International Association of Oil & Gas Producers

SPECIFICATION S-710

October 2019

Supplementary Specification to API Standard 661 Air-cooled Heat Exchangers

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
0.1	October 2019	Issued for Public Review

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Project 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization for projects globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly approved specification, building on recognized industry and/or international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages, facilitating improved standardization of major projects across the globe. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2014).

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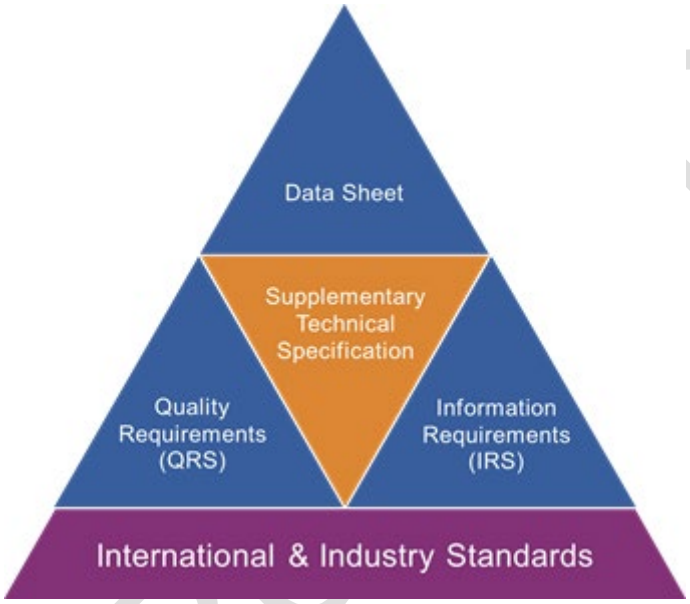
List of Tables

Introduction

The purpose of this specification is to define a minimum common set of specification requirements for the procurement of Air-cooled Heat Exchangers in accordance with API Standard 661, Seventh Edition, July 2013 - Reaffirmed, June 2018.

This JIP33 standardized procurement specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents
Supplementary Technical Specification

It is required to use all of these documents in conjunction with each other when applying this specification, as follows.

S-710: Supplementary Specification to API Standard 661 Air-cooled Heat Exchangers

This specification is written as an overlay to API Standard 661(parent standard), following the clause structure of the parent standard, to assist in cross-referencing the requirements. Where clauses from the parent standard are not covered in this specification, there are no supplementary requirements or modifications to the respective clause. The terminology used within this specification follows that of the parent standard and otherwise is in accordance with ISO/IEC Directives, Part 2.

Modifications to the parent standard defined in this specification are identified as *Add* (add to clause or add new clause), *Replace* (part of or entire clause) or *Delete*.

S-710D: Data Sheet for Air-cooled Heat Exchangers

This document provides project specific requirements where this specification requires the purchaser to define an application specific requirement. It also includes information required by the purchaser for technical evaluation. Additional purchaser supplied documents are also listed in the data sheet, to define scope and technical requirements for enquiry and purchase of the equipment.

S-710L: Information Requirements for Air-cooled Heat Exchangers

This document defines the information requirements, including format, timing and purpose, for information to be provided by the vendor. It also defines the specific conditions which must be met for conditional information requirements to become mandatory. The information requirements listed in the IRS have references to the source of the requirement.

S-710Q: Quality Requirements for Air-cooled Heat Exchangers

This document includes a conformity assessment system (CAS) which specifies standardized user interventions against quality management activities at four different levels. The applicable CAS level is specified by the purchaser in the data sheet.

The data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The supplementary specification and QRS are fixed documents.

Unless defined otherwise in the purchase order, the order of precedence (highest authority listed first) of the documents shall be:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser defined requirements (data sheet, IRS, QRS);

d) this specification;

e) the parent standard.

2 Normative References

API STD 660: 2015	Shell-and-Tube Heat Exchangers
ASME BPVC Section VIII Division 1: 2019	Rules for Construction of Pressure Vessels
ASME BPVC Section VIII Division 2: 2019	Alternative Rules for Construction of Pressure Vessels
ASME BPVC Section IX	Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators
IOGP S-619	Specification for Unfired, Fusion Welded Pressure Vessels
RMA IP-27	Specifications for Drives Using Curvilinear Toothed Synchronous Belts

3 Terms and Definitions

Add new term

3.34 Carbon Equivalent

Value calculated for material by formula : % C + % Mn / 6 + (% Cr + % Mo + % V) / 5 + (% Ni + % Cu) / 15 .

