



PROCESS  
INDUSTRY  
PRACTICES

TECHNICAL CORRECTION  
*August 2017*

***Vessel***

**PIP VESTA002**  
**Atmospheric Storage Tank Specification**  
**(Supplement to *API Standard 650*)**

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In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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### **PUBLISHING HISTORY**

<i>June 2000</i>	<i>Issued</i>
<i>June 2009</i>	<i>Complete Revision</i>
<i>October 2012</i>	<i>Technical Revision</i>
<i>November 2016</i>	<i>Technical Revision</i>
<i>August 2017</i>	<i>Technical Correction</i>

Not printed with State funds



# PIP VESTA002 Atmospheric Storage Tank Specification (Supplement to *API Standard 650*)

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## Scope

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This Practice supplements *API 650, Welded Steel Tanks for Oil Storage*. Together, this Practice and *API 650* provide requirements for the construction of atmospheric storage tanks.

This Practice and *API 650* describe minimum construction requirements for the materials, design, fabrication, erection, examination, and testing of aboveground, non-refrigerated storage tanks. This Practice describes additions and modifications made to *API 650*. In addition, this Practice describes decisions made regarding options offered by *API 650*. This Practice supplements, but does not supersede, *API 650* and any applicable jurisdictional requirements.

This Practice covers storage tanks that have design internal pressures of 17.2 kPa (2.5 psig) or less (see *API 650, Annex F*) and design temperatures less than 260°C (500°F) (see *API 650, Annex M*).

This Practice presumes the use of the *API 650* Data Sheet to cover the requirements in *API 650*, and the Data Sheet, as a supplement, to define the additional requirements of this Practice.

## References

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Applicable parts of the following Practices and industry codes and standards shall be considered an integral part of this Practice. The edition and addendum in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

### Process Industry Practices (PIP)

- VEFTA100 - *Tank Miscellaneous Details*
- VEFV1116 - *Vessel Manway Hinges* (included in PIP VEFV1100 and PIP VEFV1100M - *Vessel/S&T Heat Exchanger Standard Details*)
- VEFV1117 - *Vessel Vertical Manway Davits* (included in PIP VEFV1100 and PIP VEFV1100M - *Vessel/S&T Heat Exchanger Standard Details*)

### Industry Codes and Standards

- American Petroleum Institute (API)
  - API Standard 650 - *Welded Steel Tanks for Oil Storage*, 12<sup>th</sup> Edition, including Addendum 2, January 2016
- American Society for Testing and Materials International (ASTM International)
  - ASTM A283/A283M Specification for Low and Intermediate Strength Carbon Steel Plates
- National Fire Protection Association (NFPA)
  - NFPA 11 - *Standard for Low-, Medium, and High-Expansion Foam*

## Definitions

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*Minimum Design Metal Temperature (MDMT)*: A site-specific temperature which is used in Figures 4-1a and 4-1b to select materials for the tank.

See *API 650* for other definitions.

## Requirements

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### General

If neither *API 650* nor this Practice addresses requirements for miscellaneous items and appurtenances, the additional requirements shall be approved by Purchaser and provided within a supplement to the Purchaser's *API 650* Tank Data Sheet.

Purchaser's Data Sheet shall be used to specify the requirements covered in this Practice. The Data Sheet shall not be used to contradict, void, or diminish any requirement covered in *API 650*. References in this Practice to the "*API 650* Tank Data Sheet" shall mean the data sheet included in *API 650*, Annex L.

The numbering of the following headings and paragraphs in the Requirements section corresponds to the numbering of *API 650*, which this Practice supplements. All of the following requirements are in addition to, or modifications of, those in *API 650*. Provisions of *API 650* that are not revised remain in force.

## 4. Materials

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### 4.2 Plates

**4.2.2(c)** *ASTM A283C* shall not be used for shell, shell reinforcement, or tank bottom annular plates for thicknesses greater than 13 mm (1/2 inch).

