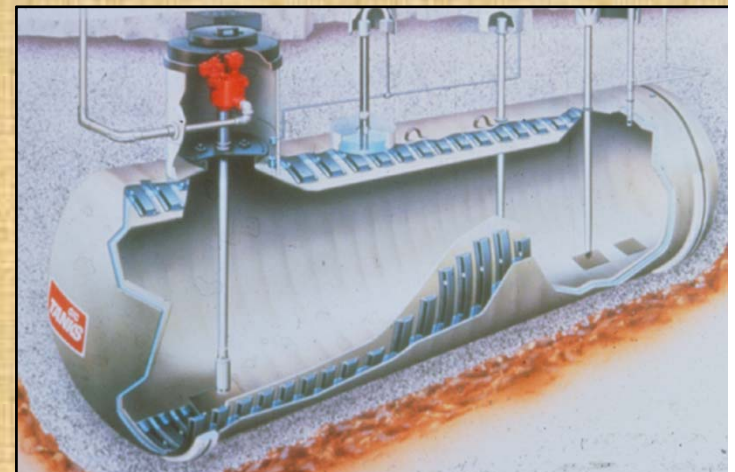
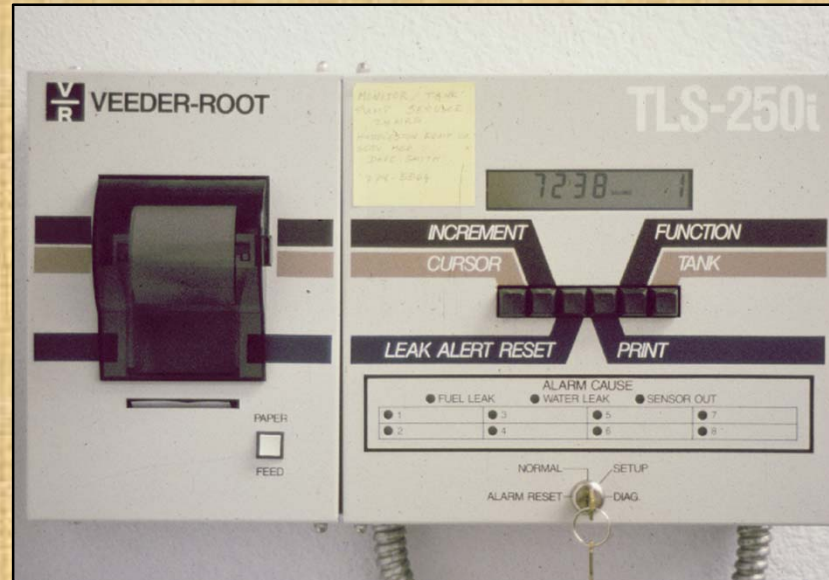


# Where Are We Going?



# Leak Detection Used to be Straightforward





# Now We Have Acronyms and Mysterious Words

---

**CSLD**

**CONTINUOUS ATG**

**SCALD**

**SIR**

**STATIC TEST**

**MIR**

**HYBRID ATG**

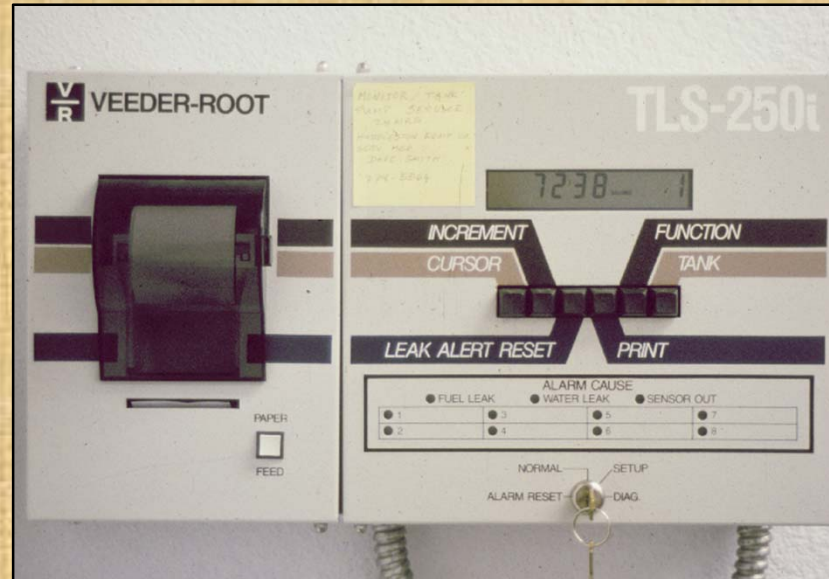
**INVENTORY**

**CITLD**

**PERIODIC TEST**

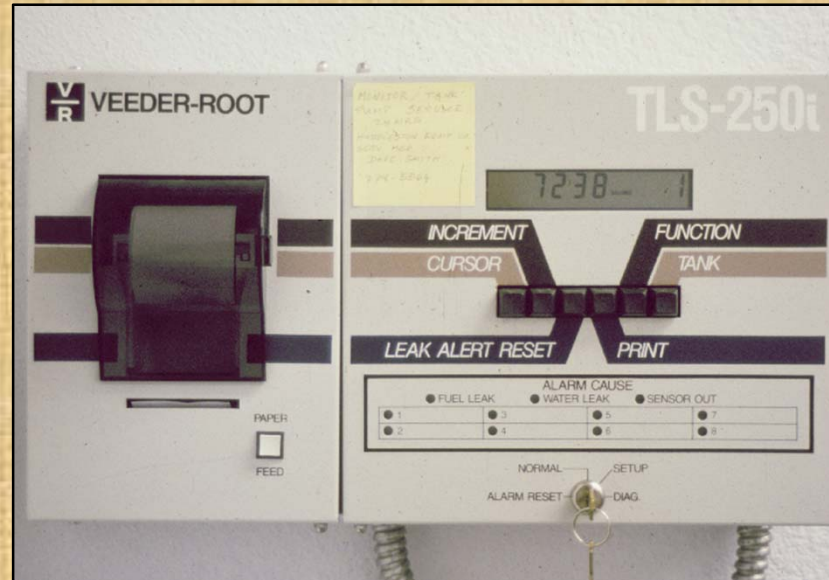
**CONTINUAL  
RECONCILIATION**

# Leak Detection Used to be Straightforward





# Leak Detection Used to be Straightforward



Will Focus on Leak Detection  
Approaches that Have Evolved the Most

# Leak Detection Used to be Straightforward

---



# What is Inventory?

---



# What is Inventory?

---

Counting things to see how many we have





# What is Inventory Reconciliation?

---



# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**





# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**

How many did you buy?      100



# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**

How many did you buy?      100

How many did you sell?      60





# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**

How many did you buy?      100

How many did you sell?      60

How many **SHOULD** be left?      40



# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**

How many did you buy? 100

How many did you sell? 60

How many SHOULD be left? 40

How many ARE left? 37





# What is Inventory Reconciliation?

---

**The process of ensuring that two sets of records are in agreement**

How many did you buy? 100

How many did you sell? 60

How many SHOULD be left? 40

How many ARE left? 37

Variance -3



# What is Fuel Inventory?

---



# What is Fuel Inventory?

---

How much was delivered?



# What is Fuel Inventory?

---

How much was delivered?

