Secondary Containment and Interstitial Monitoring

Standardized Inspection Manual

Technical Chapter 3.4

Tennessee Department of Environment & Conservation | Division of Underground Storage Tanks | October 2015

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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS

TECHNICAL CHAPTER 3.4
SECONDARY CONTAINMENT AND INTERSTITIAL MONITORING

EFFECTIVE DATE - October 1, 2015

PURPOSE

The purpose of this technical chapter is to assist Division of Underground Storage Tanks (Division) staff in understanding the regulatory requirements for the installation, operation, release detection, and recordkeeping requirements for underground storage tank (UST) systems that are secondarily contained and are monitored using interstitial monitoring.

This technical chapter contains the current policy of the Division based on the statute and regulations governing the Tennessee Petroleum Underground Storage Tank program. This document supersedes all previously published versions. The most current version of this technical chapter will be posted and always available on the Division's website.

AUTHORITY

All rules referred to in this technical chapter are contained in Chapter 0400-18-01 and are available on the Division of Underground Storage Tanks website at http://www.state.tn.us/sos/rules/0400/0400-18/0400-18-01.20130121.pdf

APPLICABILITY

This document provides technical and specific industry knowledge regarding the installation, inspection and operation of interstitial monitoring (IM) devices for UST systems. The document also provides specific information related to monthly monitoring requirements for secondarily contained UST systems. Continuous interstitial monitoring is required on all secondarily contained UST systems installed on or after July 24, 2007 as required by rule .02(1)(c), .02(2)(a)2., .02(2)(b)2. and .04(3)(g)1. If IM is chosen as the primary release detection method, for use on secondarily contained UST systems installed prior to July 24, 2007, the requirements in the release detection portion of this document must be implemented for those systems also. **Manual (visual) monitoring is no longer allowed for interstitial monitoring. See rule .04(3)(g)1.(ii). The Division requires sensors in every sump unless vacuum or hydrostatic IM is used.**

INTRODUCTION

The use of IM as a release detection method for petroleum underground storage tank systems (tanks and piping) involves two elements. First, secondary containment is installed outside the portion of the tank and/or piping routinely containing petroleum. An example of secondary containment for piping is a 3 inch pipe constructed around the outside of a 2 inch pipe. The 2 inch pipe delivers fuel from the tank to the dispenser and is considered the primary (inner) pipe. The 3 inch pipe is the secondary (outer) pipe and is the barrier which allows liquids to flow to a location where a sensor is located. The area between the primary and secondary walls of the tank/piping is referred to as the interstice, annular area or interstitial space.

The purpose of the secondary containment system is to prevent the release from entering the surrounding environment and allow it to be detected by the monitoring system. The outer wall must also divert any liquids which accumulate in the interstice to the lowest point in the secondary containment system. For product piping, the lowest point is typically a tank top sump or dispenser sump. For tanks, this location is typically the bottom of the tank in the interstitial space.

In addition, a monitoring system is used to detect product in the interstice between the inner and outer walls of the secondary containment system. A monitoring device such as an electronic sensor must be installed in all secondary containment sumps where product or water can accumulate to comply with rule .04(3)(g)1.(i). The monitoring system must be a method that is 3rd party approved and on the National Work Group on Leak Detection Evaluations (NWGLDE) web site at www.nwglde.org

Interstitial monitoring, if designed and performed properly, will usually detect releases before they can contaminate the environment. Some interstitial monitoring devices use sensors that indicate the presence of liquid. Other monitoring devices check for a change in condition that indicates a hole may be in the inner or outer wall of the secondary containment system. These conditions may include a loss of pressure or a change in the level of fluid between the walls of a secondarily contained system.

Some double-walled tanks have fluid, a vacuum or electronic sensors within the interstitial space. A change in fluid level or vacuum or an electronic sensor alarm may indicate a breach of the inner or outer wall of the tank and is considered an unusual operating condition that must be reported as a suspected release.

DEFINITIONS

<u>Compartmentalized tank</u>- a single UST that consists of two or more tank compartments, which are separated from each other by a wall or bulkhead.

<u>Containment Sump</u>- a liquid-tight compartment that provides containment of any product releases. Containment sumps are typically used underneath product dispensers and/or for enclosing the submersible turbine pump (STP) head and piping connections at the top of a pressurized piping UST system.

<u>Discriminating sensor</u>- a sensor with the ability to distinguish between petroleum hydrocarbons and water.

Dispenser- a device designed to transfer petroleum products from USTs into tanks in motorized vehicles, equipment tanks, or other containers, while simultaneously measuring the amount of product dispensed.

Interstitial sensor- an electronic device installed within the secondary containment system (tank interstice, tank top sump, transition sump, or dispenser sump) which is connected to a monitoring console or another device that will signal an alarm. The sensor alerts the operator when the presence of petroleum, liquid, or loss of vacuum is detected.

Non-discriminating sensor- a sensor that activates in the presence of any liquid.

Penetration fitting- a gasket or sealing device installed on secondary containment sumps to allow piping and electrical connections to enter the sump. These fittings allow the piping to enter the containment sump and the sump to remain liquid tight.

Release- any spilling, overfilling, leaking, emitting, discharging, escaping, leaching or disposing of a petroleum substance from an UST including its associated piping, into groundwater, surface water, or subsurface soils.

Release Detection- a method used to determine whether or not a release of petroleum has occurred from the UST system into the environment or into the interstitial space between the UST system and its secondary barrier immediately around or beneath it.

Repair- in the context of UST system operation, to restore the tank or UST system component that has caused the release of petroleum from the UST system. In the context of replacement of piping on or after July 24, 2007, restoration of a portion of piping in lieu of replacement of an entire piping run authorized by the Division in writing.

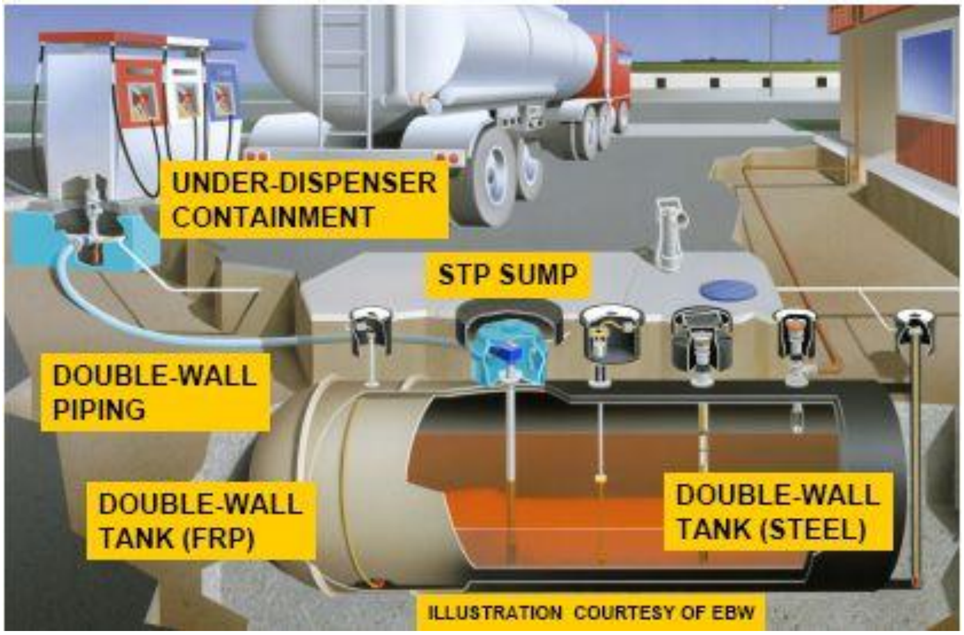
Routinely contains petroleum- those parts of the UST system designed to store, transport, or dispense petroleum.

Secondary containment- a system designed and installed so that any material that is released from the primary containment is prevented from reaching the environment. Components of a secondary containment system include, but are not limited to, double-walled tanks, double-walled piping, tank sumps, transition sumps, dispenser sumps and all of their associated components.

