

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 312

Design and fabrication of metallic vertical storage tanks
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General Specification		GS EP PVV 312
Design and fabrication of metallic vertical storage tanks		
Rev.: 09	Effective date: 10/2015	Page: 2 of 33

Contents

1. Scope	4
2. Reference documents	4
3. General requirements	6
3.1 Storage tank data sheet	6
3.2 Documents required by local authorities	6
3.3 Documentation required prior to start of fabrication	6
4. Materials	7
4.1 General	7
4.2 Bolting	8
4.3 Plates	8
5. Design and fabrication	9
5.1 Overloads	9
5.2 Product Specific Gravity (SG)	9
5.3 Foundation	9
5.4 Corrosion allowance	10
5.5 Shell plates	10
5.6 Tank fastening	10
5.7 Nozzles	10
5.8 Bottom and Annular Plate	12
5.9 Fixed Roof	14
5.10 Floating roof	15
5.11 Accessories	17
5.12 Tank equipment	19
5.13 Corrosion protection	22
5.14 Safety devices	22
6. Site erection	24
6.1 Acceptance of foundations	24
6.2 Wind bracing	25
6.3 Erection attachments	25

General Specification		GS EP PVV 312
Design and fabrication of metallic vertical storage tanks		
Rev.: 09	Effective date: 10/2015	Page: 3 of 33

6.4	Shell tolerances	25
6.5	Erection of fixed roof	26
6.6	Welding.....	27
7.	Testing and inspection	28
7.1	General.....	28
7.2	Shell reinforcement of the compactness inspections.....	28
7.3	Temporary welds	29
7.4	Bottom plates.....	29
7.5	Tank shells.....	29
7.6	Fixed Roof	29
7.7	Floating roof.....	29
7.8	Floating-roof drains	30
7.9	Hydrostatic test procedure	30
8.	Tank Repair.....	31
9.	Quality control, inspection	31
9.1	General.....	31
9.2	Organisation	31
	Bibliography.....	32
Appendix 1	Nameplate and supports for storage tanks	33

Design and fabrication
of metallic vertical storage tanks

Rev.: 09

Effective date: 10/2015

Page: 4 of 33

1. Scope

This specification covers the definition of Carbon Steel vertical cylindrical metallic storage tanks for hydrocarbons, assembled by welding on site. It applies to tanks whose working pressure in the gaseous phase remains close to atmospheric pressure (i.e. ≤ 50 mbar), the pressure limit depending on the codes used. For tanks in other material, a specific requisition will be established subject to Company review.

This document shall be used in conjunction with the applicable code or Standard.

The choice between code and Standard shall be defined in the project particular specification and/or in the equipment data sheet, and shall then become the reference to be applied to the word "code".

API STD 650 is considered as the preferred code. EN 14015 could be use as an alternate to API STD 650 code. Selection of CODRES Div 1 is subject to specific derogation by the managing entity identified on the front page of the present specification.

The present specification does not address any national or local regulation rules.

Unless otherwise specified by the present document, all rules and requirements expressed in the selected code are applicable.

The Manufacturer shall follow the requirements given by the selected code or standard using SI units, and provide engineering documents using SI units.

The specification does not address the civil works and foundation requirements except for section 5.3.

Low pressure storage tanks as per API STD 620 are not covered by this specification. For these tanks a specific Particular Project Specification shall be established for Company review with a focus on the compression ring area and the anchoring system (if any) in junction with the foundation.

2. Reference documents

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

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
API RP 2003	Protection against ignitions arising out of static, lightning and stray currents
API STD 2000	Venting atmospheric and low-pressure storage tanks
API STD 620	Design and Construction of Large, Welded, Low-pressure Storage Tanks
API STD 650 ⁽¹⁾	Welded Tanks for Oil Storage

Design and fabrication
of metallic vertical storage tanks

Rev.: 09

Effective date: 10/2015

Page: 5 of 33

Reference	Title
API STD 653	Tank Inspection, Repair, Alteration, and Reconstruction
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 B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASTM A20/A20M	Standard Specification for General Requirements for Steel Plates for Pressure Vessels
CODRES Div 1	French code for construction of metallic vertical cylindrical tanks
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 14015 (1)	Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above
NFPA 780	Standard for the installation of lightning protection systems
EEMUA Publication No. 159	Above ground flat bottomed storage tanks A guide to inspection, maintenance and repair

(1) API STD 650 shall be used for all points not covered by EN 14015, and vice versa.

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 101	Internal cathodic protection of equipment and storage tanks
GS EP COR 110	External cathodic protection of onshore structures
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 INS 101	Instrumentation Design
GS EP PVV 202	Standard drawings for accessories and equipment of vessels

Design and fabrication
of metallic vertical storage tanks

Rev.: 09

Effective date: 10/2015

Page: 6 of 33

Reference	Title
GS EP PVV 411	Shell and tube heat exchangers
GS EP SAF 341	Location and protection of onshore hydrocarbon storage

National and/or local regulation

If national and/or local regulations exist in which some of the requirements may be more stringent than in this specification, Contractor shall carefully scrutinize which combination of requirements will be acceptable with regard to the safety, environmental, economic and legal aspects.

