions:

- height: 1000 mm
- width: 1000 mm

When the airflow is too high, the Drop Eliminator shall be divided into two or more independent parts to not exceed the maximum dimensions per part. The set of Drop Eliminators shall be rigid enough to be mounted as a single panel.

The Drop Eliminators shall be fully built in stainless steel AISI 316.

8.13. Air Ducts

8.13.1. General Remarks

The air ducts shall be designed and built according to the ASHRAE and SMACNA standards.

The air duct layout / arrangement shall consider the best practices indicated in the ASHRAE and SMACNA standards to avoid high pressure loss and noise level, allowing a suitable airflow balancing and adjusting of the systems.

Classified air ducts shall be constructed according to SOLAS and Classification Society requirements.

Whenever an air duct crosses a classified bulkhead, the penetration piece shall have enough thickness and insulation, to achieve the same bulkhead classification, according to SOLAS and Classification Society requirements.

Welded penetration sleeves shall be installed wherever the air ducts pass through bulkheads or decks, even if it is not required by the safety classification, in order to render these penetrations air-tight.

Inspection/access doors shall be installed along HVAC ducts on each 10 meters length. An exception shall be considered for the Galley, where it shall be installed on each 4 meters length. The ducts inside Battery Rooms, Paint Shop, Paint Stores and Laboratory shall not have inspection doors. Inspections/access doors shall have the minimum dimensions of 600 mm x 600 mm, if the air duct size allows. If not, the door shall have the maximum dimensions allowed.

The air speed in the supply ducts shall be specified according to ISO 15138 and comply with noise levels defined in I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements.

The air ducts shall have smooth transitions and shall have a maximum slope angle of 30 degrees. The first elbow downstream the fan outlet shall have, whenever possible, the same flow direction of the fan rotation.

Whenever possible, accessories and fittings connection, e.g. elbows, dampers, plenum box, shall have a minimum distance from each other equal to six circular equivalent duct diameters.

Whenever possible, non-return dampers shall have a minimum distance from the fan outlet equal to one circular equivalent duct diameter.

Elbows and transitions downstream the fan outlet shall be placed at a minimum distance of 1.5 x L, where L is the largest duct dimension.

8.13.2. Construction

Material selection shall comply with ISO 15138.

The external air ducts, or any other air duct affected by marine atmosphere, shall be built in welded stainless steel AISI 316L sheets, except exhaust ducts mentioned in the next paragraph. The internal air ducts (inside a module or a room, without natural ventilation, protected from marine atmosphere and wind action) shall be built in hot dip galvanized steel sheets.

Exhaust ducts with welded joints due to tightness requirements, such as Battery Room and Galley, shall be built in carbon steel plate. The thickness shall comply with the Classification Society requirements and SOLAS.

Exhaust ducts for laboratory equipment (hoods and bonnets) shall be built of stainless steel plate AISI 316L.

The air ducts crossing openings at main deck structure shall be built in carbon steel and shall comply with the Classification Society requirements. In these ducts, the openings shall be positioned above the watertight line according to the requirements of Classification Society.

All ducts shall be painted externally, except those installed over the ceiling void in Accommodation Module. For the insulated air ducts, the painting shall be applied to the insulation mechanical protection, except those installed over the ceiling void in Accommodation Module. If the internal part is not built in galvanized steel or stainless steel AISI 316L, it shall be painted according to I-ET-3010.00-1200-956-P4X-002 - General Painting.

All air ducts for exhaust system of Battery Room, Galley, Paint Shop, Paint Store and Laboratory shall be built air-tight.

The internal surfaces of the air ducts shall be free and uncluttered, without protuberances or obstructions, with flanged joints of the same duct material.

The side joints of the air ducts shall have complete sealing arrangements to ensure the necessary tightness in the system. All joints and crimps or bends in the sheeting shall be given rustproofing treatment.

All rectangular ventilation ducts with sides measuring over 500 mm shall have their faces reinforced by cross breaking. For the insulated ducts, only the insulation mechanical protection shall have cross breaking.

The changes in the direction of the duct branches shall be performed with curves, constructed with a minimum ratio of 100 mm, and/or elbows, both with deflector vanes (exception to the Galley hood exhaust, which shall not have deflector vanes), with proper dimensions and spacing to maintain an uniform airflow speed. The deflectors shall be built in gauge 18 sheet, whatever is the sheet gauge used to construct the air duct itself.

The collars which connect the air duct to the supply openings shall have extractors to help balancing the airflow in the system.

8.13.3. Thickness of Ducts

For rectangular air duct made of stainless steel AISI 316L sheet (SMACNA Recommendation), see Table 5:

Table 5 - Rectangular ducting made of stainless steel sheet

LARGEST DIMENSION OF DUCT	LOW SPEED (up to 10m/s) LOW PRESSURE (up to 500 Pa)	LARGEST DIMENSION OF DUCT	HIGH SPEED (over 10 m/s) MEDIUM PRESSURE (over 500 Pa to 1500 Pa)	HIGH SPEED (over 10 m/s) HIGH PRESSURE (over 1500 Pa to 2500 Pa)
(mm)	USSG	(mm)	USSG	USSG
0 – 1350	22	0 - 1200	22	22
1360 – 2100	20	1210 - 1800	20	20
2110 – 2400	18	1810 -2400	18	18
		> 2440	18	16

For circular ducting made of stainless steel sheet for low-pressure systems (SMACNA recommendations), see Table 6.

Table 6 - Circular ducting made of in stainless steel sheet for low-pressure systems

DUCT DIAMETER	DUCTS WITH SPIRAL JOINTS	DUCTS WITH LONGITUDINAL JOINTS	ACCESSORIES (ELBOWS, TEES ETC.)
(mm)	USSG	USSG	USSG
0 – 700	22	22	22
710 – 900	22	20	20
920 - 1300	20	18	18

For circular ducting in stainless steel sheets for high-pressure systems, see Table 7.

Table 7 - Circular ducting in stainless steel sheets for high-pressure systems

DUCT DIAMETER	DUCTS WITH SPIRAL JOINTS	DUCTS WITH LONGITUDINAL JOINTS	ACCESSORIES (ELBOWS, TEES ETC.)
(mm)	USSG	USSG	USSG
0 – 200	22	22	22
210 – 550	22	22	20
560 – 900	22	20	20
910 - 1250	20	20	18
1260 -1500	-	18	18
1510 - 2100	-	16	16

For ducting made of galvanized steel sheets (SMACNA recommendation), see Table 8:

Table 8 - Ducting made of galvanized steel sheets (reference pressure class 1000 Pa)

DUCT POSITION	LARGEST DIMENSION OF RECTANGULAR DUCT OR DIAM. OF CIRCULAR DUCT (mm)	mm
HORIZONTAL OR VERTICAL (PROTECTED)	0 a 300	0.85
	301 a 400	1.00
	401 a 600	1.31
	> 600	1.61

For other higher-pressure ratings, see SMACNA standards.

Galley ducts thickness shall also follow SOLAS requirements.

8.13.4. Hanger and Supporting Members

The air duct supports shall be constructed of carbon steel trapezoidal supporting members or steel corner-pieces, spaced according to SMACNA Standards.

8.13.5. Adjustments

Manual balancing/regulating dampers shall be provided in branches ducts take-offs. The damper shall be of opposed-blade type, capable of being manually adjusted and locked at any position. Single-blade damper may be used for air ducts with any single dimension equal or smaller than 250 mm. Splitter type (flow divider) dampers shall be avoided.

8.13.6. Connections

Each air duct connection to any dynamic equipment shall be carried out with a flanged flexible connection, built in non-combustible materials. The flange shall be built of gauge 20 steel sheet. The flexible connection shall have high mechanical strength.

The connection between any dynamic equipment and the air duct shall be centre-aligned. The flexible connection shall not be used to correct a misalignment or a dimensional difference between connections. The flexible connection length shall not exceed 150 mm.

Mechanical joint fitted in classified Class "A" ducts is to be Class "A" approved under Fire Test Procedure Code or equivalent.

The connections between the ducts and the diffusers or grilles may be carried out with a flexible connection thermally insulated with glass fibre or similar and minimum thickness of 10 mm, allowing adjustment during the assembly to minimize small variations in the positions of the supply devices.

The flexible connection and the gaskets between flanges of air ducts which cross a classified partition shall attend the following requirements:

- Combustibility – both shall be of non-combustible material as Classification Society requirements;
- Fibre Release – both shall not release fibres and if that occurs, the fibres must not be toxic;
- Humidity – both shall resist the humidity and the marine atmosphere;
- Flexible connections shall be fire resistant certificated (FTP code);
- Flexible connections shall be UV resistant;
- Toxicity: all used material shall not give off toxic vapours when submitted to a temperature equal or less than 750ºC.

The contact between different metallic materials should be insulated to prevent galvanic corrosion, e.g. air duct supports and air ducts surface etc.

8.13.7. Thermal and Acoustical Insulation

The insulating material shall have the following characteristics:

- Combustibility:

- Non-combustible material shall be used as Classification Society requirements;

- Toxicity:
  - The material shall not give off toxic vapours when submitted to a temperature equal or less than 750ºC;
- Humidity Resistant Qualities:
  - The material shall not spoil in contact with water nor trap water within itself;
- Thermal insulation shall also have a vapour seal and an external mechanical protection;
- Before the insulation material application, the surface of the air duct shall be completely clean and dry;
- The insulating material shall be attached to the ducts by applying two or more layers of glue to perform a perfect and complete adherence. No air shall keep between the air duct surface and the glued insulation material;
- The insulating material shall not display any discontinuity, including the flanged connection zones;
- The thermal conductivity of the material shall be, at most, 0.04 W/m.K (0.034 Kcal/h.m.ºC) at the insulation operating temperature. The density of the materials shall be, at least, 20 kg/m³. Insulated ducts shall be covered externally with aluminium sheet to form a vapour seal. Mechanical protection shall be provided for all insulated exposed duct. In case of external ducts, the mechanical protection shall be completely tight to avoid water penetration.
- The mechanical protection material shall be the same of the duct, with minimum thickness of 0.7 mm.

The Table 9 gives the minimum recommended thickness based in the criteria of "humidity condensation control on the outer surface of the insulation system".

