



OPW-FCS Loop System Operational and Regulatory Questions

The purpose of this document is to discuss the theory, operation, and applications of the OPW-FCS Loop System, and to specifically address questions regulators may have with respect to differences between the Loop System and traditional piping systems. All OPW-FCS products must be installed and maintained in compliance with all appropriate federal, state, provincial, and local laws, codes, and regulations. Loop System must be installed in complete accordance with OPW-FCS's comprehensive Loop System Installation Manual.

Loop System Primary Environmental Advantages:

The entire premise behind the development of the OPW FCS Loop System is to attain the most environmentally safe underground piping system possible. The system was designed to address and eliminate or at least minimize the possibility of many of the known problems associated with installation, maintenance, and performance of some current and previous generations of rigid and flexible piping systems. Every component of the loop system is designed to work together as an integrated system to enhance:

- 1.) The level of environmental protection***
- 2.) Long term system reliability***
- 3.) The ability of contractors to attain a quality installation***
- 4.) The ability of owners to inspect, maintain, monitor, and identify and easily repair any potential problem that may develop BEFORE there is an environmental or safety issue.***

Loop System Components

- 1.) OPW UL 971 Listed Coaxial Pipe with all exposed surfaces of PVDF (Polyvinylidene Fluoride-KYNAR): PVDF liner; PVDF Primary pipe cover; and solid PVDF Coaxial Jacket. PVDF is completely compatible for long term exposure to all motor fuels, alcohol fuels, bio-fuels and additives. All pipe connections and fittings are contained in shallow sumps that are easily inspected, maintained, or repaired.

- 2.) Double-wall pipe couplings with integral, permanent fitting taps into the interstitial space eliminate the need for rubber test boots and the need to trim back the secondary pipe jacket to expose the interstitial space. This provides a reliable means of isolating the coaxial jacket to test, and/or continuously monitor the pipe's interstitial space with vacuum, pressure, or liquid.
- 3.) OPW Crush resistant, dual-wall access pipe provides an added layer of protection against product releases and external pipe damage, and enables the supply pipe and all fittings to be inspected, maintained, repaired, removed or replaced from the surface without excavation or removal of the dispenser. Though not any longer UL listed for containment, OPW's access pipe provides a de-facto tertiary containment vessel for the double wall primary pipe in the unlikely event that there be a simultaneous breach of both the primary and secondary pipe. While officially acting as an access or chase pipe, it can be easily integrity tested if desired. Double entry boots isolate the access pipe interior from the containment sumps preventing fluid collected in the sump from entering the chase pipe.
- 4.) Prefabricated Shallow Dispenser sumps come assembled from the factory complete with OPW's UL listed double entry boots, stabilizer bars, and shear valves eliminating numerous opportunities for field fabrication mistakes. They allow easy visual inspection and repair of all under dispenser components. Riser pipes, flex connectors, and many additional pipe fittings are not required eliminating numerous traditional leak points and the associated field plumbing and fabrication. Shallow dispenser sumps also reduce the potential for problems caused by ground water forces exerted on deep sumps in high water table areas.
- 5.) Double Flexible Entry Boots, pre-installed at the factory, provide double containment protection against releases from the sump into the environment as well as prevent ground water intrusion into the sump. The double entry boot design also totally eliminates communication from the sump into the access pipe interior preventing possible contamination of the access pipe from fluid collected in the sump.
- 6.) OPW 10PLUS emergency valves, pre-installed into Loop Quick Couple Sumps, feature a new shut-off mechanism to provide added protection against leaks from low impact cracks of the shear valve.