**How much was dispensed?**



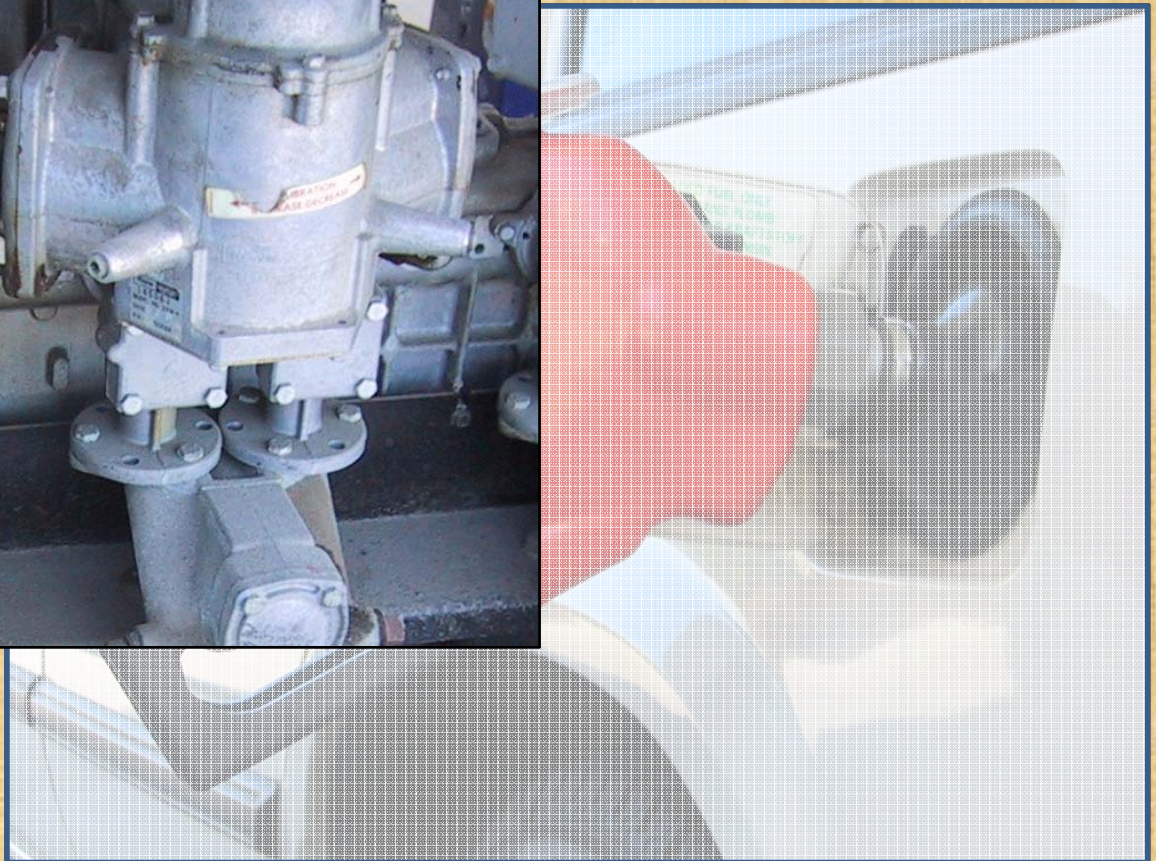
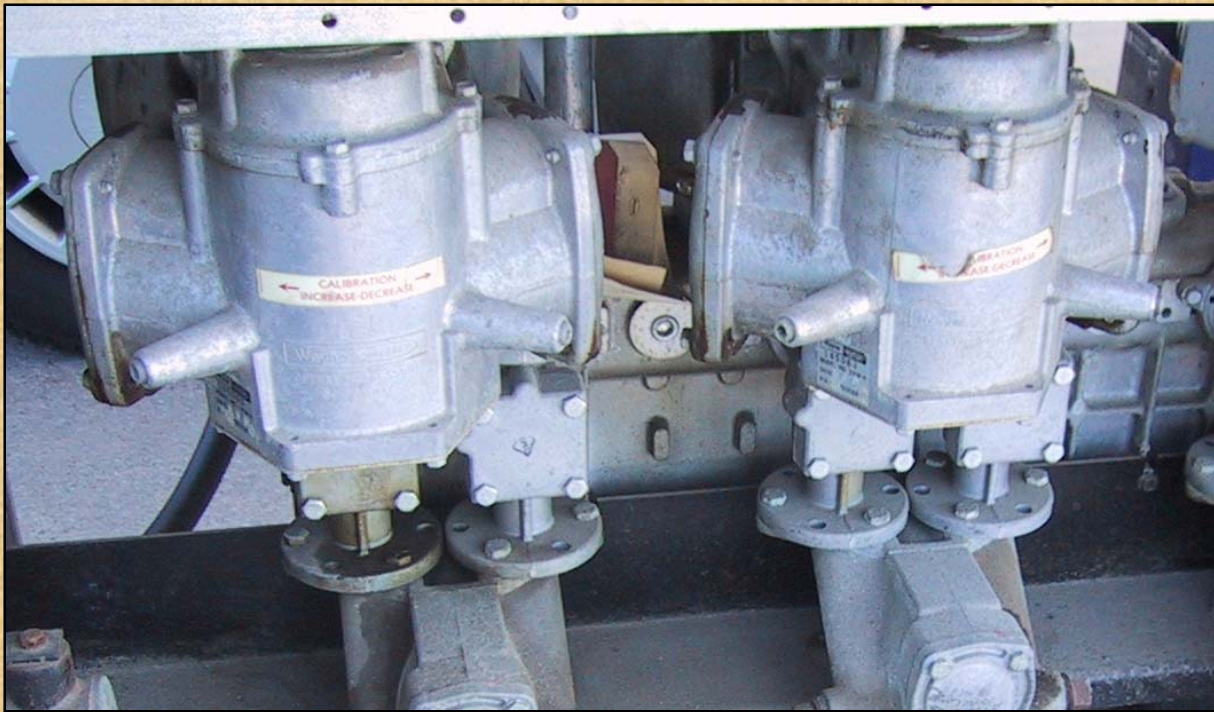


# What is Fuel Inventory?

---

How much was delivered?

**How much was dispensed?**





# What is Fuel Inventory?

# How much was delivered?

## How much was dispensed?

## How much SHOULD be left?





# What is Fuel Inventory?

How much was delivered? 1,000 gal

How much was dispensed? 600 gal

How much **SHOULD** be left? 400 gal



# What is Fuel Inventory Reconciliation?

---

How much was delivered?

How much was dispensed?

How much should be left?

**How much is left?**





# What is Fuel Inventory Reconciliation?

How much was delivered?

How much was dispensed?

How much should be left?

**How much is left?**



# What is Fuel Inventory Reconciliation?

---

How much was delivered?

How much was dispensed?

How much should be left?

**How much is left?**

**Should be left**

**400 gal**





# What is Fuel Inventory Reconciliation?

---

How much was delivered?

How much was dispensed?

How much should be left?

**How much is left?**

Should be left	400 gal
Actually in tank	395 gal



# What is Fuel Inventory Reconciliation?

---

How much was delivered?

How much was dispensed?

How much should be left?