C, Mn, Cr, Mo, V, Ni and Cu are alloying material elements carbon, Manganese, Chromium, Molybdenum, Vanadium, Nickel and Copper respectively.

4 General

4.1

Replace second paragraph with

Pressure components shall comply with the pressure design code, requirements given in this supplementary specification and relevant requirements specified in IOGP S-619.

4.6

Replace section with

The Purchaser shall specify if the service is designated as sour in accordance with NACE MR0175/ISO 15156 or NACE MR0103/ISO 17945.

5 Proposals

5.2

Add to section

Plot plans, if provided by the Purchaser, shall be agreed between the Vendor and the Purchaser.

5.5

Replace section with

Any proposal for a design that is not fully described in this specification, the design code or other purchaser documents shall include additional drawings, construction details and description of design methods proposed to sufficiently describe the design.

Add new section

5.11

When thermal and hydraulic design is in the scope of supply of the Vendor, thermal and hydraulic design calculations shall be submitted as per the Purchaser specified software package.

Add new section

5.12

The use of pressure vessel code cases, if any, shall be subject to approval by the Purchaser.

6 Documentation

6.1 Approval Information

6.1.1

Add to list item f)

including location and dimensions of walkways, platforms, ladders and stairways;

Add new list items u) to bb)

u) recommended spare parts;

v) pickling and passivation;

w) positive material identification;

x) tube expansion into tubesheet;

y) lifting and handling;

z) noise data;

aa) non-destructive examination personnel qualification records;

bb) sub-vendor list.

6.1.2

Replace section with

If specified by the Purchaser, the Vendor shall submit detail drawings for:

a) gaskets;

b) tube bundle and tube bundle frame;

c) field assembly;

d) all auxiliary equipment and controls including cable trays and junction boxes;

e) electrical and control connections including those of motive and signal air for any pneumatically actuated louvers or fans;

f) structure, walkways, platforms, ladders and stairways;

g) motor suspension assembly including fans, bearings, pulleys, belts, etc.;

h) plenum chamber including plenum beams;

i) fan ring including support;

j) fan screens and guards;

k) header guard.

6.1.3

Replace section with

If specified by the Purchaser, the Vendor shall submit the following calculations:

a) calculations required by the pressure design code for design of pressure components, including header boxes, tubes, tube joints, inlet and outlet process nozzles and other non-standard pressure boundary components such as swage nozzles;

b) structural calculations to evaluate column reactions for each load type listed in 7.3.3;

c) thermal and hydraulic design calculations;

d) restraint relief calculations in accordance with 7.1.6.1.3;

e) local load analysis due to external forces and moments on nozzles in accordance with 7.1.10.

6.2 Final Records

6.2.2

Add new list item q)

q) shop run-in test report, including all recorded test results.

7 Design

7.1 Tube Bundle Design

7.1.1 General

7.1.1.4

Replace first sentence with

Tubes shall be supported with tube support boxes, aluminium lockbars, aluminium wiggle strips, support rings or collar zinc supports to prevent sagging and meshing or deformation of fins.

Add to section

Carbon steel supports, guides and spacers shall be hot-dip galvanized.

Add to section

Supports, guides, and spacers directly contacting austenitic stainless steel tubes, high nickel alloy tubes or their fins shall be aluminum.

7.1.1.7

Replace section with

The last pass of tubes in multi-pass condensers shall be sloped 10 mm/m (1/8 in./ft) in the direction of flow.

Add new section

7.1.1.13

Multiple tube passes on the same tube row shall be considered only for liquid service.

7.1.2 Heating Coils

7.1.2.3

Replace section with

The tube pitch of the heating coil shall not exceed the smaller of twice the tube pitch of the tube bundle or 3.75 times the nominal heating coil tube diameter.

7.1.6 Headers

7.1.6.1 General

7.1.6.1.3

Replace first sentence with

The requirement for restraint relief in single- or multi-pass exchangers shall be investigated regardless of the fluid temperature difference between the inlet and outlet of the exchanger for all operating conditions, including off-design conditions such as the coldest ambient temperature.

