طرح نگهداشت و افزایش تولید 27 مخزن

SPECIFICATION FOR AIR COOLED HEAT EXCHANGERS

نگهداشت و افزایش تولید میدان نفتی بینک

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1.0 INTRODUCTION

Binak oilfield in Bushehr province, a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

2.0 GENERAL DEFINITION

The following terms shall be used in this document.

COMPANY:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Surface Facilities; New Gas Compressor Station
GENERAL CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR(GC) and approved by COMPANY (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by COMPANY rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

SCOPE

This specification outlines the minimum technical requirements for design, material supply, fabrication and test of Air Cooled Heat Exchangers and it is intended to amendments and supplement of the IPS-G-ME-245, “ENGINEERING AND MATERIAL STANDARD FOR AIR COOLED HEAT EXCHANGER” First Edition, and November 2012. However, Generally Air Cooled Heat Exchangers should meet requirements of ASME code “Unfired Pressure Vessel, Sec. VIII, Div.1”

The following paragraphs specifying the modifications follow the IPS-G-ME-245 numbers and each paragraph denotes an addition, modification, substitution or deletion:

- (Substitution):

The IPS standard clause is deleted and replaced by the new clause.

- (Deletion):

The IPS standard clause is deleted without any replacement.

- (Addition):

A new clause with a new number is added.

- (Modification):

Part of the IPS Standard clause is modified, and/or a new description and/or condition is added to that clause.

3.0 NORMATIVE REFERENCES

3.1 LOCAL CODES AND STANDARDS

• IPS-G-ME-245	Engineering & Material Standard for Air Cooled Heat Exchangers
• IPS-E-GN-100	Engineering Standard for Units
• IPS-G-ME-220	General Standard for Shell and Tube Heat Exchangers
• IPS-M-PM-320	Materials and Equipment Standard for Lubrication Shaft Sealing and Control Oil Systems for Special Purpose
• IPS-E-EL-100	Engineering Standard for Electrical System Design
• IPS-M-EL-131 (2)	Materials and Equipment Standard for Low Voltage Induction Motors

- IPS-M-EL-161 (2) Material & Equipment Standard for Electrical Items
- IPS-G-SF-900 General Standard for Noise and Vibration Control
- IPS-E-TP-100 Engineering Standard for Paints
- IPS-M-PI-150 Material and Equipment Standard for Flanges & Fittings
- IPS-E-CE-120 Engineering Standard Foundations
- IPS-E-CE-500 Engineering Standard for Loads
- IPS-G-GN-210 General Standard for Packing and Packages
- IPS Standard drawings
- NIOC Standard Drawings
- NIOEC Standard Drawings

3.2 INTERNATIONAL CODES AND STANDARDS

- API American Petroleum Institute
  - 673 Centrifugal Fans for Petroleum, Chemical and Gas Industry Services
  - 613 Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
  - 671 Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services
  - 614 Lubrication, Shaft-Sealing, and Control- Oil System and Auxiliaries
- ASME American Society of Mechanical Engineers
  - A14.3 Ladders – Fixed – Safety Requirements
  - A1264.1 Safety Requirements for Workplace Walking/Working Surfaces and their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails systems
  - B16.1 Gray Iron Pipe Flanges and Flanged Fitting Classes 25,125 and 250
  - B16.11 Forged Steel Fittings, Socket Welding and Threaded
  - B16.9 Steel Butt Welding Fittings
  - B16.21 Non- Metallic Gaskets For Pipe Flanges
  - B16.25 Butt Welding Ends
  - B16.5 Standard for Pipe Flanges and Fittings
  - B31.3 Process Piping
  - Section II Materials
  - Section V Non-destructive Examination
  - Section VIII, Div. 1 Rules for Construction of Pressure Vessels

- Section IX — Welding and Brazing Qualifications

- TEMA — Tubular Exchanger Manufacturers Association
- AGMA — American Gear Manufacturer Association
  - 6011 — Specification for High Speed Helical Gear Units
- BSI — British Standard Institution
  - EN 14399-1 — High-Strength Structural Bolting Assemblies for Preloading - Part 1: General Requirements
  - EN 1993 -1-8 — Euro code 3: Design of Steel Structures – Part 1-8: Design of Joints
- PD-5500 — Unfired Fusion Welded Pressure Vessels
- ASCE 7-10 — American Society of Civil Engineers 7-10
- Welding Research Council (WRC)
  - 107 — Local Stresses in Spherical & Cylindrical Shells Due to External Loading
  - 297 — Local Stresses in Cylindrical Shells Due to External Loading on Nozzles – Supplement to WRC Bulletin No. 107
- AWS — American Welding Society
  - D1.1 — Structural Steel Welding Code
- ASTM — American Society for Testing and Materials
  - Applicable Material Standards.
- AISC — American Institute of Steel Construction
  - Applicable Standards.
- EEMUA 143 — Engineering Equipment And Materials Users Association
  - Publication No. 135 — Heat Exchanger Tubes
- ISO 13706 — International Organization for Standardization

