International Association of Oil & Gas Producers

SPECIFICATION

IOGP S-749J

December 2023

Version 1.0

Supplementary Specification to API Standard 667 for Plate-and-frame Heat Exchangers

NOTE This version (S-749J) of the specification document provides the justification statements for each technical requirement, but is otherwise identical in content to S-749.

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
1.0	December 2023	First Edition

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 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 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 agreed specification, building on recognized industry and 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. 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 2020).

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Introduction

The purpose of the IOGP S-749 specification documents is to define a minimum common set of requirements for the procurement of plate-and-frame heat exchangers in accordance with API Standard 667, First Edition, March 2022, Plate-and-Frame Heat Exchangers, for application in the petroleum and natural gas industries.

The IOGP S-749 specification documents follow a common structure (as shown below) comprising a specification, also known as a technical requirements specification (TRS), a procurement data sheet (PDS), an information requirements specification (IRS) and a quality requirements specification (QRS). These four specification documents, together with the purchase order, define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Requirements Specification (TRS)

This specification is to be applied in conjunction with the supporting PDS, IRS and QRS as follows.

IOGP S-749: Supplementary Specification to API Standard 667 for Plate-and-frame Heat Exchangers

This specification defines technical requirements for the supply of the equipment and is written as an overlay to API Standard 667, following the API Standard 667 clause structure. Clauses from API Standard 667 not amended by this specification apply as written. Modifications to API Standard 667 defined in this specification are introduced by a description that includes the type of modification (i.e. Add, Replace or Delete) and the position of the modification within the clause.

NOTE Lists, notes, tables, figures, equations, examples and warnings are not counted as paragraphs.

IOGP S-749D: Procurement Data Sheet for Plate-and-frame Heat Exchangers (API)

The PDS defines application-specific requirements. The PDS is applied during the procurement cycle only and does not replace the equipment data sheet. The PDS may also include fields for supplier-provided information required as part of the purchaser's technical evaluation. Additional purchaser-supplied documents may also be incorporated or referenced in the PDS to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-749L: Information Requirements for Plate-and-frame Heat Exchangers (API)

The IRS defines information requirements for the scope of supply. The IRS includes information content, format, timing and purpose to be provided by the supplier, and may also define specific conditions that invoke the information requirements.

IOGP S-749Q: Quality Requirements for Plate-and-frame Heat Exchangers (API)

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the PDS or in the purchase order.

The specification documents follow the editorial format of API Standard 667 and, where appropriate, the drafting principles and rules of ISO/IEC Directives Part 2.

The PDS and IRS are published as editable documents for the purchaser to specify application-specific requirements. The TRS and QRS are fixed documents.

The order of precedence of documents applicable to the supply of the equipment, with the highest authority listed first, shall be as follows:

a) regulatory requirements;

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

c) purchaser-defined requirements (e.g. PDS, IRS and QRS);

d) this specification;

e) API Standard 667.

2 Normative References

Add to first paragraph

The following publications are referred to in this document, the PDS (IOGP S-749D) or the IRS (IOGP S-749L) in such a way that some or all of their content constitutes requirements of this specification.

Replace NACE MR0103 with

ANSI/NACE MR0103/ISO 17945, *Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments*

Replace NACE MR0175 with

ANSI/NACE MR0175/ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production*

Add to section

API 579-1/ASME FFS-1, *Fitness-For-Service*

ASME, Boiler and Pressure Vessel Code, (BPVC) Section IX, *Welding, Brazing, and Fusing Qualifications*

ASME, Boiler and Pressure Vessel Code, (BPVC) Section VIII, Division 1, *Rules for Construction of Pressure Vessels*

ASME, Boiler and Pressure Vessel Code, (BPVC) Section VIII, Division 2, *Rules for Construction of Pressure Vessels: Alternative Rules*

ASTM A380/A380M, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*

ASTM A578/A578M, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

AWS D1.1, *Structural Welding Code - Steel*

EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*

EN 10204, *Metallic products — Types of inspection documents*

EN 13445, *Unfired pressure vessels*

IOGP S-715, *Supplementary Specification to NORSOK M-501 Coating and Painting for Offshore, Marine, Coastal and Subsea Environments*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 12944 (all parts), *Paints and varnishes — Corrosion protection of steel structures by protective paint systems*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

PD 5500, *Specification for unfired pressure vessels*

Replace Section 3 title with

3 Terms, Definitions, and Abbreviated Terms

Add new section 3.0 heading before first paragraph

3.0 Additional Abbreviated Terms

CAS conformity assessment system

EPDM ethylene propylene diene monomer

FKM fluoroelastomer

FFKM perfluoroelastomer

HBW Brinell hardness with tungsten ball

HNBR hydrogenated nitrile butadiene rubber

IRS information requirements specification

NBR nitrile butadiene rubber

NDE nondestructive examination

PDS procurement data sheet

PMI positive material identification

PN nominal pressure

QRS quality requirements specification

TRS technical requirements specification

Add new term 3.22

3.22
austenitic stainless steel
Stainless steel whose microstructure at room temperature consists predominantly of austenite.

Add new term 3.23

3.23
carbon equivalent
CE

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

with chemical element concentration expressed in mass fraction percent.

NOTE Definition sourced from the International Institute of Welding.

Add new term 3.24

3.24
carbon steel
Alloy of carbon and iron that contains up to 2 % mass fraction carbon, up to 1.65 % mass fraction manganese and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation, usually silicon/aluminium.

Add new term 3.25

3.25
low-alloy steel
Steel that contains a total alloying element content of less than 5 % mass fraction, or steels whose chromium mass fraction is less than 10.5 % and more than that specified for carbon steel.

Add new term 3.26

3.26
utility service
Process operation consisting of only demineralized water, steam, potable water, sea water, cooling tower water, refrigerant (all phases), glycol/water solutions, lubricating oil, diesel oil, air, inert gases or any combination thereof.

NOTE Plate-and-frame heat exchangers in utility service typically form part of an equipment package or skid for which the consequences of failure can be lower than for plate-and-frame heat exchangers in non-utility service.

4 General

4.1

Add to second sentence

except where modified by this specification

Justification

The design code and this specification contain requirements that cover aspects including general design, materials, fabrication, NDE and tolerances.

4.7

Replace first sentence with

Materials and welds in sour service or wet hydrogen sulfide service shall comply with ANSI/NACE MR0175/ISO 15156 (all parts) or ANSI/NACE MR0103/ISO 17945, as specified.