7.1.6.1.4

Replace section with

Headers shall be designed so that the corresponding cross-sectional flow area of each pass, including the flow area through any internal stiffeners, is at least 110 % of the flow area in the subsequent tube pass.

7.1.6.1.6

Add new section

7.1.6.1.6.1

Expanded only tube-to-tubesheet joints shall have a minimum of two grooves.

Add new section

7.1.6.1.6.2

For expanded only tube-to-tubesheet joints, the minimum tubesheet thickness (as per Table 1) shall be 25 mm (1 in.).

Add new section

7.1.6.1.6.3

For expanded only tube-to-tubesheet joints, when the tubesheet holes are recessed to accommodate extension of the unfinned portion of aluminum sleeves for corrosion protection, the recess depth shall be added to the minimum tubesheet thickness.

Table 1 — Minimum Nominal Thickness of Header Components

Replace last sentence of Table 1 NOTE with

Tubesheet thicknesses specified are for welded only tube-to-tubesheet joints.

7.1.6.1.7

Add new section

7.1.6.1.7.1

Partition plates shall be provided with 5 mm ($^{3}/_{16}$ in.) diameter drain holes as specified below:

a) for headers up to 1.5 m (60 in.) in length, one drain hole;

b) for headers over 1.5 m (60 in.) in length, two drain holes.

Add new section

7.1.6.1.7.2

Drain holes shall be at least one nozzle internal diameter away from the process nozzle centerline.

7.1.6.1.8

Delete section 7.1.6.1.8

Add new section

7.1.6.1.9

Cover plate headers shall not be used in hydrogen, toxic, cyclic, sour, lethal service or where the tube side design pressure is above 3000 kPag (435 psig).

Replace section heading with

7.1.6.2 Removable Cover Plate Headers

7.1.6.2.2

Replace first sentence with

Bonnet type headers shall not be used.

7.1.6.2.3

Replace first sentence with

Bolted joints shall be designed using through bolts with confined gaskets as shown in Figure 4 a) or Figure 4 b).

Delete second sentence

Replace fourth sentence with

For the gasket types specified in Table A.3, the gasket contact surface finish of header box flanges, cover plates and pass partition plates shall be as per Table A.4.

Delete fifth sentence

Delete sixth sentence

Add to section

The gasket contact surfaces (including pass-partition surfaces) of header box flanges and cover plates shall be provided with a 3 mm ($^1/_8$ in.) machining allowance.

Add to section

The additional thickness for machining allowance specified in 7.1.6.2.3.3 shall not be used in the calculation of maximum allowable working pressure.

7.1.6.2.4

Replace section with

Jackscrews shall be provided at the cover periphery to facilitate dismantling.

7.1.6.2.7

Replace section with

The minimum nominal diameter of through-bolts shall be 20 mm (¾ in.).

7.1.8 Gaskets

7.1.8.4

Replace section with

For the joint type shown in Figure 4 a), cover plate gaskets shall be as specified in the data sheet.

7.1.8.5

Replace section with

For the joint type shown in Figure 4 b), cover plate gaskets shall be as specified in the data sheet.

7.1.8.6

Replace section with

The joint type shown in Figure 4 c) shall not be used.

7.1.8.7

Replace section with

The perimeter portion of removable cover plate gaskets shall be minimum 13 mm ($^1/_2$ in.).

Add to section

The minimum width of the pass partition rib plate shall be 10 mm ($^3/_8$ in.).

Add new section

7.1.8.10

Nubbins shall not be used.

Add new section

7.1.8.11

Gaskets containing asbestos shall not be used.

7.1.9 Nozzles and Other Connections

7.1.9.2

Replace section with

The minimum nozzle size shall be DN 40 (NPS $1^1/_2$).

7.1.9.6

Add to section

The minimum nominal thickness for austenitic stainless steel and other high alloy nozzles shall be equal to schedule 80S.

7.1.9.8

Replace section with

Flanged connections shall be one of the following types:

a) a forged, integrally flanged weld neck;

b) a pipe welded to a forged weld neck flange;

c) a seamless transition piece attached to a forged weld neck flange.

7.1.9.10

Replace section with

Threaded nozzle connections are not permitted.

7.1.9.11

Delete section 7.1.9.11

7.1.9.14

Delete section 7.1.9.14

7.1.9.17

Delete section 7.1.9.17

7.1.9.20

Delete section 7.1.9.20

Add new section

7.1.9.22

Set-on type nozzles shall not be used for sour, lethal, hydrogen, wet hydrogen sulfide, toxic and cyclic services.