Pipe Fall and the Loop System™

From the tank to the first dispenser sump, the piping configuration of Loop and traditional systems are the same. The difference with Loop is that the piping runs between dispenser sumps in a pressure system are "looped" from one to the next. This enables the use of factory assembled shallow sumps

and eliminates the need for the intense field fabrication and plumbing associated with traditional systems. The paradigm shift is that a constant slope back to the tank is not required. Slope has traditionally been recommended for supply lines to promote leak detection in suction systems or to promote drainage of leaked product back to containment sumps where it could be detected. Pressure delivery lines do not require slope for leak detection. Vent and vapor lines require slope to prevent liquid traps from forming and blocking the line. Fill lines obviously require slope as they are gravity fed. In the case of product lines, recommendations to slope supply lines originated before the widespread use of pressure pumping systems when suction pumps were used exclusively in the gasoline delivery application.

Suction Systems: The reason that pipe slope is important in suction system applications is so that the contents of the pipe will drain back to the tank if the suction is released due to a breach in the system. No release detection for suction systems is specifically mandated when the suction lines are sloped because:

- 1.) Suction pump hesitation provides the necessary indication of a non-tight system.
- 2.) Suction systems tend to suck in air or water if a breach in the system occurs, as opposed to permitting a release as would be the case in a pressure system.

For the reasons above, slope back to the tank for each suction line is required as per EPA 40CFR section 280.41 and API 1615 section 8.7.4, but for suction systems applications only.

Pressure Systems: Slope is required as a practical matter only in suction system supply piping systems as mentioned above. Since slope back to the tank will not allow a breach in a pressure system to be identified, requirements for pressure systems differ. Slope is not required, but instead, pressure lines must be equipped with automatic line leak detectors as per EPA 40CFR section 280.41.

Loop System™ pressure lines do not require a continuous fall from the last dispenser to the underground storage tank. Traps in pressure lines should still be avoided, however, to prevent air entrapment. The Loop System design facilitates the easy avoidance of traps.

The absence of constant slope between dispenser Loop runs has no effect on fuel delivery performance nor does it diminish the ability to integrity test, monitor, or detect leaks in the primary or secondary pipe in pressure systems.

Slope and Recommended Practices

General guidelines recommending that product lines, vapor and vent lines, and fill lines be sloped to the tank exist in PEI Recommended Practices RP100 and in API Recommended Practice 1615. By design, these publications contain recommendations outlining general guidelines to follow when installing fueling systems. They clearly state that are not meant, nor could they in practical terms, address or take into consideration every type of equipment, installation, or application. For this reason, they outline best practices, but specifically defer to equipment manufacturer's instructions for formal installation procedures. Quoting from PEI RP100 with regard to this discussion with the understanding and permission of PEI are the following excerpts that pertain to this issue. They specifically define the general nature of the document, state that sloping recommendations are general in nature, and that Manufacturer's instructions are to be followed:

PEI RECOMMENDED PRACTICES FOR INSTALLATION OF UNDERGROUND LIQUID STORAGE SYSTEMS

PEI/RP100-05

From 1.3 Scope – Paragraph 4.

"This document is not meant to provide interpretation of regulatory or legislative requirements related to underground storage systems, nor does it endorse or recommend particular materials, equipment, suppliers, or manufacturers. The inclusion of procedures for the installation of equipment or devices is not meant to imply that such equipment or devices should always be used. Nothing in this document is intended to discourage the development and implementation of new installation methods and procedures."

From 1.4 Sources – Paragraph 3

".....Manufacturers' instructions should be considered as the minimum acceptable standard to protect product warranties."

From 8.3 Double-Walled Piping.

"Install double-walled piping in accordance with manufacturer's installation instructions and good pipefitting practices."

From 9.3.4 Interstitial Monitoring.

"1. Install piping so that any released liquid will flow to a sump, where it can be visually observed or detected by sensors."

From 10.4 Piping Layout and Trenches

*"As a **general** rule, carefully grade and compact bedding for product piping to ensure a minimum slope of 1/8-inch per foot. Piping may slope toward the tank, a dispenser sump, or a collection sump."*

From 10.10 Flexible Piping.

"Install all flexible-piping systems in strict accordance with the manufacturer's installation instructions."