Justification

The current requirement in 4.7, first sentence applies only to carbon steel, while sour service or wet hydrogen sulfide service also affects the integrity of CRA materials and welds. ISO 15156 (all parts) is the internationally accepted equivalent of NACE MR0175 for sour service. The full designation of the current edition of NACE MR0175 is ANSI/NACE MR0175-2021/ISO 15156:2020 (all parts). ISO 17945 is the internationally accepted equivalent of NACE MR0103 for sour (refinery) service. The full designation of the current edition of NACE MR0103 is ANSI/NACE MR0103/ISO 17945:2015. The applicable standard will be specified in the PDS based on the plate-and-frame heat exchanger's service.

4.10

In second sentence, replace "subject to the agreement of the purchaser" with

as specified in 4.11

Justification

Specifying the use of the screening and evaluation method for fatigue analysis provided by the selected design code removes ambiguity and allows standardization around the methods provided in these codes.

Add new section

4.11 Screening and Evaluation Method for Fatigue Analysis

4.11.1

The screening and evaluation method for fatigue analysis shall be in accordance with the specified pressure design code.

Justification

This removes ambiguity by requiring the fatigue screening criteria and evaluation methods detailed in the specified pressure design code to be used.

4.11.2

Where the selected pressure design code is ASME *BPVC,* Section VIII, Division 1, the screening and evaluation method for fatigue analysis shall be in accordance with ASME *BPVC*, Section VIII, Division 2.

Justification

This requirement is needed to direct the user to ASME BPVC, Section VIII, Division 2, as this standard contains the requirements for fatigue screening rather than ASME BPVC, Section VIII, Division 1.

4.11.3

Where the specified pressure design code does not include a screening and evaluation method for fatigue analysis, the method described in EN 13445, PD 5500, API 579-1/ASME FFS-1 or ASME *BPVC,* Section VIII, Division 2, shall be applied.

Justification

If the specified pressure design code does not include methods for the performance of fatigue screening and analysis, the methods provided in these specified codes are acceptable and industry recognized. The use of these specified methods provides consistency.

5 Proposal Information Required

5.2

Replace section with

For components that are not described in this specification, the specified design code or purchase order documentation, details of the design method, construction and assembly shall be provided with the proposal.

Justification

This requirement has been amended to add the design code and the purchaser's documents to expand the range of documents applicable to this section. This means that the number of components to be described by the vendor is likely to be reduced as the components already covered by the additionally specified documents do not need to be described again. The sharing of the design methods for such components assists in the technical evaluation process.

5.5

Add new NOTE

NOTE Gasket material selection is covered in 7.8.6.

Justification

5.5 is contained within the section of API 667 covering the information to be provided by the vendor with the proposal. This note is added to assist the vendor by directing them to the specified requirement in 7.8.6 including Table 2.

5.10

Add new NOTE

NOTE Fouling margins, wall shear stress and the associated pressure drop multiplier are covered in section 7.4.

Justification

5.10 is contained within the section of API 667 covering the information to be provided by the vendor with the proposal. This note is added to assist the vendor by directing them to the requirements of 7.4 including Table A.1 which is made normative unless the purchaser has specified values for these attributes. This increases the likelihood of these values being adhered to at the proposal stage.

6 Drawings and Other Data Requirements

6.1 Outline Drawings and Other Supporting Data

6.1.1

Add to start of list item o)

gasket location on the plates (see Figure 6), gasket groove pressing depth in the plates,

Justification

A dimensioned depiction in the general arrangement drawing of the gasket location and gasket groove depth is required for field replacement of the gaskets and for assembly.

Add new list item u)

u) maximum allowable working pressure for new-and-cold and hot-and-corroded conditions.

Justification

The maximum allowable working pressure is required to allow rerating during the engineering phase and at a future date following a period of operation.

6.2 Information Required After Outline Drawings Are Reviewed

6.2.2

Delete "If specified by the purchaser"

Justification

The weld procedure qualification record, weld procedure specification and weld map documents are required to verify and confirm compliance with the design code and design requirements for all plate-and-frame heat exchangers.

6.2.3

Delete "If specified by the purchaser"

Justification

Submission of the mechanical design calculations including pressure parts, supports, lifting devices and nozzle loads is required in all cases to allow verification of the mechanical integrity of the plate-and-frame heat exchanger design.

6.3 Reports and Records

6.3.1

In list item d), replace "mill" with

material

Justification

"Material test report" is a more appropriate term than "mill test report" (refer for instance to the definitions in ASME BPVC, Section VIII, ISO 10474 or EN 10204) as the mill certificate / test report is generally understood as the certificate issued by the base material manufacturer and may not include further processing performed by other parties and affecting the final material properties. Material inspection certificate 3.1 includes the test results and, in addition, defines limitations and responsibility for certification.

7 Design

7.1 General

Add new section

7.1.4

During the pressure test, the general primary membrane stress in pressure parts shall not exceed the limit specified by the design code or 95 % of the specified minimum yield strength of the material, whichever is less.

Justification

The use of general primary membrane stresses exceeding 95 % of SMYS may result in dimensional changes due to permanent strain. Therefore, general primary membrane stresses exceeding 95 % of the SMYS are not recommended where small amounts of distortion can result in leakage during service. If the specified pressure design code provides different stress limits, the governing criteria therein also apply. Test pressures range from 1.25 to 1.5 times the design pressure, depending on the selected design code, and therefore an allowable stress criterion for design is provided.

Add new section

7.1.5

Pressure-retaining components shall withstand the most severe combination of specified design pressure and coincident design temperature.

Justification

In some cases (e.g. cyclic load), pressure-retaining components may experience multiple pressure and temperature combinations. This requirement ensures that the plate-and-frame heat exchanger is designed to operate at the most severe of these coincident pressure and temperature combinations specified in the PDS.

7.4 Fouling Margin

Add to section

When the maximum solid particle size is not specified, the solid particle size used as the basis for design shall be 1 mm (0.04 in.).

Justification

Limiting the solid particle size reduces the frequency of maintenance intervals and the definition of a specific particle size provides clarity.

Add to section

If not specified, the fouling margins, minimum wall shear stresses and associated pressure drop multiplier shall be in accordance with Table A.1.

Justification

The fouling margin is an additional overdesign margin to ensure the performance of the plate-and-frame heat exchanger under the specified fouled condition. The minimum wall shear stress guides/assists in the design of plate-and-frame heat exchangers with lower rates of fouling. The associated pressure drop multiplier provides a guideline to estimate the plate-and-frame heat exchanger pressure drop in the fouled condition. When the purchaser does not specify the fouling margins, minimum wall shear stresses and associated pressure drop multiplier for the process fluids, Table A.1 provides standard values for typical fluids which are to be applied. This provides consistency across suppliers in the values used for these attributes when the typical fluids from Table A.1 are specified, leading to improvements in standardization.

