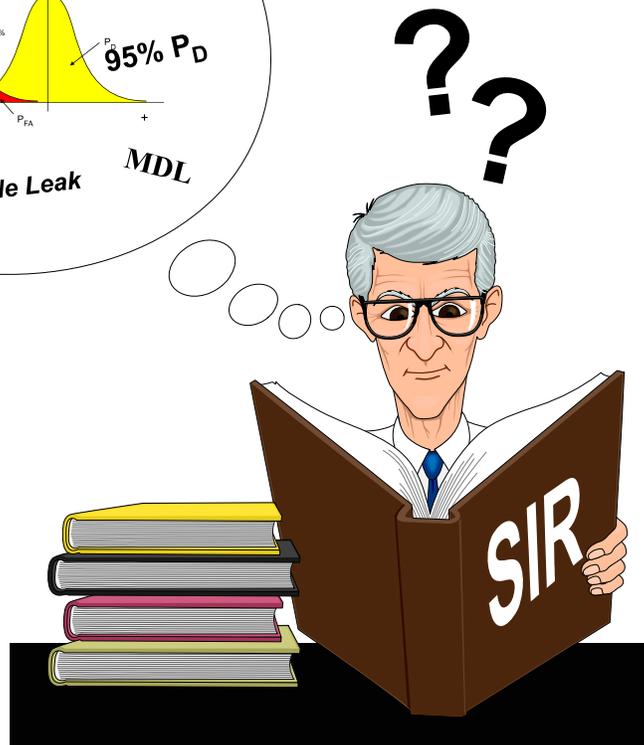
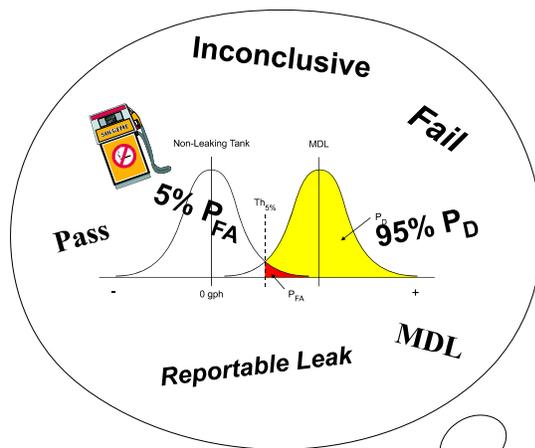


# ADEM Introduction to Statistical Inventory Reconciliation for Underground Storage Tanks



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## **Why You Should Read this Booklet**

Federal and state laws require underground storage tank systems (USTs) to have leak detection. One of the available leak detection methods is Statistical Inventory Reconciliation (SIR). In this method, a trained professional uses sophisticated computer software to conduct a statistical analysis of inventory, delivery, and dispensing data.

SIR can allow the owner or operator of an UST facility to meet leak detection requirements without an extensive outlay of capital, using only the equipment that most facilities have readily at hand—a tank stick and a tank chart used for inventory control. The SIR analysis itself is usually provided as a service by vendors who charge a monthly fee based on the number of tanks.

This booklet provides basic information on the method—what it is, how it works, factors that impact data quality—to assist you in determining if SIR is appropriate to your needs.

## **Do You Need Additional Information on Leak Detection?**

If you need additional information on leak detection or need leak detection related forms, go to the ADEM web site at [www.adem.state.al.us](http://www.adem.state.al.us) or call the ADEM Groundwater Branch at 334/270-5655.

## How Does SIR Work?

On the face of it, SIR looks very similar to old-fashioned inventory control—the owner or operator, using simple equipment, tracks tank volumes, deliveries, and sales. However, the similarity ends there. Simple inventory control is relatively imprecise. Depending on your system throughput, you could be losing hundreds of gallons every month without realizing anything is wrong!



To many people, SIR may seem like magic, but it is based on sound mathematical principles.

