DOE F 1325.B
(8-89)
EFG (07-90)

United States Government **Department of Energy**

memorandum

DATE: March 8, 1999

REPLY TO ATTN OF: Office of Environmental Guidancc:Dicerho:6-5047

SUBJECT: DOE's Underground Storage Tank (UST) Leak Detection Workshop

TO: Distribution

The Office of Environmental Guidance, RCRAICERCLA Division (EH-231) sponsored an Underground Storage Tank (UST) Leak Detection workshop in Atlanta, Georgia on April 26, 1994. The workshop was designed to familiarize participants with the regulatory and technical basis for identifying and reporting leaks from USTs. The workshop utilized a combination of lectures and interactive discussions and included the following modules:

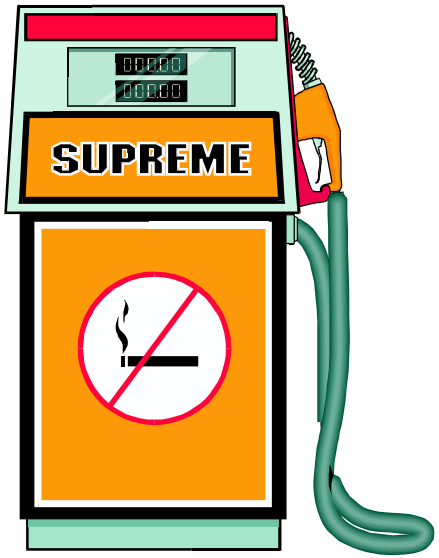
- Leak detection methods and deadlines;
- Inventory control including measurements and calculations;
- Recordkeeping;
- Designing and implementing a teak detection program;
- Selecting the proper leak detection technology;
- What to do when a leak occurs; and
- Contracting considerations

The following materials are from this training course.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Leak Detection
at Federal Facilities
U.S. Environmental Protection Agency
Office of Underground Storage Tanks

What is 40 C.F.R. § 280?

Federal regulations enacted in 1988 to minimize the impact of leaks of petroleum and hazardous substances into the environment. Major parts:



- **UST Design, Construction, Installation, & Notification**
- **General Operating Requirements**
- **Release Detection**
- **Release Reporting, Investigation, & Confirmation**
- **Release Response & Corrective Action**
- **Out-of-Service & Closures**

What an UST Is under 40 CFR § 280...

Any one or combination of tanks (including any underground piping) that is used to contain an accumulation of regulated substances, and the volume of which (including the volume of the piping) is 10% or more beneath the surface of the ground. Two broad categories:

- Petroleum
- Chemical (CERCLA Hazardous Substances)

...and What Isn't!

Exclusions

- Tanks holding hazardous waste
- ***Heating oil*** tanks for fuel consumed on site
- Tanks holding 110 gallons or less
- Tanks on or above the floor of an underground area
- Wastewater treatment tank systems
- ***Machinery tanks*** such as hydraulic lift tanks
- Emergency spill or overflow containment tanks

...and What Isn't! (cont.)

Deferred (except release response)

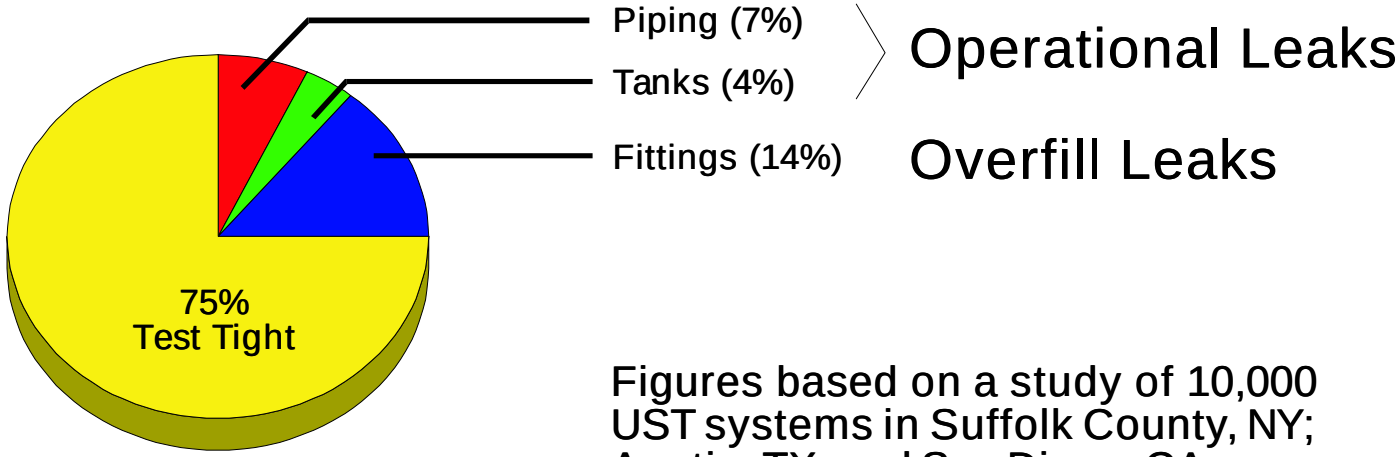
- Field-constructed tanks
- Airport hydrant fuel systems
- Tanks holding radioactive materials regulated under Atomic Energy Act of 1954
- Emergency generator tanks at nuclear power generation facilities

Deferred (leak detection only)

- All other emergency power generation USTs

Why the Need?

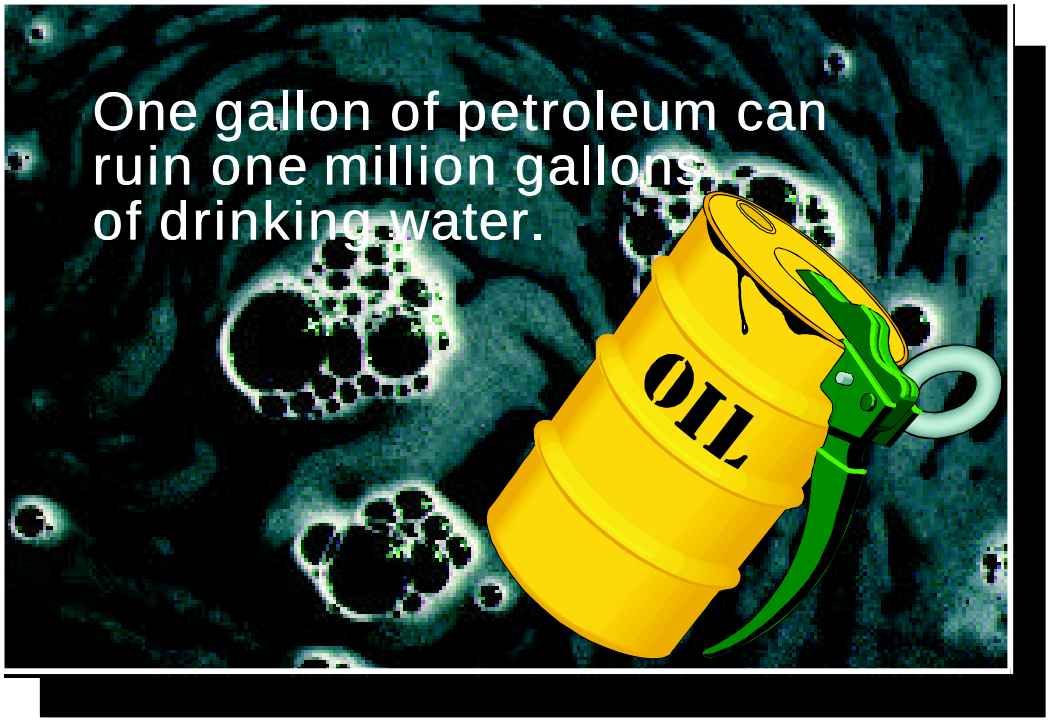
An estimated 25% of all USTs may be leaking. Releases occur as a result of piping failures, corrosion, spills, and overfills.



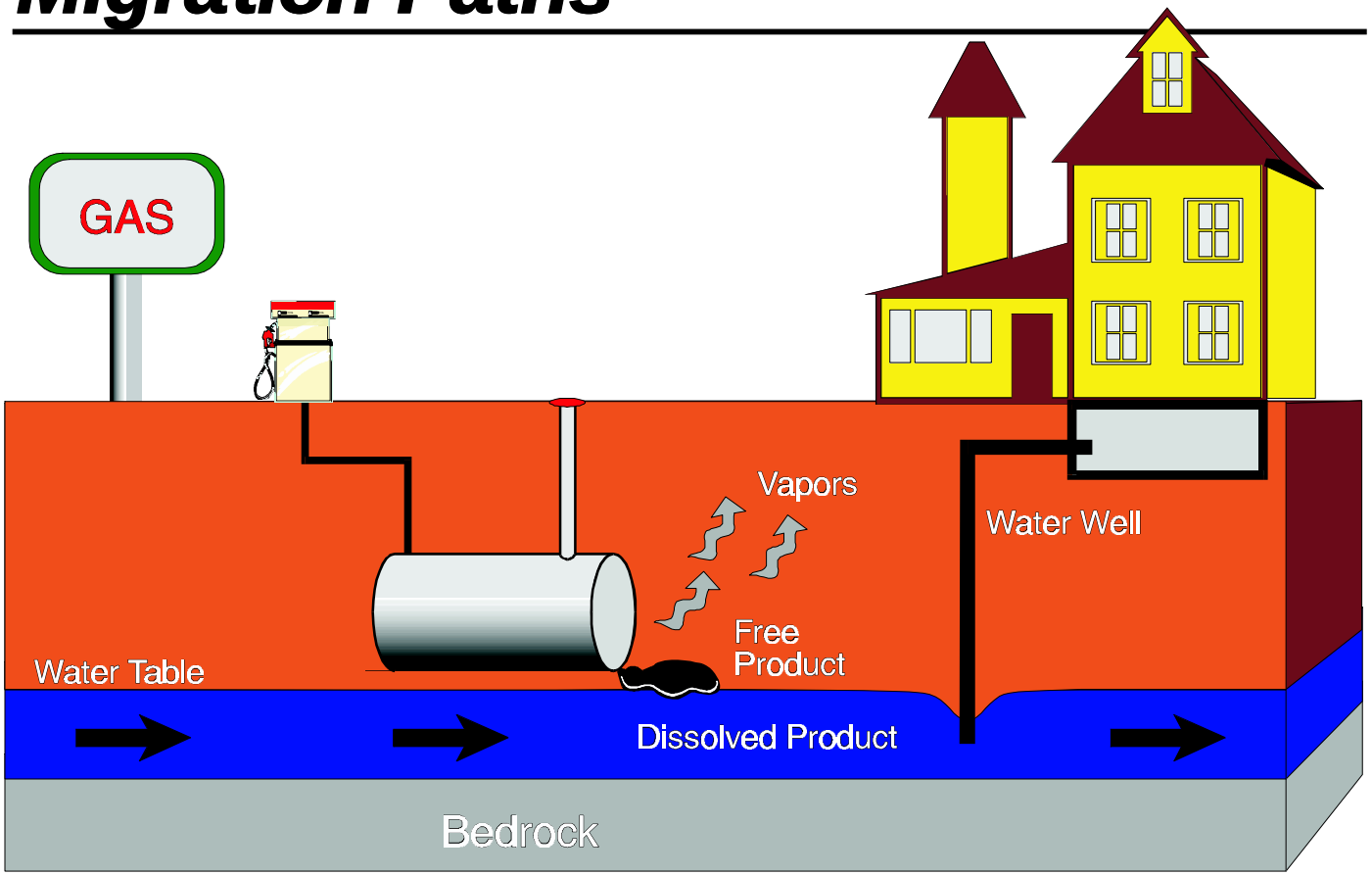
Figures based on a study of 10,000 UST systems in Suffolk County, NY; Austin, TX; and San Diego, CA.

Why the Need? (cont.)

Leaking tanks threaten ground & surface water.



Migration Paths



Why the Need? (cont.)

Leaking tanks cost you in lost product, too!

Leak Detection Methods

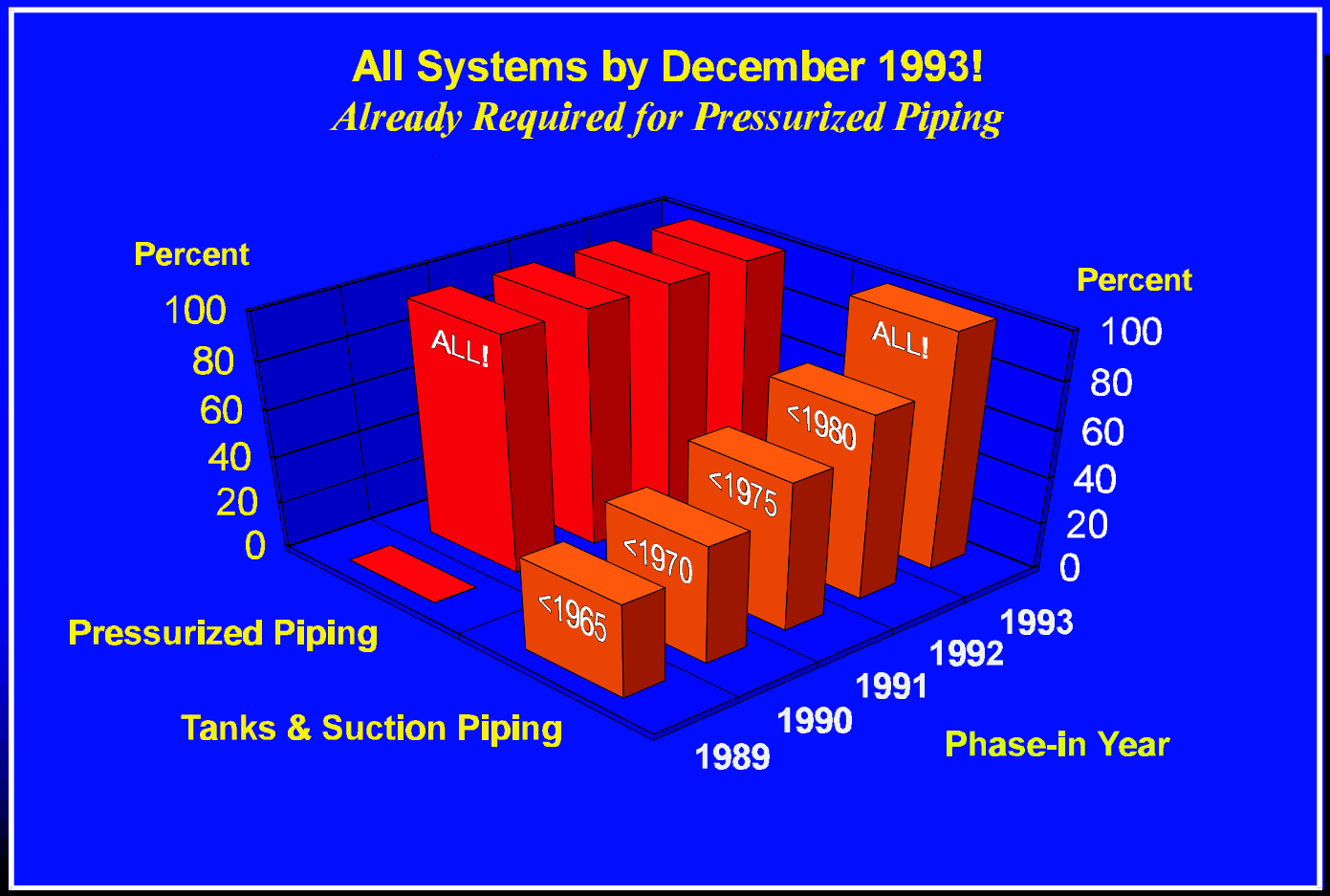
Tanks

- Internal Monitoring
- Interstitial Monitoring
- External Monitoring

Piping

- Varies according to whether pressurized or suction piping
- Most tank methods can also apply to piping
- Pressurized piping must also have automatic line leak detectors

