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TO: Tank Inspectors
Tank Installers

FROM: Sheldon Schall
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SUBJECT: Flex Connector Installation

Inspectors and one distributor have brought up a series of flex connector installation issues and subsequent access issues for clarification.

The July 2002 edition of Comm 10 included a section on flexible connections in the performance standards for USTs (section Comm 10.51(3)) which carries through to the current day code. My recall of the reason for crafting that section was to incorporate consistency among the various standards' language that addressed flex connectors and apply the application of flex-connectors to all USTs; i.e., heating fuel tanks as well as motor vehicle fueling tanks.

> **SPS 310.500(2)** FLEXIBLE CONNECTIONS. Flexible piping approved under s. SPS 310.130 or listed metallic flex connectors shall be used in all of the following locations:
> (a) At the top of the tank.
> (b) Between the tank and the vent pipe.
> (c) Below the dispenser.
> (d) In fiberglass pipe, where there are sections less than 4 feet long between turns.

Paragraphs (a) and (c) are quite clear. Paragraph (b) is not as prescriptive in nature as the adopted standards. Paragraph (d) brings to question if (d) applies to other points in the system other than (a) through (c) or if it means that in sections of FRP pipe 4 ft. or longer connected to the tank do not require a flex-connector. Paragraph (d) does not have a diameter (i.e., 2" or 4") tolerance. Flexible connections as stated is the subsection sentence is limited to flexible pipe and flex-connectors and therefore (d) is intended to require that either flex-pipe or a flex-connector be used in section where there is less than 4 ft. between turns.

Unfortunately the adopted standards each take a little different approach to language for flexible connections. All flexible pipe with Wisconsin Material Approval installed within the parameters of the material approval is considered equivalent to a flex-connector. SPS 310 recognizes and applies the PEI Recommended Practices (i.e., RP100 & 200) and NFPA 30/30A as an extension of the SPS 310 Administrative Code. However, the term "may" in the PEI RP standards do not become a "shall" or "must."

> PEI 100-10.6 Flexible connectors <u>may</u> be installed at the tank end of product line, vent line and vapor-recovery line and at the base of dispensers. Flexible connectors are not required on flexible pipe. [Less restrictive than NFPA 30A or API 1615]

Also, PEI 100 is written to address underground tanks and the associated underground pipe. If the pipe is not underground, meaning single or double-wall not in contact with soil or backfill, the PEI 100 pipe configurations do not necessarily apply to the pipe if it is all aboveground pipe. In this situation we would defer to PEI 200 for the aboveground pipe configuration requirements. *However, the technical team has taken the interpretation / position that the SPS 310.500(2)(a) flex-connector requirement language is specific to the UST and not to the piping.*

Surprisingly NFPA 30 does not require flexible connections at any specific location in a system. The wording in NFPA 30 doesn't move beyond "flexible connectors shall be permitted." The more specific flexible connection requirements are within NFPA 30A. The scope of NFPA 30A is primarily motor vehicle fueling tanks or tanks at motor vehicle fueling or repair facilities.

NFPA 30A **5.3.2 Flexible Connections.**

5.3.2.1 Flexible piping connections shall be provided at the following points in the piping system:

(1) Where liquid, vapor return, and vent piping connect to underground tanks
(2) At the base of any vent riser
(3) Where required to relieve stress at points where the piping changes direction

5.3.2.2 Acceptable means for providing flexibility in piping systems shall include the following:

(1) Listed -- connectors that are approved for the purpose.
(2) Piping that is inherently flexible and is approved for the purpose. [This would appear to apply to (1) and (2) in 5.3.3 below.]
(3) Other means acceptable to the piping manufacturer.

5.3.3 Fiberglass-Reinforced Plastic Piping. Fiberglass-reinforced plastic (FRP) piping shall not be required to have flexible joints if both of the following conditions exist:

(1) The piping does not exceed 100 mm (4 in.) in diameter.
(2) The piping has a straight run of not less than 1.2 m (4 ft) on one side of the connection when the connection results in a change of direction.

The commentary language in the NFPA 30/30A Handbook clearly exempts FRP piping that does not exceed 4 inches in diameter and is 4 ft. or longer in length from the flexible joint (i.e.,. flex-connectors) requirement in NFPA 30A.