Test Boot- A boot found on secondarily-contained piping and is a flexible sleeve usually made of rubber with a valve located on the piping in the sump. It is used to test the space between the inner and outer piping walls for tightness.

REQUIREMENTS

Secondary Containment



This illustration demonstrates multiple ways secondary containment may be used.

INSTALLATION & REPAIR REQUIREMENTS FOR SECONDARY CONTAINMENT SYSTEMS

UST system installations must be certified, as required by rule .03(1)(d)1. and .03(2)(a)1., when the UST system is registered by one of the following methods:

a. Manufacturer Certified Installer
b. Installation Certification by a registered professional engineer
c. Installation inspected/approved by Division personnel
d. Manufacturer's installation checklists are completed

The certification method must be indicated within 15 days of completion of installation using the Division's Notification Form (CN-1260) as required by rule .03(1)(a)2. for the newly installed system and within 30 days of completion for any subsequent change in status as required by rule .03(1)(g). Although the Division currently does not conduct UST installation certification inspections, as allowed under rule .03(1)(d)1.(iii), installers are encouraged to contact the local Division field office and notify them of construction activities before beginning work. The Pre-installation Notification Form (CN-1288) must be submitted fifteen (15) days prior to installation as required by rules .03(1)(a)1. and .02(1)(a). Division personnel may choose to observe and document the installation process to verify equipment installed, piping type, configuration, etc.

Please be advised, manufacturers may also require specific training before the UST system is installed. It is recommended that installers maintain current certifications and receive specific training for any products they install if the product manufacturer requires such training.

The following Division requirements apply to installation of double-walled tanks, double-walled piping, and secondary containment systems for new tank systems:

1) **Air Pressure or Vacuum Test**

Rule .02(1)(d)3. requires tank and piping components be tested for integrity prior to placing them into operation. For UST systems with a dry interstice, the most common practice is to place the primary tank compartment under not less than 3 but not more than 5 pounds per square inch (psi) of air pressure for a minimum of one hour prior to placing tanks into the tankhold area. The interstitial area between the inner and outer tank walls is pressurized to five (5) psi for one hour. Test results are documented by the installer on checklists provided by the tank/piping manufacturer. NFPA 30 installation practices specify that "secondary containment tanks shall have the primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than 3 psig (gauge pressure of 20.6 kPa) and not more than 5 psig (gauge pressure of 34.5 kPa). The interstitial space (annulus) of such tanks shall be tested either hydrostatically or with air pressure at 3 to 5 psig (gauge pressure of 20.6 to 34.5 kPa), by vacuum at 5.3 in. Hg (17.9 kPa), or in accordance with the tank's listing or manufacturer's instructions. The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. Care shall be taken to ensure that the interstitial space is not over pressured or subjected to excessive vacuum". Rule .02(1)(d)3. requires testing results at installation to be maintained for the operational life of the UST system.

For hydrostatic (liquid-filled) monitoring systems, the level of liquid in the monitoring reservoir is measured at the highest point and checked again after a period of time established by the tank/ piping manufacturer. If no amount of liquid loss is measured, the secondary containment system is considered to be tight. However, installers must follow the tank and/or piping manufacturer's instructions for the system to be in compliance, especially if longer testing times are required. The results of the test are recorded on the manufacturer's installation checklist or warranty forms and must be maintained for the operational life of the UST system as required by rule .02(1)(d)3. A permanent record of these tests must be maintained by the tank owner for the operational life of the UST system. Upon transfer of ownership, including, but not limited to, sale of the UST systems, originals and/or copies of all documents required to satisfy the reporting and recordkeeping requirements shall be transferred to the new owner of the USTs at the time of ownership transfer. See rule .03(2)(d).

Installers are advised to consult Petroleum Equipment Institute Recommended Practices PEI-RP100 and the manufacturer's installation instructions for further guidance on air and vacuum testing of UST system components performed during installation. Startup tank and line tightness tests are also required upon completion of installation by rule .02(1)(d)6. and must be maintained for the operational life of the UST system as required by rule .02(1)(d)3. Air pressure testing of the secondary containment cannot be done in lieu of tank and line tightness testing at installation.

2) Integrity Testing of Sumps

All secondary containment sumps must be verified as "liquid-tight" upon completion of installation in order for the UST system to be in compliance with the secondary containment requirements of rule .02(2)(c)1. Consequently, sumps must be hydrostatically or vacuum tested after all joints have been assembled, sealing materials have cured, and all penetration fittings have been installed and prior to backfilling of piping trenches in accordance with the manufacturer's instructions. If no installation instructions are available, consult the procedure set forth in Appendix 1 to confirm all sumps are liquid tight. If a sump is not liquid tight at any time, it must be immediately repaired or replaced, and retested for integrity.

When existing sumps are used for replacement piping and are now subject to secondary containment and interstitial monitoring in accordance with rule .02(2)(b)4., integrity of the existing sumps must be verified.

If the sump is double-walled, then the interstitial space must be tested in accordance with the manufacturers' specifications in lieu of a hydrostatic or vacuum test of the primary sump wall.

Testing of secondarily contained components of UST systems may also be done using the testing procedures specified in Petroleum Equipment Institute- Recommended Practices PEI-RP1200, 2012 edition or later. Proper documentation of such testing must be maintained in accordance with recordkeeping requirements in rule .02 and .03.

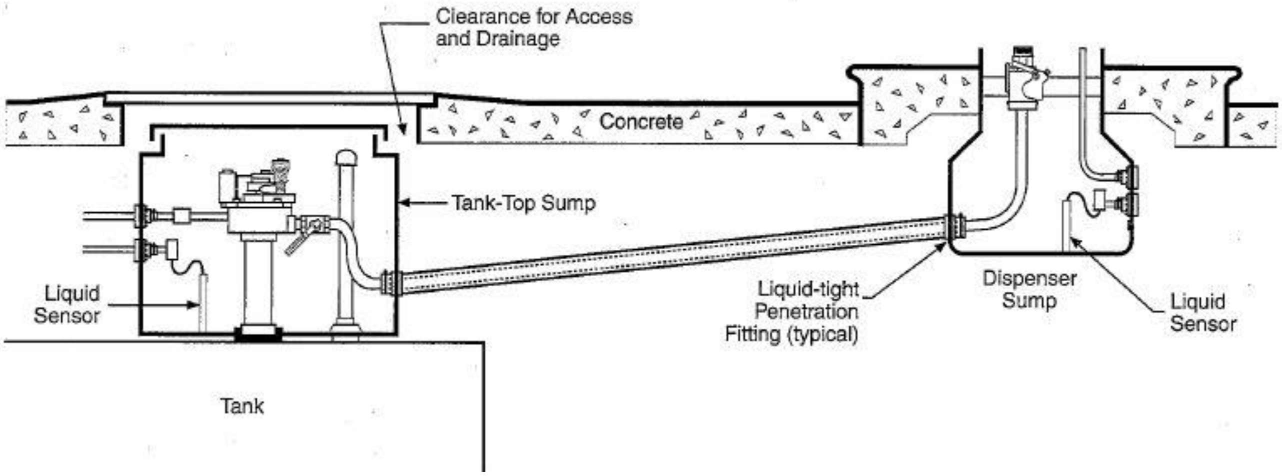
3) Tank & Piping Installation Checklists

The Division does not currently have a UST installation inspection program. However, certain documents are required to be completed by the installer and retained for the life of the UST system. Tank and piping manufacturers require installers to complete work checklists in order to validate the product warranties. The owner/operator may choose to have a registered professional engineer (RPE) certify the installation under rule .03(1)(d)1.(ii), but documentation provided by the RPE is required to certify the installation.

Industry standards require that piping trenches must be sloped back to the tank to drain liquid for systems that use a single sump sensor at the tank sump. However, the Division requires sensors in every sump unless vacuum or hydrostatic IM is used.