Table 9 - Ducts insulation requirements **DUCTS**	**LOCATION** [1]	**MINIMUM RECOMMENDED THICKNESS (mm)**
Supply of conditioned air	Air-conditioned rooms	No insulation[2]
	Ventilated Rooms (Ta ≤ 40°C) [3]	25
	Open areas or Ventilated Rooms (Ta ≥ 40°C)	50
Ventilation supply or exhaust	Ventilated rooms	No insulation
	Air-conditioned rooms	25
Return of conditioned air and exhaust air from air-conditioned rooms	Air-conditioned rooms	No insulation [4]
	Open areas and Ventilated rooms [5]	25

Thermal insulation`s vapor barrier shall not have tears, cuts and perforations. All tears, punctures and other penetrations on thermal insulation`s vapor barrier shall be sealed with tape or mastic to provide a vapor-tight system.

[1] T_a = ambient temperature
[2] For Electrical / Automation rooms 25 mm insulation shall be considered
[3] Ducts installed within a ceiling void are included
[4] For Electrical / Automation rooms 25 mm insulation shall be considered
[5] Ducts installed within a ceiling void are included

8.14. Air Distribution Devices

8.14.1. General Remarks

All supply and exhaust/return openings inside any compartment shall be provided with an air distribution device. The use of flaps and screens or any improvised solution is not acceptable.

All indoor air distribution devices (diffusers, grilles, louvers) and balancing dampers shall be built of extruded aluminium sheets and frames shapes, anodized in natural colour and composed of ASTM-B 221/83 alloy 6063. For outdoors and aggressive ambient applications (corrosive atmosphere), the stainless steel AISI 316 shall be used.

All devices shall be provided with balancing dampers to improve the airflow balancing of the systems. The access to these dampers shall be provided via the frontal surface of the air outlet and it shall be possible to move the position of such items only by use of a special tool for this purpose.

When applicable, it shall be used plenum boxes installed with the diffusers or grilles.

Air conditioning supply in manned areas shall be always made by means of air diffusers when located on the ceiling. Except for electrical panels room that the air conditioning shall be supplied by grilles.

For manned areas with high air conditioning flow rate, such as CCR operation ambience, Laboratory equipment area etc, the swirl air diffusers type with perforated plate shall be considered to creates high induction levels, thereby rapidly reducing the airflow velocity and the temperature difference between supply air and room air, creating only very little turbulence in the occupied zone.

All air distribution devices shall be selected considering architectural layout (workstations, bulkheads, closets/lockers etc.) to select proper air direction.

Air distribution devices selection shall be based on manufacturer technical catalogue and be in accordance with technical requirements regarding noise level, terminal velocity, throw etc. Supply diffusers and grilles shall be selected to avoid high air velocities in occupied areas (draft).

8.14.2. Supply Grilles and Diffusers

Supply grilles shall be double deflection type, with independently adjustable blades and the vertical elements located in the front part of the grille and register.

Air conditioning supply grilles shall not be installed in the ceiling of occupied areas. For technical rooms (panels rooms) air conditioning supply grilles may be installed with or without ceiling. Only diffusers shall be used in the ceiling of occupied areas for air conditioning supply.

8.14.3. Return and Exhaust Grilles

These accessories may be of the single deflection type, with fixed blades.

Where specified, adjustable ventilation grilles, made of stainless steel AISI 316, shall be provided in the lower portion of the door leaf. Ventilation grilles, where provided, shall be certified to be used in B-15 doors, and acceptable to the Classification Society.

8.14.4. Louvers

These devices shall have fixed horizontal blades. When installed outdoors, it shall be built in stainless steel AISI 316.

8.15. Dampers

8.15.1. General Remarks

The blades, casing, shafts, etc shall be built of stainless steel AISI 316L.

Casing of all dampers shall have flanges suitably drilled for interconnecting with air duct networks or with other equipment parts.

If it is not possible to visualize from floor level the position of the damper blades, there shall be an external indication of the blade(s) position. The manufacturer shall be informed which position the indicator shall be installed.

All fire-gas and tightness dampers shall be fail-closed position in case of electrical or pneumatic supply fail. Except for Emergency Generator Room fire-gas and tightness dampers that shall be fail-open according to IMO MODU CODE and Classification Society.

8.15.2. Fire and Gas Dampers

8.15.2.1. Construction

The usage and installation of fire and gas dampers shall comply with IMO MODU CODE and Classification Society requirements. They shall be installed at the opposite side of the fire risk and shall have the same classification of the bulkhead where installed.

The fire and gas damper blades, casing, shafts, etc shall be built of stainless steel AISI 316L. Type-approved by Classification Society.

Blade damper shall close through a 72ºC (144ºC for Galley) fusible link, located inside the damper, acting a manual 3-way valve and in serial the 3-way solenoid valve. In such cases the triggering temperature shall be, at most, 20ºC higher than the respective air temperature or ambient temperature.

The damper is open when a non-opened fusible link is in position, 3-way solenoid valve is energized.

The shafts, bearings, rod, levers etc shall be built in stainless steel AISI 316.

For tubing specification, see I-ET-3010.00-1200-800-P4X-015 (REQUIREMENTS FOR TUBING AND FITTING).

Fire and Gas Dampers shall be driven by pneumatic actuator. The pneumatic actuator shall be built in stainless steel AISI 316. Damper actuators shall not contain moving parts built in plastic material.

The solenoid control valve shall be the automatic re-setting type.

The pneumatic operating device shall have a spring-loaded return (or closure) system made of AISI 316.

Fire and gas dampers shall have a magnetic type limit switch to indicate position open/close (external indication), with two SPDT for each position: ZSL - closed damper; ZSH - opened damper; IPW-55.

Leakage class shall meet Class 3 (for blades) and Class B (for case) in accordance with EN1751 and Classification Society.

The dampers shall ensure proper sealing and tightness to the airflow, fire-resistance and gas tightness according to the characteristics required by the Certifying / Classifying Authorities (“Type Approval”).

Easy access to damper shall be provided for inspection. The damper actuator shall be externally protected and shall have a position indication in an easily visible place.

For the Emergency and Auxiliary Generator rooms, the dampers access shall be possible without scaffolding or specific operational team. Both sets of air intake and exhaust fire dampers shall be easily operated manually in the event of a black start or any other situation where there is no compressed instrument air.

All fire dampers shall have a device provided by manufacturer for an easy manual operation.

For more details, see DR-ENGP-M-I-1.3- Safety Engineering.

8.15.3. Pressure Relief and Non-Return Dampers

The dampers shall have a rectangular shape and shall be built of parallel crimped blades, self-superimposed and attached on the top. The blades shall be controlled automatically by tension spring or counterbalanced weight, set to restrict blade opening until the pre-set pressure is exceeded. The pressure relief set point should be site-adjustable.

The blades shall be self-attached by a rod to have an uniform opening and avoid the detachment of blades.

The damper casing, shafts, blades, etc shall be built in stainless steel AISI 316L. The sealing elements of the fins shall be made of non-corrodible, incombustible and non-toxic material.

When the width is larger than 650 mm, the blades shall be divided, and a support shall be installed between the parts.

Leakage class shall meet Class 2 (for blades) and Class B (for case) in accordance with EN1751 and Classification Society.

8.15.4. Tightness dampers

The Tightness dampers blades, casing, shafts, etc shall be built of stainless steel AISI 316L. Type-approved by Classification Society.

The shafts, tubing, bearings, rod, levers etc shall be built in stainless steel AISI 316.

Tightness dampers shall be driven by pneumatic actuator. The pneumatic actuator shall be built in stainless steel AISI 316. The solenoid control valve shall be the automatic re-setting type.

The pneumatic operating device shall have a spring-loaded return (or closure) system made of AISI 316.

Tightness dampers shall have a magnetic type limit switch to indicate position open/close (external indication), with two SPDT for each position: ZSL - closed damper; ZSH - opened damper; IPW-55.

Leakage class shall meet Class 3 (for blades) and Class B (for case) in accordance with EN1751 and Classification Society.

The dampers shall ensure proper sealing and tightness to the airflow and gas tightness according to the characteristics required by the Certifying / Classifying Authorities.

When the width is larger than 1000 mm, the blades shall be divided and a support shall be installed between the parts.

8.15.5. Modulating Dampers

The blades and casing shall be built of stainless steel AISI 316 when located outdoors and galvanized steel for indoor locations.

The shafts, tubing, rod, levers etc shall be built in stainless steel AISI 316.

8.15.6. Regulating Dampers

The dampers shall have rectangular shape, with exception for dampers with diameter equal or smaller than 200 mm that shall follow duct shape. The blades shall be convergent type and an external regulate device shall be provided.

The blades and casing shall be built in stainless steel AISI 316 when located outdoors and galvanized steel for indoor locations.

For regulating dampers with diameter equal or smaller than 200 mm, the construction of the dampers shall be considered as a simple circular duct accessory.

8.16. Watertight Valves

Watertight valves shall be provided according to watertight limits specified by stability analysis, following ISO 15138 requirements.

Remote controlled watertight valves shall be installed wherever a HVAC air duct crosses a watertight bulkhead/floor or a sliding door on the side that is not subject to flood hazard. The duct between the valve and bulkhead shall have a watertight construction.

These valves actuators shall be hydraulic type and automatically controlled by the flooding sensors. Valves shall be fail-close type and shall have an independent system to be closed, actuated by a float valve, if a water flooding reaches damper level, on extreme inclination Unit situation. They shall be butterfly, wafer type.

Operation and monitoring shall be done both locally (close to the valves) and in the Control Room, located over flooding line.

8.17. Sound Attenuators

The Sound Attenuators shall be of the absorptive type, designed to have their internal parts easily accessed and removed. The absorptive material shall be glass fibre or rock wool, both adequate to the airflow speed inside the Sound Attenuator.

The absorptive material shall be protected by a perforated steel sheet, which shall be sized during the Detailed Engineering Design, considering the criteria of erosion, corrosion, durability and sound tuning. The steel sheet protection shall avoid the absorptive material to get loose.

The acoustically treated piece of duct shall be built according to the items below:

- The external steel sheet shall be the same of the non-treated duct;
- The same internal free area shall be kept;
- 25 mm of absorptive material shall be installed in the four internal air duct walls. The absorptive material shall be covered by a perforated aluminium sheet or stainless steel AISI 316 sheet in the case of non-filtered air, with 25% of open area.

8.18. Electric Motors

Electric Motors shall be according to I-ET-3010.00-5140-712-P4X-001 - Low-Voltage Induction Motors for Offshore Units.