**4.2.10.1** The design metal temperature is defined in *API 650*, Section 3.6. If the MDMT is specified by the Purchaser on the Data Sheet, the MDMT shall be used for the design metal temperature to determine the materials for the tank. For sites covered by *API 650*, Figure 4-2, the MDMT shall not be higher than the lowest one-day mean temperature plus 8°C (15°F). If the MDMT is not specified, the procedures in *API 650* that are based on *API 650*, Figure 4-2, shall be used to determine the materials for the tank.

## 5. Design

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### 5.1 Joints

#### 5.1.3 Restrictions on Joints

**5.1.3.6.1** Unless otherwise specified, fillet welds or groove welds covered in *API 650*, Section 5.1.3.6.1, and with legs or throat dimensions greater than 4.8 mm (3/16 inch) shall be multi-pass.

**5.1.3.7** Joints for external attachments (e.g., wind girders, wind girder gussets, stairs, platforms, clip angles, etc.) shall be completely seal welded at every juncture.

For austenitic stainless steel tanks, where service temperature may be in the range of chloride stress corrosion cracking (i.e., equal-to or greater-than 140F), intermittent welds shall not be used.

**5.1.3.8** Unless otherwise approved by Purchaser, permanent weld joint backing strips shall not be permitted. See Purchaser's *API 650* Tank Data Sheet.

### 5.1.5 Typical Joints

**5.1.5.1(c)** Shell courses on open top tanks and tanks with external or internal floating roofs shall be flush-stacked on the inside. Shell courses on other tank types may be centerline-stacked or flush-stacked on the inside or outside as specified on *API 650* Tank Data Sheet.

**5.1.5.8** Continuous welds are required, i.e., no exceptions.

**5.1.5.9(e)** Unless otherwise specified, for open top tanks and floating roof tanks, all horizontal elements of the top shell stiffener shall project outward. See Purchaser's *API 650* Tank Data Sheet Line 11.

### 5.3 Special Considerations

The specific gravity of the media (e.g., sea water) used to hydrotest the tank shall be considered in the determination of the design thicknesses of the tank, determination of foundation loadings, and determination of hydrotest fill height.

### 5.6 Shell Design

**5.6.1.1** Shell plate thicknesses shall be in accordance with the design requirements of *API 650*, except that the minimum nominal bottom shell course thickness for carbon steel tanks shall be determined based on the nominal tank diameters shown in the following table:

Nominal Tank Diameter D meters (feet)	Min. Nominal Carbon Steel Shell Thickness mm (inches)
D < 15 (50)	6 (1/4) [4.8 mm (3/16 inch) permitted if Purchaser approves]
D ≥ 15 (50)	In accordance with <i>API 650</i> , Section 5.6.1.1

**5.6.1.6** For tanks with internal pressure, the shell design thickness shall include the effects of the internal pressure.

**5.6.3.2** Unless otherwise specified, the design liquid level for calculating shell thicknesses for non-floating roof tanks shall be to the top of the shell, irrespective of operating liquid levels. See Purchaser's *API 650* Tank Data Sheet Line 7.

### 5.7 Shell Openings

**5.7.2.1** Nozzle reinforcing pads must be at least the same thickness as the shell plate.

**Tables 5.4a & 5.4b, Notes a & b.** Nozzle reinforcing pads must be at least the same thickness as the shell plate.

**5.7.2.2** The reinforcing plate to nozzle neck weld shall consist of a full penetration weld, in addition to the fillet weld as described by Figure 5-7B.

**5.7.4.5** The alternate thermal stress relief of *API 650*, Section 5.7.4.5, shall not be used.

## 5.8 Shell Attachments and Tank Appurtenances

**5.8.3.5** Hinges and davits for shell manholes shall be in accordance with *PIP VEFV1116* and *PIP VEFV1117*. (Note: for API plate flanges >34 kg (>75 lbs.), the hinge and davit details and dimensions for Class 150 flanges shall apply.)

**5.8.5.6** Roof nozzle reinforcing plate to nozzle neck welds shall utilize full groove welds.

**5.8.7** Additional water drawoff sump details are provided in *PIP VEFTA100*.

### 5.8.12 Roof Nozzles

Unless otherwise specified on Purchaser's *API 650* Tank Data Sheet Line 23 or on the tank roof plan view, roof nozzle bolt-hole orientation shall straddle the "Plant North" direction.

