Department of Environmental Protection

2600 Blair Stone Road ♦ Tallahassee, Florida 32399-2400

DEP Form: 62-761.900(9)
Form Title: Storage Tank Equipment Registration Form
Effective Date: July 2019
Incorporated in Rule 62-761.850, F.A.C.

Storage Tank System Equipment Registration Form

Fill out completely

General Information

Company Name: Pneumercator Co., Inc.
Contact Name: Jonathan Levy
Company Address: 1785 Expressway Drive N.
City, State: Hauppauge, NY Zip: 11788
E-mail: jlevy@pneumercator.com
Contact Number: 631-293-8450
Product Name: TMS4000 Series and TMS4000M Series Tank Management Systems
Model Number(s): TMS4000-xx-xxx-xxx-x, TMS4000M-xx-xxx-xx
Product Type: ATG
Rule(s) citation that registration is being requested within Chapter 62-761 (UST), and/or 62-762 (AST), F.A.C.: In-Tank Volumetric and Secondary Containment Leak Detection, Overfill Prevention

Write a brief description of equipment registration request including product limitations:

Same as existing TMS4000 and TMS4000M systems under EQ950.

Information Checklist (Choose Yes, No, or N/A - Not Applicable):

		Yes	No	N/A
1.	Third-party Certification by a Nationally Recognized Testing Laboratory? (Required)	✓		
2.	Documentation of third-party evaluation that the equipment meets DEP Rules?	✓		
3.	Documents included about the qualifications of the Nationally Recognized Testing Laboratory?	✓		
4.	Technical information and drawings included?		✓	
5.	Installation instructions included?		✓	
6.	Annual Operability Testing Requirements (Rules 62-761.500, 62-762.501, & 62-762.502 F.A.C.)?			✓
7.	Integrity Testing Requirements (Rules 62-761.700, 62-762.701, & 62-762.702, F.A.C.)?			✓
8.	Compatible with fuel blends containing >10% ethanol or >20% biodiesel?	✓		
9.	Has the product been approved or registered in other countries or states? (If so provide list)	✓		
10.	Any requirements for company-certified installers or trainers?		✓	
11.	Was this product(s) previously approved or registered by the Department? If yes, EQ- 950	✓		
12.	Any changes or modifications to the equipment since the last submittal to DEP?		✓	

Document Information: Provide supporting documents indicated as "Yes" above including this form via email to Tanknotify@floridadep.gov, or documents can be sent to FDEP, Division of Waste Management, 2600 Blair Stone Road, MS 4560, Tallahassee, FL 32399.

Write a brief description of equipment installation and performance in the U.S.:

The TMS4000 series and TMS4000M series are suitable for volumetric in-tank leak detection in UST applications, secondary containment leak detection, overfill prevention for both UST and AST applications. Enclosure options support both indoor and outdoor weatherproof/corrosionproof applications. Installation may be performed by any qualified electrician meeting local requirements, however, the installation must be inspected and started up by a Pneumercator-certified technician. Listed in Wisconsin and LG113 and California.

Equipment Registration Certification:

To the best of my knowledge and belief, all information submitted on this form is true, accurate and complete.

Jonathan Levy - President
Printed Name and Title

Jonathan Levy
Digitally signed by Jonathan Levy
DN: cn=Jonathan Levy, o=Pneumercator Co., Inc., ou, email=jlevy@pneumercator.com, c=US
Date: 2025.03.20 20:08:37 -04'00'
Signature (right click to sign)

03/20/2025
Date

For Department Use Only:

Date Application Received: 03/21/2025 Application complete: Yes: [X] No: [ ]

EQ- 950 Date of complete or incomplete letter sent: 03/21/2025 Date Equipment Requires Renewal: 03/21/2030

Storage tank system equipment requires renewal every 5 years in accordance with subsection 62-761.850(2), F.A.C.

Department of Environmental Protection

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Contact Number: 631-293-8450
Product Name: TMS4000 Series Tank Management Systems
Model Number(s): TMS4000 and TMS4000M(Series)
Product Type: ATG

Rule(s) citation that registration is being requested within Chapter 62-761 (UST), and/or 62-762 (AST), In-Tank Volumetric and Secondary Containment Leak Detection, Overfill Prevention

F.A.C.: Write a brief description of equipment registration request including product limitations:
Same as existing TMS2000 and TMS3000 ATG systems under EQ303

Information Checklist (Choose Yes, No, or N/A - Not Applicable):

		Yes	No	N/A
1.	Third-party Certification by a Nationally Recognized Testing Laboratory? (Required)	✓		
2.	Documentation of third-party evaluation that the equipment meets DEP Rules?	✓		
3.	Documents included about the qualifications of the Nationally Recognized Testing Laboratory?	✓		
4.	Technical information and drawings included?	✓		
5.	Installation instructions included?	✓		
6.	Annual Operability Testing Requirements (Rules 62-761.500, 62-762.501, & 62-762.502 F.A.C.)?			✓
7.	Integrity Testing Requirements (Rules 62-761.700, 62-762.701, & 62-762.702, F.A.C.)?			✓
8.	Compatible with fuel blends containing >10% ethanol or >20% biodiesel?	✓		
9.	Has the product been approved or registered in other countries or states? (If so provide list)	✓		
10.	Any requirements for company-certified installers or trainers?	✓		
11.	Was this product(s) previously approved or registered by the Department? If yes, EQ-		✓	
12.	Any changes or modifications to the equipment since the last submittal to DEP?			✓

Document Information: Provide supporting documents indicated as "Yes" above including this form via email to Tanknotify@floridadep.gov, or documents can be sent to FDEP, Division of Waste Management, 2600 Blair Stone Road, MS 4560, Tallahassee, FL 32399.

Write a brief description of equipment installation and performance in the U.S.:
The TMS4000 series is suitable for volumetric in-tank leak detection in UST applications, secondary containment leak detection and overfill prevention for both UST and AST applications. Enclosure options support both indoor and outdoor, weatherproof/corrosionproof applications. Installation may be performed by any qualified electrician meeting local requirements, however, the installation must be inspected and started up by a Pneumercator-certified technician.

Equipment Registration Certification:

To the best of my knowledge and belief, all information submitted on this form is true, accurate and complete.

Jonathan Levy - President
Printed Name and Title

Signature (right click to sign)

1-8-21
Date

For Department Use Only:

Date Application Received: 1/8/2021
Application complete: Yes: ☐ No: ☐

EQ- 950 Date of complete or incomplete letter sent: 1/12/2021
Date Equipment Requires Renewal: 1/12/2026

Storage tank system equipment requires renewal every 5 years in accordance with subsection 62-761.850(2), F.A.C.

Evaluation of the Pneumercator RSU-800 Series Dual-Float, ES825-100F/XF/CF Non-Discriminating, ES825-200F/XF Discriminating, LS600-LD Series, LS-610, RSU-810 with TMS4000 Series Consoles

Final Report

PREPARED FOR:

Pneumercator

December 3, 2020

Ken Wilcox Associates, Inc.
1125 Valley Ridge Drive, Grain Valley, MO 64029, USA
Voice (816) 443-2494, Fax (816) 443-2495
Email – cwilcox@kwaleak.com

KWA

Evaluation of the Pneumercator RSU-800 Series Dual-Float, ES825-100F/XF/CF Non-Discriminating, ES825-200F/XF Discriminating, LS600-LD Series, LS-610, RSU-810 with TMS4000 Series Consoles

Final Report

PREPARED FOR:
Pneumercator
1785 Expressway Drive North
Hauppauge NY 11788

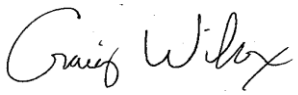
December 3, 2020

Preface

This report presents the results of an independent third-party evaluation of the Pneumercator TMS4000 Series consoles with RSU-800 Series Dual-Float, ES825-100F/XF/CF, ES825-200F/XF, LS600-LD Series, LS-610, RSU-810 sensors. The evaluation was conducted by Ken Wilcox Associates, Inc. using procedures described in section 4.5.1, “Liquid Phase Sensor Test Procedures”, of the 2019 revised standard protocol “Standard Test Procedures For Evaluating Release Detection Methods: Volumetric And Non- volumetric Tank Tightness Testing”, May 2019. The official results of this evaluation are contained in Attachment A of this report on the EPA Results forms. All work was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri.

This report was prepared by Craig Wilcox, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to Jonathan Levy, at (631) 293-8450.

KEN WILCOX ASSOCIATES, INC



Craig Wilcox, President
December 3, 2020

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1.0 Description of the Equipment

TMS4000 Series Console and RSU-800 Series Dual-Float, ES825-100F/XF/CF, ES825-200F/XF, LS600-LDxx Series, LS-610, RSU-810 Sensors

The TMS4000 console is part of the TMS4000 Series that also includes the TMS4000M. The only difference between the TMS4000 and TMS4000M console is the size of the touchscreen and the capacity of probes and sensors. TMS4000 Series consoles can interface to any dry-contact type float sensor with either normally open or normally closed contacts, and to electronic sensors using optical non-discriminating or optical/conductivity discriminating technologies. The TMS4000 Series consoles provide both audible and visual annunciation for all alarm conditions. Any sensor can be easily removed, cleaned and reinstalled if an alarm is triggered or if the sensor is periodically tested.

Model ES825-200F/XF Discriminating Sensor
This sensor will respond to any liquid after the sensor's threshold has been exceeded. The sensor incorporates an optical liquid sensor and a conductivity sensor. The sensor discriminates between product and water by determining if the optical sensor, which responds to any liquid, or the conductivity sensor, which responds to water only, causes an alarm.

ES825-100F/XF/CF Non-Discriminating Sensor
This sensor incorporates an optical liquid sensor that will respond to any liquid after the sensor's threshold has been exceeded.

RSU-800 Series/RSU-810 Reservoir Sensors
The Pneumercator reservoir sensors detect the presence of fluid in reservoirs associated with liquid-filled interstitial spaces of a double-wall tank. Two models are available: The Model RSU800 Series dual-point tank interstitial sensor consisting of normally open high-level and normally closed low-level alarms, and the RSU-810 single-point sump interstitial sensor with normally closed low-level alarm.

Both sensor models generate an alarm condition when the associated reservoir reaches a low-level threshold, indicating a loss of reservoir fluid that could potentially be due to a leak. Additionally, the RSU800 Series will generate an alarm condition when the associated reservoir reaches a high-level threshold, indicating a possible ingress of groundwater through the tank's exterior shell wall. All console models listed provide both audible and visual alarm annunciation, and for models so equipped, display messages and printed reports.

The time necessary to detect a 0.1 gal/hr leak will depend on the size of the reservoir. An RSU-800 series sensor installed in a reservoir having a capacity of 13 gal/inch or less will detect a leak rate of 0.1 gal/hr within one month. This calculation is based on a float displacement from normal to alarm state of 5.5" and a 72-gallon loss over 30 days.

LS610 Sensor

The LS610 is a normally closed dry contact leak sensor that consists of a flat float that swivels up and down on a square shaped body. The float actuates a switch when the level rises to a certain level activating the alarm.

LS600-LD Series

The LS600-LD Series leak sensors are normally open/normally closed dry contact types having a common construction where the float travels vertically on a stem enclosed in a protective housing. The series provides various constructions using different stem, housing and cable materials, with Buna-N and SS float options. Since leak detection performance is a function of the float, the LS600-LD-BN Sensor (Buna-N float) and LS600-LD-SS (SS float) sensors were evaluated in order to represent each of the two float types within the LS600-LD Series. Considering this, the results of the LS600-LD-BN sensor results are applicable to any of the sensors within the LS600-LD Series that utilize a Buna-N float type. Likewise, the results of the LS600-LD-SS and sensor results are applicable to any of the sensors within the LS600-LDxx Series that utilize a SS float type.

2.0 Evaluation Procedures

Test Apparatus

The evaluation of this system was designed to determine if the liquid level sensor operates as described by the vendor. The sensor was mounted in a test container in which water, diesel fuel, and unleaded gasoline were added. The ES825-200F/XF sensor was also placed in a test container with an E85/Water mixture in order to evaluate the accuracy of the discrimination feature between water and fuel. The percentages of E85/Water that were used in this evaluation were 80%/20%, 60%/40% and 30%/70%.

Threshold Determination

A peristaltic pump was used to add water, diesel fuel and unleaded gasoline from the test cylinder containing the sensor until the sensor alarmed. The threshold was measured directly with a dial micrometer. This procedure was repeated a total of 10 times for each threshold.

Detection Time

The time required for the sensor to respond to product levels above the sensor's threshold is the sensor's detection time. The average time to alarm for the ten tests conducted for each product type is reported as the detection time. In the case of on/off float switches this time is within a few seconds. The manufacturer supports a detection time of less than 1 minute.

Fall Times

The time required for the sensor to stop responding once the product level has been lowered below the sensor's threshold is the sensor's fall time. The average fall time for the ten tests conducted for each product type is reported as the fall time. In the case of on/off float switches this time is within a few seconds. The manufacturer supports a fall time of less than 1 minute.

Specificity

The specificity defines the different products that liquid level sensors will respond to. Most sensors will respond to any liquid once the sensor's threshold level has been exceeded unless the sensor has been designed otherwise. Although these sensors will respond to any liquid, the testing conducted for this evaluation determined the sensor's response to water, diesel fuel and unleaded gasoline. The ES825-200F/XF sensor was also placed in a test container with an E85/Water mixture in order to evaluate the accuracy of the discrimination feature between water and fuel. The percentages of E85/Water that were used in this evaluation were 80%/20%, 60%/40% and 30%/70%.

3.0 Test Results

The data and results for the RSU-800-2, ES825-100F/XF/CF, ES825-200F/XF, LS-610, RSU-810, LS-600-LDxx Series sensors are contained in Table 1 thru 9.

Lower Detection Level (Threshold)
The sensors were only tested for their ability to detect liquid levels at the alarm levels.

Precision (Standard Deviation)
Ten replicates were conducted for each liquid level for each float. The standard deviation was determined from these replicates.

Detection Time
The sensor alarms within a few seconds after the threshold was reached. This will be true for any liquid in the reservoir. The manufacturer supports a detection time of less than 1 minute.

Fall Time
The sensor stops alarming within a few seconds after contacting liquid. This will be true for any liquid in the reservoir. The manufacturer supports a fall time of less than 1 minute.

Specificity
This sensor will respond to any liquid that is compatible with the system in which it is installed. Water, diesel fuel and unleaded gasoline were used for this evaluation. The discrimination sensors was also tested in three E85/Water mixtures.

Time to Alarm under Operating Conditions
The time for a given liquid level sensor to alarm will depend on the size and geometry of the tank or sump in which it is installed and the rate of leakage into this space. The time to alarm can be calculated by dividing the volume necessary to reach the threshold by the leak rate.

Accuracy of Discrimination between Fuel and Water with Alcohol Blended Fuels
The sensors ability to accurately discriminate between water and fuel with alcohol blended fuel with the presence of water. The sensor was evaluated for the top layer containing hydrocarbons as well as the lower level that contained water.

Pneumercator Sensor Data

Table 1. Results for the Pneumercator RSU-800-2 Sensor

Run #	Height at Alarm(inches) Lower Float			Height at Alarm(inches) Upper Float		
	Water	Diesel	Unleaded	Water	Diesel	Unleaded
1	2.13	2.31	2.40	13.33	13.40	13.55
2	2.15	2.35	2.38	13.26	13.42	13.50
3	2.16	2.34	2.40	13.23	13.40	13.51
4	2.15	2.33	2.42	13.25	13.39	13.50
5	2.17	2.35	2.41	13.24	13.45	13.65
6	2.16	2.39	2.40	13.24	13.40	13.57
7	2.13	2.38	2.44	13.25	13.41	13.45
8	2.12	2.36	2.41	13.25	13.37	13.55
9	2.13	2.36	2.39	13.26	13.44	13.59
10	2.13	2.35	2.40	13.28	13.42	13.50
Mean	**2.1430**	**2.3520**	**2.4050**	**13.2590**	**13.4100**	**13.5370**
STDEV	**0.0170**	**0.0230**	**0.0165**	**0.0285**	**0.0236**	**0.0572**
Threshold	**2.2061**	**2.4373**	**2.4662**	**13.3645**	**13.4974**	**13.7489**

Table 2. Results for the Pneumercator ES825-100F/XF/CF Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.295	0.351	0.340
2	0.305	0.355	0.338
3	0.305	0.350	0.340
4	0.298	0.347	0.341
5	0.299	0.350	0.340
6	0.304	0.354	0.339
7	0.305	0.350	0.341
8	0.310	0.355	0.340
9	0.300	0.351	0.338
10	0.303	0.356	0.340
Mean	**0.3024**	**0.3519**	**0.3397**
STDEV	**0.0044**	**0.0029**	**0.0011**
Threshold	**0.3186**	**0.3627**	**0.3436**

Table 3. Results for the Pneumercator ES825-200F/XF Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.270	0.354	0.303
2	0.275	0.350	0.301
3	0.272	0.355	0.313
4	0.285	0.344	0.305
5	0.279	0.349	0.310
6	0.272	0.345	0.311
7	0.275	0.348	0.300
8	0.280	0.347	0.309
9	0.279	0.350	0.311
10	0.280	0.345	0.308
Mean	**0.2767**	**0.3487**	**0.3071**
STDEV	**0.0047**	**0.0037**	**0.0046**
Threshold	**0.2940**	**0.3625**	**0.3240**

Table 4. Results for the Pneumercator LS600-LD Series Sensors with Buna N Float*

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	1.012	1.166	1.239
2	1.009	1.168	1.241
3	1.011	1.168	1.240
4	1.005	1.166	1.245
5	1.015	1.166	1.241
6	1.007	1.161	1.244
7	1.006	1.166	1.249
8	1.014	1.168	1.245
9	1.015	1.165	1.243
10	1.016	1.166	1.244
Mean	**1.0110**	**1.1660**	**1.2431**
STDEV	**0.0041**	**0.0021**	**0.0030**
Threshold	**1.0260**	**1.1736**	**1.2541**

*LS600-LDBN sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/Buna N float

Table 5. Results for the Pneumercator LS-610 Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.455	0.515	0.570
2	0.453	0.513	0.571
3	0.454	0.513	0.570
4	0.452	0.512	0.569
5	0.450	0.516	0.570
6	0.455	0.516	0.570
7	0.451	0.515	0.570
8	0.453	0.510	0.571
9	0.452	0.515	0.571
10	0.453	0.514	0.571
Mean	**0.4528**	**0.5139**	**0.5703**
STDEV	**0.0016**	**0.0019**	**0.0007**
Threshold	**0.4588**	**0.5210**	**0.5728**

Table 6. Results for the Pneumercator RSU-810 Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.735	0.847	0.912
2	0.733	0.857	0.915
3	0.730	0.849	0.914
4	0.742	0.847	0.912
5	0.740	0.848	0.919
6	0.745	0.849	0.918
7	0.745	0.847	0.920
8	0.741	0.847	0.917
9	0.743	0.848	0.920
10	0.741	0.849	0.917
Mean	**0.7395**	**0.8488**	**0.9164**
STDEV	**0.0051**	**0.0030**	**0.0030**
Threshold	**0.7585**	**0.8600**	**0.9276**

Table 7. Results for the Pneumercator LS600-LD Series Sensors with SS Float*

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.864	0.946	1.002
2	0.860	0.940	0.997
3	0.862	0.942	1.005
4	0.864	0.945	1.002
5	0.868	0.945	0.991
6	0.865	0.940	0.995
7	0.869	0.951	0.995
8	0.865	0.940	1.003
9	0.864	0.946	1.003
10	0.863	0.947	1.005
Mean	**0.8644**	**0.9442**	**0.9998**
STDEV	**0.0026**	**0.0036**	**0.0049**
Threshold	**0.8742**	**0.9577**	**1.0179**

*LS600-LDSS sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/SS float

Table 8. Results for the Pneumercator ES825-200F/XF Sensor (console response of water or fuel with E85/Water mixtures

Run #	E85/Water Mixture Response to Lower Layer (Water)			E85/Water Mixture Respose to Upper Layer(Fuel)		
	80%/20%	60%/40%	30%/70%	80%/20%	60%/40%	30%/70%
1	Water	Water	Water	Fuel	Fuel	Fuel
2	Water	Water	Water	Fuel	Fuel	Fuel
3	Water	Water	Water	Fuel	Fuel	Fuel
4	Water	Water	Water	Fuel	Fuel	Fuel
5	Water	Water	Water	Fuel	Fuel	Fuel
6	Water	Water	Water	Fuel	Fuel	Fuel
7	Water	Water	Water	Fuel	Fuel	Fuel
8	Water	Water	Water	Fuel	Fuel	Fuel
9	Water	Water	Water	Fuel	Fuel	Fuel
10	Water	Water	Water	Fuel	Fuel	Fuel
Discrimination Accuracy between water and fuel	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**

4.0 Conclusions

Ken Wilcox Associates, Inc. has conducted this evaluation in accordance to the procedures described in section 4.5.1, “Liquid Phase Sensor Test Procedures”, of the 2019 revised standard protocol “Standard Test Procedures For Evaluating Release Detection Methods: Volumetric And Non- volumetric Tank Tightness Testing”, May 2019. Ken Wilcox Associates, Inc. has come to the conclusion that the Pneumercator RSU-800-2, ES825-100F/XF/CF, ES825-200F/XF, LS-610, RSU-810 and LS-600-LD Series sensors evaluated in this report, when connected to the Pneumercator TMS4000 Series console, will detect the presence of liquid wherever the sensor is installed once the sensors threshold is exceeded.

Attachment A

Results Forms for the Pneumercator Liquid Sensors with TMS4000 Series Console

RSU-800-2, ES825-100F/XF/CF, ES825-200F/XF, LS-610, RSU-810 and LS600-LD Series Sensor

Results of U.S. EPA Evaluation

Liquid Level Sensor

This form documents the performance of the liquid level sensor described below. Ken Wilcox Associates, Inc. has conducted this evaluation in accordance to the procedures described in section 4.5.1, "Liquid Phase Sensor Test Procedures", of the 2019 revised standard protocol "Standard Test Procedures For Evaluating Release Detection Methods: Volumetric And Non- volumetric Tank Tightness Testing", May 2019. The full evaluation report also includes a report describing the method, a description of the evaluation procedures, and a summary of the test data.

Tank owners using this system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with state and local agencies to make sure this form satisfies their requirements.

Method Description

Name Pneumercator TMS4000 Series Console and Liquid Sensors

Version number(s) RSU-800-2, ES825-100F/XF/CF, ES825-200F/XF, LS-610, RSU-810, LS600-LD Series sensor and Pneumercator TMS4000 Series console

Vendor Pneumercator
(Name of Manufacturer)

1785 Expressway Drive North
(Address)

Hauppauge	NY	11788	(631) 293-8450
(City)	(State)	(Zip Code)	(Phone)

Evaluation Parameters

The sensors listed above were tested for their abilities to respond to liquids when the sensors are installed in underground storage tank applications. The following parameters were determined from this evaluation.

Threshold Levels – The liquid levels at which alarms are triggered.

Precision (standard deviation) - Agreement between multiple measurements of the same product level.

Detection Time - Amount of time the detector must be exposed to product before it responds.

Fall Time - Amount of time before the detector stops responding after being removed from the product.

Specificity - Types of products that the sensor will respond to.

Evaluation Results

Results for the Pneumercator RSU-800-2 Sensor

	Low Level Float			High Level Float		
Parameter	**Water**	**Diesel**	**Unleaded**	**Water**	**Diesel**	**Unleaded**
Threshold Level (inches)	2.206	2.437	2.466	13.365	13.497	13.749
Precision - Standard Deviation (inches)	0.0170	0.0230	0.0165	0.0285	0.0236	0.0572
Detection time (minute)	< 1	< 1	< 1	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1	< 1	< 1	< 1

Results for the Pneumercator ES825-100F/XF/CF Sensor

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	0.302	0.352	0.340
Precision - Standard Deviation (inches)	0.0044	0.0029	0.0011
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

Results for the Pneumercator ES825-200F/XF Sensor

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	0.294	0.362	0.324
Precision - Standard Deviation (inches)	0.0047	0.0037	0.0046
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

Results for the Pneumercator LS600-LD Series Sensors with Buna N Float*

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	1.026	1.174	1.254
Precision - Standard Deviation (inches)	0.0041	0.0021	0.0030
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

*LS600-LDBN sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/Buna N float

Results for the Pneumercator LS-610 Sensor

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	0.459	0.521	0.573
Precision - Standard Deviation (inches)	0.0016	0.0019	0.0007
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

Results for the Pneumercator RSU-810 Sensor

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	0.759	0.860	0.928
Precision - Standard Deviation (inches)	0.0051	0.0030	0.0030
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

Results for the Pneumercator LS600-LD Series Sensors with SS Float*

Parameter	Water	Diesel	Unleaded
Threshold Level (inches)	0.874	0.958	1.018
Precision - Standard Deviation (inches)	0.0026	0.0036	0.0049
Detection time (minute)	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1

*LS600-LDSS sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/SS float

Results for the Pneumercator ES825-200F/XF Sensors Discrimination Feature

Parameter	E85/Water Mix Lower Layer (water)			E85/Water Mix Upper Layer(fuel)		
	80%/20%	60%/40%	30%/70%	80%/20%	60%/40%	30%/70%
Discrimination Accuracy between Water and Fuel	100%	100%	100%	100%	100%	100%
Detection time (minute)	< 1	< 1	< 1	< 1	< 1	< 1
Fall Time (minute)	< 1	< 1	< 1	< 1	< 1	< 1

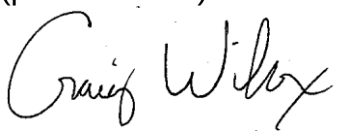
Specificity – These sensors will respond to any liquid after its threshold is exceeded. This testing was specifically for performance using water, diesel fuel and unleaded gasoline. The ES-825-200F/XF sensor was also evaluated for its discriminating ability with Ethanol/water mixtures.

Additional Limitations or Considerations - None

> Safety Disclaimer: This test procedure only addresses the issue of the methods ability to respond to liquids. It does not test the equipment for safety hazards.

Certification of Results

I certify that the liquid level sensors were tested under conditions according to the vendor's operating instructions. I also certify that the evaluation was performed using methods described in the attached Alternative EPA Test Procedures for Liquid level sensors, and that the results presented above are those obtained during the evaluation.

Craig Wilcox	Ken Wilcox Associates, Inc.
(printed name)	(organization performing evaluation)
	
	Grain Valley, MO 64029
(signature)	(city, state, zip)
(816) 443-2494	December 3, 2020
(phone number)	(date)

Laboratory Data

Table 1. Results for the Pneumercator RSU-800-2 Sensor

Run #	Height at Alarm(inches) Lower Float			Height at Alarm(inches) Upper Float		
	Water	Diesel	Unleaded	Water	Diesel	Unleaded
1	2.13	2.31	2.40	13.33	13.40	13.55
2	2.15	2.35	2.38	13.26	13.42	13.50
3	2.16	2.34	2.40	13.23	13.40	13.51
4	2.15	2.33	2.42	13.25	13.39	13.50
5	2.17	2.35	2.41	13.24	13.45	13.65
6	2.16	2.39	2.40	13.24	13.40	13.57
7	2.13	2.38	2.44	13.25	13.41	13.45
8	2.12	2.36	2.41	13.25	13.37	13.55
9	2.13	2.36	2.39	13.26	13.44	13.59
10	2.13	2.35	2.40	13.28	13.42	13.50
Mean	**2.1430**	**2.3520**	**2.4050**	**13.2590**	**13.4100**	**13.5370**
STDEV	**0.0170**	**0.0230**	**0.0165**	**0.0285**	**0.0236**	**0.0572**
Threshold	**2.2061**	**2.4373**	**2.4662**	**13.3645**	**13.4974**	**13.7489**

Table 2. Results for the Pneumercator ES825-100F/XF/CF Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.295	0.351	0.340
2	0.305	0.355	0.338
3	0.305	0.350	0.340
4	0.298	0.347	0.341
5	0.299	0.350	0.340
6	0.304	0.354	0.339
7	0.305	0.350	0.341
8	0.310	0.355	0.340
9	0.300	0.351	0.338
10	0.303	0.356	0.340
Mean	**0.3024**	**0.3519**	**0.3397**
STDEV	**0.0044**	**0.0029**	**0.0011**
Threshold	**0.3186**	**0.3627**	**0.3436**

Table 3. Results for the Pneumercator ES825-200F/XF Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.270	0.354	0.303
2	0.275	0.350	0.301
3	0.272	0.355	0.313
4	0.285	0.344	0.305
5	0.279	0.349	0.310
6	0.272	0.345	0.311
7	0.275	0.348	0.300
8	0.280	0.347	0.309
9	0.279	0.350	0.311
10	0.280	0.345	0.308
Mean	**0.2767**	**0.3487**	**0.3071**
STDEV	**0.0047**	**0.0037**	**0.0046**
Threshold	**0.2940**	**0.3625**	**0.3240**

Table 4. Results for the Pneumercator LS600-LD Series Sensors with Buna N Float*

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	1.012	1.166	1.239
2	1.009	1.168	1.241
3	1.011	1.168	1.240
4	1.005	1.166	1.245
5	1.015	1.166	1.241
6	1.007	1.161	1.244
7	1.006	1.166	1.249
8	1.014	1.168	1.245
9	1.015	1.165	1.243
10	1.016	1.166	1.244
Mean	**1.0110**	**1.1660**	**1.2431**
STDEV	**0.0041**	**0.0021**	**0.0030**
Threshold	**1.0260**	**1.1736**	**1.2541**

*LS600-LDBN sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/

Table 5. Results for the Pneumercator LS-610 Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.455	0.515	0.570
2	0.453	0.513	0.571
3	0.454	0.513	0.570
4	0.452	0.512	0.569
5	0.450	0.516	0.570
6	0.455	0.516	0.570
7	0.451	0.515	0.570
8	0.453	0.510	0.571
9	0.452	0.515	0.571
10	0.453	0.514	0.571
Mean	**0.4528**	**0.5139**	**0.5703**
STDEV	**0.0016**	**0.0019**	**0.0007**
Threshold	**0.4588**	**0.5210**	**0.5728**

Table 6. Results for the Pneumercator RSU-810 Sensor

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.735	0.847	0.912
2	0.733	0.857	0.915
3	0.730	0.849	0.914
4	0.742	0.847	0.912
5	0.740	0.848	0.919
6	0.745	0.849	0.918
7	0.745	0.847	0.920
8	0.741	0.847	0.917
9	0.743	0.848	0.920
10	0.741	0.849	0.917
Mean	**0.7395**	**0.8488**	**0.9164**
STDEV	**0.0051**	**0.0030**	**0.0030**
Threshold	**0.7585**	**0.8600**	**0.9276**

Table 7. Results for the Pneumercator LS600-LD Series Sensors with SS Float*

Run #	Height at Alarm(inches)		
	Water	Diesel	Unleaded
1	0.864	0.946	1.002
2	0.860	0.940	0.997
3	0.862	0.942	1.005
4	0.864	0.945	1.002
5	0.868	0.945	0.991
6	0.865	0.940	0.995
7	0.869	0.951	0.995
8	0.865	0.940	1.003
9	0.864	0.946	1.003
10	0.863	0.947	1.005
Mean	**0.8644**	**0.9442**	**0.9998**
STDEV	**0.0026**	**0.0036**	**0.0049**
Threshold	**0.8742**	**0.9577**	**1.0179**

*LS600-LDSS sensor used for this evaluation, results applicable to all LS600-LD Series sensors w/SS float

Table 8. Results for the Pneumercator ES825-200F/XF Sensor (console response of water or fuel with E85/Water mixtures

Run #	E85/Water Mixture Response to Lower Layer (Water)			E85/Water Mixture Respose to Upper Layer(Fuel)		
	80%/20%	60%/40%	30%/70%	80%/20%	60%/40%	30%/70%
1	Water	Water	Water	Fuel	Fuel	Fuel
2	Water	Water	Water	Fuel	Fuel	Fuel
3	Water	Water	Water	Fuel	Fuel	Fuel
4	Water	Water	Water	Fuel	Fuel	Fuel
5	Water	Water	Water	Fuel	Fuel	Fuel
6	Water	Water	Water	Fuel	Fuel	Fuel
7	Water	Water	Water	Fuel	Fuel	Fuel
8	Water	Water	Water	Fuel	Fuel	Fuel
9	Water	Water	Water	Fuel	Fuel	Fuel
10	Water	Water	Water	Fuel	Fuel	Fuel
Discrimination Accuracy between water and fuel	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**	**100% accurate**

TMS4000

Tank Management System with 10.4” Color Touchscreen Designed for Indoor and Outdoor Installations

Modular, Multi-Tank Gauging System w/Easy-to-Navigate 10.4” Color Touch Screen for Applications up to 48 Tanks

Panel-Mount

Wall-Mount

The TMS4000 Tank Management System is the latest generation of the TMS family, and the first touchscreen-based system in the industry available for both indoor and outdoor installation without requiring a secondary enclosure or supplemental heating/cooling. The large, 10.4” color, SVGA display provides an extremely easy-to-use graphical interface with real-time tank measurement data presented in three distinct formats; easy-to-read meters, detailed spreadsheet and quick-view bar graphs. Each format is user-configurable, and the spreadsheet display prioritizes active or alarming tanks to the top of the window. Leak sensor statuses and alarm acknowledgement are just one touch away. Simply put, the easiest to navigate in the industry! Existing TMS2000 and TMS3000 users, we’ve thought of you, too! The TMS4000 was designed to work with all your existing probes and sensors, and even your plug-in option cards! The TMS4000, next generation ATG from Pneumercator designed and built to the same high performance and reliability standards we’ve been manufacturing for over 100 years.