By contrast, SIR analysis can be very sensitive and accurate. A SIR vendor can take the same inventory data and analyze them for leaks so small that many would go unnoticed with inventory control. By using a month's worth of good tank data, it is possible for SIR methods to detect a release of just over 1½ pints per hour (that's about 145 gallons per month) from a tank or its product lines 95 times out of a hundred.

The mechanics of how SIR works are beyond the scope of this booklet. SIR vendors actually use a variety of statistical tools to evaluate inventory data, and no two vendors' methods are exactly alike—the information they collect and the results they provide can vary. Still, for fundamental release detection purposes, there are only three possible bottom-line responses for any SIR test: *PASS*, *FAIL*, and *INCONCLUSIVE*. These bottom-line responses are described below and on the following pages.

**PASS**—According to the analyzed data, the UST system tests tight.

**FAIL**—Analyzed data indicate a loss of product from the system or an influx of groundwater. However, a *FAIL* does not *necessarily* indicate that your system is leaking. A *FAIL* may indicate miscalibrated dispensers, inaccurately metered deliveries, or stolen product. There is also a chance that a *FAIL* is a false alarm.

Therefore, when you receive SIR results that *FAIL*, you are first required to perform an investigation to determine whether or not a suspected release has occurred. If the investigation indicates a suspected release has occurred, then you must notify ADEM. **See page 6 for detailed information on how *FAIL* results are to be handled.**

**INCONCLUSIVE**—Analyzed data cannot make the call. There is a chance that the information provided to the SIR vendor is so bad that it is not possible to make a determination. This often can be traced back to poor tank sticking or bookkeeping practices (for example, a new hire who has received inadequate training). Whatever the reason, an *INCONCLUSIVE* result means, in effect, that you have failed to perform leak detection on the UST in question for that month and you are in violation of state and federal leak detection requirements until you perform certain actions.

Therefore, when you receive SIR results that are *INCONCLUSIVE*, you are first required to perform an investigation to determine whether or not a suspected release has occurred. If the investigation indicates a suspected release has occurred, then you must notify ADEM. **See page 6 for detailed information on how *INCONCLUSIVE* results are to be handled.**

**A 'FAIL' does not necessarily mean your system is leaking.**

**An 'Inconclusive' means that you effectively have no leak detection for that month.**

## Necessary Equipment

One of the major attractions of SIR for UST owners and operators is that it does not require a large, up-front investment of capital. The primary cost is subscribing to the SIR vendor's services. The equipment needed to use the method is usually already found on-site at most UST facilities.

### Gauge Stick or Other Gauges

A gauge stick, made of wood or other non-sparking material, is used to measure the depth of liquid in the UST. Typically, such sticks are marked or notched in 1/8-inch increments starting with the bottom of the stick. It is important that the stick be in good condition. Sticks that have worn ends, cut-off ends, worn-off numbers, or worn-off varnish coatings are not acceptable and should be replaced.

Other forms of gauges can also be used if they are available and in good operating condition. Automatic tank gauges, for instance, can simplify measuring tank volumes. (Keep in mind, of course, that some automatic tank gauging systems can serve as acceptable monthly tank leak detection methods by themselves.)

Whatever form of gauge you choose to use, you must follow the SIR vendor's instructions carefully to gather useful data. For instance, many providers of SIR services require that the tank measurements are made to the nearest 1/8-inch. If you fail to follow the vendor's instructions, you may end up with inconclusive test results.

### Pastes for Finding Fuel or Water

If you use a gauge stick, you can improve the quality of your readings if you use a fuel-sensitive paste smeared over about six inches of the stick where you expect the fuel level to be. The paste changes color where it comes into contact with the fuel.

Similarly, you can use a water-sensitive paste on the end of the stick to monitor for the presence of water in the bottom of the tank. While water in the tank can come with your deliveries or as a result of condensation of moisture inside the tank, it can also come from groundwater leaking in through holes or through loose fittings in the top of your tank.

### Tank Chart

The strapping chart used to convert stick measurements into gallons must be the right one for the tank. The chart should have stick measurements listed to 1/8 of an inch to minimize math errors that occur when using charts marked off to the nearest inch. SIR vendors can quickly determine if the chart is inappropriate to your tank, and will often generate a proper one for your tank.