**How much is left?**

Should be left	400 gal
Actually in tank	395 gal
Variance	-5 gal

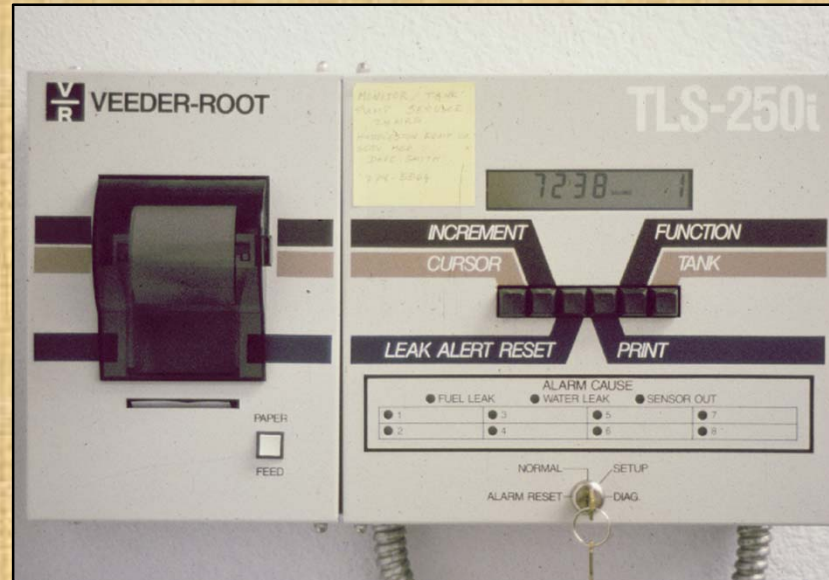




# Questions?

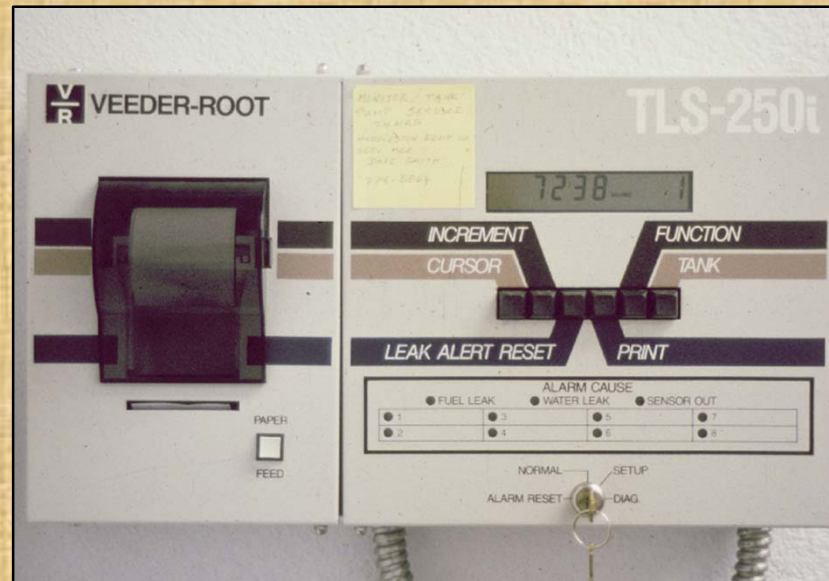


# Leak Detection Used to be Straightforward





# Leak Detection Used to be Straightforward



# What is an Automatic Tank Gauge (ATG)?



A device that measures the level of liquid in an underground tank



# ATG Leak Detection

---

# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection



# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection
- If an electronic line leak detector is installed, the tank gauge can monitor the piping to detect leaks

# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection
- If an electronic line leak detector is installed, the tank gauge can monitor the piping to detect leaks
- If the tank is double-walled, the tank gauge can monitor a sensor in the tank interstitial space



# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection
- If an electronic line leak detector is installed, the tank gauge can monitor the piping to detect leaks
- If the tank is double-walled, the tank gauge can monitor a sensor in the tank interstitial space
- If there are containment sumps at the facility, the tank gauge can monitor sensors in these locations

# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection
- If an electronic line leak detector is installed, the tank gauge can monitor the piping to detect leaks
- If the tank is double-walled, the tank gauge can monitor a sensor in the tank interstitial space
- If there are containment sumps at the facility, the tank gauge can monitor sensors in these locations
- If there are sensors installed in observation wells, the tank gauge can be used to monitor for the presence of product in groundwater or increases in product soil vapor levels



# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection

# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection

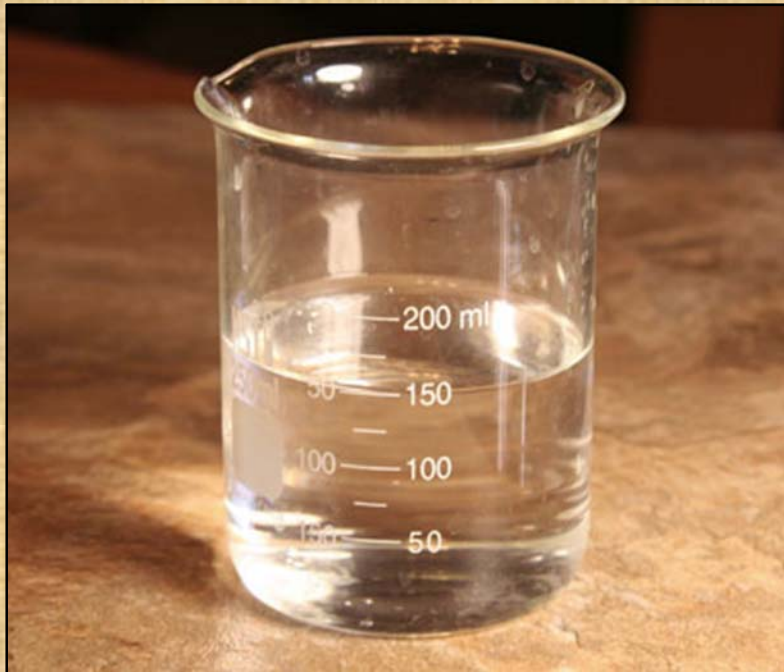
This Presentation Only Addresses This  
Method of ATG Leak Detection!



# ATG Leak Detection

---

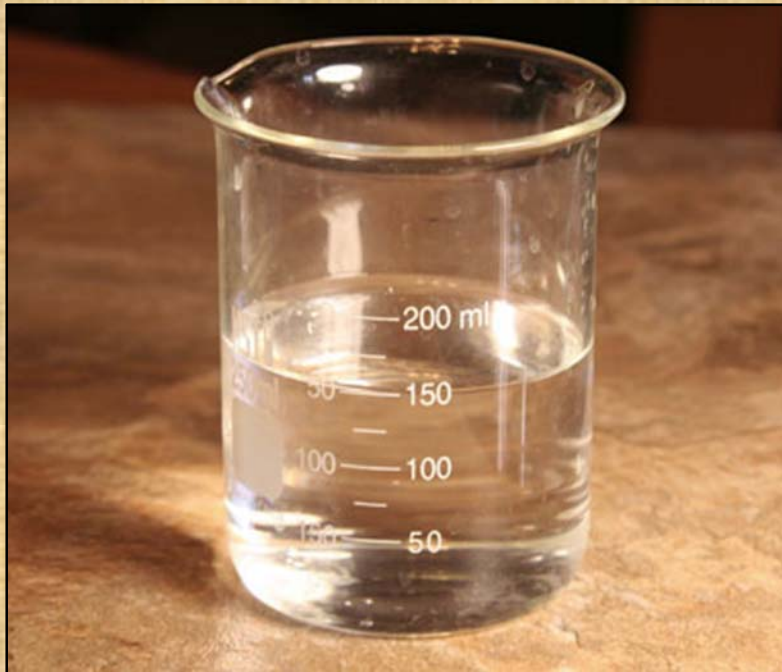
- **M**onitoring the liquid level in the tank over time is a form of leak detection



# ATG Leak Detection

---

- **Monitoring the liquid level in the tank over time is a form of leak detection**



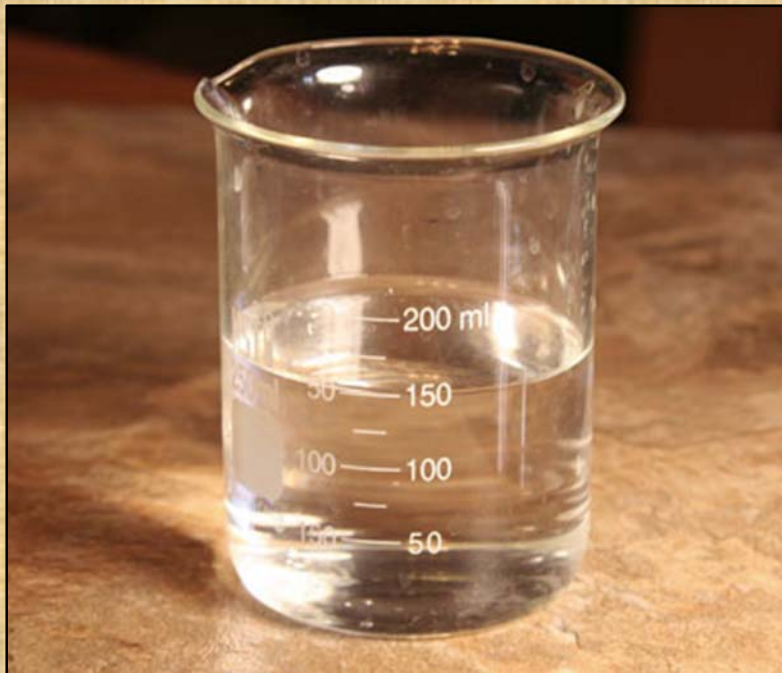
**The liquid level must be stable during the test period**



# ATG Leak Detection

---

- **M**onitoring the liquid level in the tank over time is a form of leak detection



# ATG vs Inventory Based Leak Detection

---

## Data Requirements

ATG	Inventory Reconciliation



# ATG vs Inventory Based Leak Detection

---

## Data Requirements

### ATG

Liquid Level

### Inventory Reconciliation

# ATG vs Inventory Based Leak Detection

---

## Data Requirements

ATG	Inventory Reconciliation
Liquid Level	
Temperature	



# ATG vs Inventory Based Leak Detection

---

## Data Requirements

ATG	Inventory Reconciliation
Liquid Level	Volume Delivered
Temperature	

# ATG vs Inventory Based Leak Detection

---

## Data Requirements

ATG	Inventory Reconciliation
Liquid Level	Volume Delivered
Temperature	Volume Dispensed