  Air Cooled Heat Exchangers

3.3 THE PROJECT DOCUMENTS

- BK-GNRAL-PEDCO-000-PR-DB-0001 — Process Basis of Design
- BK-GNRAL-PEDCO-000-PR-DC-0001 — Process Design Criteria
- BK-GNRAL-PEDCO-000-ME-DC-0001 — Mechanical Design Criteria
- BK-GNRAL-PEDCO-000-ST-DC-0001 — Structural Design Criteria
- BK-GNRAL-PEDCO-000-EL-SP-0010 — Specification For LV Electro Motors

- BK-GNRAL-PEDCO-000-PI-SP-0005 Specification For Fittings, Flanges, Gaskets and Bolts
- BK-GNRAL-PEDCO-000-PI-SP-0006 Specification For Painting
- BK-GNRAL-PEDCO-000-PI-SP-0008 Specification For Material Requirements in Sour Service
- BK-GNRAL-PEDCO-000-PI-SP-0011 Specification For Welding of Plant Piping System
- BK-GCS-PEDCO-120-PI-RT-0001 Corrosion Study & Material Selection Report
- BK-GNRAL-PEDCO-000-IN-SP-0001 Specification For Instrumentation
- BK-GNRAL-PEDCO-000-IN-SP-0004 Specification For Instrument and Control of Package Unit System (PU)
- BK-GNRAL-PEDCO-000-EL-DC-0001 Electrical System Design Criteria
- BK-GNRAL-PEDCO-000-EL-SP-0011 Specification For Electrical Requirements of Packaged Units
- BK-GNRAL-PEDCO-000-SA-SP-0001 Specification For Fire Fighting Equipment
- BK-GNRAL-PEDCO-000-SA-SP-0002 Specification For Hazardous Area Classification
- Piping and Instrumentation Diagrams

3.4 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK-GNRAL-PEDCO-000-PR-DB-0001".

3.5 ORDER OF PRECEDENCE

In case of conflict between requirements specified herein and the requirements of any other referenced document, the most approved stringent requirements of below listed items shall be considered:

- Purchase Material Requisition (PMR)/ Purchase order
- Data sheets
- This specification
- Drawings and other Reference Project Specifications
- IPS standards
- International codes and standards

When the terms “Authorized”, “Authorization”, “Approval” or “Approved” are used in this specification, it shall mean authorization or approval from COMPANY.

4.0 GENERAL (IPS CLAUSE 4)

4.1 MODIFICATION TO ARTICLE 4.5

This standard is based on International System of Units (SI) as per **IPS-E-GN-100**, unless otherwise specified. In this international standard, where practical, US customary units are included in the brackets for information.

4.2 ADDITION TO ARTICLE 4

(4.8) If the service is designated as severe sour in accordance with BK-00-HD-000-PI-SP-0008 for oil and gas production facilities (e.g. petroleum refineries, LNG plants and chemical plants), in which case all materials in contact with the process fluid shall meet the requirements of the project applicable reference document BK-00-HD-000-PI-SP-0008 to mitigate the potential for sulfide stress cracking (SSC). Identification of the complete set of materials, qualification, fabrication, and testing specifications to prevent in-service environmental cracking is the responsibility of the user (COMPANY).

(4.9) For refinery applications, horizontal heat exchangers of either type are preferred, so that several air cooled heat exchangers can be grouped into one bank.

5.0 DOCUMENTATION (IPS CLAUSE 6)

5.1 ADDITION TO ARTICLE 6

All documentation shall be in English unless otherwise specified. However, descriptions on drawings and similar documents may be in other languages providing English translations are also given.

The Vendor shall furnish all drawings, design details, operation and maintenance manuals and other information necessary for the design assessment, erection, operation and maintenance of the installation. The design details shall include stress calculations of header box and tube bundle covering all combinations of flow, temperatures and pressure for the specified operating conditions. All information, especially the manuals for operation and maintenance, shall be explicit and not open to misinterpretation, and shall apply specifically to the installation supplied.

Use shall be made of the data/requisition sheets for the exchange of information between the Company and Vendor Units of measurement shall be as shown on the data/requisition sheets.

5.2 ADDITION TO ARTICLE 6.1.1

(S.) The VENDOR shall provide the detailed drawings and information required by clause 6.1.2 and 6.1.4 of API standard 661, as amended by this specification when submitting outline drawings for approval.

(T.) Tube-to-tubesheet joint and details of joint preparation.

(U.) Maximum and minimum plug torque values with recommended thread lubrication.

(V.) When sour or wet sulfide service is specified by the COMPANY, a certified material test report (CMTR) shall be supplied for all carbon steel materials in contact with the process fluid.

5.3 ADDITION TO ARTICLE 6.1.3

Calculations required by the pressure design code shall be provided for the design of pressure components, including header boxes, tubes, and tube joints. Sufficient detail shall be supplied for any non-standard pressure boundary components, such as swage type transition nozzles. Calculations shall also be provided for restraint relief in accordance with 7.1.6.1.3, and also for the defined external moments and forces on nozzles in accordance with 7.1.10.

5.4 MODIFICATION TO ARTICLE 6.1.4

Weld maps, all proposed welding procedures, including tube to tubesheet welding procedures and qualifications (including impact test results, if applicable) shall be submitted for approval prior to fabrication.