Phase-in of Leak Detection



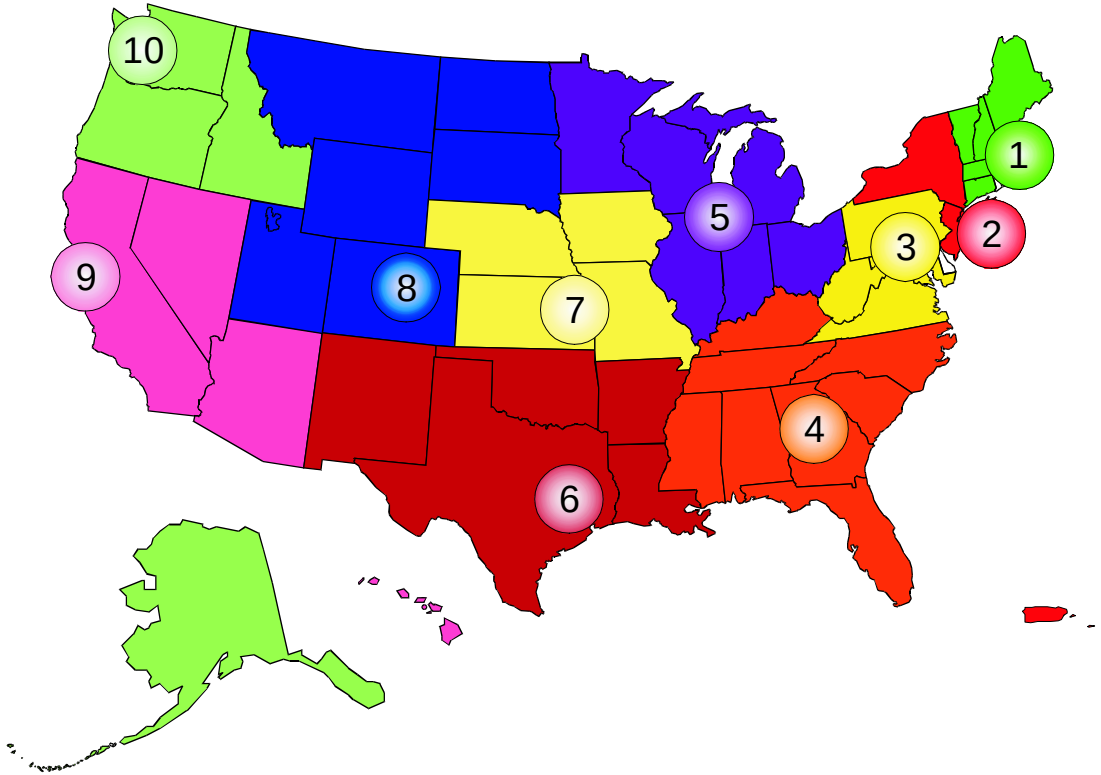
Important Aspects of the UST Program

Things You Should Know

- The UST program is designed for flexibility and the acceptance of new technologies as they become available.
- The federal UST program is designed to be deligated down to the states. Once approved, a state will run its UST program in lieu of the federal program.
- States are only required to have programs as stringent as the federal program. They can, and frequently do, have higher requirements than the federal program.

The Best Source of Information...

Your Regional EPA Office!



Leak Detection Methods for Tanks

Leak Detection Methods

Tanks

- **Internal monitoring**
  - ***Inventory control with tightness testing***
  - ***Manual tank gauging***
  - ***Statistical Inventory Reconciliation (SIR)***
  - ***Automatic Tank Gauging (ATG)***

- **Interstitial monitoring**
  - ***Vapor or liquid monitors***

- **External monitoring**
  - ***Vapor monitoring wells***

Inventory Control with Tightness Testing

Leak Detection Methods: Inventory Control

Overview

- **Uses product deliveries, sales, and current inventory to determine if a leak is present**
- **Requires daily tank measurements of product level *to the nearest 1/8-inch***
- **Requires monthly check for water in tank**
- **Data reconciled at the end of each month to determine if within limits of error**
- **Must report *possible leak* if two consecutive months of data are outside tolerance**
- **Requires periodic tightness testing**

Leak Detection Methods: Inventory Control (cont.)

Considerations

- **Numerous areas for error:**

  Bad stick
  Bad strapping chart
  Bad delivery metering
  Bad dispenser calibration
  Bad math

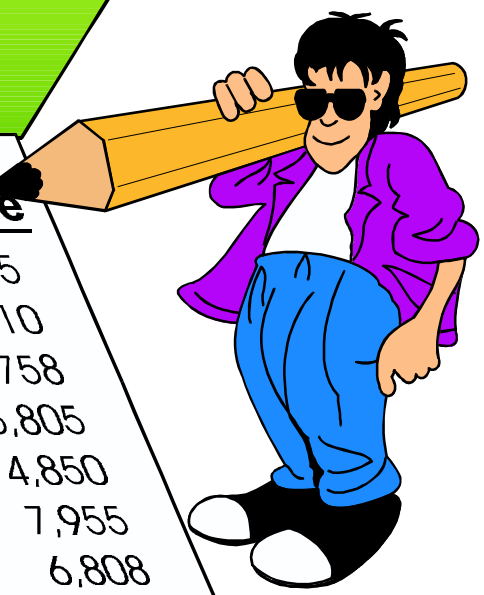
- **Can be used on older tanks only until 1998**
- **Can be used on newer or upgraded tanks for only 10 years**
- **Requires use of tightness testing**

Leak Detection Methods: Inventory Control (cont.)

Inventory Control

Like a checkbook—all deposits and withdrawals must be kept current.

Date	Deposits	Withdrawals	Water	Balance
6/1		876	-0-	3,365
6/2		855		2,510
6/3	5,500	1,252		6,758
6/4		953	-0-	5,805
6/5		955		4,850
6/6	4,000	895		7,955
6/7		1,147	-0-	6,808



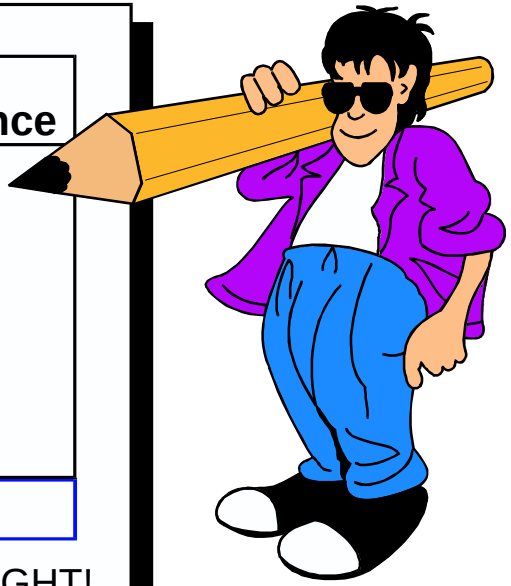
Leak Detection Methods: Inventory Control (cont.)

Inventory Control:

Unlike a checkbook, you are allowed a margin of error—1% of thruput + 130 gallons.

Date	Product Removed	Metered Sales	Difference
6/24	339	373	34
6/25	501	457	(44)
6/26	780	507	(273)
6/27	211	518	307
6/28	479	471	(8)
6/29	531	480	(51)
6/30	368	473	105
		15,049	62

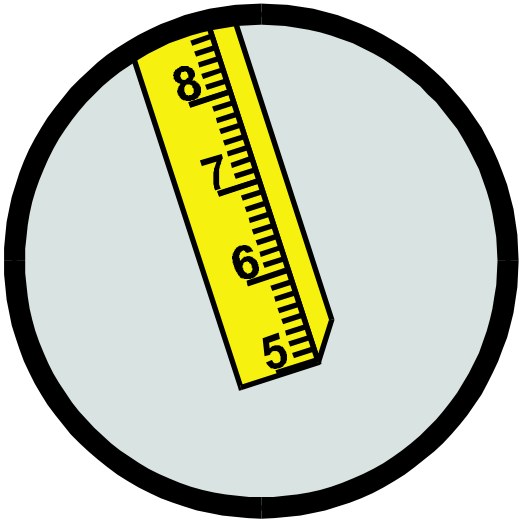
1% of 15,049 + 130 = 280.5. TANK TESTS TIGHT!



Leak Detection Methods: Inventory Control (cont.)

Problems & Limitations

Bad stick leads to poor data quality.



Splintered

Cut off

Warped

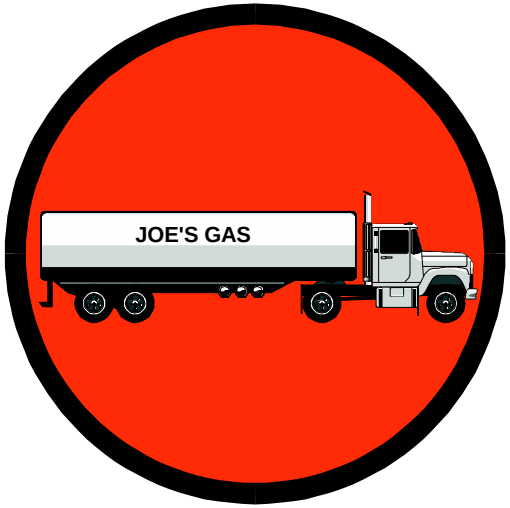
Unreadable

Increments not to nearest 1/8 inch

Leak Detection Methods: Inventory Control (cont.)

Problems & Limitations

Inaccurately metered deliveries



Shortages (or, less likely, overages) in delivery will influence final monthly tabulations.

Leak Detection Methods: Inventory Control (cont.)

Problems & Limitations

Poor dispenser calibration

Miscalibration results in false apparent gains or losses. The more product dispensed, the greater the discrepancy.

Leak Detection Methods: Inventory Control (cont.)

Problems & Limitations

Staff requirements

Requires knowledgeable and conscientious staff to maintain accurate daily records.

Leak Detection Methods: Tightness Testing

Overview

- **High-precision, sensitive measurements of tank (or line) tightness**
- **Two classifications:**

  Volumetric

  Overfilled

  Partially Filled

  Non-Volumetric

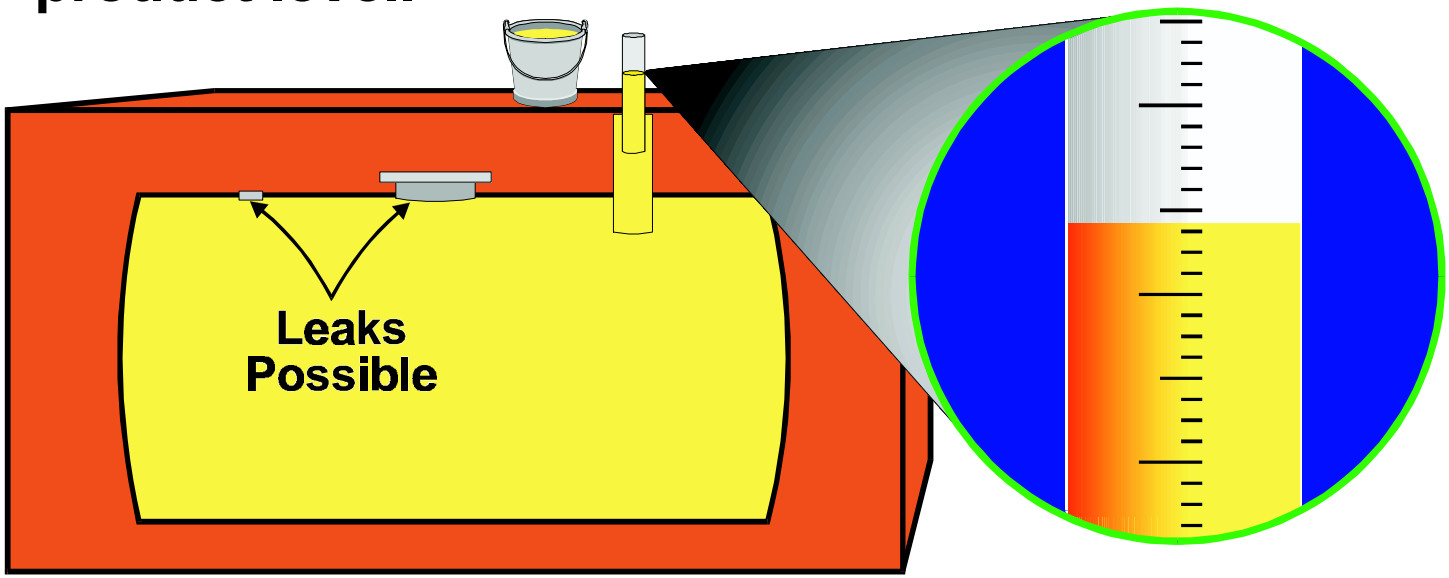
  Vacuum

  Tracers

Leak Detection Methods: Tightness Testing (cont.)

Volumetric

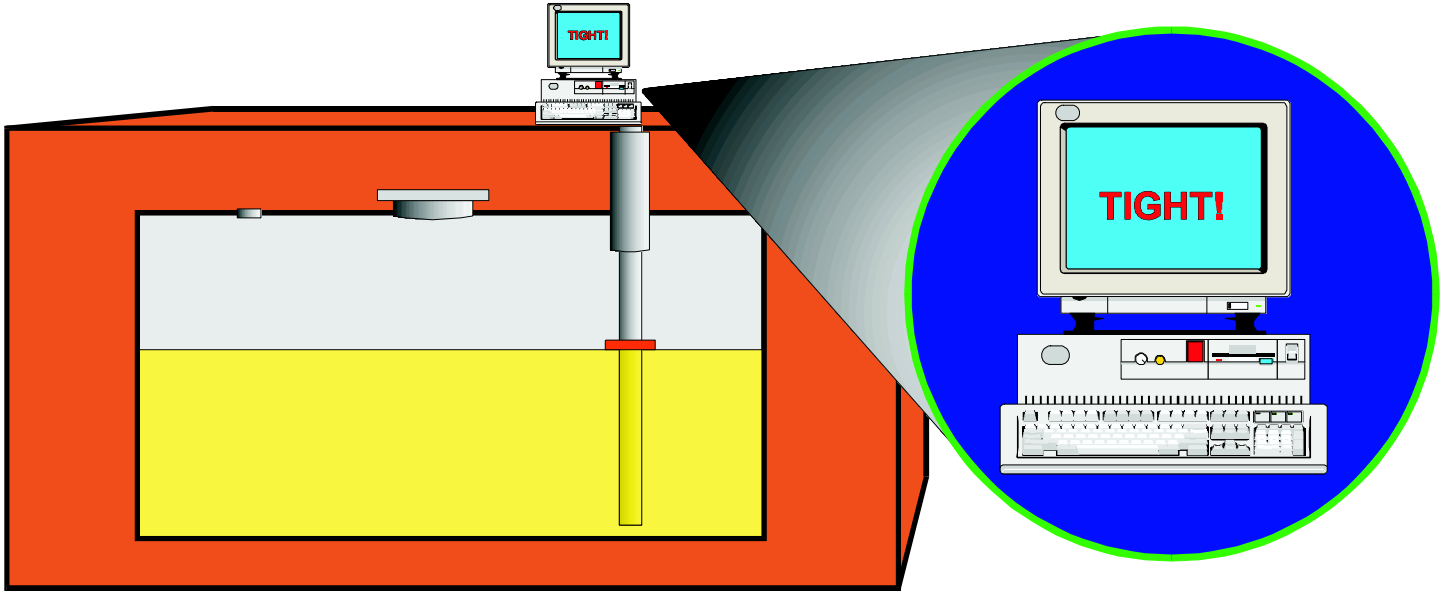
Overfilling **is most common. A small change in volume is measured as a large change in product level.**



Leak Detection Methods: Tightness Testing (cont.)