Add to section

The pressure drop multiplier over the calculated pressure drop in the clean condition shall be used to calculate the pressure drop in the fouled condition for the specified design and rating cases.

Justification

This defines the method for calculating the pressure drop in the fouled condition to assist in assessing the suitability of the plate-and-frame heat exchanger against the allowable pressure drop of the plate-and-frame heat exchanger.

7.6 Components

7.6.1

Delete "unless approved by the purchaser" from list section c)

Justification

This deletion aligns 7.6.1 paragraph 1, item c with the modification made to 7.6.1 paragraph 1, item g which prohibits the use of stiffeners on the plate-and-frame heat exchanger end plates, by also prohibiting the use of stiffeners on heat transfer plates. Heat transfer plates are typically manufactured from thin plate materials which can be damaged or otherwise adversely affected by the welding of stiffeners.

Replace list section g) with

g) stiffeners shall not be used on end plates to meet the specified design conditions.

Justification

Heat transfer plates are typically manufactured from thin plate materials which can be damaged or otherwise adversely affected by the welding of stiffeners.

7.6.3

Add to list section a)

in utility service and at least 19 mm ($^3/_4$ in.) in non-utility service

Justification

Small-sized plate-and-frame heat exchangers are expected/used in utility service where suppliers can offer their standard units, hence the requirement for tie bolts to have a minimum diameter of 16 mm ($^5/_8$ in.) is retained for utility service exchangers. For non-utility services, which are typically larger in size and where the consequences of leaks are more severe, larger tie bolt sizes are more commonly used. For such applications, the minimum tie bolt size is specified as 19 mm ($^3/_4$ in.).

7.6.5

Add to section

The bolt holes on the mounting foot plate located at the movable cover end shall be slotted to allow for free thermal expansion of the unit.

Justification

Slotted holes at the movable cover end foot plate allow for free thermal expansion by means of sliding, avoiding additional thermal stress.

7.7 Connections

7.7.5

Replace "if agreed by the purchaser" with

in utility service and only if specified

Justification

Slip-on or lap joint connections are comparatively weak and more prone to leaks than weld-neck flanged joints, hence their use is restricted to utility service applications only where the consequences of such failures are lower than they would be in process applications. If the purchaser wishes to specify these connection types due to having a successful track record of their use in utility services or based on other considerations such as cost, the use of slip-on or lap joint connections can be permitted.

7.7.7

Add new list section d)

d) Reinforcing pads shall not be used for nozzles.

Justification

As cover plates are thick and nozzles are located close to the edge, the ability to add a reinforcing pad is limited (i.e. not the entire pad would be effective). With the current uncertainty of ASME BPVC, Section VIII, Division 1, UG-46b nozzle load pressure equivalency, there is a concern that vendors may resort to using reinforcing pads to meet the nozzle load/nozzle reinforcement requirements of this specification. Hence, self-reinforcement is required to provide effective strengthening to the nozzle.

Add new list section e)

e) Set-on nozzles shall be used in sour service or wet hydrogen sulfide service.

Justification

Typically, cover plates are thicker than the nozzle neck. The set-on butt weld allows better access to weld and perform NDE over the set-in type nozzle connection. This helps ensure weld quality for sour service or wet hydrogen sulfide service.

Add new list section f)

f) Set-in nozzles shall not protrude beyond the inside surface of the cover plate.

Justification

This ensures that nozzles are not protruding beyond the inside of the cover plate of the plate-and-frame heat exchanger to avoid any damage to the heat transfer plates during assembly.

Add new list section g)

g) The inside corners of solid nozzles and weld overlaid nozzles shall be rounded to a minimum radius of 3 mm ($^{1}/_{8}$ in.).

Justification

Smooth corners at the nozzle-to-cover plate junctions avoid stress concentrations, allow smooth flow transition of fluids and avoid sharp edges, resulting in safer handling.

7.7.13

Delete "the purchaser shall specify if " from first sentence

Justification

Alloy-lined flanged connections can be prone to leakage, and early detection through the use of a tell-tale hole allows the issue to be rectified before a more serious leak with the associated potential safety implications can develop.

Add to section

Tell-tale holes shall be filled with grease after pressure testing.

Justification

Surface treatment of the inside of the tell-tale hole reduces the likelihood of corrosion in this area.

7.7.17

In first sentence, replace "listed in Table 1, unless otherwise specified by the purchaser" with

in accordance with one of the following, as specified:

a) Table 1 for onshore applications;

b) Table 1 values multiplied by 2.5 for offshore applications;

c) specified actual loads.

Justification

Offshore oil and gas application layouts can be compact and piping flexibility options are often limited. Applying a factor of 2.5 aligns with API 662-1, severe service nozzle loads. Vendors have developed their existing designs based on these loads, hence maintaining these standard loads offers cost and schedule benefits.

Add to NOTE

When the nozzle flange rating is increased based on the selected code requirements in combination with Table 1 loads, Table 1 load values used should be those corresponding to the original flange rating.

Justification

Some nozzle sizes/flange classes may not meet the updated ASME BPVC, Section VIII, Division 1 UG-44(b) requirements. If the nozzle size/flange class is increased as a result, the corresponding higher Table 1 values again call for UG-44(b) requirements to be met, resulting in a loop of increasing nozzle size/flange class. The application of Table 1 loads associated with the original nozzle size/flange class prevents this loop from increasing the nozzle size/flange class.

Add new section

7.7.18

Localized stress on nozzles and covers resulting from concentrated loads on nozzles or on structural attachments shall be evaluated using a recognized industry standard or a method referred to in the selected pressure design code (e.g. finite element analysis in accordance with ASME *BPVC*, Section VIII, Division 1, Mandatory Appendix 46, ASME *BPVC*, Section VIII, Division 2 or EN 13445-3).

Justification

External loads such as piping reactions and equipment lifting can result in excessive local stress in the nozzles or other attachments. The performance of a local stress check ensures that stresses are within the applicable code limits.

Add new section

7.7.19

Radius or profiling at nozzle connections shall not reduce the clad thickness below the specified minimum value.

Justification

A reduction in the weld overlay thickness to below the minimum specified value resulting from machining at the nozzle connection may reduce corrosion resistance in this area.

7.8 Plate Gaskets

7.8.6

In first sentence, replace "operating conditions and fluid compositions"

operating conditions, fluid compositions, the specified process application and the design pressure

Justification

Gaskets are critical components whose failure can lead to leakage. This requirement ensures that in addition to the operating conditions and fluid composition, the vendor also considers the additionally specified parameters in combination with these, as they can also influence the integrity and design life of the gasket, and consequently the material selection.

Add after first sentence

Gasket material recommendations shall be accompanied by supporting data evidencing their suitability for the specified design conditions and parameters.