# ATG vs Inventory Based Leak Detection

---

## Data Requirements

ATG	Inventory Reconciliation
Liquid Level	Volume Delivered
Temperature	Volume Dispensed
	Volume in Tank



# Questions?



# Leak Detection Family Tree

---

**ATG**

**INVENTORY RECONCILIATION**

# Leak Detection Family Tree

---

**ATG**

**INVENTORY RECONCILIATION**



**Manual (MIR)**



# Leak Detection Family Tree

---

**ATG**

**INVENTORY RECONCILIATION**



**Manual (MIR)**



**Statistical (SIR)**

# Inventory Based Leak Detection

---

## Data Requirements

<i>Manual Inventory (MIR)</i>	<i>Statistical Inventory (SIR)</i>

# Inventory Based Leak Detection

---

## Data Requirements

### *Manual Inventory (MIR)*

Volume in tank  
(stick or ATG)

### *Statistical Inventory (SIR)*

Volume in tank  
(stick or ATG)



# Inventory Based Leak Detection

---

## Data Requirements

### *Manual Inventory (MIR)*

Volume in tank  
(stick or ATG)

Volume dispensed  
(totalizers or point of sale  
system)

### *Statistical Inventory (SIR)*

Volume in tank  
(stick or ATG)

Volume dispensed  
(totalizers or point of sale  
system)

# Inventory Based Leak Detection

---

## Data Requirements

### *Manual Inventory (MIR)*

Volume in tank  
(stick or ATG)

Volume dispensed  
(totalizers or point of sale  
system)

Volume delivered  
(bill of lading)

### *Statistical Inventory (SIR)*

Volume in tank  
(stick or ATG)

Volume dispensed  
(totalizers or point of sale  
system)

Volume delivered  
(bill of lading)

# Inventory Based Leak Detection

---

## Procedures

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>



# Inventory Based Leak Detection

---

## Procedures

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Once a day measurements	Once a day measurements

# Inventory Based Leak Detection

---

## Procedures

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Once a day measurements	Once a day measurements
Reconciliation using arithmetic (usually by the operator or accountant)	Statistical procedures on data (usually by third party vendor)

# Inventory Based Leak Detection

---

## Procedures

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Once a day measurements	Once a day measurements
Reconciliation using arithmetic (usually by the operator or accountant)	Statistical procedures on data (usually by third party vendor)
Variance more than 1% + 130 gallons of sales	Calculated leak rate greater than threshold



# Inventory Based Leak Detection

---

## Regulatory Requirements

*Manual Inventory*

*Statistical Inventory (SIR)*

Regulatory Requirements	
<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>

# Inventory Based Leak Detection

---

## Regulatory Requirements

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Leak detection for tank only	Leak detection for tank and piping

# Inventory Based Leak Detection

## Regulatory Requirements

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Leak detection for tank only	Leak detection for tank and piping
Measure to 1/8 inch, drop tube, record water once a month	Per vendor requirements



# Inventory Based Leak Detection

## Regulatory Requirements

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Leak detection for tank only	Leak detection for tank and piping
Measure to 1/8 inch, drop tube, record water once a month	Per vendor requirements
Once every 30 day reconciliation	Results within 30 days

# Inventory Based Leak Detection

## Regulatory Requirements

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Leak detection for tank only	Leak detection for tank and piping
Measure to 1/8 inch, drop tube, record water once a month	Per vendor requirements
Once every 30 day reconciliation	Results within 30 days
Two consecutive months of excessive variance is suspected release	One failed analysis is suspected release

# Inventory Based Leak Detection

## Regulatory Requirements

<i>Manual Inventory</i>	<i>Statistical Inventory (SIR)</i>
Leak detection for tank only	Leak detection for tank and piping
Measure to 1/8 inch, drop tube, record water once a month	Per vendor requirements
Once every 30 day reconciliation	Results within 30 days
Two consecutive months of excessive variance is suspected release	One failed analysis is suspected release
	"Inconclusive" result is failure to do leak detection



# Questions?



# Leak Detection Family Tree

---

**ATG**

**INVENTORY RECONCILIATION**

# Leak Detection Family Tree

---

ATG

INVENTORY RECONCILIATION



Periodic (static) ATG





# Leak Detection Family Tree

---

ATG

INVENTORY RECONCILIATION

Periodic (static) ATG



Continuous (segmented) ATG  
(CSLD, SCALD)



# ATG Based Leak Detection

---

## Data Requirements

Periodic	Continuous

# ATG Based Leak Detection

---

## Data Requirements

### Periodic

Liquid level

### Continuous

Liquid level



# ATG Based Leak Detection

---

## Data Requirements

### Periodic

Liquid level

Temperature

### Continuous

Liquid level

Temperature

# ATG Based Leak Detection

---

## Data Requirements

### Periodic

Liquid level

Temperature

### Continuous

Liquid level

Temperature

No dispensing activity

# ATG Based Leak Detection

---

## Procedures

Periodic	Continuous



# ATG Based Leak Detection

---

## Procedures

### Periodic

Tests conducted at  
scheduled times

### Continuous

Test data gathered on an  
ongoing basis

# ATG Based Leak Detection

---

## Procedures

### Periodic

Tests conducted at scheduled times

No dispensing or deliveries during test period

### Continuous

Test data gathered on an ongoing basis

No dispensing or deliveries while test data are gathered

# ATG Based Leak Detection

---

## Procedures

### Periodic

Tests conducted at scheduled times

No dispensing or deliveries during test period

Failed test results when dispensing occurs during test period

### Continuous

Test data gathered on an ongoing basis

No dispensing or deliveries while test data are gathered

Test period may be interrupted by dispensing

# ATG Based Leak Detection

---

## Regulatory Requirements

Periodic	Continuous



# ATG Based Leak Detection

---

## Regulatory Requirements

### Periodic

Tests only the tank

### Continuous

Tests only the tank

# ATG Based Leak Detection

---

## Regulatory Requirements

### Periodic

Tests only the tank

Tests conducted at level where tank routinely contains product

### Continuous

Tests only the tank

Tests conducted at level where tank routinely contains product

# ATG Based Leak Detection

---

## Regulatory Requirements

Periodic	Continuous
Tests only the tank	Tests only the tank
Tests conducted at level where tank routinely contains product	Tests conducted at level where tank routinely contains product
Results obtained in a matter of hours	Valid test must be completed at least every 30 days