5.5 ADDITION TO ARTICLE 6.1.6

a) Header details including metal thicknesses, internal header dimensions, pass partitions, stiffeners and tube layout, shall be provided. If the entire header thickness is increased to provide necessary reinforcement for nozzles, the thickness for reinforcement shall be noted on the header drawing.

b) Fabrication drawings shall show weld details and reference applicable welding procedures. The drawing shall also include impact test requirements, showing (as applicable):

1) Component
2) Thickness for impact purpose
3) Material specification
4) Critical Exposure Temperature
5) Appropriate charpy V-notch impact requirements (average/minimum values).

c) Vendor's proposal for spare parts shall include proposed method of protection from corrosion during shipment and subsequent storage.

d) Fabrication drawing, showing weld details with referenced procedures; All proposed Welding Procedure Specifications (WPS), Procedural Qualification Record (PQR) and repair procedures, shall be submitted for review and approval prior to the commencement of fabrication.

e) Calculations for structural design shall be submitted for review and approval.

f) List of spare parts, including startup and the first year of operation, including detailed prices and delivery times and full specification of the part or the supplier's part number (e.g. in reference drawings)

g) List of tools necessary for operation, maintenance, inspection and cleaning air-cooled heat exchanger.

h) Operation and maintenance manuals.

5.6 ADDITION TO ARTICLE 6.2.1.1

The following documents shall be submitted after the contract has been awarded, and well in advance of estimated date of shipment:

a) List of all tools necessary for operation, maintenance, inspection and cleaning insofar as not normally found in a refinery workshop.
b) Six copies of the operation and maintenance manuals.

5.7 SUBSTITUTION OF ARTICLE 6.2.2

g) Parts list and list of all spare parts including a list of initial spare parts necessary for start-up and first year of operation with detailed prices and time of delivery.

6.0 DESIGN

6.1 TUBE BUNDLE DESIGN

6.1.1 GENERAL

SUBSTITUTION OF ARTICLE 7.1.1.1

7.1.1.1 Each tube bundle shall be rigid and self-contained so that it can be handled as one complete assembly. The width of the tube bundle shall be chosen with due regard to transport and handling aspects, and shall not, in general, exceed 3 meters. Tube-to-tube sheet joints shall preferably be rolled and shall also be strong enough to contain the stresses caused by differential thermal expansion in the case of plugged or fouled tubes. Moreover, tube-to-tubesheet joints shall also be able to sustain transportation / erection loads.

MODIFICATION OF ARTICLE 7.1.1.4

7.1.1.4 The following statement to be added to this clause:

Tubes shall be adequately supported either by tube support boxes or proprietary collar zinc supports. Collar zinc supports shall not be used in combination with austenitic stainless steel tubes in that case Aluminum supports shall be used

ADDITION TO ARTICLE 7.1.1.13

7.1.1.13 Wind and seismic forces shall be considered in the design of a tube bundle as required in the data sheet.

6.1.2 TUBE BUNDLE DESIGN TEMPERATURE

SUBSTITUTION OF ARTICLE 7.1.3.1

7.1.3.1 Design temperature shall be in accordance with "Process Design Criteria; Doc. No. BK-GNRAL-PEDCO-000-PR-DC-0001"

MODIFICATION OF ARTICLE 7.1.3.2

7.1.3.2 Fin selection shall be based on the max. specified operating temperature (fin design temp.) (See Fig. 1 in this Standard).

6.1.3 TUBE BUNDLE DESIGN PRESSURE

SUBSTITUTION OF ARTICLE 7.1.4.1

7.1.4.1 Design pressure shall be in accordance with "Process Design Criteria; Doc. No. BK-GNRAL-PEDCO-000-PR-DC-0001".

6.1.4 HEADERS

MODIFICATION OF ARTICLE 7.1.6.1

7.1.6.1.5 Headers with multiple nozzles or an increased header cross-sectional area may be required. At least one inlet nozzle is required per meter of bundle width.

7.1.6.1.6 The minimum tube sheet thickness shall be in accordance with TEMA R standard.

ADDITION TO ARTICLE 7.1.6.1

7.1.6.1.9 In multi-pass headers, split headers shall be used where the temperature differential across the bundle is sufficient to cause wrap age of the header tube sheets or bowing of tubes.

This would normally occur when the temperature differential between inlet and outlet exceeds 110°C.

7.1.6.1.10 Header pass arrangements and location of nozzles for bank arrangement shall be designed to minimize piping runs and thermal stresses.

6.1.5 REMOVABLE COVER PLATE AND REMOVABLE BONNET HEADERS

MODIFICATION OF ARTICLE 7.1.6.2

7.1.6.2.3 Bolted joints shall be designed with confined gaskets in accordance with Fig. 4 (A) or (B).

7.1.6.2.4 Either jackscrews or 5 mm minimum clearance shall be provided at the cover periphery to facilitate dismantling. Lifting lugs or eye bolts shall be provided for all cover plates.

7.1.6.2.7 Stud bolts and through bolts shall be used.

ADDITION TO ARTICLE 7.1.6.2

7.1.6.2.11 Cover plate bolting smaller than 16 mm (5/8 inch) shall not be used.

7.1.6.2.12 Unless otherwise specified, the headers shall be of the cover-plate-type designed for working pressures up to 30 bar. For hydrogen service and for working pressures above 30 bar, plug-type headers shall be applied. For very high pressures, manifold type headers may be used with return bends.