Justification

This requirement ensures that data is provided to allow confirmation that the proposed gasket material has been proven as suitable for the specified design and operating parameters.

Add new NOTE

NOTE Examples of supporting data include laboratory test reports, field test reports, other test reports, customer references, past track records and product datasheets.

Justification

This note provides examples of the types of data that are considered valid evidence that the proposed gasket material has been proven as suitable for the specified design and operating parameters.

Add after first sentence

When data supporting the suitability of the selected gasket for the specified operating temperature cannot be provided, the gasket material selection shall be in accordance with the operating temperature limits specified in Table 2.

Justification

This requirement ensures that if data cannot be provided to confirm that the proposed gasket material has been proven suitable for the specified operating temperature, the acceptable values in Table 2 are made mandatory.

Add new Table 2

Table 2—Maximum Operating Temperature Limits for Common Gasket Materials

Gasket Material	Maximum Operating Temperature [a]	
	°C	°F
Natural rubber, neoprene	100	215
Nitrile butadiene rubber (NBR)	110	230
Ethylene propylene diene monomer (EPDM)	140	285
Hydrogenated nitrile butadiene rubber (HNBR)	150	300
Silicone	175	350
Peroxide-cured EPDM	150	300
Fluoroelastomer (FKM)	200	390
Perfluoroelastomer (FFKM)	230	450

[a] For glued-type gaskets, the service temperature range of the selected glue can dictate the maximum operating temperature rather than the gasket material.

Justification

This table standardizes and ensures that the selected gasket material is suitable for the specified maximum operating temperature. Footnote [a] is included to highlight that, for glued-type gaskets, the service temperature range of the glue rather than the gasket material can be the limiting factor which dictates the maximum operating temperature.

8 Materials

8.1 General

Add new section

8.1.5

The material for grounding lugs shall be austenitic stainless steel.

Justification

The use of a corrosion-resistant material for the grounding lug improves its longevity.

Add new section

8.1.6

The maximum allowable carbon equivalent (CE) for carbon steel pressure-containing parts requiring welding shall be in accordance with Table 3 or the specified value, whichever is lower.

Justification

This ensures sufficient weldability of carbon steel, controls the hardness of the heat-affected zone and prevents fabrication hydrogen cracking.

Add new Table 3

Table 3—Maximum Allowable Carbon Equivalent (CE)

Plate Thickness		Maximum Allowable CE
t		
mm	**in.**	
$t \leq 50$	$t \leq 2$	0.43
$50 < t \leq 100$	$2 < t \leq 4$	0.45
$t > 100$	$t > 4$	0.48

Justification

This table ensures the weldability of carbon steel, controls the hardness of the heat-affected zone and prevents fabrication hydrogen cracking.

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

8.2.2

Delete "that are used in the formula to calculate the carbon equivalent (CE) as defined by NACE MR0175 (all parts) or NACE MR0103" from second sentence

Justification

NACE MR0175 and NACE MR0103 do not provide a formula for the calculation of CE. There is a formula, provided in NACE SP0472, that is a bibliographic, non-normative reference in NACE MR0103 only. In addition, CE is not the only chemistry parameter that needs controlling in sour service, but this is addressed in 8.2.3, second sentence.

8.2.3

Add new NOTE

NOTE Maximum allowable CEs for carbon steel pressure-containing parts requiring welding are covered in 8.1.6.

Justification

This assists the purchaser/vendor by directing them to where the maximum allowable CE values are specified.

9 Fabrication

9.1 Welding

9.1.3

Delete "except when approved by the purchaser"

Justification

This requirement is made mandatory to avoid gaps and crevices that could result in crevice corrosion.

9.1.5

In first sentence, replace "micro-hardness" with

hardness

Justification

Hardness surveys (not micro-hardness surveys) are used for weld procedure qualification records. Micro-hardness testing is done with a lower test force of less than 9.8 N (1 kg) and is not used for weld procedure qualification record tests which conventionally use 5 kg or 10 kg force. NACE SP0472:2020 does not include any further details on hardness surveys. Instead, this is defined in ANSI/NACE MR0103/ISO 17945, Annex C which also states that weld procedure qualification record hardness surveys done to previous editions of NACE SP0472 are not acceptable after 2015.

Replace second sentence with

Hardness testing and hardness testing acceptance criteria shall be in accordance with ANSI/NACE MR0103/ISO 17945 or ANSI/NACE MR0175/ISO 15156 (all parts).

Justification

Hardness surveys (not micro-hardness surveys) are used for weld procedure qualification. Micro-hardness testing is done with a lower test force of less than 9.8 N (1 kg) and is not used for weld procedure qualification record tests which conventionally use 5 kg or 10 kg force. NACE SP0472:2020 does not include any further details on hardness surveys. Instead, this is defined in ANSI/NACE MR0103/ISO 17945, Annex C which also states that weld procedure qualification record hardness surveys done to previous editions of NACE SP0472 are not acceptable after 2015. ISO 15156 (all parts) is the internationally accepted equivalent of ANSI/NACE MR0175 for sour service. The full designation of the current edition of NACE MR0175 is ANSI/NACE MR0175-2021/ISO 15156:2020 (all parts).

Add new section

9.1.6

Butt welds on the primary pressure boundary shall be full penetration type.

Justification

Though partial penetration butt welds are cost-effective compared to full penetration welds, full penetration welds have comparative benefits over partial penetration welds (i.e. higher resistance to corrosion, greater strength and a lower probability of root defects).

Add new section

9.4 Coating and Painting

9.4.1

The external surface of carbon steel and low-alloy steel pressure-containing and structural components shall be coated.

Justification

This requirement is added to specify the minimum requirements for coating to protect surfaces from corrosion. 9.3, which covered coating requirements in API 662-1, has not been replicated in API 667. 11.7 only addresses surface protection for preservation for shipment and storage. Surface preparation and coating can be specified in accordance with IOGP S-715, ISO 12944, the manufacturer's standard or the purchaser's specification.

9.4.2

Surface preparation and coating shall be in accordance with the specified painting specification.

Justification

This requirement is added to specify the minimum requirements for coating to protect surfaces from corrosion. 9.3, which covered coating requirements in API 662-1, has not been replicated in API 667. 11.7 only addresses surface protection for preservation for shipment and storage. Surface preparation and coating can be specified in accordance with IOGP S-715, ISO 12944, the manufacturer's standard or the purchaser's specification.

10 Inspection and Testing

10.1 Quality Control

10.1.5

Delete "If specified by the purchaser" from first sentence

Justification

Laminations in plates can lead to premature failure and leaks. Ultrasonic testing is made mandatory to ensure that no laminations have formed in the cover plate adjacent to the nozzle during welding.