Add new section

7.1.9.23

Set-in nozzles shall be flush with the inside of the header box.

Add new section

7.1.9.24

The inside corners of all nozzles shall be rounded to a minimum radius of 3 mm (1/8 in.).

Add new section

7.1.9.25

Nozzles shall be self-reinforced without the use of reinforcing pads.

7.1.11 Tubes

7.1.11.7

Add new section

7.1.11.7.1

Fin type maximum process temperature shall be as specified in Table A.1.

Add new section

7.1.11.7.2

Thickness of the remaining sleeve of aluminum between fins shall be at least 0.51 mm (0.020 in.).

Add new section

7.1.11.7.3

Any residual cutting oil used during the manufacture of fins shall be removed prior to installation of the fins.

7.1.11.8

Add new section

7.1.11.8.1

The minimum fin tip thickness for integral or extruded fins shall be 0.20 mm (0.008 in.).

Add new section

7.1.11.8.2

The tolerance allowed on the outer diameter of the fin shall be +/- 0.5 mm (0.02 in.).

Add new section

7.1.11.14

The maximum fin density shall not exceed 394 fins per meter (10 fins per in.).

Add new section

7.1.11.15

Fin density tolerance shall be -1 % to +2 %.

Add new section

7.1.11.16

The minimum gap between the fins on adjacent tubes shall be 6.4 mm (1/4 in.).

Add new section

7.1.11.17

Serrated, segmented and louvered fins and fins with spacing tabs shall not be used.

Add new section

7.1.11.18

The method of protection (such as metallizing or using sleeves) for the unfinned area of the tube ends shall be as specified in the data sheet.

Add new section

7.1.11.19

When metallizing is applied to stainless steel or other high alloy tubes, only aluminium metallizing shall be applied.

Add new section

7.1.11.20

Metallizing of the unfinned area of tubes shall extend to 3 mm (1/8 in.) inside the tubesheet.

Add new section

7.1.11.21

When coating is applied to unfinned tubes, the coating shall extend over the full length of the exposed section of the tube plus 3 mm (1/8 in.) inside each tubesheet.

7.2 Air-side Design

7.2.1 General

7.2.1.3

Replace definition of h with

h is the height above grade to the bottom of the fan ring inlet for forced draft type units, or to the bottom of the tube bundle side frames for induced draft type units, expressed in meters (feet);

7.2.1.8

Add to section

For single tube pass units, the maximum exposure temperature for fan shall be based on the fan nearest to the process inlet end of the heat exchanger.

Add new section

7.2.1.9

Drive shafts shall be designed so that the maximum operating speed does not exceed 80 % of the first critical shaft speed.

7.2.3 Fans and Fan Hubs

7.2.3.4

Add new section

7.2.3.4.1

The plenum depth shall not be less than 915 mm (36 in).

Add new section

7.2.3.4.2

For induced draft exchanger designs, the fan blade shall be located no closer than 35 % of the fan diameter, from the upper tube row of the bundle.

7.2.3.9

Add to section

A center hub seal disc shall be installed to minimize reverse air flow at the hub.

7.2.3.14

Replace first sentence with

The natural frequency of the fan or fan components shall not be within 20 % of the blade-pass frequency.

Add new section

7.2.3.17

All forced draft fan rings inlet shall be conical or rounded (e.g. inlet bell).

Add new section

7.2.3.18

Glass-reinforced plastic blades shall be provided with ultraviolet protection.

Add new section

7.2.3.19

Induced draft fan mountings and bearing arrangements shall be designed to allow fan and hub removal and re-installation without disturbing the tube bundle.

Add new section

7.2.3.20

For forced draft ACHE, the actuators and positioners of automatically variable fans shall be installed under the fan.

7.2.4 Fan Shafts and Bearings

7.2.4.2

Add to section

An external conical slinger shall be fitted to the fan shaft above the upper bearing housing to prevent water from entering the housing along the shaft.

Add new section

7.2.4.7

The upper fan shaft (radial) bearing shall be a single row ball bearing with metal retainer.

Add new section

7.2.4.8

The lower fan shaft (thrust) shall be a double row spherical roller bearing in a flange block housing.