## 5.10 Roofs

### 5.10.4 Supported Cone Roofs

**5.10.4.7(e)** Bearing plates shall be circular. The diameter of bearing plates shall be the greatest of the following:

1. 350 mm (14 inches)
2. Twice the diameter of the pipe column
3. Twice the greatest diagonal dimension of the structural shape column
4. Non-circular bearing plates may be used with a minimum 6" radius rounded corners.

**5.10.4.7(f)** Bearing plates shall be attached to tank bottom by continuous full-fillet welds.

## 5.12 Tank Anchorage

**5.12.6** Notwithstanding any other requirements, the anchor attachment design load shall be no less than the minimum specified yield strength multiplied by the nominal root area of the anchor.

## 6. Fabrication

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### 6.1 General

**6.1.1.3** In addition to the substances listed in *API 650*, Section 6.1.1.3, the following substances are not permitted:

1. Tapes (e.g., duct tape)
2. Materials causing carbon pick-up
3. Harmful metal or metal salts (e.g., zinc, lead, mercury, cadmium, or copper)

*Comment:* The listed substances can create a variety of conditions detrimental to the tank's integrity (e.g., hot-shortness, liquid metal embrittlement, heat-affected zone excessive hardness, corrosion, etc.), especially if tank part is heated.

### **6.1.2 Finish of Plate Edges**

Edges as-produced in the mill shall be removed from plates before installation.

## **7. Erection**

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### **7.1 General**

**7.1.7** Purchaser may reject the use of any materials, equipment, or tools that are not in accordance with contract documents, jeopardize the safety of personnel, or impose a hazard at the site.

**7.1.8** Tank bottom shall be protected from standing water during erection using a method approved by Purchaser.

**7.1.9** All coating or lining shall be applied after all weld examinations and hydrotesting has been completed.

### **7.3 Examination, Testing, and Repairs**

#### **7.3.3 Examination and Testing of the Tank Bottom**

**7.3.3(c)** Water shall not be pumped under the tank as a leak detection method.

**7.3.3(d)** If tank bottom welds are to be inspected by any method other than vacuum box testing, the examination procedure and acceptance criteria shall be submitted to the Purchaser for approval.

**7.3.3(e)** Before any coating is applied to the tank bottom, all weld joints shall be vacuum box tested.

#### **7.3.5 Testing of the Shell**

**7.3.5(b)** Tank shells shall be hydrostatically tested in accordance with *API 650*.

#### **7.3.6 Hydrostatic Testing Requirements**

**7.3.6.5** For tanks with diameters greater than 15 m (50 feet), filling may be continued while elevation measurements are being recorded. For tanks with diameters equal to or less than 15 m (50 feet), filling shall be stopped while measurements are being recorded and then evaluated.

**7.3.6.10** If Purchaser exercises the option of keeping a high water level in the tank (see Purchaser's *API 650* Data Sheet Line 14) and if the maximum test height is greater than the maximum product fill height, the draining of the test water may be started after the initial 24 hours at maximum test height if authorized by Purchaser, but the test water height shall not be lowered below the maximum product fill height until Purchaser approves draining the tank.

**7.3.6.11** Floating roof legs shall be adjusted after hydrotest if not in full contact with the landing pads.



## **7.5 Dimensional Tolerances**

### **7.5.6 Nozzles**

**7.5.6(a)** Specified projection from the outside of the tank shell or roof to the extreme face of the flange shall be within plus or minus 5 mm (3/16 inch).

### **7.5.8 Roof Manholes**

**7.5.8.1** Elevation or radial location within plus or minus 13 mm (1/2 inch)

**7.5.8.2** Flange tilt in any plane, measured across the flange diameter within plus or minus 13 mm (1/2 inch)

## **8. Methods of Inspecting Joints**

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### **8.1.2 Number and Location of Radiographs**

Radiography shall be in accordance with *API 650* and the following:

**8.1.2.10** All vertical welds in shells fabricated of quenched and tempered material shall be fully radiographed.

### **8.1.4 Submission of Radiographs**

“Inspector” in this paragraph shall refer to the Purchaser’s inspector:

Before any welds are repaired, the radiographs shall be submitted to the Purchaser’s inspector with any information requested by the inspector regarding the radiographic technique. This shall apply unless the Purchaser provides in writing that the radiographs shall be reviewed by the Manufacturer’s inspector, and then repaired prior to submitting radiographs to the Purchaser’s inspector or other representative.