10.1.10

In list section d), replace "NACE MR0175 (all parts) or NACE MR0103" with

ANSI/NACE MR0175/ISO 15156 (all parts) or ANSI/NACE MR0103/ISO 17945

Justification

ISO 15156 (all parts) is the internationally accepted equivalent of NACE MR0175 for sour service. The full designation of the current edition of NACE MR0175 is ANSI/NACE MR0175-2021/ISO 15156:2020 (all parts). ISO 17945 is the internationally accepted equivalent of NACE MR0103 for sour (refinery) service. The full designation of the current edition of NACE MR0103 is ANSI/NACE MR0103/ISO 17945:2015.

Add new section

10.1.12

Positive material identification (PMI) shall be carried out on alloy components including cladding, weld overlay, alloy bolting and alloy plates.

Justification

This requirement ensures that the correct material that meets the specification has been used to assemble the plate-and-frame heat exchanger by a nondestructive test (i.e. PMI).

Add new section

10.1.13

In sour service and wet hydrogen sulfide service, butt welds shall be subjected to 100 % volumetric examination.

Justification

Process fluids in sour service contain hydrogen sulfide (H_2S) which is toxic and corrosive. Butt welds with defects can be susceptible to cracking mechanisms in sour service and therefore, 100 % volumetric examination is required to ensure welds are defect free.

Add new section

10.1.14

Where 100 % volumetric examination is specified, the complete length of butt welds, nozzle neck weld seams and nozzle-to-flange joint welds shall be examined.

Justification

This clarifies the extent of NDE to be performed when 100 % volumetric examination is specified.

Add new section

10.1.15

Pressure-retaining plates with a nominal thickness greater than or equal to 50 mm (2 in.), excluding the thickness of cladding or weld overlay if present, shall be ultrasonically examined in accordance with the specified standard.

Justification

The probability of laminar defects in pressure-retaining plates increases with the plate thickness, particularly when the plate thickness is greater than or equal to 50 mm. This requirement ensures that such defects are identified.

Add new section

10.1.16

Magnetic-particle or liquid-penetrant examination shall be performed on lifting attachment final welds.

Justification

NDE requirements for lifting attachment welds are not specified in ASME codes. Due to the inherent safety concerns associated with equipment lifts, a minimum expectation for NDE of lifting lugs is specified.

Add new section

10.1.17

Weld overlay, clad restoration welds and internal attachment welds shall be subjected to 100 % liquid penetrant examination.

Justification

The performance of a liquid-penetrant inspection ensures that no surface defects/cracks or porosity remain following cladding, cladding repair or performance of internal attachment welds.

Add new section

10.1.18

Weld-overlaid surfaces shall be examined with the liquid-penetrant method after final machining.

Justification

This ensures that the finished surface of the weld overlay is free from surface defects that, if not repaired, may impair the corrosion resistance.

Add new section

10.1.19

The test acceptance criteria for liquid penetrant inspection of weld overlay shall be in accordance with the specified design code, except on gasket sealing surfaces where no indications are acceptable.

Justification

The acceptance criteria for liquid-penetrant testing are not specified in API 667.

Add new section

10.1.20

Defects in weld overlay shall be repaired.

Justification

This is required to meet the design code requirements and ensure the integrity of the overlay.

Add new section

10.1.21

On surfaces where the final weld overlay or clad layer has been partially removed, a copper sulphate test in accordance with ASTM A380/A380M shall be performed.

Justification

Grinding or machining of clad areas can inadvertently result in the exposure of the base material that, if not detected and rectified, may reduce the corrosion resistance of the affected area. This can be particularly prevalent at the nozzles where grinding is performed to achieve the radius requirements. Copper sulfate testing provides a visual indication of where the base material has been exposed.

Add new section

10.1.22

If not specified by the pressure design code, the extent of magnetic-particle and liquid-penetrant examination shall be in accordance with ASME *BPVC*, Section VIII, Division 2.

Justification

This requirement defines the minimum extent of NDE to be performed when not specified by the pressure design code.

10.2 Hydrostatic Testing

10.2.5

Replace section with

The water temperature for hydrostatic testing shall be as specified or recommended in the selected pressure design code.

Justification

As per ASME BPVC, Section VIII, Division 1, UG-99(h), the minimum recommended water temperature is MDMT +17 °C (63 °F). This requirement has been updated to align with API 660, 10.2.4 to require that the fluid temperature for hydrostatic testing is as required by or recommended by the pressure design code.

Replace section 10.3 title with

10.3 Nameplates and Markings

10.3.1

Replace "attached" with

mounted on a T-shaped bracket (see Figure 7) welded

Justification

Welded T-shaped nameplate brackets are commonly used as they do not obstruct access to the fixed cover for future maintenance of the anti-corrosion coating. Also, with welded brackets, there is no need to drill rivet holes in the pressure-retaining fixed cover to attach the nameplate. Over time, water ingress into such rivet holes and behind flush nameplates can lead to corrosion of the cover. By specifying a T-shaped nameplate bracket welded to the cover, such corrosion issues are prevented.

10.3.2

Replace list item g) with

g) hydrostatic or pneumatic test pressure, as applicable, and

Justification

This clarifies the intent of the original list item and adds pneumatic test pressure for cases where pneumatic testing has been performed in place of hydrostatic testing.

Add new section

10.3.3

Welds between the nameplate bracket and the exchanger cover plate shall be continuous fillet welds all around.

Justification

This requirement defines the welding requirements for the nameplate bracket to plate-and-frame heat exchanger cover plate welds. The use of continuous fillet welds all around prevents crevice corrosion.

Add new section

10.3.4

The thickness of the nameplate bracket material shall not be less than 5 mm ($^1/_5$ in.).

Justification

This defines the minimum thickness for the bracket material to ensure its robustness.

Add new section

10.3.5

The nameplate bracket projection from the cover plate shall not be less than 100 mm (4 in.).

Justification

This requirement standardizes the projection of the nameplate bracket to allow adequate access to the rear of the nameplate for fabrication, coating and inspection.

