Agenda Item 625-1016 (DDOME)

Title: Addition of Double Roof Full Containment Tank (DRFCT) System

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Revision: **2**

Handled By:

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Purpose: To add Double Roof Full Containment Tank System in API 625 as a variation of Full Containment Tank System.

Source: Iizuka email to Rama Challa.

Impact: Clarifies the requirements for double roof tanks to comply with the requirements as full containment tank system.

Rationale:

Demand:
Double roof full containment tanks (DRFCT) have been selected for above ground LNG tanks in Taiwan due to high seismic conditions. This type is similar to the PCLNG tank specified in JGA's Recommended Practice for LNG Aboveground Storage. In June 2019, Taiwan OSHA (under the Ministry of Labor of Taiwan) has legislatively specified API 625 or EN14620 as the applicable standard for the refrigerated liquefied gas storage tanks.
Current API 625 Figures 8 through 11 for full containment tanks are all suspended deck types and figure for DRFCT is not provided. Double roof single containment tank system is shown in Figure 5.
Some of the requirements in current API 625 presumes that the tank is suspended deck type and lacks details for double roof tanks.

Advantages of DRFCT:
Advantages of DRFCT can be summarized to 2 points.
First, there is an advantage in having refrigerated temperature roof for site locations where high seismic is expected and when the calculated sloshing height is high. Since the primary container is fully enclosed, the seismic freeboards are not required to be added to the design liquid level.
Second, the insulation space between the inner and outer tank is purged with inert gas which allows easy detection of inner tank leakage by monitoring the inert gas.

PRV and VRV for insulation space

PRV and VRV for annular and roof insulation space must be provided apart from the PRV/VRV for primary container. PRV must be sized for inner tank leak scenario per section 7.4.2.5.a).

Insulation space monitoring system

Section 7.5.2.3 requires the insulation space monitoring system for membrane tanks. A similar system should be specified for tanks with purge gas container.

Proposed Changes in API 625:

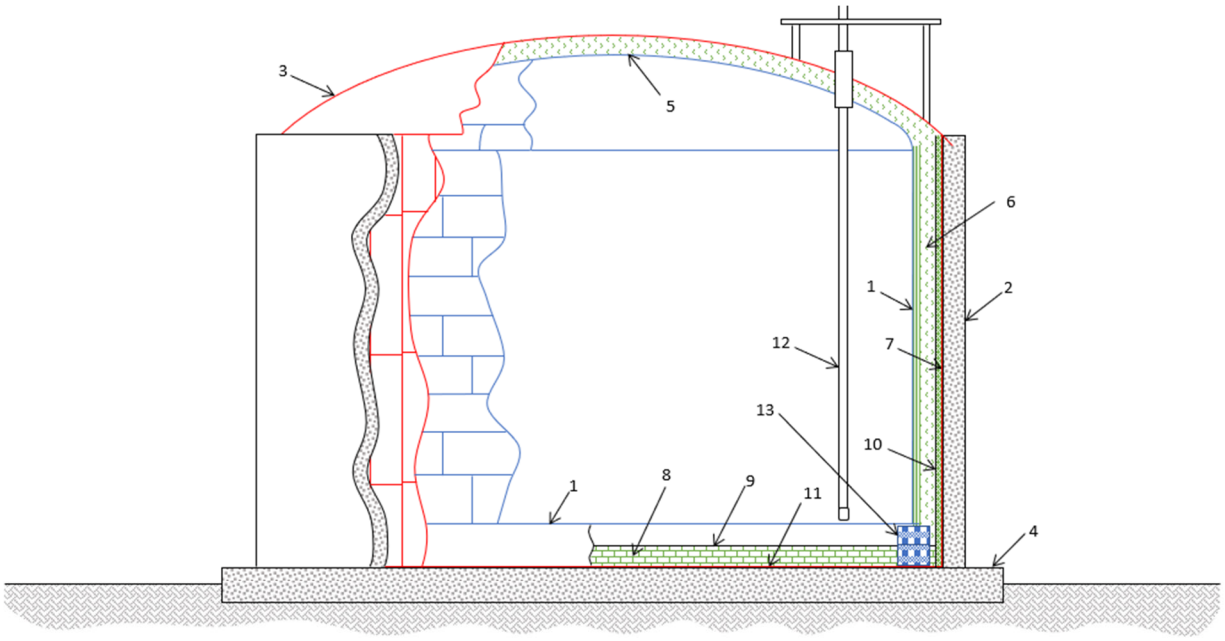
SECTION 5 STORAGE CONCEPTS

5.4 Full Containment Tank System

5.4.6 Some variants of full containment concepts are depicted in Figure 8, Figure 9, Figure 10, Figure 11 and Figure 12~~11~~.