Primary Pipe Monitoring, Testing and Leak Detection

Pressurized Systems: The Loop System™ primary piping can be monitored for releases using both mechanical and electronic automatic pressurized line leak detection systems in accordance with the requirements of EPA 40CFR section 280.41 and API 1615; section 8.7 (No slope requirements are mandated for pressure applications). The Loop piping geometry has no effect on the proper operation of pressurized line leak detectors provided that traps in the pressure lines, as is also necessary in deep sump applications, are avoided. ***The upward slope of each Loop pipe section facilitates a trap free installation and provides additional paths for air to be expelled from the system. Any air introduced into the system is quickly expelled through the nearest dispenser thus eliminating the possibility of compressible air pockets that can affect the accuracy of line leak detectors.***

Integrity Testing: The primary pipe and secondary containment jacket interstitial space in Loop piping runs can be connected and pressure tested in the same manner as any conventional installation in accordance with the requirements of NFPA 30A, Section 5.4, and API 1615, section 10.2. Primary and interstitial space pressure integrity tests are typically performed during installation and start up, and if there is indication that the pipe is leaking. Integrity testing on Loop System installations can be easily performed any time during the operational life of the system or as required by local code.

Testing and Monitoring Loop System™ Primary Pipe and Interstitial Space

Monitoring Information: **Loop System piping runs can be monitored in the same manner as any other piping system.** Installation of Automatic line leak detectors and an annual line tightness test or monthly monitoring program meet the EPA 40CFR section 280.41 and NFPA 30A section 5.4.4 requirements for pressurized piping release detection.

Monitoring of the Interstitial Space and the Loop System: Jumper tubes in Loop System sumps can be disconnected after completion of integrity testing, leaving the interstitial space of each pipe section open to a containment sump. A leak into the interstitial space of the piping run from the tank to the first dispenser will flow to the tank sump as this run is sloped in the same manner as a traditional system. A leak from the primary pipe into the interstitial space in a looped section between dispenser sumps will also quickly migrate to the dispenser sump where it

can be detected by a sump sensor. Slope is ***NOT*** necessary to ensure that the leak migrate to the sump as pressurized fuel will quickly fill the small interstice and flow into the sump. The interstitial volume of the OPW coaxial pipe is .0056 gallons/foot for 1-1/2" pipe and .0065 gallons/foot for 2" pipe. ***A small leak into the interstice of 0.2 gallons per hour in a 35 foot run of 1-1/2" pipe between dispensers will enter the sump in a maximum of 0.98 hours. A 0.2 gallons per hour leak in a 35 foot run of 2" pipe will enter the sump in a maximum of 1.14 hours. The leak will then be detected, and the situation can be addressed. The offending pipe section can be easily removed if necessary to replace the line or flush the interstice.***

Supplemental Continuous Monitoring Options (E-Vac™): The interstitial space of Loop System pipe can also be left closed and easily monitored using commercially available liquid, pressure, and vacuum monitoring systems if desired. Slope is not required for any of these methods. Double wall couplings eliminate the need for less reliable rubber test boots when isolating the interstitial space.

The interstitial space of Loop System™ pipe can also be monitored continuously for the presence of liquid by employing OPW-FCS's simple vacuum interstitial monitoring system, E-Vac™. This continuous monitoring system uses the vacuum generating capability of the STP to impart a constant negative pressure (vacuum) on the pipe interstice. Any liquid that enters the interstice (fuel or water) rapidly migrates to the source of the vacuum, trips the float switch alarm when it reaches the E-Vac™, and is then harmlessly dumped into the UST. The E-Vac™ is equipped with a liquid sensor that continuously monitors for the presence of liquid in the pipe interstice. Switched low voltage signals from E-Vac™ can be wired to an intrinsically safe tank monitor console or a stand alone alarm console. Vacuum gauges that can be connected to the end of each piping run to provide a visual means to check for the presence of a tight vacuum are also available.