Volumetric

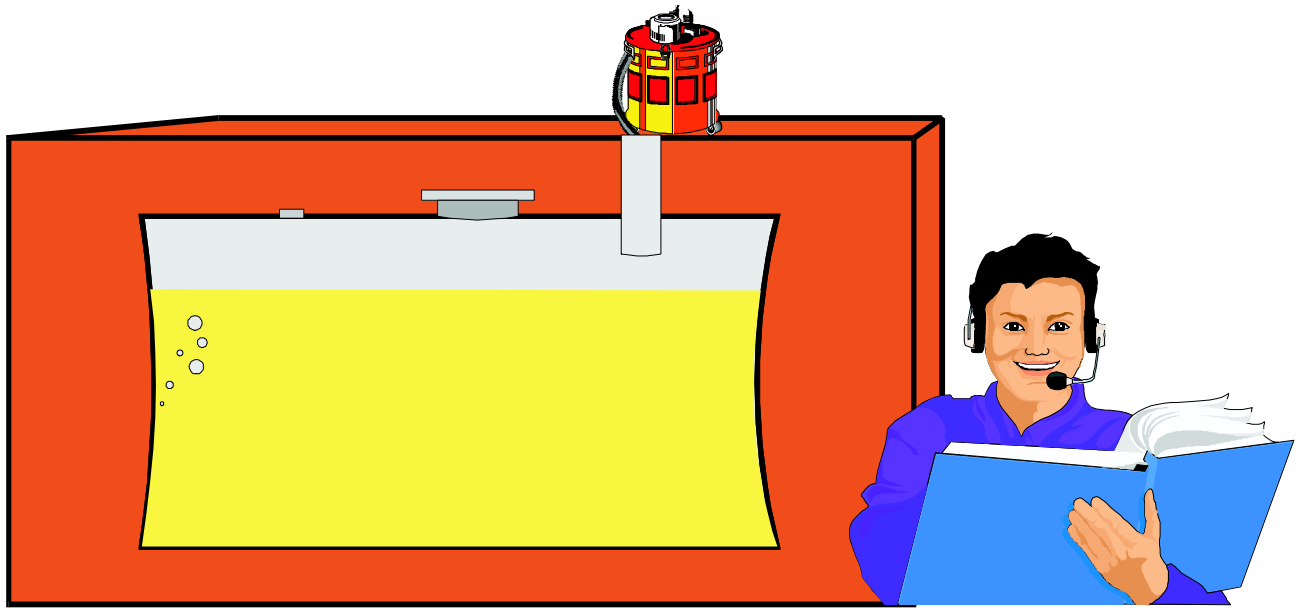
Partially filled **tightness testing relies on sensitive measurement of product level.**



Leak Detection Methods: Tightness Testing (cont.)

Non-volumetric

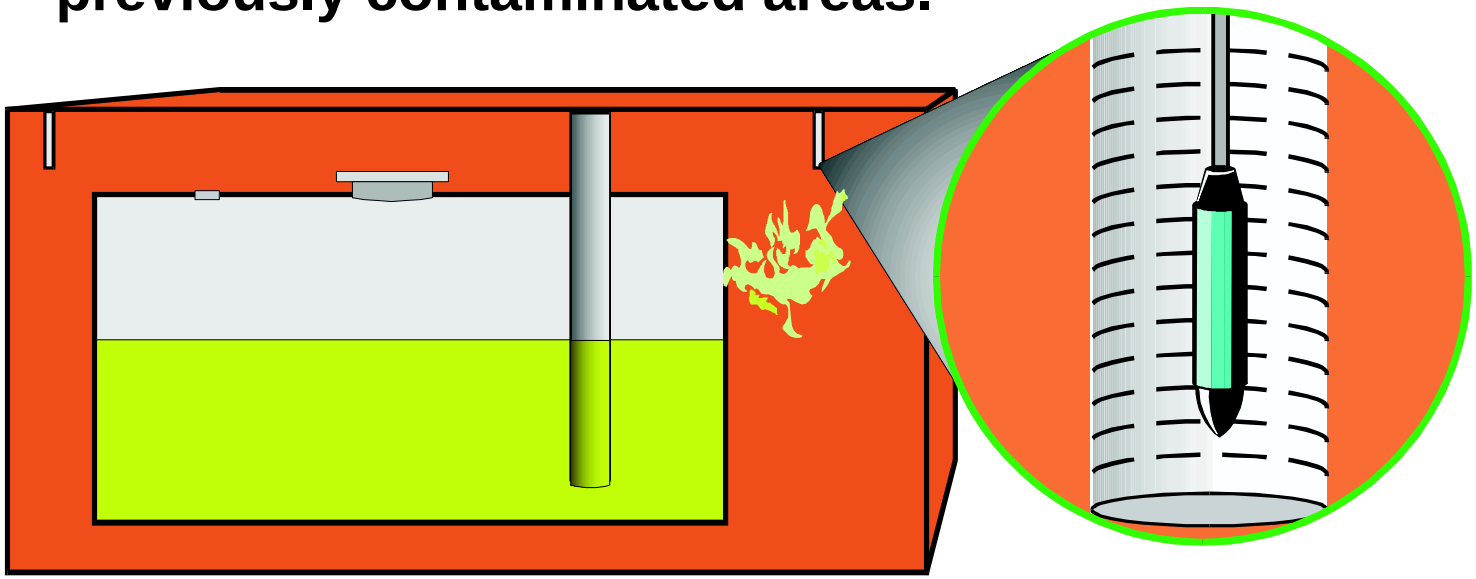
Vacuum tightness **testing places a slight negative pressure on the tank. The operator monitors for the sound of air bubbles entering**



Leak Detection Methods: Tightness Testing (cont.)

Non-volumetric

Tracers injected into the tank are monitored by special vapor monitors in the soil. Helpful in previously contaminated areas.



Manual Tank Gauging

Leak Detection Methods: Manual Tank Gauging

Overview:

- **Static form of inventory control—uses tank sticking.**
- **Usually used for low-throughput tanks such as used oil.**
- **Can be used exclusively on tanks of 1000 gallons or less for the life of the tank.**
- **When combined with tank tightness testing, can be used on tanks up to 2000 gallons.**
- **Use on tanks >1000 gallons after 1998 restricted to new or upgraded tanks. Even then, usable for only 10 years.**

Leak Detection Methods: Manual Tank Gauging (cont.)

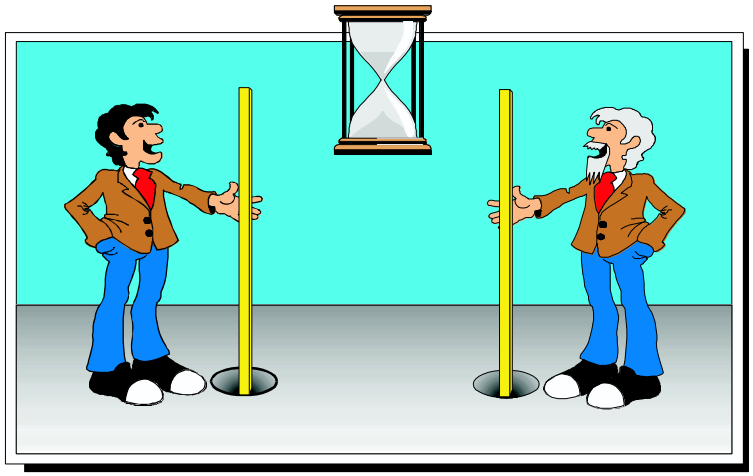
Method

- Close tank for duration of test (at least 36 hours)
- Stick tank twice at beginning of test period and average the two
- Stick tank twice at end of test period and average the two
- Compare difference with chart of maximum variance allowed

Leak Detection Methods: Manual Tank Gauging (cont.)

Considerations

- **Tank sizes are limited**
- **Tanks must be taken out of service >36 hours for test**
- **Must be tested weekly; time consuming**
- **Only good for tanks,**



It's a pain!

Statistical Inventory Reconciliation (SIR)

Leak Detection Methods: Statistical Inventory Reconciliation

Overview

- **Uses stick measurements and product sales, just like inventory control**
- **Data forwarded monthly to SIR contractor for evaluation**
- **Three possible replies: tight, suspected release, & indeterminable**
- **Dual usage: as monthly monitoring or as annual tightness test**

Leak Detection Methods: SIR (cont.)

Considerations

- **Shares many of the same concerns as inventory control:**

  Tanks must be measured daily
  Requires diligent staff

- **Offsite record maintenance a benefit**
- **Low upfront costs**
- **Monitors entire UST system—tanks and lines**
- **Currently limited to tanks under 18,000 gallons.**

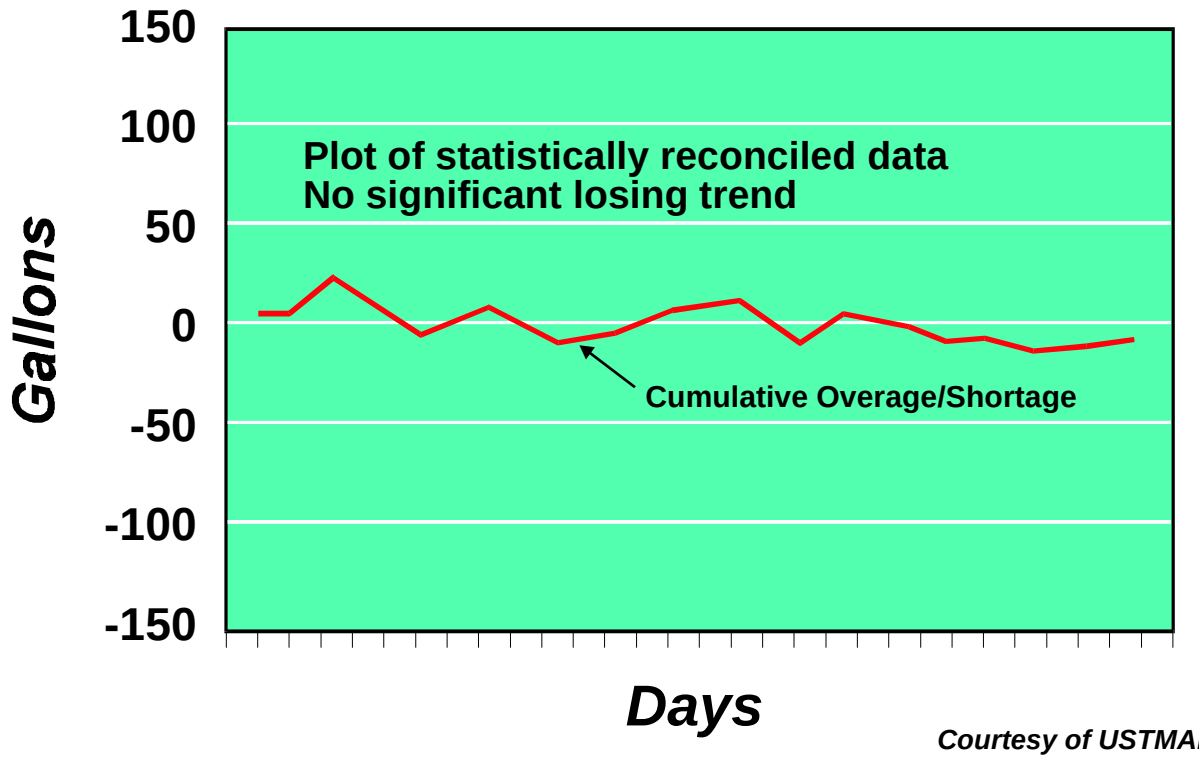
Leak Detection Methods: SIR (cont.)

Other Features

- **Determines dispenser miscalibration**
- **Sometimes can determine vertical location of tank leak**
- **Identifies shortages in delivery or possible theft**
- **Provides off-site record storage**
- **Low up-front cost per UST**

Leak Detection Methods: SIR (cont.)

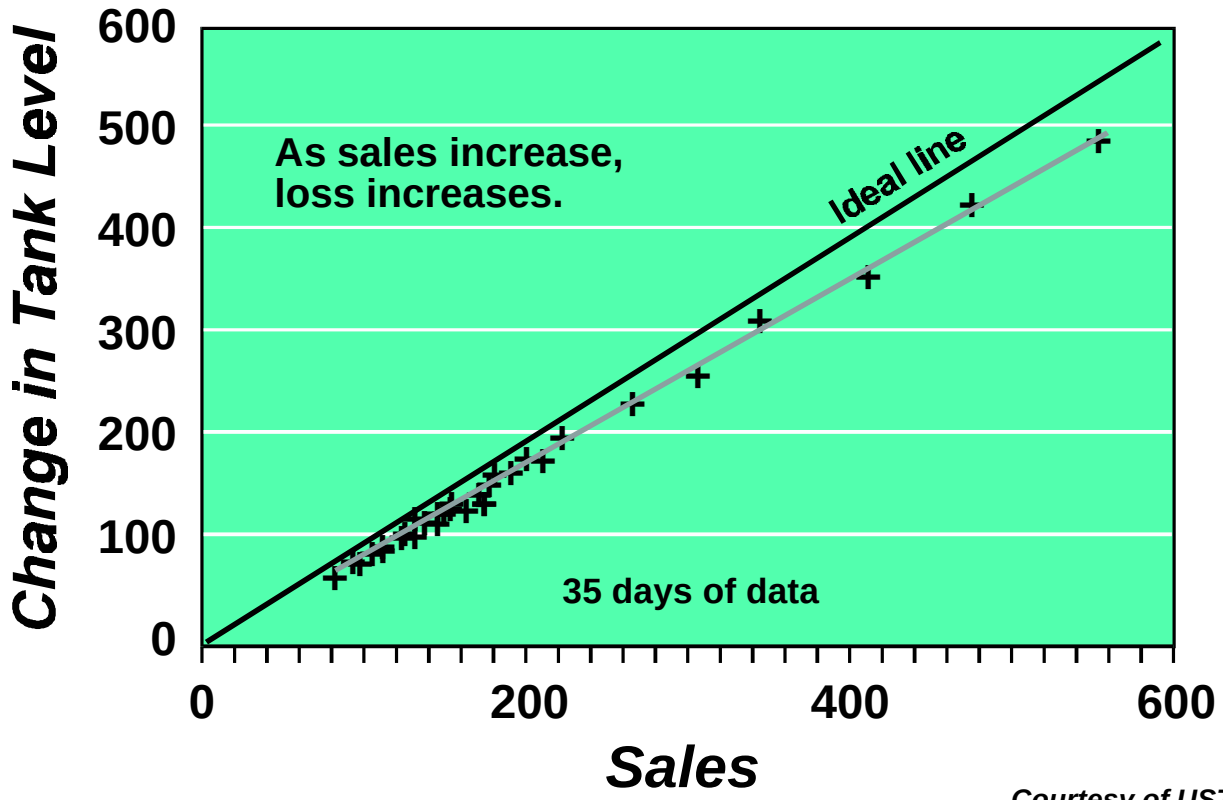
Tank Tightness



Courtesy of USTMAN Industries

Leak Detection Methods: SIR (cont.)

