

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 211

Design and fabrication of pressure vessels according to ASME VIII

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General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 2 of 55

Contents

1. Scope	5
1.1 Additional requirements for high pressure vessels	5
1.2 Geometric scope	5
1.3 Classification outside the scope	5
1.4 Miscellaneous	6
1.5 Units of measurements	6
1.6 Code Cases	6
2. Reference documents.....	6
3. General.....	8
3.1 Definitions	8
3.2 Selection of the Code.....	9
3.3 Responsibilities	10
4. Design Data	10
4.1 Design Conditions	10
4.2 Combination units	11
4.3 Corrosion allowance	11
4.4 Environmental conditions	11
4.5 Earthquake	12
4.6 Loads and load cases	12
5. Materials.....	12
5.1 Selection of materials.....	12
5.2 Certification	14
5.3 Supplemental requirements	14
5.4 Clad materials	16
5.5 Supplemental requirements for Bolting	16
5.6 Flange gaskets and gasket contact faces.....	17
5.7 Suborders of materials	17
6. Design by rule requirements.....	17
6.1 General requirements	17

6.2	Design rules for welded joints	23
6.3	Conical shells.....	24
6.4	Heads	24
6.5	Openings in shells and heads: Nozzles and Manholes.....	25
6.6	Flat heads and covers.....	28
6.7	Quick opening closure.....	29
6.8	Support and Attachments.....	29
6.9	Vessels subject to fatigue	31
6.10	Specific design cases.....	31
6.11	Calculation notes	33
7.	Fabrication requirements	34
7.1	General.....	34
7.2	Materials	34
7.3	Cutting	34
7.4	Forming.....	35
7.5	Welding.....	35
7.6	Pre-heating	36
7.7	Post-weld heat treatment	37
7.8	Production test pieces.....	38
7.9	Repair of weld defects.....	39
7.10	Special requirements for clad or weld overlay	39
7.11	Internals.....	40
8.	Inspection and quality assurance.....	41
8.1	Responsibilities and duties.....	41
8.2	Quality plan.....	41
8.3	Welding inspection.....	41
9.	Pressure tests	42
9.1	Selection of pressure test methods	42
9.2	Testing procedure	43
9.3	Precautions.....	43
10.	Final operations	44

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 4 of 55

10.1	Dimensional check	44
10.2	Nameplate	44
10.3	Internal and external components	44
11.	Preparation for shipment.....	44
11.1	General.....	44
11.2	Particular requirements	45
11.3	Packing & fastening	45
12.	Fittings and spare parts.....	46
12.1	Fittings	46
12.2	Spare parts	46
13.	Documentation	46
13.1	Language and format of documents.....	46
13.2	Detail of documents to be submitted for review	46
13.3	Manufacturer data report.....	48
Bibliography.....		49
Appendix 1	Nozzle loads.....	50
Appendix 2	Manufacturer design report summary	54

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 5 of 55

1. Scope

This General Specification covers Company practices and minimum requirements for the design, materials, fabrication, examination, inspection, testing of pressure vessels in accordance with the [ASME BPVC Section VIII Div 1](#) or [ASME BPVC Section VIII Div 2](#).

The other activities such as corrosion protection or thermal insulation are outside the scope of this specification.

For the scope of this General Specification, pressure vessels are containers for the containment of pressure either internal or external. This pressure may be obtained from an external source, or by application of heat from a direct or indirect source, or any combination thereof.

The scope is limited to the container only. Any other item connected to the pressure vessel (for example, piping) is not part of this specification.

The scope is limited to pressure vessels in surface application or in buried conditions; subsea applications are outside the scope of this specification.

This General Specification may be used for the construction of pressure vessels listed in the [ASME BPVC Section VIII Div 2](#) paragraph 1.2.1.2.

Laws or regulations issued by state or other enforcement or regulatory bodies having jurisdiction at the location of an installation establish the mandatory applicability of the Code rules, in whole or in part, within their jurisdiction. These laws or regulations shall be reviewed to determine size or service limitations that may be different or more restrictive than those given by the Code.

1.1 Additional requirements for high pressure vessels

Additional requirements are defined in this General Specification for high-pressure vessels. High pressure vessels are those with a design pressure greater than 6 MPag (60 barg).

This General Specification is not applicable for Very High Pressure vessels. Very High Pressure Vessels are pressure vessels intended for operating pressure exceeding 68.95 MPag (689.5 barg).