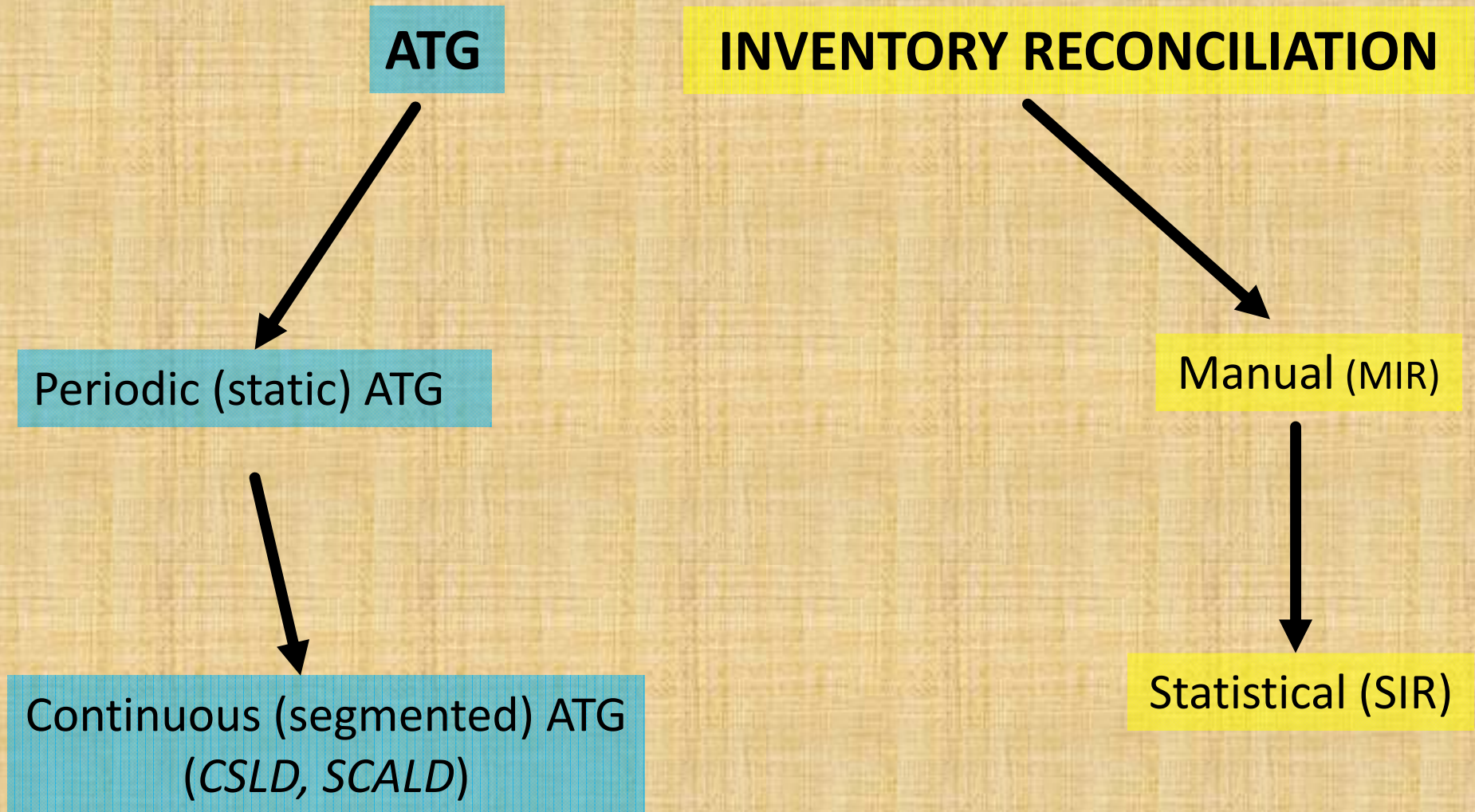
# Questions?





# Leak Detection Family Tree

---



# Leak Detection Family Tree

---

ATG

INVENTORY RECONCILIATION

Continual  
Reconciliation  
(*PetroNetwork,*  
*ClearView*)

```
graph TD; ATG[ATG] --> CR["Continual Reconciliation (PetroNetwork, ClearView)"]; IR[INVENTORY RECONCILIATION] --> CR;
```

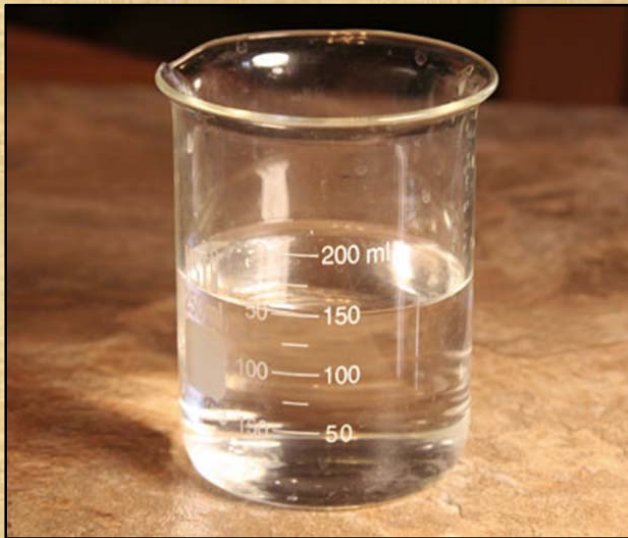
# Leak Detection Family Tree

---

ATG

INVENTORY RECONCILIATION

Continual  
Reconciliation  
(*PetroNetwork,*  
*ClearView*)



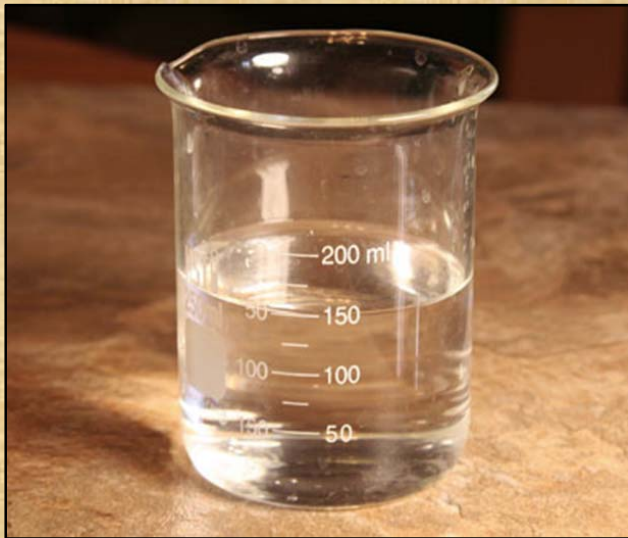


# Leak Detection Family Tree

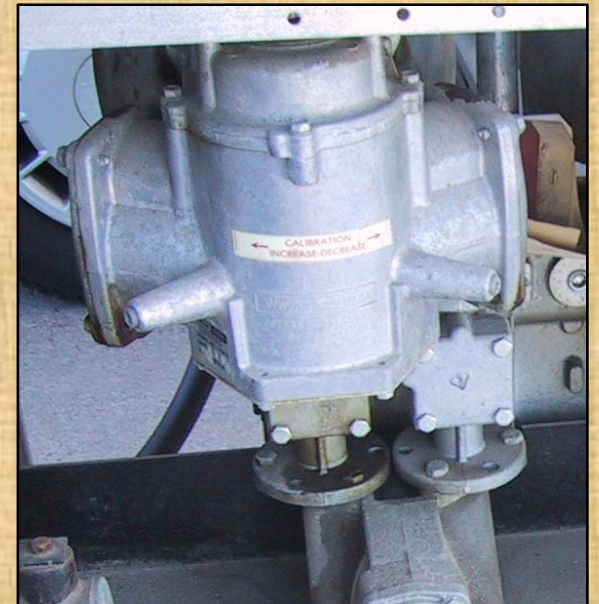
---

ATG

INVENTORY RECONCILIATION



Continual  
Reconciliation  
(*PetroNetwork,  
ClearView*)





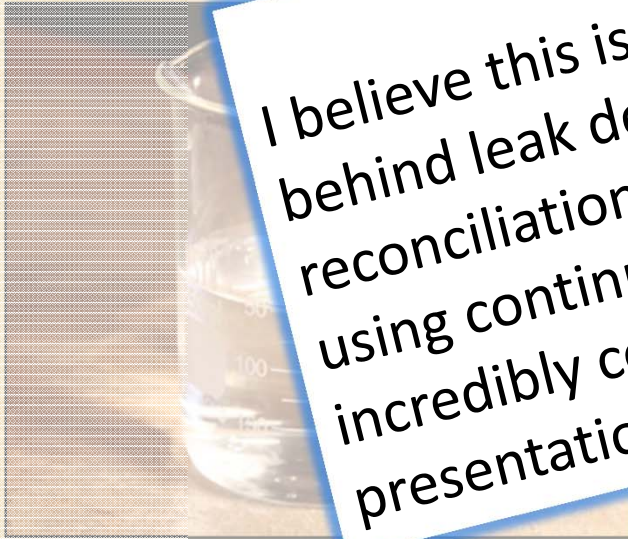
# Leak Detection Family Tree

ATG

INVENTORY RECONCILIATION

## **DISCLAIMER!!**

I believe this is the fundamental principle behind leak detection using continual reconciliation. Fuel management services using continual reconciliation are incredibly complex systems which this presentation does not begin to address!