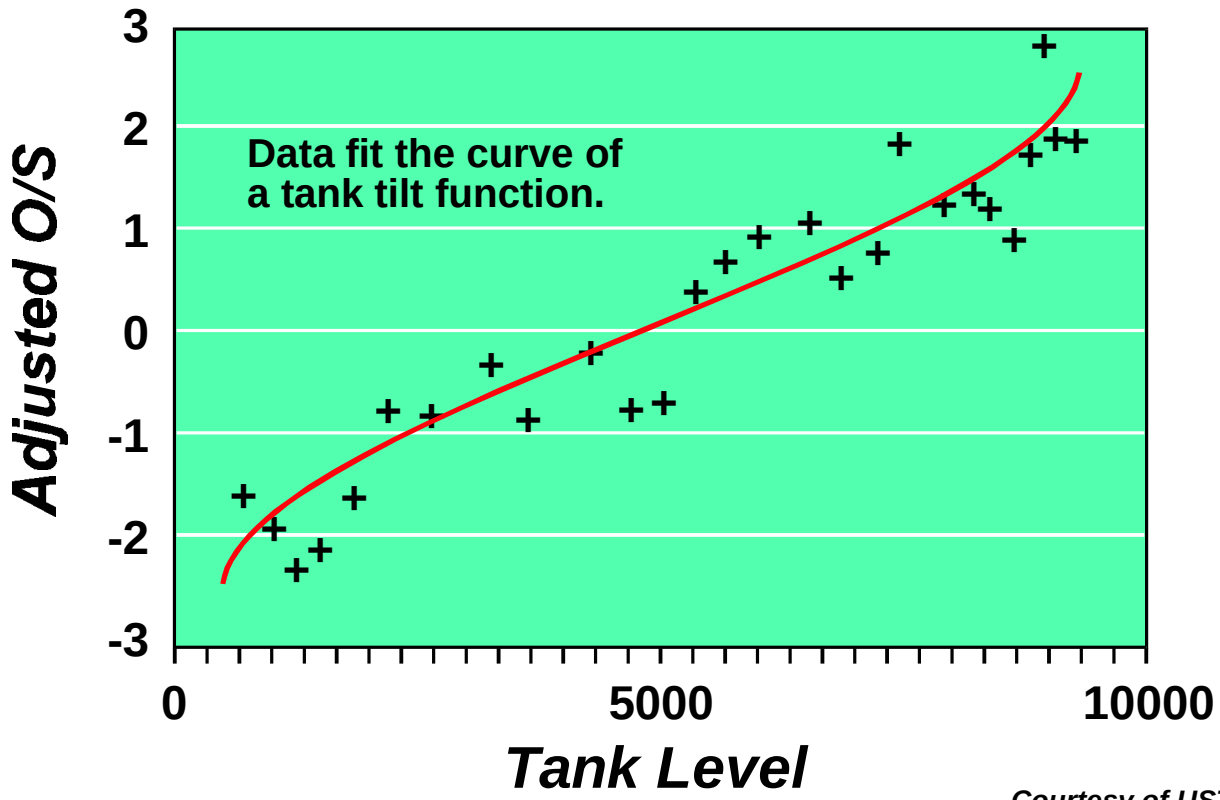
Dispenser Error



Courtesy of USTMAN Industries

Leak Detection Methods: SIR (cont.)

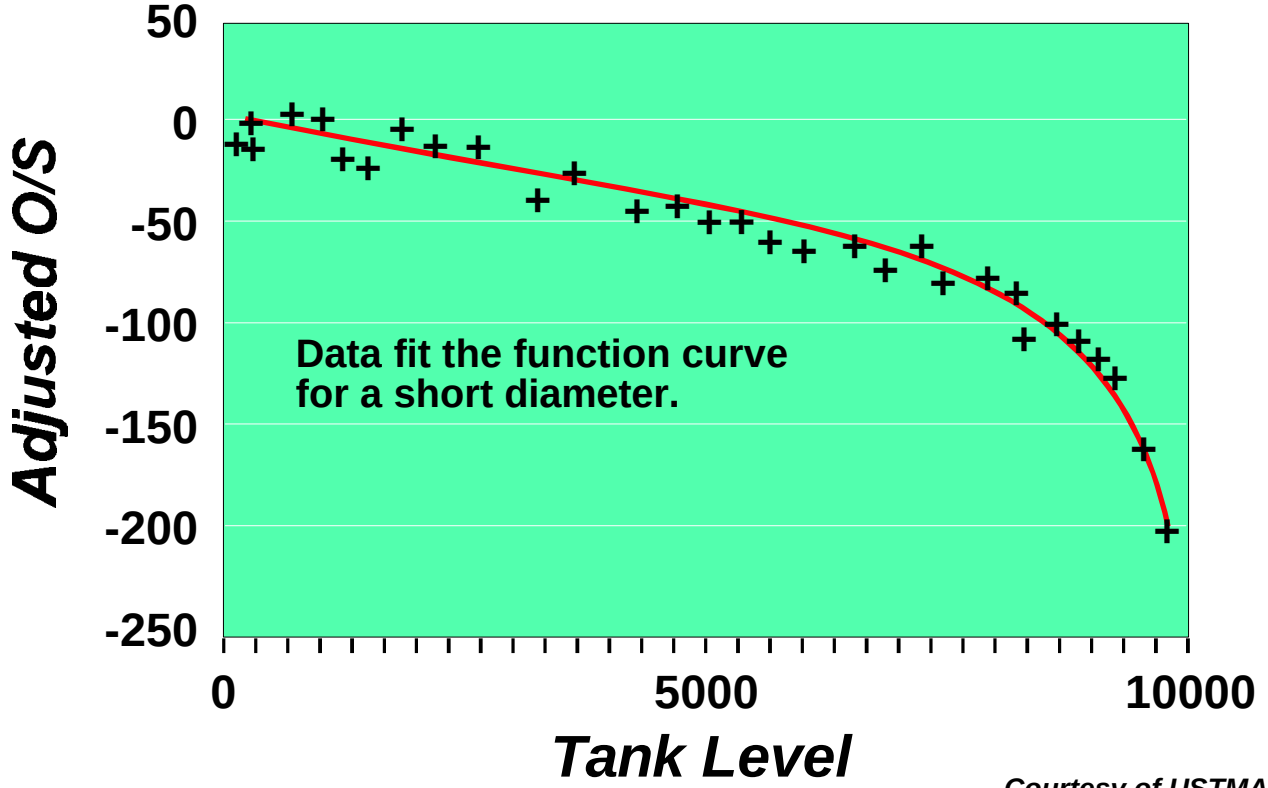
Tilted Tank



Courtesy of USTMAN Industries

Leak Detection Methods: SIR (cont.)

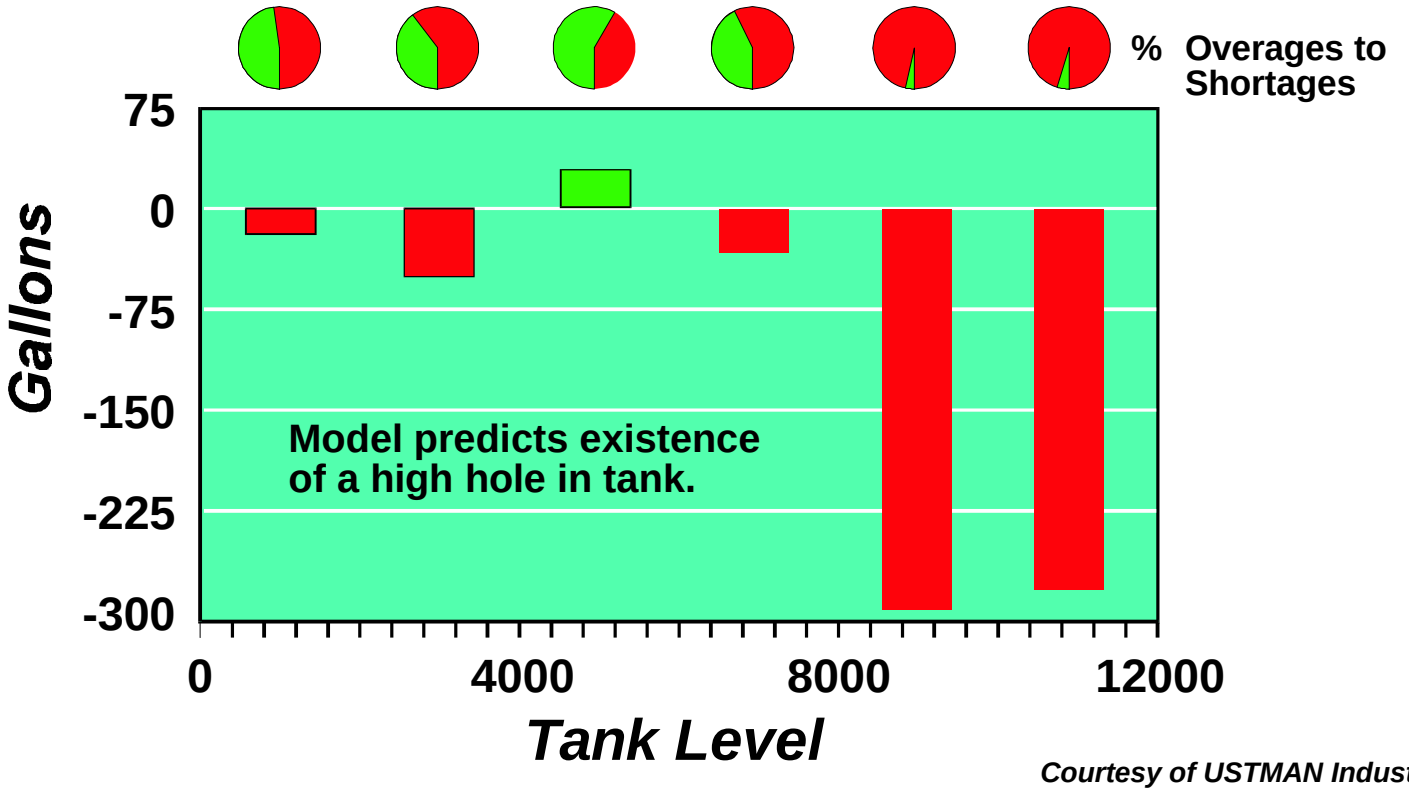
Chart Error Identification



Courtesy of USTMAN Industries

Leak Detection Methods: SIR (cont.)

High Hole Detection



Courtesy of USTMAN Industries

Automatic Tank Gauges (ATGs)

Leak Detection Methods: Automatic Tank Gauges — ATGs

Overview

- **In-tank equipment that electronically monitors product level, water level, and temperature.**
- **Primarily used with petroleum products.**
- **Two modes of operation:**

  Inventory Control

  Leak Testing

Leak Detection Methods: Automatic Tank Gauges — ATGs (cont.)

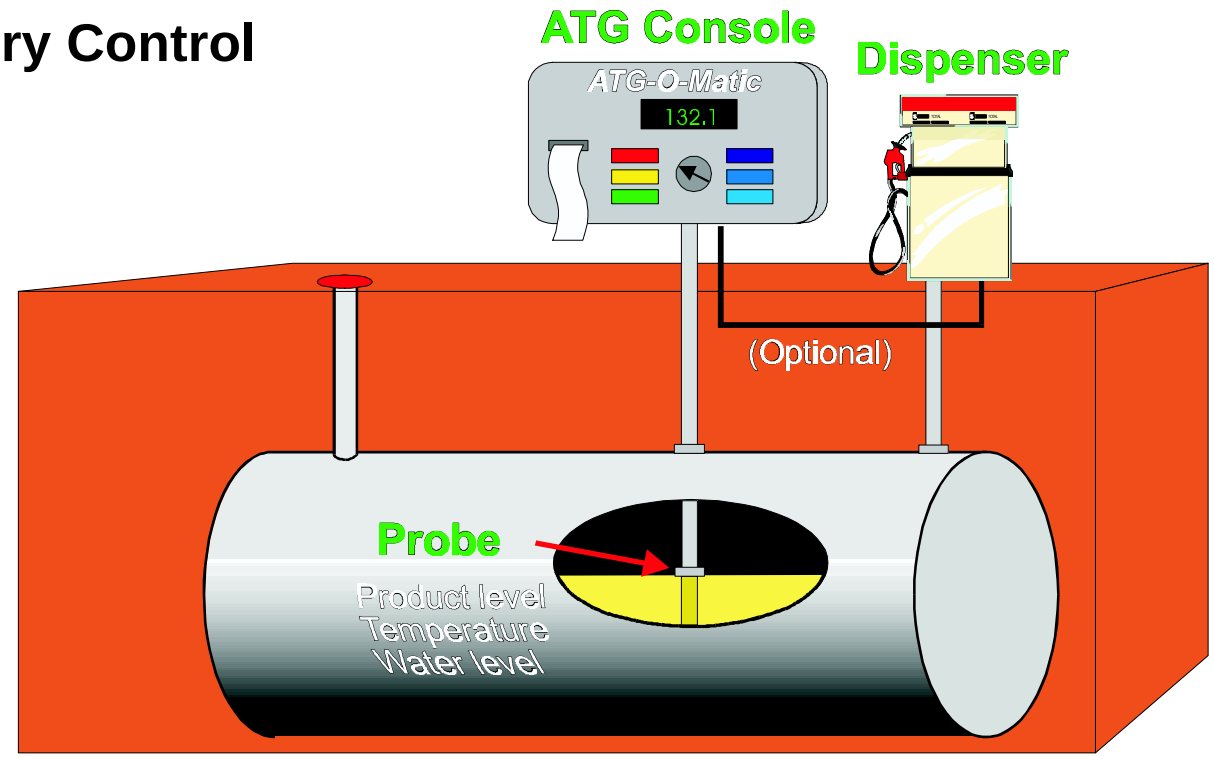
Considerations

- **Primarily for petroleum tanks under 15,000 gallons**
- **Cannot be used for piping**
- **Generally not retrofitted on older systems**

Leak Detection Methods: Automatic Tank Gauges — ATGs (cont.)

Dual Operating Modes

- Inventory Control
-



Leak Detection Methods: Automatic Tank Gauges — ATGs (cont.)

Inventory Control Mode

- **Records product levels corrected for temperature. Data used in inventory control.**
- **Provides alarms for high and low product levels, high water level, and theft of product.**
- **Modular systems can be expanded to link to dispensers, monitoring wells, computers, etc.**
- ***Use of inventory control mode required of ATG use by regulation!***

Leak Detection Methods: Automatic Tank Gauges — ATGs (cont.)

Leak Test Mode

- **High-precision tightness test done, typically during extended periods of inactivity when tank not in use.**
- **New, statistically-modeled ATGs can test tank tightness without taking tank out of operation.**
- **Tests can be run at any level of product in**

Secondary Containment

Leak Detection Methods: Secondary Containment Monitoring

Overview

Interstitial monitors test for product in the space between the tank and the outer containment barrier. Methods include:

- **Vapor sensors**
- **Liquid sensors**
- **Electrical conductivity**
- **Pressure sensing**
- **Hydrostatic sensing**
- **Manual sticking**

Leak Detection Methods: Secondary Containment Monitoring (cont.)