Pipe Section Removal

In the event of a problem, each pipe section in a Loop System installation can be easily disconnected and removed without removing the dispenser from the island. By opening the shear valve at the terminating end of the pipeline and releasing the check valve at the submersible pump, the primary line will drain into the tank leaving only a minimal amount of fuel inside each looped pipe section. By capping each end of a pipe section, the section can be easily retracted out of the Access Pipe without removing the dispenser and with no leakage of product. The interior of the access pipe is isolated from the containment sump to ensure that it is not contaminated by fluid collected in the sump. In the unlikely event that fluid enters the access pipe, it can be

easily flushed and evacuated without the need for excavation.

Sump Monitoring Options

To ensure that fuel is not left in containment sumps for extended periods, each containment sump should be visually inspected regularly (at least once a month) and/or the system should have electronic or mechanical leak detection sensors that will effectively indicate that there is fuel collecting in the sump. Both sump inspections and sensors are useful regardless of whether the system interstitial space is closed or open to the sumps. Fuel leaks can develop in equipment other than the piping and connections such as submersible pumps and dispensers. Fuel can also be introduced into the containment sumps during maintenance operations (i.e. line testing, changing dispenser filters, etc.). A sump inspection program augmented by a leak detection device will identify the presence of fuel in the sump, regardless of the source, and indicate that action needs to be taken to investigate and correct the situation.

Pipe Burial Depth

General statements recommending pipe burial depth exist in PEI Recommended Practices RP100 and in API Recommended Practice 1615. Once again, these publications contain general recommendations, but defer to both manufacturer's installation instructions and federal state, and local codes for specific applications. NFPA also discusses burial depth. Below is a summary of the guideline recommendations listed in each publication:

PEI Recommended Practices RP100 Section 9.4: Total of 18" of backfill and pavement in traffic areas

API Recommended Practice 1615 section 9.2.3: Total of 18" burial depth for FRP or Steel Pipe in unpaved areas; 12" for steel and 14" for FRP in paved areas.

- ❖ *NFPA 30, section 27.6.5: 6" of backfill in non-traffic areas; 18" Total of backfill and pavement in traffic areas OR 2" of asphalt and 8" of backfill, OR 4" of concrete and 4" of backfill.*
- *NFPA 30A section 5.3: Installation of Piping Systems. Piping shall be installed in accordance with manufacturers' instructions.*

OPW requires maintaining 4" of packed pea gravel between the OPW access pipe and the pavement or other objects. Pipes exit Loop System sumps at a 45° angle by design which allows pipe to easily be buried beneath sufficient backfill to thoroughly protect the pipe in all installation configurations. Regardless, depths of 18", while not specifically recommended by all publications can easily be attained in the traffic area in application with or without an island form.

Environmental Protection Agency
§280.41 Requirements for Petroleum UST Systems

.....(b) *Piping*. Underground piping that routinely contains regulated substances must be monitored for releases in a manner that meets one of the following requirements:

- (1) *Pressurized piping*. Underground piping that conveys regulated substances under pressure must:
 - i. Be equipped with an automatic line leak detector conducted in accordance with §280.44(a); and
 - ii. Have an annual line tightness test conducted in accordance with §280.44(b) or have monthly monitoring conducted in accordance with §280.44(c).
- (2) *Suction piping*. Underground piping that conveys regulated substances under suction must either have a line tightness test conducted at least every 3 years and in accordance with §280.44(b), or use a monthly monitoring method conduct in accordance with §280.44(c). No release detection is required for suction piping that is designed and constructed to meet the following standards:
 - i. The below-grade piping operates at less than atmospheric pressure;
 - ii. The below-grade piping is sloped so that the contents of the pipe will drain back into the storage tank if the suction is released;
 - iii. Only one check valve is included in each suction line;
 - iv. The check valve is located directly below and as close as practical to the suction pump; and
 - v. A method is provided that allows compliance with paragraphs (b) (2) (ii) – (iv) of this section to be readily determined.