8.19. Piping

Chilled water / cooling water pipes and drain pipes shall not be installed inside the electrical equipment rooms, panels rooms, transformers rooms, control rooms, radio room, telecom room, etc.

Fluid velocity in chilled water and cooling water piping shall not exceed 4,0 m/s.

9. TAG NUMBERING

The tagging of all items, including valves, dampers and accessories, shall be carried out according to I-ET-3000.00-1200-940-P4X-001 - Tagging Procedure for Production Units Design.

Tags shall be supplied with number and description in the Portuguese language.

All tag plates shall be made from 316 stainless steel material, with the minimum thickness of 1.5 mm.

Valves shall be tagged with the applicable number only.

Tag numbers for remaining ancillary equipment shall be given after purchase order placement.

10. TESTING, ADJUSTING AND BALANCING (TAB)

SELLER shall perform the tests, adjustments and system to guarantee the design conditions (water flow rates, airflow rates, internal temperatures and pressures, rooms and equipment noise level etc). The tests shall be performed in all rooms and equipment, with the doors closed, and the results shall be indicated in performance reports. The balancing and tests procedures shall be previously submitted to Petrobras for approval and execution will be witnessed according to Petrobras orientation.

At least, 10 % (ten percent) of the ductwork shall be tested for leakage, according to DW 143 guidelines. The branches to be tested shall be defined by Petrobras, before the test execution. If large leakage rates are found in the first test, all corrections shall be made to reach the required tightness. Petrobras can extend the sample to be tested to ensure the system integrity.

The Factory Acceptance Test (FAT) shall be performed under all necessary design and operational conditions to attest the compliance of all tested equipment to the design information, e.g. design cooling water flow and temperature, design environment temperature and humidity etc.

The FAT for all equipment shall comply with the ANSI/AHRI standards.

The main objective of the FAT is to confirm, at least, the following equipment design information:

a. Cooling capacity,
b. Supply temperature,
c. Flow rates (air and water),
d. Static pressure (internal and external),
e. Noise and vibration,
f. Rotation speed of all dynamic equipment (pulley, electric motors etc),
g. All necessary electrical information (source electrical information, operational electric current and voltage, megger test etc),
h. All communications between the equipment and the respective control panel. All required certificates for the equipment and the instruments used during the FAT shall be presented before the FAT starts.

All vendor data sheets of all equipment to be tested shall be released with no comments by Petrobras. It must be attached to the FAT procedure.

The FAT procedure shall present a table with the design and tested information for a better check during the test. The design information must be pre-filled in the procedure.

After concluding the FAT, a punch list with pictures shall be created to properly record the pending items, if any. A complete description of the punch shall be written. Instead of creating general punches, each punch must refer to a tag number for a proper recording into the Petrobras pending items monitoring system.

The control panel of each equipment must be tested before of the respective equipment FAT.

Should this test be performed under any adverse environmental conditions, such as winter temperatures, then the equipment design information unable to be confirmed shall be checked and confirmed before the PAT, during the commissioning stage.

The Performance Acceptance Test (PAT) shall be performed after the acceptance of the Mechanical Completion, at least, under the same operational conditions considered in the design, such as design cooling water flow and temperature, design environment temperature and humidity etc.

The PAT for all equipment shall comply with the ANSI/AHRI standards.

The main objective of the PAT is to confirm compliance of the tested system with Petrobras design and operational requirements, such as:

a. Room temperature,
b. Room humidity, if applicable,
c. Room internal pressure,
d. Room air balancing,
e. Air flow rates, considering:
    - Air flow rate per grille (supply, exhaust and relief) according to the design,
    - Total equipment air flow rate,
f. Noise levels,
g. All necessary electrical information (source electrical information, operational electric current and voltage, megger test etc),
h. Remote control interaction with the Central Control Room,
i. Instruments and sensors test and adjust, if applicable,
j. All applicable accessories interactions, such as damper closing x equipment shut down, door opening and equipment shut down etc.

For the item d - Room air balancing, it may be necessary to test more than one system at the same time to finely adjust the internal room pressure. It requires an advanced system compatibility configuration to guarantee that any equipment operating combination will ensure the proper air balancing and room pressure.

For the Generator Rooms, a manual fire damper opening must be performed during the PAT.

All required certificates for the equipment and the instruments used during the PAT shall be presented before the PAT starts.

The PAT procedure shall present a table with the design and tested information for a better check during the test. The design information must be pre-filled in the procedure.

After concluding the PAT, a punch list with pictures shall be created to properly record the pending items, if any. A complete description of the punch shall be written. Instead of creating general punches, each punch must refer to a tag number for a proper recording into the Petrobras pending items monitoring system.

The PAT shall not be performed under adverse environmental conditions to avoid invalidating the equipment compliance verification.

The airflow, water measurement and others commissioning procedures shall be made according to recognized standards, such as:

- Air Balancing Council;
- ANSI/ASHRAE Standard 111;
- NEEB (National Environmental Balancing Bureau): “Procedural Standards for Testing Adjusting and Balancing of Environmental Systems”;
- SMACNA: “HVAC Systems – Testing, Adjusting and Balancing” Manual;
- CIBSE: Commissioning Code Series A Section A.2.7;

All regulating dampers shall be fixed in the adjusted position. This position shall be painted in the regulation device. Excess air flow shall be adjusted through a correct selection of belt and pulley dimensions. Regulating dampers shall never be used to adjust the total air flow of any equipment.

Measurement and Instruments shall comply with requirements of ASHRAE - Fundamentals Handbook Chapter – Measurement and Instruments. All instruments used shall be calibrated before being used, which results shall be indicated in specific reports submitted to Petrobras approval.

11. APPENDIX

The following pages show models of data-sheets for HVAC devices that are not included in the Basic Design, but which shall be filled in by Detailing Design and manufacturers.

PETROBRAS	**DATASHEET**	N°	
	CLIENT :		SHEET 1 of 1
	JOB :		
	AREA :		
DP&T-SRGE	TITLE: **DIFFUSERS**		INTERNAL ESUP

1	**GENERAL DATA**							
2	TAG:							
3	INSTALLATION (SAFETY ZONE CODE):							
4	QUANTITY:							
5	TYPE (SQUARE / ROUND / RECTANGULAR / LINEAR) :							
6	FUNCTION: SUPPLY / EXHAUST							
7	DIMENSIONS WITHOUT FRAME	REQUIRED DIAMETER(mm)						
8		REQURIED WIDTH (mm)						
9		SUPPLIED DIAMETER (mm)						
10		SUPPLIED WIDTH (mm)						
11	TOTAL DEPTH (mm):							
12	FRONT FRAME (TYPE AND DIMENSIONS):							
13	DAMPER	BLADE TYPE						
14		DRIVE LOCATION.						
15		DAMPER LOCATION.:						
16		QUANTxDIST. BETWEEN BLADES						
17	OPERATING CONDITIONS	DESIGN FLOW RATE (m^3 / h)						
18		MAX. PRESS. LOSS (Pa) (N1)						
19		EFFECTIVE VELOCITY (m / s)						
20		THROW DISTANCE (m)						
21		Δ TEMPERATURE BETWEEN						
22		AIR AND ENVIRONMENT (Δ °C)						
23		AIR JET VELOCITY (m / s)						
24		NOISE LEVEL dB (A) MAX.						
25	FREE CROSS SECTION (cm^2)							
26	TYPE AND DIMENSIONS OF MOUNTING FRAME							
27	NUMBER OF DRAWING FOR LOCATION							
28	**MATERIALS**							
29	VANES:							
30	BLADES:							
31	FRONT FRAME:							
32	BACK SIDE:							
33	**MISCELLANEOUS**							
34	TECHNICAL SPECIFICATION:							
35	PAINTING:							
36	MODEL / SERIES:		MANUFACTURER:					
37	**REMARKS**:							
38	1 - WITH 50% OPENING OF DAMPER AND AT INFORMED EFFECTIVE SPEED.							
39								
40								
41								
42								
43								
44								
45								
46								

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									

PETROBRAS

A

DATA SHEET

N°

CLIENT :

SHEET 1 of 1

JOB :

AREA:

DP&T-SRGE

TITLE:

FILTER BOX

INTERNAL

ESUP

SERVICE: ITEM Nº: QUANTITY:

MANUFACTURER: MODEL / SERIES:

FLOW RATE: m³/h OPERATING TEMPERATURE.: °C

DENSITY: kg/m³ RELATIVE HUMIDITY: %

INSTALLATION PLACE: ☐ DUCT ☐ WALL

PRE-FILTER	FINAL FILTER
TYPE: MODEL:	TYPE : MODEL:
FILTER CLASS :	FILTER CLASS: /
SYNTHETIC DUST WEIGHT ARRESTANCE TEST (N1): %	SYNTHETIC DUST WEIGHT ARRESTANCE TEST (N1): %
ATMOSPHERIC DUST SPOT EFFICIENCY TEST (N1): %	ATMOSPHERIC DUST SPOT EFFICIENCY TEST (N1): %
FILTER ELEM.: ☐DISPOSABLE ☐PERMANENT	FILTER ELEM.: ☐DISPOSABLE ☐PERMANENT
FILTER ELEMENT MATERIAL	FILTER ELEMENT MATERIAL
FRAME MATERIAL	FRAME MATERIAL:
QUANT. OF FILTER ELEMENTS:	QUANT. OF FILTER ELEMENTS
FILTER ELEMENT DIMENSIONS (mm):	FILTER ELEMENT DIMENSIONS (mm):
FACE SPEED (N2): m/s	FACE SPEED (N2): m/s
SERVICE TYPE: ☐ CONTINUOUS	SERVICE TYPE: ☐ CONTINUOUS ☐ INTERMITTENT
USEFUL LIFE:	USEFUL LIFE:
ΔP WITH CLEAN FILTER: Pa	ΔP WITH CLEAN FILTER: Pa
ΔP WITH DIRTY FILTER: Pa	ΔP WITH DIRTY FILTER: Pa

BOX

INSPECTION DOOR: ☐ RIGHT ☐ LEFT

DIMENSIONS (mm) (N6):

MATERIAL:

PAINTING:

WEIGHT (FILTER + DROP ELIM. + ACCESSORIES):

SEALING SYSTEM:

DROP ELIMINATOR

TYPE: MODEL:

DIMENSIONS (mm):

FACE SPEED: m/s HEAD LOSS:

VANE MATERIAL:

TRAY AND DRAIN MATERIAL:

BACTERICIDAL AGENT (N5):

OTHER DATA

INSTALLATION IN ENVIRONMENT:

☐ CLOSED ☐ OPEN ☐ COVERED

ACCESSORIES

☐ FLANGE TO CONNECT WITH DUCTS

■ DIFFERENTIAL PRESSURE SENSOR WITH INDICATOR

☐ PRESSURE REGULATOR

☐ AUTOMATIC MODULATING DAMPER

☐ DIFFERENTIAL PRESSURE CONTROLLER

■ DIFFERENTIAL PRES. "U" MANOMETER (1 FOR FILTER AND 1 FOR PRE-FILTER)

■ INSPECTION DOOR AFTER FILTERS

REMARKS:

1 - ASHRAE AVERAGE FILTERING GRADE.