### **8.1.5 Radiographic Standards**

Tungsten inclusions in gas tungsten arc welds shall be evaluated as individual rounded indications. Clustered or aligned tungsten inclusions shall be removed and repaired.

### **8.1.6 Determination of Limits of Defective Welding**

“Inspector” in this paragraph shall refer to the Purchaser’s inspector:

The minimum weld length of 6 inches for a radiograph per requirement 8.1.2.8 shall not be the limiting factor when evaluating weld defects in radiographs showing more than Code-minimum 6 inches of weld length. The additional spots to be radiographed to determine the limits of defective welding shall be determined from the full length of the radiograph, and shall not be limited to the 6 inches between location markers only. Radiographic film, digital images or developed radiographs shall not be cut or trimmed or cropped from original length to obtain the 6-inch minimum length.

### **8.3 Ultrasonic Examination**

**8.3.2.4** In this paragraph, “direct supervision of the Level-II or Level-III personnel” shall mean that the supervising Level-II or Level-III shall be present at all times, at the location of the work, to directly observe the

work of the Level-I, and shall take full responsibility for the quality and interpretation of the ultrasonic examination.

**8.3.2.5** Acceptance standards shall be agreed upon by the Purchaser and the Manufacturer. The acceptance criteria shall be provided in writing to the UT Level II or Level III who is conducting or responsible for the examination. The acceptance standards used shall be indicated in the written report with all exceptions and/or additions to Annex U acceptance criteria that were previously agreed to by the Purchaser and the Manufacturer.

## **Annexes**

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**B. Recommendations for Design and Construction of Foundations for  
Aboveground Oil Storage Tanks**

**C. External Floating Roofs**

**F. Design of Tanks for Small Internal Pressures**

**H. Internal Floating Roofs**

**S. Austenitic Stainless Steel Storage Tanks**

**W. Document Submittals and Review**

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## **Annex B**

### **Recommendations for Design and Construction of Foundations for Aboveground Oil Storage Tanks**

#### **B.3 Tank Grades**

**B3.1** Notwithstanding any allowance in this Section to design tanks foundations for large settlements, the intended design settlement to the final elevation shall be no more than 75 mm (3 inches). That is, after settlement, the final elevation shall be a minimum of 225 mm (9 inches) above surrounding grade or surface. This will provide adequate drainage, compensate for small settlement that may occur, help keep the bottom dry and extend the life of the tank bottom.

In addition, if an under-tank leak detection system is required, the detection piping shall be above grade after any designed foundation settlement.

## Annex C External Floating Roofs

### C.3 Design

#### C.3.1 General

**C.3.1.3** Penetrations shall extend 150 mm (6 inches) minimum into the liquid.

**C.3.1.6** Shunts shall be spaced as shown in the following table:

Tank Diameter D m (ft)	Maximum Shunt Spacing m (ft)
$D \leq 43$ (140)	3 (10)
$43$ (140) $< D \leq 84$ (275)	2.1 (7)
$84$ (275) $< D$	1.5 (5)

#### C.3.3 Decks

**C.3.3.3** Lap joints that are not adjacent to girders, support legs, or relatively stiff members on the underside of an uncoated roof shall have full-fillet intermittent welds of 50 mm lengths on 400 mm centers (2-inch lengths on 16-inch centers). The underside surface of deck plates exposed to product or vapors shall be seal-welded to each roof leg sleeve for removable legs and to each fixed leg with a 5 mm (3/16-inch) minimum leg fillet weld.

#### C.3.4 Pontoon Design

**C.3.4.1(a)** Calculations confirming the buoyancy requirements of *API 650*, Section C.3.4.1(a), for both single-deck and double-deck roofs shall be provided to Purchaser.