❖ NFPA 30 Flammable and Combustible Liquids Code

27.7 Testing of Piping Systems

27.7.1 Initial Testing. Unless tested in accordance with the applicable sections of ASME B31, *Code for Pressure Piping*, all piping shall be tested before being covered, enclosed, or placed in use.

27.7.1.1 Testing shall be done hydrostatically to 150 percent of the maximum anticipated pressure of the system or pneumatically to 110 percent of the maximum anticipated pressure of the system, and the test pressure shall be maintained while a complete visual inspection of all joints and connections is conducted.

27.7.1.2 In no case shall the test pressure be less than 5 psig (gauge pressure of 35 kPa) measured at the highest point of the system, and in no case shall the test pressure be maintained for less than 10 minutes.

27.7.2 Initial Testing of Secondary Containment Piping. The interstitial (annular) space of secondary containment-type piping shall be tested hydrostatically or with air pressure at 5 psig (gauge pressure of 35 kPa) or *shall be tested in accordance with its listing or with the manufacturer's instructions*.

27.7.2.1 The pressure source shall be disconnected from the interstitial space to ensure that the test is being conducted on a closed system.

27.7.2.2 The pressure shall be maintained for a minimum of 1 hour.

27.7.3 Testing During Maintenance. Existing piping shall be tested in accordance with this subsection if there is indication that the piping is leaking.

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➤ NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages

5.3 Installation of Piping Systems. Piping shall be installed in accordance with the manufacturers' instructions.

5.4 Testing.

5.4.1 **General.** All piping and secondary containment piping shall be tested before being covered, enclosed, or placed in service in accordance with the requirements of Section 27.7 of NFPA 30, *Flammable and Combustible Liquids Code*.

5.4.2* **Secondary Containment Piping.** In addition to the test required in 5.4.1, secondary containment-type piping shall have the interstitial space (annulus) tested hydrostatically or with air pressure at minimum gauge pressure of 34.5 kPa (5 psi) or shall be tested in accordance with the listing or the manufacturers' instructions. The pressure source shall be closed from the system being tested to ensure that the test is being conducted on a closed system.

5.4.3 **Maintenance Testing.** Existing piping shall be tested in accordance with 5.4.1 when the authority having jurisdiction has reasonable cause to believe that a leak exists. Piping that could contain flammable or combustible liquids shall not be tested pneumatically. Such tests shall be at the expense of the owner or operator.

5.4.4 **Leak Detection.** On remote pressure pumping systems, each pump shall have installed, on the discharge side, a listed leak detection device that will provide an audible or visible indication if the piping and dispensing devices are not liquid tight.

5.5 **Detector Maintenance.** Each leak-detecting device shall be checked and tested at least annually according to the manufacturers' specifications to ensure proper installation and operation.

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P.O. Box 2380
Tulsa, Oklahoma 74101-2380

(918) 494-9696
Fax (918) 491-9895
www.pei.org
E-mail rrenkes@pei.org

May 19, 2008

To: Whom It May Concern

From: Robert N. Renkes, PEI Executive Vice President and General Counsel

RNR

RE: Slope of Piping and RP100

The slope of product piping is mentioned three times in PEI RP100-05 and says this: “As a general rule, carefully grade and compact bedding for product piping to ensure a minimum slope of 1/8-inch per foot. Piping may slope toward the tank, a dispenser sump, or a collection sump.” (10.4) “Slope trenches 1/8-inch per foot so that leaked product will drain into sumps. Depending on the distance between dispenser sumps and tank sumps, an intermediate sump may be needed to maintain a 1/8-inch slope per foot between connecting sumps.” (10.11)

Users of the document should note qualifiers to the general rule (above) that appear elsewhere in the document which may obviate the statements in 10.4 and 10.11. These include:

- “Follow local codes, designer’s plans and specifications, and piping and component installation instructions provided by the manufacturer.” (10.1)
- “Install double-walled piping in accordance with manufacturer’s installation instructions and good pipefitting practices.” (8.3)
- “Strict adherence to the manufacturer’s installation instructions is generally required to preserve product warranties.” (10.1)
- “Install all flexible-piping systems in strict accordance with the manufacturer’s installation instructions. (10.10)

In addition to the above, RP100 contains these general admonitions:

- “Nothing in this document is intended to discourage the development and implementation of new installation methods and procedures.” (1.3)
- “Manufacturers’ instructions should be considered as the minimum acceptable standard to protect product warranties.” (1.4)
- “Install piping so that any released liquid will flow into a sump, where it can be visually observed or detected by sensors.” (9.3.4)

Ken Wilcox Associates, Inc.