1.2 Geometric scope

The geometric scope is defined in the applicable Code Division:

- [ASME BPVC Section VIII Div 1](#) Part U-1(e)
- [ASME BPVC Section VIII Div 2](#) paragraph 1.2.3.

Any other consideration shall be clarified at early stage by the datasheet or project specification.

1.3 Classification outside the scope

The classes of vessels not included in the scope of the applicable Code Division are outside the scope of this General Specification. These vessels are listed in the following paragraphs:

- [ASME BPVC Section VIII Div 1](#) Part U-1(c)(2)
- [ASME BPVC Section VIII Div 2](#) paragraph 1.2.4.

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 6 of 55

1.4 Miscellaneous

1.4.1 Field assembly of vessels

Field assembly of pressure vessels is subject to derogation.

1.4.2 Sour service

Any vessel in H₂S service subject to the [NACE MR 0175 / ISO 15156](#) requirements shall be considered in "Lethal service" and also subject to application of section UW-2 of the code [ASME BPVC Section VIII Div 1](#).

1.4.3 Pressure relief devices

Pressure relief devices are not part of this General Specification.

1.5 Units of measurements

SI units shall be used only.

1.6 Code Cases

The use of Code Cases related to any applicable ASME code is subject to Company approval prior to any design activity.

2. Reference documents

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

Any conflicting requirements between this specification and any other relevant document shall be reported to the Company for decision. In any case, and notwithstanding the final decision of the Company, the most stringent requirement is always first meant to govern.

External Documents

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

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

Unless otherwise agreed Boilers (unfired) covered by this specification shall comply with the [ASME BPVC Section VIII Div 1](#) or [ASME BPVC Section I](#).

Throughout this General Specification, references are made to various codes or standards, such as ASME Codes, ASTM standards and others. These standards are listed in the applicable ASME BPVC Code:

- [ASME BPVC Section VIII Div 1 Table U-3](#)
- [ASME BPVC Section VIII Div 2 Table 1.1](#).

Design and fabrication of pressure vessels according to ASME VIII

Rev.: 12

Effective date: 11/2016

Page: 7 of 55

The following documents shall be considered as additional to the ASME BPVC Codes:

Reference	Title
AISC	Manual of Steel Construction
ASCE 7	Minimum design loads for buildings and other structures
ASME B1.1	Unified Inch Screw Threads, UN and UNR Thread Form
ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.47	Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
ASME B31.3	Process Piping - Includes Interpretation 23
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME BPVC Section I	Rules for Construction of Power Boilers
ASME BPVC Section II	Materials
ASME BPVC Section IX	Welding and Brazing Qualifications
ASME BPVC Section VIII Div 1	Rules for Construction of Pressure Vessels - Division 1: Pressure Vessels
ASME BPVC Section VIII Div 2	Rules for Construction of Pressure Vessels - Division 2: Alternative Rules
ASME SA-264	Standard Specification for Stainless Chromium-Nickel Steel-Clad Plate
ASME SA-265	Standard Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate
ASTM A380/A380M	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A991/A991M	Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products
PD 5500	Specification for unfired fusion welded pressure vessels
EN 10204	Metallic products - Types of inspection documents
NACE MR 0175 / ISO 15156	Petroleum and natural gas industries - Materials for use in H ₂ S- containing environments in oil and gas production
UBC Volume 2	Uniform Building Code: Wind And Earthquake

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 8 of 55

Reference	Title
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 addendums, is the latest revision published.

Reference	Title
GS EP ECP 103	Process sizing criteria
GS EP PVV 102	Piping Hook-up Standards
GS EP PVV 145	Flanges
GS EP PVV 175	Cleaning of piping and vessels
GS EP PVV 202	Standard drawings for accessories and equipment of vessels
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
GS EP PVV 614	Welding of duplex and super-duplex stainless 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 PVV 630	TOFD Inspection
GS EP PVV 631	Phased Array Inspection (PAUT)

3. General

3.1 Definitions

The definitions are defined in the applicable Code Division:

- [ASME BPVC Section VIII Div 1](#) Mandatory Appendix 3
- [ASME BPVC Section VIII Div 2](#) Annex 1-B.

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 9 of 55

With the following additional ones:

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

Company: The Group, Headquarter or the Affiliate.

Owner: Organization that owns or operates the pressure vessel.