2 - FOR THE DESIGN AIR FLOW RATE.

3 - MAXIMUM DESIGN PRESSURE LOSS IS 180 Pa.

4 - MAXIMUM DESIGN PRESSURE LOSS IS 450 Pa.

5 - THIS FILTER, AS PER DESIGN, IS BACTERICIDE. INFORM ITS BACTERICIDAL AGENT.

6 - PROVIDE A MINIMUM FREE DISTANCE OF 650 mm BETWEEN THE DROP ELIMINATOR AND PRE-FILTER.

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									

	DATA SHEET		N°							
PETROBRAS	CLIENT :							SHEET 1 of 1		
	JOB :									
	AREA :									
DP&T-SRGE	TITLE: **GRILLES**							INTERNAL		
								ESUP		
1	**GENERAL DATA**									
2	TAG:									
3	INSTALLATION: (SAFETY ZONE CODE)									
4	QUANTITY:									
5	FUNCTION: SUPPLY/EXHAUST									
6	DIMENSIONS WITHOUT FRAME		REQUIRED HEIGHT (mm)							
7			REQUIRED WIDTH (mm)							
8			SUPPLIED HEIGHT (mm)							
9			SUPPLIED WIDTH (mm)							
10	TOTAL DEPTH (mm):									
11	FRONT FRAME (TYPE AND DIMENSIONS):									
12	INSTALLATION LOCATION: FLOOR/WALL/DUCT									
13	VANES	FRONT ROW	HORIZONTAL/VERTICAL							
14			FIXED / MOVING							
15			ADJUSTMENT:							
16			VANE TYPE							
17			QUANT. x DIST. BETWEEN BLADES (							
18		BACK ROW	HORIZONTAL/VERTICAL							
19			FIXED / MOVING							
20			ADJUSTMENT:							
21			VANE TYPE							
22			QUANT. x DIST. BETWEEN BLADES(							
23		DAMP	BLADE TYPE							
24			LOCATION WHERE ACTUATED							
25			LOCATION OF DAMPER							
26			QUANT. X DIST. BETWEEN BLADES							
27	OPERATING CONDITIONS		DESIGN FLOW RATE (m^3/h)							
28			MAX. PRESSURE LOSS (Pa) (N1) (N2							
29			EFFECTIVE VELOCITY (m / s)							
30			THROW DISTANCE (m) (N2)							
31			MAX. NOISE LEVEL dB(A) (N2)							
32	FREE CROSS SECTION (cm^2)									
33	TYPE AND DIMENSIONS OF MOUNTING FRAME									
34	NUMBER OF DRAWING FOR LOCATION									
35	**MATERIALS**									
36	VANES:									
37	BLADES:									
38	FRONT FRAME:									
39	BACK SIDE:									
40	**MISCELLANEOUS**									
41	TECHNICAL SPECIFICATION:									
42	PAINTING:									
43	MODEL / SERIES:: MANUFACTURER:									
44	**REMARKS:**									
45	1 - WITH 50 % OPENING OF DAMPER AND AT INFORMED EFFECTIVE VELOCITY.									
46	2 - WITH DIVERGING ANGLE BETWEEN VANES = WITH AIR FLOW DIFFUSION ANGLE =									

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									

FORM OWNED TO PETROBRAS N-0381 REV. L.

PETROBRAS	DATA SHEET	N°	
	CLIENT :		SHEET 1 OF 1
	JOB :		
	AREA :		
DP&T-SRGE	TITLE: **MODULATING DAMPERS**		INTERNAL / ESUP

1	**GENERAL DATA**								
2	TAG:								
3	INSTALLATION : (SAFETY ZONE CODE)								
4	QUANTITY								
5	DRIVE: MANUAL/BY ACTUATOR								
6	INTERNAL DIMENSIONS	REQUIRED HEIGHT							
7		REQUIRED WIDTH (mm)							
8		SUPPLIED HEIGHT (mm)							
9		SUPPLIED WIDTH (mm)							
10	DEPTH (mm):								
11	FRAME (TYPE AND DIMENSIONS):								
12	BLADES: PARALLEL/DIVERGENT								
13	NUMBER OF BLADES								
14	BLADE WIDTH (mm)								
15	BLADE TYPE								
16	FREE CROSS SECTION (OPEN) %								
17	LIMIT SWITCH OPEN POS. /CLOSED POS.								
18	BLADE POSITION FIXING								
19	DESIGN FLOW RATE (m^3/h)								
20	MAX. PRESSURE LOSS AT DESIGN FLOW RATE								
21	TOTAL TORQUE (kgf x cm)								
22	LEVER LENGTH (mm)								
23	DRIVING FORCE (kgf)								
24	LOCATION OF LEVER (LEFT/RIGHT) (N1)								
25	PROTECTION SCREEN								
26	WEIGHT (kgf)								
27	DUCT WHERE INSTALLED								
28	NUMBER OF DRAWING FOR LOCATION								
29	**MATERIALS**								
30	BLADES:								
31	FRAME:								
32	SHAFTS:								
33	BEARINGS:								
34	PROTECTION SCREEN:								
35	SOLENOID VALVE:								
36	LIMITSWITCH:								
37	**ACTUATOR**								
38	TYPE:								
39	MAKE/MODEL:								
40	PRESSURE OF CLOSING SIGNAL:								
41	IN ABSENCE OF AIR (OPENS/CLOSES):								
42	CHARACTERISTICS:								
43	**MISCELLANEOUS**								
44	TECHNICAL SPECIFICATION:								
45	PAINTING:								
46	MODEL / SERIES:						MANUFACTURER:		
47	**REMARKS:** 1 - FLOW DIRECTION								
48	2 - BOLTS, NUTS AND WASHERS: CADMIUM AND BI-CHROMIUM PLATED								

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									

FORM OWNED TO PETROBRAS N-0381 REV. L.

PETROBRAS	DATA SHEET	N°	
	CLIENT ;		SHEET 1 OF 1
	JOB :		
	AREA :		
DP&T-SRGE	TITLE:	REGULATING DAMPERS	INTERNAL / ESUP

1	**GENERAL DATA**								
2	TAG:								
3	INSTALLATION : (SAFETY ZONE CODE)								
4	QUANTITY								
5	DRIVE: MANUAL/BY ACTUATOR								
6	INTERNAL DIMENSIONS	REQUIRED HEIGHT							
7		REQUIRED WIDTH (mm)							
8		SUPPLIED HEIGHT (mm)							
9		SUPPLIED WIDTH (mm)							
10	DEPTH (mm):								
11	FRAME (TYPE AND DIMENSIONS):								
12	BLADES: PARALLEL/DIVERGENT								
13	NUMBER OF BLADES								
14	BLADE WIDTH (mm)								
15	BLADE TYPE								
16	FREE CROSS SECTION (OPEN) %								
17	LIMITSWITCH OPEN POSITION / CLOSED								
18	BLADE POSITION FIXING								
19	DESIGN FLOW RATE (m^3/h)								
20 21	MAX. PRESSURE LOSS AT DESIGN FLOW RATE (Pa)								
22	TOTAL TORQUE (kgf x cm)								
23	LEVER LENGTH (mm)								
24	DRIVING FORCE (kgf)								
25	LOCATION OF LEVER (LEFT/RIGHT) (N1)								
26	PROTECTION SCREEN								
27	WEIGHT (kgf)								
28	DUCT WHERE INSTALLED								
29	NUMBER OF DRAWING FOR LOCATION								
30	**MATERIALS**								
31	BLADES:								
32	FRAME:								
33	SHAFTS:								
34	BEARINGS:								
35	PROTECTION SCREEN:								
36	**ACTUATOR**								
37	TYPE:								
38	MAKE/MODEL								
39	PRESSURE OF CLOSING SIGNAL:								
40	IN ABSENCE OF AIR (OPENS/CLOSES):								
41	CHARACTERISTICS:								
42	MISCELLANEOUS								
43	TECHNICAL SPECIFICATION:								
44	PAINTING:								
45	IDENTIFICATION: MANUFACTURER :								
46	**REMARKS:**								
47	1 - WITH BLADE ANGLE = _____ AT DESIGN FLOW RATE								

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									

FORM OWNED TO PETROBRAS N-0381 REV. L.