*Good sticking practices are essential to good SIR analyses.*



## Calibrated Dispensing Meters

A poorly calibrated totalizer can produce bad data that may be mistaken for some types of releases. While many SIR vendors can identify this pattern as a possible cause for a result of *FAIL* or *INCONCLUSIVE*, it is wise to avoid the problem entirely. Keep your dispensers in good operating condition and have them periodically recalibrated as recommended by your equipment manufacturer and as required by your state and local weights and measures agencies.

## Forms

The SIR vendor typically provides forms on which daily stick readings, sales, and deliveries are recorded. These forms often resemble the inventory sheets usually maintained at UST facilities. In some instances, SIR vendors may allow submission of the data on a facility's own inventory sheets. Some vendors may also permit data submission in electronic format, such as computer spreadsheets.

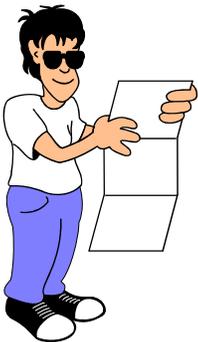
ADEM has an annual and monthly SIR report form. The annual form is used to document all SIR results within one calendar year, and must be submitted to ADEM each year. The monthly SIR form is used to document a monthly SIR result and must be submitted monthly when the SIR vendor results are *FAIL* or *INCONCLUSIVE*. These forms are available on ADEM's web site at [www.adem.state.al.us](http://www.adem.state.al.us) or by calling the ADEM Groundwater Branch at 334/270-5655.

## SIR Reporting and Recordkeeping

### What You Should Provide to the Vendor

Although SIR vendors may ask for a variety of information, some of the more common elements include:

- Tank size (capacity, diameter, and length).
- Tank type, material of construction, and manufacturer.
- Product type.
- Date each stick measurement was taken.
- Daily opening stick measurement and volume.
- Daily closing stick measurement and volume.
- Daily sales volume.
- Gross deliveries over the course of the month.
- Thirty days of inventory records.



## What the Vendor Should Provide to You

Vendors supply different levels of service to their clients. You will need to consult with individual vendors to find the collection of features you desire. However, there is a core of reporting elements that should be common to all SIR analyses. These include:

- Clear and timely reporting of results including the estimated leak rate in gallons per hour, the leak threshold at which a leak would be declared, the minimum detectable leak (MDL) rate based on the data provided for each tank, as well as the results in terms of *PASS*, *FAIL*, or *INCONCLUSIVE*.
- Complete and annotated copies of inventory records used in the analysis, showing such problems as errors in delivery records or bad measurements tossed out by the test.
- Suggestions as to the likely cause of any test failure or inconclusive result.
- Instructions on follow-up actions to be taken in the event of a *FAIL* or *INCONCLUSIVE*.

Your SIR vendor may also supply you with other useful information and services beyond the basics itemized above. SIR vendors may further provide:

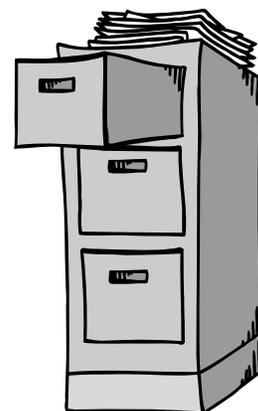
- Off-site storage of leak detection records.
- Potential reasons for a *FAIL* other than a release of product:
  - ☞ Apparent product theft
  - ☞ Missed product delivery entry
  - ☞ Suspected totalizer miscalibration
- Potential reasons and possible solutions for any *INCONCLUSIVE* results.
- Possible location of leak within the system.
- Assessment of tank sticking practices.
- Special tank-specific strapping charts for those tanks needing them (such as tilted tanks and odd-sized tanks).