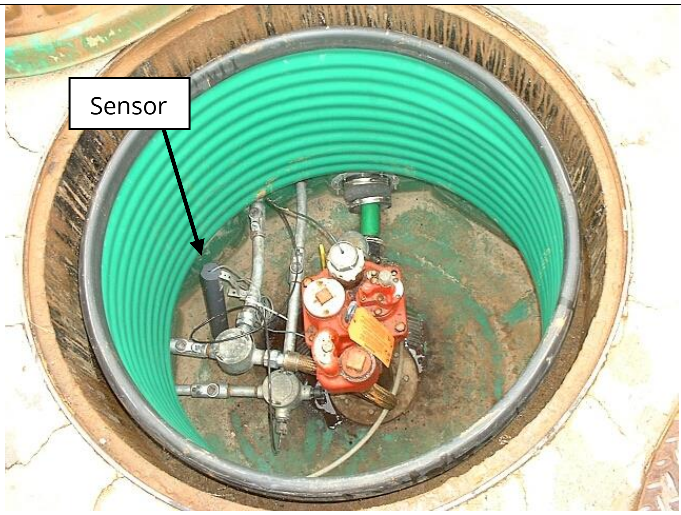
COMPONENTS OF SECONDARY CONTAINMENT SYSTEMS

Secondary containment systems provide an additional layer of protection against the accidental release of petroleum in to the environment. They should be designed to contain any release from tanks, piping, or associated equipment, allow the detection of any release and provide access for recovery of released product. See rule .02(1)(c) and .02(2). Secondary containment systems typically consist of:

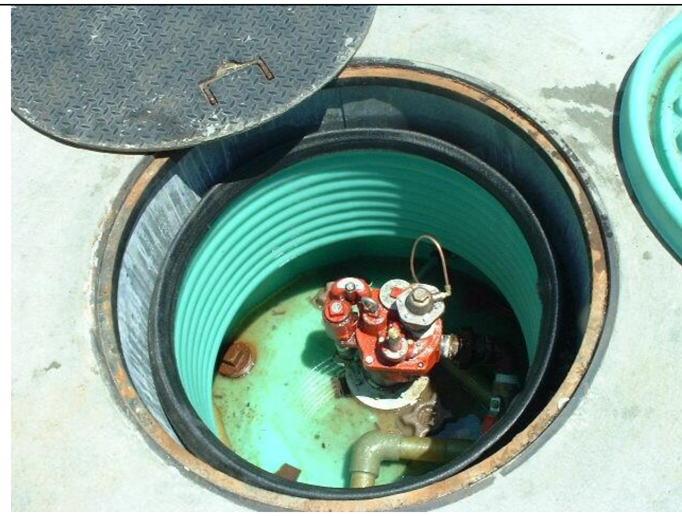


1) **Tank Interstitial Space-**space between the primary (inner) and secondary (outer) wall of a tank.

2) **Tank Sumps**- a liquid tight containment device that houses the submersible turbine pump (STP) and product piping termination and is designed to temporarily contain leaking product. Tank sumps are also designed to provide access to the submersible turbine pump (STP) head unit above the tank. The tank sump may house the STP head unit, piping, line leak detectors, interstitial monitoring devices, wiring, and other equipment. Tank sumps are typically located directly above the USTs. Tank sump lids generally range from 3 to 4 feet in diameter and can be round, oval, square, or rectangular in shape. Tank sumps must be equipped with lids which have a properly fitted gasket. This gasket provides a water tight seal to the sump to prevent surface water intrusion.

 Tank sump showing sump lid gasket in place and sensor in proper position in sump.	 Oval shaped sump (FRP tank top)

Shallow Under Dispenser Containment sump with sensor



Typical STP sump showing sump lid and cover

Water and product in sump and sensor has been moved out of position and cannot properly detect liquids in sump.

At this uncontained sump, the tank owner made use of a plastic container to keep backfill from caving in on pump head. This would not meet present installation standards.

3) **Dispenser Sumps**- Dispenser sumps are designed to contain any leaking product from fuel dispensers or their associated components within the sump. They also provide access to a portion of the piping, flex connectors, shear valves, and other equipment located beneath the dispenser. Dispenser sumps are found directly under the dispensers.

4) **Transition/Intermediate Sumps** – Transition/intermediate sumps are less common than other sumps, but can be found along the piping runs that connect the tanks to the dispensers, and are designed to provide access to the piping. Transition sumps are used to transition from above-ground piping to below-ground piping or, in some cases, to transition between different types of piping or where a piping union may occur. Intermediate sumps are located at key points in the piping system (e.g., low spots, branches, tees). Transition/intermediate sump lids generally range from 3 to 4 feet in diameter and can be round, oval, square, or rectangular in shape.

5) **Outer Secondary Piping -** The outer or secondary piping layer of a double-walled piping system is designed to contain a leaking primary line which may allow fuel to flow to a sump where it can be contained or detected. The outer secondary piping may be manufactured with the piping or installed on site. All piping installed must be compatible with the product stored in the UST system as required by rule .02(5). Installers are required to verify outer piping integrity at installation by performing pressure or vacuum tests in accordance with manufacturer's instructions or the National Fire Prevention Association (NFPA).

6) **Sump penetration fittings (secondary piping termination fittings) -** When piping enters a secondary containment sump, penetration fittings are installed in the sump to allow the piping to enter. These fittings are designed to provide a liquid-tight seal, preventing fuel from escaping the sump or water from entering. Penetration fittings are usually made of rubber or a composite material which can degrade over time. **These fittings should be maintained as required by rule .02(2)(b)1.(ii), .02(2)(b)3., .02(2)(b)4., and .02(1)(c), to prevent fuel from escaping the secondary containment.**

7) **Inlet Test Boots -** These boots are used during installation to verify secondary containment integrity by introducing air pressure into the piping interstitial area. Some test boots may be a part of the penetration fitting itself (figure 2), or in some flexible piping systems, it is a separate boot (figure 1) which can be adjusted to fit on the outer piping termination after it enters the sump. Inspectors should insure the test boots are loosened or removed after installation **if** interstitial monitoring is required for release detection.

1. APT Poly-Tech Test Boot

2. Environ Geo-Flex Test Boot attached to penetration fitting; test boot on right is torn.

Common Problems with Secondary Containment and IM

1) **Fuel in Sumps or Interstitial Area**
The first sign of a problem with a secondary containment system is when petroleum product escapes from the primary tank or piping system. When the system is functioning properly, it is designed to allow fuel to accumulate at the lowest point where a sensor will automatically alert the operator. The most common source of fuel intrusion in containments sumps is leaking components of the STP head, such as leak detectors, functional elements, gaskets or seals. Some components of the outer wall of flexible piping and sump systems manufactured prior to 2004 are not compatible with petroleum, and long-term exposure may lead to degradation. If fuel is detected in any portion of the secondary containment system, this constitutes an

unusual operating condition and must be reported to the Division within seventy-two (72) hours as a suspected release as required by rules .04(1)(b) and .05(1)(a)2. and 3. If debris or liquid found (small amounts of debris/liquid/residue are acceptable as long as it does not interfere with the placement or the operation of the sensor), then it should be expeditiously removed and properly disposed of in accordance with local, state and federal requirements.