PEI MEMBER

PNEUMERCATOR
Liquid Level Control Systems

Pneumercator Company, Inc.
1785 Expressway Drive North
Hauppauge, New York 11788

Tel: 631-293-8450
Fax: 631-293-8533
http://www.pneumercator.com

- Support for up to 48 precision, dual-float magnetostrictive level probes, or varying combinations of level probes and leak sensors. Rigid or flexible probes for sub-base tank heights from 8”[200mm] to bulk tank heights of 70’[21M].
- Plug-In Relay I/O Cards provide up to 64 relay outputs with extensive relay and contact closure input programming options.
- Standard communications interfaces include Ethernet TCP/IP, USB host and client, RS232(2 standard, expandable to 6) and RS485. Single, dual or quad ModBus, 4-20ma and other industrial protocols are supported.
- Chemically treated, 7H hardness, full glass touch screen provides high durability and extreme clarity. For outdoor installation, glove-touchable and guaranteed not to fog.
- Dedicated POWER, NORMAL, ALARM LEDs, and ALARM ACKNOWLEDGE and Display Brightness touch buttons.
- Lockable metal enclosure, NEMA 12 dustproof standard, NEMA 4X weatherproof/corrosionproof optional. Both available in wall-mount or panel-mount versions.

- Front panel-mounted, weatherproof USB flash drive connector standard for NEMA 4X enclosure, optional on NEMA 12.
- Inspector’s report can be printed to a PDF file on a removeable flash drive.
- Optional thermal or impact printer is field-upgradeable. Landscape, 116-character wide inventory reports.

- TMSmobile application for Android phones
- E-mail and SMS text message alerts
- In-Field localization settings include operation in English, Spanish or French, with Metric(LT/mm) or English(Gal/in) units of measure.
- Encrypted SD card Log Reports database exportable in standard CSV format.
- Extensive system security settings allow the administrator to assign users with widely varying degrees of accessibility.
- Auto-switching universal power supply operates with any line voltage between 95-250VAC, 50/60Hz. DC input options available.
- Operating temperature -22°F[-30°C] to 160°F[70°C] for non-printer units, -5°F[-20°C] to 140°F[60°C] with printer.
- Upgrade path for existing TMS2000 and TMS3000 users. Use your existing probes, sensors and most plug-in cards.
- UL/cUL approved, file # E139464

Current Tank Inventory

Smiths Tank Farm Site ID: 10352 Unit ID: 1 Report Date: 10/ 4/2018 10:35

Tank ID	Tank Name	Status	Alarms	Gross Vol Gal	Net Vol Gal	% Vol	Ullage Gal	Product Height In	Water Height In	Temp °F
1	Diesel			14081	13969	70.4	3918	54.2	1.1	77.6
2	Diesel			13692	13591	68.4	4307	52.7	1.8	76.3
3	Diesel			9458	9390	47.2	8541	36.4	.8	76.0
4	Diesel		High Water	35409	35153	59.0	18590	59.0	2.3	76.0
5	Regular		Low Prod	2866	2836	19.1	10633	14.7	.6	76.0
6	Plus	Leak Test IP		12314	12181	82.0	1185	63.2	1.2	76.6
7	Super		Crit High Prod	14399	14240	95.9	0	73.9	.8	76.9
8	Transmission Oil			1855	1841	46.3	1744	35.7	.4	76.1

Landscape Inventory Print

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Liquid Level Control Systems

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http://www.pneumercator.com

Modular, Multi-Tank Gauging System w/Color Touch Screen Suitable for Indoor and Outdoor Applications, EPA-Compliant In-Tank and Secondary Containment Leak Detection

Product Description

The TMS4000 Tank Management System is the latest generation of the TMS family, and the first touchscreen-based system in the industry available for both indoor and outdoor use without requiring a secondary enclosure, supplemental heating or cooling. The large, 10.4" color, SVGA display provides an extremely easy-to-use graphical interface with real-time tank measurement data presented in three distinct formats; easy-to-read meters, detailed spreadsheet and quick-view bar graphs. Each format is user-configurable, and the spreadsheet display prioritizes active or alarming tanks to the top of the window. Standard communications interfaces include Ethernet TCP/IP (e-mail/SMS alerts included), USB host and client, RS232 (2 standard, expandable to 6) and RS485. Single, dual or quad ModBus, 4-20ma and other industrial protocols are supported. Web-ready for PCO CloudView access via Ethernet or internal cellular modem. Hardcopy reports are provided via optional internal thermal or impact printer in portrait and 116-character landscape modes, Ethernet-connected printer, or PDF to flash drive via front-panel weatherproof USB port. Extensive system security settings allow the administrator to assign users with widely varying degrees of accessibility. Localization features include operation in English, Spanish or French, with Metric(LT/mm) or English(Gal/in) units of measure, and an auto-switching universal power supply that will operate with any line voltage between 95-250VAC, 50/60Hz.

Console

- Dimensions (W x H x D): 14.3" x 11.8" x 7.9" (363 mm x 300 mm x 200 mm)
- Weight: 21 lb (9.6 kg) (4-Tank w/ Printer), 23.5 lb (10.7 kg) (12-Tank w/ Printer)
- Operating Temperature: -22 ºF to 160 ºF (-30 ºC to 70 ºC) w/o Printer (Consult factory for applications below -22 °F)
  -5 ºF to 140 ºF (-20 ºC to 60 ºC) w/ Printer
- Humidity: 95% Non-condensing
- Enclosure Rating: Locking NEMA 12 (IP52) or NEMA 4X (IP56) (304 SS)
- Power Requirements: 115/230 VAC ±15% Autoswitching, 50-60 Hz, 30 W Max.
  10-60 VDC Optional
- Memory: Configuration/Setup Data – SD Card, 50 year data retention, no batteries
  Log Reports – Removable SD Card, 50 year data retention, no batteries
  Real-Time Clock – Lithium Battery-Backed
- Audible Alarm: 85 db

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- Display: 10.4” (264 mm) Diagonal SVGA LCD w/Integral 7H Hardness Touch Panel – Glove Touchable
  Dedicated High Brightness POWER, NORMAL, ALARM LEDS, Visible from 75’ (22.9 m)
- Communications: Two (2) RS-232 Included Standard, RJ-13 Jack, Optional Expansion to six(6), four of which are field-selectable for RS232 or RS485
  Single RS485 Included Standard, RJ-13 Jack (For Pneumercator Peripherals)
  Ethernet TCP/IP Port Included Standard
  USB Host and Client Included Standard
  Internal, Secured Cellular or Landline Modem, Single/Dual/Quad-Channel ModBus Optional
- Probe/Sensor Capacities: Probe/Sensor Card Options (3 slots available) All Sensor Inputs Supervised-Wiring-Ready
  4 Probe/8 Sensor, 16 Probe, 16 Sensor (Max 48 Tanks)
- I/O, Non-Haz.: Expansion Options (2 slots available):
  4 Relays, 1 Form C, Rated 10 A@120 VAC, 6 A@240 VAC, w/ 4 Opto-Isolated Inputs
  8 Relays, 1 Form A, Rated 5 A@120 VAC, 5 A@240 VAC, w/ 8 Opto-Isolated Inputs
  16 Relays, 1 Form A, Rated 5 A@120 VAC, 5 A@240 VAC
  32 Relays, 1 Form A, Rated 1 A@24 VDC
  6 or 12-Ch. Programmable Analog Outputs: 0-1 mA, 0-20 mA, 0-24 mA, 4-20 mA, 0-5 VDC, 1-5 VDC

Probes

- Technology: Magnetostrictive, Dual Float, w/ reflection resolution doubling
- Accuracy (Minimum):

MP45xS:		MP46x:	
Product Level:	0.0005” (0.013 mm)	Product Level:	0.01” (0.25 mm)
Water Level:	0.001” (0.025 mm)	Water Level:	0.01” (0.25 mm)
Temperature:	0.001 ºF (0.0006 ºC)	Temperature:	0.001 ºF (0.0006 ºC)

- Materials: Shaft: 316 SS or PVDF
  Floats: 316 SS, Buna-N, Urethane, or PVDF
- Mounting: In-Tank Leak Testing: 4” (102mm) diameter riser
  Inventory Only: 2” (51 mm) minimum riser or direct bushing / flange mount
- Temperature Sensing: 5 Thermistors in shaft, 1 in probe head
- Location Approval: UL Class I, Div 1, Groups C and D; cUL Class I, Zone 0, Group IIB
- Operating Temperature: -40 ºF to 175 ºF (-40 ºC to 80 ºC)
- Operating Pressure: 150 PSIG (1034 kPa) 316SS, 50 PSIG (345 kPa) PVDF
- Field Wiring: 22AWG, 2-Conductor twisted pair w/ shield
  Belden 8441, 8761, Alpha 1736C or equiv., max. length 3000’ to 4600’ (914 m to 1402 m)
- Models: MP45xS Series rigid SS max. length 24’ (7.3 m)
  MP46xS Series flex. PVDF max. length 70’ (21.3 m)

Sensors

- ES825-200F: Electronic, Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular, Includes Fault Detection Feature as Standard
- ES825-100F: Electronic, Non-Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular, Includes Fault Detection Feature as Standard
- LLP-203: 3GPH Catastrophic Line Leak Detector
- LS600LD: Float, Containment, Manway and Piping Sumps, Dispenser Pan
- LS600xx: Multi-Float, High / Low Level and Pump Control
- RSU800: Float, Wet Annular / Reservoir
- LS610: Float, Dry Annular
- HS100D: Polymer / Float – Wet Well, 10’ to 20’ (3.1 m to 6.1 m) depth
- HS100ND: Polymer – Dry Containment, 1’ to 45’ (0.3 m to 13.7 m) length

Most sensors are available with Fault-Detect Supervised sensor and wiring option. Add “F” Suffix to Model Number

Remote Displays

- ETD1000: Addressable (up to 16), Multi-Drop, Remote Electronic Tank Display Panel
- RA400: Addressable (up to 16), Multi-Drop, Programmable Remote Audible/Visual Alarm Panel
- ETD1000W: Wireless Remote Electronic Tank Display Panel*
- RA400W: Wireless Programmable Remote Audible/Visual Alarm Panel*

*Note: MPX200 Master Peripheral Expansion Module required.

Certifications / Approvals

- UL/cUL Approved, File #E139464
- Third-party approved, NWGLDE-listed

Note: Specifications subject to change without notice. 12-16-2020

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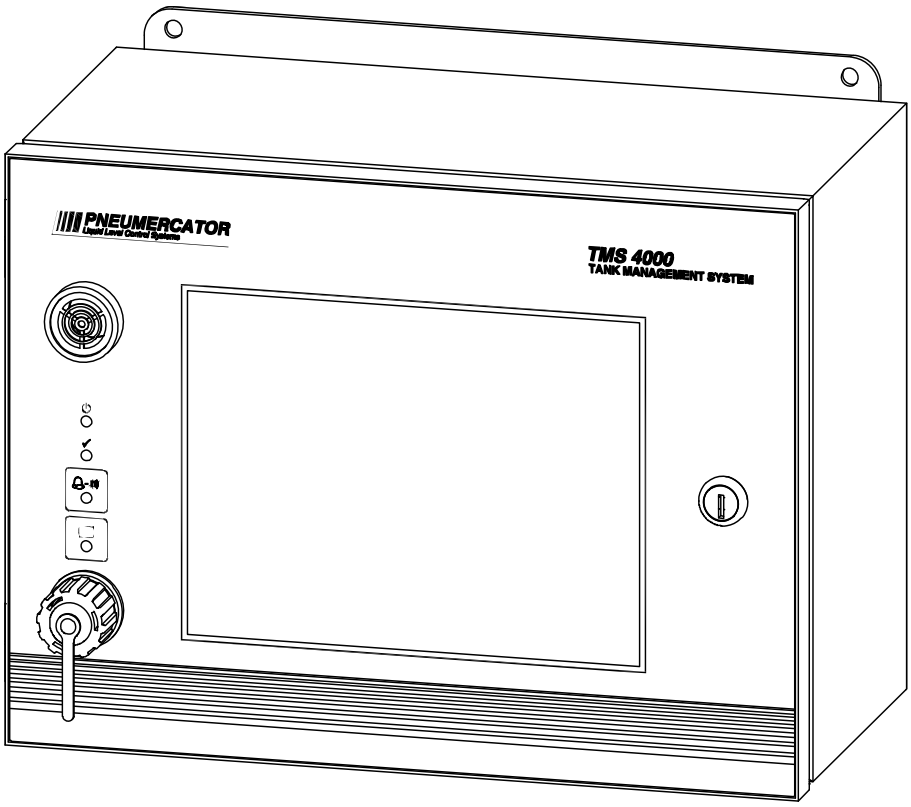
PNEUMERCATOR
Liquid Level Control Systems

MULTI TANK
MONITORING
SYSTEM

OPERATION MANUAL



DRAWING NO. 20208 REV. A

MODEL TMS4000

1785 EXPRESSWAY DRIVE NORTH
HAUPPAUGE, NY 11788

TEL: (631) 293-8450
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http://www.pneumercator.com

Note: A separate INSTALLATION MANUAL is available, but NOT required for TMS4000 operation.

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TABLE OF CONTENTS

SECTION 1 – PRODUCT DESCRIPTIONS

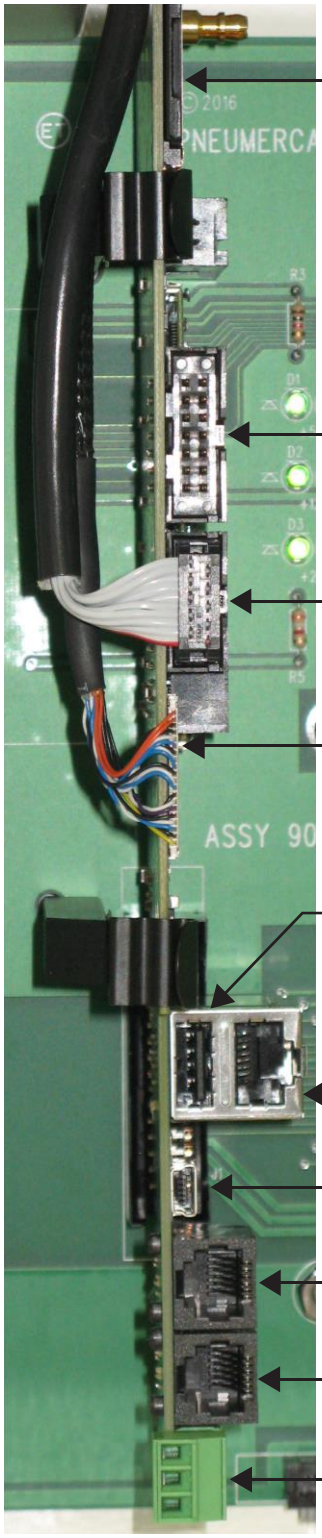
1.1 GENERAL SYSTEM OVERVIEW

This document covers the operation of the TMS4000 using the touch screen interface. A few additional details are visible on the face of the TMS4000 as shown below. Below the integrated horn in the top left corner are three LEDs. From top to bottom, these are the Green Power LED, Green Normal Status LED, and Red Alarm Status LED. The Alarm Status LED will blink for new alarms. Once the TMS alarm has been acknowledged using the Acknowledge button (Bell icon) in the top corner of the touch screen, the Alarm Status LED will not blink and will stay on until the alarm condition is satisfied. Once the alarm condition is satisfied, the Alarm Status LED will be off and the Normal Status LED will be on. Below the LEDs is the Day/Night sensor used to detect the ambient light and automatically adjust the screen brightness, when enabled.

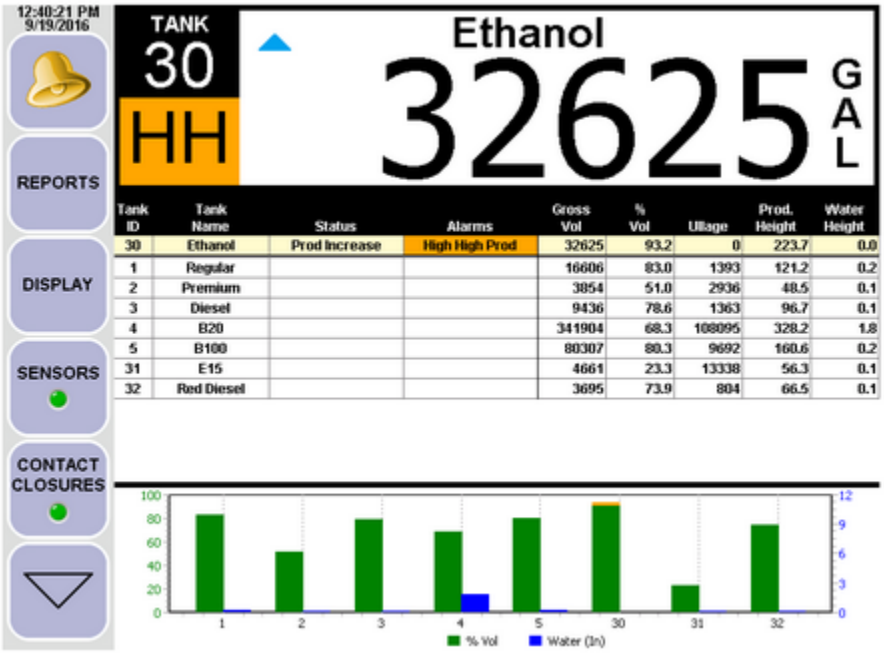
The touch screen is the primary interface for viewing real-time status of tank probes, sensors, and contact closure inputs. Additional access is provided for viewing system reports, changing the system Configuration, and upgrading the TMS firmware.

This manual was written referencing TMS4000 firmware version 10.044. Although some screen shots may vary between firmware versions, the principle of operation remains the same. Contact Pneumercator for any firmware version specific questions.

1.1.1 PROCESSOR CARD CONNECTIONS

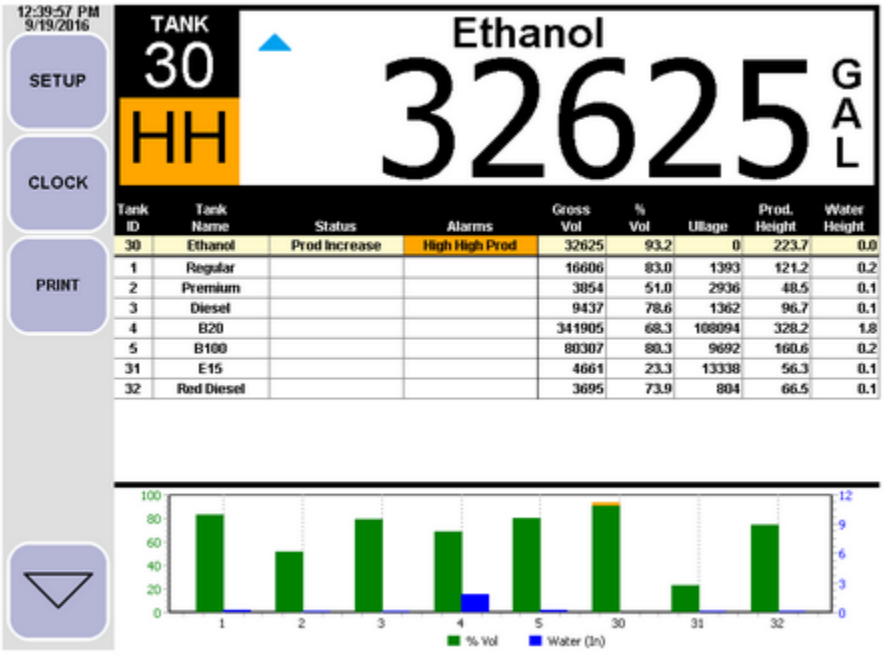


1.2 MAIN SCREEN



Tank ID	Tank Name	Status	Alarms	Gross Vol	% Vol	Ullage	Prod. Height	Water Height
30	Ethanol	Prod Increase	High High Prod	32625	93.2	0	223.7	0.0
1	Regular			16606	83.0	1393	121.2	0.2
2	Premium			3854	51.0	2936	48.5	0.1
3	Diesel			9436	78.6	1363	96.7	0.1
4	B20			341904	68.3	108095	328.2	1.8
5	B100			80307	80.3	9692	160.6	0.2
31	E15			4661	23.3	13338	56.3	0.1
32	Red Diesel			3695	73.9	804	66.5	0.1

Scroll to next set of buttons using down arrow in bottom left corner.



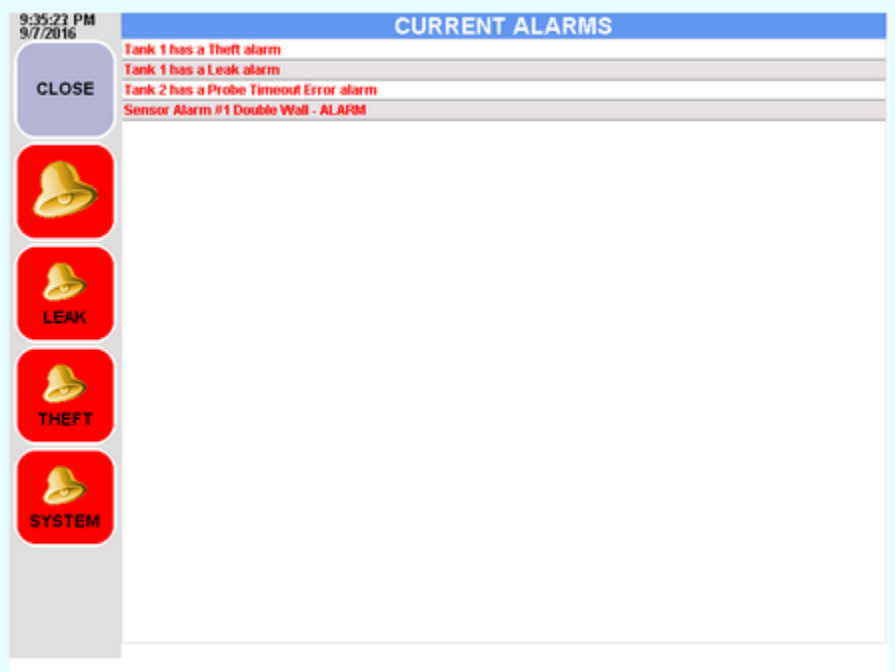
Tank ID	Tank Name	Status	Alarms	Gross Vol	% Vol	Ullage	Prod. Height	Water Height
30	Ethanol	Prod Increase	High High Prod	32625	93.2	0	223.7	0.0
1	Regular			16606	83.0	1393	121.2	0.2
2	Premium			3854	51.0	2936	48.5	0.1
3	Diesel			9437	78.6	1362	96.7	0.1
4	B20			341905	68.3	108094	328.2	1.8
5	B100			80307	80.3	9692	160.6	0.2
31	E15			4661	23.3	13338	56.3	0.1
32	Red Diesel			3695	73.9	804	66.5	0.1

Single Large Meter with Product and Water Bar Graphs shown

The above screens show the Main screen for the TMS4000. The buttons along the left edge provide access to different features that are described on the pages to follow. Above the buttons are shown the current date and time. The display to the right of the buttons show a large meter representing Tank 1, Gross Volume; a tabular display capable of displaying a minimum of 12 rows containing tank information without scrolling vertically; and a bar graph at the bottom showing bars for both percentage of tank volume and water level. The real-time display can be customized to suit your preferences as described in the following section.

1.3 ALARM ACKNOWLEDGMENT

Clicking on the Alarm Acknowledgment button (shown with a Bell icon) in the top left corner of the Main screen will silence the integrated horn and present the screen shown below. This provides the means of viewing the current Alarm/Event status and contains four different buttons on the left edge for acknowledging different categories of Alarm/Event conditions. The conditions that may be acknowledged in each button are listed below the screenshot.



General Acknowledgment: Represented by a bell icon without supporting text. The list of common conditions that may be acknowledged include:

- Tank Product Set Points
- Tank Water Set Points
- Tank Temperature Set Points
- Leak/Point Level Sensor Alarms
- CC Inputs

Leak Acknowledgment: The bell icon shown with LEAK below it is used to acknowledge a Failed In-Tank Leak Test. Once acknowledged, the failure will be removed from the list and will no longer cause the Alarm LED to be lit.

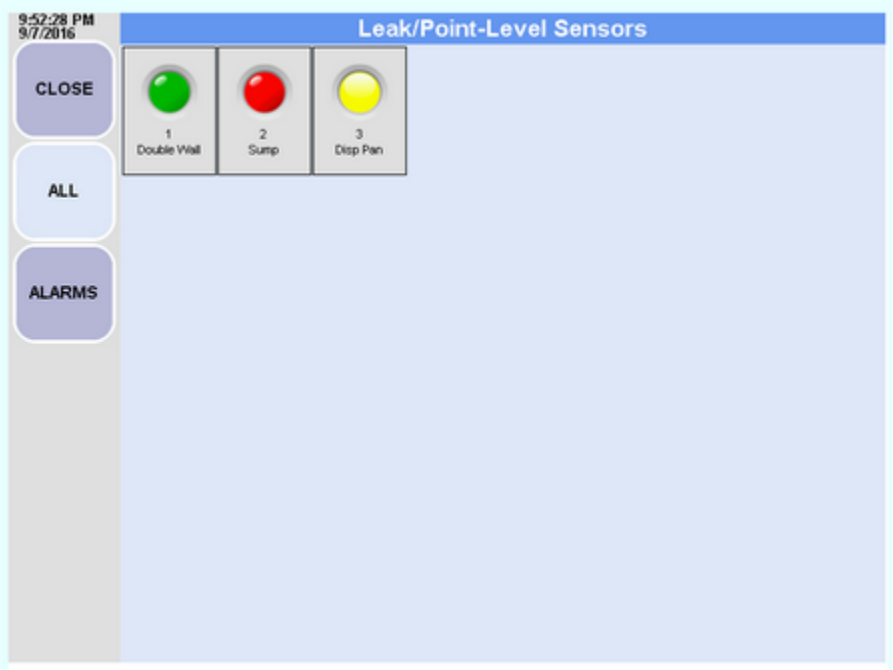
Theft Acknowledgment: The bell icon shown with THEFT below it is used to acknowledge a theft of product from a tank. Theft is an optional feature that must be enabled through the system configuration. Details are provided in a later section.

System Acknowledgment: The bell icon shown with SYSTEM below it is used to acknowledge system Events. These include Probe Timeout, Probe Sync, and Sensor Fault Errors.

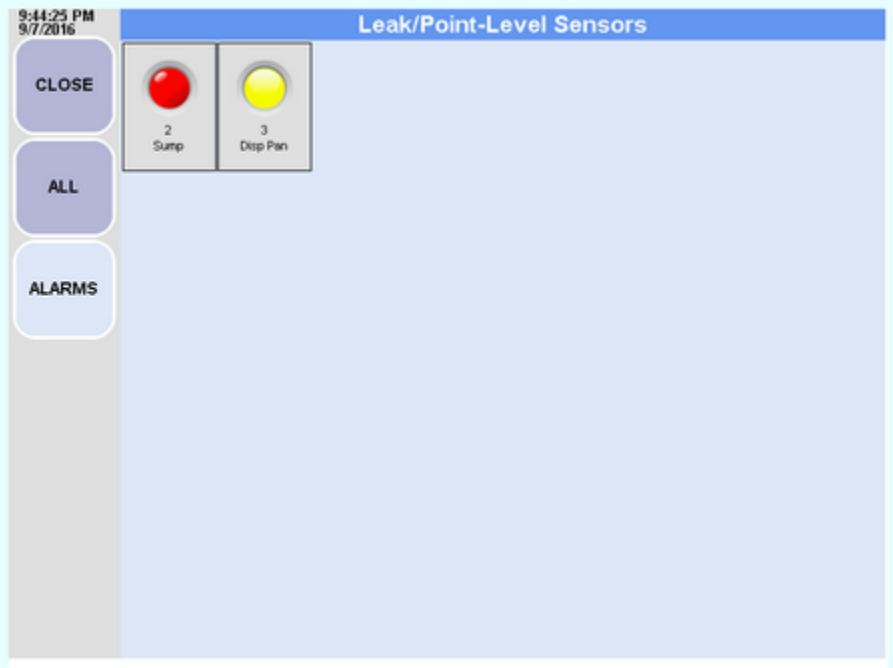
1.4 LEAK/POINT LEVEL SENSOR STATUS

The sensor's alarm or activity status is represented graphically as illustrated below. The colors represent the following:

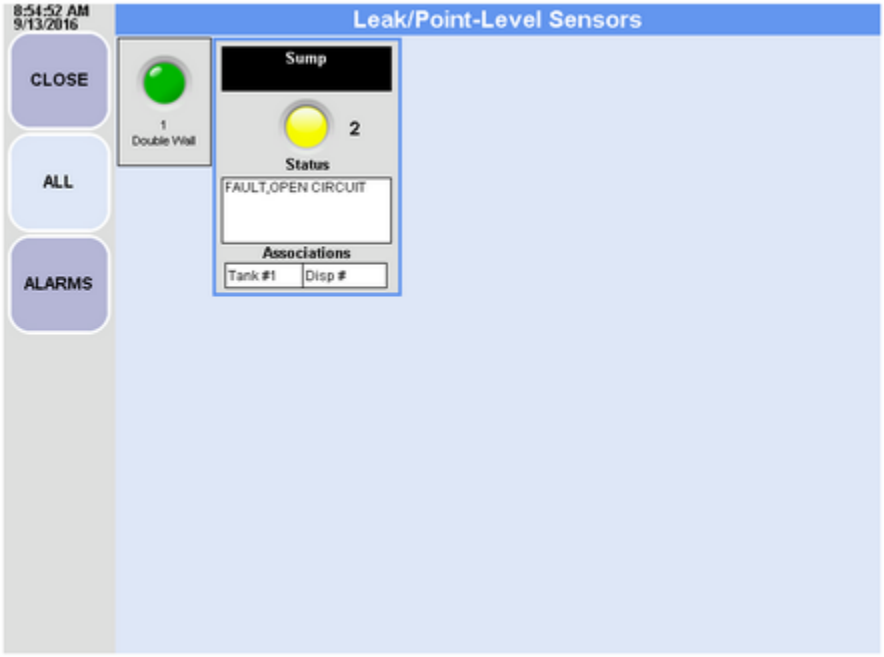
- Green: Normal or inactive sensor
- Red: Sensor alarm or activity. May be a general, product, or water alarm.
- Yellow: Sensor fault error. Either open or short-circuited wiring or a faulty sensor.



All view: shows the status for all enabled sensors



Alarms view: shows only the sensors in an alarm or error state.