Add new section

7.2.4.9

The radial run-out tolerance, expressed as total indicator reading, of the supplied fan shaft not exceed 0.05 mm (0.002 in.) for forced draft fans and 0.13 mm (0.005 in.) for induced draft fans.

Add new section

7.2.4.10

The radial run-out tolerance of the sprocket attached to the fan shaft at its outer edge, shall not exceed the values permitted by RMA IP-27.

Add new section

7.2.4.11

The axial run-out tolerance of the sprocket attached to the fan shaft shall not exceed the values permitted by RMA IP-27. The axial run-out may be measured on both the top and bottom faces of the sprocket, with the smaller of the two readings being used.

7.2.5 Lubrication Facilities

Add new section

7.2.5.1

A grease release shall be provided for all bearings.

Add new section

7.2.5.2

One greasing line per bearing injection point shall be provided.

7.2.6 Fan Guards

7.2.6.1

Replace section with

Removable steel fan guards shall be furnished.

Add new section

7.2.6.10

Fan guards shall have one hinged section to provide maintenance access.

7.2.7 Drivers

7.2.7.2 Electric Motor Drivers

7.2.7.2.9

Replace section with

A self-actuating braking device shall be installed on the fan shaft to prevent reverse rotation of an idle fan.

7.2.7.3 Variable-speed Drive Systems

Add to section

All motors shall be compatible with variable speed drive systems.

7.2.8 Couplings and Power Transmissions

7.2.8.2 Belt Drives

7.2.8.2.1

Replace section with

Belt drives shall be high-torque, anti-static, positive-drive belts.

7.2.8.2.2

Replace section with

All belt drive assemblies shall be suspended from the bundle support structure.

7.2.8.2.4

Add to section

Belt tension shall be adjustable without removing the fan guard or belt guard.

7.2.8.2.5

Replace section with

High torque,anti-static type belt drives shall be in accordance with ISO 9563.

7.2.8.2.6

Delete section 7.2.8.2.6

7.2.8.2.8

Delete section 7.2.8.2.8

7.2.8.2.9

Replace section with

High-torque type positive-drive belts shall have a minimum service factor of 2.0 based on driver-rated power.

7.2.8.2.10

Delete section 7.2.8.2.10

7.2.8.2.13

Replace section with

Drive-belt materials shall be selected for an exposure temperature of 60 °C (140 °F) and minimum atmospheric temperature.

7.2.8.3 Gear Drives

7.2.8.3.2

Replace section with

Where gear drives are used, the motor and the gearbox shall be mounted on a common rigid surface.

7.2.8.3.5

Add to section

Gear drives shall be provided with drip pans.

7.2.8.4 Mechanical Power Transmission Guards

Add new section

7.2.8.4.4

The material selected for mechanical transmission components and transmission guards shall be a non-sparking combination.

7.2.9 Vibration Cut-out Switches

7.2.9.1

Replace section with

One readily accessible, double-throw, two-contact, vibration cut-out switch, vibration transmitter or accelerometer shall be provided for each fan driver unit support structure.

7.2.9.2

Add to section

Vibration cut-out switches, accelerometers and vibration transmitters shall be as per the hazardous area classification specified in the data sheet.

7.2.10 Louvers

7.2.10.16

Replace section with

If used for automatic pneumatic control, a positioner shall be provided at each actuator.

7.2.10.25

Add to section

All linkage joints and bearings shall be sealed (self-lubricating).

7.2.11 Screens

7.2.11.2 Insect/lint Screens

7.2.11.2.1

Add to section

Screens shall not impede the actuator or louver stroke.

7.2.11.3 Hail Screens

7.2.11.3.1

Add to section

Screens shall not impede the actuator or louver stroke.

7.3 Structural Design

7.3.1 General

Add new section

7.3.1.7

The ACHE shall be provided with sufficient grounding (or earthing) lugs to maintain earthing continuity throughout the assembly.

Add new section

7.3.1.8

One grounding lug shall be provided on each header.

7.3.3 Structural Design Loads and Forces

7.3.3.2 Dead Loads

Add to section

The dead load used in the design of the structure shall be 120 % of the calculated dead load.

7.3.3.7 Wind Load

Replace section with

Wind loads shall be calculated as per the applicable structural code and any additional data specified in the data sheet.

7.3.3.8 Earthquake Forces

Replace section with

Earthquake loads shall be calculated as per the applicable structural code and any additional data specified in the data sheet.