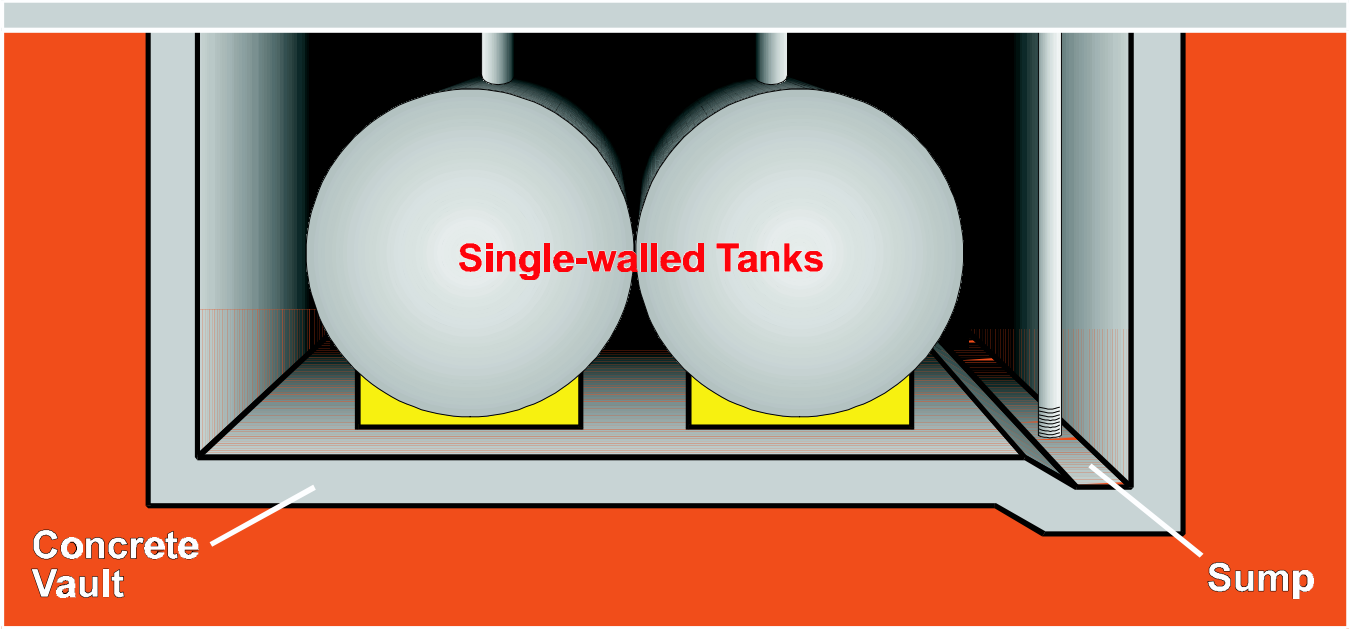
Considerations

- **Double-walled tanks generally limited to sizes under 20,000 gallons.**
- **Secondary containment is generally impractical for pre-existing tanks and piping.**
- **Use of excavation liners requires more careful attention on the part of installers.**
- **Can be expen$ive! Double-walled tanks cost double.**
- **Corrective action costs are minimized or eliminated entirely—leaks are contained.**

Leak Detection Methods: Secondary Containment Monitoring

Vaulted Tanks:

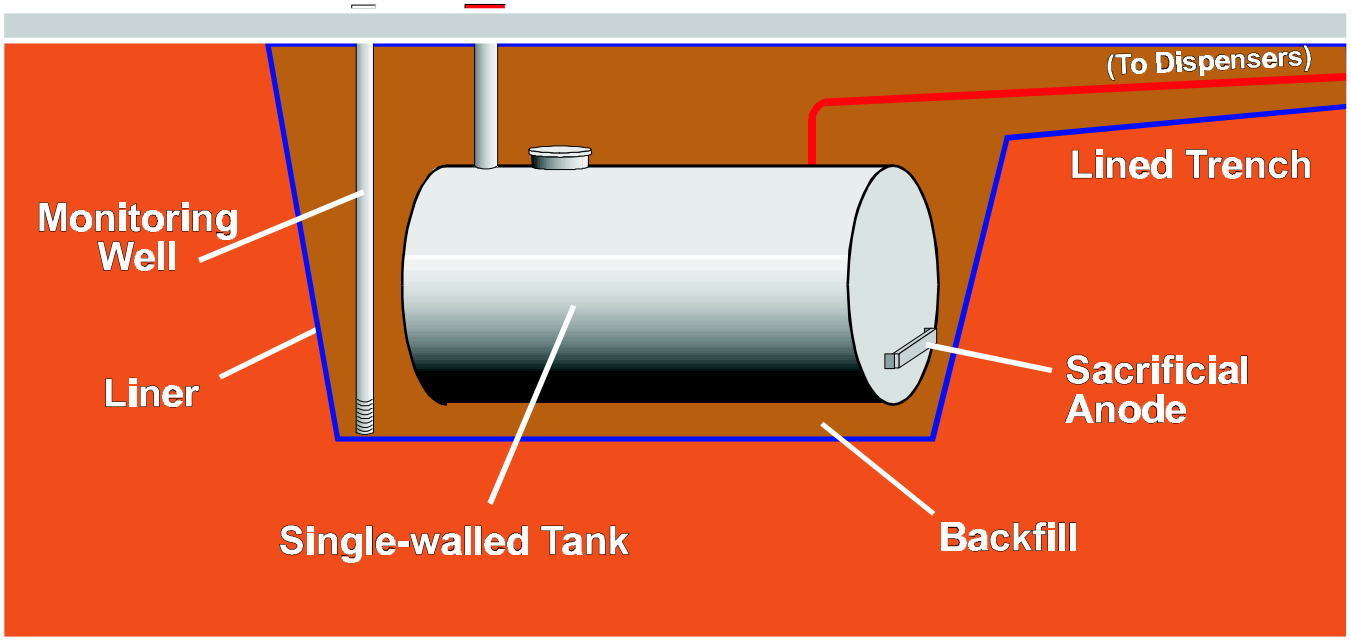
- **Not considered as USTs!**



Leak Detection Methods: Secondary Containment Monitoring (cont.)

Excavation liner

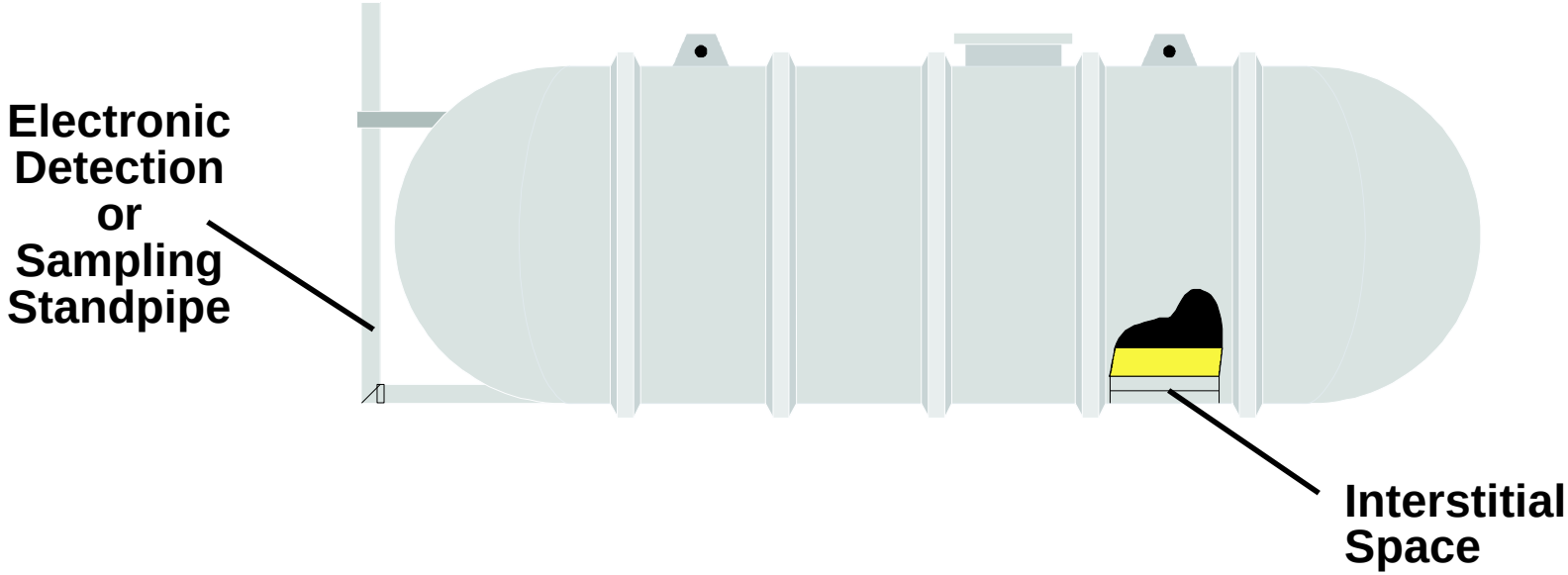
Not practical for retrofits



Leak Detection Methods: Secondary Containment Monitoring (cont.)

Double-walled Tanks

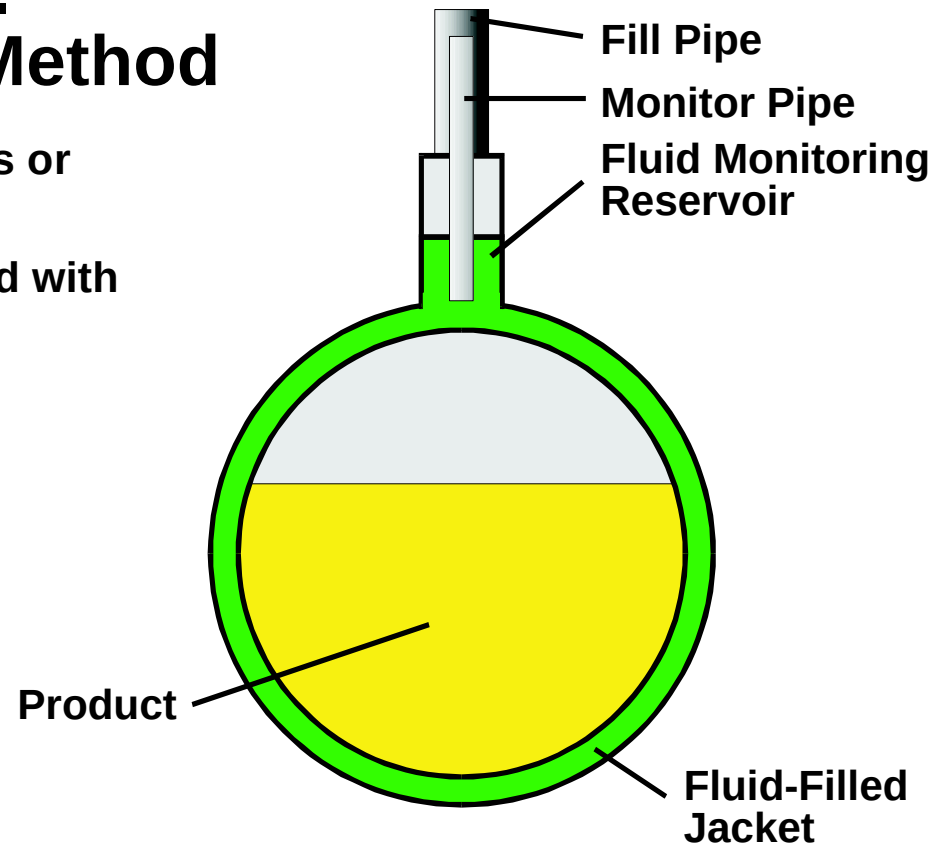
- Various electronic sensors can be used.
- Manual monitoring is another option.



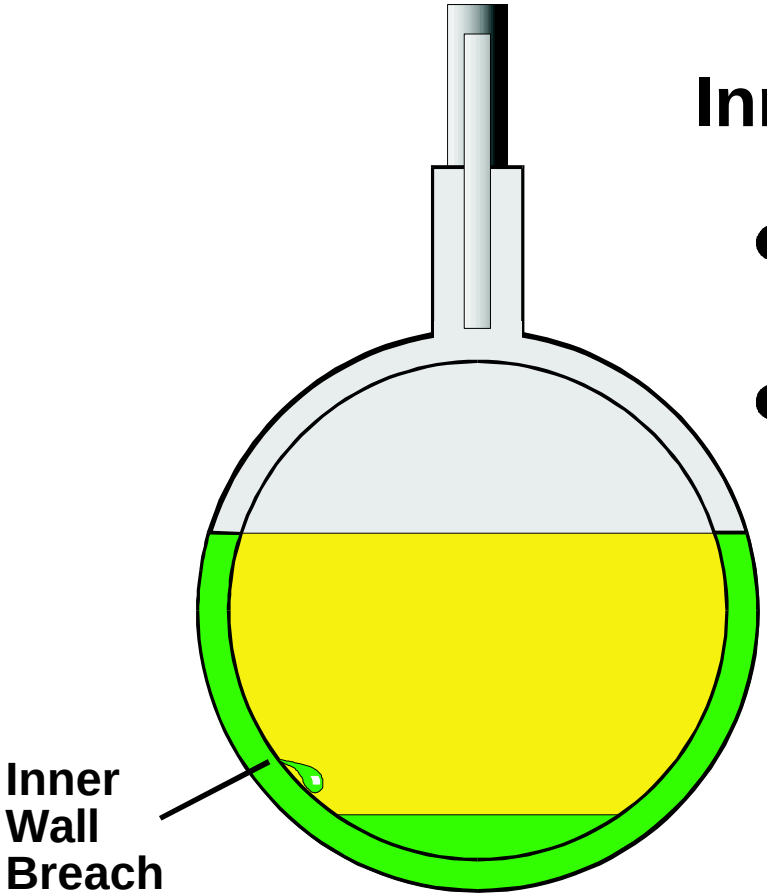
Leak Detection Methods: Secondary Containment Monitoring (cont.)

Another Option... the Hydrostatic Method

- Monitored by sensors or manually
- Interstitial space filled with detectable solution



Leak Detection Methods: Secondary Containment Monitoring (cont.)