6.1.6 PLUG HEADERS

MODIFICATION OF ARTICLE 7.1.6.3.1

7.1.6.3.1 Plugged holes shall be provided opposite the ends of each tube for access. Plug type headers shall have easy accessibility for:

a) Cleaning;
b) Re-rolling to tighten tube joint, and;
c) Plugging tube in case of singular tube leaks;
d) Inspection.

6.1.7 GASKETS

SUBSTITUTION OF ARTICLE 7.1.8.4

7.1.8.4 The selection of gaskets for cover plate header flanges depends on the temperature, pressure, and corrosive conditions of the fluids to be sealed.

For air-cooled heat exchangers made of steel, and provided that hydrocarbon streams are free from hydrogen, gaskets shall be selected as per following Table. (For hydrogen service, the plug-type header design only shall be allowed.)

GASKETS DIMENSIONS

TEMPERATURE (°C)	PRESSURE (Bar)	GASKET TYPE	MINIMUM GASKET WIDTH (mm)	GASKET THICKNESS (mm)
Max. 240	Max. 20.5	Oil or acid resistant	10	1.5
> 240-Max. 450	Max. 30	Corrugated metal	12	3

For certain chemical services, Gaskets of the Type, e.g., solid metal or spiral-wound may be required.

MODIFICATION OF ARTICLE 7.1.8.7

7.1.8.7 Gaskets shall have a continuous periphery with no radial leak paths. This shall not exclude gaskets made continuous by welding or other methods which produce a homogeneous bond.

6.1.8 NOZZLES AND OTHER CONNECTIONS

SUBSTITUTION OF ARTICLE 7.1.9

7.1.9.6 Flanges shall be in accordance with ASME B.16.5 unless specified by Purchaser. The use of DN 65, DN 90 and DN 125 is not permitted.

7.1.9.8 Flanged carbon steel connections shall be one of the following types:

1) Integrally forged steel with welding-neck-type flange.

2) Seamless pipe or, for sizes DN 400 (16 in.) and larger, pipe rolled from steel plate and longitudinally double butt welded, to which a welding-neck flange or slip-on flange is attached.

Welding neck flange shall be used for swaged nozzle for low-temperature applications, for the containment of lethal substances or liquefied gases, and in hydrogen service. The minimum permissible thickness of flanged carbon steel nozzles and connections shall be:

For size DN 40 (1½ in.) and DN 50 (2 in.) schedule 160

For size DN 75 (3 in.) and DN 100 (4 in.) schedule 80

For size DN 150 (6 in.) and DN 200 (8 in.) schedule 40

For size DN 250 (10 in.) and larger schedule 30

7.1.9.13 All flanged nozzles of DN 100 (4 in.) or larger shall be provided with one connection of DN 25 (1 in) minimum, for a thermometer. For smaller sizes connection shall be on header adjacent to the nozzle.

7.1.9.14 All flanged nozzles of DN 50 (2 in.) or larger shall be provided with one connection of DN 20 (¾ in) minimum, for a pressure gage. If the nozzle is less than DN 50 the connection shall be on the header adjacent to the nozzle.

7.1.9.15 When required, chemical cleaning connections, shall be considered in accordance with the Air Cooler Data Sheets.

MODIFICATION OF ARTICLE 7.1.9

7.1.9.6 Flange rating and type of facing will be specified. Flange dimensions and facing shall be in accordance with ASME B16.5. The finish of the nozzle flange facing shall conform to the appropriate piping class. (For flange face finish and gaskets see Annex J of relevant IPS)

7.1.9.12 All pipe tap connections shall be a minimum of 41,500 kPa (6000 psi) standard coupling or equivalent. Each connection shall be fitted with a round head bar stock plug conforming to ASME B16.11 of the same material as the connection.

Alternate plug materials may be used when galling is anticipated, except cast iron plugs shall not be used.

7.1.9.20 Vent and drain connections, of DN 20 (¾ in) minimum, shall be provided at high and low points on each header or header nozzle unless larger size is specified. Connections serving as vents and drains shall not extend into the header beyond the inside surface.

ADDITION TO ARTICLE 7.1.9

7.1.9.23 Screwed or socket weld connection for hydrogen service shall not be used. All flanged nozzles shall be directly welded to the header.

7.1.9.24 Telltale holes, on reinforcing pads shall be threaded ¼ in. NPT in accordance with ANSI B2.1. Reinforcing pads are not allowed in hydrogen service.

7.1.10 MAXIMUM ALLOWABLE MOMENTS AND FORCES FOR NOZZLES AND HEADERS

ADDITION TO ARTICLE 7.1.10

7.1.10.1 The components of a nozzle loading on a single header, shall not exceed three times the loads shown in Figure 6 and Table 4 in API Std. 661, 7th Edition (2018).

6.1.9 TUBES

MODIFICATION OF ARTICLE 7.1.11

7.1.11.1 The minimum acceptable tube diameter is 25.4 mm (1 in.) OD.

7.1.11.3 The minimum wall thickness for carbon steel tubes shall be 2.7mm.

7.1.11.5 Tubes shall be finned tube or bare tube as specified.

7.1.11.6 The total unfinned length of a finned tube between tube sheets after assembly shall be 50 mm.

7.1.11.7 Fins may be of same or different material than tube wall. Aluminum fins are most popular for average installation.

