

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 411

Shell and tube heat exchangers

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1. Scope

This General Specification covers the Company practices and minimum requirements for the mechanical design, materials, fabrication, inspection and testing of Shell and Tube Heat Exchangers subject to internal and/or external pressure.

The scope is limited to heat exchangers in surface applications offshore and onshore. This specification shall be complemented by a dedicated particular project specification for the purchase of equipment and supported by the relevant process and mechanical data sheets.

This specification does not address local regulation, nor specific requirements imposed by Classification Society (for floating units).

Such equipment may contain liquid or gaseous petroleum or chemical products, air, water or steam. However, this specification does not cover steam condensers, double pipe, multi-tube heat exchangers, plate heat exchangers, cryogenic heat exchangers and air cooled heat exchangers.

The design, material selection, inspection, testing and preparation for shipment shall be performed according to the [ISO 16812](#) with the amendments defined in the present General Specification.

The sections 3 to 12 below follow the plan of the [ISO 16812](#) and the section 13 states additional requirements.

This General Specification shall be read in conjunction with the [GS EP ECP 103](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Any divergence between any of the Contractual Reference Documents, or between this specification and any other Contractual Reference Document, shall be reported to the Company for decision. In such a case, and unless otherwise agreed or decided by the Company, it is understood that the more stringent requirement shall apply.

Exceptions to, or deviations from this specification are not permitted unless previously accepted in writing by the managing entity named on the front page. For this purpose, Manufacturer's requests for substitution or change of any kind shall be complete with all pertinent information required for the Company assessment.

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External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ASME B16.47	Large diameter steel flanges NPS 26 through NPS 60
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASME B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	ASME Code for Pressure Piping - Process Piping
ASME BPVC Section IX	Welding and Brazing Qualifications - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
ASME BPVC Section V	Non-destructive Examination
ASME BPVC Section VIII Div 1	Rules for Construction of Pressure Vessels - Pressure Vessels
ASME BPVC Section VIII Div 2	Rules for Construction of Pressure Vessels - Alternative Rules
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A578	Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
BS 4871-3	Specification for approval testing of welders working to approved welding procedures. Arc welding of tube to tube-plate joints in metallic materials
BSI PD 5500	Specification for unfired fusion welded pressure vessels
EN 10160	Ultrasonic testing of steel flat product of thickness equal to or greater than 6 mm (reflexion method)
EN ISO 15156	Materials for use in H ₂ S-containing environments in oil and gas production
EN ISO 15614-8	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 8: Welding of tubes to tube-plate joints
ISO 16812	Petroleum, petrochemical and natural gas industries - Shell-and- Tube Heat exchangers

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Reference	Title
TEMA	Standards of the Tubular Exchanger Manufacturers Association
WRC 107	Local stresses in spherical and cylindrical shells due to external loadings
WRC 297	Local stresses in cylindrical shells due to external loadings on nozzles-Supplement to WRC Bulletin 107
WRC 537	Precision equations and enhanced diagrams for local stresses in spherical and cylindrical shells due to external loadings for implementation of WRC Bulletin 107

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP COR 005	Material selection for oil and gas production systems
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 352	Internal protection of equipment by painting
GS EP COR 356	Corrosion Protection of Fasteners for Subsea and Topsides Applications
GS EP COR 771	Thermal insulation (hot and dual service)
GS EP COR 772	Thermal insulation (cold service)
GS EP ECP 103	Process sizing criteria
GS EP EXP 407	Identification of Safety Critical Elements
GS EP PVV 146	Bolting for piping
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS EP PVV 212	Design and fabrication of pressure vessels according to BSI PD 5500
GS EP PVV 402	Standards for exchanger accessories and equipment
GS EP PVV 441	Procedure for shop hydraulic tests of shell and tube heat exchangers
GS EP PVV 611	Welding of pressure containing piping and equipment
GS EP PVV 612	Piping and equipment subject to severe sour service. Metallurgical and welding requirements

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Reference	Title
GS EP PVV 614	Welding of duplex and superduplex stainless steel
GS EP PVV 615	Welding of UNS 31254 alloy
GS EP PVV 616	Welding of titanium pipe and fittings
GS EP PVV 617	Welding of 3 ½ % nickel steel
GS EP PVV 619	Piping or pressure vessel components in duplex and superduplex stainless steel
GS EP PVV 622	Piping and equipment subject to mild and intermediate sour service. Metallurgical and welding requirements
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures

3. Terms and definitions

The terms and definitions used in this specification are in accordance with the [ISO 16812](#) section 3 with the following amendment:

General Specification Total General Specification as referenced in the section 2.

Managing Entity Entity named on the front page of the document.