DATE BY PETROBRAS	DATA SHEET	Nº	
	USER:		SHEET 1 OF 4
	PROJECT:		
	UNIT:		
DP&T - SRGE	**CHILLER**		

	CONTRACT :	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**GENERAL DATA**				
2	ITEM Nº:			EQUIPMENT HEIGHT:	mm
3	TYPE: WATER CONDENSATION			EQUIPMENT WIDTH:	mm
4	REQUIRED RATED CAPACITY:	kw		EQUIPMENT DEPTH:	mm
5	MANUFACTURER:			VIBRATION CHOCKS:	
6	MODEL:			SHUT-DOWN REMOTE CONTROL:	
7	QUANTITY/ RESERVE:			☐ ELECTRIC ☐ PNEUMATIC ☐ HYDRAULIC	
8	Nº OF REFRIGERATION CIRCUITS/EQUIP.:			ALARM CONTACTS MUST BE:	
9	MARINE ENVIRONMENT			☐ ENERGIZED ☐ NON-ENERGIZED FOR SHUT-DOWN	
10	INSTALLATION PLACE: ☐ CLOSED ☐ COVERED ☐ OUTDOORS			POWER FOR INSTRUMENTS	
11	ENVIRONMENT TEMPERATURE:	ºC		Volts Phase Hz	
12	ALTITUDE:	m		CONTROL BOX: ☐ EXPLOSION PROOF ☐ WEATHER PROOF	
13	AREA: ☐ SAFE ☐ DANGEROUS			☐ NEMA CLASS	
14	EMPTY EQUIPMENT WEIGHT:	Kg			
15	OPERATING EQUIPMENT WEIGHT.:	Kg		USEFUL LIFE:	
16	PAINTING:		SUPERHEATING:		UNDER COOLING:
17	**INSTRUMENTS AND CONTROL (NOTE 1)**				
18	COMPRESSOR	SUCTION MANOMETER / STAGE: MANUFACT:			MOD.:
19		DISCHARGE MANOMETER / STAGE: MANUFACT.:			MOD.:
20		SUCTION THERMOMETER / STAGE: MANUFACT.:			MOD.:
21		DISCHARGE THERMOMETER / STAGE: MANUFACT.:			MOD.:
22		OIL COOLER THERMOMETER INLET/OUTLET: MANUFACT.:			MOD.:
23		CARTER OIL LEVEL INDICATOR: MANUFACT.:			MOD.:
24		CYLINDER OIL FLOW INDICATOR: MANUFACT.:			MOD.:
25		OIL DIFFERENTIAL PRESSURE INDICATOR: MANUFACT.:			MOD.:
26		HIGH PRESSURE SWITCH / CIRCUIT: MANUFACT.:			MOD.:
27		LOW PRESSURE SWITCH / CIRCUIT: MANUFACT.:			MOD.:
28		OIL HIGH PRESSURE SWITCH / COMPRESSOR: MANUFACT.:			MOD.:
29		OIL LOW PRESSURE SWITCH / COMPRESSOR: MANUFACT.:			MOD.:
30		HIGH PRESSURE SWITCH AGAINST LOW TEMP. OF CONDENS. / CIRCUIT: MANUFACT.:			MOD.:
31		THERMOSTAT AGAINST MOTOR / COMPRESSOR SUPERHEATING: MANUFACT.:			MOD.:
32		DISCHARGE THERMOSTAT / COMPRESSOR: MANUFACT.:			MOD.:
33		CAPACITY CONTROL	CHILLED WATER TEMP. CONTROLLER:		
34			QUANT. OF STAGES:	MANUFACT.:	MOD.:
35					
36	PRESSURE CONTROL VALVE FOR CONDENSATION WATER :		MANUFACT.:		MOD.:
37	SERVICE VALVE / CONDENSER:		MANUFACT.:		MOD.:
38	LOW TEMP. THERMOSTAT FOR CHILLED WATER / EVAPORATOR:		MANUFACT.:		MOD.:
39	CHILLED WATER FLOW SWITCH / EVAPORATOR:		MANUFACT.:		MOD.:
40	LIQUID SIGHT GAGE W/ HUMIDITY INDICATION/ CIRCUIT:		MANUFACT.:		MOD.:
41	SOLENOID VALVE FOR GAS COLLECTION / CIRCUIT:		MANUFACT.:		MOD.:
42	GAS COLLECTION PRESSURE SWITCH / CIRCUIT:		MANUFACT.:		MOD.:
43	REFRIGERANT DRIER FILTER / CIRCUIT:		MANUFACT.:		MOD.:
44	THERMOSTATIC EXPANSION VALVE / CIRCUIT:		MANUFACT.:	MOD.:	
45	CONDENSATION WATER FLOW SWITCH:		MANUFACT.:		MOD.:
46	**REMARKS:**				
47	1 – SEE ITEM 7.7 of I-ET-3010.2Q-5250-300-P4X-001, HVAC TECHNICAL SPECIFICATION.				
48					
49					
51					
52					
54					

PETROBRAS	DATA SHEET	Nº	
	USER:		SHEET 2 OF 4
	PROJECT:		
	UNIT:		
DP&T-SRGE	**CHILLER**		

	CONTRACT :	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**INSPECTION AND TESTS**											
2	DIMENSION INSPECTIONS OF ASSEMBLY:											
3	INSPECTION OF THERMAL INSULATION:											
4	INSPECTION OF ASSEMBLY PAINTING:											
5	CONTROL OPERATION: (SIMULATION AND ELECTRIC PANEL OPERATION):											
6	ELECTRIC INTERCONNECTION LOOP TEST:											
7	HYDROSTATIC TEST (1,5 DESIGN PRESSURE): EVAPORATOR AND CONDENSER:											
8	LEAK AND DEHYDRATION TEST: REFRIGERANT FLUID SIDE:											
9	PRESSURE LOSS CHECK ON THE WATER SIDE: EVAPORATOR AND CONDENSER:											
10	PERFORMANCE TEST OF COMPRESSOR/MOTOR: ROUTINE TEST AS PER NBR-7094 / IEC 34:											
11												
12	NOISE LEVEL at m		CENTRAL FREQUENCY	63	125	250	500	1000	2000	4000	8000	
13	OF EQUIPMENT: dB(A)		LW at m FROM EQUIPMENT									
14	**COMPRESSOR**											
15		TYPE		MANUFACTURER:								
16		MODEL:		QUANTITY:								
17	GENERAL	RPM: MAX.: NOM:		Kw NOM. - DRIVER:								
18	DATA	DRIVER:		TRANSMISSION:								
19		DRIVER SUPPLIED BY COMPR. MANUFACTURER.:		WEIGHT: kg								
20		UNLOADED OPERATION: NO		APPLICABLE STANDARDS:								
21		GAS:		DISCHARGE TEMPERATURE: °C								
22		FLOW RATE: kg / h		OPERATING DISCHARGE TEMP..: bar abs								
23	NORMA L	MOL. WEIGHT IN SUCTION:		MINIMUM DISCHARGE PRESSURE.: bar abs								
24	OPERATING	TEMP. IN SUCTION: ^{o} C		MAXIMUM DISCHARGE PRESSURE.: bar abs								
25	CONDITIONS	OPERATING SUCTION PRESSURE: bar abs		Kw ON SHAFT / STAGE:								
26		LOW SUCTION PRESSURE: bar abs		TOTAL Kw TOTAL ON SHAFT (INCLUDES LOSSES):								
27		MAXIMUM SUCTION PRESSURE: bar abs		VOLUMETRIC EFFICIENCY:								
28	ELECTRIC POWER: Kw			AMPERES W/ LOCKED ROTOR AND AMPERES FULL LOAD:								
29												
30	OIL HEATING IN CARTER:											
31		Nº OF STAGES:		ADMISSIBLE MANOM. PRES..: bar N								
32		Nº OF CYLINDERS/STAGE:		ADMISSIBLE MANOM. TEMP.: °C								
33		CYLINDER TYPE: STEP / TANDEM		RELIEF VALVE ADJUSTMENT: bar N								
34	CYLINDER	SIMPLE / DOUBLE ACTION:		HYDROSTATIC TEST: bar N								
35	DATA	SLEEVE EXT. DIAMETER: mm		SUCTION: DIAMETER / DIRECTION:								
36	FOR	INTERNAL CYLINDER DIAMETER: mm		CLASS / FACING:								
37	ALTERNATING	PISTON LIFT: mm		DISCHARGE: DIAMETER / DIRECTION:								
38	COMPRESSOR	Nº SUCTION VALVES / DISCHARGE / CYLINDER:		CLASS / FACING:								
39		TYPE OF VALVES:		POSITION AS SEEN FROM DRIVER SIDE:								
40		TYPE OF COOLING:										
42	SEALS	OF SHAFT:		TYPE:								
43		OF COVER:		TYPE:								
44		OIL PUMP DRIVEN BY COMPRESSOR SHAFT / ELECTRIC MOTOR:										
45	LUBRIC.	OIL QUANTITY IN SYSTEM: m^3										
46		OIL TYPE: GRADE:										
47												
48	SUCTION FILTERS: ☐ TEMPORARY ☐ PERMANENT			DIAM. / MANUFACTURER:								
49	SAFETY VALVES: MANUFACTURER:			MODEL:								
50	DISCHARGE PULSATION ATTENUATOR:											
51	AUTOMATIC OIL SEPARATOR:											
52	**REMARKS:**											
54												
55												

PETROBRAS	DATA SHEET	Nº	
	USER :		SHEET 3 OF 4
	PROJECT :		
	UNIT :		
DP&T-SRGE	**CHILLER**		

	CONTRACT:	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**EVAPORATOR**				
2	GENERAL DATA	TYPE:		HORIZONTAL INSTALLATION:	
3		MODEL:		HEAT EXCHANGE AREA /SHELL: m²	
4		MANUFACTURER:		OPERATING WEIGHT: kg	
5		SHELLS/UNIT:		WATER FILLED WEIGHT: kg	
6	NORMAL OPERATING CONDITIONS	FLUID LOCATION:	SHELL SIDE	TUBE SIDE	
7		FLUID:			
8		TOTAL FLOW RATE: Kg / h			
9		VAPOR (INLET/OUTLET): %			
10		LIQUID: %			
11		TEMPERATURE (INLET/OUTLET): °C			
12		SPECIFIC HEAT: kJ / Kg°C			
13		THERMAL COND.: W / m°C			
14		LATENT HEAT: kJ / Kg			
15		OPER. PRES. (MAX) INLET: K Pa			
16		MAX. PRESS LOSS INLET/CALC.: K Pa			
17		FOULING COEFF.: m²°C / W			
18		EXCHANGED HEAT: Kw	LMTD (CORRECTED): °C		
19		TRANSFER COEFF.: W/m²°C	SERVICE:	CLEAN:	
20		MIN. EVAPORATION TEMPERATURE: °C	MÁX. VELOCITY IN TUBES: m / s		
21	CONSTRUCTION DATA PER SHELL		SHELL SIDE	TUBE SIDE	
22		DESIGN/TEST MAX. PRES.: K Pa			
23		MAX. DESIGN TEMP.: °C			
24		Nº OF PASSES:			
25		CORROSION ALLOWANCE: mm			
26		STRESS RELIEF			
27		X-RAY			
28		NOZZLES INLET			
29		DIAMETER/PRES. CYL. OUTLET			
30		TUBES QUANT.:	DIAMETER:		
31		LENGTH.:	ARRANGEMENT:		
32		PITCH:	THICKNESS:		
33		MATERIAL SHELL: I.D.: mm	SPOOL COVER:		
34		FIXED COVER:	DEFLECTING PLATE:		
35		TUBE / TUBE SHEET CONNECTION:	TRANSVERSE BAFFLE:		
36		TUBES:	GASKETS ON TUBE SIDE:		
37		FIXED TUBESHEET:	TYPE OF SEAL:		
38	DESIGN CODE:				
39	THERMAL INSULATION:				
40	INSULATION MECHANICAL PROTECTION:				
41	**REMARKS:**				
42					
43					
44					
45					
46					
47					
48					
49					
51					
52					
53					
54					