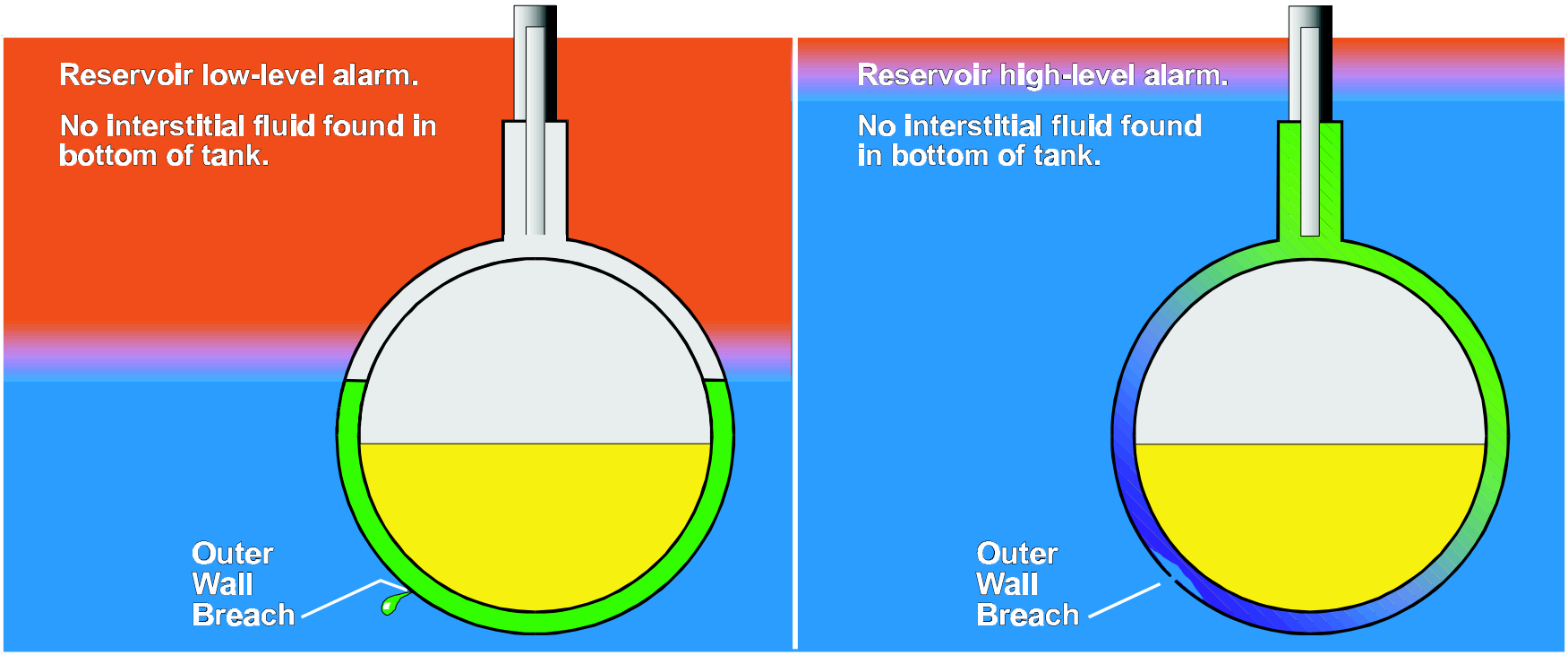
Inner Wall Breach

- Reservoir low-level alarm
- Interstitial fluid found in bottom of tank

Leak Detection Methods: Secondary Containment Monitoring (cont.)

Outer Wall Breach

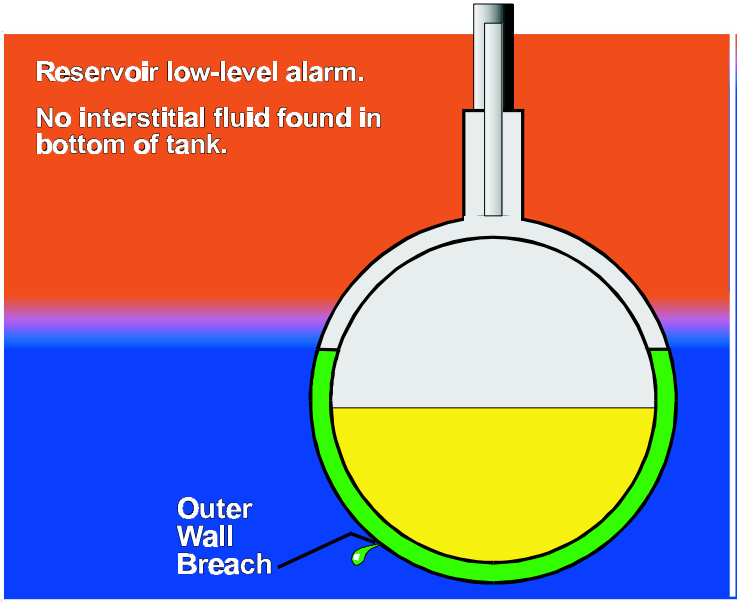
- Low Groundwater
- High Groundwater

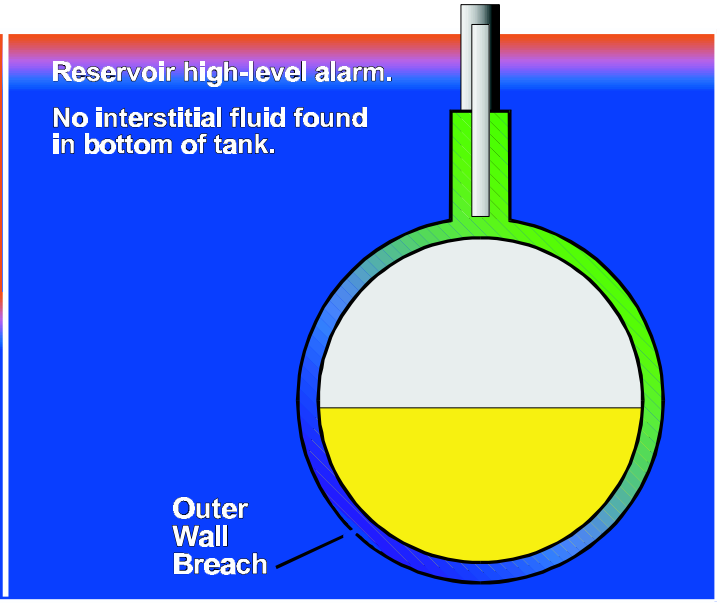


Leak Detection Methods: Secondary Containment Monitoring (cont.)

Outer Wall Breach

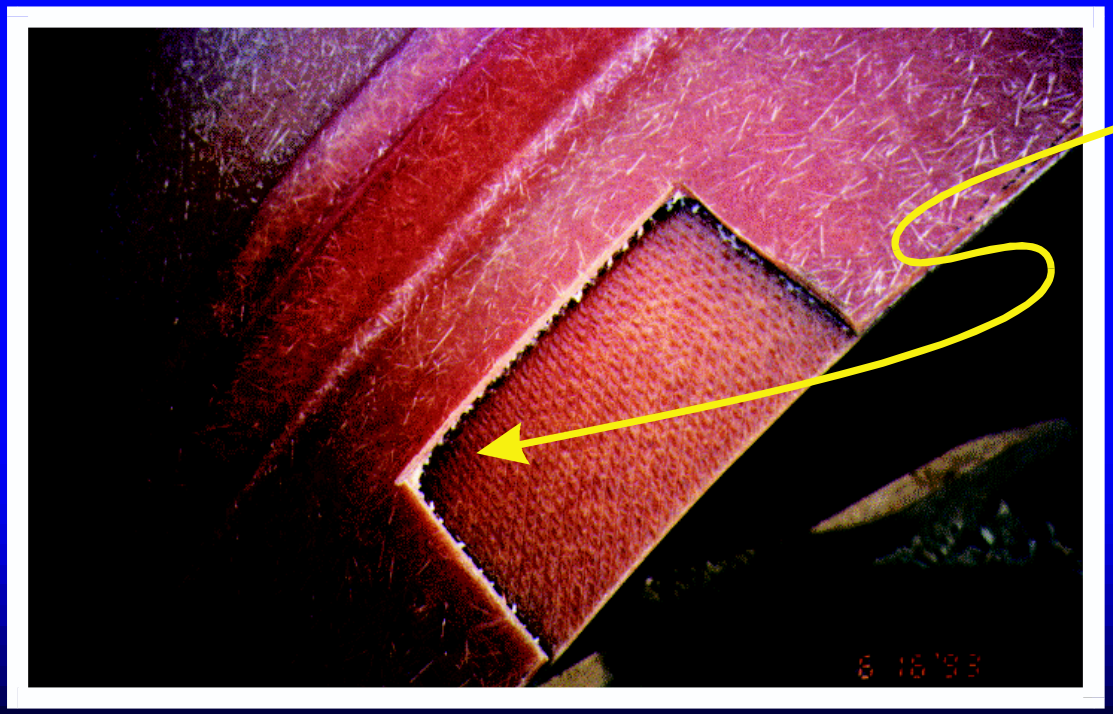
- **Low Groundwater**
- **High Groundwater**





Leak Detection Methods: Secondary Containment Monitoring

Hydrostatic FRP Tank



- Actual space between inner and outer walls is quite small.

Tanks are shipped with fluid already in place.

Groundwater Monitoring

Leak Detection Methods: Groundwater Monitoring

Overview:

- Used to check for the presence of product floating on the groundwater.
- Wells are placed in or near the backfill of the excavation pit to detect leaks rapidly.
- Number and spacing must be adequate to detect any leak from monitored tank(s) or line(s).
- Two major system classes: *manual* and *automatic*.

Leak Detection Methods: Groundwater Monitoring (cont.)

Considerations

- **Product must float on water.**
- **Soil in which well is placed must be porous and permeable.**
- **Level of groundwater must at no time be greater than 20 feet below surface.**
- **Gradient of groundwater flow must be known for effective well placement. Site assessment is required!**
- **Groundwater monitoring can be used with existing as well as new systems.**

Leak Detection Methods: Groundwater Monitoring (cont.)

Manual Devices

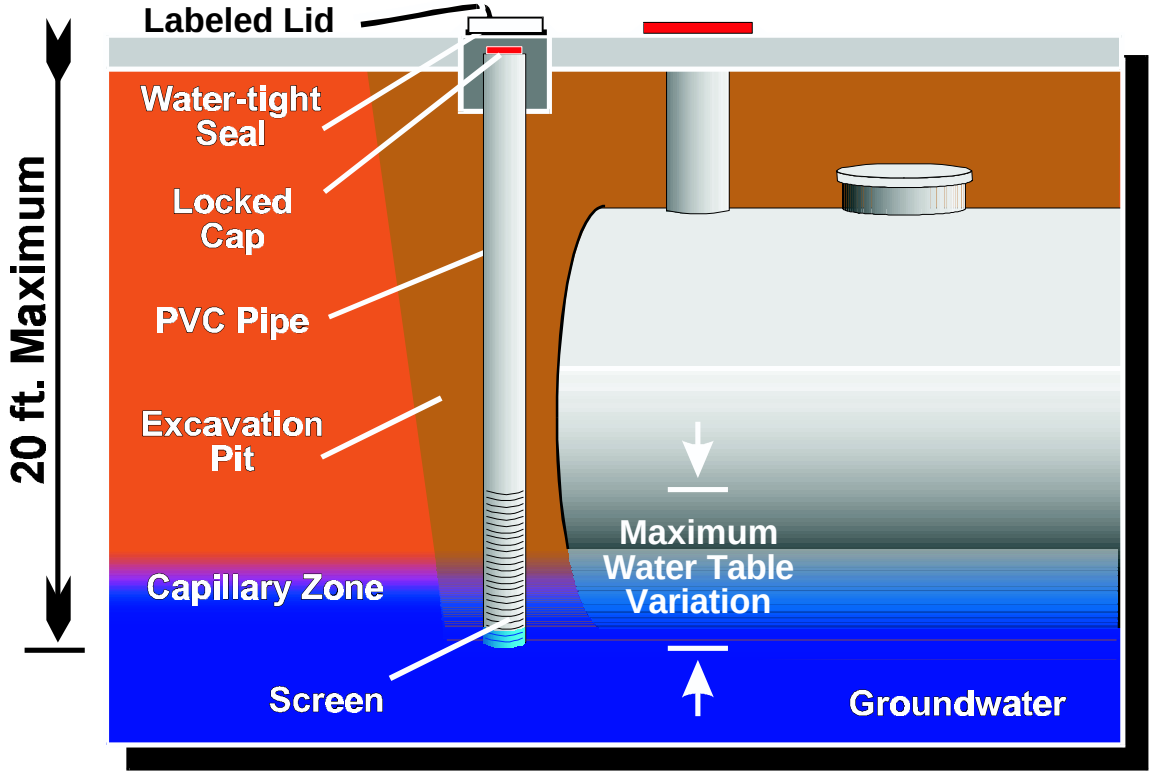
- Grab samplers (bailers)
- Chemically-sensitive pastes

Automatic Devices

- Differential floats
- Product soluble devices
- Thermal conductivity devices
- Electrical conductivity devices

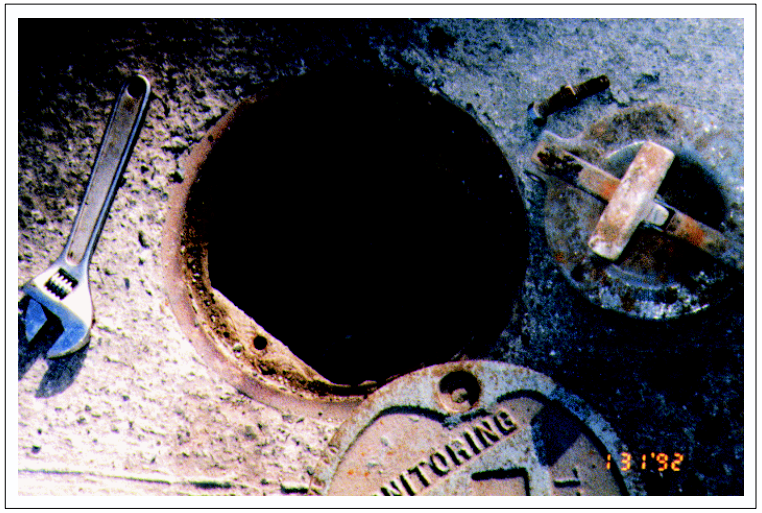
Leak Detection Methods: Groundwater Monitoring (cont.)

Monitoring Well

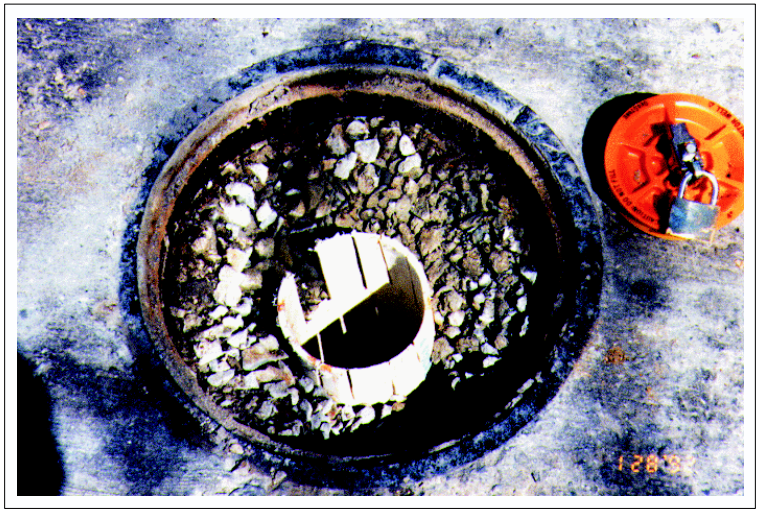


Leak Detection Methods: Groundwater Monitoring (cont.)

NOT the way to do it!



Would you believe...
a well with a *tank fill fitting*?



