



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 211

Design and fabrication of pressure vessels according to ASME VIII

Rev.	Date	Notes
07	01/2011	New revision
06	10/2009	Update of reference documents
05	10/2008	General review
04	10/2007	Revision crossed references
00	02/2001	First issue
Rev.	Date	Notes

Owner: EP/TDO/TEC

Managing entity: EP/TDO/TEC/PVV



Contents

1. Scope	5
2. Reference documents.....	5
3. General.....	9
3.1 Definitions	9
3.2 Responsibilities	9
4. Design Data	10
4.1 Pressures.....	10
4.2 Temperatures	10
4.3 Thermal insulation	10
4.4 Combination units	10
4.5 Corrosion allowance	10
4.6 Wind.....	11
4.7 Earthquake	11
4.8 Transport	11
5. Design rules.....	12
5.1 General	12
5.2 Combinations of loads	12
5.3 Local loads.....	13
5.4 Maximum allowable stresses.....	13
5.5 Clad vessels	13
5.6 Deflection.....	14
5.7 Minimum thicknesses	14
6. Calculation notes	16
7. Materials.....	16
7.1 Selection of materials	16
7.2 Equivalent materials	18
7.3 Weldability of C-Mn steels	18
7.4 Procurement of heavy thick plates.....	19
7.5 Clad vessels	19



7.6	Flange gaskets and gasket contact faces.....	19
7.7	Bolting.....	19
7.8	Suborders of materials.....	20
8.	Rules of construction	20
8.1	Shell and heads welded joints number	20
8.2	Welded joint layout	20
8.3	Type of welded joints	21
8.4	Heads	21
8.5	Transitions	21
8.6	Body flanges	21
8.7	Supports	22
8.8	Connections - Nozzles and Manholes	22
8.9	Other attachments to vessel walls	25
8.10	Lifting devices	26
8.11	Internals	26
9.	Fabrication.....	26
9.1	General.....	26
9.2	Cutting	27
9.3	Forming.....	27
9.4	Welding.....	27
9.5	Post-weld heat treatment.....	29
9.6	Production test pieces	30
10.	Pressure tests	31
10.1	Shop tests.....	31
10.2	Testing procedure	31
10.3	Temperature and quality of the test water	31
11.	Inspection and quality assurance.....	32
11.1	General.....	32
11.2	Quality Assurance system	32
11.3	Quality plan.....	32
11.4	Material verification, inspection, and testing	32
11.5	Welding inspection.....	33



11.6	Dimensional check.....	34
12.	Nameplate	34
13.	Preparation for shipment.....	34
13.1	General.....	34
13.2	Particular requirements.....	35
13.3	Packing.....	35
14.	Fittings and spare parts.....	36
14.1	Fittings	36
14.2	Spare parts	36
15.	Documentation	36
15.1	Language and format of documents	36
15.2	Detail of documents to be submitted for review.....	36
15.3	Manufacturer data report	38
Appendix 1	Nozzle loads	39
Appendix 2	Manufacturer design report summary	42



1. Scope

This General Specification covers Company practices and minimum requirements for the engineering design, selection of materials, fabrication, inspection and testing of fusion welded unfired pressure vessels and pressurized storage tanks conforming in definition to the Code mentioned in section 2 of this specification.

For the purpose of this specification, the name "pressure vessels" includes all nozzles up to the flange facing of the first flange, blind flanges of manways, and blind flanges of any other nozzles which are part of the supply as shown on the relevant datasheet. It also includes vessel's supports (e.g., skirts with base rings, legs, saddles, etc.), as well as lifting lugs and trunnions.

In this specification, high-pressure vessels are those designed for a coincident pressure and temperature equal to or greater than class 600 rating as defined per [ASME B16.5](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Pressure vessels covered by this specification shall be designed, engineered, and built in accordance with the latest revisions issued at the date of the call for tender of the following documents listed hereafter.

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 Technology Division for decision. In such a case, and unless otherwise agreed or decided by the Company Technology Division, 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 Company Technology Division. For this purpose, Manufacturer's requests for substitution or change of any kind shall be complete with all pertinent information required for the Company Technology Division assessment.

Standards

Reference	Title
EN 584-1	Non destructive testing - Industrial radiographic film. Classification of film systems for industrial radiography
EN 10204	Metallic Products - Type of inspection documents
NACE MR0175 / ISO 15156	Material for Use in H ₂ S-containing Environments in Oil and Gas Production



Professional Documents

Reference	Title
WRC 107 and WRC 297	Welding Research Council: Bulletin 107 and 297

Regulations

If the country of installation has its own regulation, it must be applied wherever more stringent than the Code.