# Continual Reconciliation Leak Detection

---

## Data Requirements

# Continual Reconciliation Leak Detection

---

## Data Requirements

Level Change in Tank (ATG)

Must generate tank specific calibration chart



# Continual Reconciliation Leak Detection

---

## Data Requirements

Level Change in Tank (ATG)

Must generate tank specific calibration chart

Volume Dispensed (meter or point of sale system)

Meter calibration must be known when first implemented



# Continual Reconciliation Leak Detection

---

## Data Requirements

Level Change in Tank (ATG)

Must generate tank specific calibration chart

Volume Dispensed (meter or point of sale system)

Meter calibration must be known when first implemented

Temperature

# Continual Reconciliation Leak Detection

---

Procedures

# Continual Reconciliation Leak Detection

---

## Procedures

Measurements once per minute or more (fuel level and meters)

# Continual Reconciliation Leak Detection

---

## Procedures

Measurements once per minute or more (fuel level and meters)

Complex statistical analysis of mountains of data



# Continual Reconciliation Leak Detection

---

Regulatory Requirements

# Continual Reconciliation Leak Detection

---

## Regulatory Requirements

Can be used for both tank and piping leak detection (??)

# Continual Reconciliation Leak Detection

---

## Regulatory Requirements

Can be used for both tank and piping leak detection (??)

Results documented once every 30 days (can detect leaks in much less than 30 days)

# Continuous ATG & Continual Reconciliation

---

Advantages	
Continuous ATG	Continual Reconciliation



# Continuous ATG & Continual Reconciliation

---

## Advantages

Continuous ATG	Continual Reconciliation
Do not have to interrupt business activity	Do not have to interrupt business activity

# Continuous ATG & Continual Reconciliation

---

## Advantages

Continuous ATG	Continual Reconciliation
Do not have to interrupt business activity	Do not have to interrupt business activity
Test results every 24 hours	Monitored by knowledgeable third party

# Continuous ATG & Continual Reconciliation

---

## Advantages

Continuous ATG	Continual Reconciliation
Do not have to interrupt business activity	Do not have to interrupt business activity
Test results every 24 hours	Monitored by knowledgeable third party
Can test manifolded tanks	Can test manifolded tanks

# Continuous ATG & Continual Reconciliation

---

## Advantages

Continuous ATG	Continual Reconciliation
Do not have to interrupt business activity	Do not have to interrupt business activity
Test results every 24 hours	Monitored by knowledgeable third party
Can test manifolded tanks	Can test manifolded tanks
	Leak detection from fill pipe to the dispenser meter



# Continuous ATG & Continual Reconciliation

---

## Advantages

Continuous ATG	Continual Reconciliation
Do not have to interrupt business activity	Do not have to interrupt business activity
Test results every 24 hours	Monitored by knowledgeable third party
Can test manifolded tanks	Can test manifolded tanks
	Leak detection from fill pipe to the dispenser meter
	Monitors for theft, meter calibration, delivery volume

# Continuous ATG & Continual Reconciliation

---

Limitations/Issues	
Continuous ATG	Continual Reconciliation

# Continuous ATG & Continual Reconciliation

---

## Limitations/Issues

Continuous ATG	Continual Reconciliation
Does not monitor the piping	Does not monitor piping to satellite dispensers

# Continuous ATG & Continual Reconciliation

---

## Limitations/Issues

Continuous ATG	Continual Reconciliation
Does not monitor the piping	Does not monitor piping to satellite dispensers
Throughput limit	Throughput limit



# Continuous ATG & Continual Reconciliation

---

## Limitations/Issues

Continuous ATG	Continual Reconciliation
Does not monitor the piping	Does not monitor piping to satellite dispensers
Throughput limit	Throughput limit
May not detect large leaks	

# Questions?



# What is CITLD?

---

# What is CITLD?

---

**Continuous In Tank Leak  
Detection**



# What is CITLD?

---

Evaluation Protocol for Continuous In-Tank Leak  
Detection Systems  
Revision 1

**Let's start with the protocol...**

Original Protocol April 7, 1995, Revised January 7, 2000

# CITLD

---

## Background

# CITLD

---

## Background

–Why do we have protocols?

# CITLD

---

## Background

- Why do we have protocols?
- What LD equipment requires certification?



# CITLD

---

## Background

- Why do we have protocols?
- What LD equipment requires certification?
- Why was another protocol needed?

# CITLD

---

## Background

- Why do we have protocols?
- What LD equipment requires certification?
- Why was another protocol needed?
- Role of the NWGLDE

# CITLD

---

**What Leak Detection Methods are Included in the CITLD Protocol?**

# CITLD

---

## **What Leak Detection Methods are Included in the CITLD Protocol?**

- Continuous ATG



# CITLD

---

## **What Leak Detection Methods are Included in the CITLD Protocol?**

- Continuous ATG
- Continual Reconciliation

# CITLD

---

## **What Leak Detection Methods are Included in the CITLD Protocol?**

- Continuous ATG
- Continual Reconciliation
- Automatic Monthly Inventory Control

# What is CITLD?

---

The Federal rule refers to CITLD as a method of leak detection...

## FEDERAL REGISTER

---

Vol. 80  
No. 135

Wednesday,  
July 15, 2015

(3) The test must be performed with the system operating in one of the following modes:

- (i) In-tank static testing conducted at least once every 30 days; or
- (ii) Continuous in-tank leak detection operating on an uninterrupted basis or operating within a process that allows the system to gather incremental measurements to determine the leak status of the tank at least once every 30 days.

40 CFR 280.43(d)



# What is CITLD?

The Federal rule refers to CITLD as a method of leak detection

## FEDERAL REGISTER

Vol. 80  
No. 135

Wednesday,  
July 15, 2015

...but CITLD is  
TWO methods  
of leak  
detection

40 CFR 280.43(d)

(3) The test must be performed with the system operating in one of the following modes:

- (i) In-tank static testing conducted at least once every 30 days; or
- (ii) Continuous in-tank leak detection operating on an uninterrupted basis or operating within a process that allows the system to gather incremental measurements to determine the leak status of the tank at least once every 30 days.



# What is CITLD?

---

The Federal rule refers to CITLD as a method of leak detection

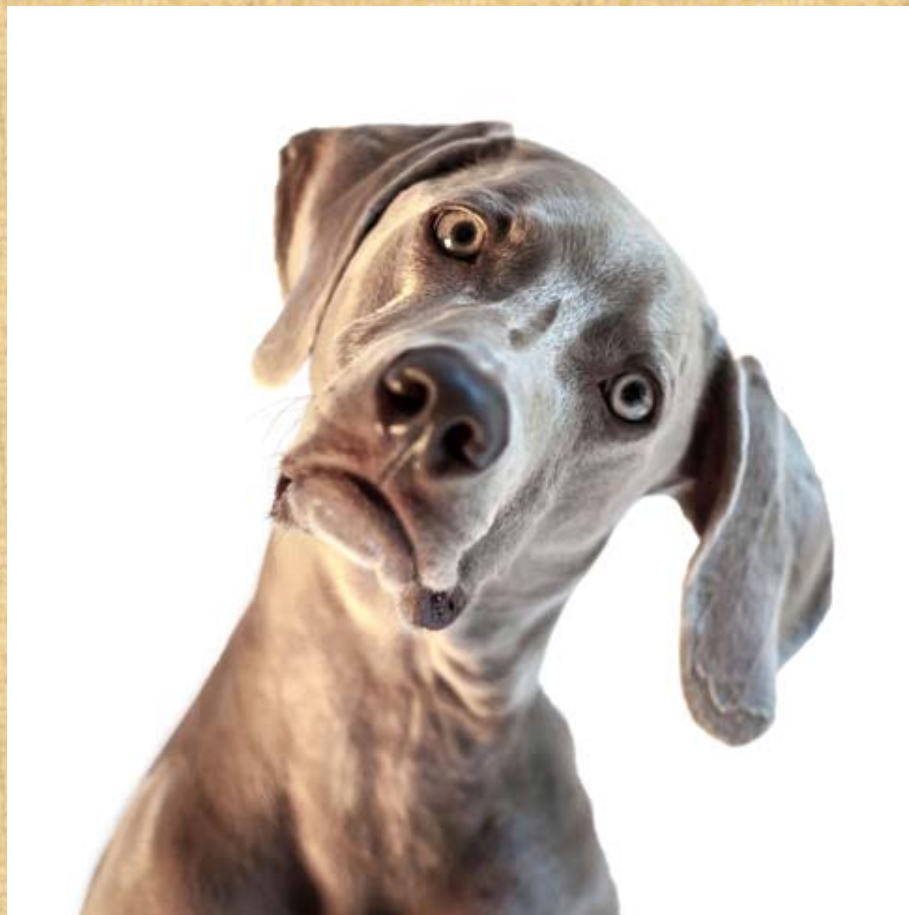
I believe this is the source of much confusion...