The fins may be extruded on the host tube, embedded, wrapped into spiral grooves cut into the host tube, or just wrapped on the host tube (see Fig. 1 of this Standard). For aluminum fins maximum design temperatures are listed below:

- Tubes of mechanically embedded fin type shall not be used for design temperatures exceeding 400°C (750°F).

- Tubes of extruded fin type shall not be used for design temperatures exceeding 260°C (500°F).

- Tubes of footed tension wound fin type shall not be used for design temperatures exceeding 150°C (300°F).

- Tubes of overlapped footed tension wound fin type shall not be used for design temperatures exceeding 150°C (300°F).

- Tubes of spiral groove footed fin type shall not be used for design temperatures exceeding 260°C (500°F). The groove shall be per sub-item 1 above for mechanically embedded fins. The fin foot shall be extruded into the groove to a minimum depth of one-half the fin thickness ±0.05 mm (±0.002 in).

- Tubes of tension wound fin type shall not be used for design temperatures exceeding 120°C

(250°F). Tubes of tension wound fin type are prohibited in steam condensing services.

7.1.11.8 Minimum stock thickness for L-shaped and embedded fins shall be 0.35 mm for up to a fin height of 6.35 mm (0.25 in.) and 0.40 mm for fin heights above 6.35 mm. For extruded fins these thicknesses shall apply at the root of the fin.

SUBSTITUTION OF ARTICLE 7.1.11

7.1.11.2 Most common tube length for IPS project is preferred to be 9144 mm (30 ft) although standard bundles are available in lengths of 2438.4 mm (8 ft), 3048 mm (10 ft), 4572 mm (15 ft), 6096 mm (20 ft), 7315.2 mm (24 ft) 10363.2 mm (34 ft), and 12192 mm (40 ft).

ADDITION TO ARTICLE 7.1.11

7.1.11.14 Stainless steel and non-ferrous tubes shall be seamless. Carbon steel tubes shall be seamless. If electric resistance welded type is used prior approval of the Company shall be obtained. For high pressure and high temperature the use of seamless tube is mandatory.

7.1.11.15 Carbon steel, ferritic alloy and austenitic alloy steel tubes shall meet the requirements of ASTM A-450 "General Requirements for Carbon, Ferritic and Austenitic Alloy Steel Tubes".

7.1.11.16 All tubes shall have no circumferential weld seam.

7.1.11.17 Fin ends of tension wound fins shall be secured by rivet, screw, or staple fasteners.

7.1.11.18 The maximum allowable number of fins is 400 per meter of the tube length. In order to prevent fouling, fin surfaces shall be smooth.

6.2 AIR SIDE DESIGN

6.2.1 GENERAL

ADDITION TO ARTICLE 7.2.1

7.2.1.5 The driver and fan assemblies shall be so located as to have easy access to all components.

7.2.1.6 Fouling on the outside of finned surface is usually rather small, but must be recognized. Values of 0.020 to 0.030 kJ/h.m². °C usually satisfy most fin site conditions.

6.2.2 NOISE CONTROL*

ADDITION TO ARTICLE 7.2.2.4

7.2.2.4 The noise level is usually limited to 75 decibels maximum at 15.24 meters (50 ft) from the fan, and the blade tip speed is limited: to 3352.8-3657.6 meter per minute (11,000-12,000 feet per minute). This may run higher for unit below 121.92 cm (48 in) dia.

6.2.3 FANS AND FAN HUBS

MODIFICATION OF ARTICLE 7.2.3

7.2.3.5 The rated speed of the fan shall not exceed 1200 revolutions per minute unless otherwise approved by the Company.

7.2.3.11 Fans equipped for pneumatically actuated, automatically controlled pitch adjustment of blades shall comply with the followings:

1) The actuators shall be diaphragm or piston type, and be suitable for an air supply pressure of 7 barg normal and 2.5 barg. Make and type shall be approved.

2) Each actuator shall have an integral positioner mechanism and mechanical maximum and minimum stops. These stops shall be adjustable over the full range without dismantling the mechanism. The positioner shall be EEx(ia) with degree of protection minimum IP65. The positioner shall be designed to operate by 4-20 mA, HART control signal coming from main control system. Each change in the control signal shall result in a corresponding change in the fan blade pitch. The operating range of the positioner shall be adjusted so that the maximum pitch obtained is equal to the selected design blade angle setting. Maximum and minimum blade pitch limit stops shall be set by the fan manufacturer. Unless otherwise specified by the Company, the minimum blade pitch limit will result in essentially zero air flow with hot bundles. Exposed actuator shafts shall be protected with canvas gaiters. The stroking time, from minimum to maximum pitch or reverse, shall be 10 seconds maximum with the fan rotating. Hysterics shall not exceed 1% of full stroke.

3) In the case of air failure, blades shall move to a maximum pitch and be locked in position.

4) Actuators and positioners shall be easily accessible for maintenance and adjustment. For induced drought, actuators and positioners may be installed above the fans provided ease of access is maintained and outlet air temperatures do not exceed 100°C. For forced drought, actuators and positioners shall be installed under the drive mechanism. Typical arrangements for forced drought, induced drought, direct drive, and A-belt in-direct drive are shown respectively, in Appendices H and K of this Standard.