Any Construction Code or Government Regulations, which may be listed in the Project Specifications, in the requisition or in the Purchase Order, if any, shall have precedence except where this Specification is more stringent.

Reference	Title
Not applicable	

Codes

The basic code is the ASME (Boiler and Pressure Vessel Code) Section VIII div. 1.

Alternatively, Division 2 may be specified by the Engineering Company in the particular specifications of the vessel, or may be proposed by the Manufacturer. In such a case, pressure vessels must be stamped, which includes the required User Design Specifications to be issued by the Engineering Company and approved by a Registered Professional Engineer (RPE). This RPE approval must be obtained prior to any Manufacturer's design activity of the related vessels.

The basic code is referenced to as "the Code" in the present document.

Boilers (unfired) covered by this specification must comply with the ASME Section VIII or Section I.

The use of Code Cases related to any applicable ASME code is not permitted. Exceptions to this rule may be submitted for consideration to the Company Technology Division on a case-by-case basis only, and prior to any design activity.

Reference	Title
AISC	Manual of Steel Construction
ASCE 7-95	Minimum design loads for buildings and other structures
ASME B1.1	Unified Inch Screw Threads
ASME B16.5	Pipe Flanges and flanged fittings (NPS ½ through NPS 24)
ASME B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.20	Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed

Reference	Title
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.25	Buttwelding Ends
ASME B16.30	Unfired pressure vessel flange dimensions
ASME B16.47	Large diameter steel flanges (NPS 26 Through NPS 60)
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME Section I	
ASME Section II	Materials specification
ASME Section V	Non-destructive examination
ASME Section VIII div. 1	Boiler and Pressure Vessel Code
ASME Section VIII div. 2	Boiler and Pressure Vessel Code
ASME Section IX	Welding and brazing qualifications
ASTM E 1815	Standard Test Method for Classification of Film Systems for Industrial Radiography
BSI PD 5500	Specification for unfired fusion welded pressure vessels
UBC	Uniform Building Code: Volume 2 Wind And Earthquake

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
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 354	External protection of onshore structures and equipment by painting
GS EP COR 356	Corrosion Protection of Fasteners for Subsea and Topsides applications
GS EP ECP 103	Process sizing criteria
GS EP PVV 145	Flanges
GS EP PVV 202	Standard drawings for accessories and equipment of vessels



Reference	Title
GS EP PVV 611	Welding of pressure containing piping and equipment
GS EP PVV 630	TOFD Inspection
GS EP PVV 771	Thermal insulation (hot service)
GS EP PVV 772	Thermal insulation (cold service)
GS EP PVV 773	Thermal insulation (cyclic service)
SD EP PVV 201 *	Tolerances of pressure vessels
SD EP PVV 202 *	Horizontal tanks, heads with large knuckle radius
SD EP PVV 203 *	Horizontal tanks, elliptical heads
SD EP PVV 204 *	Lifting lugs
SD EP PVV 205 *	Anchor lugs and base rings of vertical vessels
SD EP PVV 206 *	Saddles for horizontal containers, diameter 350 to 550 mm
SD EP PVV 207 *	Saddles welded for horizontal tanks
SD EP PVV 208 *	Standard equipment of column skirts
SD EP PVV 209 *	Legs for small vessels
SD EP PVV 210 *	Nozzle designation
SD EP PVV 211 *	Minimum nozzle thickness
SD EP PVV 212 *	Nozzles less than 2" in diameter
SD EP PVV 213 *	Protruding length and bolt holes of nozzles
SD EP PVV 214 *	Vertical manhole with davit (WN flange)
SD EP PVV 215 *	Vertical manhole with davit (SO flange)
SD EP PVV 216 *	Horizontal manhole with davit (WN flange)
SD EP PVV 217 *	Horizontal manhole with davit (SO flange)
SD EP PVV 218 *	Hinged manhole (WN flange)
SD EP PVV 219 *	Hinged manhole (SO flange)
SD EP PVV 220 *	Handles and rungs for manholes
SD EP PVV 221 *	Vortex Breaker
SD EP PVV 222 *	Deflector on steam inlet
SD EP PVV 223 *	Name Plates for vessels
SD EP PVV 224 *	Earthing plate
SD EP PVV 225 *	Monorail davit
SD EP PVV 230 *	Insulation supports on vertical vessels
SD EP PVV 231 *	Insulation supports on horizontal vessels



Reference	Title
SD EP PVV 232 *	Welding of clad vessels
SD EP PVV 233 *	Coating of nozzles
SD EP PVV 234 *	Weld deposits on RTJ flange facings

* see GS EP PVV 202

3. General

Pressure vessels covered by this specification shall be marked with the Code U or U2 symbol. Consequently they shall be manufactured under the survey of an Authorized Inspector.