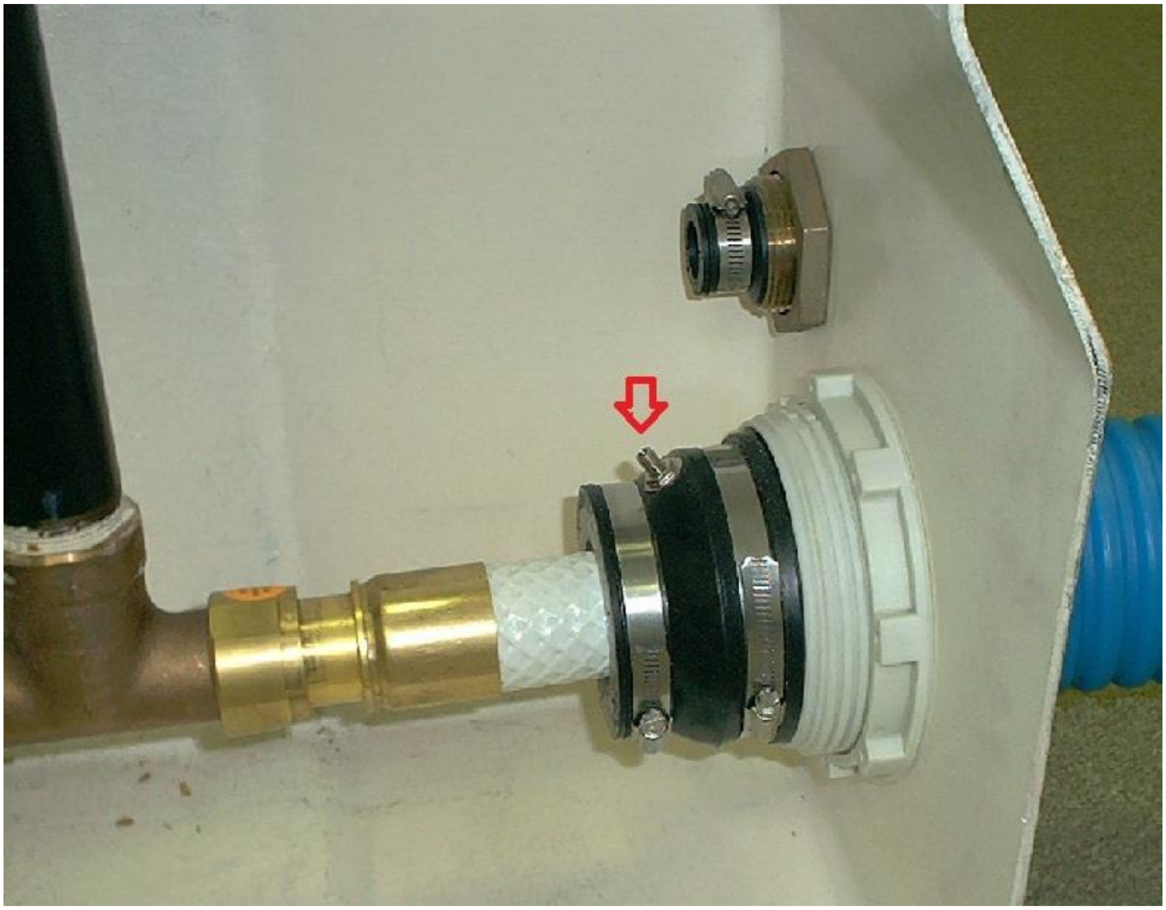
2) Water Intrusion in Secondary Containment

The presence of water in a containment sump or tank interstice may not necessarily be due to a leaking UST system. Loose or missing sump lid seals can allow surface or groundwater to accumulate and activate sensor alarms. Water should be removed; lids and all joints, seals, and boots should be visually inspected to determine the source of intrusion. Water intrusion will interfere with properly conducting continuous monitoring with UST systems installed on or after July 24, 2007 or any UST systems that have IM as release detection. See rule .04(3)(g)1.(ii). If water continues to accumulate in the secondary containment system and the intrusion cannot be eliminated, then that is an indication the system is damaged and must be repaired to be in compliance with rules .02(1)(c), .02(2)(a)3. and 4, .02(2)(b)3. and 4. and .02(2)(c)1. and 3. or replaced to be in compliance with rules .02(6)(a) through (f). Recurring presence of water (not related to condensation) must be reported to the Division as a suspected release within 72 hours in accordance with rule .05(1)(a)2. and 3. unless the device or containment system is immediately repaired or replaced and additional monitoring within 30 days eliminates water intrusion in the interstice as the cause. The Division will determine if additional action is required on a site specific basis.

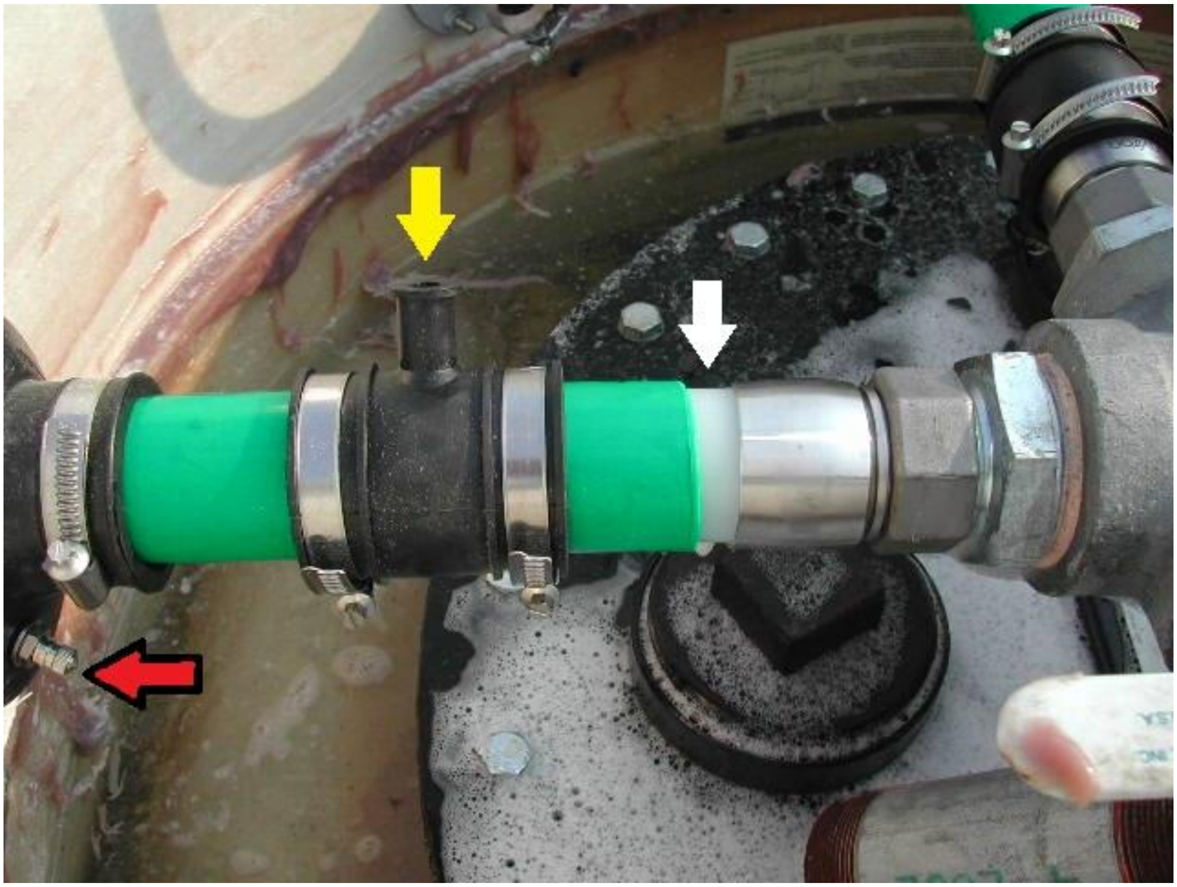
3) Inlet Test Boots Not Loosened

When double-walled flexible piping is installed, piping manufacturers often provide a rubberized test boot over the primary and secondary piping inside the secondary containment sump. This test boot allows the installer to pressurize the secondary pipe to verify tightness at startup. If the O-ring clamps on the boots are not loosened or removed after air testing is completed, liquids cannot enter the containment sump and be detected by sensors for proper release detection as required by rule .04(3)(g)1.

4) Similar to number 3 above, a problem may exist when a fitting or a test boot equipped with a Schrader valve has the valve core in place. These situations will require the inspector to take a closer look. See following illustrations:



This example shows single wall flexible piping inside chase pipe. Secondary containment is the space between the blue chase pipe and the white primary pipe. The Schrader valve (red arrow) allows air testing of the secondary containment. If the silver band clamps are tight and the valve core in the Schrader valve is in place, any liquid leaking into the secondary containment would not reach a sensor in this sump. Liquid accumulating under pressure in the interstice could result in a rupture of the chase piping and release to the environment that would not be detected by this interstitial monitoring method. The solution would be to loosen the band clamp on the smaller end of the penetration fitting, or remove the valve core from the Schrader valve. Either of these adjustments would allow product to reach a sensor and signal an alarm.