7.3.3.13 Loading Combinations

7.3.3.13 a)

Add new list item 4)

4) snow load;

7.3.3.13 b)

Add new list item 7)

7) snow load;

7.3.3.13 c)

Add new list item 8)

8) snow load.

7.3.5 Mechanical Access Facilities

7.3.5.3

Replace section with

All platforms and walkways, including header access walkways, shall have a clear width of 915 mm (36 in.).

Add new section

7.3.5.9

For forced draft coolers, the minimum clearance between the fan ring inlet and access platform, or grade for grade-mounted coolers, shall be 2.1 m (7 ft).

Add new section

7.3.5.10

For induced draft coolers, the minimum clearance between the tube bundle frame and access platform shall be 2.1 m (7 ft).

8 Materials

8.1 General

8.1.1

Add to section

Materials specified in the main ACHE data sheet or component data sheet shall not be substituted.

8.1.2

Replace section with

Cast iron shall not be used for pressure components.

Add new section

8.1.7

Attachments welded to pressure retaining components shall be of the same nominal chemical composition as the pressure component.

Add new section

8.1.8

The maximum carbon content of carbon steel material shall not exceed 0.23 %.

Add new section

8.1.9

The maximum allowable carbon equivalent for carbon steel plates shall be in accordance with Table 13.

Add new table

Table 13 — Maximum Allowable Carbon Equivalent

Nominal Plate Thickness mm (in.)	Maximum Allowable Carbon Equivalent
≤ 50 (2)	0.43
> 50 (2) ≤ 100 (4)	0.45
> 100 (4)	0.48

Add new section

8.1.10

Ultrasonic examination shall be performed on plates and forgings welded to other components if the thickness exceeds 50 mm (2 in.).

Add new section

8.1.11

Ultrasonic examination shall be performed on all forgings exceeding 100 mm (4 in.) thickness, except for bolted flat covers and standard flanges.

Add new section

8.1.12

Corrosion-resistant lining or cladding shall not be applied.

8.2 Requirements for Carbon Steel in Sour or Wet Hydrogen Sulfide Service

8.2.3

Replace section with

Restrictions on residual elements and micro-alloying elements, apart from requirements specified in 8.1.8 and 8.1.9, shall be specified by the Purchaser.

8.3 Headers

8.3.4

Add to section

Plugs used in alloy headers shall be of same nominal composition as the header material.

8.5 Other Components

8.5.1

Add to section

For offshore installations, aluminium fin material shall be marine grade.

Add new section

8.5.7

Fan drive sheaves shall be metallic.

Add new section

8.5.8

All welded tubes shall be eddy-current tested in the finished condition over their full length.

9 Fabrication of Tube Bundle

9.1 Welding

9.1.1 General

9.1.1.1

Replace section with

Welding and welder qualification shall be performed as per the requirements specified in the design code, datasheet and requirements within this specification.

9.1.1.3

Add to beginning of section

Use of a permanent backing strip is not allowed.

Add new section

9.1.1.6

All welds directly onto pressure parts shall be continuous.

9.2 Postweld Heat Treatment

9.2.3

Add to end of section

or NACE MR0175/ISO 15156.

9.3 Tube-to-Tubesheet Joints

9.3.2 Tube-hole Grooving

9.3.2.1

Replace section with

All tubesheet holes for expanded joints in tubesheets shall be machined with two grooves approximately 3 mm ($^1/_8$ in.) wide and 0.4 mm ($^1/_{64}$ in.) deep.

9.3.2.3

Replace section with

Add new section

9.3.2.3.1

Grooves shall be located at least 3 mm ($^1/_8$ in.) plus the corrosion allowance from the process face of the tubesheet for expanded only tube-to-tubesheet joints.

Add new section

9.3.2.3.2

Grooves shall be located at least 9 mm ($^3/_8$ in.) from the process face of the tubesheet for welded and expanded tube-to-tubesheet joints.

Add new section

9.3.2.3.3

Grooves shall be located at least 6 mm ($^1/_4$ in.) from the air-side face of the tubesheet.

9.3.3 Expanded Tube-to-Tubesheet Joints

9.3.3.1

Replace section with

Expansion of the tubes shall be for the full thickness of the tubesheet, 6 mm ($^1/_4$ in.) from the weld edge up to 3 mm ($^1/_8$ in.) from the air-side face of the tubesheet (excluding recess depth, if any).