Acronyms

FEA	Finite Element Analysis
MAWP	Maximum Allowable Working Pressure
MDMT	Minimum Design Metal Temperature
PTC	Production Test Coupon
PQR	Procedure Qualification Record
PWHT	Post-Weld Heat Treatment
RPE	Registered Professional Engineer
RGD	Rapid Gas Decompression
TMCP	Thermo-Mechanical Control Process
QOC	Quick Opening Closure
UDR	User's Design Requirements
UDS	User's Design Specification
WPS	Welding Procedure Specification

3.2 Selection of the Code

The selection of the Code [ASME BPVC Section VIII Div 1](#) or [ASME BPVC Section VIII Div 2](#) is the User's responsibility.

The use of the Code shall be limited to the following pressures:

- [ASME BPVC Section VIII Div 1](#): 200 barg (MAWP)
- [ASME BPVC Section VIII Div 2](#): 689.5 barg (MAWP).

The selected Code shall be submitted to the Company acceptance with the relevant technical and economical justifications.

The selection of the [ASME BPVC Section VIII Div 2](#) is recommended for the following cases as long as the pressure vessel remains in the scope of this division:

- High Pressure vessels
- Situations for which the weight limitation is critical
- Economical reason.

Pressure vessels designed according to [ASME BPVC Section VIII Div 2](#) shall be stamped with the Certification Mark.

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 10 of 55

Pressure vessels designed according to [ASME BPVC Section VIII Div 1](#) shall be stamped with the Certification Mark, except otherwise agreed.

3.3 Responsibilities

3.3.1 User's Responsibilities

The User's responsibilities are specified in the [ASME BPVC Section VIII Div 1](#) Part U-2(a) and in the [ASME BPVC Section VIII Div 2](#) Part 2 paragraph 2.2 o.

3.3.2 Manufacturer's Responsibilities

The Manufacturer's responsibilities are specified in the [ASME BPVC Section VIII Div 1](#) Parts U-2(b) and UG-90(b) and in the [ASME BPVC Section VIII Div 2](#) Part 2 paragraph 2.3.

This specification together with the particular specifications shall not be construed as releasing the Manufacturer from his responsibility, fulfillment 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.

3.3.3 Authorized Inspector's Duties

The Authorized Inspector's duties are specified in the [ASME BPVC Section VIII Div 1](#) Parts U-2(e) and UG-90(c) (1) and in the [ASME BPVC Section VIII Div 2](#) Part 2 paragraph 2.4.3.

4. Design Data

For each pressure vessel, the design requirements shall be established by the User in a specific document:

- [ASME BPVC Section VIII Div 1](#): User's Design Requirements as per defined in the Appendix KK (this Appendix becomes Mandatory): forms U-DR-1 or U-DR-2
- [ASME BPVC Section VIII Div 2](#): User's Design Specification as per defined in the paragraph 2.2.2.

The User's Design Specifications shall be certified by a Registered Professional Engineer (RPE). The Certification of the User's Design Specification shall be obtained prior to any Manufacturer's design activity of the related vessels.

The following design data shall be clearly defined in the User's Design Requirements and the User's Design Specifications:

4.1 Design Conditions

4.1.1 Design Pressure

The specified design pressure is the design pressure required at the top of the vessel in its operating position. The design pressure shall be selected by adding a safety margin on the normal operating pressure following the [GS EP ECP 103](#) for both conditions:

- Maximum design pressure
- Minimum design pressure.

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 11 of 55

In case of external pressure, the vessel shall be designed for the maximum external pressure plus a margin of 0.15 bar.

4.1.2 Minimum Design Metal Temperature

A unique value of Minimum Design Metal Temperature shall be used for the complete vessel.

It shall be based upon the lowest temperature of either (a), (b) and (c) as follows:

- The minimum design temperature specified
- The minimum environmental air temperature or -10°C , whichever the lesser
- For the vessels subject to autorefrigeration the wall temperature specified at the end of depressurization.

4.1.3 Additional toughness requirements

Impact test is required at the Minimum Design Metal Temperature for all materials of construction, the impact test exemptions of the Code is not permitted.

Notes:

- For vessels subject to autorefrigeration, and wherever the Code requirements are less restrictive, the difference of the final autorefrigeration temperature with the impact test temperature of the materials shall not exceed 30°C .
- The same requirements apply for the impact tests of welding procedures.