In this example, the piping is double wall. Secondary containment is provided by the space between green outer layer and the white inner layer. The Schrader valve (red arrow) would be used to test the integrity of the chase piping. The test boot has been pulled back allowing any product leaking from the primary piping to enter the sump. In this case, the test boot could be left in the testing position, as long as there is no obstruction in the nipple on the test boot (yellow arrow). The nipple allows for an air test of the secondary containment. Since it is difficult to verify whether there is an obstruction in the test boot, this is the preferred position of the test boot unless the secondary containment space is being tested.

5) Flexible Piping Degradation

Flexible plastic piping has become popular for installation at new UST facilities because it can be installed in a single section without sections or fittings. Some types of flexible plastic piping manufactured prior to 2005 have experienced problems with swelling and deformity of end fittings near the tank or dispenser due to incompatibility with the product. In addition, microbial degradation has been found to cause piping failures in Total Containment (TCI) brand Enviroflex piping manufactured prior to 1994, referred to as 1st generation. 1st generation TCI piping, which is yellow in color, was recalled and shall be replaced as required by rule .02(5) and rule .02(4)(b).

MAINTENANCE

Maintenance on IM components shall be carried out in accordance with manufacturer's recommendations as required by rules .04(3)(g)1.(iii), .04(5), .03(2)(b)3. and 4. and .02(7)(f).

TYPES OF ELECTRONIC INTERSTITIAL MONITORING-SENSORS

1) Dry Annular

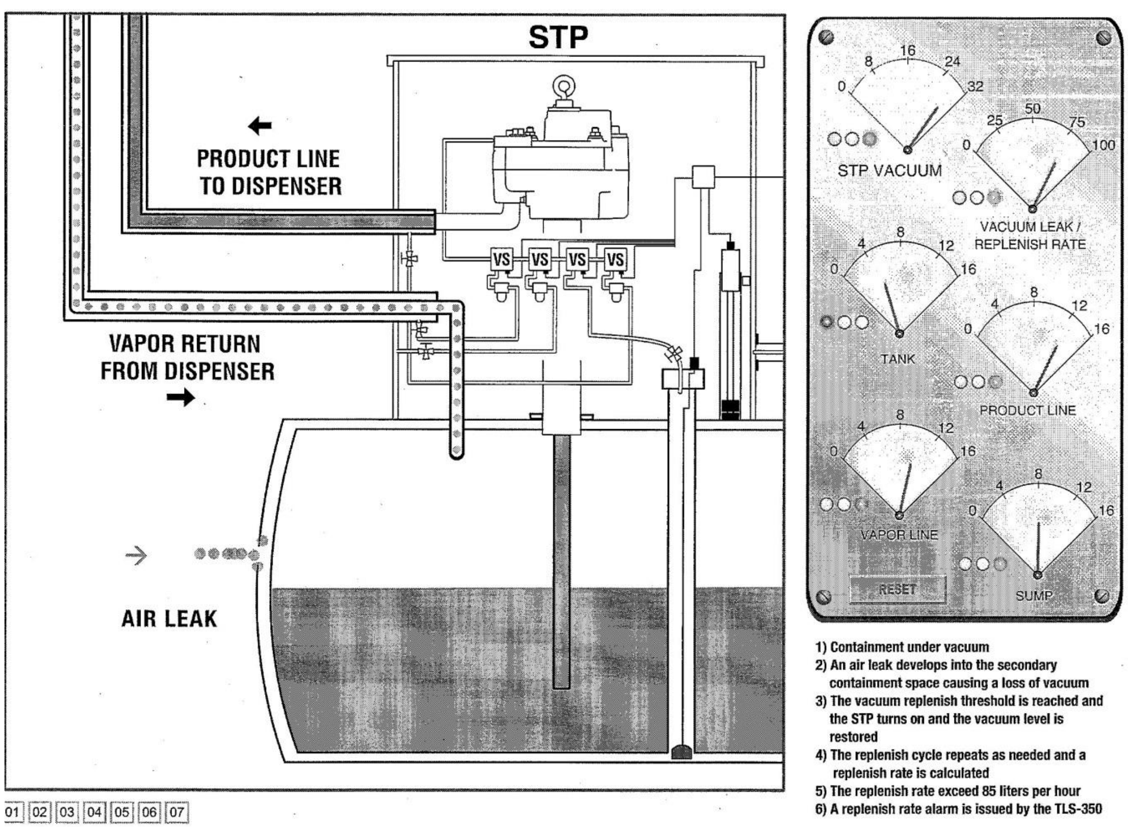
Sensors are used in empty sumps or tank interstitial areas to detect the presence of fuel or water. Dry annular monitoring systems are capable of detecting breaches from the inner wall and intrusion of liquid through the outer walls of double-walled tanks and double-walled piping.

2) Hydrostatic

Sensors are used in an interstitial area filled with brine or other acceptable liquid which is monitored continuously. If the outer wall is breached, the loss of brine will activate a normally submerged hydrostatic sensor and alert the operator of a problem. Hydrostatic monitoring systems are capable of detecting breaches in both the inner and outer walls of double-walled tanks and double-walled piping.

3) Vacuum

For double-walled tanks equipped with a vacuum interstice, the system uses vacuum generated by the turbine pump to continuously maintain a partial vacuum within the interstitial space. The system is designed to activate a visual and acoustic alarm, and optional turbine pump shutdown before stored product can escape to the environment. Vacuum monitoring systems are capable of detecting breaches in both the inner and outer walls of double-walled tanks and double-walled piping.



INTERSTITIAL MONITORING COMPONENTS

TYPES OF SENSORS

1) **Float Switches (non-discriminating)**
   A basic float switch consists of two magnets, one of which is attached in a permanently fixed location inside the sensor. A second magnet is attached to an object which will float on fuel or water. When a liquid is introduced to a predetermined level, the magnets contact and complete an electronic circuit. The active circuit is then translated as an alarm by the monitoring device.

2) **Float Switches (discriminating)**
   A discriminating sensor can differentiate between fuel and water by the use of multiple magnetic circuits in a single sensor. Since water and fuel have different liquid densities, each magnetic circuit will trigger a separate alarm.

3) **Optical Sensors (discriminating and non-discriminating)**
   Sensors which use a light beam directed at a reflective surface inside the sensor. When liquid is introduced, the light beam is refracted and converted to an electrical signal. The console is then notified of the presence of liquid.

4) **Electrical Conductivity**
   These devices take advantage of the electrical conductivity of fluids. When a liquid is in contact with the sensor, an electrical bridge is completed between two contact points and sends a signal to the monitoring device.

5) **Pressure Monitoring Device**
   Uses pressurized nitrogen gas to continuously maintain an overpressure within the interstitial space of double-walled piping. The system is designed to activate a visual and acoustic alarm before stored product can escape to the environment. The system is capable of detecting breaches in both the inner and outer walls of double-walled piping.

6) **Vacuum Monitoring Device**
   Uses vacuum generated by the turbine pump or separate external vacuum pump to continuously maintain a partial vacuum within the interstitial space of double-walled tanks and double-walled piping. These systems are designed to activate a visual and acoustic alarm, and optional turbine pump shutdown before stored product can escape to the environment. These systems are capable of detecting breaches in both the inner and outer walls of double-walled tanks and double-walled piping.

7) **Hydrostatic (Liquid Filled) Interstitial Sensors**
   These systems use propylene glycol or a brine solution to fill the tank and/or piping interstice. The tank interstice and/or double-walled sump interstice (continuous with piping interstice) is monitored by a liquid level sensor and sends a continuous signal to the monitoring device. If liquid is removed, the electrical contact is broken in the sensor and an alarm is triggered.

