Agenda Item 625-1018

Title: Expansion Bellow Installation Location

Date: 04 May 2026

Revision: 1

Handled By: Eric Gnade
CB&I
14105 S. Route 59
Plainfield, IL 60544-8984
Telephone: 815-439-6476
Email: Eric.Gnade@cbi.com

Purpose: Clarify the acceptable locations and types of expansion bellows to be used within a tank system.

Source: Request by Alex Cooperman (CB&I) after reviewing 625-1016 Double Roof System

Impact: Neutral cost.

Rationale: API 620 7.3.1.4.1 does not allow flanged joints in refrigerated liquid and vapor piping in the inner and outer containers or membrane and membrane tank outer container due to danger of potential cold media leak. Bellows in the space between containers are similar weak links prone to cold media leaks as there are known cases of bellows leaking gas in service.

There are some owners that prefer vapor line in-line bellows through the roof annular space for inert gas (LIN/LAR) tanks. This item clarifies that detail is only acceptable when specified by the purchaser and for single containment LIN/LAR tanks. This is deemed unacceptable risk for systems storing hydrocarbon products, oxygen or ammonia.

The preferred standard practice should be for the convolutions of the pass-through bellows to be installed on the outermost shell or roof surface. This allows for easy visual inspection of the bellows throughout the life of the tank system and may allow bellows repair without taking the tank out service. It's especially important for bellows to be leak tight in double/full containment systems with penetrations in order to properly function in case of a primary container leak.

While not preferable, an alternative detail was used on a few tanks in the past. Pass-through bellows may be attached to the inside surface of the purge gas container of single containment double-wall, double roof tank because a leak in the bellows only releases purge gas to atmosphere and the outer container is not intended to maintain liquid tightness if there's a primary container leak. For similar reasons, a Type M-1 membrane tank may also have inside bellows with purchaser approval. However, the purchaser must be aware of the risks associated with such alternative details.

In order to avoid confusion, definitions have been added to differentiate in-line and pass-through expansion bellows. Reorganized subsections of 7.3.1.4 to have similar format, which allows for easier addition of future items.

The addition of purge gas container to 6.4.7(d) is necessary because it is not only warm product vapor containers that have to consider the local areas that may have a cooling affect due to nozzle penetrations.

The additions in Annex C provides information beneficial for purchaser risk assessment and will be helpful in conjunction with the future API RP 626 since Annex C discusses different events which could lead to event triggered inspections.

Proposed Changes in API 625:

SECTION 3 – TERMS AND DEFINITIONS

3.2.2 Components

…

3.2.2.X

in-line expansion bellows

An expansion bellows connecting two sections of a process line intended to contain the same contents as the process line while providing flexibility between two boundaries

3.2.2.Y

pass-through expansion bellows

An expansion bellows connecting a rigid boundary to a pipe attached to a different boundary with the purpose of accommodating differential movements and rotations between the two boundaries while not needing to contain the same contents as the piping (i.e. when used as part of a thermal distance piece).

(Master Editor to assign values for X and Y)

SECTION 6 – DESIGN AND PERFORMANCE CRITERIA

6.4 Performance Criteria

…

6.4.7 Design Temperature

d) For local areas of the warm product vapor and purge gas container (e.g., process nozzle thermal distance piece connections to the vapor container) that are subjected to temperatures below ambient conditions: determined taking this local cooling effect into consideration.

SECTION 7 – ACCESSORIES AND APPURTENANCES

…

7.3 Process Piping

7.3.1 General Requirements

…

7.3.1.4 Configuration requirements are as follows.

7.3.1.4.1 Flanged joints and in-line expansion bellows in refrigerated liquid and vapor piping systems are not permitted in the space between the inner and outer containers, or between the membrane and membrane tank outer container except where special permissions are given in this standard. Pass-through expansion bellows shall be installed on the outer surface of a purge gas container, warm vapor container, secondary liquid container or membrane tank outer container except where special permissions are given in this standard.

7.3.1.4.2 Specific requirements for single containment tank systems are as follows:

a) Process lines may penetrate the roof, bottom, or shell unless restricted by specification or regulation.

b) In-tank valves shall be considered when bottom or shell process lines are used. The in-tank valves shall be automatically activated due to failure of external piping and shall also be automatically activated during a loss of electrical power and shall be capable of being activated from a remote location. The design and installation of an in-tank valve shall be such that any failure of the penetrating nozzle resulting from external pipe strain is beyond the shutoff seats of the internal valve itself.

c) For double-roof systems storing inert gases, such as argon or nitrogen, in-line expansion bellows in the roof annular space may be used for vapor lines when accounted in the risk assessment and specified by the purchaser. Purge gas container material selection shall consider the potential local cold spots generated due to a bellows leak or rupture as

required by 6.4.7. The purge gas container pressure relief system shall be sized to accommodate possible leak or rupture of the in-line bellows.

d) Pass-through expansion bellows may be installed on the inside surface of a purge gas container shell with purchaser approval. Local design temperature of the container shall be evaluated per 6.4.7. The tank system contractor shall demonstrate that any condensation and ice formation on the container wall and expansion bellows does not impact the functionality, longevity, or performance of the bellows, purge gas container, primary container, and interconnected piping.