<u>Aboveground pipe:</u>

Occasionally we experience an underground tank with all the piping classified as aboveground pipe. In this situation we would follow the underground tank standards for the tank and the SPS 310.400 and PEI 200 requirements for the pipe. PEI 200 is oriented to aboveground tanks and the associated aboveground or underground piping. Subsequently, there is no PEI 200 requirement for flex-connectors at the aboveground tank connection for either underground or aboveground piping, but a flex is required at the base of the dispenser for underground piping.

UST with aboveground pipe

PEI 200-9.5 addresses flexible type fittings or connections in aboveground piping to facilitate alignment, but does not mandate a fitting.

NFPA 30-18.3.7 states "Listed flexible connectors shall be permitted to be used where vibration exists." The language "shall be permitted" is not a "shall be installed" requirement.

Keeping with the technical interpretation or position that the SPS 310.500(2) flex-connector requirement language is specific to the tank and not to the piping, aboveground

piping connected to an underground tank must have a flex-connector at the tank-pipe connection. The exception would be where the system is designed by a Professional Engineer (PE) who factors tolerances in the design, as the system in the previous photo reflects.

In configurations where underground pipe makes a transition to aboveground the code requires a containment sump and sensor, but does not specifically require a flexible connection. It would be required for FRP pipe that falls outside the 4 inch diameter or inside the 4 ft. length dimension for a flex.

Access:

The requirement for an access to system components is intended to provide a means to service and repair components that have wear cycles or periodically need parts replaced.

(4) SYSTEM ACCESS. (a) Underground storage tank systems shall be designed and constructed to *allow access to all connections between the tank and piping, venting, and appurtenances that require maintenance, inspection or replacement*.

Note: Piping elbows are an example of connections that do not need access because typically they do not need maintenance or inspection. Valves, extractor fittings, flex connectors, corrosion-protection test connections and overfill prevention devices are examples of connections that need this access.

(b) The means of access shall be sufficient in size to allow for installation, maintenance and inspection of all system appurtenances.

(c) The means of access shall allow sufficient clearance for proper drainage from surface water incursion.

What meets the access requirement for flex-connectors on vent lines has been brought into question. The System Access code language in (4) italics above is performance based applying to components that "require maintenance, inspection or replacement." Product line flex connectors certainly are within that oversight; however there is a strong argument that flex connectors in the vent line are not within the typical maintenance, inspection or replacement oversight as in the product line or within the scope of the (4)(a) note. Flex-connectors have a projected service life based upon the stress from the number of surges at a given pressure. UL tests flex-connectors by cycling from 15 psig through rated pressure (typically 300 psig) at 15 cycles per minute for 200,000 cycles. Flex-connectors installed in the vapor line would not experience pressure anywhere near those pressures or the surge cycling and therefore not be considered any different than other components of the vent line.

Conflicting standards:

During the technical team assessment of the flex-connector issues the discussion involved what code or standard language is the trump card. The last page of this document reflects the variation in standard language dealing with flex-connectors. In several areas of the code it would appear that manufacturer's recommendations would prevail, however we also discovered inconsistency with that as well. SPS 310 addresses manufacturer's recommendations as follows:

SPS 310.400(5)(b) All installation shall be in accordance with the manufacturer's instructions, the applicable national standards adopted in s. SPS 310.200, plans and specifications approved under s. SPS 310.100 and this chapter.

SPS 310.500(6)(a) 2. All installation shall be in accordance with the manufacturer's instructions, the applicable national standards adopted in s. SPS 310.200, plans and specifications approved under s. SPS 310.100 and this chapter.

Reviewing manufacturer's recommendations brought us to another curve in the road to a conclusion.
Ameron's recommendations:

> "Use flexible connectors to connect fiberglass pipe to tanks, turbine outlets at tanks and to shear valves at dispensers. A 4-ft. minimum length of fiberglass pipe (dogleg) is allowable per API Specification 1615 in lieu of a flexible connector." Ameron does not reference pipe diameter and API 1615 only recognizes the FRP flexibility up to 2 inch diameter pipe.

Therefore the Ameron installation guidance is not consistent with other standards.

Smith Fiberglass recommendations:

> C. Connecting to Pump/Dispenser
> Several methods are available to connect the product piping lines and vent/vapor recovery lines to the underground storage tank and dispenser: fiberglass fitting, flexible connector, steel fitting or swing joint. Use of flexible connectors at each location facilitates ease of installation.