## What You Should Keep on File

The minimal recordkeeping requirements for facilities using SIR are the same as for other release detection methods:

- The monthly SIR reports, along with the results of any other sampling, testing, or monitoring, must be kept for at least one year.
- Records of equipment calibration and maintenance must be kept for at least one year. Any schedules of required calibration and maintenance provided by the SIR vendor must be kept for five years from the date you began using the method at the facility.

<input checked="" type="checkbox"/>	<b>Pass</b>
<input type="checkbox"/>	<b>Fail</b>
<input type="checkbox"/>	<b>Inconclusive</b>



# HELP!



## What to Do When You Get a 'FAIL' or an 'INCONCLUSIVE'

When your SIR vendor notifies you that the result of your SIR monthly analysis is either *FAIL* or *INCONCLUSIVE*, you must perform an investigation to determine the cause of the problem within 7 days. Your SIR vendor may, on the basis of the test results, be able to provide you with areas to examine, such as a miscalibrated totalizer. You must have any defective equipment repaired or replaced immediately.

If the results of the investigation do not indicate that a suspected release has occurred, you are only required to:

- Within 10 days of receiving the SIR vendor report, submit to ADEM the results of the investigation on the "ADEM SIR 7 day Release Investigation Report" form and the SIR results on the "ADEM Monthly SIR Report" form.

If the results of the investigation indicate that a suspected release has occurred, you must:

- Report the incident to ADEM at 334/270-5655 within 24 hours of completing the investigation.
- Perform a system tightness test within 7 days of completing the investigation.
- Within 10 days of completing the investigation, submit to ADEM the "ADEM SIR 7 day Release Investigation Report" form, the "ADEM Monthly SIR Report" form, and the results of the system tightness test on the appropriate "ADEM Tank Tightness Test Report" form.

If the system tightness test fails, ADEM will require investigative and/or cleanup actions. If the system tightness test passes, ADEM will not require any further action at this time.

## What to Do When You Get a 'FAIL' or an 'INCONCLUSIVE' a Second Consecutive Month

When the results of your investigation from the previous month indicate that a suspected release has not occurred, and your SIR vendor notifies you that the result of your SIR monthly analysis is either *FAIL* or *INCONCLUSIVE* for the second consecutive month, your tank system is considered to have a suspected release and you are required to:

- Report the incident to ADEM at 334/270-5655 within 24 hours of receiving the SIR vendor report.
- Perform a system tightness test within 7 days of receiving the SIR vendor report.
- Within 10 days of receiving the SIR vendor report, submit to ADEM the "ADEM Monthly SIR Report" and the results of the system tightness test on the appropriate "ADEM Tank Tightness Test Report" form.

If the system tightness test fails, ADEM will require investigative and/or cleanup actions. If the system tightness test passes, ADEM will not require any further action at this time.

Please be aware that an *INCONCLUSIVE* should in no way be taken as demonstrating the failings of a given vendor's method—it is inherent to *all* methods. Even if vendors use terms other than “inconclusive,” they represent the same condition.

In all cases, you will want to double check your operating procedures to see what caused the *INCONCLUSIVE* and prevent its recurrence. Your SIR vendor will provide assistance in locating the problem and offer suggestions to improve your data collection.

### What You Need to Send to ADEM

- The “ADEM SIR 7 day Release Investigation Report” form, the “ADEM Monthly SIR Report” form and the appropriate “ADEM Tank Tightness Test Report” form must be submitted when necessary as outlined on page 6.
- A summary of all monthly SIR results must be submitted by January 31<sup>st</sup> of each year on the “ADEM Annual SIR Report” form.

The above forms are available on the ADEM web site at [www.adem.state.al.us](http://www.adem.state.al.us) or by calling the ADEM Groundwater Branch at 334/270-5655.

## Answers to Frequently Asked Questions

### “Can SIR be used on manifolded tanks?”

SIR methods can be used on tank systems that have multiple tanks linked together by siphon bars only as follows:

- Each tank in the manifolded system must be individually stuck for inventory measurements and the volume of both tanks must be less than the volume of the maximum tank capacity indicated by the vendor's third party test certification, or
- The vendor's SIR method must have a third party test certification for use on manifolded tanks and the maximum capacity of the tanks must be less than that indicated by the vendor's third party test certification.