3. General requirements

3.1 Storage tank data sheet

Each tank is described by a specific storage tank data sheet. The storage tank data sheet will conform to the model developed in the Appendix L of the [API STD 650](#) or in Annex A1 and A2 of [EN 14015](#).

The storage tank data sheet shall also incorporate all necessary requirements coming from national or local regulations.

3.2 Documents required by local authorities

It is the Contractor's responsibility to make all drawings and calculations required by the local authorities.

3.3 Documentation required prior to start of fabrication

Contractor should submit the following documents to Company for review prior to the start of fabrication:

1. Mechanical data sheet and tank requisitions.
2. Static design calculations for shell plate thicknesses.
3. Static design calculations checking for resistance to wind loading (wind girders, stiffening rings).
4. Design details and calculations of roof supporting structure.
 - For fixed roof tanks: frangibility check to be included
 - For floating roof tanks: The design of floating roofs is not covered by this GS since floating roofs are generally Manufacturer's standard designs. However all design details, including required buoyancy and strength calculations, shall be submitted.
5. Static design calculations for preventing overturning by wind loading and for resistance to uplift (tank anchorage).
6. Design details and calculations of seismic provisions (if applicable).
7. Tank venting calculations.

General Specification		GS EP PVV 312
Design and fabrication of metallic vertical storage tanks		
Rev.: 09	Effective date: 10/2015	Page: 7 of 33

8. All design and fabrication drawings. Drawings shall include the following data (where applicable):
 - Material and welding consumable specification
 - Welding details and procedures
 - Location and details of welded seams
 - Parts that require post-weld heat treatment
 - Testing procedure
 - Extent of any NDT and visual inspection.
9. A general arrangement drawing of each tank. This drawing shall be to scale and shall show the position of all mountings and accessories required, with reference to the relevant detail drawings.
10. All static calculations and drawings required by local authorities.
11. A marking diagram.
12. Engineering, procurement and construction documents list (including fabrication and construction drawings).
13. Corrosion allowances to be applied.
14. The soil investigation and foundation design.
15. A specific Inspection and test plan shall be issued for prefabrication and site erection
16. All required procedure shall be issued (non limitative list here after) :
 - Site erection procedure
 - NDT procedure
 - Hydrostatic test procedure.

Fabrication shall not begin until the Company has agreed that there are no outstanding review comments and only after the Contractor has released the required documents as "Issued For Construction".

4. Materials

4.1 General

The materials used shall be selected from those allowed by the code, under the responsibility of the Manufacturer on the basis of the tank operating conditions supplied. However, in certain cases of special service (corrosive environment for instance), supplementary requirements may be added by the Contractor.

The carbon steels shall be produced either in an electric furnace or in a pure oxygen furnace, or, subject to Company approval, by any other method giving technically equivalent steels.

All steels shall be killed. Effervescent steels are not accepted.

General Specification		GS EP PVV 312
Design and fabrication of metallic vertical storage tanks		
Rev.: 09	Effective date: 10/2015	Page: 8 of 33

All the plates and tubular components shall be fully identified and be shipped with a specific inspection certificate (type 3.1 according to standard [EN 10204](#)).

Material certificates shall be available for Company assessment prior to commencement of fabrication.

4.2 Bolting

Carbon steel bolting shall be protected against corrosion as stated in [GS EP COR 356](#).

Heavy series according to [ASME B18.2.2](#) shall be used for all kind of bolting.

4.3 Plates

Steel plates produced by the thermo-mechanical control process (TMCP) are subject to Company approval. Post Weld Heat Treatment is not accepted on TMCP steel.

For the plates for which the guaranteed minimum yield strength is greater than 380 MPa (5500 psi), the minimum impact strength values shall be satisfied in the longitudinal direction and the transversal direction.

4.3.1 Dimensional tolerances

As a minimum, permissible variations from Flatness for Carbon Steel Plates As-Rolled or Normalized shall be ordered with Restrictive Flatness (Supplementary Requirement [ASTM A20/A20M S27](#)).

4.3.2 Chemical composition of the steels

The steels with a specified minimum yield strength ≤ 275 MPa shall have percentages on casting and on products not exceeding 0.25% for carbon, 0.035% for phosphorous and sulphur and 0.5% for silicon.

The steels with a specified minimum yield strength > 275 MPa shall have percentages on casting and on products not exceeding 0.20% for carbon, 0.03% for phosphorous and sulphur and 0.5% for silicon.