4. General

The section 4 of the [ISO 16812](#) applies with the following amendments:

4.1 Pressure design code

The pressure design code shall be one of the following:

- [ASME BPVC Section VIII Div 1](#) as amended/supplemented by the [GS EP PVV 211](#)
- [ASME BPVC Section VIII Div 2](#) as amended/supplemented by the [GS EP PVV 211](#)
- [BSI PD 5500](#) as amended/supplemented by the [GS EP PVV 212](#).

The selection of the construction category shall be done as follow:

- Full radiographic examination as per [ASME BPVC Section VIII](#) (or Category 1 as per [BSI PD 5500](#)) shall be selected in any case for the following applications:
 - Heat exchangers which contain lethal substances
 - Heat exchangers to operate at low temperature¹
 - Heat exchangers in vacuum service (when vacuum occurs during start-up or in other conditions than normal service, it is not considered as "vacuum service")

¹ Whatever the environmental conditions an exchanger is considered as "low temperature service" when the design temperature is equal or lower than -30°C, or for an exchanger with a design temperature in operation greater than -30°C when the impact tests are required at -30°C and lower.

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- Heat exchangers which are to be heat treated for any reason
- Heat exchangers in cyclic service
- Heat exchangers made in Titanium.
- Spot radiographic examination as per [ASME BPVC Section VIII](#) or (Category 2 as per [BSI PD 5500](#)) may be selected for other heat exchangers not related for category 1.
- No radiographic examination option as per [ASME BPVC Section VIII](#) or (Category 3 as per [BSI PD 5500](#)) shall not be selected.

4.2 TEMA Class

Heat-exchanger construction shall conform to [TEMA](#), Class R, except for utility services for which Class C may be used.

For such occurrence, the utility services shall be defined by the project specification; the corresponding fluids shall be classified Category D as per Appendix M of [ASME B31.3](#).

4.3 Local regulations

The applicable local regulations shall be specified in the Project documentation.

4.4 Annexes

The Annexes A, B, C and D of the [ISO 16812](#) shall be considered as mandatory.

5. Proposals

The section 5 of the [ISO 16812](#) applies with the following amendments:

5.1 Data Sheet

The shell-and-tube heat exchangers data sheets shall comply with the form provided in by the [ISO 16812](#) Annex C.2 (SI units).

The service, duty and other design parameters as well as proposed type, position, arrangement and materials, shall be specified on the Heat Exchanger data sheets.

All data/information mentioned as "Optional" on the data sheet shall be provided.

5.2 Design not fully defined by the TEMA Nomenclature

The section 5.2 of the [ISO 16812](#) applies without any additional amendment.

5.3 Annular distributor

The section 5.3 of the [ISO 16812](#) applies without any additional amendment.

5.4 Expansion joints

The section 5.4 of the [ISO 16812](#) applies without any additional amendment.

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5.5 Description of exceptions

The section 5.5 of the [ISO 16812](#) applies without any additional amendment.

5.6 Stacked Heat Exchangers

The section 5.6 of the [ISO 16812](#) applies without any additional amendment.

5.7 Separate quotation for test ring and spare parts

Spare parts shall be as follow, for each heat-exchanger unit:

- 10% spare bolting with a minimum of two bolts of each size and type shall be supplied
- Two spare gaskets for each girth flanges and blinded nozzle in addition to the service gasket shall be supplied.

6. Drawings and other required data

The section 6 of the [ISO 16812](#) applies with the following amendments:

6.1 Outline drawings and other supporting data

6.1.1 The drawings shall include the maximum allowable external forces and moment on each nozzle.

6.1.2 The need for flow-induced vibration analysis shall be assessed and confirmed by the Project Process and Mechanical disciplines. It will be part of the Project Particular Specification.

The comprehensive vibration study as defined in [TEMA](#) and HTRI (Heat Transfer Research Inc.) method shall be performed as minimum requirement for all conditions including Fluidelastic Instability Analysis.

The vibration study shall be verified by qualified third party approved by Company.

The necessary mechanical features to avoid the vibration shall be provided without affecting the thermal performances.

6.2 Information required after outline drawings are reviewed

6.2.1 The section 6.2.1 of the [ISO 16812](#) applies without any additional amendment.

6.2.2 The qualified welding procedure specifications and procedure qualification records as required by the pressure design code and the applicable General Specifications shall be submitted for review. This includes the qualifications of the tube-to-tubesheet joints.

6.2.3 The section 6.2.3 of the [ISO 16812](#) applies with the following additional amendment:

Weld preparation shall be designed as to allow the required Non Destructive Examination (ultrasonic and / or radiographic examinations)

6.2.4 The section 6.2.4 of the [ISO 16812](#) applies with the following additional amendment:

Design calculations for stacked heat exchangers shall consider all combination loadings.

6.2.5 The design calculations for supports, lifting and pulling devices shall be submitted for review, with the description of the lifting and handling operations.