5.4.8 In case of tanks with refrigerated temperature roof, the primary liquid container and refrigerated temperature roof shall be capable of both containing liquid and vapor product during normal service.

Add Figure 12 below.



1. Primary liquid container (low temp steel)
2. Secondary liquid container (concrete)
3. Purge gas container (roof)
4. Concrete foundation
5. Refrigerated temperature roof (low temp steel)
6. Insulation (annular and roof space)
7. Purge gas container (liner)
8. Load-bearing insulation (bottom)
9. Thermal protection system (bottom)
10. Thermal protection system (wall)
11. Purge gas container (bottom)
12. Pump column
13. Ring beam

Figure 12 – Full Containment Tank System

Double Roof with Steel Primary Liquid Container and Concrete Secondary Liquid Container

Renumber figures 12, 13, 14 to 13, 14, 15 respectively.

SECTION 6 DESIGN AND PERFORMANCE CRITERIA

6.3.1 Figures 16a and 16b provides a graphical representation of the relationship of the terms used to define liquid levels and volumes.

Figure 16a – Liquid Levels and Volumes (tanks with suspended deck)

Add Figure 16b.

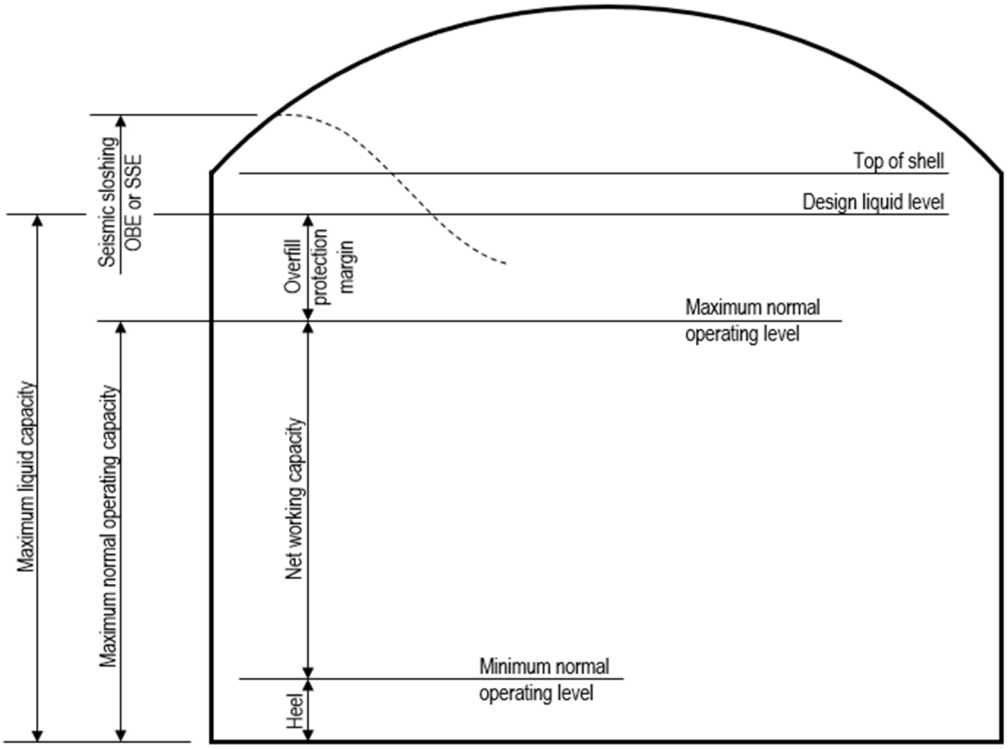


Figure 16b – Liquid Levels and Volumes (tanks with refrigerated temperature roof)

6.3.2 The shell height of the primary liquid container shall be determined by the requirements herein.

6.3.2.1 For tanks with a suspended deck, a ~~A~~ nominal freeboard of 300 mm (12 in.) above the design liquid level shall be included in the height of the tank as a buffer against overtopping and to provide for free vapor flow above the design liquid level. This shall be the lesser of the height of primary liquid container or top of the membrane above the maximum design liquid level and the distance between the maximum design liquid level and the suspended deck. The height of the tank may need to be increased further to satisfy seismic freeboard requirements. Seismic freeboard shall be calculated per 6.6.8.