Vendor third party test certification summaries are listed on the National Leak Detection List, which can be found on the ADEM web site at [www.adem.state.al.us](http://www.adem.state.al.us).

As with single tank systems, no product deliveries or sales should be made during the time the sticking and totalizer readings are taking place.

“Can SIR be used as an annual tightness test?”

The ADEM has not found the SIR method to be equivalent to an annual method of leak detection. Therefore, SIR may only be used as a monthly method of leak detection.

***There is no such thing as an “acceptable” leak. Any leak will cost you in the long run and should be fixed.***

“Why did a SIR vendor fail my tank for a leak under 0.2 gph?”

The performance standard by which monthly leak detection methods (including SIR) are measured says that leaks of 0.2 gph must be detected 95 out of 100 times (probability of detection), and false alarms should not occur more than five times in a hundred (probability of false alarm). What this means is that the SIR vendor looks at the estimated leak rate determined for a tank—say 0.15 gph—and asks the question “What is the likelihood that the *true* leak rate is actually 0.2 gph?” On the basis of a statistical analysis of the data you provide the vendor, the SIR vendor can make the call as to whether your system tests tight or not.

Typically, a *FAIL* will be called for apparent releases of around 0.1 gph. See the next question on ‘estimated leak,’ ‘threshold,’ and ‘MDL’ for additional information.

“What is this ‘estimated leak rate,’ ‘threshold,’ and ‘MDL’ stuff all about?”

***SIR vendors offer a diverse number of supplemental reporting options. Look over what each has to offer and choose the one that best meets your needs.***

These are rather technical statistical terms often used by quantitative SIR vendors to provide their clients with more detailed information on their analyses. They provide insight beyond the simple *PASS*, *FAIL*, and *INCONCLUSIVE*, including just how bad a leak appears to be (estimated leak rate) and how good the data are that you have been providing to the vendor for analysis (MDL).

The ***estimated leak rate*** is the number a SIR method comes up with for the amount of product your tank appears to be losing. The number is usually expressed in gallons per hour.

This estimated leak rate is rarely, if ever, zero. All tanks, whether leaking or tight, will generally show a leak rate. The question is, is this leak rate significant? This is where the threshold comes in.

The ***threshold*** is basically an action level leak rate. That is, if the estimated leak rate exceeds the threshold leak rate, the SIR vendor declares a *FAIL*. It is important to note that the threshold is *not* a fixed number, such as 0.1 gph. Instead, it is typically the value associated with a fixed percentage set to the probability of false alarms (that is, declaring a leak on a system that is actually tight) the SIR vendor is willing to accept. ADEM’s regulations allow no more than 5% of analyses to turn out to be false alarms. However, many SIR vendors consider one failure in twenty analyses to be too high and set their thresholds to a 1% probability of false alarm.

Finally, the **MDL** is the **Minimum Detectable Leak**. The MDL is the smallest leak rate the vendor can determine for the quality of data provided with a probability of detection 95% or better. The MDL is tied to the threshold and is usually twice the threshold leak rate. The MDL must be less than or equal to the ADEM performance standard rate of 0.2 gph at a probability of detection of 95% and a probability of false alarm of 5% in order to make a *PASS/FAIL* call. If the MDL exceeds the performance standard, your system cannot be given a *PASS*—an *INCONCLUSIVE* is the best you can get.

Fortunately, most vendors who provide this level of detail often provide a “plain English” translation as well.

#### **“Can SIR be used as a monthly test of my piping, too?”**

Since the SIR method reports losses regardless of their origins, SIR tests the entire UST system. So, whether you are losing product as a result of a tank leak, a line leak, miscalibrated equipment, or theft, a *FAIL* will result if the estimated leak rate exceeds the threshold for calling a leak. Remember, if you are using pressurized lines, you will also need to have an automatic flow restrictor, shutoff device, or continuous alarm in place to fully meet piping leak detection requirements.