Add new Figure 7

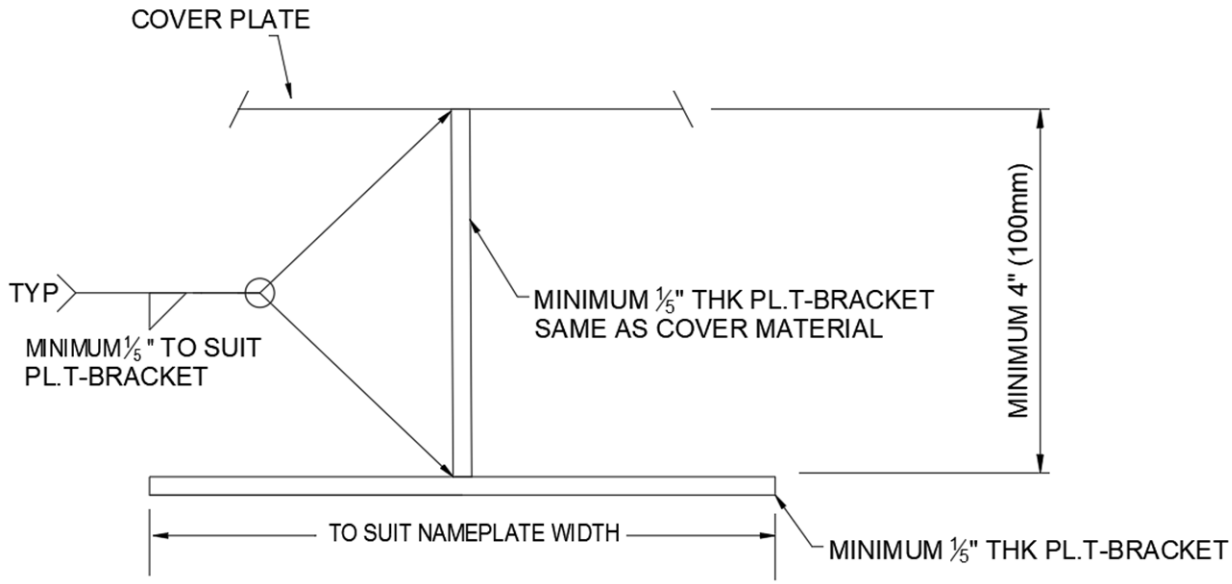

Figure 7—Typical T-shaped Nameplate Bracket

Justification

This figure provides a visual reference for the nameplate bracket requirements.

Add new section

10.3.6

Pressure-retaining components that have received post-weld heat treatment shall be permanently marked with the text "POST-WELD HEAT TREATED – DO NOT BURN OR WELD".

Justification

Uncontrolled heating or welding of post-weld heat-treated areas without approval and monitoring of the temperatures and durations may adversely affect the material properties in that area. This marking provides a visual warning that heating and welding of pressure-retaining components that have received post-weld heat treatment is prohibited.

11 Preparation for Shipment

11.7

Add after "(e.g. painting)"

for shipping

Justification

The application of a full coating system during manufacture is covered by the supplementary requirements in 9.4.1 and 9.4.2. This requirement is within the preparation for shipment section and has been modified to differentiate between surface preparation and protection for shipping purposes and the application of the full coating system.

Add new section

11.11

When desiccant bags are specified, they shall be located in the bottom portion of the plate-and-frame heat exchanger in either nozzles or ports.

Justification

If desiccant bags are damaged during transit, the loose desiccant can be more easily cleared from the bottom, reducing the likelihood of loose desiccant being stuck between the plates.

Add new section

11.12

When the plate-and-frame heat exchanger is purged with dry air and desiccant bags are inserted, the quantity and location of the desiccant bags shall be recorded in the handling, shipping, storage and preservation procedure.

Justification

This provides the purchaser with information regarding the location and quantity of desiccant bags, making it easier to locate and remove them prior to commissioning. This reduces the likelihood of desiccant bags being left in the plate-and-frame heat exchanger once put into service, which could result in blockages.

Add new section

11.13 Markings for Shipment

11.13.1

Markings on the exterior of the packing shall include the tag number, shipping weight and purchase order number.

Justification

This provides the minimum requirements for marking the plate-and-frame heat exchanger packing for ease of identification and handling.

11.13.2

Markings for the tag number, shipping weight and purchase order number on the exterior of the packing shall have a character height of at least 75 mm (3 in.).

Justification

This provides the minimum requirements for marking the plate-and-frame heat exchanger packing for ease of identification and handling.

11.13.3

Markings on the exterior of the packing not specified in 11.13.1 shall have a character height of at least 25 mm (1 in.).

Justification

Due to potentially limited space, permission is given for markings that are considered less critical for identification and handling purposes to be presented in a smaller size.

11.13.4

Markings shall be in a contrasting color relative to the background.

Justification

This provides the minimum requirements for marking the plate-and-frame heat exchanger. Markings in a contrasting color relative to the background are easy to read.

Annex A
(informative)

Recommended Practice

A.1 General

Add to second sentence of first paragraph

, except where "should" is replaced with "shall", which changes the recommendation to a requirement.

Justification

This clarifies that where modifications and references have been made to the content of this annex, such modifications shall be considered normative requirements rather than informative.

A.1.1 Sour or Wet Hydrogen Sulfide Service—Guidance to 4.7 and 4.8

In first sentence of first paragraph, replace "NACE MR0103" with

ANSI/NACE MR0103/ISO 17945

Justification

ISO 17945 is the internationally accepted equivalent of NACE MR0103 for sour (refinery) service. The full designation of the current edition of NACE MR0103 is ANSI/NACE MR0103/ISO 17945:2015.

In third sentence of first paragraph, replace "NACE MR0103" with

ANSI/NACE MR0103/ISO 17945

Justification

ISO 17945 is the internationally accepted equivalent of NACE MR0103 for sour (refinery) service. The full designation of the current edition of NACE MR0103 is ANSI/NACE MR0103/ISO 17945:2015.

In first sentence of second paragraph, replace "NACE MR0175 (all parts)" with

ANSI/NACE MR0175/ISO 15156 (all parts)

Justification

ISO 15156 (all parts) is the internationally accepted equivalent of NACE MR0175 for sour service. The full designation of the current edition of NACE MR0175 is ANSI/NACE MR0175-2021/ISO 15156:2020 (all parts).

In first sentence of third paragraph, replace "NACE MR0175 (all parts)" with

ANSI/NACE MR0175/ISO 15156 (all parts)

Justification

ISO 15156 (all parts) is the internationally accepted equivalent of NACE MR0175 for sour service. The full designation of the current edition of NACE MR0175 is ANSI/NACE MR0175-2021/ISO 15156:2020 (all parts).

A.3 Design

A.3.2 Fouling Margin—Guidance to 7.4

A.3.2.1

Delete "recommended" from third sentence of first paragraph

Justification

The fouling margin for various services included in Table A.1 is made normative instead of recommended by the modification to 7.4, fifth paragraph. These are overdesign margins to ensure the performance of the plate-and-frame heat exchanger under the given fouled condition.