The carbon equivalent on casting calculated according to the formula:

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

shall not exceed 0.42% for plates of all thicknesses.

For the other elements, the limit percentages are as follows:

- $Mn \leq 1.5\%$
- $Cr \leq 0.25\%$
- $Ni \leq 0.30\%$
- $Cu \leq 0.35\%$
- $Mo \leq 0.20\%$
- $Nb \leq 0.05\%$

- $V \leq 0.10\%$
- $Nb + V \leq 0.10\%$
- $Al \leq 0.07\%$
- $N \leq 0.01\%$
- $Cr + Ni + Cu + Mo \leq 0.80\%$

4.3.3 Ultrasonic inspections of the plates

In addition to the requirements of the applicable construction reference code or standard, the first shell ring plates and annular plates shall be inspected ultrasonically according to the stipulations of standard [EN 10160](#) classes S2 E3.

5. Design and fabrication

5.1 Overloads

With respect to fixed roofs, the uniform live load value to be applied shall not be less than 12.2 hPa.

5.2 Product Specific Gravity (SG)

When the SG of the stored product is greater than 1, the actual SG of the reference product at the minimum storage temperature shall be adopted.

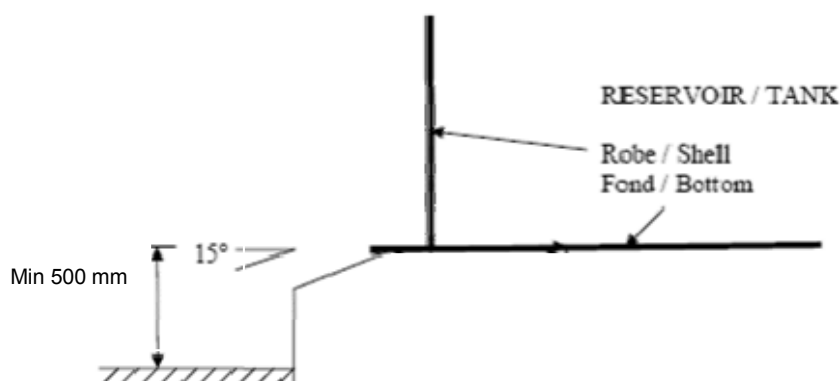
Unless specifically agreed otherwise, the density of the product to be considered for the calculations shall not be less than:

Max [Density of the hydraulic test fluid, Density of the stored product; 1000 kg/m³]

5.3 Foundation

The height between the bottom and the ground level shall be at least 500 mm.

The peripheral slop shall be à least 15°.



General Specification		GS EP PVV 312
Design and fabrication of metallic vertical storage tanks		
Rev.: 09	Effective date: 10/2015	Page: 10 of 33

5.4 Corrosion allowance

The corrosion allowance, where applicable, shall be conform to the equipment Mechanical Data Sheet. Any corrosion allowance must be added to the minimum thickness calculated on all surfaces of non removable internals.

5.5 Shell plates

5.5.1 General

For tanks with diameters greater than 75 m, the thickness of the top shell rings shall not be less than 12 mm.

The vertical joints of shell plates shall not be in alignment between any 3 consecutive courses and the distance between vertical joints in adjacent courses shall be approximately one-third of the plate length. If this is not possible the minimum distance between vertical joints in adjacent courses shall not be less than 0.3 m.

The shell shall be formed of butt-welded plates. In the case of tanks with thin walls, the plates may be arranged vertically. In this case, the mechanical properties of the plates shall be inspected in the transverse direction.

All tanks shall be provided with a top angle bracket either butt welded or double lap-jointed to the shell plates.

The plates shall be arranged so that the vertical joints of the first shell course do not coincide with the joints of the bottom plates (see section 5.8.1).

5.5.2 Allowable stresses

The thicknesses of each of the shell rings shall be calculated according to the requirements of the applicable reference code or standard.

For the dimensioning of the bottom shell ring, the allowable stress as defined by the applicable reference code or standard shall be reduced by 15% at the relevant design temperature.

Note a and note b of tables 5-2 [API STD 650](#) are not applicable.

For large tank diameter, ($D \geq 60$ m) the allowable stress used for the dimensioning of the bottom shell ring is subject to approval by the managing entity, identified on the front page of the present general specification.

5.6 Tank fastening

For fixed-roof tanks subjected to internal pressure, an inspection shall be made to ensure that the specific weights of the shell course and the roof are sufficient to prevent the shell course from being lifted off by the pressure load exerted under the roof (empty tank). If this is not the case, anchor bolts shall be provided around the shell (see [API STD 650](#) Appendix F7). The Manufacturer shall indicate the stress acting on those anchor bolts.

5.7 Nozzles

Calculations of nozzles connecting piping or equipped with heavy devices (instruments, agitators, etc.) shall be performed taking into account the effect of all loads or combinations of