5) The rotating parts of actuators shall be protected by a wire mesh screen with a removable

panel allowing actuator adjustment.

* For more information refer to the following standards:

IPS-G-SF-900 "Noise & Vibration Control"

ISO 1999 "Assessment of Occupational Noise Exposure for Hearing Conservation Purposes"

EEMUA "Guide to the Use of Noise Procedure Specification Publication No. 141"

BS 4142 "Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas"

BS 5330 "Method of Test for Estimating Hearing Handicap Due To Noise Exposure"

ADDITION TO ARTICLE 7.2.3

7.2.3.17 The equipment, including auxiliaries, covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation. It is recognized that this is a design criterion.

7.2.3.18 Fans shall be designed and constructed to operate satisfactorily at all specified operating conditions, maximum continuous speed, and to the trip speed setting of the driver, if applicable.

7.2.3.19 Induced draft fans shall be mechanically designed for operation at least at 37.7°C (100°F) above maximum specified fan inlet air temperature.

7.2.3.20 Fan, components, and accessories shall be designed to withstand all loads and stresses during rapid load changes, such as across-the-line starting of motor drivers, failure of damper operator and sudden opening of dampers.

7.2.3.21 All equipment shall be designed to permit rapid and economical maintenance.

6.2.4 FAN SHAFTS AND BEARINGS

ADDITION TO ARTICLE 7.2.4

7.2.4.7 Shafts shall be one piece; heat treated, forged steel, and suitably ground. Shafts 15 centimeters (6 in.) in diameter and smaller may be machined from hot rolled steel. Shaft diameter shall be stepped on both sides of impeller fit area to facilitate impeller removal.

7.2.4.8 Ball type thrust bearings shall be dual single row, 40 degree, light preload, angular contact type (7000 series), installed back-to-back.

7.2.4.9 Fan wheels preferably shall have a non-overloading horsepower characteristic and shall be designed for highest possible efficiency.

7.2.4.10 Impellers shall have solid hubs, be keyed to the shaft, and be secured with a thermal shrink fit. Cast iron, nodular iron, and hollow hubs are not acceptable.

7.2.4.11 Shaft seals shall be replaceable from the outside of the inlet boxes without disturbing the shaft or bearings.

7.2.4.12 Bearing housing mounting surfaces shall be machined in a flat continuous plan parallel to the bearing bore.

7.2.4.13 Bearing housings shall be drilled with pilot holes for use in final doweling.

6.2.5 LUBRICATION FACILITIES

ADDITION TO ARTICLE 7.2.5.1

7.2.5.1 All linkage, shaft fittings, and bearings preferably shall be permanently lubricated. Components requiring periodic lubrication shall be furnished with lubrication fittings which are accessible while the fan is in operation.

6.2.6 FAN GUARDS

ADDITION TO ARTICLE 7.2.6

7.2.6.9 Where the fan guards are specified for induced-draft with top mounted drivers, the guard shall be provided with a hinged door to enable replacement of V-belts without removal of the entire guard.

7.2.6.10 The guard shall be constructed to be rigid enough to withstand a 91 kilogram (200 pound) static load with a deflection of not more than 0.0005 times the unsupported length of the guard.

7.2.6.11 The guard shall contain anti swirl baffles, as required, to minimize the effects of wind age and air swirl.

7.2.6.12 materials of fan blades and fan guards shall be a non-sparking combination.

6.2.7 DRIVERS

6.2.7.1 GENERAL

MODIFICATION OF ARTICLE 7.2.7.1.1

7.2.7.1.1 The type of driver will be specified by the COMPANY.

ADDITION TO ARTICLE 7.2.7.1.3

7.2.7.1.3 All fans shall be electric-motor driven.

6.2.7.2 ELECTRIC MOTOR DRIVERS

SUBSTITUTION OF ARTICLE 7.2.7.2.1

7.2.7.2.1 The specification of the electric motors shall be in general as per **"IPS-M-EL-131"** and "Specification for LV Electro Motors; Doc. No. BK-GNRAL-PEDCO-000-EL-SP-0010"

Insulation class shall be class F with temperature rise of class B.

MODIFICATION OF ARTICLE 7.2.7.2

7.2.7.2.2 The motor manufacturer shall be advised that the motor is intended for air-cooled heat exchanger service and operation outdoors, unprotected from weather conditions. Motors shall be suitable for operation at vertical position either shaft up or shaft down.

7.2.7.2.3 Motors frames shall be of cast steel or corrosion resistant cast iron, with integrally cast support feet. Motors enclosures shall be made of cast steel or corrosion resistant steel and shall be totally enclosed fan cooled with degree of protection IP 54. The enclosures shall be suitable for the area classification in which they are to be installed and shall be Exd for zone 1, Exd or Exe for zone 2.

7.2.7.2.6 For motors mounted in shaft up position means shall be provided so to prevent water from being directed to the motor shaft in idle running condition. A conical slinger shall be fitted to the shaft in order to prevent the water from entering the motor, when in running condition.