PETROBRAS	DATA SHEET	N°	
	USER :		SHEET 4 OF 4
	PROJECT :		
	UNIT :		
DP&T-SRGE	**CHILLER**		

	CONTRACT:	RESPONSIBLE :
	DOC. N°	REG. CREA :
		SIGNATURE :

CONDENSER

GENERAL DATA	TYPE:		HORIZONTAL INSTALLATION:	
	MODEL:		HEAT EXCHANGE AREA /SHELL:	
	MANUFACTURER:		OPERATING WEIGHT:	
	SHELLS/UNIT:		WATER FILLED WEIGHT:	
NORMAL OPERATING CONDITIONS	FLUID LOCATION:		SHELL SIDE	TUBE SIDE
	FLUID:			
	TOTAL FLOW RATE: Kg / h			
	VAPOR (INLET/OUTLET): %			
	LIQUID: %			
	TEMPERATURE (INLET/OUTLET): ºC			
	SPECIFIC HEAT: kJ / Kg°C			
	THERMAL COND.: W / m°C			
	LATENT HEAT: kJ / Kg			
	OPER. PRES. (MAX) INLET: K Pa			
	MAX. PRESS LOSS INLET/CALC.: K Pa			
	FOULING COEFF.: m²°C / W			
	EXCHANGED HEAT: Kw		LMTD (CORRECTED):	° C
	TRANSFER COEFF.: W/m²°C		SERVICE:	CLEAN:
	MÁX. CONDENSATION TEMPERATURE :	° C	MAX. VELOCITY IN TUBES:	m / s

CONSTRUCTION DATA PER SHELL			SHELL SIDE	TUBE SIDE	
	DESIGN/TEST MAX. PRES.: K Pa				
	MAX. DESIGN TEMP.: °C				
	N° OF PASSES:				
	CORROSION ALLOWANCE: mm				
	STRESS RELIEF				
	X-RAY				
	NOZZLES	INLET			
	DIAMETER/PRES. CYL.	OUTLET			
	TUBES	QUANT.:	DIAMETER:		
		LENGTH.:	ARRANGEMENT:		
		PITCH:	THICKNESS:		
	MATERIAL	SHELL: I.D.: mm	SPOOL COVER:		
		FIXED COVER:	DEFLECTING PLATE:		
		TUBE/TUBE SHEET CONNECTION:	TRANSVERSE BAFFLE:		
		TUBES:	GASKETS ON TUBE SIDE:		
			TUBE SHEET:		

DESIGN CODE:

REMARKS:

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
CHECKED									
APPROVED									

PETROBRAS

DATA SHEET | Nº

USER : | SHEET 1 de 2

PROJECT :

UNIT :

DP&T-SRGE

AIR HANDLING UNIT

CONTRACT : | RESPONSIBLE :

DOC. Nº | REG. CREA :

SIGNATURE :

GENERAL DATA

SERVICE: | ITEM Nº: | QUANTITY:

MANUFACTURER: | MODEL / SERIES: | SAFETY ZONE CODE:

CONSTRUCTION: ☐ HORIZONTAL ☐ VERTICAL ☐ 2 FANS WITH ONE COIL

OUTLET TYPE: ☐ PLENUM ☐ SIMPLE ☐ OTHERS:

AIR FLOW: FAN / COIL ☐ BLOW-THRU ☐ DRAW-THRU

OPERATION CONDITIONS

COOLING CAPACITY (DESIGN): | SERVICE: ☐ CONTINUOUS ☐ INTERMITTENT ☐ ONE IS SPARE

COOLING CAPACITY(RATED): | START: ☐ MANUAL ☐ AUTOMATIC

AIR FLOW RATE (DESIGN.): | MARINE ENVIRONMENT

AIR FLOW RATE (RATED): m³ | INSTALLATION ENVIRONMENT: ☐ CLOSED ☐ COVERED ☐ OUTDOORS

SYSTEM: ☐ LOW PRESSURE | AREA: ☐ SAFE ☐ DANGEROUS

☐ MEDIUM PRESSURE

☐ HIGH PRESSURE

NOISE LEVEL a m / OF EQUIPMENT: dB (A)	CENTRAL FREQUENCY / LW a m FROM	63	125	250	500	1000	2000	4000	8000

CABINET

PANEL TYPE SANDWICH ☐ FIBER GLASS LINED

DIMENSIONS (mm):	HEIGHT	WIDTH	DEPTH
☐ MODULAR ENCLOSURE			
☐ COMPACT ENCLOSURE			
☐ MIXTURE BOX			
☐ FILTERING SECTION			
☐ VENTILATING SECTION			
☐ COOLING SECTION			
☐ DIFFUSER SECTION			
☐ DISCHARGE SECTION (PLENUM)			

FAN

TYPE: | QUANTITY:

☐ DOUBLE SUCTION ☐ SINGLE SUCTION

ROTOR TYPE: ☐ SIROCCO ☐ LIMIT LOAD

MOUNTING: ☐ SINGLE ☐ DUPLEX

MANUFACTURER:

MODEL/SERIES:

AIR FLOW RATE: m³/h AIR TEMPERATURE ° C

DIMENSIONS: SUCTION: mm DISCHARGE: mm

DISCHARGE POSITION (AMCA-2406):

ARRANGEMENT (AMCA-AS-2404):

TOTAL STATIC PRESSURE (N1): Pa DYN. HPRESS.: Pa

TOTAL PRESSURE (N2): Pa

EFFICIENCY: % RPM:

ABSORBED Kw: RATED Kw (N3):

BEARING TYPE: DESIGN LIFE.: 40 000 h

DRIVE: ☐ DIRECT ☐ BELT

MOTOR: ☐ IN THE CLOSURE ☐ OUT OF CLOSURE

MOTOR POSITION (AMCA-AS-2407):

AIR FILTER (N4)

FILTER CLASS: /

TYPE:

QUANTITY: MANUFACTURER/MODEL:

DIMENSIONS: mm

PRESSURE LOSS: (CLEAN): Pa (DIRTY): Pa

FACE VELOCITY: m/s

COOLING COIL

MANUFACTURER: MODEL:

WATER TYPE:

COOLING CAPACITY: Kw

SENSITIVE LOAD: Kw

AIR INLET TEMPERATURE (WB/DB): °C

AIR OUTLET TEMPERATURE (WB/DB): °C

AIR DISCHARGE TEMP.: °C

CHILLED WATER FLOW RATE: m³ / h

NUMBER OF TUBES - HEIGHT:

NUMBER OF CIRCUITS

NUMBER OF ROWS: NUMBER OF FINS / cm:

FACE AREA: m²

FACE SPEED (AIR): m / s

WATER VELOCITY: m / s

PRESS. LOSS: (AIR); Pa (WATER): Pa

INLET PRESSURE: (WATER SIDE): kPa

BY PASS FACTOR: WATER VOLUME: m³

ACCESSORIES

FLANGE: ☐ SUCTION ☐ DISCHARGE

FLEXIBLE COUPLING: ☐ SUCTION ☐ DISCHARGE

☐ INTEGRAL ELECTRIC PANEL

☐ VIBRATION ISOLATOR FOR FAN EFF%

☐ INSPECTION DOOR: QUANTITY:

☐ BELT STRETCHERS

☐ NOISE ATTENUATOR

DAMPER: ☐ SUCTION ☐ DISCHARGE

TYPE: ☐ REGULATION ☐ GRAVITY

☐ BY-PASS DAMPER AT COIL

☐ SERVO-MOTORS FOR DAMPERS

☐ MANOMETER – WATER INLET AND OUTLET

☐ THERMOMETER – WATER INLET AND OUTLET

☐ 2 WAY VALVE ☐ MOTOR

MOTOR

ITEM Nº | MOUNTED BY:

POWER Kw | PROPER FOR ZONE (IEC):

PETROBRAS	DATA SHEET	Nº
	USER :	SHEET 2 of 2
	PROJECT :	
	UNIT :	
DP&T - SRGE	**AIR HANDLING UNIT**	

	CONTRACT :	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**MATERIALS**				
2	CABINET: EXTERNAL / INTERNAL PLATE:			THICKNESS:	mm
3	ACOUSTIC INSULATION:			THICKNESS:	mm
4	THERMAL INSULATION:			THICKNESS:	mm
5	FAN: CASING:			THICKNESS:	mm
6	ROTOR:		SHAFT:		
7	BEARING BOX	SEALS:	BASE:	LUBRICATION:	COUPLINGS:
8	NAME PLATE:				
9	COIL:	TUBES:		VANES:	
10	CONDENSATE TRAY:			HEADERS:	
11	FILTER ELEMENT MATERIAL:				
12	BOLTS, NUTS : CADMIUM AND BI-CHROMIUM PLATED				
13					
14	DOOR SEALING:		PAINTING AND FINISHING:		
15	**TESTS**				
16	☐ INSPECTION AND MANUFACTURING		☐ OTHERS		
17	☐ OPERATION		☐ WITH INSPECTOR		
18	☐ PERFORMANCE		☐ WITH INSPECTOR		
19	**MISCELLANEOUS**				
20	EMPTY WEIGHT:		kg		
21	OPERATING WEIGHT:		kg		
22	PAINTING AND FINISHING:				
23	**REMARKS:**				
24	N1 - IN CASE THE FAN NOISE LEVEL IS ABOVE THE ALLOWED LIMIT, THE MANUFACTURER SHALL INCLUDE A SOUND ATTENUATOR AND SHALL ADD THIS PRESSURE LOSS TO THE FAN STATIC PRESSURE. INFORM THE PRESSURE LOSS VALUE OF THIS ITEM AS A NOTE.				
25	N2 - THE INDICATED ΔP MUST BE ADDED TO PRESSURE LOSSES IN FAN COIL (COIL, FAN SUCTION, ETC.). PRESSURE LOSSES IN PRE-FILTER AND BACTERICIDE FILTER (SEE NOTE N4) ARE ALREADY INCLUDED.				
26	N3 - FANS SHALL ALLOW, BY CHANGING PULLEYS, A $\pm$ 10 % VARIATION OF THE RATED FLOW RATE. THE ELECTRIC MOTOR IS TO CHOSEN IN ORDER TO MEET THIS CONDITION.				
27	N4 - PRE-FILTER AND BACTERICIDE FILTER HAVE A SEPARATE DATA SHEET. SEE " AIR FILTER BOX".				
28					
29					
32					
33					
34					
35					
36					