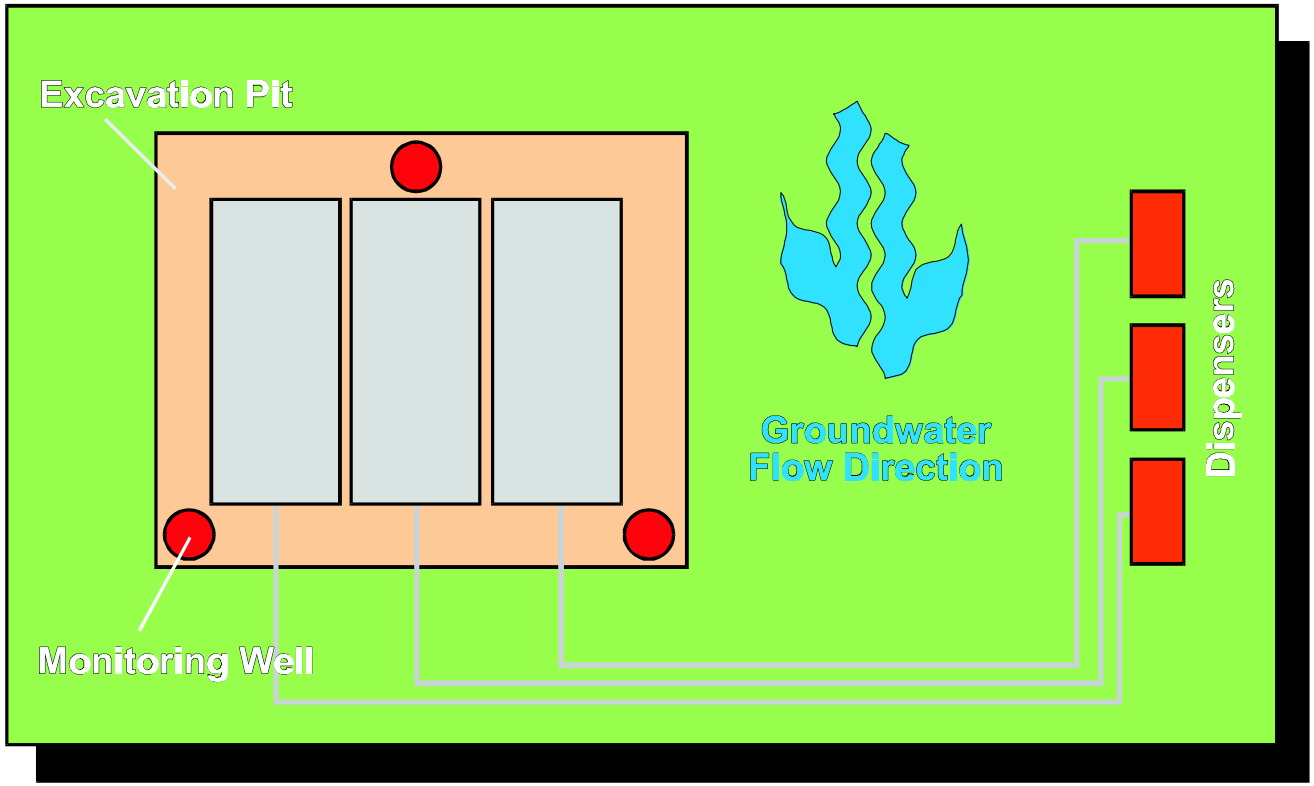
And *this* was done by an "experienced" contractor!

Leak Detection Methods: Groundwater Monitoring

Other problems...

Leak Detection Methods: Groundwater Monitoring (cont.)

Typical Facility Plan View



Vapor Monitoring

Leak Detection Methods: Vapor Monitoring

Overview

- **Vapor monitoring is used to check for the presence of product vapors in the soil.**
- **Wells are placed in or near the backfill of the excavation pit to detect leaks rapidly.**
- **Number and spacing must be adequate to detect any leak from monitored tank(s) or line(s).**
- **There are two major system classes: *manual* and *automatic*.**
- **This is *not* recommended for sites with prior contamination.**

Leak Detection Methods: Vapor Monitoring (cont.)

Considerations

- **Product must vaporize readily.**
- **Vapor monitoring can be used for tanks or piping.**
- **It can be used with existing as well as new systems.**
- **Soil in which well is placed must be porous and permeable. Site assessment is required!**
- **Soil should be free of contamination to prevent false alarms.**

Leak Detection Methods: Vapor Monitoring (cont.)

Manual Devices

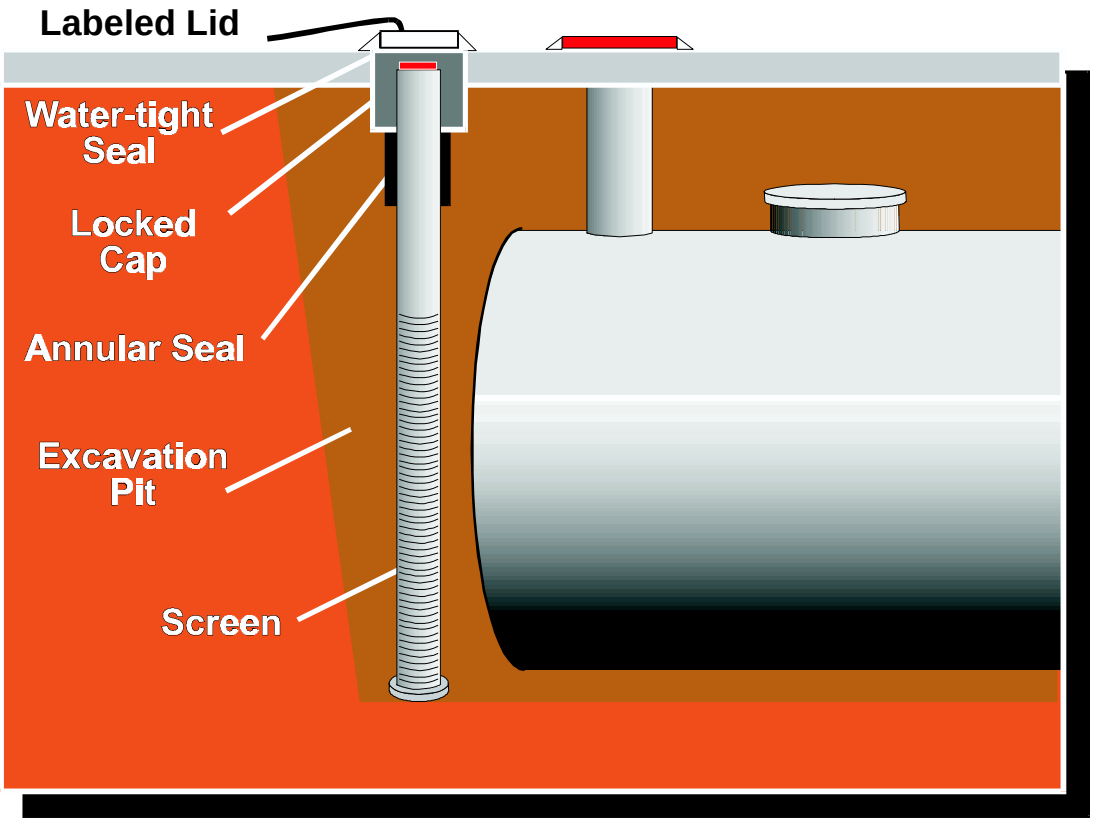
- Dräger tubes
- Photo-ionization detectors
- Flame-ionization detectors
- Gas chromatographs

Automatic Devices

- Appropriate vapor sensors tied to central alarm panel

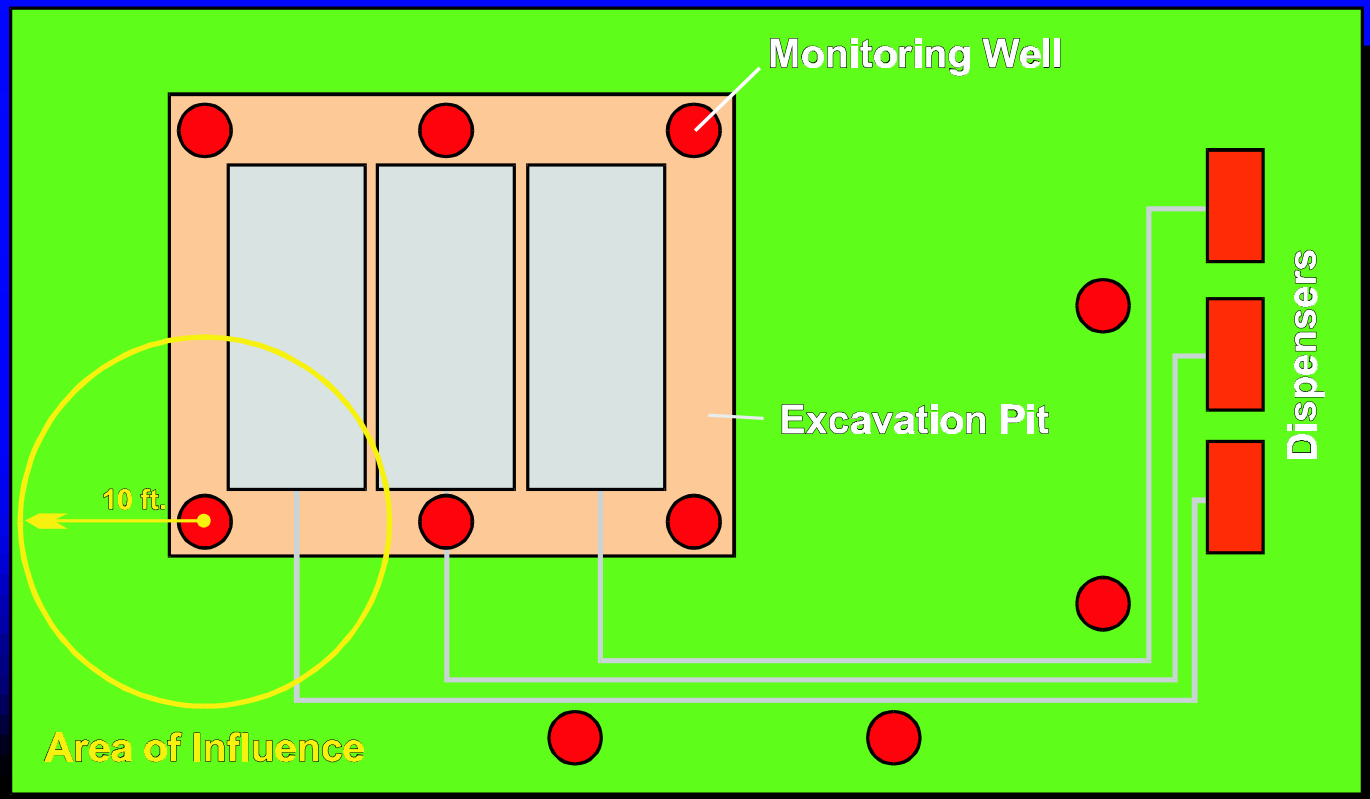
Leak Detection Methods: Vapor Monitoring (cont.)

Vapor Monitoring Well



Leak Detection Methods: Vapor Monitoring

Typical Facility Plan View:



Leak Detection Methods For Piping

Leak Detection Methods

Piping:

- **Requirements vary widely according to type of piping:**

  Suction
  Pressurized

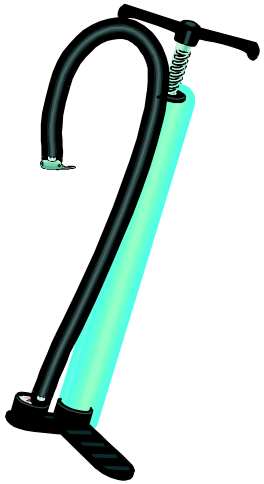
- **Many tank methods can also be used for piping:**

  Monitoring wells
  Secondary containment
  Tightness testing

Piping

Requirements differ according to system type

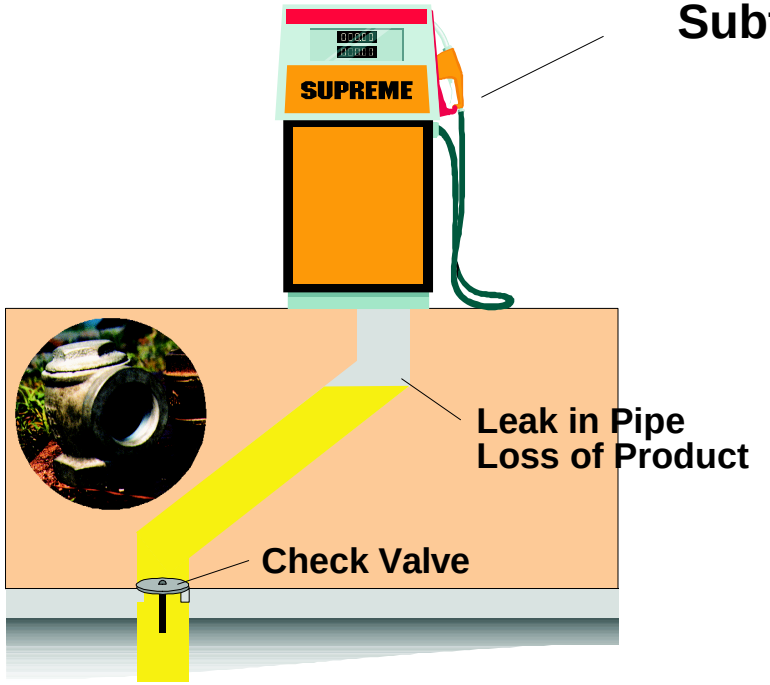
Suction
Safer, fewer requirements



Pressurized
More risk, more requirements

Leak Detection: Suction Piping

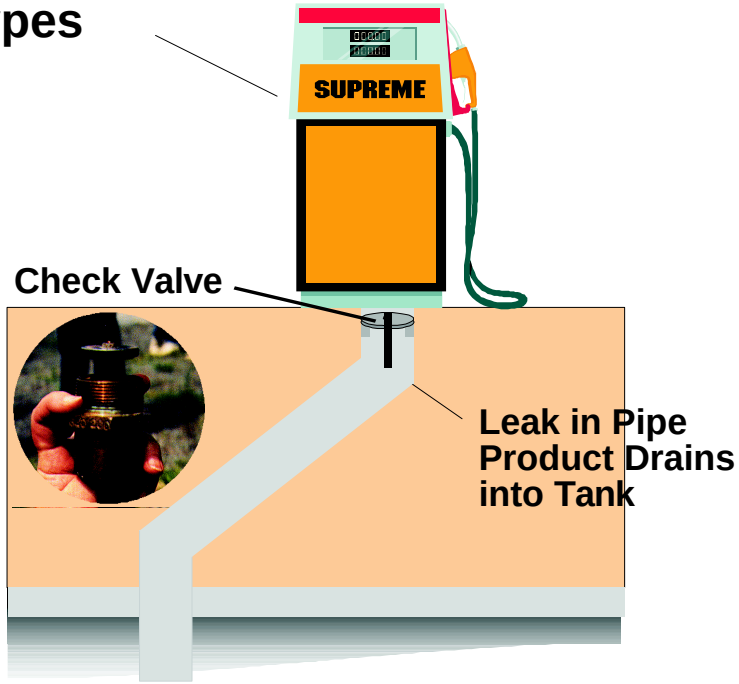
Two Subtypes



American System

Line Tests Every 3 Years

Same Phase-In Schedule as Tanks



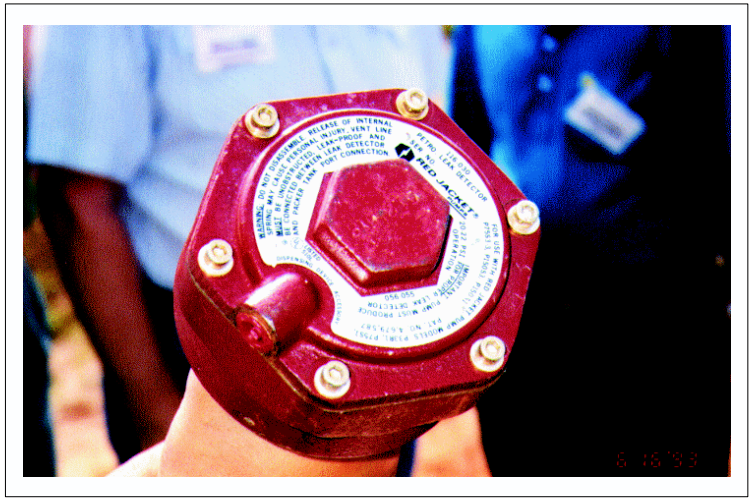
European System

Nothing Else, Ever!

