



September 2013



Changes to API 650, Twelfth Edition Welded Tanks for Oil Storage

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Three addenda were issued for the Eleventh Edition of API 650 in 2008, 2009, and 2011 since it was first published in June 2007. The Twelfth Edition of API 650 was published in March 2013. The following highlights several of the changes that were made and is not all inclusive. Refer to API 650 for complete information. One general comment is that sections that were previously called "Appendix" are now called "Annex."

Section 2 – Normative References

ASCE Standard 7-10, "Minimum Design Loads for Buildings and Other structures" has been added in addition to ASCE Standard 7-05 of the same title. Both standards are referenced later as alternatives that may be used to determine the appropriate design wind speed to use for tank design.

Section 3 – Terms and Definitions

- A definition for "examiner" has been added and is a person qualified and certified to perform a specific NDE method. This makes a distinction between an examiner and an inspector, who is the person taking responsibility for compliance with API 650 requirements. Word changes from "inspection" to "examination," etc. were made throughout the standard as appropriate, many of which are highlighted below.
- The definition of "inlet diffusers" was modified to better describe their function.

Section 4 – Materials

- Para. 4.7.b. Additional requirements and another option were added for anchor bolting.

Section 5 – Design

- Para. 5.1.3.7. Additional situations were added where attachments to tank exterior surfaces may be attached by intermittent rather than continuous welds.
- Para. 5.2.1b. Clarifies that tanks that meet API 650 requirements may be subject to a partial vacuum of 0.25 kPa (1 in. of water) without needing calculations to support this.

Work Highlights

Materials Engineering

- An assessment of a 20 inch pipeline transporting raw gas was made in accordance with ASME B31.8S and using a risk-based methodology. The objective was to determine if a change in gas composition would have an impact on anticipated internal corrosion or black powder formation. It was concluded that there was no significant difference in risk associated with the change in gas composition. However, various methods to reduce the risk of excessive corrosion or black powder formation were identified (a regular program of chemical treatment on a batch basis) for client consideration.

Process, Operations & Safety

- Providing ongoing process safety site assessment support as part of a multi-party audit team. Work covers multiple clients at various locations. CEI has two assessors on the team focused on continuous process safety improvement, and one is the team leader. Ten additional assessments have been scheduled to follow.
- Conducted dozens of patent reviews covering adsorption as part of research and development efforts.
- Involved in onsite cold eyes reviews for two adjacent refinery expansion projects, including piping and instrumentation drawings and safety.

- Para. 5.2.1k. Both ASCE 7-05 and ASCE 7-10 are now referenced as acceptable alternatives for determining the design wind speed. Explicit reference to a 190 km/hr (120 mph) design wind velocity as a “base case” is not included. However, 190 km/hr (120 mph) is still implied when calculating a design wind pressure in this paragraph and later in wind girder calculation requirements.
- Para. 5.2.2. This is a new paragraph that defines the various load combinations to be considered in the storage tank design (e.g., dead load of tank, weight of stored liquid, wind, internal or external pressure, etc.). These had been in an Appendix R, which has been deleted.
- Para. 5.8.11.2. States that inlet diffusers may be specified by either the purchaser or floating roof manufacturer. It was previously implied that only the purchaser could do this. It also provides some information regarding diffusers.
- Para. 5.10.5.2. Explicitly defines the allowable stress basis to use in the “participating area” equation for self-supporting cone roofs, rather than just referencing another standard.
- Para. 5.10.6.2. Same approach used as in Para. 5.10.5.2, but this time for self-supporting dome and umbrella roofs.
- Para. 5.11.2. Additional uplift criteria are specified that must be satisfied for unanchored tanks.
- Tables 5.21a/b. The allowable anchor bolt stress and shell stress at the anchor attachment have been changed from explicit values to functions of the bolt or bottom shell course yield strengths, respectively.

Section 7 – Erection

- Para. 7.2.4.1. Clarifies shell-to-bottom weld inspection requirements (e.g., whether inside or outside weld to be done first considering inspection method used).
- Para. 7.3. Heading changed to not incorrectly imply that “testing” requirements are included here.
- Para. 7.3.2. Heading changed to “Examination of Welds” from prior “Inspection of Welds.” The same word change was also made in later paragraphs, apparently to make a distinction between an “examiner” and an “inspector” (consistent with addition of definition for “examiner” previously noted in Section 3).