In fourth sentence of first paragraph, replace "should" with

shall

Justification

Table A.1 is made normative by the modification to 7.4, fifth paragraph. This clarifies the application of the values in Table A.1 when the fluids within the plate-and-frame heat exchanger have different fouling margins specified. This ensures that the overall fouling margin basis is consistent across suppliers.

In fifth sentence of first paragraph, replace "should" with

shall

Justification

Table A.1 is made normative by the modification to 7.4, fifth paragraph. This clarifies the application of the values in Table A.1 when the fluids within the plate-and-frame heat exchanger have higher fouling margins specified (i.e. when the fouling margin on both sides is ≥ 15 %, i.e. both sides are considered fouling, a single value of 15 % is not considered sufficient). Doubling the fouling margin (i.e. 30 %) is considered excessive and an upper limit of 25 % is set in this case. Additional example: process streams dirty = 25 % and cooling water = 15 %, the overall fouling margin = 25 % (i.e. capping an upper limit on total fouling margin to 25 % instead of adding 25 % +15 % = 40 % optimizes the size).

A.3.2.3

Delete "recommended" from first sentence of first paragraph

Justification

The minimum wall shear stresses for various services included in Table A.1 are made normative instead of recommended by the modification to 7.4, fifth paragraph. The minimum wall shear stress criteria facilitate the design of plate-and-frame heat exchangers with low rates of fouling.

Replace Table A.1 title with

Table A.1—Targets for Fouling Margins, Wall Shear Stress, and Pressure Drop Multiplier

Replace Table A.1 with

Fluid Name [b, e]	Fouling Margin	Wall Shear Stress in Clean Condition (Minimum)	Pressure Drop Multiplier for Fouled Condition
	%	Pa	
Demineralized water	5	d	1.10
Potable water	10	30	1.20
Cooling tower water	15	50	1.25
Untreated seawater [g]	15	75	1.30
Filtered and chlorinated seawater [g]	10	50	1.20
Produced water	20	75	1.30
Lubricating oil, diesel oil	10	30	1.20
Crude oil and process streams—average fouling tendencies	15	50	1.30
Hydrocarbon gas, condensate and clean/purified process streams	10	30	1.20
Crude oil and process streams—dirty/contaminated with high fouling tendencies [a, f]	25	50	1.30
Amine/sulfinol solutions	15	50	1.25
Steam, air	5	[d]	1.10
Glycol/water solutions	10	30	1.20
Condensing process streams	10	[c]	[c]
Evaporating process streams	[c]	[c]	[c]
Refrigerant—all phases, inert gases	5	[d]	1.10

[a] If the shear stress for the process fluid can achieve 75 Pa (0.01088 psi), the fouling margin may be set to 20 %.

[b] For streams subject to vapor break-out, the specified shear stress shall be achieved in the all-liquid region.

[c] To be agreed between the purchaser and vendor.

[d] No minimum requirement. The calculated actual wall shear stress shall be provided.

[e] When the specified fluid name is not listed in this table, values for the fouling margin, the wall shear stress in clean condition (minimum) and the pressure drop multiplier for fouled condition for the specified fluid name shall be proposed based on the vendor's selected plate-and-frame heat exchanger model.

[f] Impurities and natural components in crude oil that are believed to contribute to fouling include corrosion products, solids, minerals in water, waxes, naphthenates, salts, asphaltenes exceeding their solubility limit, and thermal decomposition or autoxidation products from reactive constituents. Degraded corrosion and scale inhibitors can also contribute to fouling.

[g] The maximum skin temperature shall not exceed the local scale formation temperature (e.g. calcium carbonate, calcium sulfate, magnesium hydroxide).

Justification

Table

- *The fouling margin is an additional overdesign margin to account for and ensure the performance of the plate-and-frame heat exchanger in a specified fouled condition.*
- *The minimum wall shear stress assists in the design of plate-and-frame heat exchangers with lower rates of fouling.*
- *The associated pressure drop multiplier provides a guideline to estimate the plate-and-frame heat exchanger pressure drop in the fouled condition.*
- *Addition of "produced water": plate-and-frame heat exchangers are also used for produced water fluids in oil and gas applications.*
- *Addition of "diesel oil": plate-and-frame heat exchangers are also used for diesel oil fluids in oil and gas applications.*
- *Addition of "crude oil clean": crude oil fluids can be either "clean" or "average fouling tendency". "clean" is added to distinguish between "clean" and "average fouling tendency" crude oil.*
- *Addition of "Process streams, clean hydrocarbon gas": plate-and-frame heat exchangers are also used for “hydrocarbon gas” fluids in oil and gas applications.*
- *Addition of "Process streams dirty, crude oil average fouling tendency": crude oil fluids can be either "clean" or "average fouling tendency". "Clean" is added to distinguish between "clean" and "average fouling tendency" crude oil.*
- *Addition of "Steam, air": plate-and-frame heat exchangers are also used for “air” as a fluid in oil and gas applications.*
- *Addition of "Refrigerant—all phases, inert gases": plate-and-frame heat exchangers are also used for “inert gases” in oil and gas applications.*
- *Removal of "(psi)" column: The “(psi)” column is removed to avoid a decimal-level conversion.*

Footnotes

- *Footnote a: This amendment to API 667, Table A.1. footnote a improves clarity on the allowable fouling margin to a value associated with this note.*
- *Footnote b: This footnote clarifies that the wall shear stress in all listed services is achieved in the all-liquid region since wall shear stress cannot be calculated in two-phase applications.*
- *Footnote c: This footnote has not been modified from API 667, Table A.1, footnote c.*
- *Footnote d: API 667 does not specify a wall shear stress value for some fluid types. This footnote clarifies that in such cases the actual calculated wall shear stress is required based on the vendor’s selected plate-and-frame heat exchanger model.*
- *Footnote e: The range of fluids covered by Table A.1 and their allowable wall shear stress and pressure drop multiplier is not exhaustive. This requirement ensures that when the process fluid is not covered by Table A.1, it is mandatory that the vendor proposes values for the wall shear stresses and pressure drop multiplier.*
- *Footnote f: This footnote provides a definition of "crude oil dirty" to distinguish this service from "crude oil average fouling tendency" which assists in specifying the fluid name in the PDS.*
- *Footnote g: This footnote provides a definition of "untreated seawater" versus "filtered and chlorinated seawater", which assists in specifying the fluid name in the PDS.*

Annex B
(informative)