#### C.3.4.2

- a) Rim and bulkhead plates shall have a minimum nominal thickness of 4.8 mm (3/16 inch).
- b) Evidence shall be provided to Purchaser, either by calculation or a proof test outlined in *API 650*, Section C.3.4.2, that single-deck roofs will not be permanently distorted and will not show elastic or inelastic instability when subjected to the requirements of *API 650*, Section C.3.4.2.

#### C.3.7 Ladders

Each external floating roof shall have a rolling ladder with self-leveling treads that have a minimum width of 710 mm (28 inches).

#### C.3.8 Drains

**C.3.8.1(9)** Chains or restraint connections to drains or other internal piping shall not be attached directly to the piping. Pads or collars shall be used to distribute the load.

### C.3.9 Vents

If specified on the Tank Data Sheet, rim space vents for flexible metallic primary seals shall be provided. The vents shall be capable of releasing any excess air or non-condensable vapors that enter the tank through the filling line. The minimum number and sizes of rim vents shall be provided as shown in the following table:

Nominal Tank Diameter D m (ft)	Minimum Number	Size (NPS)
$D \leq 43$ (140)	1	4
$43$ (140) $< D \leq 84$ (275)	2	6
$84$ (275) $< D$	3	6

### C.3.10 Supporting Legs

**C.3.10.1** Floating roofs shall have support legs inserted through either fixed low legs or leg sleeves.

**C.3.10.3(c)** Adjustable legs shall have a maximum setting of 78 inches) at the tank shell.

**C.3.10.3(d)** The top of the fixed legs shall extend 910 mm (36 inches) maximum above the roof deck.

**C.3.10.8** Covers and seals shall be provided at the following locations:

1. Top of the high support legs
2. Annular opening between the high support legs and the low fixed legs or sleeves
3. Other openings (e.g., position-pin holes, if used) that function to set the high, low, or adaptable positions of the legs

### C.3.13 Peripheral Seals

**C.3.13.1** Mechanical shoe seals shall be in accordance with the following:

1. Unless otherwise specified on the Purchaser's *API 650* Tank Data Sheet, Table 5, metal shoes and components employed in the sealing device between the roof and the tank shell shall be stainless steel.
2. Primary seal fabric shall span between the top of outer rim and sheet metal shoe. Fabric shall permit full range of rim space movement for which roof and seal are designed.
3. The primary shoe seal shall be capable of being removed from atop the floating roof.

**C.3.13.3** All seals shall be designed to accommodate the minimum and maximum rim spaces based on the tolerance in *API 650*, Section H.4.4.3, and the dimensions of the shell and roof through the full operating range of the roof.

**C.3.13.5** Primary Seals: Unless otherwise specified on the Purchaser's *API 650* Tank Data Sheet, Line 31, primary rim seals shall be mechanical shoe seals, and shall be approved by Purchaser.

**C.3.13.5** Secondary Seals: Unless otherwise specified, secondary seal shall be provided. Unless otherwise specified on the Purchaser's *API 650* Tank Data Sheet, Line 31, secondary seals (i.e., wiper type) shall be provided and installed by the roof manufacturer. Secondary seals shall be in accordance with the following:

1. The secondary seal shall permit examination of the primary seal without removal.
2. Rainwater, blowing sand, and product scale shall be deflected back onto the roof by design.
3. When the roof is at the maximum operating level, the top of the seal shall remain below the top edge of the shell or wind skirt.

### **C.3.16 Other Roof Accessories**

#### **C.3.16.2 Foam Dams**

Welded foam dams and support angles used for bolted foam dams shall be attached to the top deck plate by a continuous fillet weld on each side and seal-welded at any other edge to prevent crevice corrosion. Foam dams shall be in accordance with NFPA 11. Foam dam bracing shall be designed to withstand the hydrostatic pressure.

The dam shall be 0.6 m (2 feet) from the tank shell, and shall be a minimum of 0.6 m high (2 feet) or 150 mm (6 inches) above the high point of the weather shield, secondary seal, wax scraper or other mechanism. Foam Delivery Systems: In lieu of the fixed foam chamber system described in this section, PIP recommends catenary foam type delivery systems. An example of an acceptable system is shown in NFPA 11, Figure A.5.3.5.2(b).