NOTE If a pass-through expansion bellows is not accessible for repair, it would be necessary to take the tank system out-of-service to perform bellows repair or replacement.

7.3.1.4.3 For double or full containment tank systems, shell or bottom penetrations that breach the primary or secondary liquid container are not allowed.

7.3.1.4.4 For double and full containment-with-penetrations tank systems, shell or bottom penetrations that breach the primary or secondary liquid container are permitted under the provisions of 5.5.

7.3.1.4.5 For membrane containment tank systems, shell or bottom penetrations that breach the membrane and membrane tank outer container are not allowed.

7.3.1.4.6 Specific requirements f~~F~~or membrane containment-with-penetrations tank systems~~,~~ are as follows:

a) S~~s~~hell or bottom penetrations that breach the membrane or membrane outer container are permitted under the provisions of 5.7.

b) Pass-through expansion bellows may be installed on the inside surface of a Type M-1 membrane tank outer container shell with purchaser approval. Local design temperature of the container shall be evaluated per 6.4.7. The tank system contractor shall demonstrate that any condensation and ice formation on the container wall and expansion bellows does not impact the functionality, longevity, or performance of the bellows, Type M-1 membrane tank outer container, membrane, and interconnected piping.

NOTE If a pass-through expansion bellows is not accessible for repair, it would be necessary to take the tank system out-of-service to perform bellows repair or replacement.

ANNEX C – COMMENTARY ON STORAGE CONCEPTS

…

C.3 Double Containment Tank System

…

C.3.6 Release events for double containment systems are categorized as:

C.3.6.1 Primary Liquid Container Release Events

In the event of damage or degradation to the primary liquid container to the degree that it leaks, the secondary liquid container contains the liquid product. Because the secondary liquid container is open top and is generally uninsulated, significant amounts of uncontrolled product vapor generation are expected. If any pass-through expansion bellows in a double containment-with-penetrations tank system or the secondary liquid container are not properly maintained, then there is a risk of the secondary liquid container releasing liquid product at the time of a primary liquid container leak.

C.4 Full Containment Tank System

…

C.4.6 Release events for full containment tank systems are categorized as:

C.4.6.1 Primary Liquid Container Release Events

In the event of damage or degradation to the primary liquid container to the degree that it leaks, the secondary liquid container contains the liquid product. Because the secondary liquid container is generally uninsulated, increased product vaporization is expected. That increased vapor generation is released from the tank system, but in a controlled manner through relief valves. If any pass-through expansion bellows in a full containment-with-penetrations tank system or the secondary liquid container are not properly maintained, then there is a risk of the secondary liquid container releasing product liquid or vapor to atmosphere at the time of a primary liquid container leak.

C.4.6.2 Secondary Liquid Container Release Events
a) In the event of damage or degradation to the secondary liquid container to the degree that it leaks, either product gas or purge gas is released depending on whether a suspended deck or double-roof system exists.

b) In the event of an external impact that penetrates through the walls of both the secondary liquid container and the primary liquid container below the liquid level present at the time of the event, a liquid release outside the tank system would occur. Such a release would be uncontrolled unless a full volume dike exists.

c) In the event that a pass-through expansion bellows in a full containment-with-penetrations tank system is not properly maintained, either product vapor or purge gas is released depending on whether a suspended deck or double-roof system exists.

C.5 Membrane Containment Tank System

…

C.5.6.1 Membrane Release Events

b) In the event of damage or degradation to the membrane of Type M-CC system to the degree that it leaks, the membrane tank outer container contains the released liquid product. Because the released liquid will be in a space with decreased or no insulation, increased product vaporization is expected. That increased vapor generation is released from the tank system but in a controlled manner through relief valves. If any pass-through expansion bellows in a membrane containment Type M-CC with penetrations tank system or the outer container are not properly maintained, then there is a risk of the outer container releasing product liquid or vapor to atmosphere at the time of a membrane leak.

C.5.6.2 Membrane Tank Outer Container Release Events
a) In the event of damage or degradation to the outer container to the degree that it leaks, purge gas is released.

b) In the event of an external impact that penetrates through the walls of both the membrane tank outer container and the membrane below the liquid level present at the time of the event, a liquid release outside the tank system would occur. Such a release would be uncontrolled unless a full volume dike exists.

c) In the event of structural damage or degradation to the outer container to the degree that it is unable to withstand the internal liquid and vapor load, a liquid release outside the tank system would occur. Such a release would be uncontrolled unless a full volume dike or other means to control the liquid release exists.

d) In the event that a pass-through expansion bellows is not properly maintained, purge gas is released.