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
CHECKED									
APPROVED									

DATA SHEET | Nº

USER: | SHEET 1 de 3

PROJECT:

UNIT:

SELF-CONTAINED UNIT

CONTRACT : | RESPONSIBLE :

DOC. Nº | REG. CREA :

SIGNATURE :

GENERAL DATA

SERVICE: | ITEM Nº: | QUANTITY:

MANUFACTURER: | MODEL / SERIES: | SAFETY ZONE CODE:

CONSTRUCTION: ☐ HORIZONTAL ☐ VERTICAL ☐ 2 FANS WITH ONE COIL

OUTLET TYPE: ☐ PLENUM ☐ SIMPLE ☐ OTHERS:

AIR FLOW: FAN / COIL ☐ BLOW-THRU ☐ DRAW-THRU

OPERATION CONDITIONS

COOLING CAPACITY (DESIGN): kw | SERVICE: ☐ CONTINUOUS ☐ INTERMITTENT ☐ ONE IS SPARE

COOLING CAPACITY(RATED): kw | START: ☐ MANUAL ☐ AUTOMATIC

AIR FLOW RATE (DESIGN.): m³ / h | MARINE ENVIRONMENT

AIR FLOW RATE (RATED): m³ / h | LOCATION: ☐ CLOSED ☐ COVERED ☐ OUTDOORS

SYSTEM: ☐ LOW PRESSURE | AREA: ☐ DANGEROUS ☐ SAFE

☐ MEDIUM PRESSURE

☐ HIGH PRESSURE | CENTRAL FREQUENCY

NOISE LEVEL at m / OF EQUIPMENT: dB (A) | L_W at m FROM EQUIPMENT: dB re 10^{-12} w

63	125	250	500	1000	2000	4000	8000

COMPRESSOR

TYPE : QUANTITY

MODEL/SERIES;

MANUFACTURER: REF.:

CAPACITY CONTROL:

TRANSMISSION: ☐ DIRECT ☐ BELT

VOLUMETRIC EFF.: % RPM

ABSORBED kw: RATED Kw:

GAS: FLOW RATE kg/h

TEMPERATURE: SUCTION ° C DISCHARGE ° C

OPERATING PRES. SUCTION: bar abs. DISCHARGE bar abs.

FAN

TYPE: QUANTITY:

☐ DOUBLE INLET ☐ SINGLE INLET

ROTOR TYPE: ☐ SIROCCO ☐ LIMIT LOAD

MOUNTING: ☐ SINGLE ☐ DUPLEX

MANUFACTURER:

MODEL/SERIES:

AIR FLOW RATE: m³/h AIR TEMPERATURE: ° C

DIMENSIONS: SUCTION: m DISCHARGE: mm

DISCHARGE POSITION (AMCA-2406):

ARRANGEMENT (AMCA-AS-2404):

TOTAL STATIC PRESSURE (N1): Pa DYN. PRESSURE: Pa

TOTALPRESSURE (N2): Pa

EFFICIENCY: % RPM:

ABSORBED Kw: RATED Kw (N3):

BEARING TYPE: DESIGN LIFE.: 40 000 h

DRIVE: ☐ DIRECT ☐ BELT

MOTOR: ☐ IN THE CABINET ☐ OUT OF CABINET

MOTOR POSITION (AMCA-AS-2407):

AIR FILTER (N4)

FILTER CLASS: /

TYPE:

QUANTITY: MANUFACTURER/MODEL:

DIMENSIONS: mm

PRESSURE LOSS: (CLEAN): Pa (DIRTY): Pa

FACE SPEED: m/s

COOLING COIL

MANUFACTURER / MODEL:

COOLING CAPACITY: Kw

SENSIBLE LOAD: Kw

AIR INLET TEMPERATURE (WB/DB): °C

AIR OUTLET TEMPERATURE (WB/DB): °C

INSUFLATION TEMP.: °C

NUMBER OF TUBES - HEIGHT:

NUMBER OF CIRCUITS

NUMBER OF ROWS: NUMBER OF FINS / cm:

FACE AREA: m²

FACE SPEED (AIR): m/s

PRESSURE LOSS: (AIR); Pa

BY PASS FACTOR:

ACCESSORIES

FLANGE: ☐ SUCTION ☐ DISCHARGE

FLEXIBLE COUPLING: ☐ SUCTION ☐ DISCHARGE

☐ INTEGRAL ELECTRIC PANEL

☐ VIBRATION ISOLATOR FOR VENTILATOR: EFF%

☐ INSPECTION DOOR: QUANTITY:

☐ BELT STRETCHERS

☐ NOISE ATTENUATOR

DAMPER: ☐ SUCTION ☐ DISCHARGE

TYPE: ☐ REGULATION ☐ GRAVITY

☐ BY-PASS DAMPER AT COIL

☐ SERVO-MOTORS FOR DAMPERS

☐ MANOMETER - WATER INLET AND OUTLET

☐ THERMOMETER - WATER INLET AND OUTLET

MOTOR

ITEM Nº : | MOUNTED BY:

POWER: Kw | PROPER FOR ZONE (IEC):

PETROBRAS	DATA SHEET	Nº	
	USER :		SHEET 2 of 3
	PROJECT :		
	UNIT :		
DP&T-SRGE	**SELF-CONTAINED UNIT**		

	CONTRACT:	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**CONDENSER**				
2	GENERAL DATA	TYPE:		HORIZONTAL INSTALLATION:	
3		MODEL:		HEAT EXCHANGE AREA /SHELL:	
4		MANUFACTURER:		OPERATING WEIGHT:	
5		SHELLS/UNIT:		WATER FILLED WEIGHT:	
6	NORMAL OPERATING CONDITIONS	FLUID LOCATION:	SHELL SIDE	TUBE SIDE	
7		FLUID:			
8		TOTAL FLOW RATE: Kg / h			
9		VAPOR (INLET/OUTLET): %			
10		LIQUID: %			
11		TEMPERATURE (INLET/OUTLET): ºC			
12		SPECIFIC HEAT: kJ / Kg°C			
13		THERMAL COND.: W / m°C			
14		LATENT HEAT: kJ / Kg			
15		OPER. PRES. (MAX) INLET: K Pa			
16		MAX. PRESS LOSS INLET/CALC.: K Pa			
17		FOULING COEFF.: m²°C / W			
18		EXCHANGED HEAT: Kw		LMTD (CORRECTED): ° C	
19		TRANSFER COEFF.: W/m²°C	SERVICE:	CLEAN:	
20		MÁX. CONDENSATION TEMPERATURE : ° C		MAX. VELOCITY IN TUBES: m / s	
21	CONSTRUCTION DATA PER SHELL		SHELL SIDE	TUBE SIDE	
22		DESIGN/TEST MAX. PRES.: K Pa			
23		MAX. DESIGN TEMP.: °C			
24		Nº OF PASSES:			
25		CORROSION ALLOWANCE: mm			
26		STRESS RELIEF			
27		X-RAY			
28		NOZZLES	INLET		
29		DIAMETER/PRES. CYL.	OUTLET		
30		TUBES	QUANT.:	DIAMETER:	
31			LENGTH.:	ARRANGEMENT:	
32			PITCH:	THICKNESS:	
33		MATERIAL	SHELL: I.D.: mm	SPOOL COVER:	
34			FIXED COVER:	DEFLECTING PLATE:	
35			TUBE/TUBE SHEET CONNECTION:	TRANSVERSE BAFFLE:	
36			TUBES:	GASKETS ON TUBE SIDE:	
37				TUBE SHEET:	
38	DESIGN CODE:				
39	**REMARKS:**				
40					
41					
42					
43					
45					
47					
48					
49					

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
CHECKED									
APPROVED									

	DATA SHEET	Nº
	USER:	SHEET 3 of 3
	PROJECT:	
	UNIT:	

SELF-CONTAINED UNIT

	CONTRACT :	RESPONSIBLE:
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**DIMENSIONS OF CABINET**				
2	OVERALL SANDWICH PANEL THICKNESS :				
3	OVERALL DIMENSIONS (MM): (HEIGHT X WIDTH X DEPTH):				
4	MODULAR CABINET:		COMPACT CABINET:		
5	MIXTURE BOX:		FILTERING SECTION:		
6	FAN SECTION:		COOLING SECTION:		
7	DIFFUSER SECTION:		DISCHARGE SECTION (PLENUM)		
8	**MATERIALS**				
9	CABINET: EXTERNAL / INTERNAL PLATE:		THICKNESS:	mm	
10	ACOUSTIC INSULATION:		THICKNESS:	mm	
11	THERMAL INSULATION:		THICKNESS:	mm	
12	FAN: CASING:		THICKNESS:	mm	
13	ROTOR:	SHAFT:			
14	BEARING BOX	SEALS:	BASE:	LUBRICATION:	COUPLINGS:
15	NAME PLATE:				
16	COIL: TUBES:		FINS:		
17	CONDENSATE TRAY:		COVERS:		
18	FILTER ELEMENT MATERIAL:				
19	BOLTS, NUTS : CADMIUM AND BI-CHROMIUM PLATED				
20	DOOR SEALING:				
21					
22	**TESTS**				
23	☐ INSPECTION AND MANUFACTURING		☐ OTHERS		
24	☐ OPERATION		☐ WITH INSPECTOR		
25	☐ PERFORMANCE		☐ WITH INSPECTOR		
26	**MISCELLANEOUS**				
27	EMPTY WEIGHT:		kg		
28	OPERATING WEIGHT:		kg		
29	PAINTING AND FINISHING:				
30					
31					
32					
33	**REMARKS:**				
34	N1 - IN CASE THE FAN NOISE LEVEL IS ABOVE THE ALLOWED LIMIT, THE MANUFACTURER SHALL INCLUDE A SOUND ATTENUATOR AND SHALL ADD THIS PRESSURE LOSS TO THE FAN STATIC PRESSURE. INFORM THE PRESSURE LOSS VALUE OF THIS ITEM AS A NOTE				
35	N2 - THE INDICATED ΔP MUST BE ADDED TO PRESSURE LOSSES IN FAN COIL (COIL, FAN SUCTION, ETC.). PRESSURE LOSSES IN PRE-FILTER AND BACTERICIDE FILTER (SEE NOTE N4) ARE ALREADY INCLUDED.				
36	N3 - FANS SHALL ALLOW, BY CHANGING PULLEYS, A $\pm$ 10 % VARIATION OF THE RATED FLOW RATE. THE ELECTRIC MOTOR IS TO CHOSEN IN ORDER TO MEET THIS CONDITION.				
37	N4 - PRE-FILTER AND BACTERICIDE FILTER HAVE A SEPARATE DATA SHEET. SEE " AIR FILTER BOX".				
38					
39					
40					
41					