# What is CITLD?

---

The Federal rule refers to CITLD as a method of leak detection

I believe this is the source of much confusion...



# What is CITLD?

---

The Federal rule refers to CITLD as a method of leak detection

I believe this is the source of much confusion

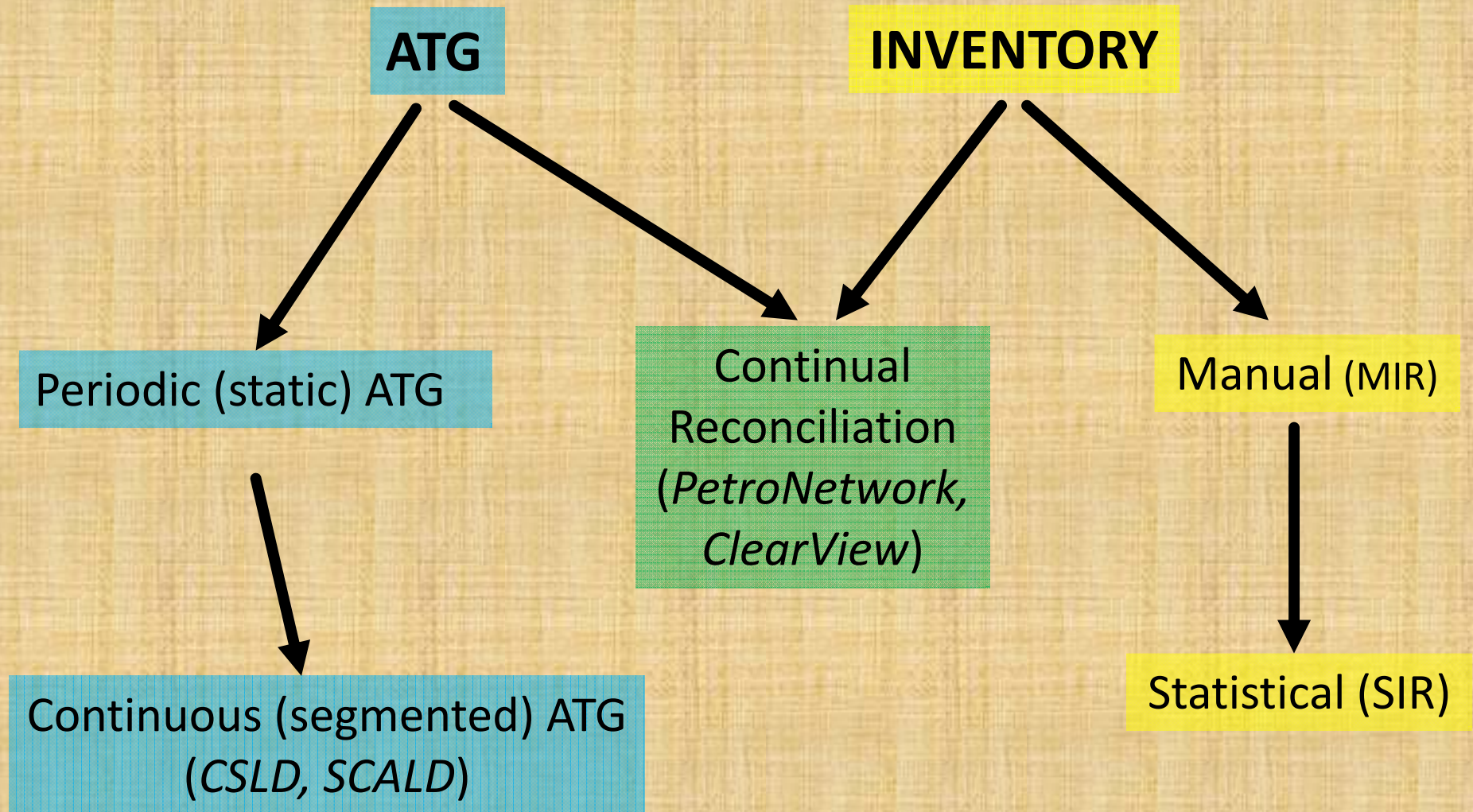
Reserving the term CITLD for the protocol only would make life much simpler!