#### **“How much does SIR cost?”**

Unlike most other methods, SIR has no installation costs and equipment costs are minimal. A well-calibrated dispensing meter and a good stick are about all you need. While vendor costs will vary, monthly monitoring for a facility with three USTs costs about \$1000 to \$1500 per year. (These figures are based on estimates in the year 2000.)

#### **“There are so many vendors. How do I choose?”**

Whether you have decided to invest in SIR services or other leak detection methods, the basic steps are similar:

- Request information from the vendors you are interested in. Compare their services, option packages, and prices to see which vendors best meet your needs. Ask for references and check them.
- Contact ADEM to obtain a list of approved SIR methods.
- Contact the Better Business Bureau to see if there have been any complaints lodged against the vendor.

**NOTE: ADEM recognizes SIR as a valid method of leak detection on suction and pressurized piping systems. For pressurized piping systems, you must also use either an alarm system, a flow restrictor, or a shutoff device.**

**ADEM QUICK REFERENCE  
OF  
STATISTICAL INVENTORY RECONCILIATION (SIR) REQUIREMENTS**

ADEM has determined the SIR method to be an acceptable stand alone monthly method of leak detection for UST's and piping under the following conditions:

1. *When pressurized piping is equipped with line leak detectors.*
2. *When the following procedures are followed.*

**THE SIR VENDOR REPORT SHOWS A *FAIL* OR AN *INCONCLUSIVE***

1. Perform an investigation of all tank systems that the SIR Vendor reports a *FAIL* or an *INCONCLUSIVE* within 7 days after receipt of the SIR Vendor report.

**THE INVESTIGATION INDICATES A SUSPECTED RELEASE**

1. Report a suspected release to ADEM at 334/270-5655 within 24 hours after completion of the investigation.
2. Perform a tightness test on all tank system(s) with a suspected release within 7 days after completion of the above investigation.
3. Submit to ADEM within 10 days after completion of the above investigation:
  - a) The results of the investigation on the "ADEM SIR 7 day Release Investigation Report" form.
  - b) The system tightness test results on the appropriate "ADEM Tank Tightness Test Report" form.
  - c) The SIR results on the "ADEM Monthly SIR Report" form.

**THE INVESTIGATION INDICATES OTHER THAN A SUSPECTED RELEASE**

1. Submit to ADEM within 10 days after receipt of the SIR Vendor report:
  - a) The results of the investigation on the "ADEM SIR 7 day Release Investigation Report" form.
  - b) The SIR results on the "ADEM Monthly SIR Report" form.

**THE INVESTIGATION INDICATES OTHER THAN A SUSPECTED RELEASE  
AND THE SECOND CONSECUTIVE SIR VENDOR REPORT FOR THE SAME TANK SYSTEM(S)  
IS A *FAIL* OR AN *INCONCLUSIVE***

1. Report a suspected release to ADEM at 334/270-5655 within 24 hours of receipt of the second *FAIL* or *INCONCLUSIVE* SIR Vendor report.
2. Within 7 days of receipt of the second *FAIL* or *INCONCLUSIVE* SIR Vendor report, perform a tightness test on the tank system(s).
3. Submit to ADEM within 10 days after receipt of the second *FAIL* or *INCONCLUSIVE* SIR Vendor report:
  - a) The system tightness test results on the appropriate "ADEM Tank Tightness Test Report" form.
  - b) The SIR results on the "ADEM Monthly SIR Report" form.

**ADEM ANNUAL SIR SUMMARY REPORT**

Submit to ADEM by January 31st of each year, a summary of the results of the previous 12 months of SIR vendor reports on the "ADEM Annual SIR Summary Report".

*You are encouraged to remove this page from this booklet, place it in a prominent location, and refer to it when you receive a *FAIL* or an *INCONCLUSIVE* report from your SIR vendor.*

**Any Questions? Call the ADEM UST Compliance Unit of the Groundwater Branch at 334/270-5655.**