Smith Fiberglass does not include a length or diameter threshold or refer to another standard and appears to advocate the use of flex-connectors.

Conclusion:
In the assessment of flex-connector application and the access requirement by the technical team we reviewed the code, standards and installation practices to determine what appeared to be a practical conclusion in meeting the spirit of the code language. The conclusion is based upon SPS 310.500(2), supporting NFPA 30/30A, API 1615 and PEI 100/200 standards and manufacturer's recommendations.

Trump card:
We occasionally experience situations that go against the typical configuration where the manufacturer finds the situation to be an acceptable practice in relation to maintaining their warranty or manufacturing and field support. As a general rule we will accept the manufacturer's recommendation. A situation where this would not be accepted is if the manufacturer's recommendation may impact another component of the system. An example would be when the manufacturer has no pipe slope or pitch requirement that in our opinion may impact the functionality of piping leak detection.

Tank top:
A flex-connector must be located at the tank top pipe connection for all UST systems with underground or aboveground product pipe; unless a PE designed system demonstrates otherwise. Rather than deal with a different policy by brand or national standard the requirement for a flex-connector on the product line at the pipe-tank connection will also apply to FRP pipe.

Vent line:
A flex-connector must be located at the tank end of the vent line (including VR) for all tanks and pipe; PLUS at the base of the riser for USTs at NFPA 30A facilities. FRP vent pipe that falls within the 4 in. / 4 ft. dimensions will be acceptable at the riser.

Base of the dispenser:
A flex-connector must be located below the dispenser applies at all UST systems.

In addition to the product and vent line focus of this program letter, PEI 300-7.5 requires flex connectors where FRP vapor recovery line connects to the dispenser:

> **7.6 Flexible Connectors**. When installing rigid non-metallic piping, install flexible connectors in vapor-recovery ping at the base of dispensers.

Access:
Flex-connectors located at the tank and dispenser connections must have adequate access for inspection and servicing. “Sufficient size” does not have any prescriptive measurements.

Access to flex-connectors in vent lines is not a requirement.

During the discussion on access to pipe components, experiences with various penetrations of pipe through the containment sump wall came up. SPS 310.520(1)(a) states:

> Where required. Vent lines, vapor lines and any portion of a single or double-wall tank system, whether new or existing, that routinely contains product and is in contact with the ground or with water shall be protected from corrosion . . . :

Installation such as the vent line penetration in the photo to the right is subject to question if the steel pipe is provided with corrosion protection. However, the fact that a wrap or coating is not visible on the existing pipe, as observed from inside the sump, is not sufficient to order the existing pipe exposed to verify corrosion protection, this is a point that needs to be verified by the installer prior to backfill.

Flex connector w/ CP sleeve. Protection against corrosion must be provided for any buried portion of a metallic component outside of the containment sump.

The table below expresses how the SPS 310 code's primary adopted national standards address the use of flex-connectors differently.

The table is for illustration of previous narrative comments; it is not a regulatory guide.

	SPS 310.500	PEI 100	NFPA 30	NFPA 30A	PEI 200
General		Mfg recommendations 10.1; 10.9			Mfg recommendations 10.8
		10.6 Flexible connectors			10.6.1 Flexible connectors
Product piping	Tank pipe connection	(may) Tank product pipe connection	Mute	Liquid pipe tank connection	Mute-
Vent piping	Between tank and vent pipe	(may)Tank end of vent line	Mute	Vent pipe tank connection PLUS base of vent riser	Mute-
Product / dispenser connection	Below the dispenser	(may) Base of dispenser	Mute	Mute-	Below the dispenser with underground pipe
FRP pipe	Required on FRP pipe < 4 ft. 310.500(2)(d)	FRP – MFG recommendations	Mfg recommendations	Not required if both the following exist: FRP $\leq$ 4" diameter AND FRP pipe $\geq$ 4 ft. 30A-5.3.3	Underground FRP – MFG recommendations
Vapor recovery	Mute	(may)Tank end of VR line	Mute	Vapor return tank connection	Mute-
Miscellaneous			Listed flexible connectors shall be permitted to be used where vibration exists.	Stress points where pipe changes direction	
Flex-pipe	Flex pipe material approval	Not required on flex pipe	Mute	Mfg recommendations	Mfg recommendations 10.9