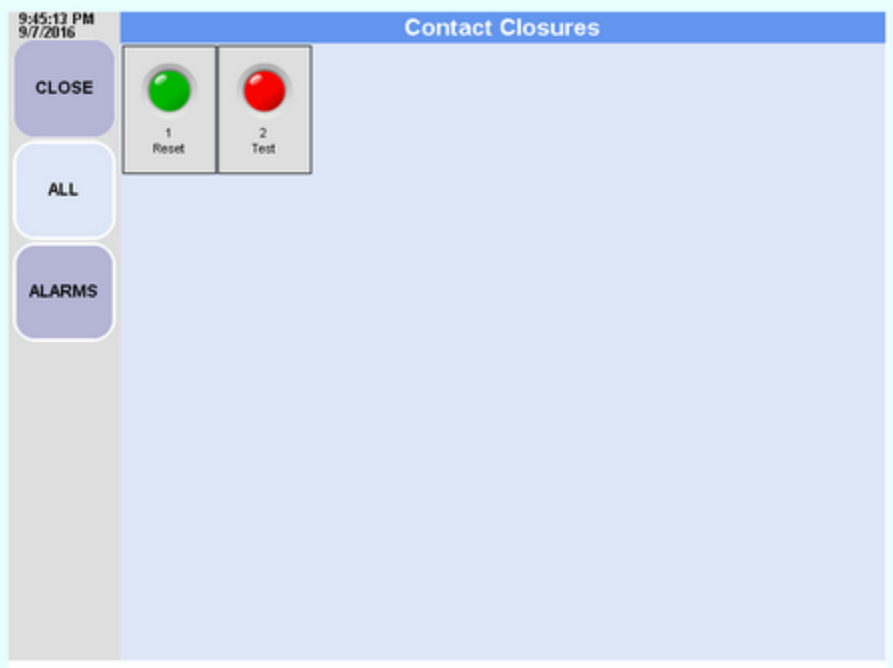


Additional details about the sensor can be obtained by touching the Sensor Status icon. The above screen shot shows a detailed description of the sensor condition in the Status section and additional information about the physical location of the sensor in the Associations section at the bottom.

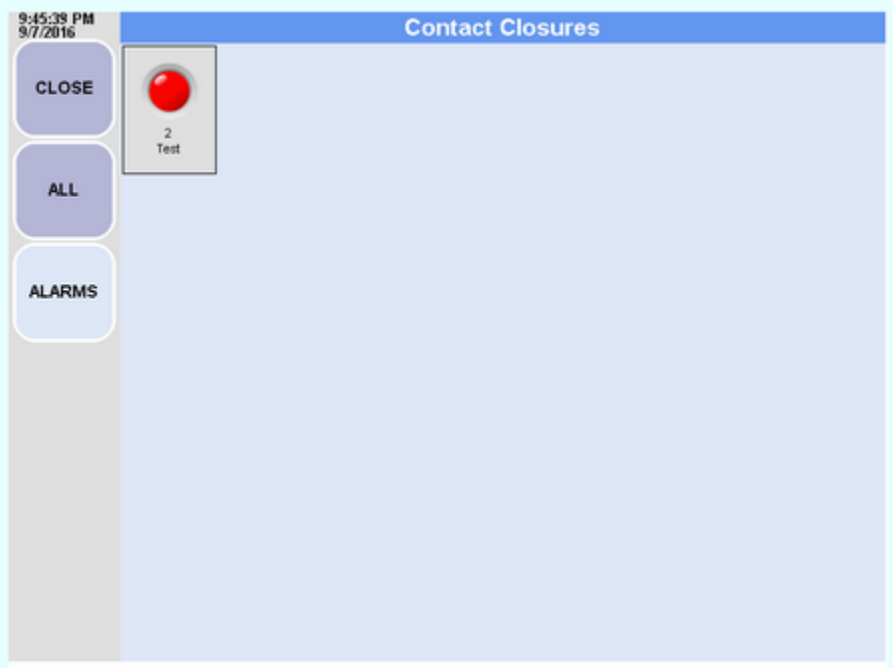
1.5 CC INPUT STATUS

The alarm or activity status of individual CC Inputs are represented graphically as illustrated below. The colors represent the following:

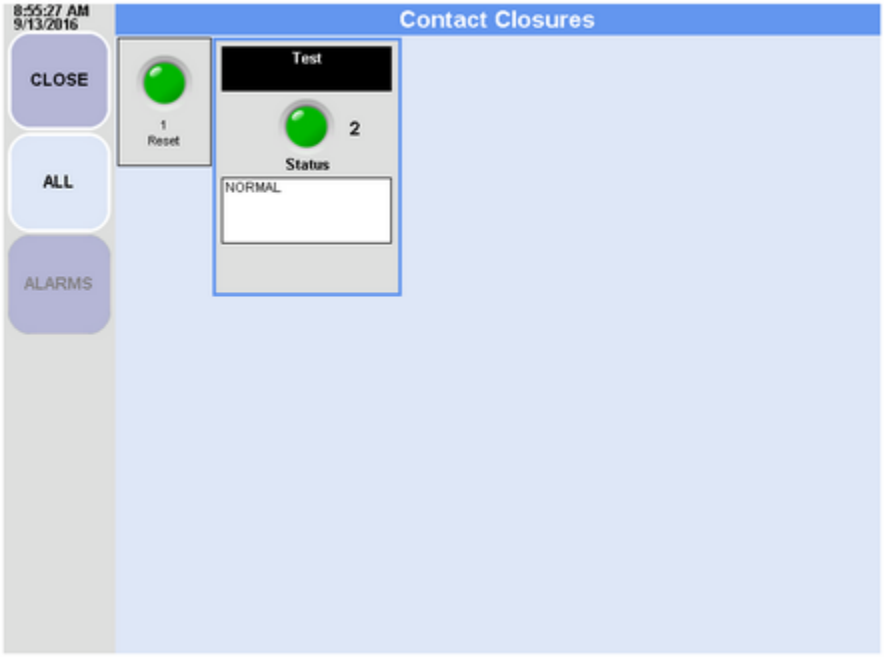
- Green: Normal or inactive sensor
- Red: CC Input in an alarm or active state.



All view: shows the status for all enabled CC Inputs



Alarms view: shows only the CC Inputs in an alarm or error state.

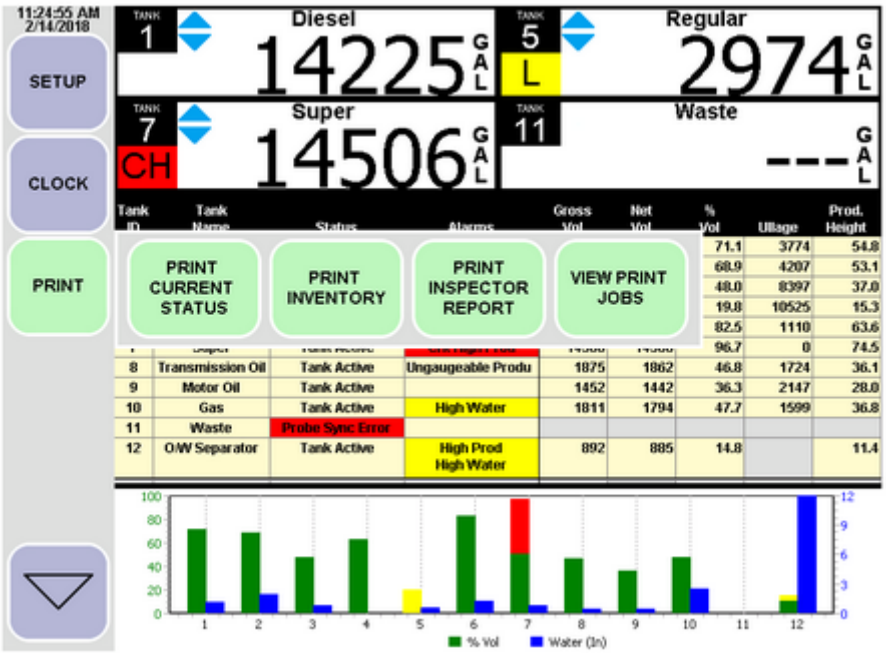


Additional details for the CC Input are show in the Status section after touching the CC Input Status icon.

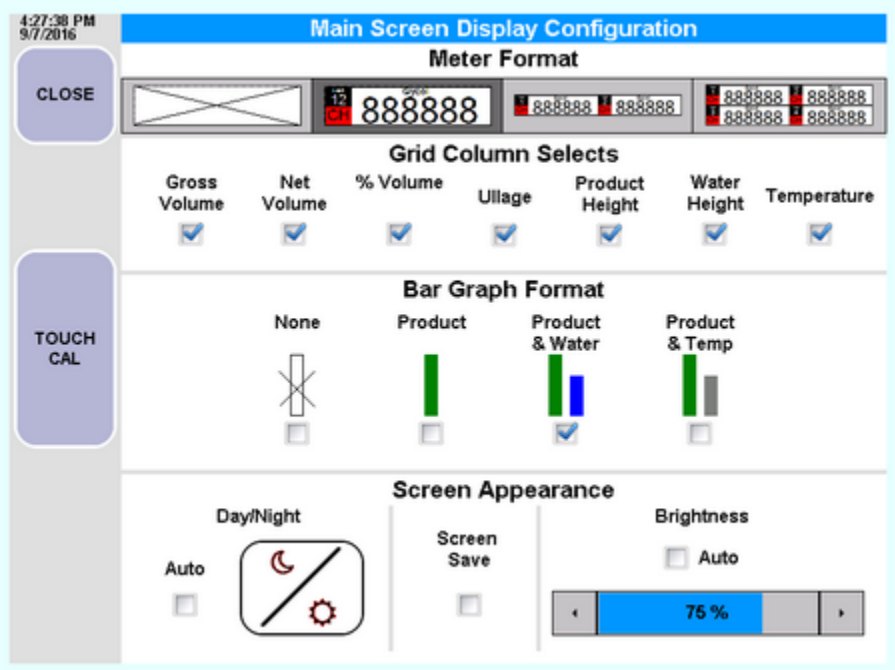
1.6 PRINTING

Many details may be printed from a TMS4000 equipped with a printer. A print button will be visible wherever printing is available. The information that can be printed includes the Reports and System Configuration. The below screen capture displays the options for the Print button accessible on the Main Screen. The reports accessible via this Print button are as follows:

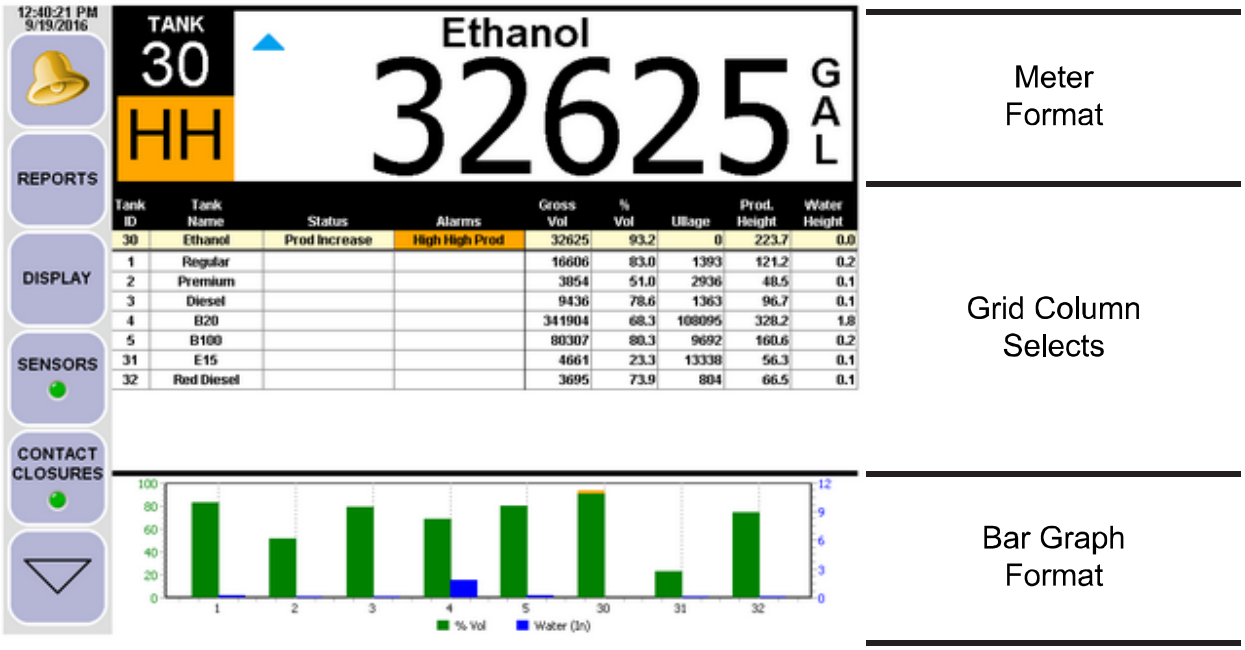
- Print Status: This prints the full system status reports including the states of all enabled tanks/probes and leak/point level sensors
- Print Inventory: The current Inventory displayed on the TMS4000 will be printed. This does not print the contents of the Inventory Report. To print the Inventory Report, simply go to the Reports button and click on the Print button. Other Reports may be printed in a similar fashion.
- Print Inspector Report: Combines the Status and Inventory Printouts into a single Report. This may either be printed or exported as a PDF.
- View Print Jobs: View the printer queue showing pending or active print jobs.



1.7 DISPLAY CUSTOMIZATION



Click on Display from the Main Screen to access the Display Customization screen, shown above. This screen offers settings to customize the real-time data presentation and screen brightness settings. The various settings are described below. Examples of screen configurations are found later in this section. The touch screen may also be recalibrated touching the Touch Cal button (First Generation Resistive LCD Screen Only). Details for recalibrating the screen are outlined in the following section.



Meter Format: The number of meters can be selected in single, dual or four-meter, or the meter window can be disabled altogether. The individual meters may be further customized from the real-time screen as described later in this section.

Grid Column Selects: The specific columns presented on the tabular display may be selected here. If more columns are selected than fit on the width of the display, the user may scroll by dragging their finger left-right across the tabular display. Note that the Tank ID, Tank Name, Status, and Alarms columns cannot be disabled.

- Gross Volume: Temperature Uncompensated volume
- Net Volume: Temperature-Compensated Volume.
- % Volume: Gross Volume/Tank Capacity x 100%.
- Ullage: Maximum delivery amount. See the Header section in Configuration for details on adjusting the maximum fill point.
- Product Height: Total height of liquid. For O/W Separator tanks, this is a measurement of the oil height.
- Water Height: Bottom water height or total water height for O/W Separator Tanks.
- Product Temperature: Volume-weighted average liquid temperature.

Bar Graph Format: Choices for configuring the bar graph are as follows:

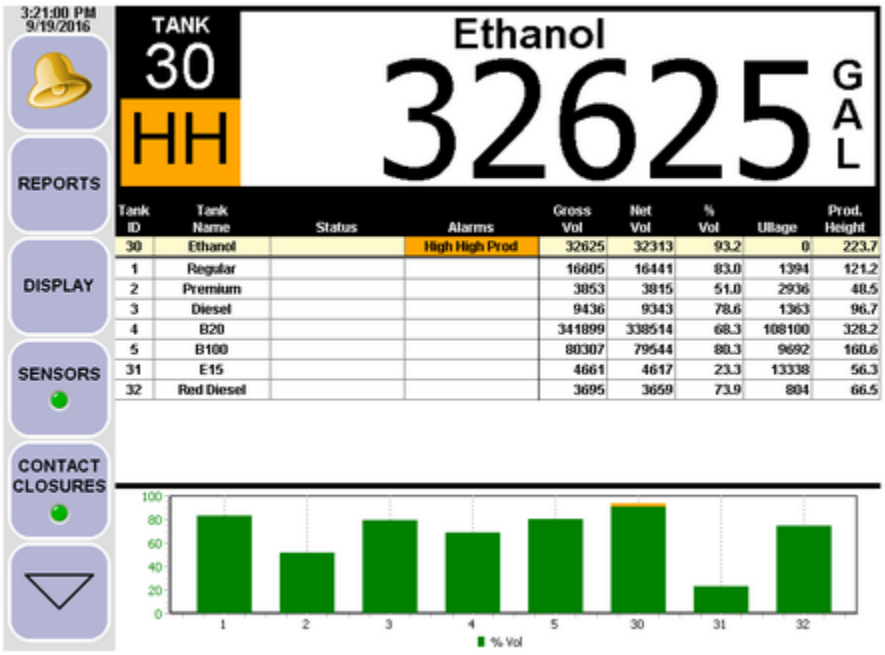
- Disabled
- Product Only
- Product and Water
- Product and Temperature

Screen Appearance: This section offers settings for configuring the Day/Night Mode, Screen Save, and Brightness features as described below:

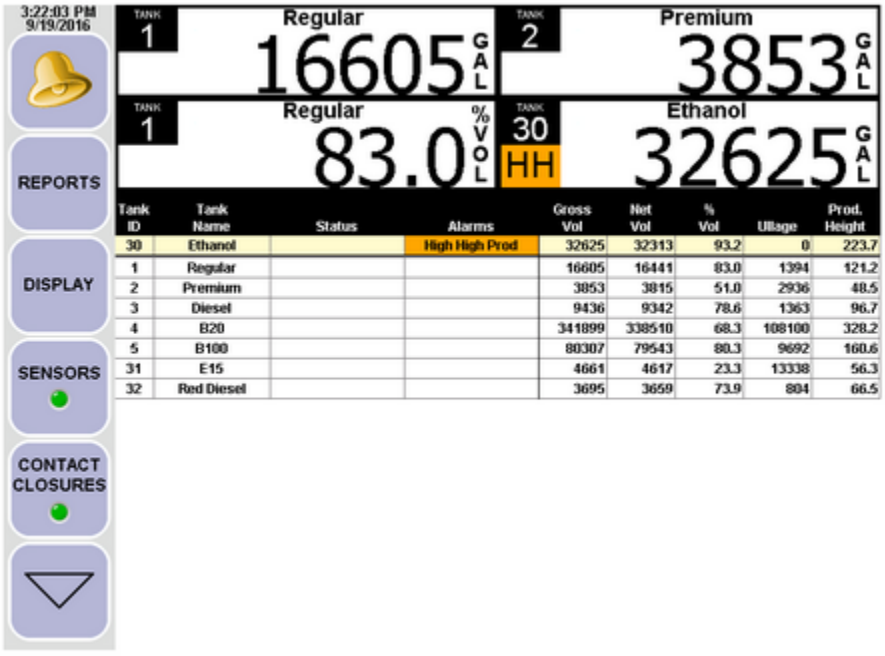
Day/Night: The LCD screen has two different color schemes to improve visibility for both Day and Night conditions. This feature can be set to automatically toggle between these two schemes using the information from the Day/Night sensor on the face of the TMS4000 or may be manually toggled by clicking on the Moon/Sun icon.

Screen Save: Dims the LCD to 3% brightness after a five-minute time delay. The screen is reactivated when the screen is touched or if an alarm or activity occur.

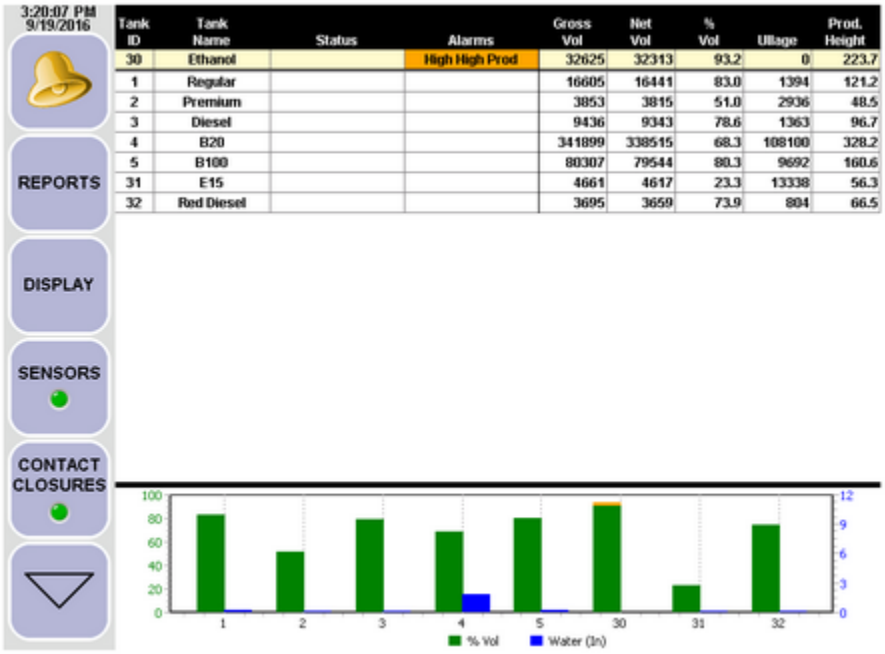
Brightness: The LCD screen brightness may be manually adjusted using the slider (default is 75%) or may be automatically adjusted using the information from the Day/Night sensor on the face of the TMS4000.



Example: One large meter with Product bar graph

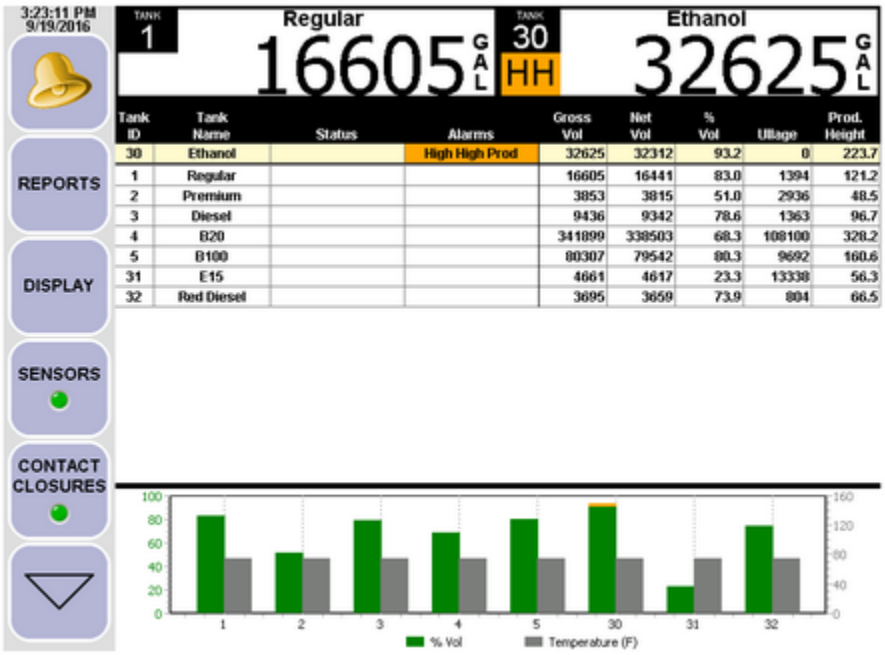


Example: Four small meters with bar graph disabled



Tank ID	Tank Name	Status	Alarms	Gross Vol	Net Vol	% Vol	Ullage	Prod. Height
30	Ethanol		High High Prod	32625	32313	93.2	0	223.7
1	Regular			16605	16441	83.0	1394	121.2
2	Premium			3853	3815	51.0	2936	48.5
3	Diesel			9436	9343	78.6	1363	96.7
4	B20			341899	338515	68.3	108100	328.2
5	B100			80307	79544	80.3	9692	160.6
31	E15			4661	4617	23.3	13338	56.3
32	Red Diesel			3695	3659	73.9	804	66.5

Example: Meters Disabled with Product and Water bar graph

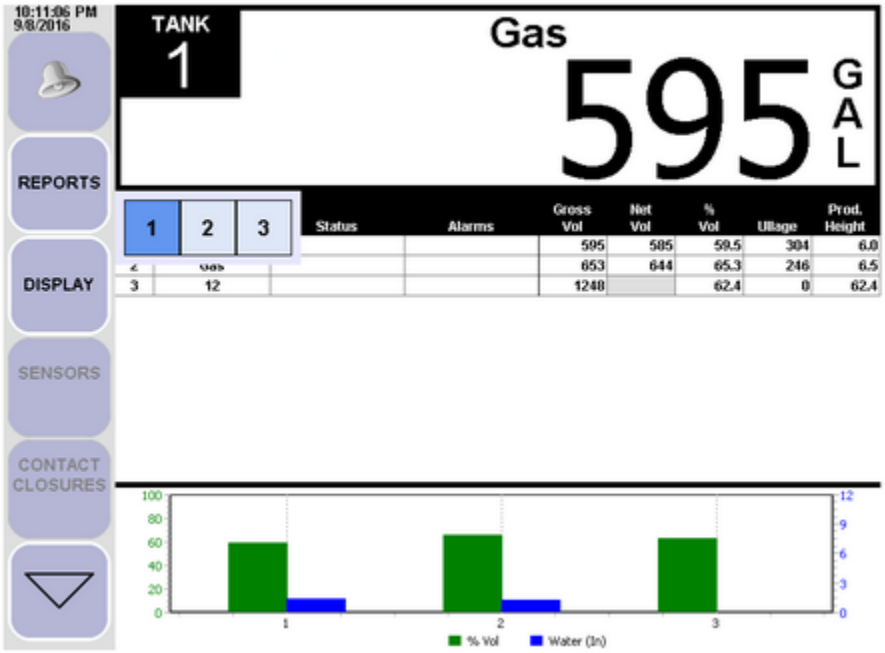


Tank ID	Tank Name	Status	Alarms	Gross Vol	Net Vol	% Vol	Ullage	Prod. Height
30	Ethanol		High High Prod	32625	32312	93.2	0	223.7
1	Regular			16605	16441	83.0	1394	121.2
2	Premium			3853	3815	51.0	2936	48.5
3	Diesel			9436	9342	78.6	1363	96.7
4	B20			341899	338503	68.3	108100	328.2
5	B100			80307	79542	80.3	9692	160.6
31	E15			4661	4617	23.3	13338	56.3
32	Red Diesel			3695	3659	73.9	804	66.5

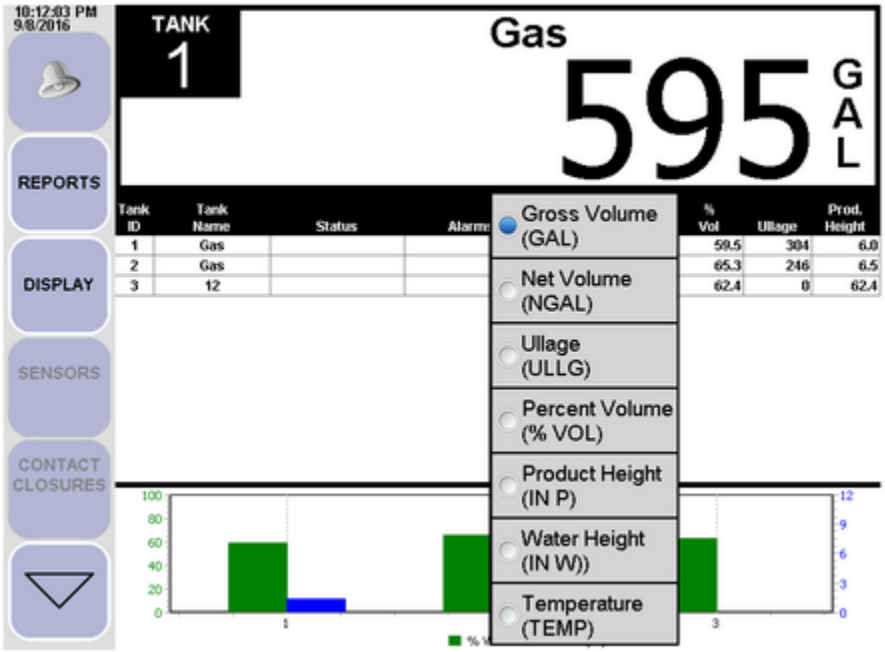
Example: 2 Small Meters with Product and Temperature bar graph

CUSTOMIZING INDIVIDUAL METERS

The below examples illustrate how each individual meter can be configured. The top example is for Tank Channel selection and the bottom example is for Unit selection.



Touch the Tank ID in the back box at the top left corner of the meter to bring up a selection of available Tank Channels that can be selected for the meter. Note that a Tank Channel represents where the probe is physically wired and may differ from the user assigned Tank ID

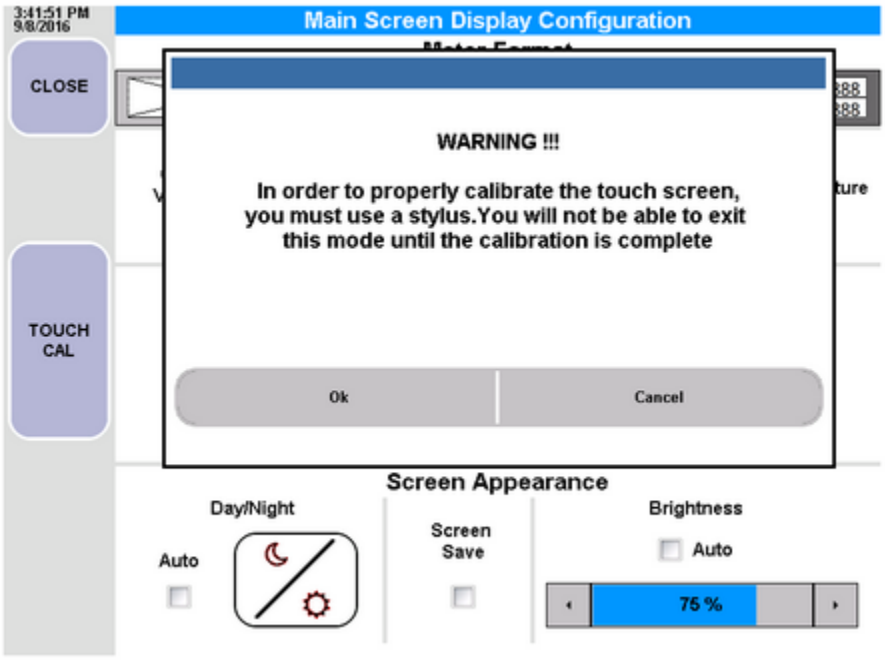


Touch the unit displayed on the far right of the meter (in this case, GAL) to display the drop down menu of choices. Touch the radio button for the desired selection to select that choice.

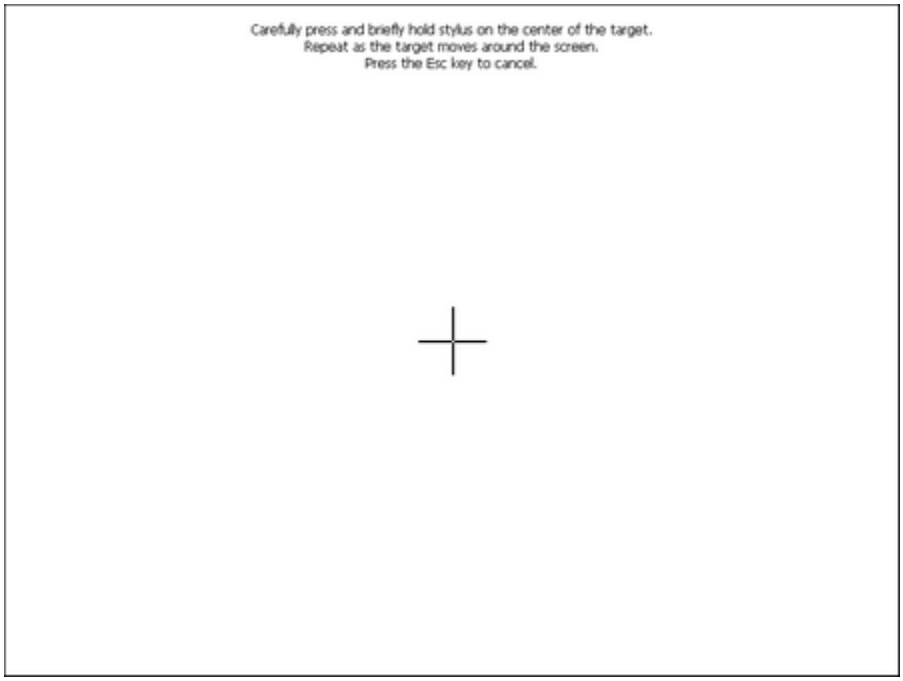
1.8 TOUCH SCREEN CALIBRATION

Note: Only applies to First Generation Resistive LCD Screens ONLY

The ability to recalibrate the touch screen is available in the event the user's touch does not match where the system responds to the touch. It is NOT recommended to perform this without contacting Pneumercator Technical Support. Note that you will need a stylus to properly recalibrate the screen. Failure to follow these instructions may result in the screen being unresponsive and require parts be returned to Pneumercator as directed by Pneumercator Technical Support.



Touching the Touch Cal button will show the above notification screen.



Follow the onscreen instructions above to complete the calibration. The calibration MUST BE COMPLETED to exit this screen.