6.2.8 BELT DRIVES

SUBSTITUTION OF ARTICLE 7.2.8.2.1

7.2.8.2.1 Whether timing belt, V-belt or power band drive is required will be specified on the data sheets. Poly V-belts shall be used instead of V-Belts.

ADDITION TO ARTICLE 7.2.8.2.14

7.2.8.2.14 The maximum parallel misalignment of motor and fan shaft shall not exceed 0.1 mm total indicator reading (TIR).

6.2.9 GEAR DRIVES

SUBSTITUTION OF ARTICLE 7.2.8.3.4

7.2.8.3.4 Gear units shall be in accordance with AGMA 421.06 and shall be of the spiral, single-reduction-type with outboard bearing and have an AGMA service factor of not less than 2.0 based on the power of the drive. The gears shall be SAE 4620 or equivalent, hardened, lapped and match-marked.

6.2.10 SCREENS

MODIFICATION OF ARTICLE 7.2.11.1

7.2.11.1 Removable bug screens shall be provided.

7.1 STRUCTURAL DESIGN

6.2.11 GENERAL REGIMENTS (SUB.)

MODIFICATION OF ARTICLE 7.3.1.1

7.3.1.1 Structural steel design, fabrication, and erection shall be in accordance with American Institute of Steel Construction (AISC) Standard Specifications for structural steel buildings or approved equivalent.

SUBSTITUTION OF ARTICLE 7.3.1.6

7.3.1.6 Structural supports for suspended drivers:

a) Shall be assembled using through-bolts;

b) Shall not be attached to the bundle side frames.

ADDITION TO ARTICLE 7.3.1

7.3.1.7 High-strength friction grip bolts in accordance with BS 4395: Parts 1 & 2 and BS 4604: Parts 1, 2 may be used for all site connections.

7.3.1.8 Manufacturer shall be responsible for meeting the vibration requirement of field assembled units.

6.2.12 PLENUMS

SUBSTITUTION OF ARTICLE 7.3.4.3

7.3.4.3 Each fan shall have its own plenum chamber effectively sealed off from adjacent chambers. Where an automatic variable-pitch fan is installed, its plenum chamber shall serve one unit only.

ADDITION TO ARTICLE 7.3.4.9

7.3.4.9 Bottom of fan ring shall be a minimum of 2 meters above grade.

6.2.13 MECHANICAL ACCESS FACILITIES

SUBSTITUTION OF ARTICLE 7.3.5.1

7.3.5.1 Platforms shall be provided to serve inlet and return headers if the elevation of the bottom of the header above grade is greater than 3 meters (10 ft).

The need for additional platforms will be determined from the final arrangement and layout of the unit. The layout and sizing of platforms to serve driver and fan assemblies shall permit access to all components. Space shall be provided for placement of drivers, transmissions, and fan components.

MODIFICATION OF ARTICLE 7.3.5

7.3.5.4 Floor plate drainage shall be provided by one 13 mm (½ in.) diameter hole for approximately every 1.5 m² (15 sq ft.) holes shall be located at low spots and drilled after erection.

7.3.5.5 The need for the ladders will be determined from the final arrangement and layout of the unit. Ladders, guard railings, toe plates, safety cages and similar items shall be constructed of steel per ANSI A1264.1 and A14.3.

1) Safety cages shall be provided for ladders with a height of over 3 meters (10 feet).

2) Chains with safety hooks or safety gates shall be provided across ladder opening on the platforms.

3) Ladders shall be provided for side-step access to platforms.

6.2.14 LIFTING DEVICES

MODIFICATION OF ARTICLE 7.3.6.4

7.3.6.4 Sufficient lifting eyes shall be provided on each driver and gear to allow safe installation and dismantling. A structural member shall be provided with load attachment points for removal and replacement of driver components.

7.0 MATERIALS

7.1 GENERAL

ADDITION TO ARTICLE 8.1

8.1.2.1 All materials of equivalent to ASTM Standard Specification may be used upon approval of purchaser.

8.1.7 Certified material and testing reports for all material of construction shall be submitted to Purchaser for review.

8.1.8 Fan blades shall be of aluminum alloy or glass-fiber reinforced plastic and in case of induced draft fan arrangement shall be able to withstand a temperature of minimum 110°C.

8.1.9 Damper or variable guide vane operating mechanisms, linkages, and other external part subject to rotary or sliding motions shall be of corrosion resistant materials suitable for the site environment.

Internal operating parts subject to rotary or sliding motion shall be stainless steel or other equally corrosion resistant material. Minor parts associated with such mechanism (bolts, nuts, springs, washer, gaskets, and keys) shall have equal corrosion resistance.

8.1.10 Proposals to use materials having a specified maximum tensile strength greater than 620 MPa (90,000 psi) at room temperature shall be approved by the Company.

8.0 FABRICATION OF TUBE BUNDLE (IPS CLAUSE 9)

8.1 ADDITION TO ARTICLE 9.1.1

(9.1.1.5) Weld procedure qualifications for carbon steel in sour or severe sure service, including tube to tubesheet welds, shall include a micro-hardness survey performed on a weld cross-section and transverse to the weld centerline. The micro-hardness testing and acceptance criteria shall be in accordance with NACE MR 0103, as applicable. Any additional restrictions on class, grade, residual elements or micro-alloying elements for the qualification test material to be specified by the Purchaser.