(If done right!)

Leak Detection: Pressurized Piping

Two Requirements

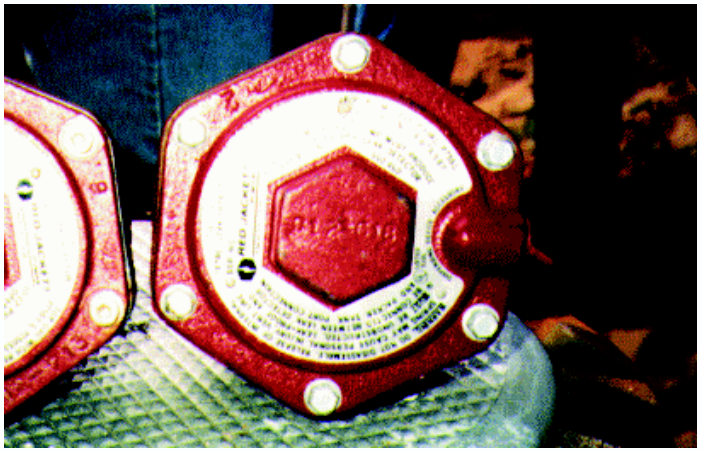


Line Leak Detector
Flow Restrictor ("Red Jacket"), or Flow Shutoff, or Alarm System

Periodic Testing
Line Tightness Testing or Appropriate Tank Methods

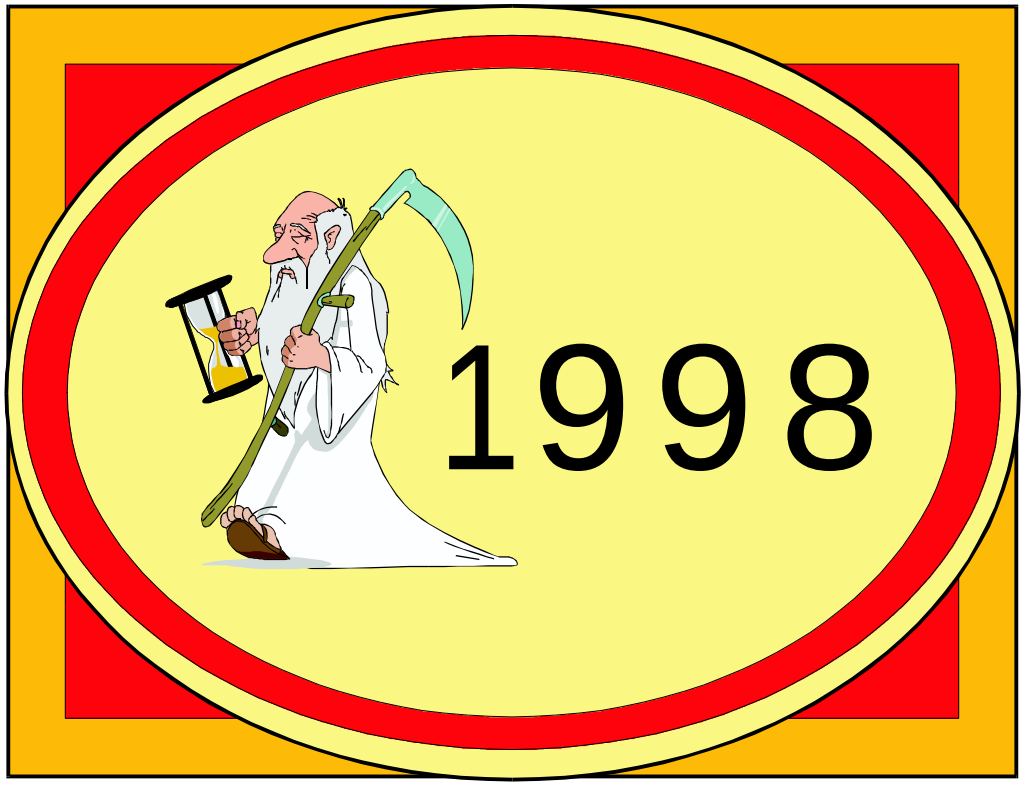
Leak Detection: Pressurized Piping (cont.)

Red Jacket ALERT!



Old Style
Hex bolts on cover.
Bolts fatigue and fail!

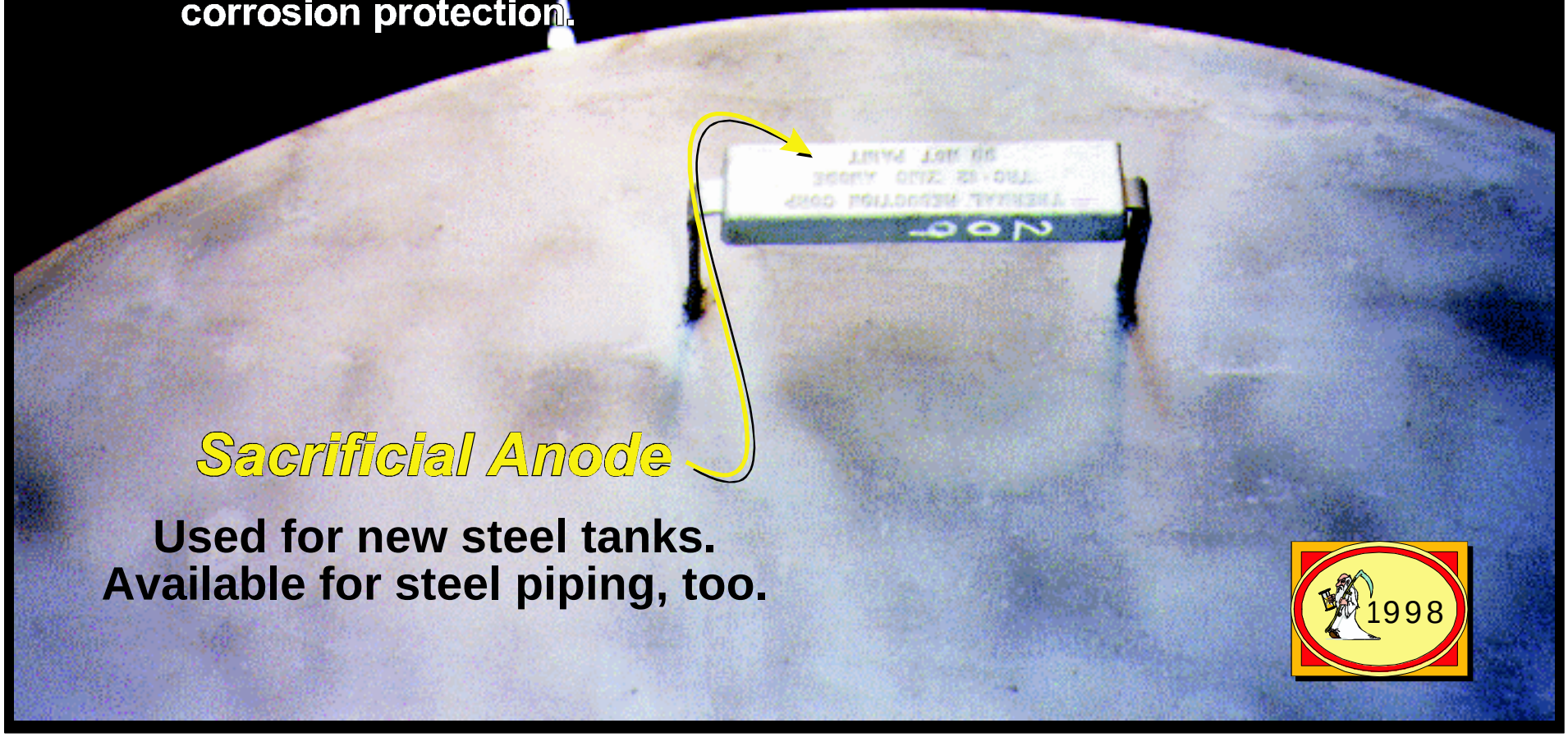
New Style
Allen head bolts.
Get yours replaced now!



You Can Run...
But You Cannot Hide!

Corrosion Protection

- By 1998, ***ALL*** UST systems must have an acceptable form of corrosion protection.



Sacrificial Anode

Used for new steel tanks.
Available for steel piping, too.

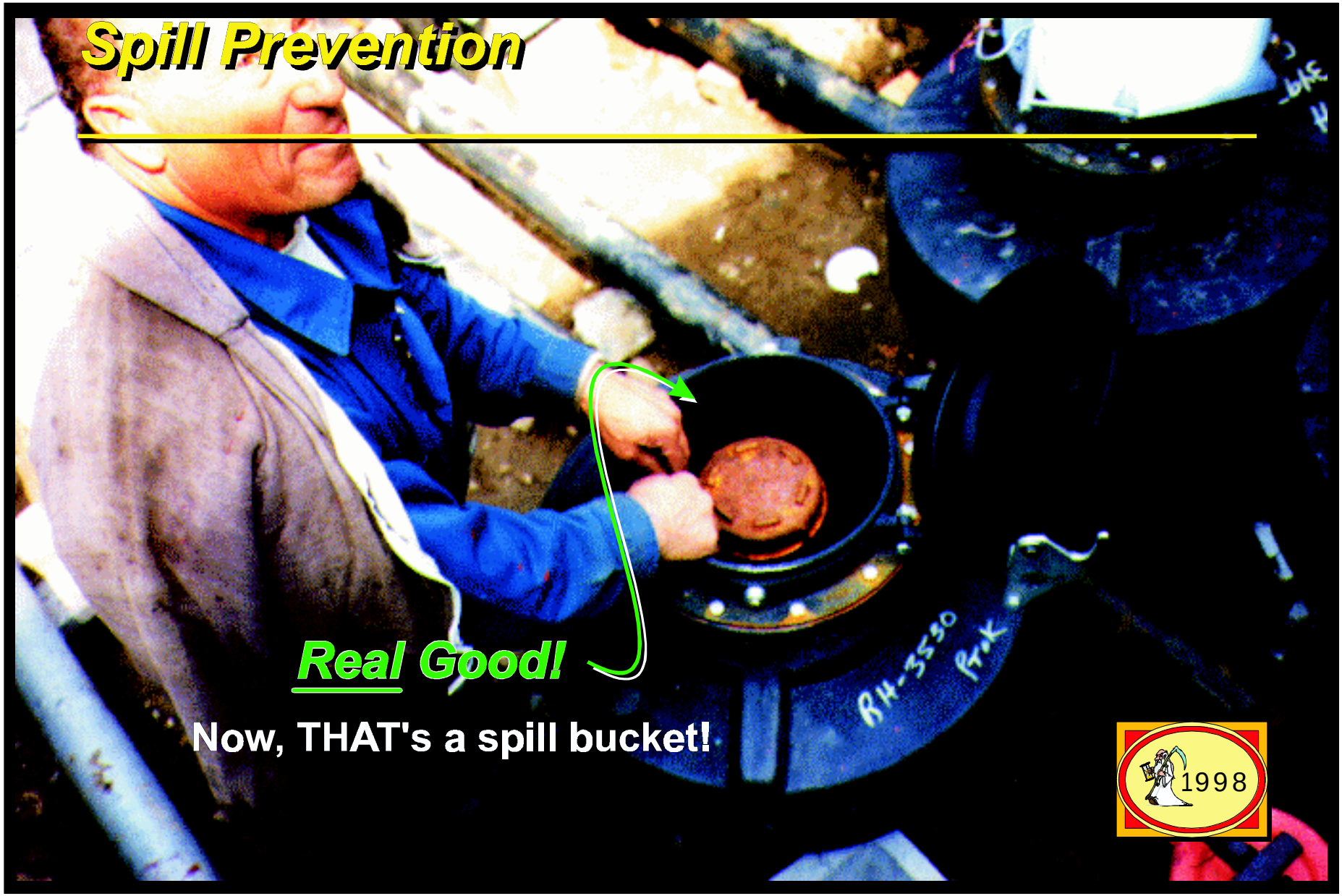
1998

Corrosion Protection

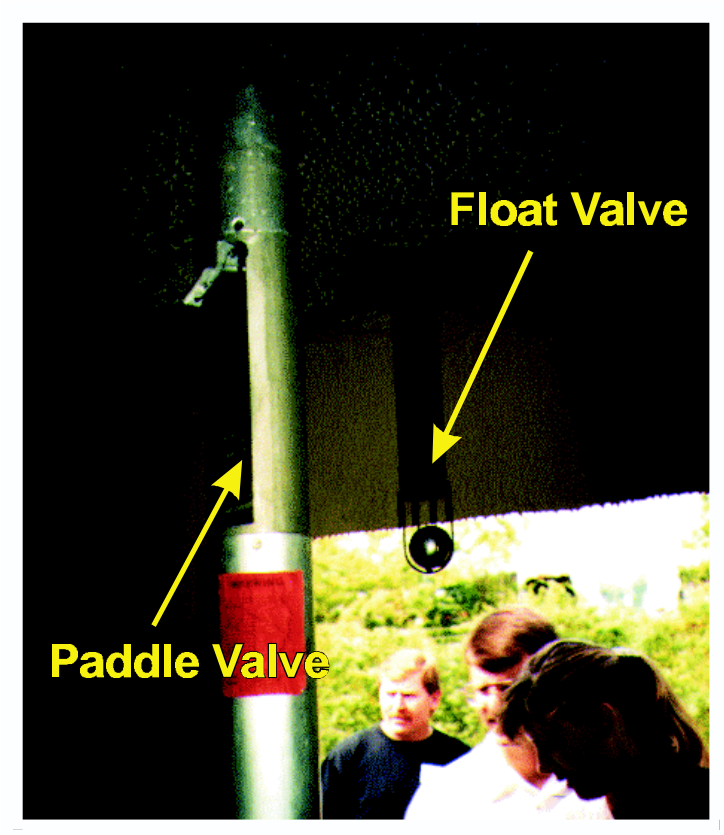
- **There are numerous options for new tank installations.**
- **Impressed current is a possibility for existing steel tank systems.**

1998

Spill Prevention
Equipment must be in place to catch transfer hose
Bad!
No spill catchment.
Good!
Rim minimizes runoff infiltration.
1998


Spill Prevention
Real Good!
Now, THAT's a spill bucket!
RH-3550
1998

Overfill Prevention



- **Mechanisms must be in place to shut off flow into the tank when the tank is more than 95% full.**
- **Equipment must alert the transfer operator when**

Secondary Containment for Hazardous Substances

Secondary containment *required* for tanks and piping holding hazardous substances *unless* another method of leak detection shown as adequate.

Aboveground Storage Tanks (ASTs)

CONSTRUCTION
1 km
ASTs

Aboveground Storage Tanks (cont.)

NOT the way to do it!

First of all, this is an UST!

Aboveground Storage Tanks

Forthcoming regulations will likely include most of the following:

- **Restricted tank sizes. Perhaps 12,000 gallons or less for flammable products.**
- **Adequate distance from property lines and buildings.**
- **Spill containment.**
- **Pressure safety valves in addition to regular vents.**
- **Product delivery safety valve.**
- **Overfill prevention.**

Aboveground Storage Tanks (cont.)

So this won't do either!

No containment wall.
No impervious flooring.
No safety valve.
No shear valve.
No nothing!

Summary — Leak Detection Methods

- Inventory and Tank Testing
- Inventory Control
- Tightness Testing
- Groundwater Monitoring

Summary — Leak Detection Methods (cont.)

- Vapor Monitoring
- Manual Gauging
- Secondary Containment
- Automatic Tank Gauging
- Statistical Inventory Reconcilation