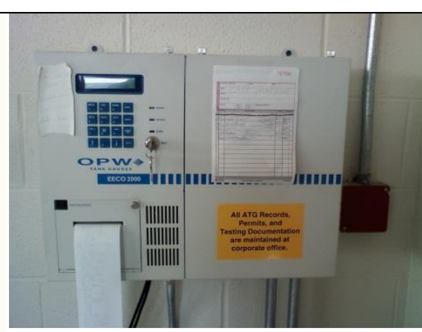
Below are some examples of various types of sensors found in interstitial monitoring systems:

 Veeder Root Interstitial Tank Sensor	 Veeder Root Discriminating Sump Sensor	 INCON Non-Discriminating Sump Sensor
 Veeder Root Vacuum Sensor (interfaces with ATG)	 Incon Brine Interstitial Sensor	 OPW Optical Interstitial Sensor
 Veeder Root Non-Discriminating Sump Sensor	 Veeder Root Mag Sump Sensor	 Veeder Root Hydrostatic Sensors

Monitoring Consoles

Electronic Interstitial Monitoring can be conducted using an Automatic Tank Gauging (ATG) console or a stand-alone console. Depending on the type of device installed, the system may or may not be able to generate a paper record. Most stand-alone monitoring consoles require the O/O to manually document the monthly leak detection result by observing the device to determine if an active alarm is present. Some examples of each type of device are shown below:

1) **ATG Consoles**

 Incon TS-1001	 OPW EECO 1500	 Veeder Root TLS-350

2) Stand Alone Consoles

 PermAlert FluidWatch	 Pneumercator LC1000	 Centeron Wireless Monitor

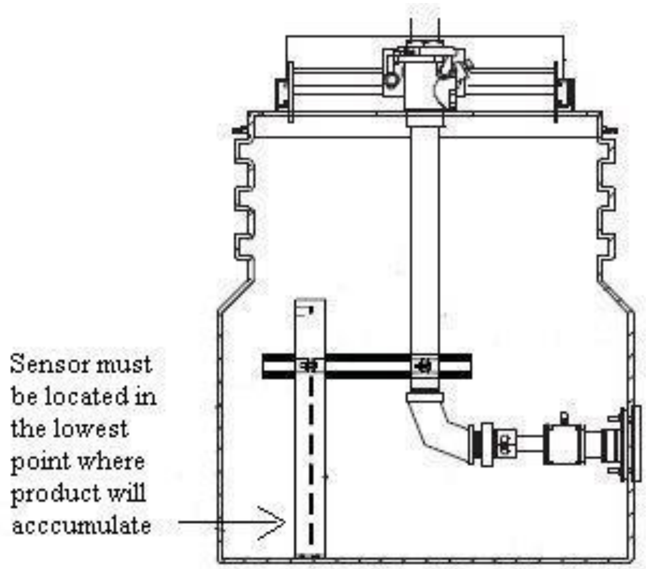
COMMON PROBLEMS WITH INTERSTITIAL MONITORING DEVICES

1) Maintenance of Sensors

All interstitial monitoring consoles and sensors must be checked annually following the manufacturer's instructions in accordance with rule .04(3)(g)1.(iii) and the results documented on the Division's form CN-1340 Annual Electronic Interstitial Monitoring Test Report. See Appendix 2. The sensor manufacturer may also be consulted for guidance.

a. **Sensors Installed Improperly**
Tank and sump sensors must be installed in a location where they can detect a loss of product or liquid as soon as a problem occurs to comply with rules .02(1)(c), .02(2)(a)2., .02(2)(b)2. and .04(3)(g)1.(i) through (iii). Sensors which are not properly installed can allow a release to go undetected indefinitely.

The following photos demonstrate improper placement of sensors.



b. **Sensor Alarm Warnings Ignored**

IM systems are equipped with audible/visual alarms to alert the operator as soon as a problem is detected. If these devices are disabled, ignored or silenced, then this is considered a violation of rules .04(1)(b) and .05(1)(a)3. Alarm messages generated from various ATG consoles may include, but not be limited to, the following:

i. Fuel Alarm- discriminating sensor has detected product in the interstice.
ii. High Liquid Alarm- sensor has detected eight inches of any liquid using a non-discriminating sensor, or water using a discriminating sensor.
iii. Liquid Alarm- sensor has detected one inch of any liquid using a non-discriminating sensor, or one inch of water using a discriminating sensor.
iv. Sensor Out Alarm- sensor has been disconnected or is inoperable.
v. Short Alarm- sensor has been disconnected or is inoperable.
vi. Active- used to describe any type of sensor alarm in the alarm history report.
vii. High Brine Level- sensor has detected an increase in brine level and therefore may indicate a release into the interstice or water ingress.
viii. Low Brine Level- sensor has detected a decrease in brine level and therefore may indicate a breach in the inner or outer containment.

The owner/operator should consult the operator's manual for their specific monitoring device to determine what each alarm from their specific device means and to maintain compliance with rule .04(1)(a)2.

c. **Failure to maintain or periodically test sensors**

Residue or debris can accumulate on float switches and prevent them from functioning properly. Electrical conductivity sensors can corrode in humid environments. Optical sensors may have a film develop on the outside of the lens which interferes with their operation. All sensors should be checked during annual testing in accordance with the Division's IM form CN-1340 Annual Electronic Interstitial Monitoring Test Report as required by rule .04(3)(g)1.(iii), .04(5) and .03(2)(b)4. See Appendix 2.

SUMP SENSOR APPLICATION AT UNMANNED FACILITIES

In Interstitial Monitoring applications, sump sensors are capable of signaling detection of liquid in interstitial spaces; however, rule .02(2)(a)4 and (b)4 also contains a provision which requires leaked product to be contained until it can be removed. It is not sufficient for sensors merely to sound an alarm when liquids are detected, they must also take action to stop the further flow of product in accordance with rule .04(3)(g)1.(iii) until the alarm can be investigated and if a piping release is evident, a piping repair can be made. For unmanned facilities, this is not possible since there is no one present to shut down and investigate. Therefore, sump sensors at unmanned facilities must do this in one of two ways when liquid is detected in a sump or secondarily contained space:

a. Sump sensors connected to an ATG console must shut off the power to the submersible turbine pump if liquid is detected in the STP sump or if liquid is detected at more than one dispenser sump, and it must disable the operation of the component(s) it is monitoring such as a dispenser sump if there is no alarm in the STP or,

b. Stand-alone (not connected to an ATG console) dispenser sensors must disable the operation of the component(s) they are monitoring when liquid is detected.

Alarms do not guarantee that a leak into the interstitial space will contain the product until it can be removed. Positive shutdown is required because alarms can go unnoticed, unaddressed, alarms can be silenced, and if those things happen a leak would continue unabated. If sensors are configured to interrupt the flow of product, then releases and damage to the environment should be minimized until the alarm condition is investigated and addressed.

MONTHLY INTERSTITIAL MONITORING

Interstitial Monitoring shall be performed continuously as required by rule .04(3)(g)1.(ii) and the results recorded on the Division's form CN-1340 Monthly Electronic Interstitial Monitoring Report (see Appendix 2) as required by rules .04(3)(g)1.(iii), .04(5) and .03(2)(b)4.

SENSOR FUNCTIONALITY TESTING

All IM sensors shall be checked for operability on an annual basis in accordance with the manufacturer's recommendations for proper testing. The results shall be recorded on the Division's form CN-1339 Annual Electronic Interstitial Monitoring Test Report (see Appendix 2). See rules .04(3)(g)1.(iii), .03(2)(b)4. and .04(5).

RECORDKEEPING

Results of any sampling, testing, or monitoring must be maintained for at least 1 year as required by rule .03(2)(b)4. and .04(5)(b) and must be recorded on the Division's form CN-1339 Monthly Electronic Interstitial Monitoring Report and CN-1340 Annual Electronic Interstitial Monitoring Test Report (see Appendix 2) as required by .04(3)(g)1.(iii). Records of all calibration, maintenance, and repairs of release detection equipment permanently located on-site must be maintained for at least one year after the servicing work is completed. Written performance claims pertaining to release detection systems must be retained for five (5) years from the date of installation or until the release detection method is no longer used, whichever is later as required by rule .04(5)(a).