4.2 Combination units

The parts separating two independent chambers of a combination unit shall be designed to withstand the design conditions (pressure and temperature) of any chamber whilst the adjacent chamber is under atmospheric conditions (pressure and temperature).

Unless otherwise authorized in writing by the Company, design based on the differential pressure or on mean metal temperature is not permitted.

4.3 Corrosion allowance

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.

In the particular case of nozzle protrusion inside vessels, the corrosion allowance applies to both sides of the nozzle. Corrosion allowance for internals shall be as specified in section 6.1.1.2 and Table 2 of this specification.

4.4 Environmental conditions

The applicable code is [ASCE 7](#), which shall be applied as design method. Alternatively, the code [UBC Volume 2](#) (wind and earthquake) may be used.

4.4.1 Wind

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

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 12 of 55

In addition to the static calculations, calculations taking account of dynamic effects shall 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 User may require that the Manufacturer furnish calculations under dynamic conditions based on the references of the Code or on other approved methods.

4.5 Earthquake

The stability of vessels shall be checked for the operating conditions as defined in Table 3.

All data required for earthquake calculation shall be specified by the User in the UDR or UDS vessel requisition.

4.6 Loads and load cases

The User shall specify all expected loads and load case combinations as defined by the Code, and the section 6.1.2 below.

4.6.1 Transport

Design data (acceleration values) shall be specified by the User in the UDR or UDS. Except otherwise specified the following shall apply:

- Sea transport: the acceleration value shall be 0.8 g in any direction. When needed, brackets for attaching sea fastenings shall be provided.
- Road transport: all equipment shall be capable of withstanding loads of 0.3 g longitudinally and 0.1 g in the vertical and transverse directions.

5. Materials

5.1 Selection of materials

5.1.1 Materials for pressure parts

Materials used shall be exclusively those listed in the relevant tables of the applicable Code (i.e., [ASME BPVC Section VIII Div 1](#) or [ASME BPVC Section VIII Div 2](#)). The use of materials not listed in the Code is not allowed, even if they are included in the ASTM specifications reproduced by the [ASME BPVC Section II](#).

The selection of materials as a function of the design data shall be made in conformity with the Table 1. This table shall be considered as a base case for the material selection.

Any material selection different from the Table 1 shall be subject to Company acceptance through derogation.

The selected materials shall be clearly specified in the data sheet.

5.1.2 Materials for attachments to pressure parts

Material for vessels supports (skirts, saddles, legs, supports, etc., including weir plates if applicable) directly welded to the pressure containing part shall be of the same material grade

as for the shell/head components to which they are welded, particularly with regards to impact test requirements.

Table 1 - Selection of materials in relation to design temperatures

Design temperature	+ 380°C to - 196°C	+ 380°C to - 101°C	+ 380°C to - 46°C	+ 380°C to - 29°C	+380°C to + 21°C	Max. 468°C
Type of steel	Austenitic stainless steel	3.5% Ni	Normalized or Quenched and Tempered carbon steel (3)(4) Duplex (5) and Superduplex (6)	Normalized Carbon steel (3)(4)	Normalized Carbon steel (3)(4)	1.25 Cr-0.5 Mo
Plates	SA 240 304 (1) SA 240 304L SA 240 316 (1) SA 240 316L SA 240 321 (2) SA 240 347	SA 203 Grade D or Grade E	SA 516 Grade 60 Grade 70 SA 240 UNS S31803 UNS S32750	SA 516 Grade 60 Grade 70	SA 515 Grade 60 Grade 70	SA 387 Grade 11 Class 1
	9% Ni SA 353					
Forgings Fittings	SA 182 F 304 (1) SA 182 F 304L SA 182 F 316 (1) SA 182 F 316L SA 182 F 321 (2)	SA 350 Gr LF3 SA 420 Gr WPL-3	SA 350 GrLF2 SA 420 Gr WPL-6 SA 182 F51, F53, F55 SA 815 UNS S31803 UNS S32750 UNS S32760	SA 105 SA 234 Gr WPB	SA 105 SA 234 Gr WPB	SA 182-F11 Cl.1 SA 234 GrWP11 Cl1
	9% Ni SA 522 Grade I					
Seamless Pipes	SA 312 TP 304 (1) SA 312 TP 304L SA 312 TP 316 (1) SA 312 TP 316L SA 312 TP 321 (2)	SA 333 Gr3	SA 333 Gr6 SA 790 UNS S31803 UNS S32750 UNS S32760	SA 333 Gr6 SA 106 GrB	SA 106 GrB	SA 335-P11
	9% Ni: SA 333 Grade 8					
Threaded rods	SA 320 - B8MA	SA 320-L7	SA 320-L7 SA 453 Gr.660 Cl.A	SA 193-B7	SA 193-B7	SA 193-B16
Nuts	SA 194Gr8MA	SA 194Gr4	SA 194Gr4 SA 453 Gr.660 Cl.A	SA 194Gr2H	SA 194Gr2H	SA 194Gr4

