Statistical Inventory Reconciliation

Twenty years ago, people tried to use product inventory reconciliation to find leaks in tank systems—Warren Rogers explains why SIR works so much better, while the National Work Group on Leak Detection Evaluations reveals its findings on SIR systems today.

Third Party Testing Results for
PE&T compiled and tabled the information on Statistical Inventory Reconciliation (SIR) testing results from the “List of Leak Detection Evaluations for Underground Storage Tank (UST) Systems” (Third Edition, April 18, 1997, published by the National Work Group on Leak Detection Evaluations (NWGLDE). The list is based on testing results supplied to NWGLDE by third-party laboratories during the last four years, and in some instances may not reflect the most recent information on any given product. Therefore PE&T recommends that readers contact manufacturers to ensure they receive the most recent test data available.

Product inventory reconciliation has long been used in attempting to detect leaking tank systems. A continuously maintained record of cumulative inventory variance will ultimately reveal the presence of even the smallest leak. However, traditional reconciliation methods took far too long to reveal whether and to what extent inventory variances were caused by leakage. Research showed that even with carefully maintained inventory records, leak rates less than 15 to 20 gallons per day could not be reliably detected within a 30-day period by traditional methods. Additionally, a computation of cumulative variances computed over 30-day intervals would frequently result in substantial apparent losses where no leakage had, in fact, occurred.

The reason for this, our analysis showed, was that numerous systematic errors were, and still are, being incorporated into the inventory data when inventory control is conducted in accordance with traditional industry practices.

Exacting SIR
The dissatisfaction with traditional inventory control and reconciliation, along with skepticism about the effectiveness of tank tightness testing, led to the 1981 introduction of Statistical Inventory Reconciliation (SIR), based on research by Warren Rogers Associates (WRA). The thrust of WRA’s research was to identify sources of errors in the inventory control system and determine how each error’s presence could be reliably identified in the inventory data to distinguish its effects from actual leakage.
Errors can and do occur in virtually every element of a traditional inventory control system. Such errors include inaccurate measurement or recording of deliveries, sales volumes, product levels and product level-to-volume conversions. SIR involves statistical analyses that enable people to accomplish two main objectives: (1) to separate out and quantify effects that are not “leak-related”; and (2) to react appropriately to those forms that are compatible with leakage. For each data set analyzed, SIR can determine not only whether or not a leak is present but also the smallest leak that could be detected, given the quality of data provided.

SIR can, therefore, provide a level of quality control unattainable with other leak detection methods because it provides an exact evaluation of its own performance for every test performed. With this control in place, SIR can effectively monitor manifold and blended sites, as well as single tanks.

Another advantage of SIR is that, unlike other leak detection systems, it tests the entire system—from the fill pipe to the dispensing meter. Of particular importance, SIR detects leaks in the dispenser housing and the joint between the dispenser and the piping. These areas are not accessible to the tank or line testers and are where, in our experience, the majority of leaks occur.

### Table 1: qualitative methods

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<th>Company</th>
<th>Data Sets</th>
<th>Median Throughput (gallons)</th>
<th>Leak Rates Used (gph)</th>
<th>Not Evaluated</th>
<th>Not Conclusive</th>
<th>Median Confidence Level</th>
<th>Test Results Time Span</th>
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### EPA Guidance

EPA’s booklet Introduction to Statistical Inventory Reconciliation for Underground Storage Tanks (EPA 510-B-95-009, September 1995) provides basic information on how SIR works, what equipment is needed and what records and reports are involved. It also provides answers to frequently asked questions about SIR. The booklet is designed to help people decide if SIR is appropriate to their needs.

In 1990, EPA published a protocol for third party testing of SIR methods (Standard Test Procedures for Evaluating Leak Detection Methods: Statistical Inventory Reconciliation Methods, EPA/530/UST-90/007, June 1990). The protocol allowed for testing both qualitative and quantitative SIR methods.

Qualitative SIR methods are designed to classify a tank system as Pass, Fail or Inconclusive. A Pass means that, according to the data analyzed, the system is tight. A Fail means that the system may be leaking, but not necessarily—it could also mean that dispensers are miscalibrated, deliveries are inaccurately metered or product has been stolen. An Inconclusive means that a determination of pass or fail could not be reached based on the data analysis. Quantitative SIR methods also classify results...
as Pass, Fail or Inconclusive, but they go beyond this by providing an estimated leak rate, usually in gallons per hour.

In 1996, EPA published the Protocol for Determining Applicability of a SIR Method for Manifolded Tanks and Determining Size Limitation (November 1996). The development of this protocol was coordinated by the SIR team of the NWGLDE.

**Third Party Test Results**

NWGLDE has provided an extremely valuable audit of SIR methods to identify those who have complied with certification requirements in accordance with the EPA protocol. The results of NWGLDE’s tests for 17 SIR methods (five qualitative and 12 quantitative) are included in the List of Leak Detection Evaluations for Underground Storage Tank (UST) Systems, April 18, 1997. Qualitative SIR methodology cannot provide minimum detectable leak information—only quantitative methods can. The results are summarized in the accompanying tables.

As stated throughout the List, it is not to be construed as an endorsement or a guarantee of the performance of the methods tested. To this caution, I would add that the listing does not help discriminate between methods that meet all applicable criteria for good SIR analyses and methods that merely comply with the minimal requirements of the EPA protocols. Potential SIR users should consider the following points before deciding on which SIR method to employ.

1. **Are site reports provided by the SIR method in accordance with EPA 510-B-95-009?** Only the quantitative methods can meet the reporting requirements.

2. **Does the method adequately diagnose faulty product-level-to-volume conversions and provide corrected conversion charts or gauge coding based on actual SIR data analysis?**

3. **Do the method’s reports for individual tanks reflect the method’s ability to identify and quantify delivery errors and unrecorded additions or removals?**

4. **Is the method’s ability to identify and quantify meter miscalibrations demonstrated?**

5. **Is there demonstration that the method has the ability to diagnose and provide corrective measures for all conditions leading to inconclusive results?**

6. **Does the method have demonstrated ability to provide turnaround and frequency of analysis sufficient to resolve inconclusive results before additional actions are mandated?**

7. **Does the method meet EPA’s suggested reporting of calculated leak rates, minimum detectable leak values, and leak declaration thresholds for each tank system evaluated?**

SIR, properly performed, has met with increasing acceptance and recognition as an effective leak detection system. Systems that integrate SIR with automatic tank gauging are appearing and the methodology is being extended to aboveground storage tanks. Long regarded as an inexpensive means of meeting monthly monitoring standards, SIR could well emerge as the dominant operating
system for volumetric monitoring in a variety of applications.

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