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
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APPROVED									

	DATA SHEET	Nº
	USER:	SHEET 1 OF 1
	PROJECT:	
	UNIT:	

FAN

	CONTRACT:	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

1	**GENERAL DATA**											
2	TYPE:			ITEM:								
3	SERVICE:			MANUFACTURER:								
4	DRIVE: ☐ MOTOR ☐ TURBINE			MODEL/SERIES:								
5	TRANSMISSION: ☐ DIRECT ☐ BELTS ☐ GEAR BOX			QUANTITY:								
6	**OPERATING CONDITIONS**											
7	GAS ANALYSIS		FLOW RATE (SUCTION CONDITION) m³/h:	OPERATION:	DESIGN.:							
8	COMPOSITION	% VOLUME	FLOW RATE (°C. 101,325 kPa) m³/h:									
9			SUCTION TEMPERATURE (°C):	min.	design.	DENSITY:	kg/m³					
10			STATIC PRESSURE (Pa):	DISCHARGE SPEED (m/s):								
11			DYNAMIC PRESSURE (Pa):	MINIMUM EFFICIENCY:								
12			TOTAL PRESSURE (Pa):									
13	EROSION/CORROSION BY: MARINE ATMOSPHERE			CENTRAL FREQUENCY								
14	NOISE LEVEL AT: m FROM SUCTION &		LW A: m	63	125	250	500	1000	2000	4000	8000	
15	DISCHARGE: dB(A)		OF EQUIPMENT (DB)									
16	**CONSTRUCTION**					**INSTRUMENTS AND PROTECTION**						
17	CASING: ☐HORIZONTAL ☐ VERTICAL	INLET: ☐ SINGLE ☐ DOUBLE				☐ MANOMETER						
18	DIMENSIONS OF: SUCTION: mm	DISCHARGE: mm				☐ THERMOMETER						
19	TYPE OF IMPELLER:	DIAMETER: mm				☐ VIBRATION ☐ ALARM ☐ TRIP						
20	BALANCING: ☐ STATIC	☐ DYNAMIC				☐ OIL LOW PRESSURE ☐ ALARM ☐ TRIP						
21	QTY OF BLADES:	BLADE ANGLE (AXIAL):	d/D:			☐ BEARING HIGH TEMP. ☐ ALARM ☐ TRIP						
22	CONSTRUCTION CLASS:	☐ NON-SPARKING TYPE (AMCA 99):				☐ FLOW SWITCH ☐ ALARM ☐ TRIP						
23	DISCHARGE POSITION (AMCA-2406):	ARRANGEMENT (AMCA-2404):				**PERFORMANCE**						
24	MOTOR POSITION (AMCA AS-2407):	Nº IMPELLER (BELT DRIVE):				CURVE Nº						
25	CABINET: ☐TYPE :	INSULATION: ☐ THERMAL ☐ ACOUSTIC				SPEED.(RPM):						
26	BEARINGS TYPE: ☐RADIAL:	☐THRUST:	DESIGN LIFE.: 40 000 h			Nº OF STAGES:						
27	LUBRICATION: ☐GREASE ☐ OIL BATH	☐ RING ☐ FORCED				EFFICIENCY, % : NORM.: DESIGN.:						
28	COOLING:	BEARINGS:	SHAFT:			INPUT POWER (kw):						
29	ROTATION DIRECTION AS SEEN FROM COUPLING SIDE:					MAXIMUM POWER (kw):						
30	SERVICE: ☐CONTINUOUS ☐INTERMITTENT ☐ ONE IS SPARE	START: ☐MANUAL ☐AUTOMATIC				PERIPHERAL SPEED (m/s):						
31	LOCATION: ☐CLOSED ☐COVERED ☐OUTDOORS	AREA: ☐ SAFE ☐ DANGEROUS				CRITICAL SPEED (m/s):						
32	CAPACITY CONTROL: TYPE:	COUPLING:	TYPE:									
33	**ACCESSORIES**					**INSPECTION/TESTS**						
34	INLET GUIDE VANES	☐MANUAL	☐AUTOMATIC			☐ DIMENSIONS	☐W/ INSPECTOR					
35	DAMPER	☐MANUAL	☐AUTOMATIC			☐ BALANCING (STATIC./DYN.)	☐ W/ INSPECTOR					
36	CONE: ☐ SUCTION ☐ DISCHARGE		☐ LIFTING LUG			☐ PERFORMANCE	☐ W/ INSPECTOR					
37	☐ INTEGRAL BASE ☐ VIBRATION ISOLATORS:		EFF%			**WEIGHT**						
38	☐ AIR FILTER	☐ OIL FILTER				FAN + BASE:						
39	☐ NOISE ATTENUATOR	☐ INSPECTION DOOR				MOTOR:	TURBINE:					
40	☐ AUX. OIL PUMP	☐ MUSHROOM	☐ MOTOR			**MOTOR**						
41	☐ OIL COOLER	☐ TRANSMISSION WITH PROTECTION				ITEM Nº:	POWER. (kw):					
42	FLEXIBLE COUPLING:	☐SUCTION	☐ DISCHARGE			ASSEMBLED BY:						
43	FLANGE:	☐ SUCTION	☐ DISCHARGE			**ADDITIONAL DATA**						
44	COUNTER FLANGE:	☐ SUCTION	☐ DISCHARGE			PAINTING AND FINISHING: ☐YES ☐NO						
45	**MATERIALS**											
46	BEARING BOX:	GLANDS SEALING:	BASE:			COUPLING:						
47	CASING:	THCK.: mm	ROTOR:			SHAFT:						
48	CABINET:	THCK.: mm	HUB:	THCK.: mm		NAME PLATE:						
49	ACOUSTIC INSULATION:	THCK.: mm	THERMAL INSULATION:			THCK.: mm						
50	**REMARKS:**											
51												

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
CHECKED									
APPROVED									

	DATA SHEET					Nº			
	USER:						SHEET 1 OF 1		
	PROJECT:								
	UNIT:								
	LOUVERS								
	CONTRACT:					RESPONSIBLE :			
	DOC. N°					REG. CREA :			
						SIGNATURE :			
1	**GENERAL DATA**								
2	TAG:								
3	INSTALLATION (CODE OF SAFETY ZONE)								
4	QUANTITY:								
5	FUNCTION: SUPPLY / EXHAUST								
6	DIMENSIONS WITHOUT FRAME		REQUIRED HEIGHT (mm)						
7			REQUIRED WIDTH (mm)						
8			SUPPLIED HEIGHT (mm)						
9			SUPPLIED WIDTH (mm)						
10	TOTAL DEPTH (mm):								
11	FRONT FRAME (TYPE AND DIMENSIONS):								
12	PLACE OF INSTALLATION: FLOOR / WALL / DOOR / AIR INTAKE								
13	VANES	FRONT ROW	HORIZONTAL/VERTICAL						
14			FIXED						
15			ADJUSTMENT:						
16			TYPE OF VANE						
17			QUANT. x DIST. BETWEEN VANES (mm)						
18		BACK ROW	HORIZONTAL/VERTICAL						
19			FIXED						
20			ADJUSTMENT						
21			TYPE OF VANE						
22			QUANT. x DIST. BETWEEN BLADES (mm)						
23	DAMPER		TYPE OF BLADES						
24			PLACE WHERE ACTUATED						
25			LOCATION OF DAMPER:						
26			QUANT x DIST. BETWEEN BLADES (mm)						
27	OPERATING CONDITIONS		DESIGN FLOW RATE (m^3 / h)						
28			PRESSURE LOSS. (Pa) (N1)						
29			EFFECTIVE SPEED (m/s)						
30	FREE SECTION (cm^2)								
31	TYPE AND DIMENSIONS OF MOUNTING FRAME								
32	NUMBER OF DRAWING FOR LOCATION								
33	**MATERIALS**								
34	VANES:								
35	BLADES:								
36	FRONT FRAME:								
37	BACK:								
38	**MISCELLANEOUS**								
39	TECHNICAL SPECIFICATION:								
40	PAINTING:								
41	MANUFACTURER: MODEL / SERIES:								
42	**REMARKS:**								
43	1 -WITH A 50% OPENING OF THE DAMPER AND AT THE SUPPLIED EFFECTIVE SPEED IN CASE OF OUTSIDE AIR INTAKES.								
44									
47									
48									

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. I
DATE									
BY									
CHECKED									
APPROVED									

	Nº	
	USER :	SHEET 1 of 1
	PROJECT :	
	UNIT :	

CHILLED WATER EXPANSION TANK

	CONTRACT:	RESPONSIBLE :
	DOC. Nº	REG. CREA :
		SIGNATURE :

DESIGN DATA

CODE:	SERVICE:
OPERATING PRESSURE (kg/cm^{2}g):	JOINT EFFICIENCY:
DESIGN PRESSURE (kg/cm^{2}g):	STRESS RELIEF:
TEST PRESSURE (kg/cm^{2}g):	X - RAY:
OPERATION TEMP. (ºC):	PAINTING: EXTERNAL INTERNAL
DESIGN TEMP. (ºC):	INSULATION:
CORROSION ALLOWANCE (mm):	

MATERIALS

SHELL:	NOZZLE REINF.:	LEGS:
COVERS:	CURVES/REDUCTION:	STUDS / NUTS (N1):
NOZZLE: FLANGE:	REMOV. INTERNAL:	NAME PLATE.:
NECK:	INTERNAL REINF.:	
SLEEVE:	GASKETS:	

NOZZLES LIST

NOZZLE	QUANT.	DIAM.	SERIES	TYPE	FACE	SCH	SERVICE

WEIGHTS (kg)

MANUFACT.:	ASSEMBLED.	OPERATION:	WATER FILLED

REMARKS

	ORIGINAL	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
BY									
CHECKED									
APPROVED									