6.3.2.2 For tanks ~~without a suspended deck~~ with a refrigerated temperature roof, consideration of a percentage of volume for vapor, design for cryogenic conditions if exposed, and dynamic behavior of the fluid under a seismic event shall be considered in the design. The design liquid level shall not be higher than the top of shell. ~~The height of the tank may need to be increased further to satisfy seismic freeboard requirements. Seismic freeboard shall be calculated per 6.6.9.~~

SECTION 7 ACCESSORIES AND APPURTENANCES

7.4.2 Pressure Relief Valves for Primary Vapor Container

7.4.3 Vacuum Relief Valves for Primary Vapor Container

7.4.4 Pressure Relief Valves for Annular and Roof Space of Double Roof Systems

7.4.4.1 Tanks with purge gas container shall be provided with pressure relief valves for the annular and roof space.

7.4.4.2 The number and size of pressure relief valves required shall be calculated based on the total inert purge gas outflow and the applicable set point for the relief valve includes consideration of ~~considering~~ flow losses from the inlet and vent piping of the relief system.

7.4.4.3 In addition, one spare valve shall be installed for maintenance purposes.

7.4.4.4 The required relief capacity shall be based on the largest single relief flow or any reasonable and probable combination of the following relief flows:
a) temperature and pressure changes in the annular and roof space;
b) failures of inert purge gas supply system;
c) barometric pressure change;
d) fire exposure.

7.4.4.5 In addition, for a double roof full containment tank, the required capacity shall be based on 7.4.2.5.a).

7.4.5 Vacuum Relief Valves for Annular and Roof Space of Double Roof Systems

7.4.5.1 Tanks with purge gas container shall be provided with vacuum relief valves for the annular and roof space.

7.4.5.2 The number and size of vacuum relief valves shall be calculated based on the total air inflow and set points specified.

7.4.5.3 In addition, one spare valve shall be installed for maintenance purposes.

7.4.5.4 The vacuum relief valves shall allow air to enter the annular and roof space. Volumetric change due to temperature change of the air shall be taken into consideration.

7.4.5.5 Required capacity shall be based on the following:
a) temperature and pressure changes in the annular and roof space;
b) withdrawal of purge gas;
c) barometric pressure change.

7.5.2 Leak Detection and Management

7.5.2.3 For tanks with purge gas container, the annular and roof space monitoring system shall be required and shall include:
a) purging with inert purge gas to ensure that during normal operation, the product vapor concentration in the insulation space remains less than 30 % of lower flammable limit in air;
b) continuous or periodic monitoring of the inert gas to detect any product vapor and with alarm set according to a purchaser-specified concentration;
c) a pressure control system and/or safety device to limit pressure of the insulation space; (refer to 7.4.4 and 7.4.5)

Renumber 7.5.2.3 to 7.5.2.4

7.5.5.3 For tank systems with insulation space isolated from the primary vapor container, pressure control in insulation space shall be provided as required in 7.5.2.3.

7.5.5.4 For membrane containment tank systems, a method of pressure control can be achieved by use of the insulation space monitoring system defined in 7.5.2.~~3~~4.

SECTION 10 TANK TESTING AND POST CONSTRUCTION ACTIVITIES

Table 3—Recommended Drying and Nitrogen Purging End Points

Section	Dew Point at 1 atm	O_2 Concentration Level
Inner tank and dome space	–5 °C (+23 °F) Max.	8 % Max.
Annular space for single, double, and full containment tank systems with suspended deck	+10 °C (+50 °F) Max.	8 % Max.
Load-bearing insulation space	No measurement necessary	No measurement necessary
Annular and roof space of a double wall double roof tank	No measurement necessary	No measurement necessary

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Renumber figures 16a, 16b, 16c and 17 to 17a, 17b, 17c and 18 respectively.

Table of Contents

Figures