Evaluation Protocol for Continuous In-Tank Leak  
Detection Systems  
Revision 1

Original Protocol April 7, 1995, Revised January 7, 2000

# Leak Detection Family Tree

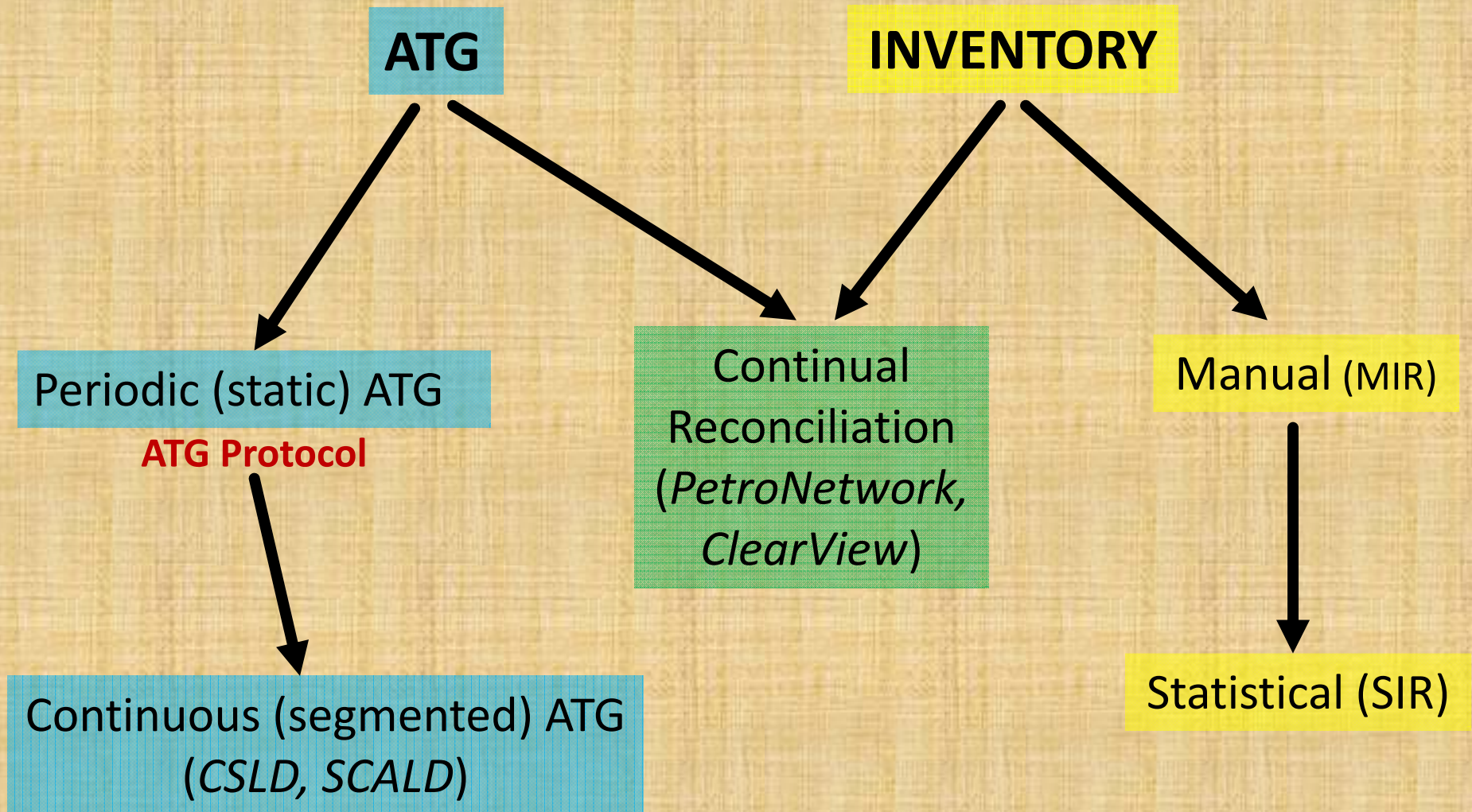
---





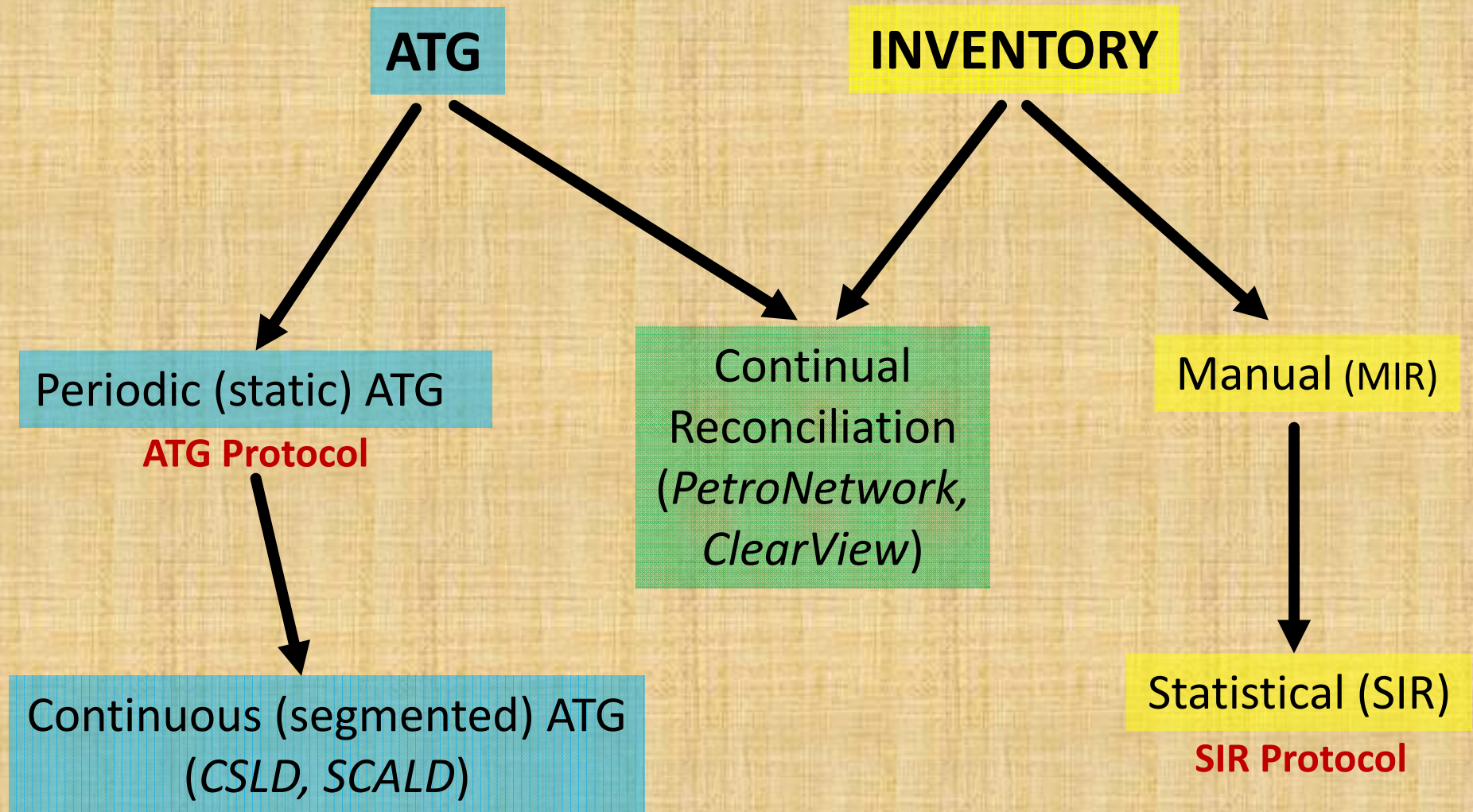
# Leak Detection Family Tree

---



# Leak Detection Family Tree

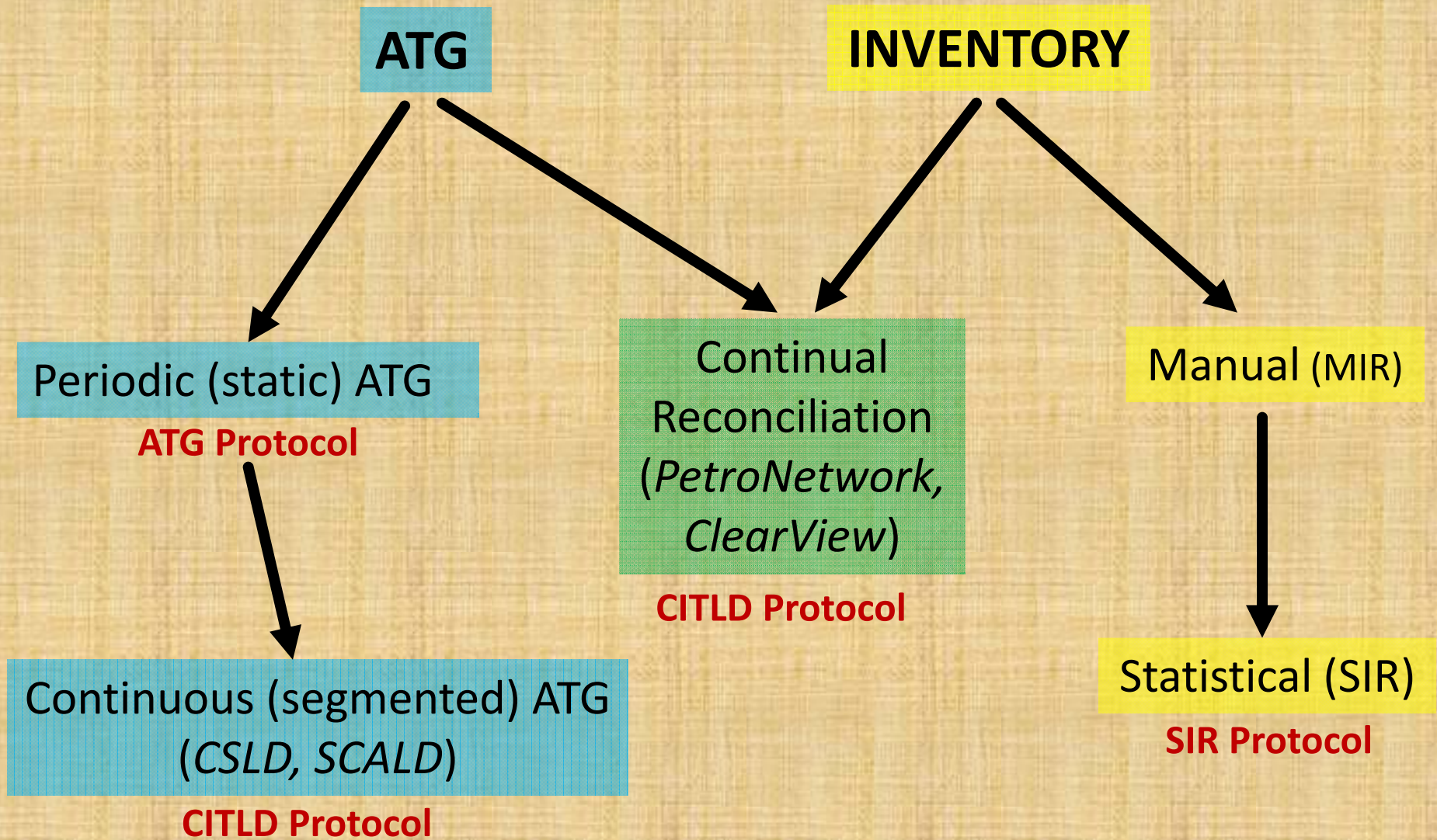
---





# Leak Detection Family Tree

---



# Questions?





# More Questions?

**Marcel Moreau**  
Marcel Moreau Associates  
Portland, Maine

[marcel.moreau@juno.com](mailto:marcel.moreau@juno.com)

[www.marcelmoreau.com](http://www.marcelmoreau.com)