Section 8 – Methods of Examining Joints

Section title changed to above from prior “Methods of Inspecting Joints.” The same word change was made in relevant paragraphs within this section.

Annex AL – Aluminum Storage Tanks

- Paras. AL.5.6.5 and AL.5.6.6. Explicitly define the allowable stress basis to use for the required roof-to-shell junction area of self-supporting cone, dome, and umbrella roofs.
- Para. AL.8. Heading changed from “Inspection of Weld” to “Examination of Welds.”

Annex C – External Floating Roofs

- Para. C.3.1.6. Deleted NFPA 780 as an additional reference standard for current carrying capacity of electrical shunts and maintained reference to API RP 2003.
- Para. C.3.15. New paragraph to supply inlet diffusers, if required, on the tank data sheet. Renumbered previous C.3.15 paragraphs as C.3.16.
- Paras. C.4.1, C.4.2, and C.4.4. Changed “inspection” or “inspected” to “examination” or “examined.”

Annex D – Inquiries and Suggestions for Change

- Title changed to also include suggestions for change. Text rewritten and expanded.
- Specific questions and replies contained in the prior edition were deleted. Links to sections in the API web site are noted.



Annex E – Seismic Design of Storage Tanks

- Para. E.2.2. New definitions are provided for the convective design response spectrum acceleration parameter and vertical earthquake acceleration parameter.
- Para. E.6.1.3. This paragraph covering vertical seismic effects has been revised.
- Para. E.6.1.4.6. Equation for calculating the total stress when vertical acceleration is specified was revised.

Annex F – Design of Tanks for Small Internal Pressures

- Para. F.2. This new paragraph requires that shell, manhole, and flush-type cleanout fitting thicknesses for Annex F tanks account for the internal design pressure. This is done by increasing the value of “H” (design liquid height) in the equations. This adjustment is not required if the design pressure is less than 1 kPa (4 in. of water, 0.14444 psi). A similar requirement had been contained in Para. F.7.1 of the previous standard for anchored tanks. The current Para. F.7.1 is the previous Para. F.7.2.
- Para. F.4.2. Clarification provided that this paragraph and associated equation only applies for anchored tanks.

Annex G – Structurally-Supported Aluminum Dome Roofs

- Para. G.9. Added statement that if screened peripheral venting is provided between the roof and shell, its area may be considered to contribute to the required emergency vent area.
- Para. G.11.3. Changed wording from “... visually inspected by...” to “... visually examined by...” with respect to aluminum structural welds.

Annex J – Shop Assembled Storage Tanks

- Paras. J.5 and J.5.1. Wording changed from “inspection” or “inspecting” to “examination” and “examining,” respectively.

Annex S – Austenitic Stainless Steel Storage Tanks

- Paras. 5.4.14, 5.4.14.1, and 5.4.14.2. Wording changed from “inspection” to “examination.”

Annex SC – Stainless and Carbon Steel Mixed Materials Storage Tanks

- Para. SC.1.2. Maximum design temperature limit increased from 93°C (200°F) to 260°C (500°F).
- Para. SC.3. The criteria for when a structural analysis of the entire tank structure is required have been modified. These are used when austenitic stainless steel is joined to either carbon steel or duplex stainless steel, and consider tank design temperature and diameter.

Annex V – Design of Storage Tanks for External Premiere

- Para. V.3.1. Correction made to SI units used to calculate the first moment of area of stiffener, q_s - cm^3 instead of mm^3 .
- Para. V.8.2.2.2. Equations used to determine the maximum spacing between adjacent intermediate stiffeners have been revised.
- Para. V.8.2.4. The equations used to determine the strength of the stiffener attachment weld have been augmented by adding equations for SI units (previous equations were apparently only valid for USC units). The USC equation was also changed in one case for unit consistency.
- Para. V.10.2. The example problem calculations were revised as needed for consistency with changes to calculation details made elsewhere in the annex.

Annex X – Duplex Stainless Steel Storage Tanks

- Para. X.1, X.2.3.1, Table X.1, and later tables. Material grade 2202 (UNS S32202) has been added.
- Paras. X.4.14 and X.4.14.1. Wording changed from “inspection” to “examination.”

About the Author

Vincent Carucci, President of Carmagen Engineering, Inc., also provides mechanical engineering expertise in the areas of pressure vessels, heat exchangers, piping systems, and storage tanks to the process and power industries, insurance companies, and attorneys. If you would like more information, please contact Vince at vcarucci@carmagen.com.