9.3.3.3

Replace section with

Tube ends shall project 3 mm ($^1/_8$ in.) from the tubesheet face.

Add new section

9.3.3.4

For roller-expanded joints, the maximum tube wall thickness reduction shall be in accordance with API 660, Table 6.

9.3.4 Welded Tube-to-Tubesheet Joints

9.3.4.3

Replace section with

If a strength welded tube-to-tubesheet joint is specified, the qualification of the weld shall be in accordance with the requirements of ASME Section IX, paragraph QW-193 or equivalent, and following additional requirements.

a) Weld design and detail shall be as per ASME Code, Section VIII, Division 1, paragraph UW-20, with geometry as shown in Figure UW-20.1, sketch (c) or (d) or equivalent;

b) A minimum of three tensile pull-tests shall be performed on the qualification test coupon whenever it cannot be proven by calculation, that the strength of the weld is greater than the axial strength of the tube.

9.4 Gasket Contact Surfaces

9.4.3

Replace section with

Plug gasket contact surfaces shall be machined to a finish of average roughness between 0.8 µm and 3.2 µm (32 µin. and 125 µin.).

10 Inspection, Examination, and Testing

10.1 Quality Control

10.1.1

Replace section with

If full or 100 % radiography is specified in the data sheet, the complete length of pressure welds including end-closure weld and nozzle attachment welds shall be radiographically or ultrasonically examined.

10.1.2

Replace section with

If spot radiography is specified in the data sheet, a length of at least 250 mm (10 in.) shall be radiographically or ultrasonically examined.

10.1.4

Replace section with

For sour, wet H2S and hydrogen service, the complete length of pressure welds including end-closure welds and nozzle attachment welds shall be radiographically or ultrasonically examined.

10.1.5

Replace section with

Add new section

10.1.5.1

If the extent of magnetic-particle or liquid-penetrant testing is not specified in the design code, then the minimum extent of this testing shall be as per ASME BPVC.VIII, Division 2, Table 7.2.

Add new section

10.1.5.2

Tube-to-tubesheet joint welds shall be 100 % liquid-penetrant examined after completion of tube expansion.

10.1.6

Replace section with

If set-on connections are used, the following non-destructive testing shall be performed prior to nozzle fit-up, with zero defect acceptance criteria:

a) liquid penetrant or magnetic particle examination of the surface of the through wall cut;

b) lamination check by 100 % ultrasonic examination of the base plate to a distance of 100 mm (4 in.) around the nozzle opening.

Replace Table 12 with

Table 12 — Maximum Weld Hardness

Material	**Maximum Weld Hardness**
Carbon steel	225 HBW
Chromium steel (up to 3 % Cr)	225 HBW
Chromium steel (5 % Cr to 17 % Cr)	241 HBW
Duplex stainless steel (22 % Cr)	320 HV10 or 28 HRC
Super duplex stainless steel (25 % Cr)	350 HV10 or 32 HRC
NOTE These hardness values are for general services. More stringent hardness testing and acceptance criteria can be required for special services (e.g. sulfide stress cracking or other types of environmental cracking services as specified in NACE standards).	

Add new section

10.1.15

All required non-destructive examination shall be performed after completion of all welding, weld repairs and post weld heat treatment, and prior to pressure testing.

Add new section

10.1.16

Prior to welding, a magnetic-particle or liquid-penetrant examination shall be performed on all edges and plate openings prepared for welding with defects cleared to sound metal.

Add new section

10.1.17

A magnetic-particle or liquid-penetrant examination shall be performed on all attachment welds (e.g. supports).

Add new section

10.1.18

A magnetic-particle or liquid-penetrant examination shall be performed on areas where temporary lugs have been removed.

10.2 Pressure Test

10.2.1

Add to section

Hydrostatic test pressure basis (e.g. maximum allowable pressure, design pressure) shall be as specified in the data sheet.

10.2.3

Add to section before last sentence

For carbon and low alloy steels, the chloride content shall not exceed 250 mg/kg (250 parts per million by mass).

Add new section

10.2.7

If not specified in the design code, the primary membrane stress in any pressure containing component shall not exceed 95 % of the material minimum yield strength during hydrostatic testing.

Add new section

10.2.8

Hydrostatic pressure testing shall be performed with the same gaskets and bolting as those required in service, for all body flanges, custom designed flanges and permanently blinded connections.