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 14 of 55

Notes to Table 1:

The above materials are to [ASME BPVC Section II](#) standards.

- (1) TP304 and 316 alloys are not authorized in welded applications.
- (2) TP321 alloy is limited in temperature to a minimum of -145°C in welded applications.
- (3) In case of sour service, materials shall be selected according to [GS EP PVV 612](#) or [GS EP PVV 622](#).
- (4) All Carbon Steel materials shall be heat treated (i.e. normalized as a minimum).
Quenched and Tempered carbon steel materials are authorized for pressure vessels according to [ASME BPVC Section VIII Div 2](#) only.
- (5) Duplex materials shall comply with the requirements of the [GS EP PVV 619](#). The maximum design temperature for UNS No. 31803 shall be limited to +325°C for [ASME BPVC Section VIII Div 1](#) and to +225°C for [ASME BPVC Section VIII Div 2](#).
- (6) Superduplex materials shall comply with the requirements of the [GS EP PVV 619](#). Superduplex materials can be used for [ASME BPVC Section VIII Div 1](#) only; the maximum design temperature for UNS No. 32750 & 32760 shall be limited to +325°C.

5.2 Certification

For all pressure parts (plates, heads, nozzles, flanges, etc.) as well as for supports (skirt, saddles, legs) and for attachment to the pressure parts (doubler plate, reinforcement pad), the Manufacturer shall provide material test reports showing the results of the required tests and inspection, including supplementary requirements if any. Material certificates shall conform to [EN 10204](#) 3.1, unless otherwise specified (case of thick plates procurement, see section 5.3.8 below).

Material certificates for non-pressure parts shall conform to [EN 10204](#) 2.2.

5.3 Supplemental requirements

The following requirements shall be applied in addition to the Code requirements

5.3.1 Weldability of C-Mn steels

Carbon-manganese steels shall have a maximum carbon content of 0.23%.

The carbon equivalent of these materials, calculated using the formula (IIW):

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

shall be limited as follow:

- 0.420 maximum (based on ladle analysis), or
- 0.430 maximum (based on product analysis).

For material with thickness greater than 50 mm, higher CE up to maximum 0.45 on product analysis may be proposed for Company approval with following condition:

- The material procurement shall be made directly to a steel mill maker approved by Company
- WPS/PQR shall be qualified with same plate and same heat number.

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 15 of 55

5.3.2 Simulated post-weld heat treatment

In case of vessels subject to PWHT, materials shall be ordered with guaranteed properties on the basis of simulated post weld heat treatment according to the intended heat treatment of the vessel and provisions for repairs.

5.3.3 Toughness requirements

All material shall be impact tested at the Minimum Design Metal Temperature; the impact test exemptions of the Code is not permitted (see the previous section 4.1.3).

5.3.4 Ultrasonic examination of plates

Plates 30 mm and thicker shall be ultrasonically examined in accordance with the requirements of SA 578. The acceptance standard shall be Level B of SA 578 (periphery and grid pattern).

5.3.5 Ultrasonic examination of forgings

All ferrous forgings (including flanges) 25 mm and over in nominal thickness shall undergo ultrasonic examination in accordance with [ASME BPVC Section VIII Div 2](#) paragraph 3.3.4. Inspection sampling ratio shall be submitted to Company for approval. However, all Ring Joint flanges shall undergo this ultrasonic examination. Ultrasonic examination reports shall be endorsed by the forged material Manufacturer.

5.3.6 Sour service

In sour service, the following General Specifications are applicable:

- [GS EP PVV 612](#) for severe sour service environments
- [GS EP PVV 622](#) for mild and intermediate sour service environments.

5.3.7 Thermo-Mechanical Control Process

When TMCP carbon steel plates are allowed by the ASME BPVC Code, the mechanical properties and impact tests shall be verified after both a simulated forming procedure and a simulated PWHT as per section 5.3.2.