3.1 Definitions

User: the organization that purchases the finished pressure vessel for its own use or as an agent for the Owner.

Manufacturer: the organization responsible for construction of a pressure vessel in accordance with the rules of the applicable division and who holds an ASME Certificate of Authorization to apply the Code Symbol Stamp.

Authorized Inspector: Inspector regularly employed by an ASME accredited Authorized Inspection Agency.

3.2 Responsibilities

3.2.1 Responsibilities of the user

The responsibilities of the user are specified in Part U-2(a) of the Code Division 1 or Part 2 Section 2.2 of the Code Division 2.

3.2.2 Responsibilities of the Manufacturer

The responsibilities of the Manufacturer are specified in Parts U-2(b) and UG-90(b) of the Code Division 1 or Part 2 Section 2.3 of the Code Division 2.

This specification together with the particular specifications shall not be construed as releasing the Manufacturer from his responsibility, fulfilment of his duties, guarantee and/or liabilities, nor does the Company, by any acceptance or approval, assume any responsibility for the conformance of the vessels to the requirements of the Code and/or of the Governing Authority.

3.2.3 Authorized Inspector's Duties

The duties of the Authorized Inspector are specified in Parts U-2(e) and UG-90(c) (1) of the Code Division 1 or Part 2 Section 2.4.3 of the Code Division 2.



4. Design Data

4.1 Pressures

4.1.1 General

Design pressures are shown on the relevant pressure vessel mechanical data sheets that shall be issued by the Engineering Company. These pressure values are meant at the top of the vessels in their final operating positions, unless otherwise specified in the data sheet.

4.1.2 Operation under partial vacuum

If the internal pressure is 0.35 bar or less (absolute pressure), the vessel shall be designed for full vacuum. In all other cases, the vessel shall be designed for the maximum external pressure plus a margin of 0.15 bar.

4.2 Temperatures

The Manufacturer shall check impact test requirements of the Code at the minimum design metal temperature. Unless otherwise specified, this temperature value shall be taken equal to the minimum design temperature as shown on the data sheet. A unique minimum design metal temperature shall be used for the complete vessel.

4.3 Thermal insulation

Thermal insulation must be provided either required by the process studies or for personnel protection (although protection by physical barriers such as stainless steel open mesh guards or protective metal sheeting/screens shall be preferred whenever possible). Any required thermal insulation shall comply with the following Company specifications, as appropriate: **GS EP PVV 771**, **GS EP PVV 772**, **GS EP PVV 773**. Surfaces shall be appropriately protected in accordance with **GS EP COR 350** or **GS EP COR 354** before installation of thermal insulation.

4.3.1 Protection of personnel

Protection of the personnel by physical barriers such as stainless steel open mesh guards or protective metal sheeting/screens must be provided on uninsulated equipment when the service temperature thereof is over 70°C. The minimum distance between protection and equipment shall be 50 mm. This protection shall also apply to cold equipment, which might be a danger to the Operators.

4.4 Combination units

The partition between two independent chambers of a combination unit shall be designed to withstand the design pressure and temperature of any chamber whilst the adjacent chamber is under atmospheric pressure and temperature.

Unless otherwise authorised in writing by the Company, design based on the differential pressure is not permitted.

4.5 Corrosion allowance

Additional thickness shall be provided for the corrosion allowance specified in the vessel data sheet.



Corrosion allowance for nozzles and manholes shall be at least equal to that specified for the vessel shell. No corrosion allowance is required on gasket face of flanges.

Corrosion allowance for internals shall be as specified in section 5.7.2 and Table 2 of this specification.

In the particular case of nozzle protrusion inside vessels, the corrosion allowance applies to both sides of the nozzle.

4.6 Wind

4.6.1 Applicable code

The applicable code is **ASCE 7-95**, which must be applied as design method. Alternatively, the code **UBC** (Uniform Building Code) volume 2 (wind and earthquake) may be used.

In addition to the static calculations, calculations taking account of dynamic effects must be carried out for all vertical vessels, such as vertical drums, columns, stacks, etc. when the slenderness ratio is greater than 5.

However, in the case of very slender or special vessels, the Company and/or the Engineering Company may require that the Manufacturer furnish calculations under dynamic conditions based on the references of the Code or on other approved methods.

4.6.2 Design data

All data required for wind calculation shall be specified by the Engineering Company in the vessel requisition.