10.3 Shop Run-in

Replace section with

If specified by the Purchaser, the minimum extent of the shop run in test shall be as follows:

a) A shop run-in test of the driver, drive assembly, and fan shall be provided for shop assembled units.

b) One bay for each ten bays in service with a minimum of one bay, shall be tested.

c) The run-in test shall be performed on assembled bays including the completed tube bundle/header box assembly, louvers (if applicable), plenums, fan rings, fans, drivers, drive assemblies, motor mounts and support columns.

d) The run-in test shall consist of the following:

1) Check and record the fan tip clearances;

2) Set and record the fan blade pitch as per design blade angle (± 0.5° blade angle);

3) Check and record the radial run-out tolerance for the fan shafts;

4) Check and record the radial and axial run-out tolerances for the sprockets attached to the fan shafts;

5) Run the motors and fans at the design speed for a minimum of 15 minutes, recording the motor voltage, motor amperage, fan speed, and vibration level (see 7.3.2.1);

6) Air flow measurements shall be taken for each fan; test procedure and acceptance criteria to be agreed between the Purchaser and the Vendor (see Annex D).

11 Preparation for Shipment

11.1 General

11.1.3

Replace section with

Flanged connection gasket surfaces shall be protected as follows.

a) Connections with permanent blind flanges or covers shall be fully bolted with service gaskets, stud bolts and nuts.

b) Connections without permanent blind flanges shall be protected with a 6 mm (1/4 in.) minimum thickness metallic cover and 1.5 mm (1/16 in.) thick composition or neoprene gaskets secured to the flange with a minimum of four bolts.

Add new section

11.1.6

Finned tubes shall be covered with 10 mm ($^3/_8$ in.) minimum thickness exterior grade plywood.

Add new section

11.1.7

Tell-tale holes or vent holes shall be plugged with grease.

Add new section

11.1.8

After draining and drying, internal surfaces shall be protected against corrosion by the addition of a desiccant (e.g. silica gel), by the addition of a volatile corrosion inhibitor or by blanketing with an inert gas such as nitrogen.

Add new section

11.1.9

When an inert gas purge is specified on the data sheet, the pressure shall be maintained at no less than 35 kPag (5 psig) indicated by a pressure gauge, during transportation and storage

Add new section

11.1.10

Shipping restraints (e.g. bolts, spacers) to be removed shall be clearly marked with bright, contrasting paint.

11.2 Surfaces and Finishes

11.2.3

Replace section with

The exterior surfaces of carbon and low alloy steel headers shall be prepared and painted in accordance with the Purchaser's specification.

Add new section

11.2.5

Surface preparation for non-galvanized structural steel shall be as specified by the Purchaser.

11.3 Identification and Notification

Add new section

11.3.3

ACHE headers protected by an inert gas fill shall have the following warning displayed on a removable warning plate:
"DANGER - NON-LIFE SUPPORTING ATMOSPHERE Contents are under <Inert gas> pressure and must be depressurized before opening"

Add new section

11.3.4

The item number, shipping mass, centre of gravity and Purchaser’s order number shall be clearly marked on the heat exchanger.

12 Supplemental Requirements

12.2 Design

12.2.2

Replace section with

Tube-to-tubesheet joints shall be strength welded.

12.3 Examination

Delete sections 12.3.1 to 12.3.9

Delete sections 12.3.12 to 12.3.13

Annex B
Checklist and Data Sheets

Replace first paragraph with

The checklist and IOGP S-710D (data sheet) contain the information necessary for the description and design of air-cooled heat exchangers.

Replace fifth paragraph with

The Purchaser may submit the checklist to the Vendor in a form other than that indicated herein.

Delete ACHE Data Sheet (SI Units)

Delete ACHE Data Sheet (US Customary Units)

Registered Office
City Tower
40 Basinghall Street
14th Floor
London EC2V 5DE
United Kingdom

T +44 (0)20 3763 9700
F +44 (0)20 3763 9701
reception@iogp.org

Brussels Office
Bd du Souverain,165
4th Floor
B-1160 Brussels
Belgium

T +32 (0)2 566 9150
F +32 (0)2 566 9159
reception@iogp.org

Houston Office
10777 Westheimer Road
Suite 1100
Houston, Texas 77042
United States

T +1 (713) 470 0315
reception@iogp.org

www.iogp.org