8.2 MODIFICATION TO ARTICLE 9.3.4.1

Generally the junction of tube to tubesheet shall be always of the expanded type, except for the following cases, for which special reasons lead to the choice of strength welding type:

When tube thickness is greater than 4.2 mm (8 BWG) with outside diameter 25.4mm.

When the design pressure is greater than 70 barg.

When a discontinuous operation is anticipated. (highly cyclic)

When more than 5000 cycles, during 10 years, are foreseen.

When the heat exchanger is in special service such as lethal service, steam, toxic …

When the design temperature is higher than:

480 ˚C with stainless steels, other than low-carbon or stabilized

300 ˚C with carbon steels

400 ˚C Cr-Mo/Mo steels

380 ˚C with 304L stainless steel

400 with 316L stainless steel

8.3 DELETION OF ARTICLE 9.3.4.6

8.4 MODIFICATION TO ARTICLE 9.5.1

Plug threads shall be coated with a suitable water resistance and thermal stability thread lubricant when is assembled in header box.

9.0 INSPECTION, EXAMINATION AND TESTING (IPS CLAUSE 10)

9.1 ADDITION TO ARTICLE 10.1

(10.1.13) All carbon steel plate in sour or wet hydrogen sulfide service shall be subjected to an ultrasonic lamination check (e.g. to EN 10160 grade S2E2 or ASTM A578, acceptance level A supplementary requirement S1).

9.2 MODIFICATION TO ARTICLE 10.3

Shop run-in tests of the steel structure, driver, the drive assembly, and the fan of shop-assembled for one bay of each item shall be in the vendor’s scope of work.

10.0 PREPARATION FOR SHIPMENT (IPS CLAUSE 11)

10.1 SUBSTITUTION OF ARTICLE 11.2.4

All surfaces requiring painting shall be painted in accordance with “Painting Specification” Doc. No. BK-GNRAL-PEDCO-000-PI-SP-0006.

11.0 SUPPLEMENTAL REQUIREMENTS (API 661 CLAUSE 12)

11.1 MODIFICATION TO ARTICLE 12.1

In general, these supplemental requirements should be considered if the design pressure exceeds 14 000 kPa gauge (2 000 psig), if the plate thickness of a box-type header of an air-cooled heat exchanger exceeds 50 mm (2 in) or if an exchanger is to be placed in a critical service.

11.2 ADDITION TO ARTICLE 12.2

(12.2.3) Nozzle connections to headers shall be made with full-penetration welds.

12.0 GUARANTEE (ADDITION.)

12.1 GENERAL

12.1.1 The VENDOR shall guarantee the exchanger against improper design and defective workmanship and materials but not against corrosion or erosion.

12.1.2 The manufacturer shall guarantee that the air-cooled heat exchanger shall meet the required design conditions of the specific application.

12.1.3 The VENDOR shall guarantee the noise level will not exceed that specified.

12.1.4 The VENDOR shall guarantee that the materials of construction comply with the material specification established by the purchase order.

12.1.5 The VENDOR shall repair or replace free of charge F.O.B at his shop, any defective parts or workmanship found within the guarantee period. Other charges, if any, shall be subject to negotiation with the purchaser.

12.1.6 The air-cooled heat exchanger supplied shall be free of defects in materials and workmanship. The guarantee period shall be eighteen (18) months from the date of delivery or twelve (12) months from the date of mechanical completion & start-up (if applicable), whichever occurs later.

12.1.7 The VENDOR shall guarantee interchangeability of equal mechanical parts

12.1.8 Commissioning & start-up and two-year normal operation spare parts shall be considered per attachment 11 of the project EPC tender dossier, as a minimum requirement.

13.0 CONTROLS AND INSTRUMENTATION (ADDITION.)

13.1 GENERAL

13.1.1 Design, supply and installation of instrumentations, shall follow the requirements of “Specification for Instrumentation”; Doc. No. BK-GNRAL-PEDCO-000-IN-SP-0001, “Specification for Instrument & Control of Packaged Unit System (PU)"; Doc. No. BK-GNRAL-PEDCO-000-IN-SP-0004 and “Specification for Hazardous Area Classification”; Doc. No. BK-GNRAL-PEDCO-000-SA-SP-0002.

13.1.2 Regarding the type of protection of the control panel (Hazardous Area or Non-Hazardous Area), it is necessary to install the appropriate local control panel according to the installation location (with the approval of the Client).

13.1.3 All instruments shall be tagged with identifying tag numbers which are assigned by Purchaser at time of drawing approval.

13.1.4 An electrical local control panel(s), Suitable for Non-hazard area, shall be provided with the facility to start and stop the package locally. For more detail refer to “Specification for Electrical Requirements of Packaged Units”; Doc. No. BK-GNRAL-PEDCO-000-IN-SP-0011.

13.1.5 VENDOR shall supply all field instruments cable to skid edge JBs. Some signals may be connected to PCS (Process Control System) and ESD (Emergency Shutdown) as per related P&ID.

13.1.6 The VENDOR shall provide wiring/connection details and narratives of any specific regulatory control or safeguarding requirements. This information shall be used by the local control panel (LCP) of the package for pump/motor control.