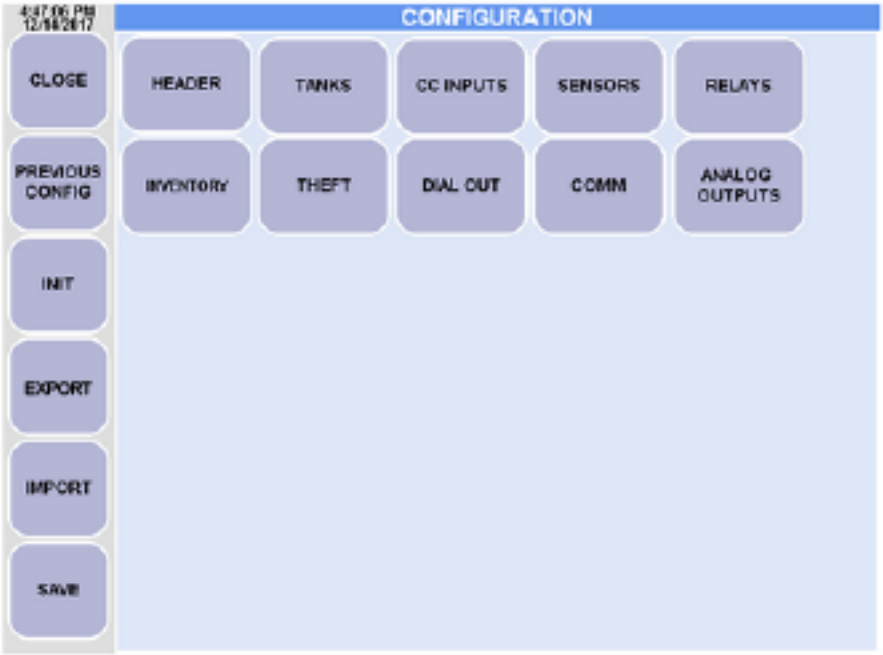
SECTION 2 – SYSTEM CONFIGURATION

2.1 SETUP MENU

The Setup Menu contains options for configuring the TMS and other select administrative functions. A brief description of each section is provided below.

- Config: The configuration of the TMS can be reviewed and/or modified in this section. This includes details for tank geometry, sensor configuration, and Communications and I/O Card configuration. Details are found in the next section.
- Leak Test: This section configures the details for the In-Tank Leak Test including the Test Length and scheduling of the test.
- The System Log contains a list of administrative events like a configuration change or firmware upgrade. Select system problems may also be documented here. This log will be described in Section 3.
- Security: sets the security for accessing select TMS features. Once enabled, a 4-digit PIN number will be needed to access select features.
- Firmware: provides the ability to upgrade the firmware or view what the current firmware level is.
- Localization: the system language and units of measure are configured here.

2.2 SYSTEM CONFIGURATION



The Config menu is divided into categories of configuration options. A brief description of each category is listed below. Additional details immediately follow this section.

- Header: global settings that affect system operation as a whole
- Tanks: all details for configuring a tank including the dimensions and probe details.
- CC Inputs: Contact Closure Inputs typically located on select Relay I/O Cards
- Sensors: Leak/Point Level Sensor
- Relays: Relay output triggers and behavior settings
- Inventory: schedule of inventory snapshot
- Theft: defines hours of operation for the facility
- Dial Out: conditions that can initiate a dial-out
- Comm: Serial, network, and modem settings
- Analog Outputs: tank data assignment to each channel

The buttons along the left edge perform the following functions:

- Close: Closes the Config Window. If changes were made, a prompt will appear questioning whether or not to save the configuration.
- Previous Config: The previously saved version of the configuration is stored in the TMS to allow recovery from accidental configuration changes.
- Init: Initializes the system configuration to the factory default settings.
- Export (Formerly labelled COPY): When a flash drive is inserted, a copy of the current configuration file will be copied to the flash drive. The User is prompted to enter a file name. The file extension used is .CFX. See Section 1.1.1 for location of USB Port.
- Import: When a flash drive is inserted with a valid file with the .CFX extension, the option to import is available. See Section 1.1.1 for location of USB Port.
- Save: The current configuration overwrites the previously saved Previous Configuration and the New Configuration changes become the current configuration.

2.3 HEADER

Site Name: Printed on system generated reports

Unit ID: Used to identify the TMS that generated a report. This is recorded in all Logs and is included on all printouts from the TMS. This is also used, in part, to identify a TMS that is making a phone call to a computer running Autopolling. See Unit ID.

Site ID: Used to identify the TMS that generated a report. This is recorded in all Logs and is included on all printouts from the TMS. This is also used, in part, to identify a TMS that is making a phone call to a computer running Autopolling. See Unit ID.

Horn Delay: Silences the integrated TMS horn after a delay set in minutes. Selecting None disables this feature.

Leak Print Mode: Choice between printing all In-Tank Leak Test Results (Pass-Fail) or only Failing results (Fail Only)

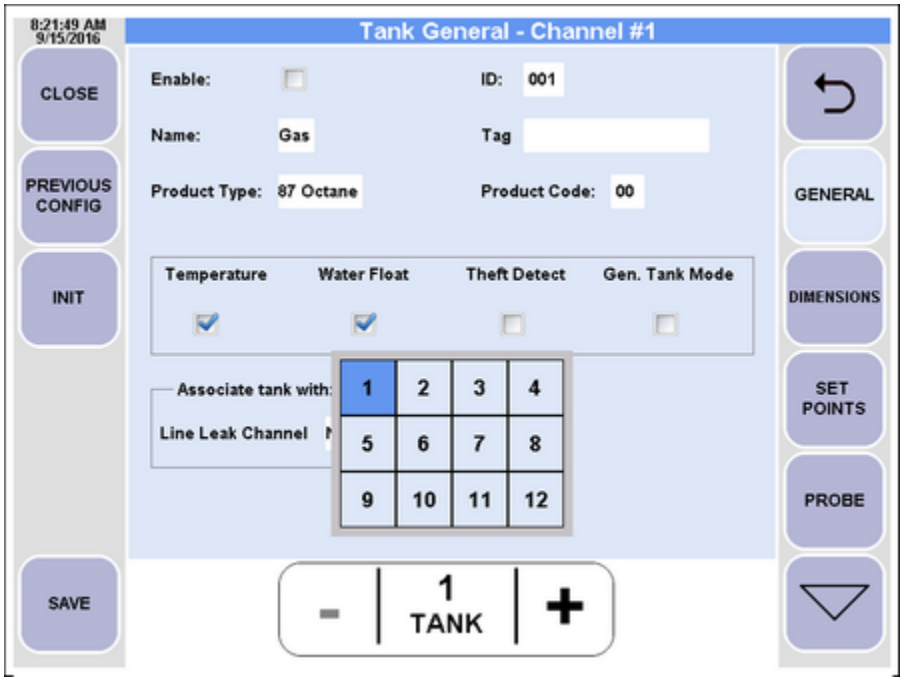
Ullage Limit: ullage is the free space in the tank. Factory default of 90% is used due to the fact that most applications do not permit the filling of a tank above the 90% volume mark. Other options include 85%, 95%, and 100%.

Sales Enable: Enables Bulk Sales Tracking and records data in the Sales Log. Not used for applications where simultaneous transactions can occur.

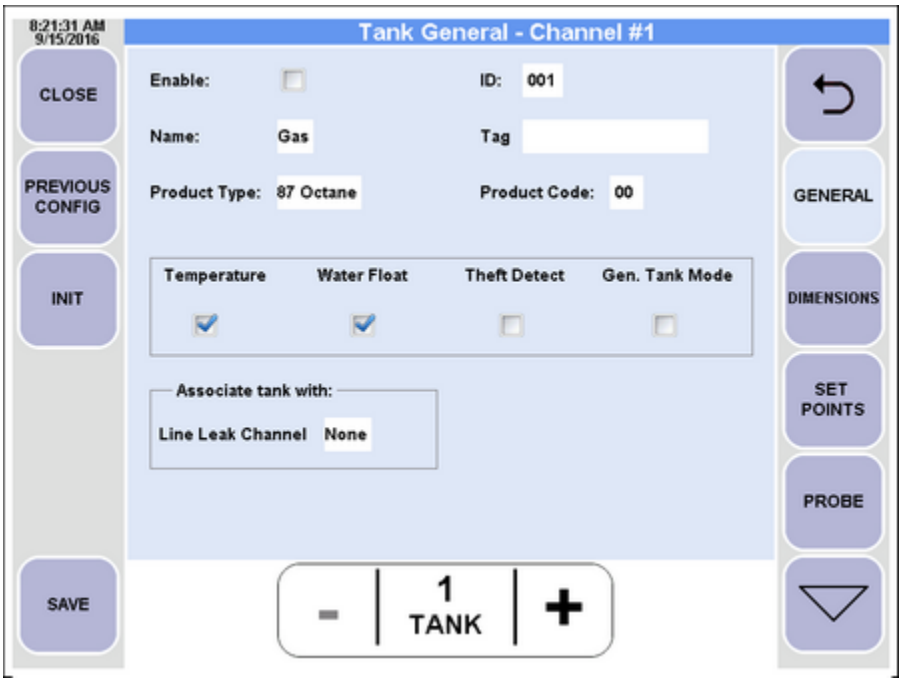
Line Leak Enable: Makes available the assignment of the Line Leak Channel number of the external LS300 Line Leak console to a specific Tank Channel

File Export Prefix: The Prefix is prepended to the file name of the exported report saved to a USB Flash Drive.

2.4 TANKS - GENERAL



Touch the +/- buttons to increment Tank Channel by 1. Touch the Tank Channel number to bring up a list of possible Tank Channels. Touch the Tank Channel number on the table to make a selection.



Enable: Activates the selected Tank Channel. The Tank Channel number is represented by the tabs across the bottom. Use the small arrow buttons on the bottom right corner to access all available tank channels or click on a visible tank tab number.

ID: Used to assign a custom 3 digit numeric tank ID to a tank channel. Default setting has the Tank ID matching the Channel Number.

Tank Name: A name assigned to a tank to identify the stored product. Select from the list or type in a 16 character custom name.

Tank Tag: Printed on system generated reports

Product Type: Defines the coefficient of thermal expansion. Consult factory if product is not listed.

Product Code: Used to support V200 and V300 protocols. Not used in any calculations and is not present on any reports.

Temperature: Selects whether or not the temperature reading is viewed. Shown as a constant zero temperature if disabled. Temperature must be enabled for in-tank leak tests.

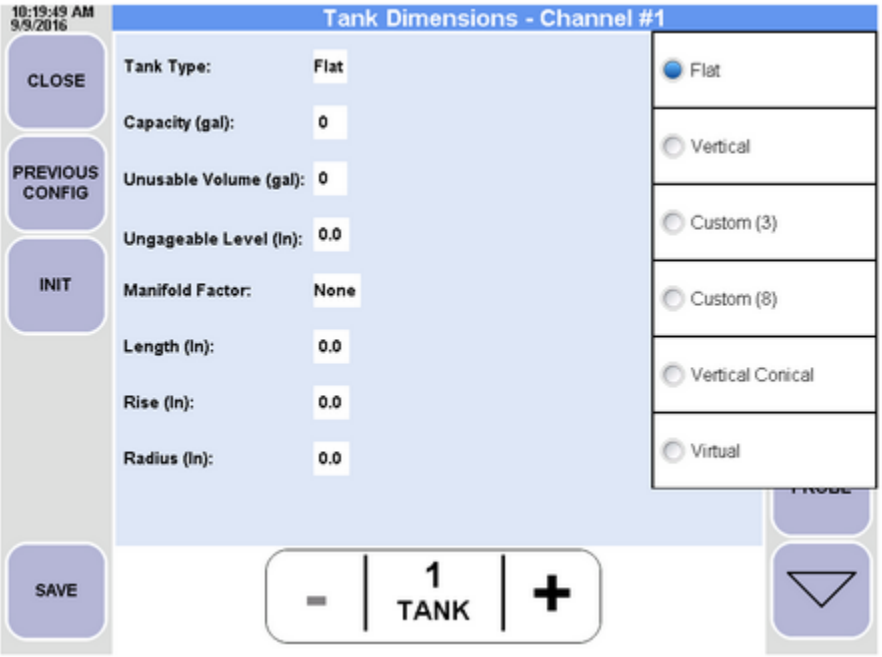
Water Float: Instructs the TMS to display the water level reported by the probe. This setting is intended for use in applications where the water reading is not desired. The TMS displays a blank in the water level field when disabled.

Theft Detect Enable: Enables a per tank setting for theft monitoring. See the Theft tab for more details.

Generator Tank: A special in-tank leak test mode intended for use on above ground generator tanks. Identical to Auto Leak Test Mode without the monthly limitation.

Associate with Line Leak Channel: Used in the Line Leak Report to identify the tank that the tested line supports. Only displayed if Line Leak Enable is checked in Header section.

2.5 TANKS - DIMENSIONS



The TMS support a wide range of tank shapes and sizes. These supported tanks can be configured by selecting the basic tank shape from the list as described below:

Flat: Flat-ended horizontal cylinder.

Vertical: includes vertical cylinders and rectangular tanks. Any tank with a constant volume per unit of level is supported with this type

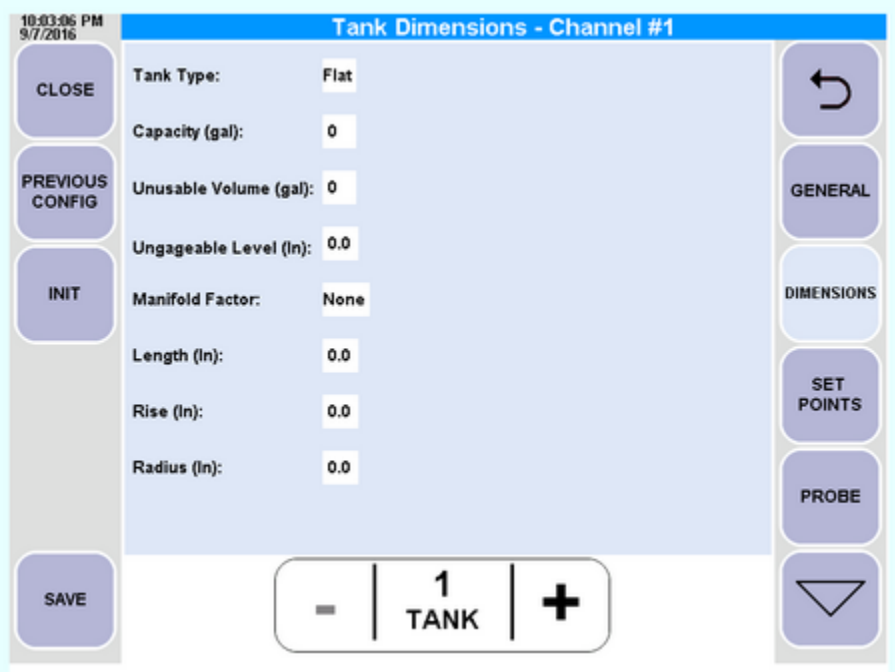
Custom (3): A horizontal cylinder with curved or dished ends.

Custom (8): An asymmetrical tank or other tank with unusual geometry. Contact Pneumercator for assistance.

Vertical Conical: A vertical cylinder with a cone bottom.

Virtual: Combines multiple tank to for a virtual tank for the purpose of defining Product Set Points for the collective volume.

2.5.1 TANKS – DIMENSIONS – FLAT



The following settings pertain to a flat-ended horizontal cylinder:

Capacity: Use actual tank capacity so that an accurate volume calculation can be performed. (i.e. a tank may be referred to as a 10,000 gallon tank for conversation but the actual capacity may actually be 9844.)

Unusable Volume: Affects the calculations performed for the Product Order Report. This volume is excluded from the total volume when calculating the number of days of usable fuel remaining in the tank.

Ungageable Level: Represents the amount of liquid that cannot be measured by the probe. This may be due to the construction of the tank or the fact that the flex probe has a weight on the end of the shaft.

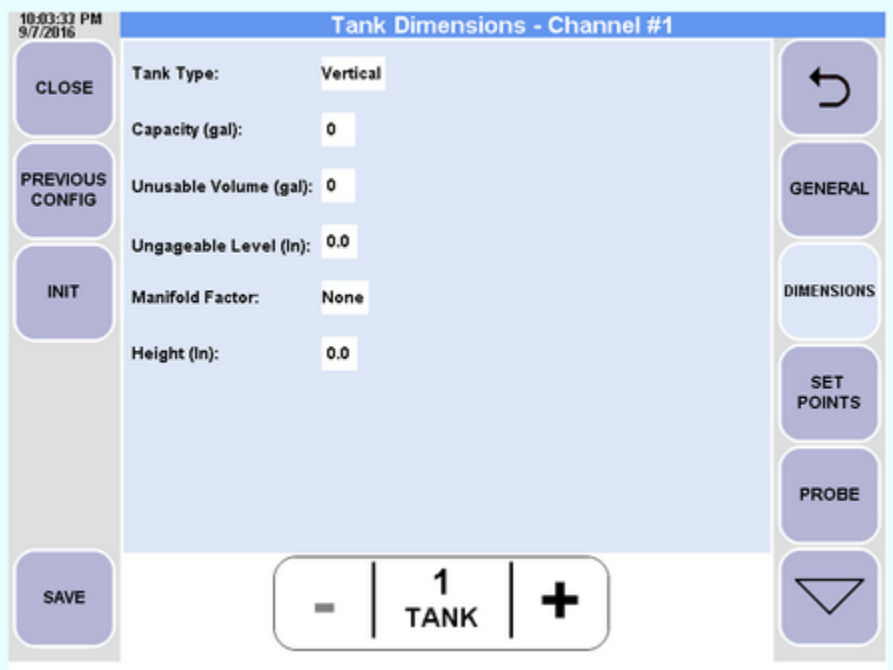
Manifold Factor: The number of Manifolds on a tank set with only one probe. Note that EPA requirements for manifolded tanks are to isolate the tank from the set before performing a leak test. Advanced settings here include the ability to auto select a pump based on the tank with the highest volume. Consult factory for details.

Length: Only used if the tank is tilted. See Tank Rise.

Rise: Amount of tank tilt present on a horizontal tank. Measured in inches and is never negative. See Probe Location Offset.

Radius: 1/2 of the inside diameter. Refer to tank drawing or chart for details.

2.5.2 TANKS – DIMENSIONS – VERTICAL



The following settings pertain to a tank with a constant volume per unit level including vertical cylinders and rectangular tanks:

Capacity: Use actual tank capacity so that an accurate volume calculation can be performed. (i.e. a tank may be referred to as a 10,000 gallon tank for conversation but the actual capacity may actually be 9844.)

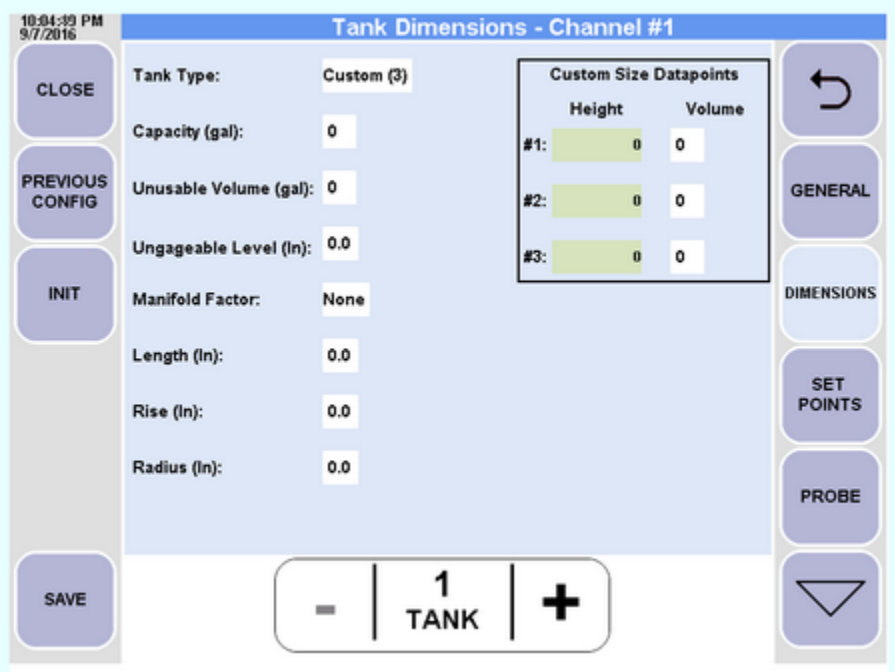
Unusable Volume: Affects the calculations performed for the Product Order Report. This volume is excluded from the total volume when calculating the number of days of usable fuel remaining in the tank.

Ungageable Level: Represents the amount of liquid that cannot be measured by the probe. This may be due to the construction of the tank or the fact that the flex probe has a weight on the end of the shaft.

Manifold Factor: The number of Manifolds on a tank set with only one probe. Note that EPA requirements for manifolded tanks are to isolate the tank from the set before performing a leak test. Advanced settings here include the ability to auto select a pump based on the tank with the highest volume. Consult factory for details.

Height: The inside height of the tank.

2.5.3 TANKS – DIMENSIONS – CUSTOM 3



The following settings pertain to a horizontal tank with curved or dished ends:

Capacity: Use actual tank capacity so that an accurate volume calculation can be performed. (i.e. a tank may be referred to as a 10,000 gallon tank for conversation but the actual capacity may actually be 9844.)

Unusable Volume: Affects the calculations performed for the Product Order Report. This volume is excluded from the total volume when calculating the number of days of usable fuel remaining in the tank.

Ungageable Level: Represents the amount of liquid that cannot be measured by the probe. This may be due to the construction of the tank or the fact that the flex probe has a weight on the end of the shaft.

Manifold Factor: The number of Manifolds on a tank set with only one probe. Note that EPA requirements for manifolded tanks are to isolate the tank from the set before performing a leak test. Advanced settings here include the ability to auto select a pump based on the tank with the highest volume. Consult factory for details.

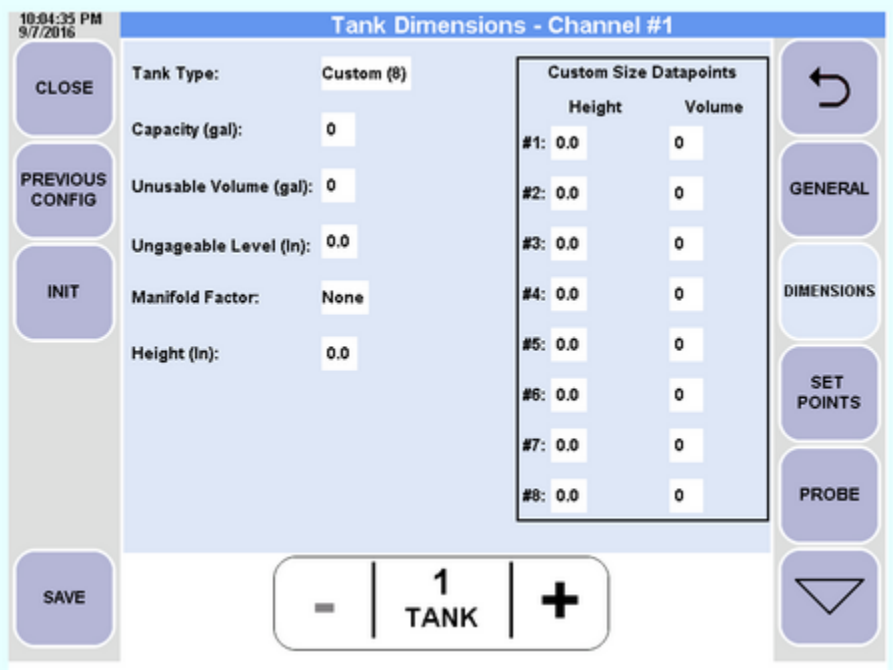
Length: Only used if the tank is tilted. See Tank Rise.

Rise: Amount of tank tilt present on a horizontal tank. Measured in level units and is never negative. See Probe Location Offset.

Radius: 1/2 of the tank diameter. Refer to tank drawing or chart for details.

Custom Size Datapoints: 3 levels are given based on the radius of the tank. Enter the volumes from the manufacturers tank chart for accurate volume calculations.

2.5.4 TANKS – DIMENSIONS – CUSTOM 8



The following settings pertain to tanks with an unusual or asymmetrical geometry:

Capacity: Use actual tank capacity so that an accurate volume calculation can be performed. (i.e. a tank may be referred to as a 10,000 gallon tank for conversation but the actual capacity may actually be 9844.)

Unusable Volume: Affects the calculations performed for the Product Order Report. This volume is excluded from the total volume when calculating the number of days of usable fuel remaining in the tank.

Ungageable Level: Represents the amount of liquid that cannot be measured by the probe. This may be due to the construction of the tank or the fact that the flex probe has a weight on the end of the shaft.

Manifold Factor: The number of Manifolds on a tank set with only one probe. Note that EPA requirements for manifolded tanks are to isolate the tank from the set before performing a leak test. Advanced settings here include the ability to auto select a pump based on the tank with the highest volume. Consult factory for details.

Height: The inside height of the tank.

Custom Size Datapoints: 8 levels and volumes are required. Refer to the manufacturers tank chart for accurate volume calculations. Contact Pneumercator for additional support in selecting specific data points best suited for the specific tank shape.

2.5.5 TANKS – DIMENSIONS – VERTICAL CONICAL

The following settings pertain to vertical tanks with a conical bottom:

Capacity: Use actual tank capacity so that an accurate volume calculation can be performed. (i.e. a tank may be referred to as a 10,000 gallon tank for conversation but the actual capacity may actually be 9844.)

Unusable Volume: Affects the calculations performed for the Product Order Report. This volume is excluded from the total volume when calculating the number of days of usable fuel remaining in the tank.

Ungageable Level: Represents the amount of liquid that cannot be measured by the probe. This may be due to the construction of the tank or the fact that the flex probe has a weight on the end of the shaft.

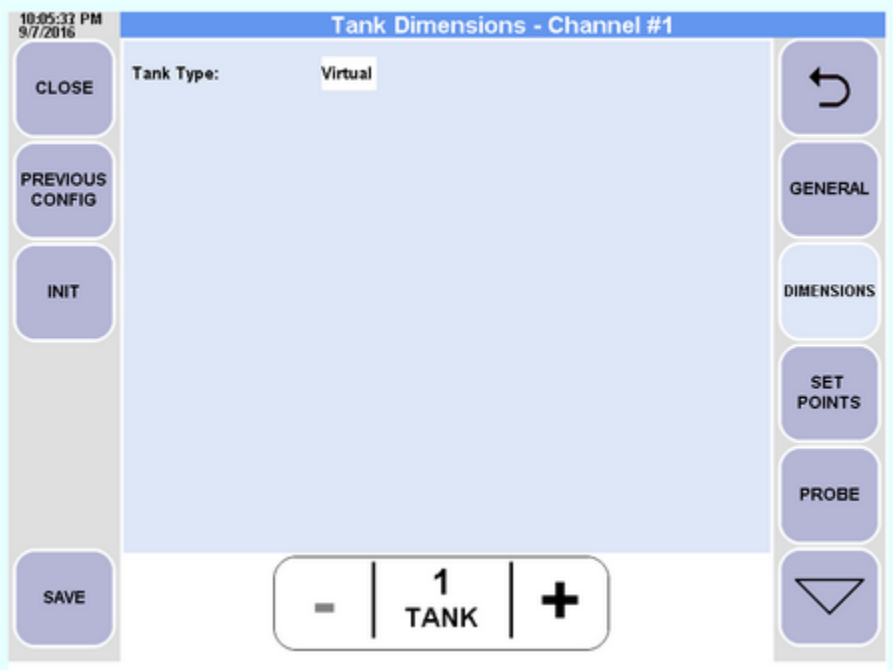
Manifold Factor: The number of Manifolds on a tank set with only one probe. Note that EPA requirements for manifolded tanks are to isolate the tank from the set before performing a leak test. Advanced settings here include the ability to auto select a pump based on the tank with the highest volume. Consult factory for details.

Height: The inside height of the tank.

Cone Height: Height of the cone and radius of the tank are used to determine the pitch of the cone.

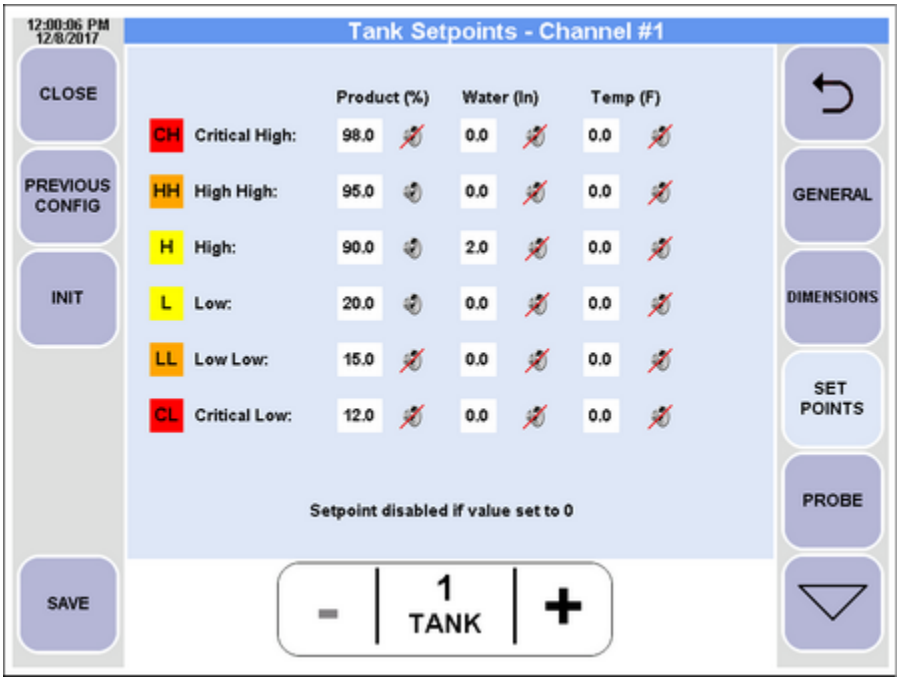
Radius: 1/2 of the diameter of the tank or cone. Refer to tank drawing or chart for details.

2.5.6 TANKS – DIMENSIONS – VIRTUAL



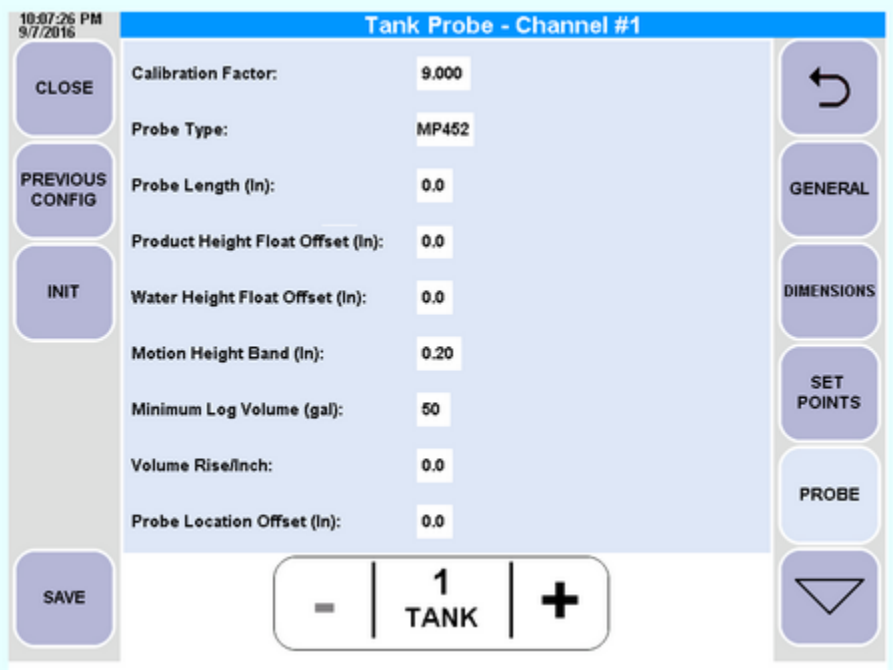
The virtual tank type is a specialized tank that allows the combining of multiple tanks into a single virtual tank for the purpose of defining Product Set Points. The tanks in the set are currently defined by assigning a custom tank name containing the Tank Channel numbers of the tanks to be included in the set.

2.6 TANKS – SET POINTS



The above screenshot shows the default values for the Tank Set Points. The units for the Set Points are displayed above each column. The horn symbol to the right of each value can be touched to toggle whether or not the internal horn activates when the alarm threshold is reached.

2.7 TANKS – PROBE



Calibration Factor: Also known as wire speed. This is a performance value that is measured for each probe and is necessary to generate an accurate level reading.

Probe Type: The model number of the probe. Only the first 5 characters are necessary. (i.e. MP461SC and MP461SA are both programmed as MP461.)

Probe Length: Used to determine the location of the temperature sensors within the probe shaft.

Product Height Float Offset: Compensates for the difference between a manual stick reading of product and the displayed product level. This setting should only be used if the product float is buoyant or floating.