4.7 Earthquake

The stability of vessels shall be checked for the operating conditions as defined in Table 1.

4.7.1 Applicable code

The applicable code is **ASCE 7-95**. It must be applied as design method. Alternatively, the code **UBC** (Uniform Building Code) volume 2 (wind and earthquake) may be used.

4.7.2 Design data

All data required for earthquake calculation shall be specified by the Engineering Company in the vessel requisition.

4.8 Transport

Design data (acceleration values) shall be specified by the Engineering Company in the vessel requisition. Except otherwise specified in the requisition, the following shall apply:

- The acceleration force shall be 0.8 g in any direction during sea transportation. Where the equipment is not adequate, bracket for attaching sea fastenings shall be provided
- All equipment shall be capable of withstanding loads during road transport of 0.3 g longitudinally and 0.1 g in the vertical and transverse directions.

5. Design rules

5.1 General

High-pressure vessels shall be designed with a joint efficiency of 1.

For design according to **ASME Section VIII div. 1** joint efficiency shall be limited to either 0.85 or 1 exclusively. A unique joint efficiency shall be used for both circular and longitudinal welds as well as for any other butt weld.

Cases and features not fully covered by the Code shall be the subject of agreement in writing between the Manufacturer and the Company Technology Division.

5.2 Combinations of loads

All vessels and their supports, including anchor bolts, shall be designed for the most adverse condition to which they may be subjected.

For that purpose, in addition to sizing the various components for the most severe condition of coincident design pressure and temperature, the Manufacturer shall determine the stress level in the shell and support resulting from all the combinations of static and dynamic loads which may occur at any time during the vessel life.

Hull movements shall be taken into account for pressure vessels to be installed on floating facilities (accelerations and hull distortion). The analysis shall cover all potential conditions (including hydrostatic testing).

The extent and methods of that investigation and the appropriate data to be used in calculations shall be agreed as early as possible (and preferably before Contract award) between the Company Technology Division and the Manufacturer.

As a minimum, the Manufacturer shall analyse the structural stability of the vessel and its support for the combinations of loading and conditions given in Table 1.

Table 1 - Combination of loadings

Loading	Condition		
	As installed	Operating	Hydrostatic testing (1)
Dead load	(2)	(3)	(3)
Live load	-	(4)	(5)
Internal and external pressure	Atmospheric	(6)	(7)
Temperature	Atmospheric	(8)	Atmospheric
Wind	(9)	(9)	(11)
Earthquake	(10)	(10)	-



Note:

- (1) In operating position, in corroded condition.
- (2) "Lifting weight" of the vessel, empty, new (non-corroded), including all fixed attachments, excluding loose internals and appurtenances, excluding insulation.
- (3) "Operating weight" of the vessel, corroded, including any permanent equipment attached to the vessel, e.g. internals, platforms, ladders, piping, rotating equipment and drive, insulation, fireproofing.
- (4) Weight of normal liquid content.
- (5) Weight of water.
- (6) Design pressure + static head of the maximum operating liquid level as specified in the data sheet of the vessel (including liquid specific gravity).
- (7) Test pressure, including static head, vessel full of water.
- (8) Design temperature.
- (9) Shall not be combined with seismic load.
- (10) As specified in the particular specifications. Shall not be combined with wind load.
- (11) 30% of the nominal wind load used in the calculations for the operating case.

5.3 Local loads

The Manufacturer shall check the localised stresses and deformations in the vessel wall due to concentrated loads caused by external and/or internal structural attachment, piping reactions, supported equipment, platform, davit, etc.

For this purpose, the Engineering Company shall issue detailed loading data to the Manufacturer for piping supports reactions, platform supports, and any other external loadings.

Piping loads on nozzles as detailed in Appendix 1 shall be used when no other data are available.

The methods for computing such stresses shall previously be submitted to the Company Technology Division acceptance (typical methods of calculations are given in [WRC 107](#)).

5.4 Maximum allowable stresses

The Manufacturer shall verify that, in any combination of loadings, except the testing condition, and in any part of the vessel and support, the computed stresses do not exceed the values prescribed in the Code.

Under the condition of the hydrostatic test, the stress shall not exceed 90% of the minimum specified yield strength of the material at testing temperature. The efficiency of full penetration butt-weld joints shall be taken as 1. This verification shall be made on shell components only, except if the shell components thickness is governed by the test condition (in this case, nozzle reinforcements shall also be checked in the testing condition).

5.5 Clad vessels

The thickness and the strength of the clad part of clad vessels shall not be taken into account in the mechanical calculations.