The mechanical properties and impact tests shall be verified as a minimum for each heat number and plate thickness.

Material certificates shall conform to [EN 10204 3.2](#).

If 3.1 certificates are only available, counter check by production tests shall be performed on offcuts of the supply

5.3.8 Procurement of heavy thick plates

The procurement of the heavy thick plates - thicker than 75 mm - shall be made directly to a steel mill with a particular material procurement specification. Thick plates from stockiest are not allowed.

Material certificates shall conform to [EN 10204 3.2](#).

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 16 of 55

5.3.9 Other additional testing or examination

Other suitable supplementary testing or examination not required by this Specification or by the Code shall be specified by the User through material specification or data sheet.

5.4 Clad materials

The base material used in the construction of clad vessels shall be either corrosion resistant integral cladding materials or weld overlay cladding. Corrosion resistance linings attached by welding is not allowed.

Unless otherwise specified the thickness of the cladding shall be 3 mm minimum (minimum clad thickness after forming). Roll bonding process is preferred for backing carbon steel up to 60 mm thick, above this thickness weld overlay is recommended.

Clad plates shall conform to [ASME SA-264](#) or [ASME SA-265](#).

Clad plates produced by explosion bonding requires a specific quality management system defining the responsibility of each Supplier involved (backing steel, alloy cladding, clad plate) and the pressure vessel's Manufacturer.

Quality control shall be implemented accordingly with appropriate quality plan identifying all parties and various "Hold" and "Witness" points.

Ultrasonic examination shall be made of the base plate and the bond between the cladding and the base plate in accordance with the requirements of SA 578. The acceptance standard shall be Level C of SA 578. This is also applicable to any part of the vessel subject to clad restoration by weld overlay (in this case, the surface subject to testing shall include a minimum of 50 mm width of clad metal each side in addition to the weld deposit surface).

All supports or attachments to the clad shall be verified to prevent damages or disbonding of the clad: stress calculation verification shall be provided and NDE (UT) inspection shall be performed.

5.5 Supplemental requirements for Bolting

5.5.1 External bolting

The external bolting of vessels for the assembly of the flanges of manholes, handholes, nozzles with blind flanges, etc., shall always consist of threaded studs and nuts. Threading shall be as per [ASME B1.1](#) (diameter in inches):

- UNC for threaded studs up to 1" in diameter
- 8N for diameters over 1".

Protection against corrosion shall follow the project or Owner requirements.

5.5.2 Internal bolting

The internal bolting shall comply with [ASME B1.1](#) threading as defined for external bolting. It may consist either of threaded studs and nuts, or of bolts and nuts. The internals bolting shall be provided with double nuts and equipped with washer

General Specification		GS EP PVV 211
Design and fabrication of pressure vessels according to ASME VIII		
Rev.: 12	Effective date: 11/2016	Page: 17 of 55

5.6 Flange gaskets and gasket contact faces

The gaskets are specified in the particular specifications and shall comply with the following standards:

- [ASME B16.20](#)
- [ASME B16.21](#)

Except otherwise specified, the finishing and hardness of gasket contact faces shall be as defined by [GS EP PVV 145](#).

Whatever the pressure class and service class elastomer O-rings are strictly forbidden as sealing barrier to prevent from leakage to the atmosphere, either as a sealing barrier between pressure vessel and piping or as a sealing barrier between pressure containing parts of a pressure vessel or a heat exchanger.

5.7 Suborders of materials

Suborders for materials or components shall include all applicable requirements from the relevant specifications and requisition of the pressure vessel. Un-priced copies of all suborders including requisitions and any further change orders shall be issued to the Company for information.

6. Design by rule requirements

The design of pressure vessels shall follow the design-by-rules methods defined in the [ASME BPVC Section VIII Div 1](#) or in the [ASME BPVC Section VIII Div 2 Part 4](#).

Design-by-analysis methods are not allowed, except for specific studies such as Quick Opening Closure and fatigue analysis.

6.1 General requirements

6.1.1 Minimum thickness requirements

In addition to the Code, the following requirements apply:

6.1.1.1 Shell and heads

The minimum thickness of shell and heads shall not be less than:

$$t = \frac{D}{800} + 3 + C$$

where:

- t Minimum thickness in mm (rounded up to next higher mm)
- D Outside diameter in mm
- C Corrosion allowance in mm