Water Height Float Offset: Compensates for the difference between a manual stick reading of water and the displayed water level. If the manual stick reading shows no water, the water float offset should be set so that the final water reading on the TMS is 0.2 inches for both the MP45Xs and MP461SC. The recommended final reading for the MP46Xs is 1 inch.

Motion Height Band: Sensitivity adjustment used by the TMS to filter out surface action from actual transactions. Set in inches per minute. Defaults to 0.2 inches per minute. When the Motion Band is met or exceeded, the transaction begins. When the Motion Band is not met or exceeded for 3 consecutive minutes, the transaction is ended, categorized, and possibly recorded. See Minimum Log Volume.

Minimum Log Volume: After a transaction is completed, the volume of the transaction is compared to this setting to determine whether to record or discard the transaction. Used to further filter out false transactions.

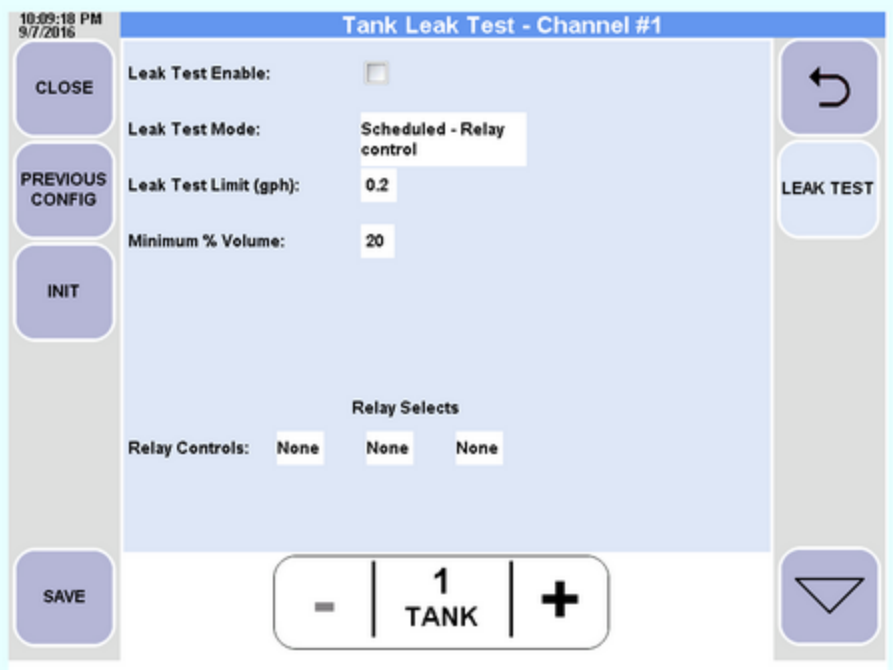
Riser Volume per Inch: MP452 only. Some designs of Oil/Water Separators allow the liquid level in the system to go above the top of the tank in one or more riser pipes. This setting allows the TMS to calculate the volume of product within the riser pipes.

Probe Location Offset: Used to pinpoint the location of the probe in a tilted tank. Represents how many inches away from the high end of the tank the probe is located.

2.8 TANKS – LEAK TEST

The below screenshots show all of the possible configuration settings for in-tank leak testing.

Auto Leak Test Mode settings



Scheduled – Relay Test Mode settings

Leak Test Enable: Test will not run if this box is not checked.

Leak Test Mode: Choose what type of test to run. Choices are as follows:

- Manual: On-demand leak test started when desired
- Timed: Runs on a programmed schedule
- Auto: Runs using information on a CC Input, likely from a current sensor (CS-10) that represents tank activity. Useful for locations where activity is possible 24 hours a day.
- Timed Relay Control: Also runs on a programmed schedule but up to 3 relays will activate at the scheduled time and the test starts 15 minutes later.

Leak Test Limit: Typically set for 0.2 GPH (Gallons Per Hour) for a monthly test. May be set to 0.1 GPH for an annual test.

Minimum % Volume: Defines minimum threshold of product in tank to allow a test to run. Must be used in conjunction with the % Volume Mode leak test schedule.

Auto Mode Pass/Fail: Auto mode completes one test per month. This setting determines what an acceptable completed test result is. A setting of Pass Only would cause the TMS to run the test again during that month if the last test failed.

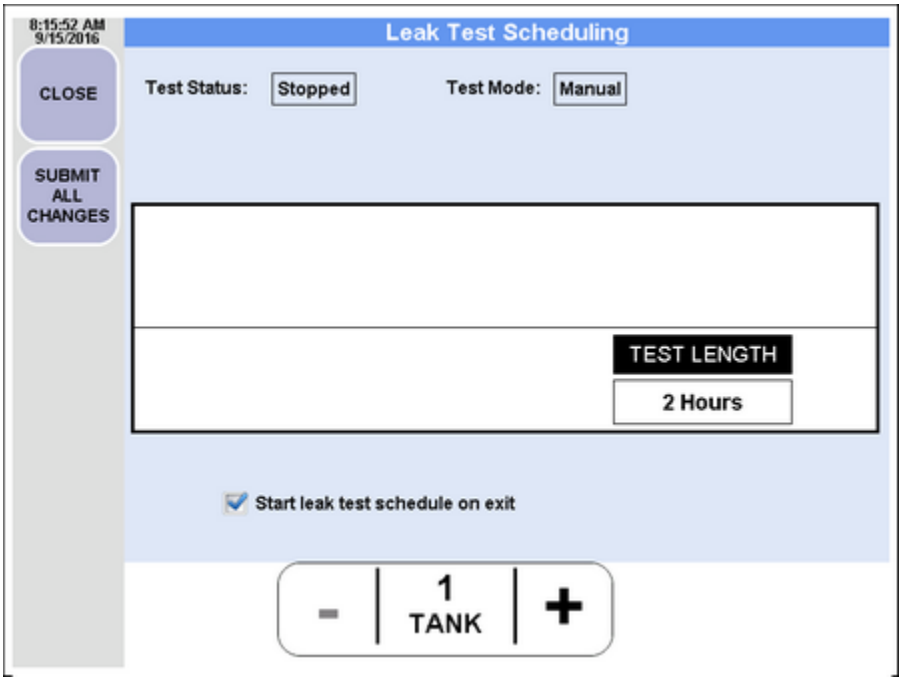
Pump/Generator Run Contact Closure Input (Auto Mode Only): Which input number is the activity signal being received on. Likely wired to a CS-10.

Relay Controls: (Timed Relay Control Mode Only): Select up to 3 relays to activate prior to running a leak test so that a tank in a manifolded set is physically isolated before beginning the leak test.

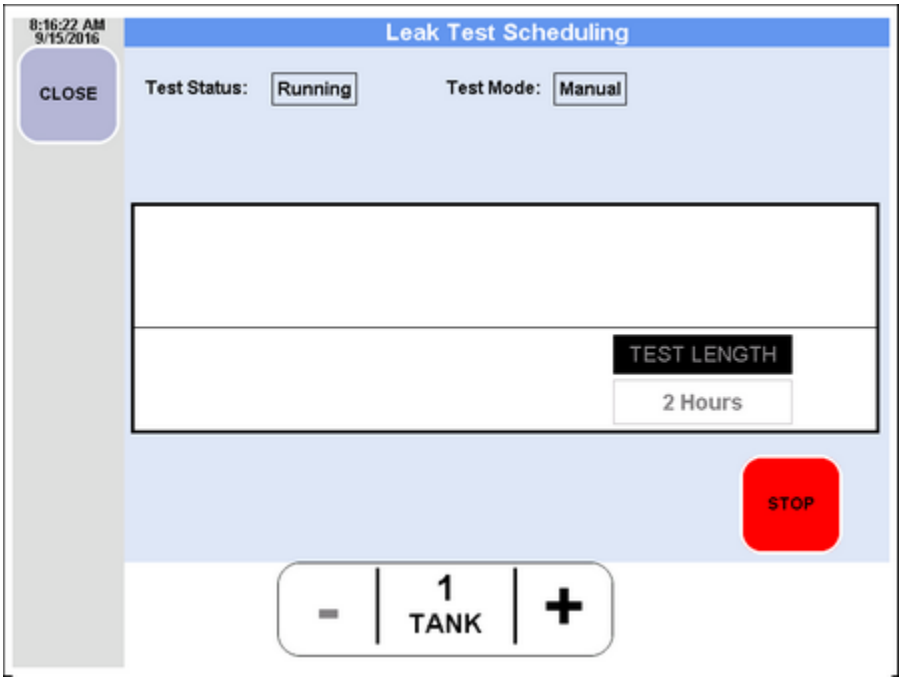
2.9 LEAK TEST SCHEDULING

The In-Tank Leak Test must be enabled as detailed in Section 2.8 above. Failure to do so will result in the below screenshot if any attempt to adjust the schedule is made.

2.9.1 LEAK TEST SCHEDULING - MANUAL

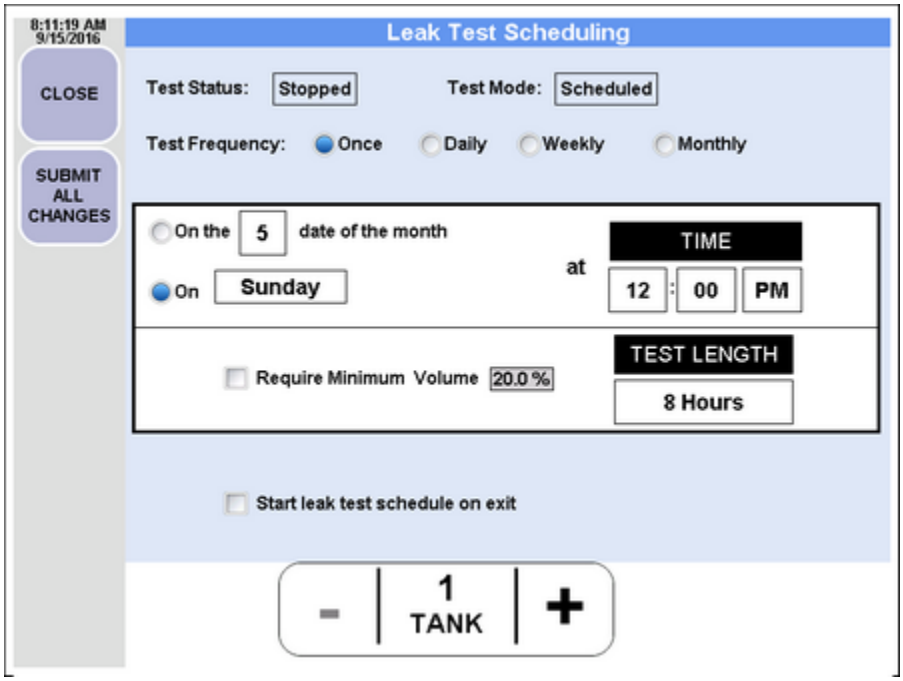


The Manual Leak Test Mode is ideal for applications where the user prefers to manually start the test, usually due to a site having a high throughput. The user would manually shutdown the tank before beginning the test. The test length must be set to comply with local regulations covering the size of tank being tested. Check the box marked “Start Leak Test Schedule On Exit” and touch the Close button to start the test immediately.



2.9.2 LEAK TEST SCHEDULING - SCHEDULED

A leak test may be scheduled to accommodate the needs of the sites and the requirements of the regulatory agencies. Several examples are shown below.



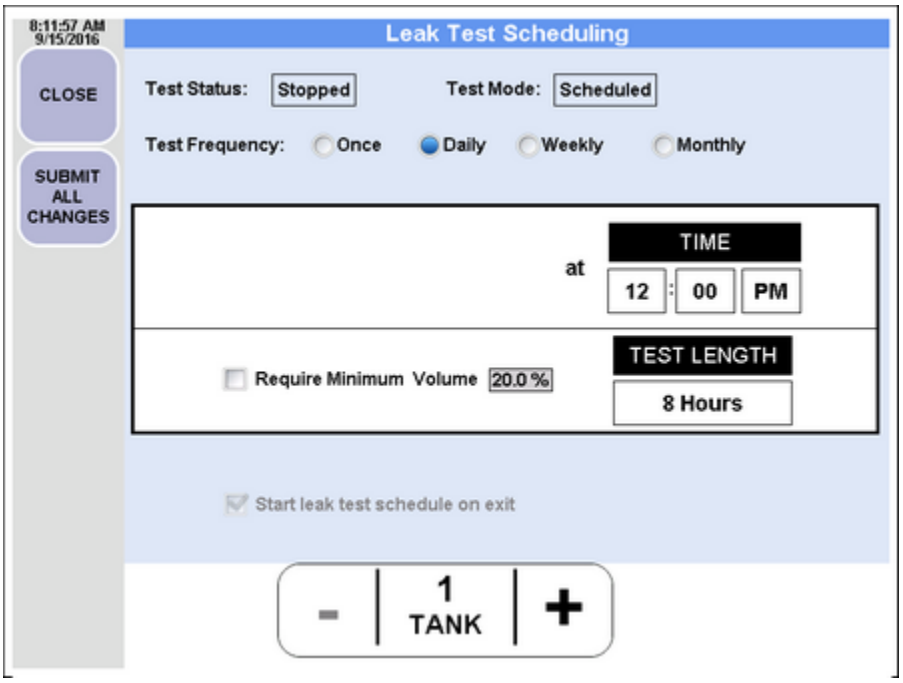
Selecting a Test Frequency of ONCE provides the means of starting a single test at the time and date configured above.

Selecting the radio button for On The nth Date Of The Month allows the user to run the test up to one month in the future. If, for example, today's date is September 15 and the value entered in the box is 14, the test will run on October 14th at the designated time. If the value entered is 15 but that time has already past, then the test will run on October 15th at the designated time.

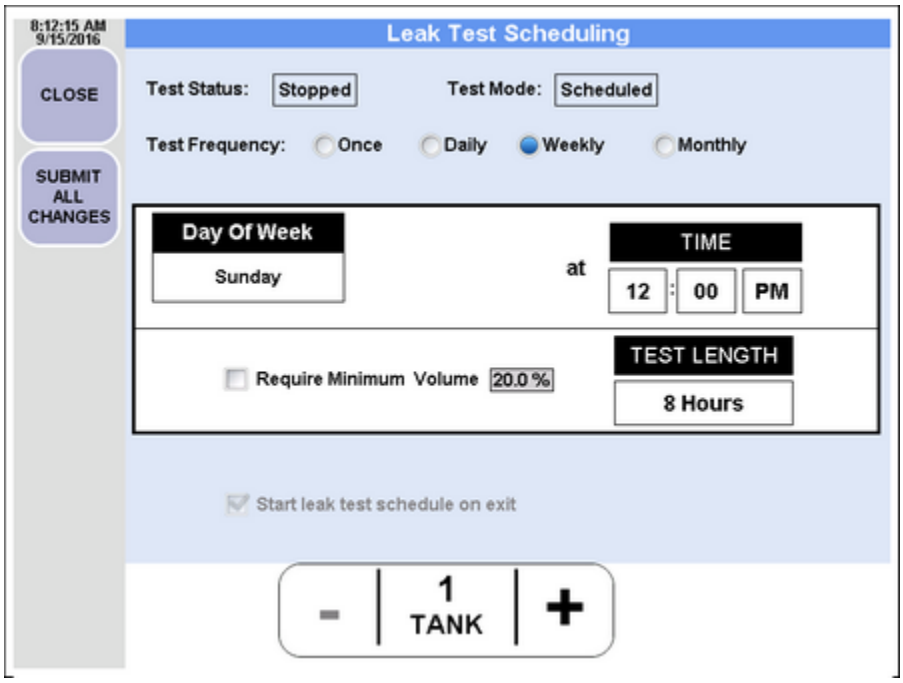
Selecting the radio button On Day of Week allows the test to be run up to one week ahead. The example above show the setting as On Sunday which would cause the TMS to begin the test on Sunday at the designated time.

If the test requires a minimum % Volume, be sure to check the box to establish that requirement. The test will NOT run if the percent volume is below this threshold. The percentage value is configured in the Setup/Config/Tanks/Leak Test menu (See Section 2.8).

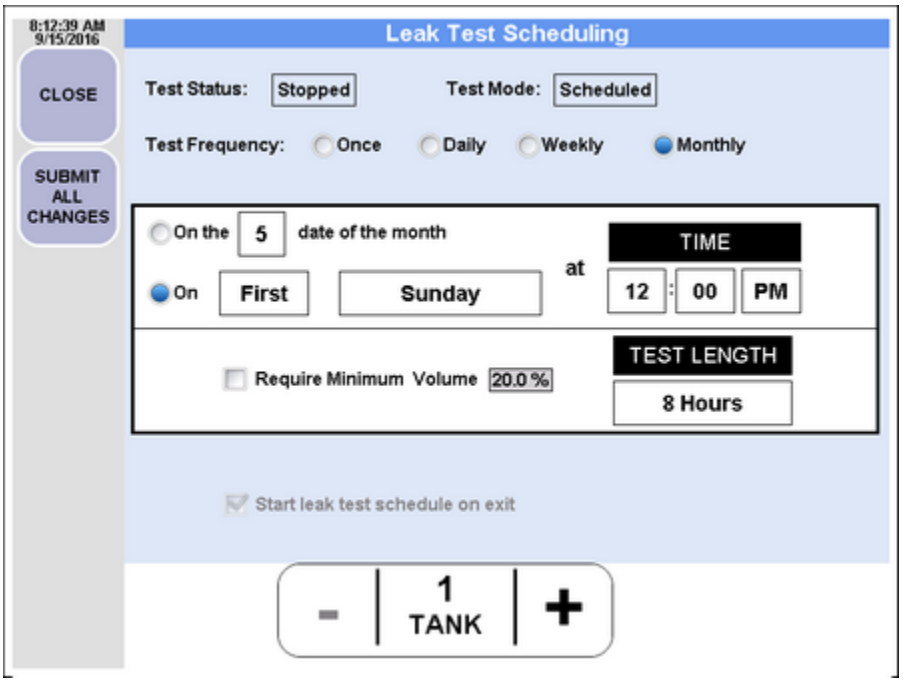
Upon completion, the schedule will be satisfied and no further tests will be run until the TMS schedule is reconfigured. This is generally used either to confirm a tank is not leaking on initial install or to manually run a test after a failure to confirm the results.



Selecting a Test Frequency of DAILY creates a repeating test that will run once a day at the configured start time displayed. Controls are provided for setting the Start Time and Test Length. If the test requires a minimum % Volume, be sure to check the box to establish that requirement. The test will NOT run if the percent volume is below this threshold. The percentage value is configured in the Setup/Config/Tanks/Leak Test menu (See Section 2.8).



Selecting a Test Frequency of WEEKLY creates a repeating test that will run once a week at the configured start time displayed. Controls are provided for selecting which Day of the Week, the Start Time, and Test Length. If the test requires a minimum % Volume, be sure to check the box to establish that requirement. The test will NOT run if the percent volume is below this threshold. The percentage value is configured in the Setup/Config/Tanks/Leak Test menu (See Section 2.8).

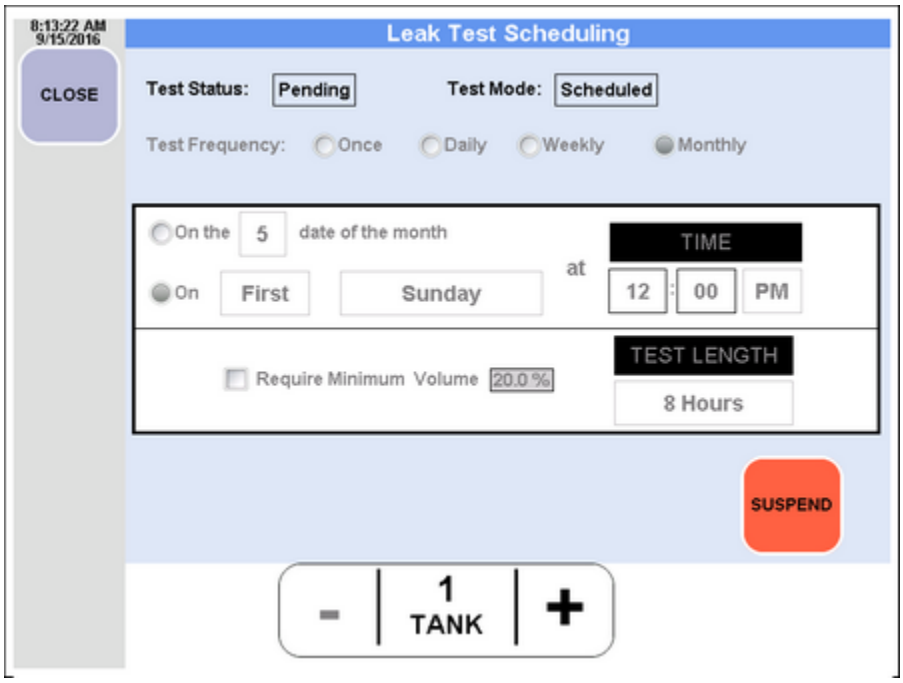


Selecting a Test Frequency of MONTHLY creates a repeating test that will run once a month at the configured start time and date displayed.

Selecting the radio button for On The nth Date Of The Month allows the user to run the test on that data every month. Do not select a date higher than 28 to avoid skipping a test in February.

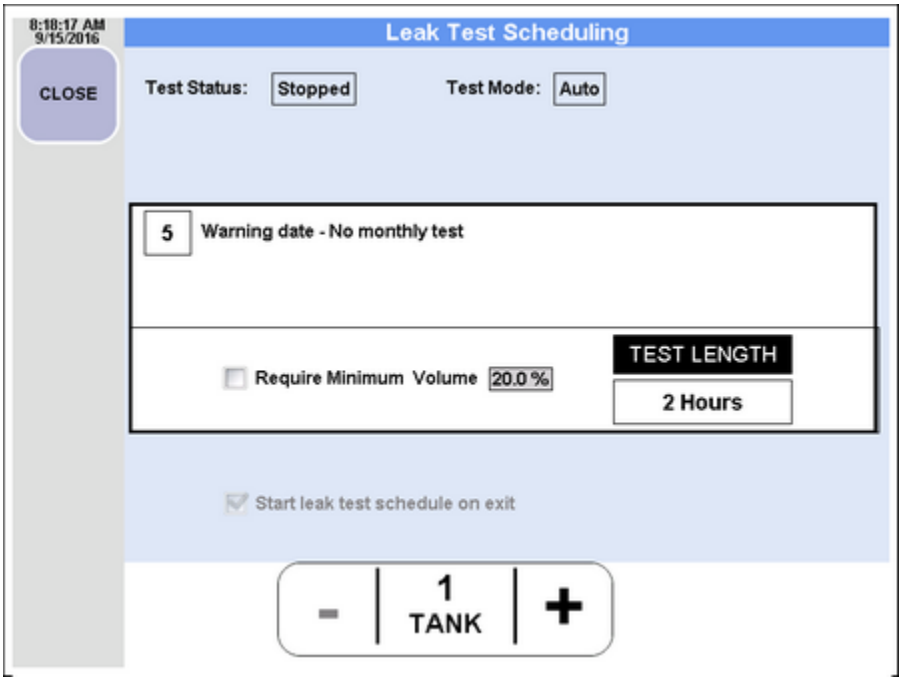
Selecting the radio button On nth Day of Week allows the test to be run once a month on a specific day of the week. The example above show the setting as On First Sunday which would cause the TMS to begin the test on First Sunday of the month at the designated time.

Controls are provided for selecting the Start Time and Test Length. If the test requires a minimum % Volume, be sure to check the box to establish that requirement. The test will NOT run if the percent volume is below this threshold. The percentage value is configured in the Setup/Config/Tanks/Leak Test menu (See Section 2.8).



To stop a test that is running or to stop the scheduler, touch the Suspend button show above.

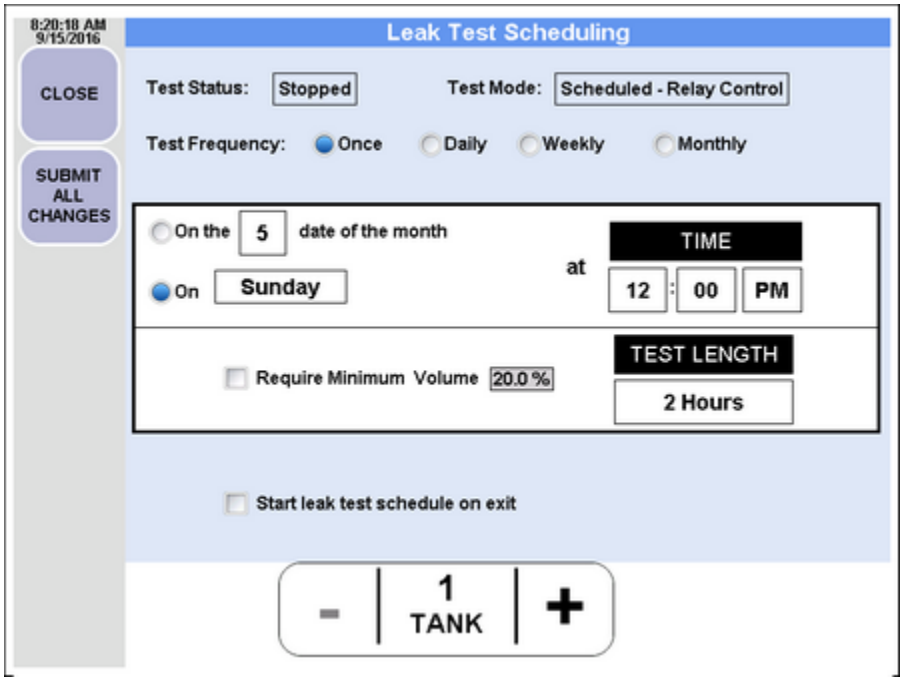
2.9.3 LEAK TEST SCHEDULING - AUTO



Auto Leak Test Mode has the leak test being started by the TMS based on the site activity monitored through a CC Input. The Scheduling window shown above shows a Warning Date – No Monthly Test feature. When configured, the TMS will provide a warning when the tank has not satisfied its monthly test requirements. It is recommended to set this value so there would be enough time to manually shut down the tank and perform a leak test.

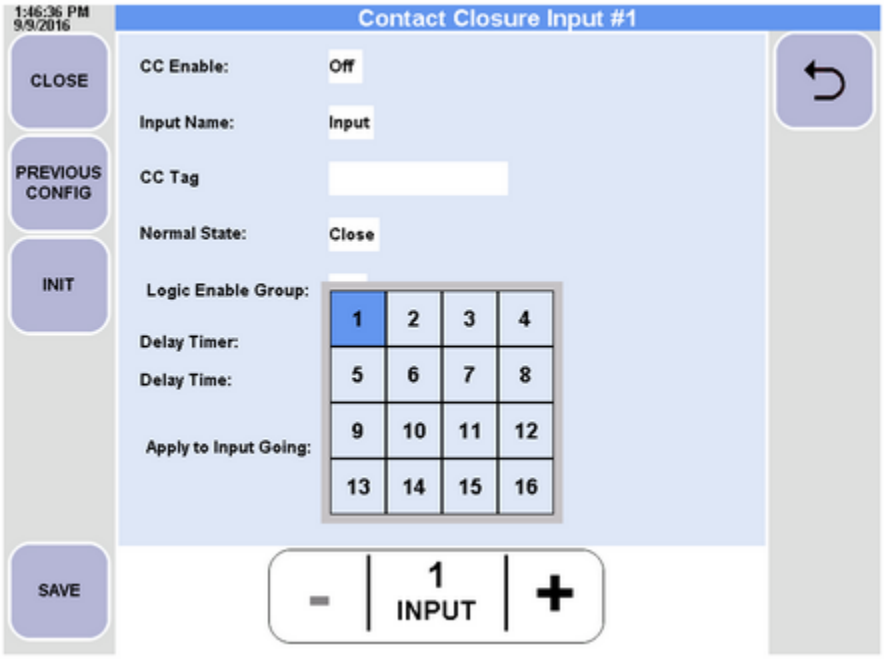
If the test requires a minimum % Volume, be sure to check the box to establish that requirement. The test will NOT run if the percent volume is below this threshold. The percentage value is configured in the Setup/Config/Tanks/Leak Test menu (See Section 2.8).

2.9.4 LEAK TEST SCHEDULING – SCHEDULED – RELAY CONTROL

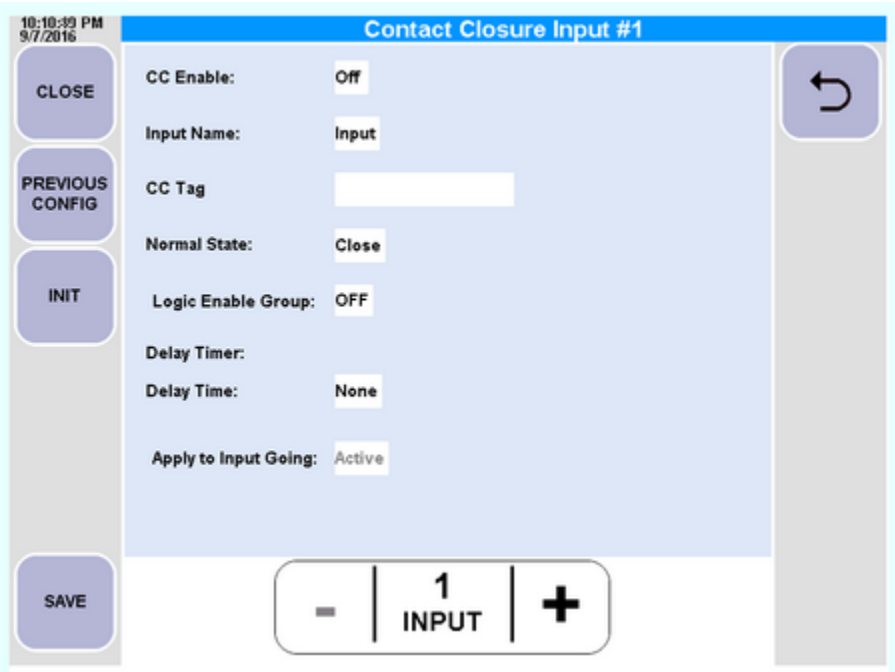


The scheduling options for the Test Mode of Scheduled – Relay Control are identical to those for the Test Mode of Scheduled. See Section 2.9.2 for complete details.

2.10 CC INPUTS



Touch the +/- buttons to increment CC Input by 1. Touch the CC Input number to bring up a list of possible CC Inputs. Touch the CC Input number on the table to make a selection.



CC Input Configuration settings. See next page for a description of each setting.

CC Enable: a CC Input can be enabled in one of several ways:

- Relay: Used to control something whether it is a relay or an auto leak test. (RS2 Test button) (CS-10)
- Gate: Advanced functionality incorporates a logic AND gate into this input. It is paired with other conditions that call out the same relay.
- Alarm: Used to represent an alarm condition from an external device.
- Acknowledge: Used to return a relay to its normal state (RS2 Reset button)
- Line Pass: Specific to specific LS300 Line Leak console configurations. Used to filter out the numerous passing tests and allow only one per month.
- FP Horn Ack: Front Panel Horn Acknowledgement allows an external automation system to send a dry contact signal to the TMS to silence the integrated TMS horn.
- Trigger Group: Part of an advanced auto pump select feature where the pump paired with the highest tank volume is selected. Consult factory for details.

Input Name: Select a name from the list or enter a 16 character custom name. Used to help to identify the input.

CC Tag: Printed on system generated reports

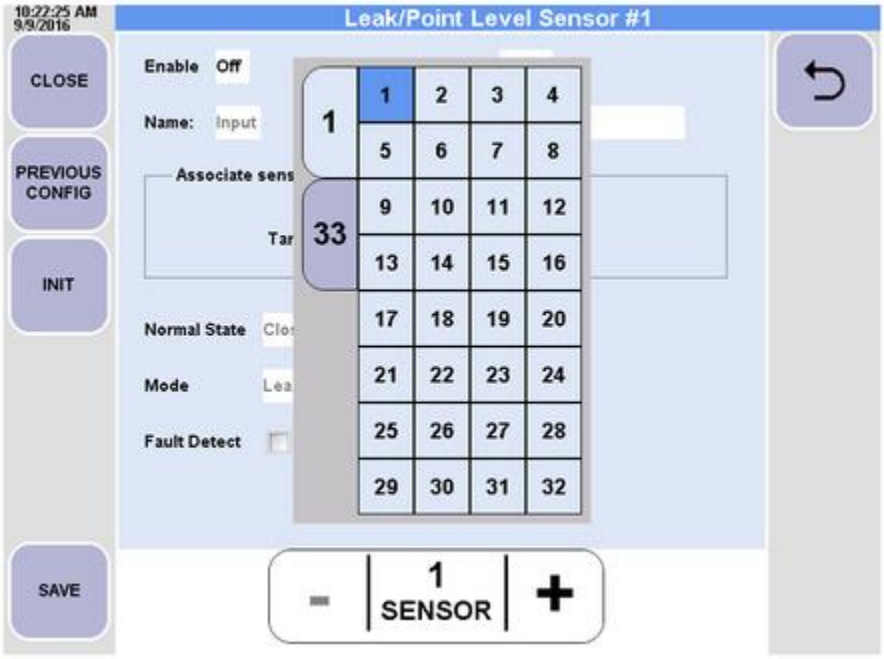
Normal State: Selects the normal contact state of the wired device.