If IM is being done by a stand-alone sensor not connected to an automatic tank gauge such as at a dispenser, then there will not be an electronic record for such stand-alone sensors to attach to form CN-1340. This form should still be used to record monthly IM results for stand-alone sensors.

Records must be kept at the UST site and immediately available for inspection by the Division, or at a readily available alternative site and be provided for inspection to the Division upon request. See rule .03(2)(c)1.(i) and (ii).

Upon transfer of ownership, including, but not limited to, sale of the UST systems, originals and/or copies of all documents required to satisfy the reporting and recordkeeping requirements shall be transferred to the new owner of the USTs at the time of ownership transfer. See rule .03(2)(b)4., .04(3)(g)1.(iii) and .04(5)(b).

Examples of reports- Release detection records for IM must be recorded using the Division's approved IM forms as required by rules .03(2)(b)4., .04(3)(g)1.(iii) and .04(5)(b).

1. Sensor Status Reports (attached to IM form)
2. Manual Sensor Status Report
3. Alarm History Report (attached to IM form)
4. Alarm Log (maintained if alarm indicated)

All IM reports shall contain at a minimum the following information:

1. Information which identifies the facility
2. Sensor location
3. Sensor Status

EXAMPLES OF SENSOR STATUS AND ALARM HISTORY REPORTS

INCON INTELLIGENT CONTROLS INC P. O. BOX 638 SACO ME 04072 1-800-984-6266 08/01/1998 12:16 PM SENSOR STATUS REPORT SENSOR NO. 1 SENSOR 1 OK SENSOR NO. 2 SENSOR 2 OK SENSOR NO. 3 SENSOR 3 OK SENSOR NO. 4 SENSOR 4 OK SENSOR NO. 5 SENSOR 5 OK SENSOR NO. 6 SENSOR 6 OK SENSOR NO. 7 SENSOR 7 STANDARD SENSOR ACTIVE SENSOR NO. 8 SENSOR 8 LOW BRINE LEVEL ACTIVE	AUG 30, 2010 13:13 LIQUID STATUS - - - - - - - - - - - - - AUG 30, 2010 13:13 L 1:DISP 1-2 SENSOR NORMAL L 2:DISP 3-4 SENSOR NORMAL L 3:DISP 5-6 SENSOR NORMAL L 4:DISP 7-8 SENSOR NORMAL L 5:DISP 9-10 SENSOR NORMAL L 6:DISP 11-12 SENSOR NORMAL L 7:DISP 13-14 SENSOR NORMAL L 8:DISP 15-16 SENSOR NORMAL L 9:PREM INTERSTITIAL SENSOR NORMAL L11:UNLEAD ANNULAP SENSOR NORMAL L12:DIESEL STP SUMP SENSOR NORMAL L13:PREM STP SUMP SENSOR NORMAL L14:UNLD STP SUMP SENSOR NORMAL * * * * * END * * * * *	INCON INTELLIGENT CONTROLS INC P. O. BOX 638 SACO ME 04072 1-800-984-6266 01/04/1999 2:22 PM SENSOR ALARMS 01/04/1999 2:20 PM HIGH BRINE LEVEL SENSOR 16 SENSOR NO. 16 01/04/1999 2:20 PM DRY WELL SENSOR 12 SENSOR NO. 12 01/04/1999 2:20 PM HIGH BRINE LEVEL SENSOR 8 SENSOR NO. 8 01/04/1999 2:19 PM STANDARD SENSOR SENSOR 15 SENSOR NO. 15 01/04/1999 2:19 PM STANDARD SENSOR SENSOR 7 SENSOR NO. 7 01/04/1999 2:12 PM DRY WELL SENSOR 4 SENSOR NO. 4
INCON TS-1001 Sensor Status Report	Veeder Root TLS-350 Liquid Status Report	Incon TS-1001 Sensor Alarm History

REPORTING

When a release is suspected or confirmed for any of the following conditions, the Division shall be contacted within 72 hours:

- Sensor alarm indicates the presence of fuel. See rules .04(1)(b) and .05(1)(a)2. and 3.
- Unexplained presence of fuel in secondary containment or sump not indicated by alarm. See rule .05(1)(a)2.
- Recurring presence of water or sensor out alarm (unless the device or containment is immediately repaired or replaced and additional monitoring within 30 days eliminates water intrusion into the interstice). See rule .05(1)(a)2. and 3.
- Evidence of a leak into the environment from a secondary containment sump or interstice is required to be reported under rule .05(1)(a)1. and .06(3)(a).

For UST systems installed on or after July 24, 2007, if interstitial monitoring cannot be conducted as required by rule .04(3)(g)1. due to failure of the secondary containment or the IM system and cannot be repaired or replaced, as allowed by rules .02(6) and (7), then the portion of UST system which can no longer be monitored must be permanently closed following the applicable parts of rule .07.

REFERENCES

NFPA 30 Underground Tank Installation, Chapter 4 Tank Storage

Petroleum Equipment Institute- Recommended Practices PEI-RP100, 2005 edition

Petroleum Equipment Institute- Recommended Practices PEI-RP1200, 2012 edition

US EPA- UST Systems: Inspecting and Maintaining Sumps and Spill Buckets, Practical Helps and Checklist, May 2005

Veeder Root Dispenser Pan Sensors & Containment Sump Sensors Installation Guide, 576013-306, Rev. G, 2007

Veeder Root Sensors Products Application Guide, 577013-750, Rev. M, 2009

Veeder Root TLS-3XX Series Consoles Operator's Manual, 576013-610, Rev. Y, 2008

INCON Tank Sentinel Operator's Guide, 000-152 Rev. C, 2009

Iowa Department of Natural Resources, UST Compliance Inspection Guide, July 2007

APPENDICES

1. **Sump Integrity Hydrostatic Testing Procedure**
2. **Sensor Descriptions**
3. **State Forms**
   Monthly Electronic Interstitial Monitoring Report
   Annual Electronic Interstitial Monitoring Test Report

APPENDIX 1

Sump Integrity
Hydrostatic Testing Procedure

A test must be performed on each sump, including under dispenser containment (UDC), submersible turbine pump (STP) and piping transition, upon initial installation. The test must be conducted for a minimum of one (1) hour. The test should be conducted only during a time when there is no chance of precipitation because inclement weather would cause the water in the device to increase by an unknown amount. If obvious damage such as cracks, holes, or defective seal is observed, the sump cannot be tested.

A. Before Testing:

1. Water and a tape measure that is capable of measuring to one-eighth of an inch shall be used. Spray paint or an indelible marker may be used if a tape measure is not available.
2. Ensure that the sump is clean.

B. Conducting the test:

1. Using an indelible marker, mark the inside of the sump at a level which is at least two inches above the highest penetration fitting.
2. Fill the sump with water to the level of the marking.
3. Allow water to stand for a minimum of one (1) hour. If no change is detected, the test may be ended. If a change is detected, continue the test for a minimum of four (4) hours.
4. Measure the difference of the water level using a tape measure to the nearest one-eighth of an inch.
5. Empty the sump.
6. At the end of the test, the water may be re-used for additional testing or be disposed of properly.

C. Results:

If the water level in the sump decreases by as much as one-eighth of an inch or more, the sump may be leaking. The sump must be evaluated to determine if it can be repaired (if allowed by the manufacturer) or if it must be replaced. If the water level in the sump decreases less than one-eighth of an inch, the sump passes the test.

D. Reporting and Recordkeeping:

The sump integrity test records must be kept until the sump is replaced as required by rules .02(6)(f) and.02(7)(f). If a sump does not pass the integrity test, then the sump shall be repaired or replaced as allowed by rules .02(6) and .02(7). Repairs must be made in accordance with rule .02(7)(a) and in accordance with guidance published by the sump manufacturer. Records of repairs must be kept for the life of the UST system or until the sump is replaced as required by rule .02(7)(f) and transferred to any new tank owner required by rule .03(2)(d).