## Annex F Design of Tanks for Small Internal Pressures

### F.3 Roof Details

The details of the roof-to-shell junction shall be in accordance with Figure F-2 (except as limited below), in which the participating area resisting the compressive force is shaded with diagonal lines.

However, unless specifically requested by the Purchaser, the acceptable roof-to-shell details shall be limited to details *a*, *f*, *h*, *i* and *k*, except that the “alternate” arrangements depicted for details *a* and *k* shall not be used. If the Purchaser specifically requests use of details *b*, *c*, *d*, *e* or *g*, a continuous internal seal weld shall be added, unless this additional requirement is waived by the Purchaser due to non-corrosive, non-chemical, services.

#### Figure F-2—Permissible Details of Compression Rings

Additional Notes:

5. Roof-to-shell attachment welds shall be a minimum of 2-pass, except for internal seal welds.
6. For detail *i*, the roof-to-compression plate joint must be either a full-penetration butt weld, or a double lap weld (that is, a full external fillet weld and a continuous internal seal weld).



## Annex H Internal Floating Roofs

### H.4 Requirements for All Types

#### H.4.1 General

**H.4.1.6** Unless otherwise specified, anti-static cables, if provided, shall be stranded stainless steel, 3 mm (1/8 inch) diameter. The length of the bonding cables shall be a minimum of twice the typical travel of the roof. See Purchaser's *API 650* Tank Data Sheet, Line 32.

#### H.4.2.4 Minimum Thickness

The minimum thickness of inner rims and bulkheads shall be 4.8 mm (3/16 in.) (permissible ordering basis—37.4 kg/m<sup>2</sup>, 7.65 lbf/ft<sup>2</sup> of plate, 0.180-in. plate, or 7-gauge sheet), including corrosion allowance.

#### H.4.3 Joint Design

**H.4.3.1** Joints that shall be liquid-tight include, but are not limited to, the following:

1. Deck panels in contact with the liquid
2. Bottom deck to rim plates
3. Bottom deck to bulkheads
4. Rim plates to bulkheads
5. Intersections between bulkheads
6. All joints of floats

Joints that shall be vapor-tight include, but are not limited to, the following:

1. All deck joints
2. For tubular pontoon supported roof, the deck to periphery rim joint

### H.6 Fabrication, Erection, Welding, Examination, and Testing

**H.6.6** Internal floating roof components that are fabricated or attached by welding (e.g., clips, gusset plates, etc.) shall be completely seal-welded.

**H.6.7** Internal floating roofs shall be installed in accordance with the instructions provided by the internal floating roof manufacturer.

## **Annex S**

### **Austenitic Stainless Steel Storage Tanks**

#### **S.2 Materials**

**S.2.1.3** No zinc (galvanizing) shall be in direct contact with stainless steel pressure boundary components. Also, for stainless steel tanks subject to external impingement fire, the use of galvanizing shall not be permitted.

## Annex W Document Submittals and Review

### W.1 Document Submittals and Review

#### W.1.3 Design Review Document Packages

If specified by the Purchaser, the weld assembly sequences shall be provided in the Design Review Document (see *API 650*).

#### W.1.5 Post-Construction Document Package

- a) The data book shall include a document that provides the required thicknesses (i.e., design thickness plus any specified corrosion allowance) for roof, floor, annular ring, nozzle and manhole necks, custom flanges and covers for all design and pressure test conditions.
- b) W.1.5(7) Manufacturer's certification per Figure 10-2. If requested, a certificate of compliance shall be provided stating that all equipment manufactured is in accordance with the Purchaser's specified requirements and any change orders.

### W.3 Manufacturer's Drawing Contents

**W.3(17)** Tank pressure test outline (e.g., test water level, fill rate, imposed pneumatic pressure, hold times, drain rate, etc.)

**W.3(18)** For stainless steel tanks that can be exposed to any heat source, including welding and impingement fire, that could melt zinc, show the following note: "Zinc-coated (i.e., galvanized or painted) components shall not be in contact with welded, bolted, or loose stainless steel parts of the tank."

**W.3(19)** Show the following note: "Substances that contain chlorine or that can decompose to hydrogen chloride (e.g., coatings to prevent adhesion of weld spatter) shall not be applied to any part of the tank."