Logic Enable Group: Another form of AND gate where all input in the same logic group are a member of the same gate.

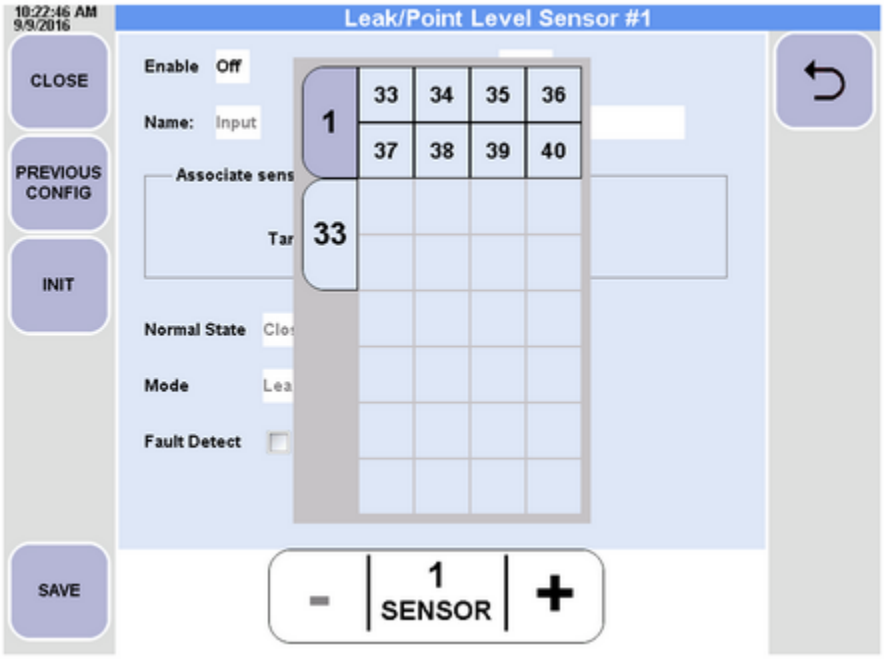
Delay Time: Delay the TMS reaction to the input.

Apply To Input Going: Selects whether the TMS response is delayed with the input going active or inactive.

2.11 SENSOR INPUTS



Touch the +/- buttons to increment Sensor Input by 1. Touch the Sensor Input number to bring up a list of possible Sensor Inputs. The tabs on the left edge show the starting Sensor Input number for the page of choices. Page 1 is shown above and Page 2 is shown below. Touch the Sensor Input number on the table to make a selection.



Sensor Input Configuration settings. See below for a description of each setting.

Enable: Enables the sensor as either Alarm to generate an alarm on the TMS or as Relay to control a relay in the TMS without an alarm. Choosing alarm does not prevent you from also activating a relay on this condition.

Type: Enter the model number of the sensor connected to the TMS.

Name: Choose from the list of predefined names or type in a 16 character name.

Tag: Printed on system generated reports.

Associate Sensor With: Helps to locate a sensor by associating it with a tank or dispenser.

Normal State: Selects the normal contact state of the sensor, open or closed.

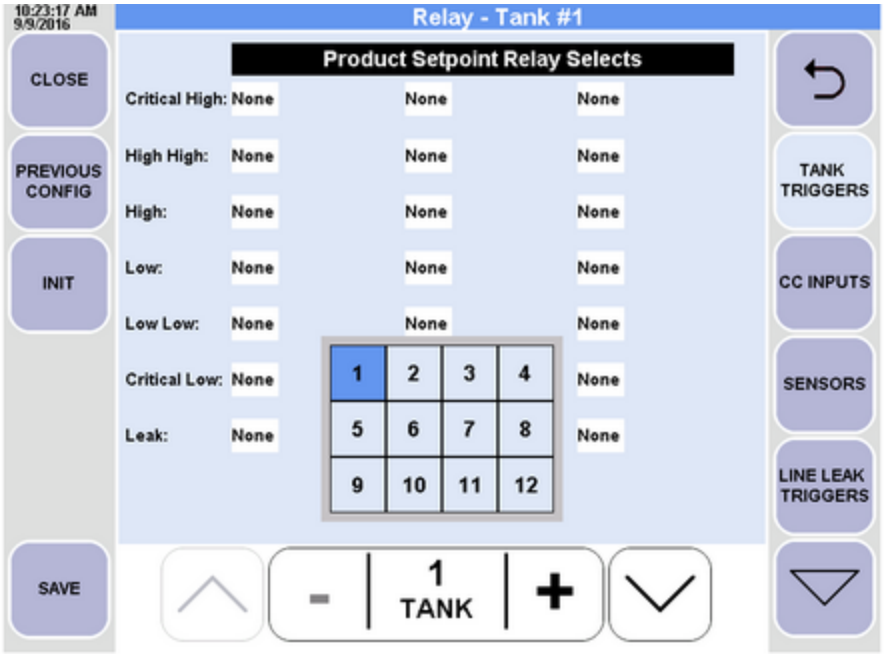
Mode: Select Leak for sensor detecting leaks. Select Other for sensor used for purposes other than leak detection. The integrated horn beeping pattern will differ for sensors defined as Leak sensors versus Other sensors.

Fault Detect: Must be selected for sensors with integrated fault detection circuitry.

2.12 RELAYS

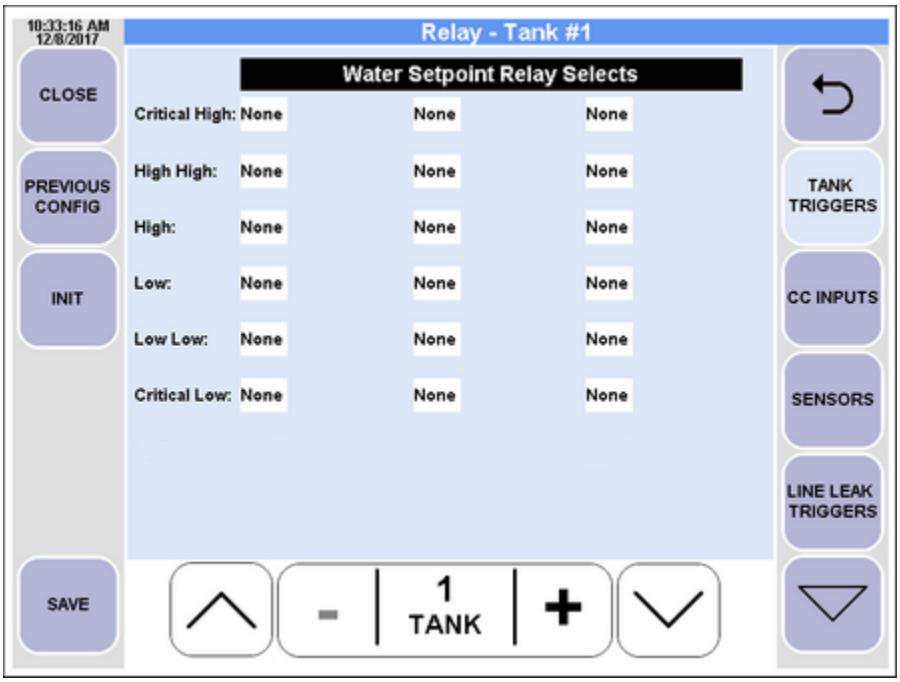
Relay outputs may be configured to trigger from any system alarm or event. The conditions are divided into several categories for easy selection. Any one condition may be assigned to up to three relays. The last category, Relay Mode, contains settings that affect the behavior of the relay.

2.12.1 RELAYS – TANK TRIGGERS

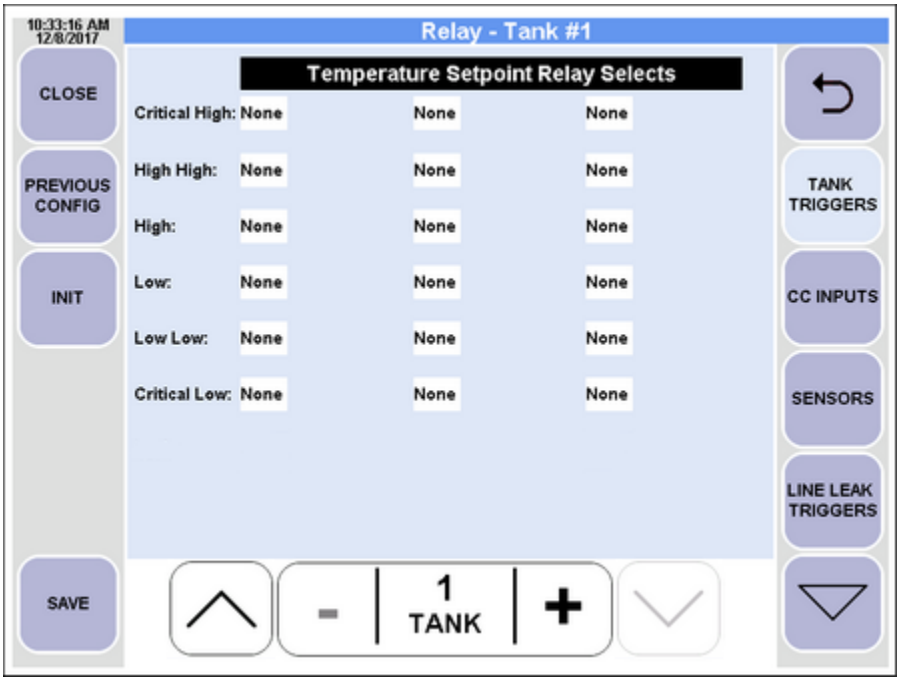


Touch the +/- buttons to increment Tank Channel by 1. Touch the Tank Channel number to bring up a list of possible Tank Channels. Touch the Tank Channel number on the table to make a selection.

Relay assignments for both the Product Set Points and the failure of an In-Tank Leak Test (Leak).

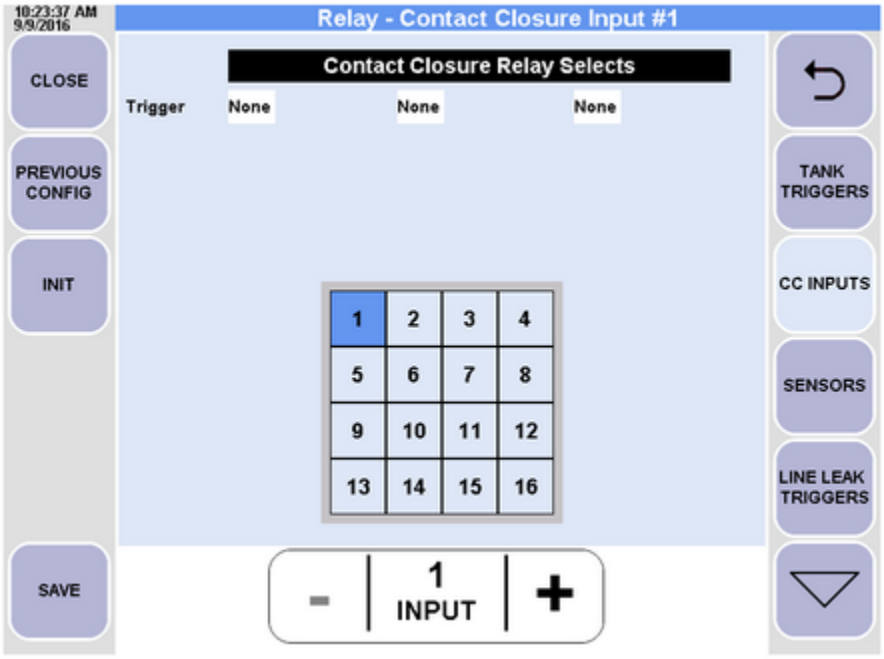


Relay assignments for bottom Water Set Points.

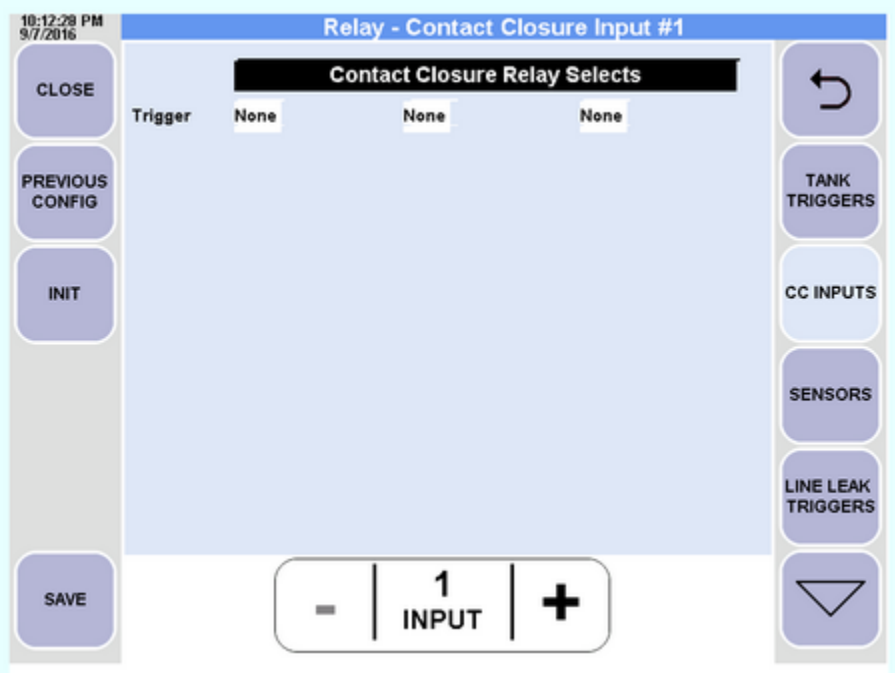


Relay assignments for Temperature Set Points.

2.12.2 RELAYS – CC INPUTS

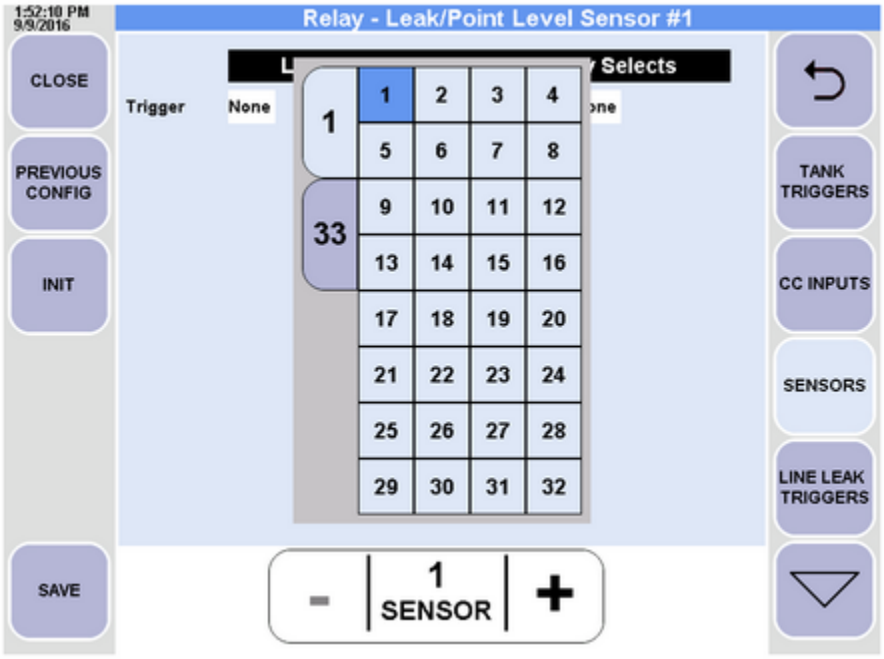


Touch the +/- buttons to increment CC Input by 1. Touch the CC Input number to bring up a list of possible CC Inputs. Touch the CC Input number on the table to make a selection.

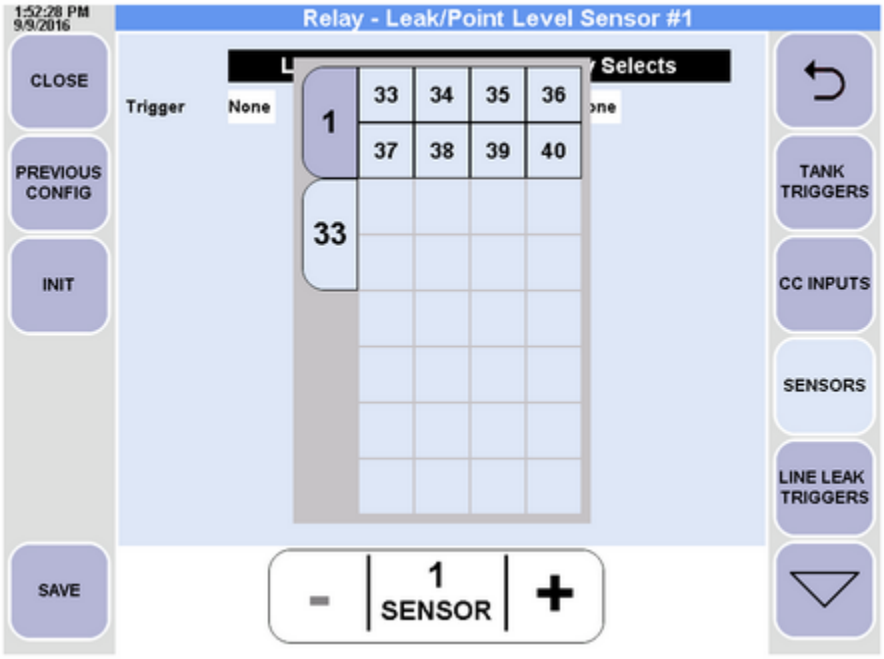


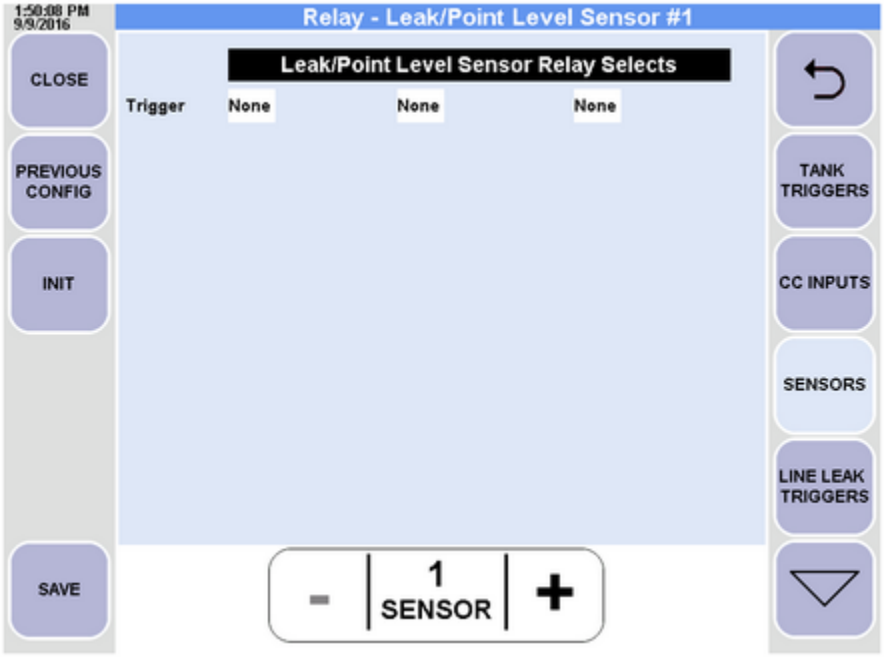
Relay assignments for the CC Inputs.

2.12.3 RELAYS - SENSORS



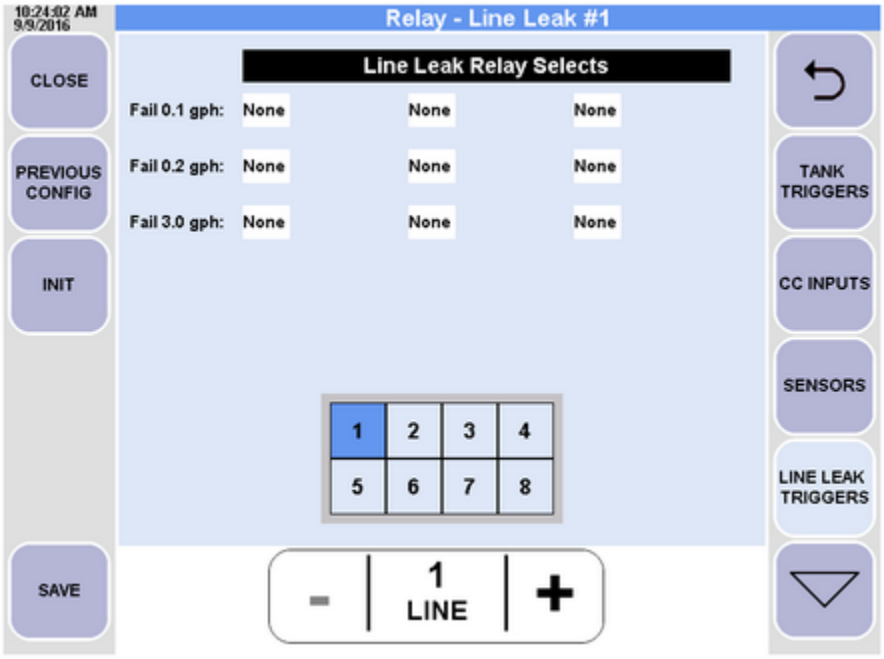
Touch the +/- buttons to increment Sensor Input by 1. Touch the Sensor Input number to bring up a list of possible Sensor Inputs. The tabs on the left edge show the starting Sensor Input number for the page of choices. Page 1 is shown above and Page 2 is shown below. Touch the Sensor Input number on the table to make a selection.



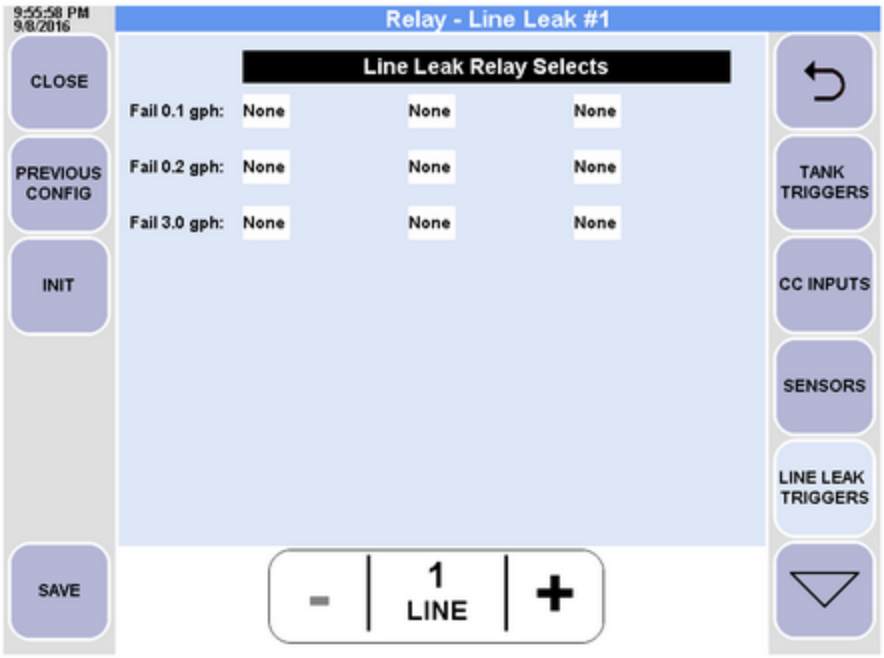


Relay assignments for the Sensor Inputs.

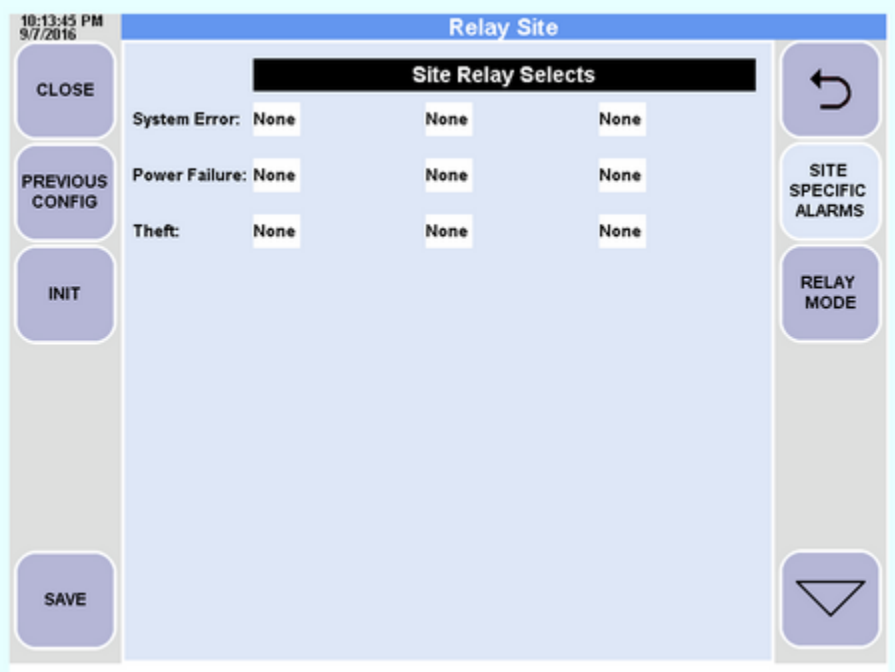
2.12.4 RELAYS – LINE LEAK TRIGGERS



Touch the +/- buttons to increment Line Leak Channel by 1. Touch the Line Leak Channel number to bring up a list of possible Line Leak Channels. Touch the Line Leak Channel number on the table to make a selection.



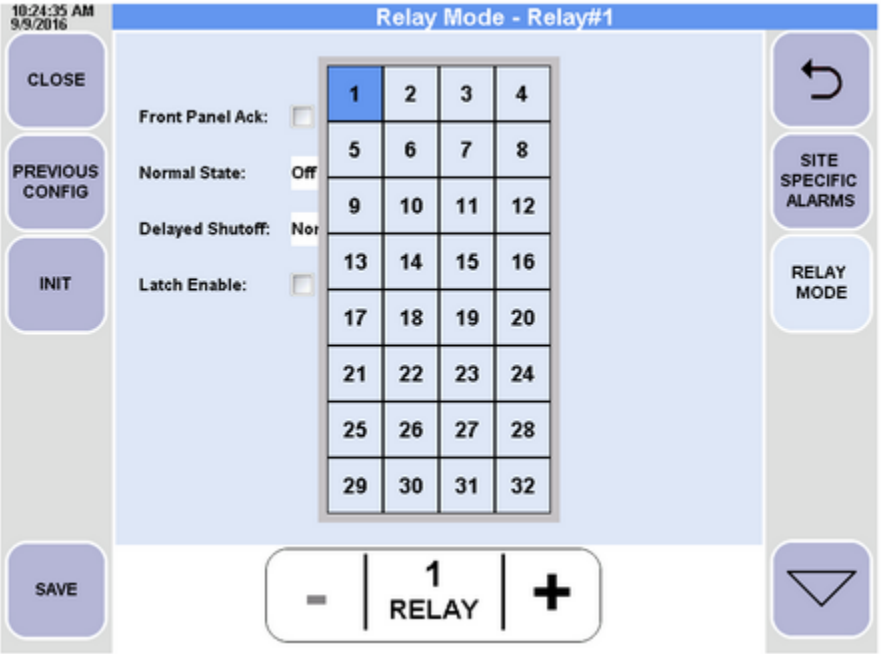
2.12.5 RELAYS – RELAY SITE



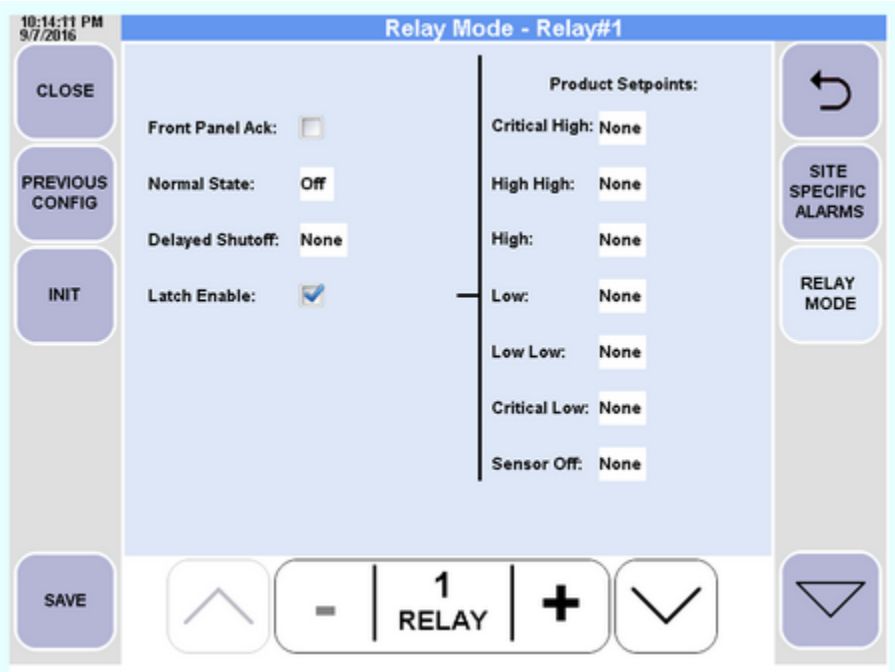
Represents site specific conditions that include System Errors, Power Failure, and Theft. The details are as follows:

- System Error: Includes Probe Timeout, Probe Sync, and Sensor Fault Error conditions.
- Power Failure: A relay will activate once power has been restored to the TMS.
- Theft: A theft condition detected for ANY tank will activate a relay output.

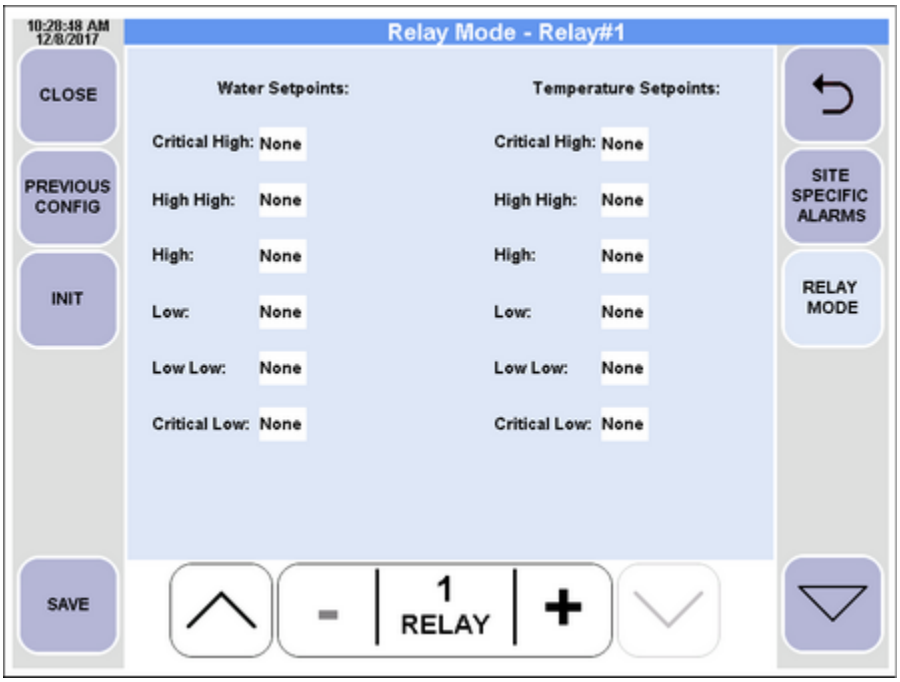
2.12.6 RELAYS – RELAY MODE



Touch the +/- buttons to increment Relay Output Number by 1. Touch the Relay Output Number to bring up a list of possible Relay Output Numbers. Touch the Relay Output Number on the table to make a selection.