APPENDIX 2

Sensor Descriptions

Table 1.	SENSOR DESCRIPTIONS		
Operating Principle	Test Method (Sensor Category)	Description of Operating Principle	Estimate of Current Use (High/Med/Low)
Liquid-filled interstitial monitoring	Continuous interstitial monitoring method (liquid filled)	A fluid reservoir containing brine, water, or propylene glycol is attached at the top of the tank and opens to the interstice. The reservoir is equipped with a dual -point float switch to provide for low-level and high-level alarms.	Low/Med (Varies with geography. Low in the mid-continent. Med in states where secondary containment is required.)
Pressure-filled interstitial monitoring	Continuous interstitial-line-monitoring method (pressure/vacuum)	Uses a pump to pressurize an inert gas to continuously maintain an overpressure using a pressure sensor within the interstitial space of double-walled piping. System is designed to activate a visual and acoustic alarm before stored product can escape to the environment and is capable of detecting breaches in both the inner and outer walls.	Low (Mainly found on newer installations in CA)
Pressure-voided interstitial monitoring	Continuous interstitial-tank-monitoring method (pressure/vacuum)	Uses an integral vacuum pump and a vacuum sensor to continuously maintain a partial vacuum within the interstitial space of double-walled tanks. System is designed to activate a visual and acoustic alarm before stored product can escape to the environment and is capable of detecting breaches in both the inner and outer walls.	Low (Mainly found on newer installations in CA)
Metal-oxide semiconductor	Interstitial liquid-phase & vapor-phase	Detects petroleum hydrocarbon vapors by monitoring for a change in electrical current in a cell inside the sensor.	Very Low
Float switch/Reed switch/Magnetic switch	Interstitial liquid-phase & out-of-tank liquid-phase	A device that monitors for a change in the level of a liquid. A float switch is made up of a reed switch activated by a magnet inserted in a float. These devices are generally specified as "normally open" or "normally closed," depending on how they are oriented. The switch completes a circuit of interrupts a circuit.	High (The most commonly used interstitial sensor.)

Table 1. (Continued)	SENSOR DESCRIPTIONS		
Operating Principle	Test Method (Sensor Category)	Description of Operating Principle	Estimate of Current Use (High/Med/Low)
Electrical conductivity	Interstitial liquid & out-of-tank liquid-phase	Uses hydrocarbon-permeable coated wire that indicates a change in the resistance of the wire when the coating degrades as a result of contact with petroleum hydrocarbons.	Very Low (Old technology - late '80s to early '90s.)
Capacitance change/RF-attenuation/Proximity sensors (capacitive)	Interstitial liquid-phase, out-of-tank liquid phase	Monitors for changes in capacitance.	Very Low
Capacitance change/RF-attenuation/Proximity sensors (capacitive)	Interstitial liquid-phase, out-of-tank liquid phase	Monitors for changes in capacitance.	Very Low
Thermal conductivity	Interstitial liquid phase	Designed to respond to heat differences between air, water, and hydrocarbons. The temperature inside the sensor element rises and triggers a response at the console.	Very Low
Fiber-optic chemical sensor	Out-of-tank liquid-phase	Characterized by a chemically sensitive film deposited on the end of an optical fiber. Any change to the film results in a decrease of light being emitted, sending a signal to the console.	Extremely Low
Adsistor/adsorption sampling	Vapor-phase	Changes electrical resistance in the presence of petroleum hydrocarbon vapors.	Very Low (Old technology.)
Photo-ionization	Vapor-phase	Uses ultraviolet radiation to ionize and detect small concentrations of volatile organic compounds in ambient air.	Very Low
Chromatographic (i.e., color change)	Vapor-phase	A granular material that changes in color in the presence of hydrocarbon vapors.	Low

Table from LustLine #60, February 2009

APPENDIX 3

Division of Underground Storage Tanks Standardized IM Forms

Fillable form versions of these documents are available on the Division website.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 12th Floor
Nashville, Tennessee 37243

MONTHLY ELECTRONIC INTERSTITIAL MONITORING ALARM REPORT

This report is used to document interstitial monitoring of underground storage tank (UST) systems equipped with secondary containment. Interstitial monitoring is required on all UST systems installed after July 24, 2007.

- Document the status of any alarms reported during the monitoring period.
- Maintain these records for a minimum of 12 months and have them available for review upon request by the division.
- Attach copies of all monthly sensor status and alarm history reports for the monitoring period.
- Report any unusual operating conditions or suspected releases discovered to the division within 72 hours of discovery.
- For required annual sensor testing, complete the Annual Electronic Interstitial Monitoring Test Report (CN-1339)

I. UST FACILITY INFORMATION

UST Facility ID #:	Facility Name:
Address:	
City:	County:

II. INTERSTITIAL MONITORING ALARM LOG

- Document all sensor alarms that occurred during the previous 30 days using this section of the report.
- Document that all alarms or suspected releases have been investigated and, if necessary, attach the appropriate documentation to this report.
- If your monitoring device is capable of producing an “alarm history” report, then attach a copy of the report to this form.

Monitoring Period (month/year):		**If no alarms, then check this box:**	☐

Date of Alarm	Sensor Location and Cause of Alarm	Describe Action Taken:

Signature:	Date:

CN- 1340 RDA 2394

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 12th Floor
Nashville, TN 37243-1541

ANNUAL ELECTRONIC INTERSTITIAL MONITORING TEST REPORT

This report is used to document functional testing of electronic interstitial monitoring devices.

- In the absence of an approved 3rd party test procedure or manufacturer's recommended practice, the procedure outlined below may be used to verify the interstitial monitoring devices are working properly.
- Interstitial monitoring is required on all UST systems installed after July 24, 2007.
- Report any unusual operating conditions or suspected releases discovered during this test to the division within 72 hours of discovery. Failure to do so could affect fund coverage in the event of a release.
- Attach documentation of all completed repairs, service invoices, or leak detection equipment replacement to this report, and maintain these records for a period of 12 months.

I. UST FACILITY		II. PERSON CONDUCTING TEST	
UST Facility ID #:		Name:	
Facility Name:		Company:	
Address:		City:	State
City:	County:	ZIP:	Phone:
Tester Signature:		Test Date:	

III. TEST AND MONITORING DEVICE INFORMATION (Attach additional pages as necessary)

Sensor ID								
Manufacturer								
Model #								
Location:								

Type of Sensor(s) (Check all that apply)	☐ Float Switch- Type: (☐ discriminating ☐ non-discriminating) ☐ Optical Sensor ☐ Electrical Conductivity Sensor ☐ Pressure Monitoring Device ☐ Vacuum Monitoring Device ☐ Other (specify):
System Setup (Check all that apply)	If a sensor is activated, the interstitial monitoring system responds with the following actions: ☐ Visual Alarm ☐ Audible Alarm ☐ Tank Monitor Leak Alarm ☐ Submersible Pump Shutdown ☐ Off Site Telemetry Alarm ☐ Other (specify)

IV. ELECTRONIC INTERSTITIAL MONITORING TEST PROCEDURE

Check Completed	Task
☐	Monitoring console is operational, no current active alarms. Activate "test" or "diagnostic" mode if applicable.
☐	Sensors are present and installed at proper level to detect a release in all appropriate locations.
☐	Sensors alarm when activated (immersed in appropriate liquid or other applicable method).
☐	Simulated alarm condition causes the appropriate response indicated in the section above.
☐	Document the simulated alarms in the facility's alarm history report records as "annual functional test".
☐	Inspect all secondary containment sumps: no evidence of leaks, appear to be liquid tight.
☐	Inspect all sump inlets and boots connected to the piping where liquid enters the sump, free of obstructions.
☐	Inspect tank sump covers to ensure gaskets and seals are installed properly to prevent surface water intrusion.

Comments (list all problems found, repairs, work performed or other information):