Plate-and-Frame Heat Exchanger Checklist

Replace Table B.1 with

Table B.1—Checklist

Subsection	Requirement	Item		
4.1	Pressure design code.	State required code.		
4.2	Structural welding code.	State required code.		
4.6	Applicable local regulations.	State required regulations		
4.7	Is the unit subject to sour or wet hydrogen sulfide service on the hot side?	Yes	No	
	Is the unit subject to sour or wet hydrogen sulfide service on the cold side?	Yes	No	
4.8	Are requirements for sour or wet hydrogen sulfide service to be applied where carbon steel is lined?	Yes	No	
4.9	Is cyclic design service required? If yes provide detailed information.	Yes (provide requirements)	No	
5.9	Vendor to provide data to allow thermal verification.	Yes	No	
6.2.2	Copies required of applicable welding procedure specifications, welding procedure qualifications and weld map.	For review	For record	[a]
6.2.3	Copies required of mechanical design calculations including for supports, lifting and pulling devices.	For review	For record	[a]
6.2.4	Specify if information about quality control system required, and if quality control plan required.	Yes (clarify requirements)	No	
6.3.1	Specify the format documentation. And quantities for the listed final documentation	Provide requirements.		
7.2.1	Specify a maximum design temperature and a minimum design metal temperature (MDMT) for hot and cold sides.	Complete on datasheet.		
7.4	Specify fouling margin (see Table A.1) [b].	Complete on datasheet.		
7.6.6	Specify if shroud required to protect against spray leaks.	Yes	No	
7.6.7	Specify if a fire-protection shroud is required and, if so, level of protection required.	Complete on datasheet.		
7.6.8	Specify if drip tray required.	Yes	No	
7.7.2	Specify if studded or flanged connections required. If flanged, specify required design code.	Complete on datasheet.		
7.7.3	Specify the flange gasket facings or the studded port liner facings.	Complete on datasheet.		
7.7.7	Specify if nozzles welded to cover plates to be set-on or set-in.	Complete on datasheet.		
7.7.13	Specify for alloy lined flanged connections if a threaded tell-tale hole to be provided.	Yes	[a]	
8.2.3	Specify maximum allowable carbon equivalent and/or restrictions on other residual elements and micro-alloying elements for carbon steel components in sour or wet hydrogen sulphide service.	Complete on datasheet.		

Table B.1—Checklist *(continued)*

Subsection	Requirement	Item	
10.1.1	Specify extent of non-destructive testing of the heat transfer plates.	Complete on datasheet.	
10.1.3	Specify NDE for semi-welded heat transfer plate pairs by vacuum or helium leak test or eddy current test.	Complete on datasheet.	
10.1.5	Specify if set-on nozzle attachments are to be ultrasonically examined.	Yes	[a]
10.1.6	Specify if all carbon steel plate in sour or wet hydrogen sulphide service shall require UT lamination check?	Yes	No
10.2.8	Are there additional requirements for equipment drying or preservation?	Yes	No
10.2.9	Specify if paint or other coatings may be applied over welds, and any installed liners, prior to the final pressure test.	Yes	No
11.7	Specify if there are requirements for surface preparation and protection (e.g. painting).	Complete on datasheet.	
11.9	Specify if inert gas purge and fill is required?	Yes	No

Justification

The modifications to Table B.1 reflect the changes made to API 667 by IOGP S-749, including additional requirements and the removal of some options that are not permitted or have been standardized by the specification.

Add Table B.1 Continuation

Table B.1 Continuation—Plate-and-Frame Heat Exchanger Checklist

Subsection	Requirement	Item	
5.10	Specify the allowable pressure drop in fouled/dirty condition.	Complete on datasheet.	
7.4	Specify the maximum solid size.	Complete on datasheet.	
7.4	Specify the concentration of solids (% volume).	Complete on datasheet.	
7.4 / Table A.1	Specify the fluid name (see Table A.1 for typical fluid names).	Complete on datasheet.	
7.4 / Table A.1	Specify the minimum wall shear stress requirement in clean condition (see Table A.1).	Complete on datasheet.	
7.4 / Table A.1	Specify the pressure drop multiplier for fouled/dirty condition (see Table A.1).	Complete on datasheet.	
7.6.3	Specify if the plate-and-frame heat exchanger is in utility service.	Yes	No
7.7.17	Specify the connection loads/moments: a) Table 1 for onshore applications; b) Table 1 values multiplied by 2.5 for offshore applications; or c) specified actual loads.	Complete on datasheet.	
7.8.2	Specify the gasket attachment method (glued or clip-on).	Complete on datasheet.	
7.8.6	Specify the gasket material (see Table 2).	Complete on datasheet.	
8.2.2	Specify the material certificate type.	Complete on datasheet.	
10.1.1	Specify the type of NDE to be performed on the heat transfer plates after forming (light box testing, liquid-penetrant testing, none, other).	Complete on datasheet.	
10.1.10	Specify if hardness testing of the heat-affected zone of pressure-retaining welds in carbon steel components is required, if not required by the selected pressure design code.	Yes	No
10.1.11	Specify the depth from the machined/finished weld overlay surface at which chemical analysis shall be carried out.	Complete on datasheet.	
10.1.12	Specify the extent of PMI required to be performed on alloy materials, (100 % of plates and welds, 10 % of heat transfer plates and 100 % of welds, none).	Complete on datasheet.	
10.1.15	Specify the acceptance criteria for ultrasonic examination of material (ASTM A578/578M acceptance level A supplementary requirement S1, EN 10160 class S2E3).	Complete on datasheet.	
10.3.2	Specify if code stamping is required.	Yes	No

NOTE Table B.1 Continuation was independently formulated by the International Association of Oil & Gas Producers (IOGP) and is not a part of API Standard 667, First Edition, Table B.1.

[a] The checklist option has been deleted and is not valid based on amendments made by this specification to API 667.

[b] The reference to Table A.1 has been added independently by IOGP and is not a part of API Standard 667, First Edition, Table B.1.

Justification

The modifications to Table B.1 reflect the changes made to API 667 by IOGP S-749, including additional requirements and the removal of some options that are not permitted or have been standardized by the specification.

Bibliography

Add to start of Bibliography

The following documents are informatively cited in the text of this document, API 667, the PDS (IOGP S-749D) or the IRS (IOGP S-749L).

Add to Bibliography

[8] API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

[9] API Specification Q2, *Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries*

[10] API Standard 660 *, *Shell-and-Tube Heat Exchangers*

[11] ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code*

[12] ISO 9001, *Quality management systems — Requirements*

[13] ISO 10005, *Quality management — Guidelines for quality plans*

[14] ISO 10209, *Technical product documentation — Vocabulary — Terms relating to technical drawings, product definition and related documentation*

[15] ISO 19901-5, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction*

[16] ISO/IEC 17000, *Conformity assessment — Vocabulary and general principles*

[17] ISO/IEC Directives, Part 2, *Principles and rules for the structure and drafting of ISO and IEC documents*

* Cited in IOGP S-749J only.

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