The left side of the above screen shows several settings that affect the behavior of the relay. The right side of the screen is visible when enabling the Latch feature and represent the Latch Off conditions. Additional Latch Off conditions are configurable on the second page, accessible by touching the down arrow to the right of the plus sign. Complete details can be found on the following page.



Front Panel Ack: Acknowledges a relay by returning it to the defined normal state after pressing any key on the front panel of the TMS

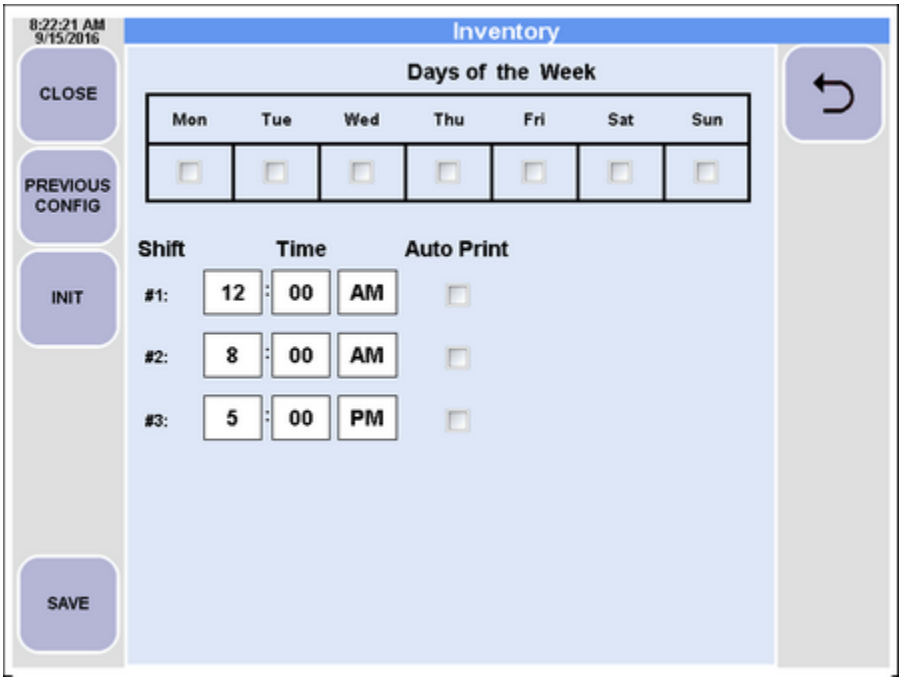
Normal State: A relay is de-energized by default when there is no condition present to activate it. This can be reversed by defining the normal state of the relay as on (energized). A de-energized relay, in that case, would represent the alarm or action state.

Delayed Shutoff: Returns the relay to normal after a delay set in minutes. Selecting None disables this feature.

Latch Enable: Enables a latching feature which separates the conditions that activate a relay from the condition that returns the relay to normal. Ideal for pump/valve control applications. By enabling this feature for a particular relay, all conditions previously assigned to that relay will be the Latch On condition for the relay. Separate conditions would be defined as the latch off conditions as follows:

- Product Set Points: Select the hardware channel of the tank next to the desired Set Point to select the Latch Off condition for the selected relay.
- Sensor Off: Located immediately below the Product Set Points. Select the Sensor number to be used as the Latch Off condition for the selected relay.
- Water Set Points: Select the hardware channel of the tank next to the desired Set Point to select the Latch Off condition for the selected relay.
- Temperature Set Points: Select the hardware channel of the tank next to the desired Set Point to select the Latch Off condition for the selected relay.

2.13 INVENTORY



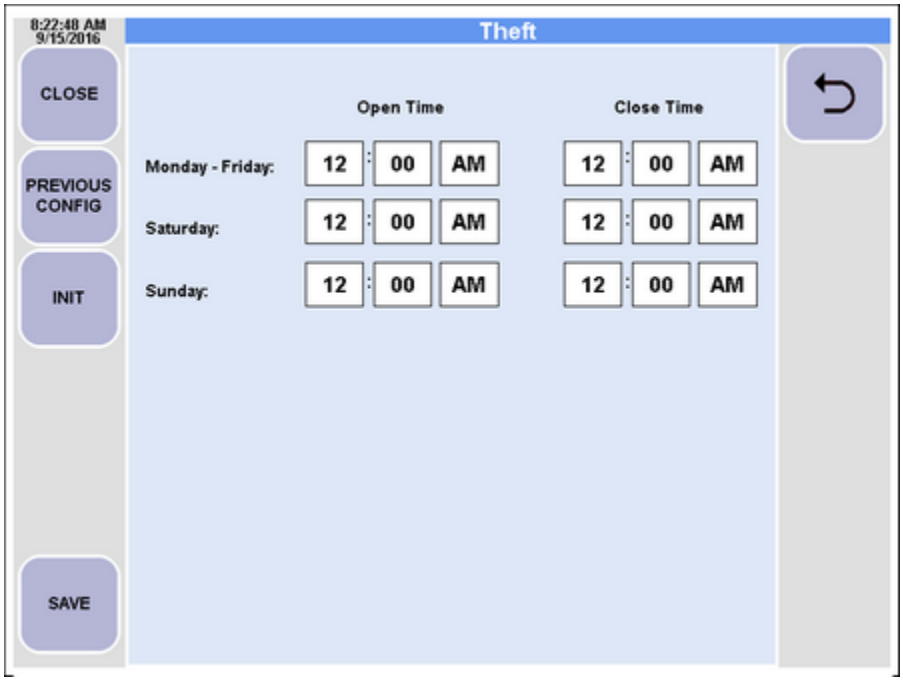
When enabled, the TMS will record inventory snapshots/shift reports to the Inventory Log, as scheduled.

The snapshot can be enabled for any or all of the seven days of the week be checking the appropriate checkboxes. The snapshot is disabled by unchecking all days of the week.

Inventory Log Times: Up to three snapshots can be made daily by setting three different times above. If only one or two snapshots daily are required, make sure that there are only that many different times listed above. For example, if all three Log Times were configured for midnight, one snapshot at midnight would occur if there were any days of the week checked. By changing one of the three times to 12:00PM, you would record two snapshots daily: one at midnight and one at noon. This assumes that at least one day of the week is checked.

Each snapshot can generate a printout on the TMS if desired by checking the appropriate box.

2.14 THEFT



A theft is defined in the TMS as a loss of product during a period when the location is scheduled to be closed. Set the hours of operation above to properly monitor for theft. See Section 2.4 for enabling theft monitoring per tank.

2.15 DIAL OUT

Touch the +/- buttons to increment Dial Out Configuration Number by 1. Touch the Dial Out Configuration Number to bring up a list of possible Dial Out Configuration Numbers. Touch the Dial Out Configuration Number on the table to make a selection.

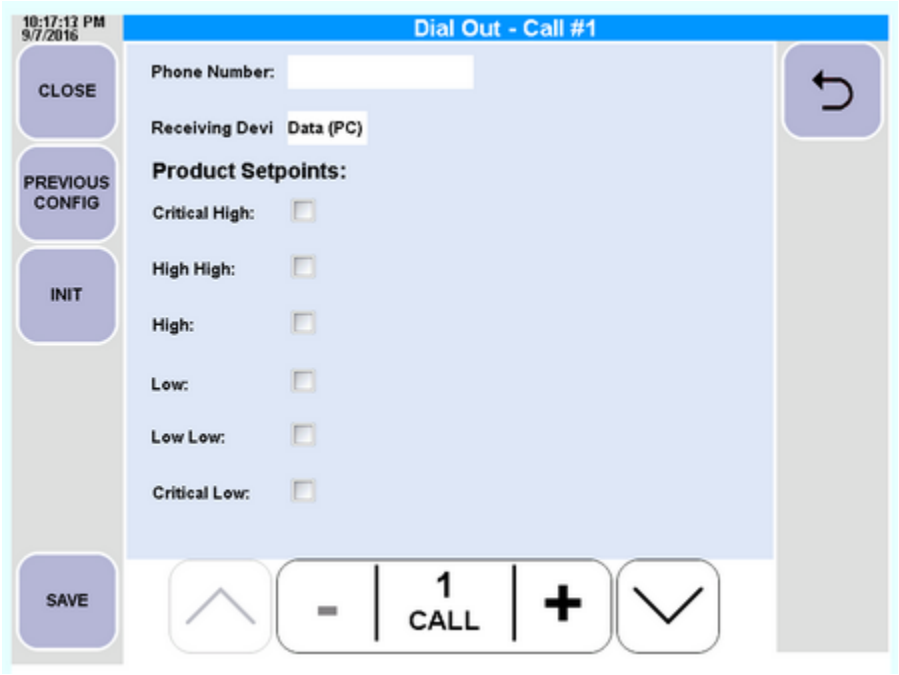
Phone Number: supports a total of 21 digits to make a phone call. A comma represents a pause. See Pause Length in Section 2.16, Modem section for details on setting the length from 1-9 seconds.

Receiving Devi: choice of the following Receiving Devices:

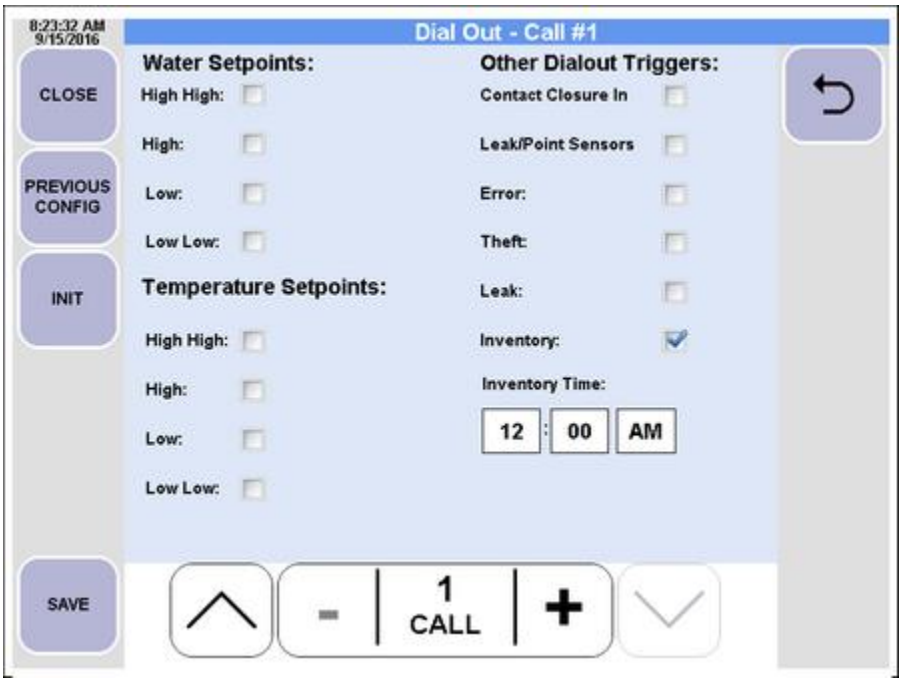
- Data (PC): a computer with TMS Communicator installed and Autopolling running and set to answer the phone upon ringing. The Autopolling configuration controls what data is requested.
- Fax: Any device capable of receiving a fax via phone. Transmits a generic fax report showing inventory with probe and sensor alarm statuses.
- TTY: A text only transmission that can be received by any TTY capable device. HyperTerminal or other terminal emulation program is capable of handling this signal. Transmits a printout comparable to the printout generated by the TMS on its integrated printer.
- Numeric pager: Any numeric pager. Alphanumeric pagers are not supported. Message is limited to what can be incorporated into the 21 digit dial out string

Conditions that will initiate an outbound phone call are as follows:

- Product Set Point: Any Product Set Point for any tank channel
- Water Set Point: Any Water Set Point for any tank channel
- Temperature Set Point: Any Temperature Set Point for any tank channel
- Contact Closure In: Any active CC Input. CC Inputs are found on select relay I/O cards.
- Leak/Point Sensors: Any Sensor alarm.
- Error: Any system error recorded in the Events log
- Theft: Any documented theft recorded in the Thefts Log
- Leak: Any Failed In-Tank Leak Test. Not to be confused with Leak Sensors.
- Inventory: A daily dialout at the time listed below the checkbox if new Inventory Report exists.

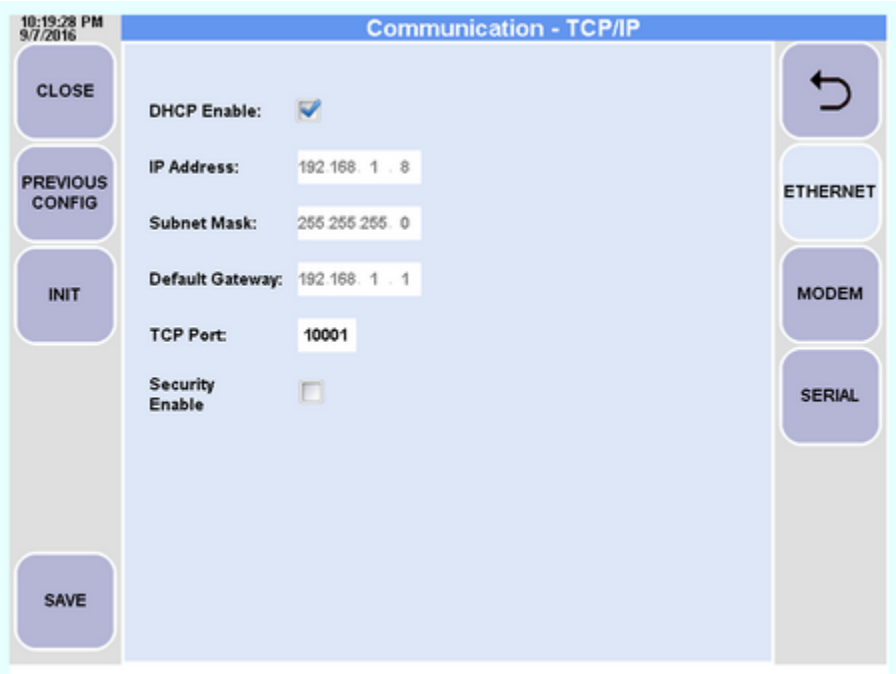


These represent the configuration settings for each set of dial out rules.



2.16 COMMS

The communications section is divided into three categories as illustrated below.



DHCP Enable: Stands for Dynamic Host Control Protocol. Used for automatically assigning an IP Address to a Network Card.

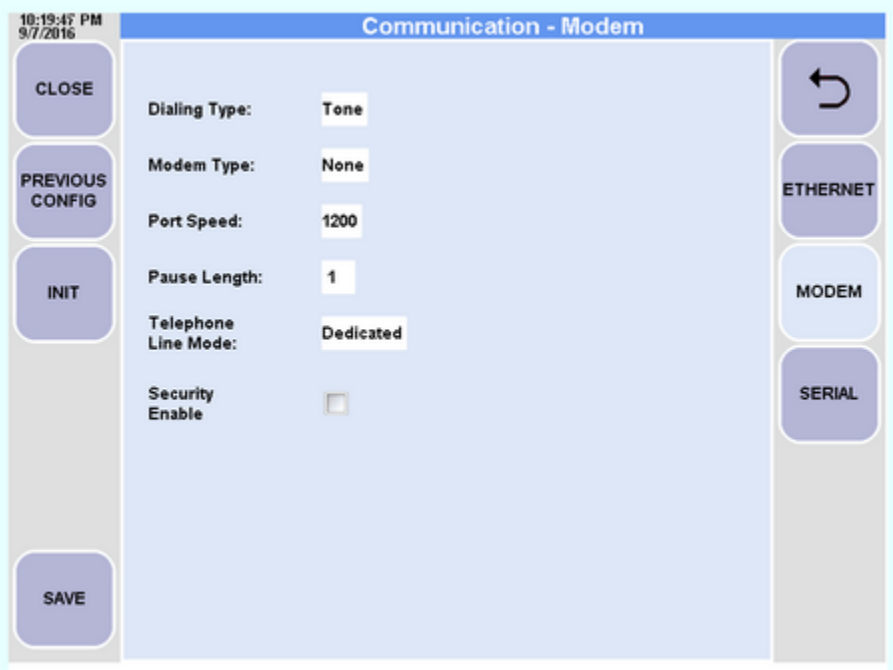
IP Address: A unique address that identifies the TMS on the network. The IP address consists of four octets separated by decimal points that can each range from 0-255. If DHCP is enabled, the currently assigned value is displayed.

Subnet Mask: A mask that defines the subnet of the network supporting the TMS. The Subnet Mask consists of four octets separated by decimal points that can each range from 0-255. If DHCP is enabled, the currently assigned value is displayed.

Default Gateway: A unique address that identifies where responses are sent to when a request is sent from outside of the network. The Default Gateway consists of four octets separated by decimal points that can each range from 0-255. If DHCP is enabled, the currently assigned value is displayed.

TCP Port: The default value of 10001 is recommended unless there are incompatibilities with the current network infrastructure.

Security Enable: Requires a 6-digit numeric Access Code that is prepended to any command issued to the TMS.



Dialing Type: Choice between tone (pushbutton) and pulse (rotary) dialing.

Modem Type: Choices are as follows:

- None: No Modem or Serial C expansion card installed
- Internal: Supports 900433-x Internal Data Modem
- Fax Modem: Supports 900503-1 Internal Fax Modem
- Port Modem: Intended for external modem connected to the RS-232 port. Contact Pneumercator for specific devices supported.
- Serial C: Supports the 900571-x Communications Expansion Cards
- Cell Modem: Intended for a cellular modem. Contact Pneumercator for specific devices supported.

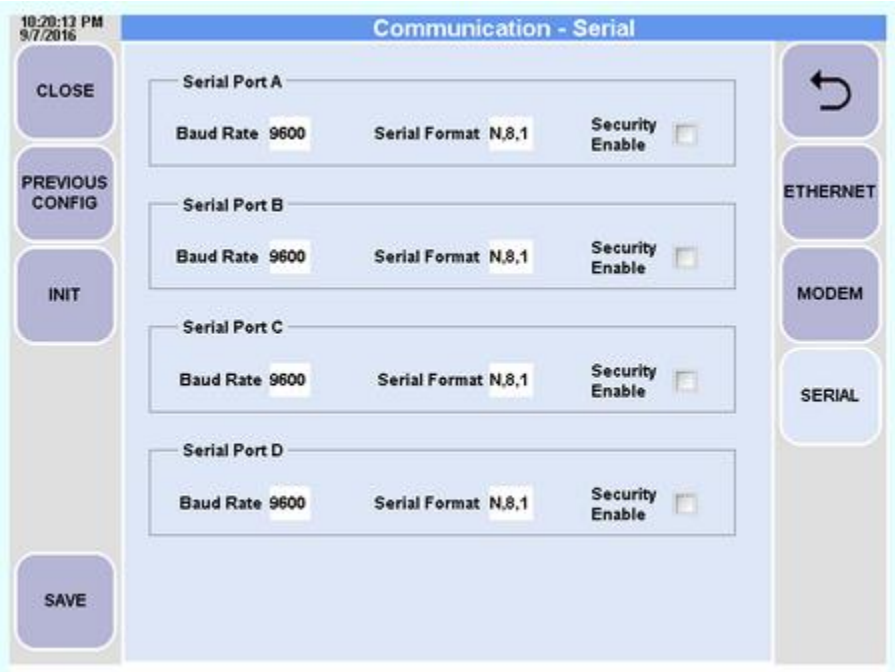
Port Speed: determines the maximum speed the modem is permitted to communicate at.

Pause length: defines the duration of the pause represented by a comma in the dial out string. See Section 2.15 for entering phone number and comma in configuration.

Telephone Line Mode:

- Dedicated: allows the TMS try placing a call without detecting a dial tone. After 5 unsuccessful attempts, the TMS will no longer attempt to place a call for this particular event.
- Shared: the TMS must detect a dial tone before attempting to place a call. After 5 unsuccessful attempts, the TMS will no longer attempt to place a call for this particular event. Failure to detect a dial tone does NOT qualify as a failed attempt.

Security Enable: Requires a 6-digit numeric Access Code that is prepended to any command issued to the TMS.

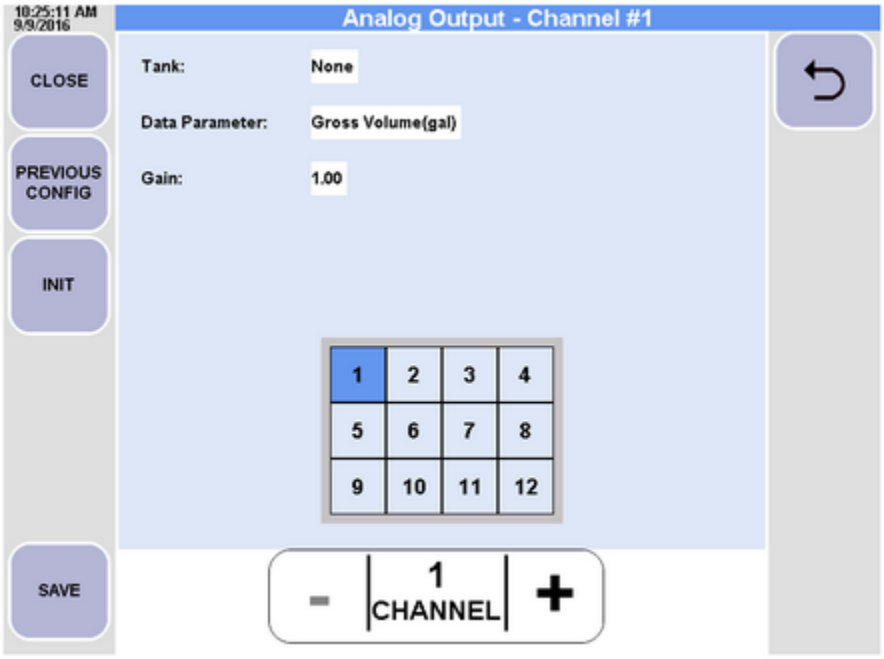


Each individual Serial Port can be configured for the following settings with the defaults shown above:

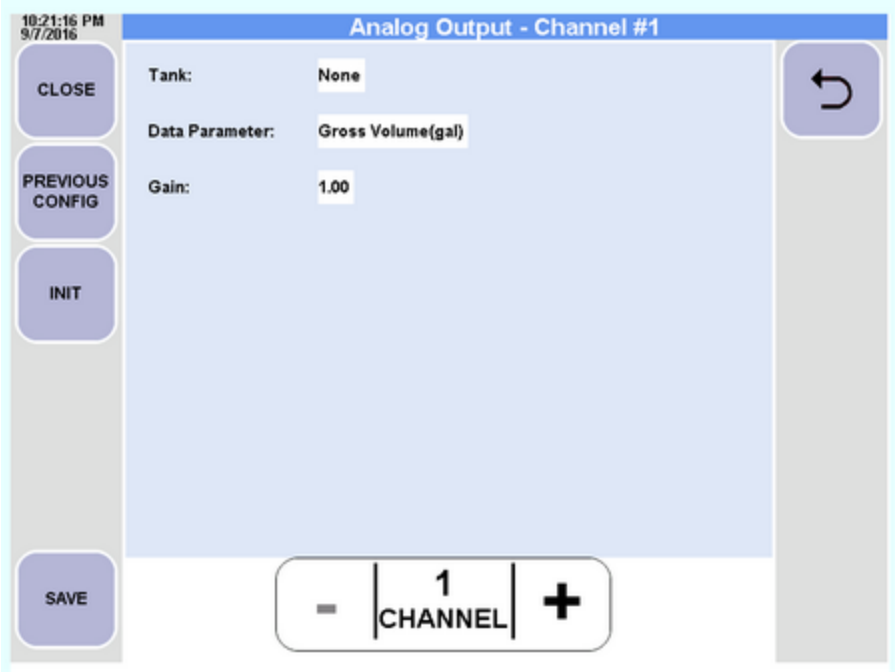
- Baud Rate: the connection speed required to communicate to the attached device
- Serial Format: Presented in the form of Parity, Data Bits, and Stop Bits. Special formats are available to support the external LS300 Line Leak console in both 4 and 8 channel configurations.
- Security Enable: Requires a 6-digit numeric Access Code that is prepended to any command issued to the TMS.

Serial Port A & B are integrated onto the Processor Card of the TMS4000. Serial C & D are optional ports found on select 900571-x communications expansion cards.

2.17 ANALOG OUTPUTS



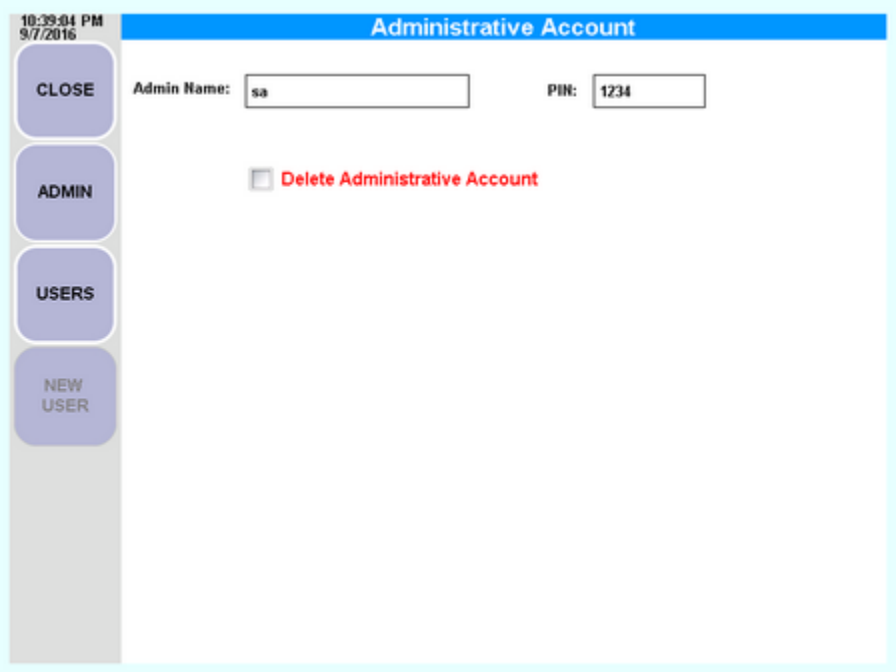
Touch the +/- buttons to increment Analog Output Channel by 1. Touch the Analog Output Channel to bring up a list of possible Analog Output Channels. Touch the Analog Output Channel on the table to make a selection.



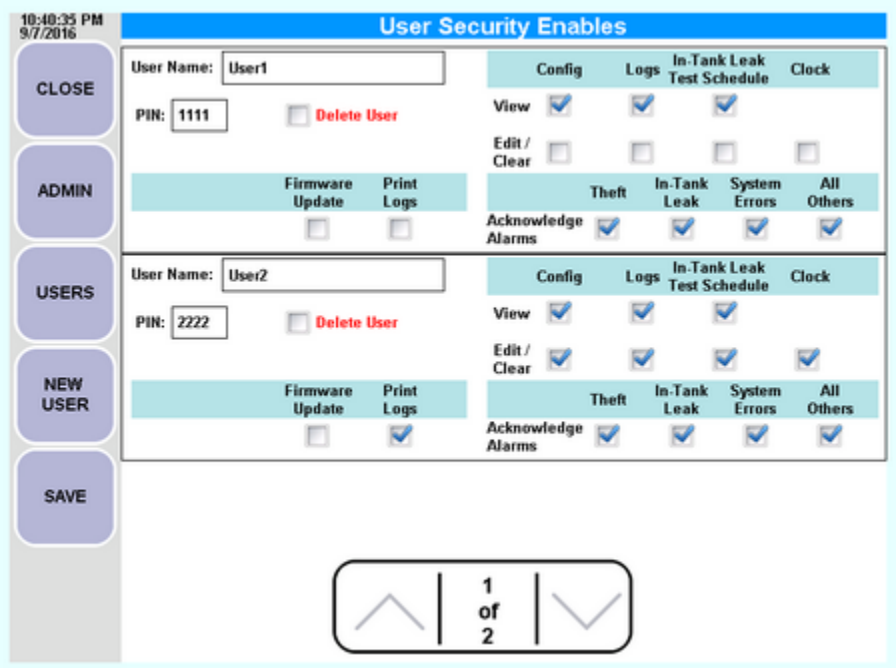
Each desired output must be assigned to a Tank Channel to enable the output. The Data Parameter specifies the information represented by the Analog Output Channel. The Gain should be left configured as 1.00 unless 0-1 mA mode is required. In that case, the Analog Output Card should be configured for 0-20 mA. Consult Bulletin 139 for complete details.

2.18 SECURITY

The TMS4000 can be configured to restrict access to specific information and/or functions. If this is desired, an Administrator account must first be created that has access to everything including the ability to create and modify additional user accounts with varying degrees of permissions.



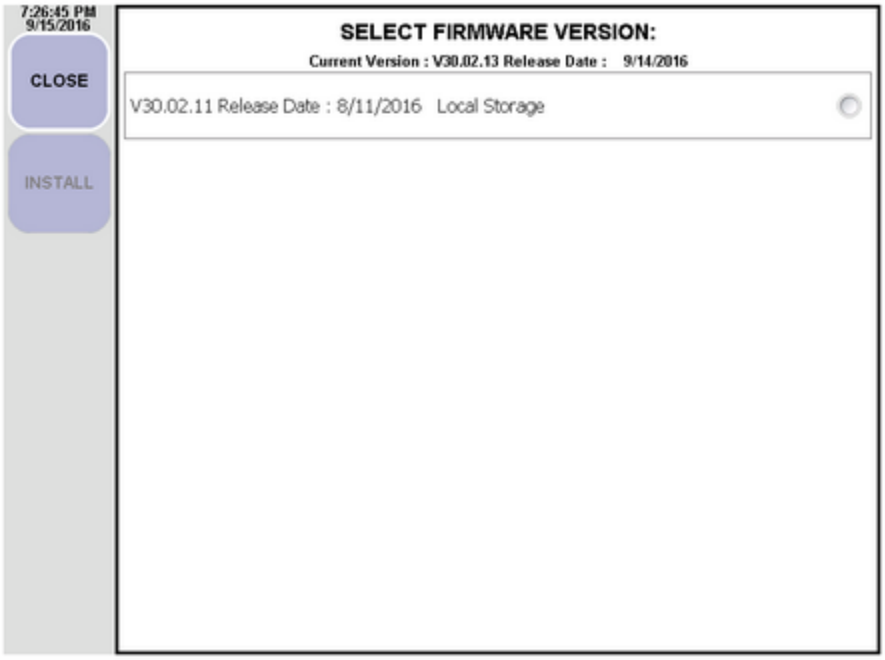
Enter a name for the Administrator and 4-digit numeric PIN. The name is only used in the System Reports to document the user responsible for taking certain actions. Delete the Administrative account to remove all restrictions from accessing TMS4000 functions. See the following page for details on the settings available in the below screenshot showing user accounts.



Each user must have a User Name and 4-digit numeric PIN number assigned. Like the Administrator account, the user name is only used in the System Reports to document the user responsible for taking certain actions. Individual users may be deleted by checking the Delete User checkbox and saving the changes. Access restrictions may currently be placed on the following functions:

- Firmware Update: Firmware Updates may be performed using a USB flash drive. Restrictions may be placed on performing any change to the system firmware
- Logs/Reports: Individual restrictions are as follows:
    - Print: using printer connected to TMS
    - View: on TMS display
    - Clear: Erasing Logs/Reports
- Config: Individual restrictions are as follows:
    - View: on TMS display
    - Edit/Clear: making changes to or erasing the system configuration
- In-Tank Leak Test Schedule: Individual restrictions are as follows:
    - View: on TMS display
    - Edit: making changes to the Leak Test Schedule
- Edit Clock: Changing the Date and Time
- Acknowledge Alarms:
    - Theft: Any detected theft
    - In-Tank Leak: Failed In-Tank Leak Test
    - System Errors: Include Probe Timeout, Probe Sync, and Sensor Fault
    - All Others: Includes Tank Set Points for Product, Water, and Temperature, CC Input and Sensor Alarms.