1125 Valley Ridge Drive
Grain Valley, Missouri 64029
Voice (816) 443-2494, Fax (816) 443-2495
E-mail: kwilcox@kwaleak.com
Web: <http://www.kwaleak.com>

March 17, 2008

To Whom it May Concern:

I have been asked to comment on the compatibility of Electronic Pressure Line Leak Detection Systems and pipeline systems such as that provided by the OPW-FCS Loop System. Although the question was directed specifically to the OPW-FCS system, most of the comments here are generic and can be applied to properly configured and installed flexline systems.

Pipeline leak detection systems relying on monitoring pressure can generally be applied to any type of piping as long as all (or nearly all) of the air can be removed from the primary pipe. The less air in the line, the better the testing conditions. Air Entrapment in the fueling system can inhibit the system from accurately monitoring system pressure. Properly purging the system at start-up is a "must" to prevent air entrapment. It is also recommended during the piping installation to avoid creating "traps" or high spots in the lines so any air introduced into the system can escape the system through the dispensers. Accurately sloping the lines within a traditional installation allows air to migrate to and escape from the last dispenser in a piping run. These requirements are the same no matter whose piping system is used. The inclusion of double wall piping will have no particular effect on the pressurized line leak detection system as long as the configuration of the piping does not inhibit the removal of air from the primary system.

The following comments directly address the specific issue of compatibility of pressurized leak detection systems with the OPW-FCS Loop System. In my opinion there is no reason that pressurized line leak detection systems should not be used with the OPW-FCS Loop System. Any air introduced into the Loop System migrates to and escapes from the nearest dispenser since the high point in all Loop System piping runs terminate at a dispenser inlet. The Loop System provides an easy sloping path for air to be eliminated from system piping runs. Because there are no fittings between dispensers, the installation of Loop piping runs inherently facilitates the prevention of traps in the lines.

Very Sincerely,
KEN WILCOX ASSOCIATES, INC.
H. Kendall Wilcox, President

**Protected under US Patent Numbers 7,073,976; 7,104,727; 5,263,794; 5,271,518; 5,297,896; 5,366,318;
5,346,625; 5,398,976; 5,713,607; 5,553,971; 5,345,813; 5,553,471; 5,567,083; 5,590,981; 5,819,975;
5,950,860; 5,813,717; 5,098,221; 6,039,201; 6,116,817; and 5,690,368**

Other US and Worldwide Patents granted and pending.

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OPW Fueling Containment Systems**

IMPORTANT: OPW Fueling Containment System products and FlexWorks by OPW Fueling Containment System products must be used in compliance with applicable federal, state, provincial, and local laws and regulations. Product selection should be based on physical specifications and limitations and compatibility with the environment and material to be handled. OPW/FLEXWORKS BY OPW FUELING CONTAINMENT SYSTEMS MAKES NO WARRANTY OF FITNESS FOR A PARTICULAR USE. All illustrations and specifications in this literature are based on the latest production information available at the time of publication. Prices, materials, and specifications are subject to change at any time, and models may be discontinued at any time in either case, without notice or obligation. For complete OPW Fueling Containment System warranty information, visit our web site at www.opwfcs.com.



3250 US Highway 70 Business West * Smithfield, NC 27577
Customer Service: (800) 422-2525
Customer Service Fax: (800) 421-3297
Technical Questions and Service: (919) 934-2786
Literature Requests: (919) 934-2786 x204
www.opwfcs.com

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