2.19 FIRMWARE



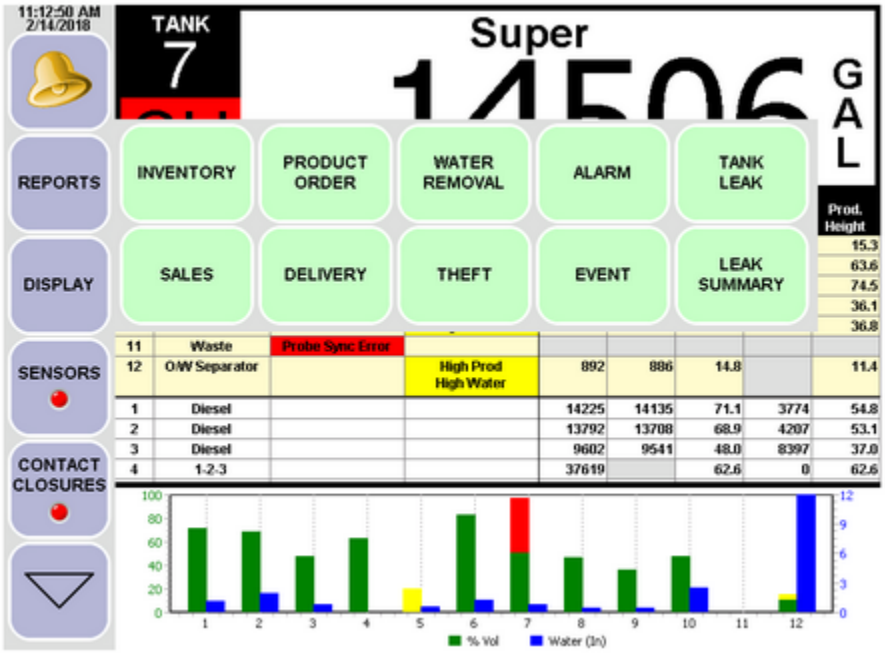
The current version of firmware is displayed across the top. The previous version is available in the event there is technical difficulties with the existing firmware. The Install button will be available once a flash drive is inserted into the internal USB Port with a valid firmware file supplied by Pneumercator. See Section 1.1.1 for location of USB Port.

2.20 LOCALIZATION

The localization screen provides a choice between English and Spanish languages and American versus Metric units of measure.

SECTION 3 SYSTEM REPORTS

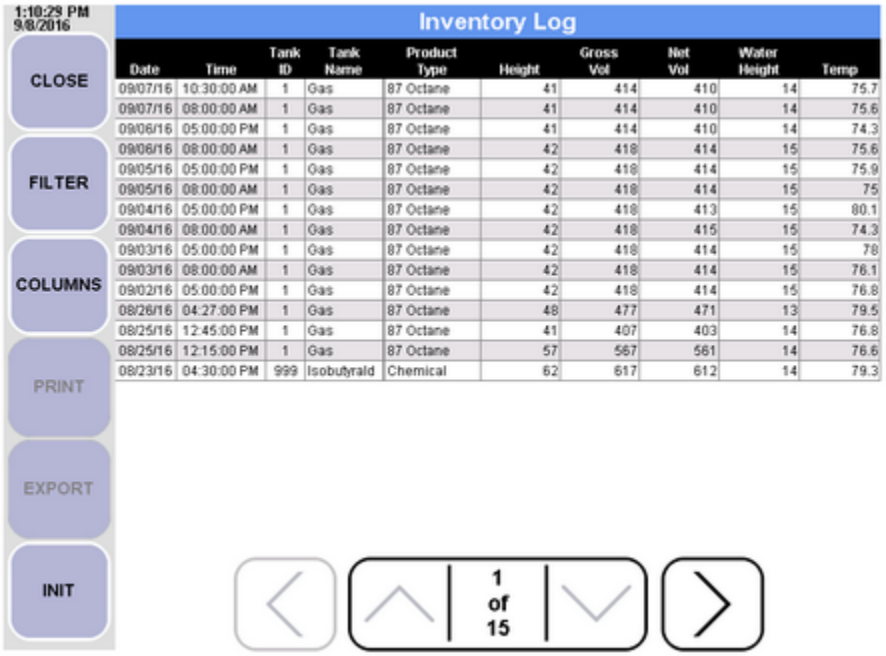
3.1 OVERVIEW



The Reports available in the TMS4000 include the 9 reports displayed above and a System Events Log found in the Setup menu. Any report may be exported to a USB Flash Drive in CSV format by touching the Export button. The CSV (Comma Separated Values) file may be opened using Microsoft Excel or any other comparable software program. See Section 1.1.1 for location of USB Port. The description for each log is as follows:

- Inventory: Contains scheduled Inventory snapshots as defined in the Configuration. Refer to Section 2.13 for additional details
- Sales: Bulk sales representing the sale or withdrawal of fuel from a tank.
- Product Order: An on-demand report indicating the number of days of usable fuel remaining based on the average daily usage since the last delivery
- Delivery: The delivery or addition of fuel to the tank.
- Water Removal: Indicates the water removed from below the fuel surface in the tank.
- Theft: Contains the unauthorized removal of fuel from the tank. Refer to Section 2.14 for additional details.
- Alarm: Alarms for Tank Set Points for Product, Water, and Temperature. Also includes CC Input and Sensor alarms.
- Event: Probe and Sensors errors, Power Fail, and problems regarding Leak Tests, excluding completed failed tests
- Tank Leak: Completed In-Tank Leak Test Results
- Leak Summary: The latest passing test per tank for all previous months. If no test passes for any one month per tank, the latest failure will be listed.
- System Events: Include select Security Events and hardware or software failures of the TMS4000.

3.2 INVENTORY



Date	Time	Tank ID	Tank Name	Product Type	Height	Gross Vol	Net Vol	Water Height	Temp
09/07/16	10:30:00 AM	1	Gas	87 Octane	41	414	410	14	75.7
09/07/16	08:00:00 AM	1	Gas	87 Octane	41	414	410	14	75.6
09/06/16	05:00:00 PM	1	Gas	87 Octane	41	414	410	14	74.3
09/06/16	08:00:00 AM	1	Gas	87 Octane	42	418	414	15	75.6
09/05/16	05:00:00 PM	1	Gas	87 Octane	42	418	414	15	75.9
09/05/16	08:00:00 AM	1	Gas	87 Octane	42	418	414	15	75
09/04/16	05:00:00 PM	1	Gas	87 Octane	42	418	413	15	80.1
09/04/16	08:00:00 AM	1	Gas	87 Octane	42	418	415	15	74.3
09/03/16	05:00:00 PM	1	Gas	87 Octane	42	418	414	15	78
09/03/16	08:00:00 AM	1	Gas	87 Octane	42	418	414	15	76.1
09/02/16	05:00:00 PM	1	Gas	87 Octane	42	418	414	15	76.8
08/26/16	04:27:00 PM	1	Gas	87 Octane	48	477	471	13	79.5
08/25/16	12:45:00 PM	1	Gas	87 Octane	41	407	403	14	76.8
08/25/16	12:15:00 PM	1	Gas	87 Octane	57	567	561	14	76.6
08/23/16	04:30:00 PM	999	Isobutyrald	Chemical	62	617	612	14	79.3

Date: Date the snapshot was taken

Time: Time the snapshot was taken

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Tank Name: The name assigned to the tank. See Section 2.4

Product Type: The Product Type assigned to the tank. See Section 2.4

Height: The total level of liquid in the tank as measured in inches/millimeters

Gross Vol: The total volume of liquid in the tank as measured in gallons/liters

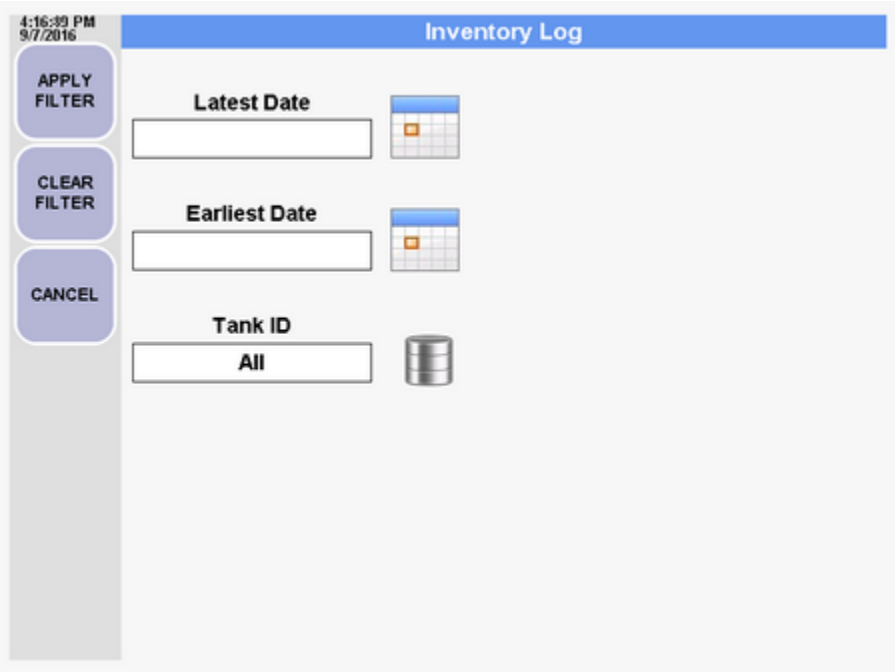
Net Vol: The total temperature-compensated volume of liquid in the tank as measured in gallons/liters. Industry standard compensation for liquid represented as if it was 68°F/20°C.

Water Height: The total level of water below the fuel in the tank as measured in inches/millimeters

Temp: The average liquid temperature in the tank

Ullage: The amount of free space in the tank up to the defined ullage threshold as measured in gallons/liters. See Section 2.3

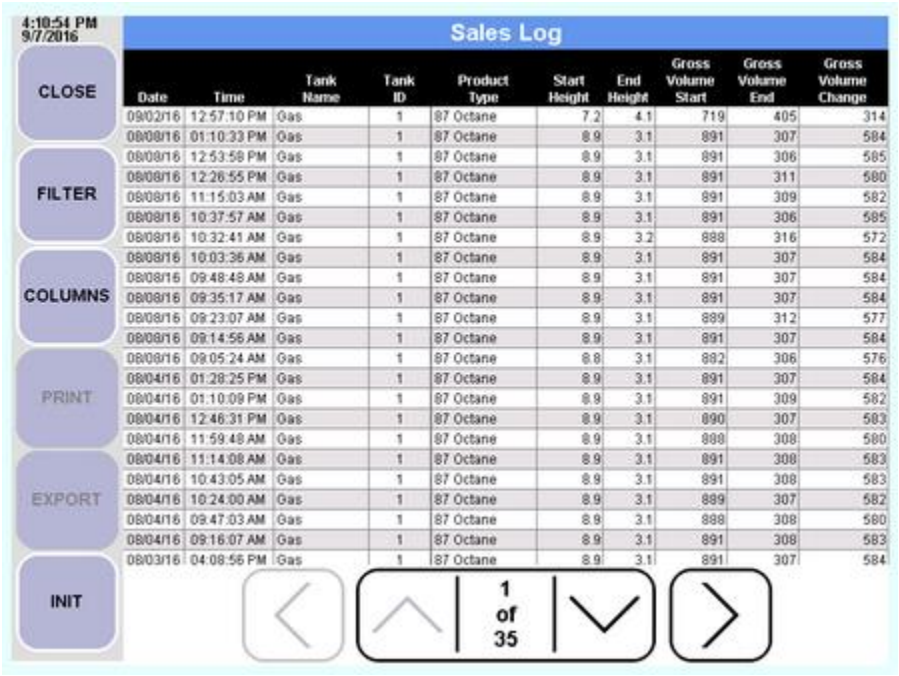
% Vol: The percentage of total tank volume at the time of the snapshot.



Provided filter can select a date range and/or specific Tank IDs.

Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.3 SALES



Date	Time	Tank Name	Tank ID	Product Type	Start Height	End Height	Gross Volume Start	Gross Volume End	Gross Volume Change
09/02/16	12:57:10 PM	Gas	1	87 Octane	7.2	4.1	719	405	314
08/08/16	01:10:33 PM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/08/16	12:53:58 PM	Gas	1	87 Octane	8.9	3.1	891	306	585
08/08/16	12:26:55 PM	Gas	1	87 Octane	8.9	3.1	891	311	580
08/08/16	11:15:03 AM	Gas	1	87 Octane	8.9	3.1	891	309	582
08/08/16	10:37:57 AM	Gas	1	87 Octane	8.9	3.1	891	306	585
08/08/16	10:32:41 AM	Gas	1	87 Octane	8.9	3.2	888	316	572
08/08/16	10:03:36 AM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/08/16	09:48:48 AM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/08/16	09:35:17 AM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/08/16	09:23:07 AM	Gas	1	87 Octane	8.9	3.1	889	312	577
08/08/16	09:14:56 AM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/08/16	09:05:24 AM	Gas	1	87 Octane	8.8	3.1	882	306	576
08/04/16	01:28:25 PM	Gas	1	87 Octane	8.9	3.1	891	307	584
08/04/16	01:10:09 PM	Gas	1	87 Octane	8.9	3.1	891	309	582
08/04/16	12:46:31 PM	Gas	1	87 Octane	8.9	3.1	890	307	583
08/04/16	11:59:48 AM	Gas	1	87 Octane	8.9	3.1	888	308	580
08/04/16	11:14:08 AM	Gas	1	87 Octane	8.9	3.1	891	308	583
08/04/16	10:43:05 AM	Gas	1	87 Octane	8.9	3.1	891	308	583
08/04/16	10:24:00 AM	Gas	1	87 Octane	8.9	3.1	889	307	582
08/04/16	09:47:03 AM	Gas	1	87 Octane	8.9	3.1	888	308	580
08/04/16	09:16:07 AM	Gas	1	87 Octane	8.9	3.1	891	308	583
08/03/16	04:08:56 PM	Gas	1	87 Octane	8.9	3.1	891	307	584

Date: Date the sale was completed

Time: Time the sale was completed

Tank Name: The name assigned to the tank. See Section 2.4

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Product Type: The Product Type assigned to the tank. See Section 2.4

Start Height: The total liquid level in the tank at the beginning of the sale

End Height: The total liquid level in the tank at the end of the sale

Gross Volume Start: The total volume of liquid in the tank at the beginning of the sale

Gross Volume End: The total volume of liquid in the tank at the end of the sale

Gross Volume Change: The total change in volume liquid as a result of the sale

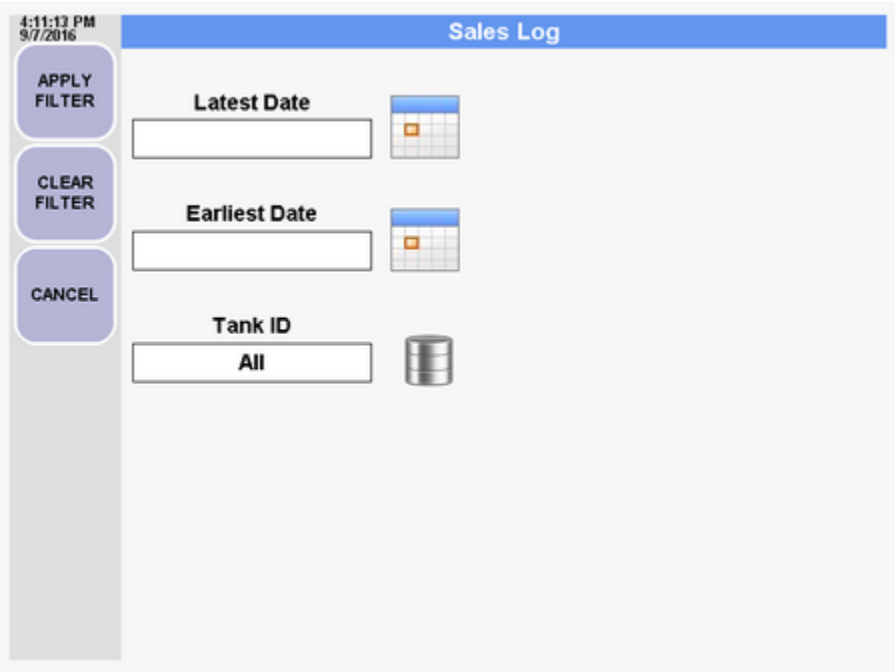
Net Volume Start: The total temperature-compensated of volume of liquid in the tank at the beginning of the sale

Net Volume End: The total temperature-compensated volume of liquid in the tank at the end of the sale

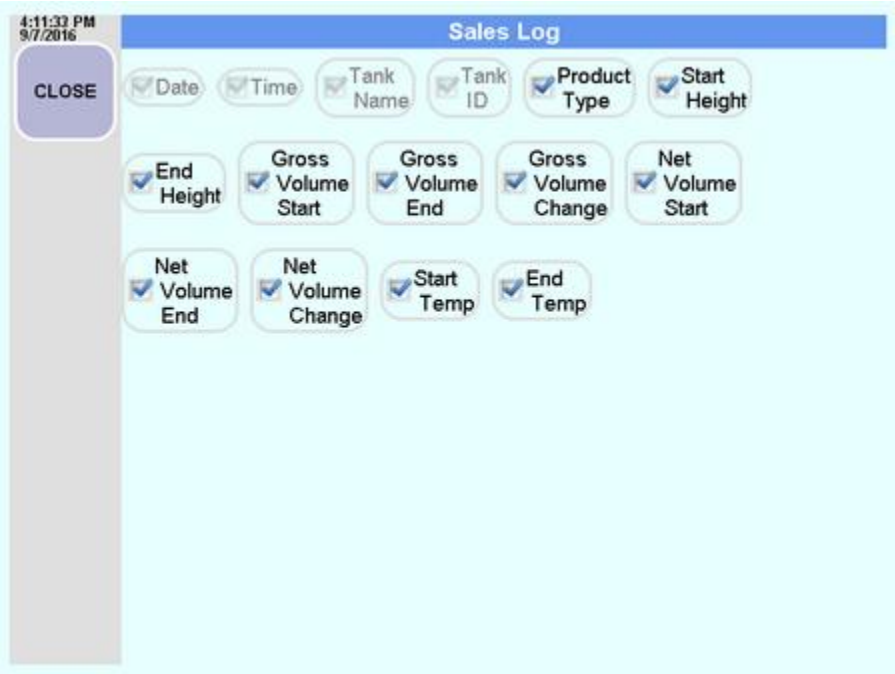
Net Volume Change: The total change in temperature-compensated volume of liquid in the tank at the beginning of the sale

Start Temp: The average liquid temperature at the beginning of the sale

End Temp: The average liquid temperature at the end of the sale



Provided filter can select a date range and/or specific Tank IDs.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.4 PRODUCT ORDER

Date: Date the report was generated

Time: Time the report was generated

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Tank Name: The name assigned to the tank. See Section 2.4

Product Type: The Product Type assigned to the tank. See Section 2.4

Usable Volume: The Total Gross Tank Volume minus the Unusable Volume. See Section 2.5

Gross Vol: The Total Gross Tank Volume

Ullage: The amount of free space in the tank up to the defined ullage threshold as measured in gallons/liters. See Section 2.3

Delivery Date: The date of the most recent delivery for this tank

Delivery Volume: The volume of fuel delivered to the tank at the most recent delivery

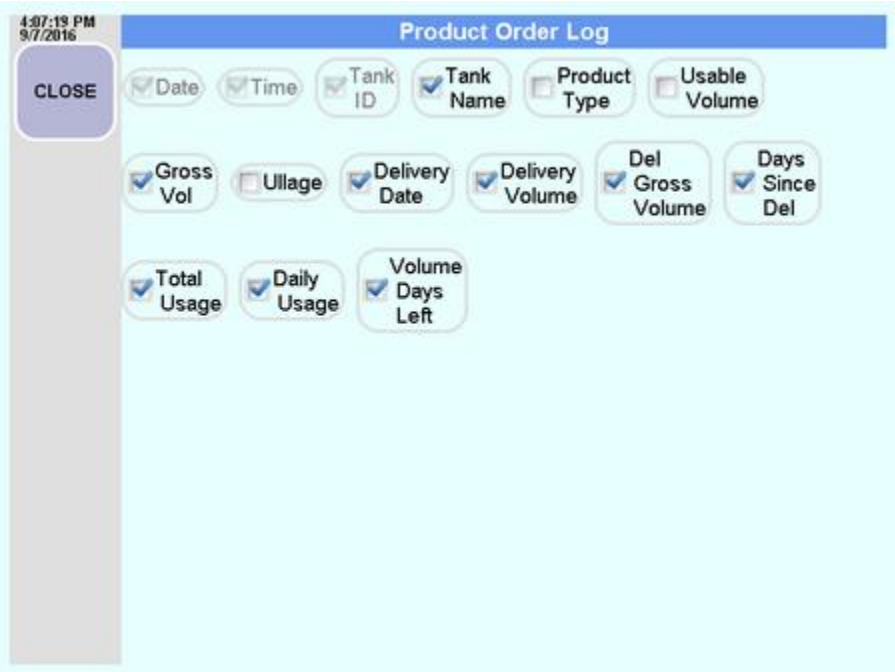
Del Gross Volume: The total volume of fuel in the tank after the latest delivery

Days Since Del: The number of days that passed since the last delivery

Total Usage: The total amount of fuel used since the last delivery

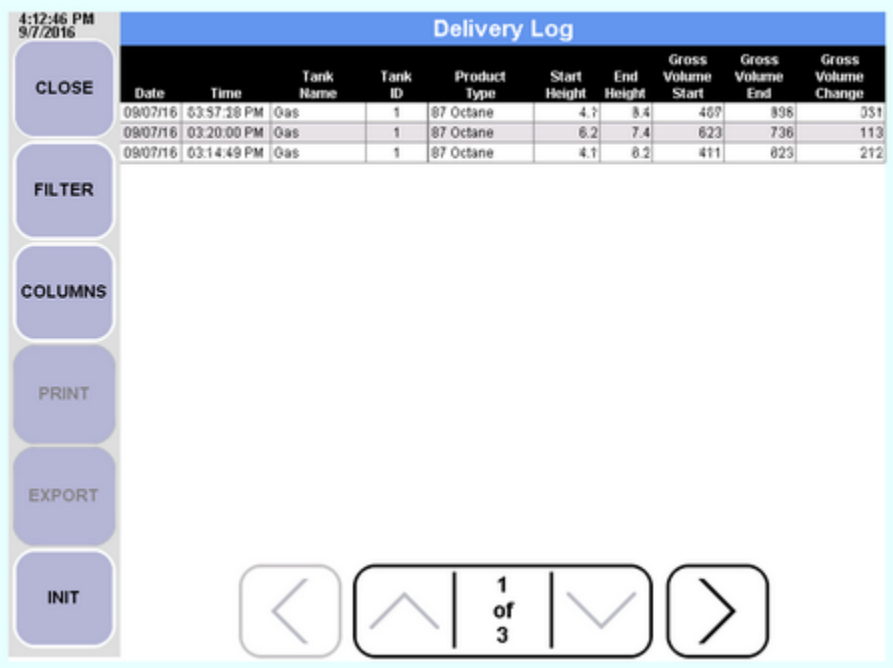
Daily Usage: The average daily usage

Volume Days Left: The estimated number of days of usable fuel remaining based on the Daily Usage.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.5 DELIVERY



Date: Date the delivery was completed

Time: Time the delivery was completed

Tank Name: The name assigned to the tank. See Section 2.4

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Product Type: The Product Type assigned to the tank. See Section 2.4

Start Height: The total liquid level in the tank at the beginning of the delivery

End Height: The total liquid level in the tank at the end of the delivery

Gross Volume Start: The total volume of liquid in the tank at the beginning of the delivery

Gross Volume End: The total volume of liquid in the tank at the end of the delivery

Gross Volume Change: The total change in volume liquid as a result of the delivery

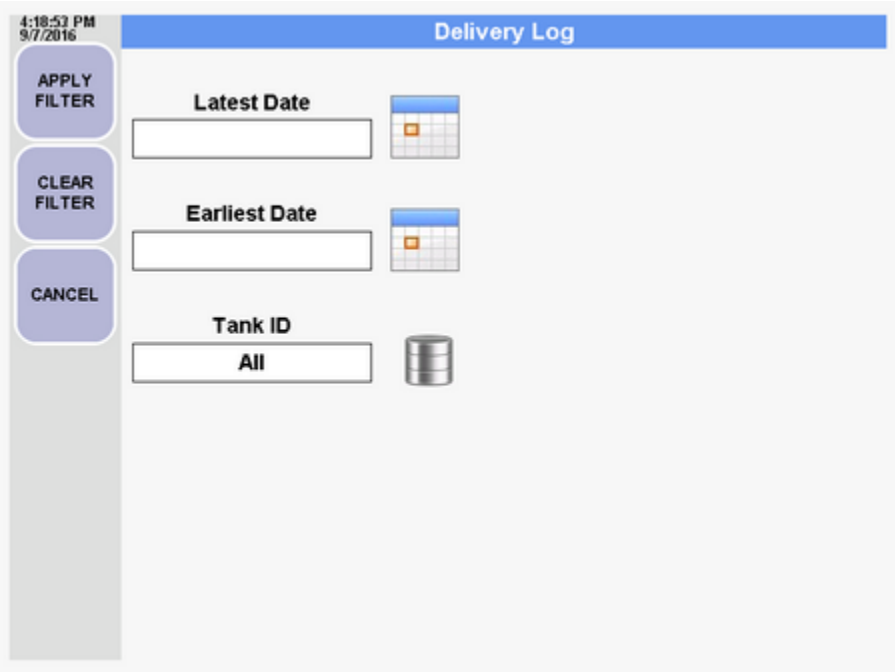
Net Volume Start: The total temperature-compensated of volume of liquid in the tank at the beginning of the delivery

Net Volume End: The total temperature-compensated volume of liquid in the tank at the end of the delivery

Net Volume Change: The total change in temperature-compensated volume of liquid in the tank at the beginning of the delivery

Start Temp: The average liquid temperature at the beginning of the delivery

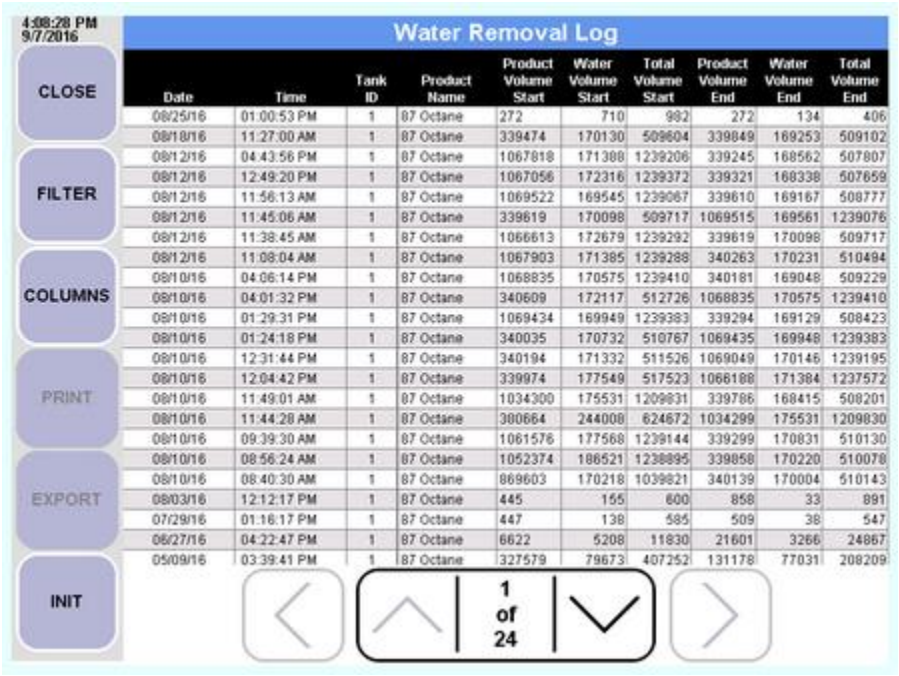
End Temp: The average liquid temperature at the end of the delivery



Provided filter can select a date range and/or specific Tank IDs.

Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.6 WATER REMOVAL



Date	Time	Tank ID	Product Name	Product Volume Start	Water Volume Start	Total Volume Start	Product Volume End	Water Volume End	Total Volume End
08/25/16	01:00:53 PM	1	87 Octane	272	710	982	272	134	406
08/18/16	11:27:00 AM	1	87 Octane	339474	170130	509604	339849	169253	509102
08/12/16	04:43:56 PM	1	87 Octane	1067818	171388	1239206	339245	168562	507807
08/12/16	12:49:20 PM	1	87 Octane	1067056	172316	1239372	339321	168338	507659
08/12/16	11:56:13 AM	1	87 Octane	1069522	169545	1239067	339610	169167	508777
08/12/16	11:45:06 AM	1	87 Octane	339619	170098	509717	1069515	169561	1239076
08/12/16	11:38:45 AM	1	87 Octane	1066613	172679	1239292	339619	170098	509717
08/12/16	11:08:04 AM	1	87 Octane	1067903	171385	1239288	340263	170231	510494
08/10/16	04:06:14 PM	1	87 Octane	1068835	170575	1239410	340181	169048	509229
08/10/16	04:01:32 PM	1	87 Octane	340609	172117	512726	1068835	170575	1239410
08/10/16	01:29:31 PM	1	87 Octane	1069434	169949	1239383	339294	169129	508423
08/10/16	01:24:18 PM	1	87 Octane	340035	170732	510767	1069435	169948	1239383
08/10/16	12:31:44 PM	1	87 Octane	340194	171332	511526	1069049	170146	1239195
08/10/16	12:04:42 PM	1	87 Octane	339974	177549	517523	1068188	171384	1237572
08/10/16	11:49:01 AM	1	87 Octane	1034300	175531	1209831	339786	168415	508201
08/10/16	11:44:28 AM	1	87 Octane	380664	244008	624672	1034299	175531	1209830
08/10/16	09:39:30 AM	1	87 Octane	1061576	177568	1239144	339299	170831	510130
08/10/16	08:56:24 AM	1	87 Octane	1052374	186521	1238895	339858	170220	510078
08/10/16	08:40:30 AM	1	87 Octane	869603	170218	1039821	340139	170004	510143
08/03/16	12:12:17 PM	1	87 Octane	445	155	600	858	33	891
07/29/16	01:16:17 PM	1	87 Octane	447	138	585	509	38	547
06/27/16	04:22:47 PM	1	87 Octane	6622	5208	11830	21601	3266	24867
05/09/16	03:39:41 PM	1	87 Octane	327579	79673	407252	131178	77031	208209

Date: Date the water removal was completed

Time: Time the water removal was completed

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Product Type: The Product Type assigned to the tank. See Section 2.4

Tank Name: The name assigned to the tank. See Section 2.4

Product Volume Start: The volume of fuel before water was removed

Water Volume Start: The volume of water before water was removed

Total Volume Start: The volume of all liquid, fuel and water combined, before water was removed

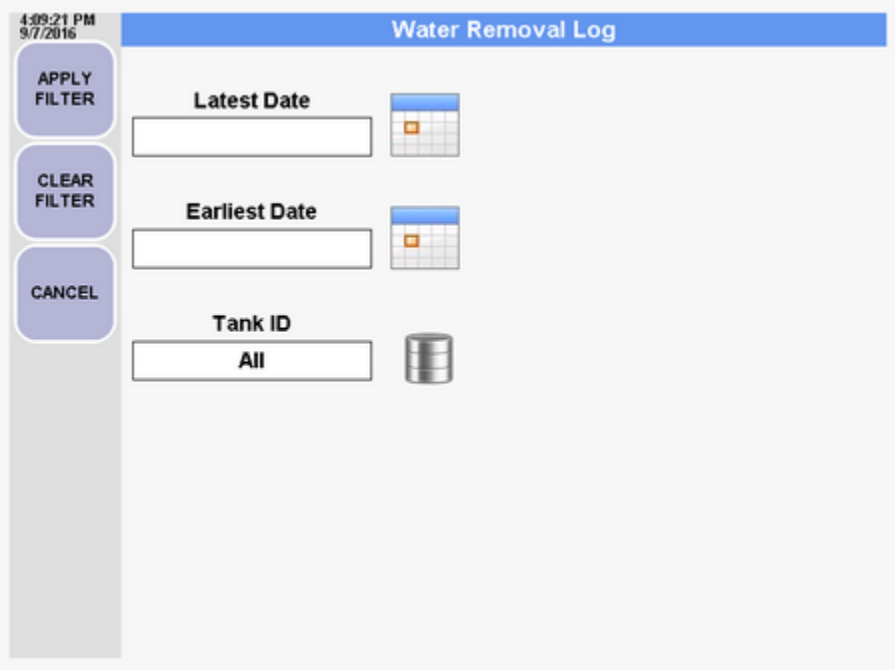
Product Volume End: The volume of fuel after water was removed

Water Volume End: The volume of water after water was removed

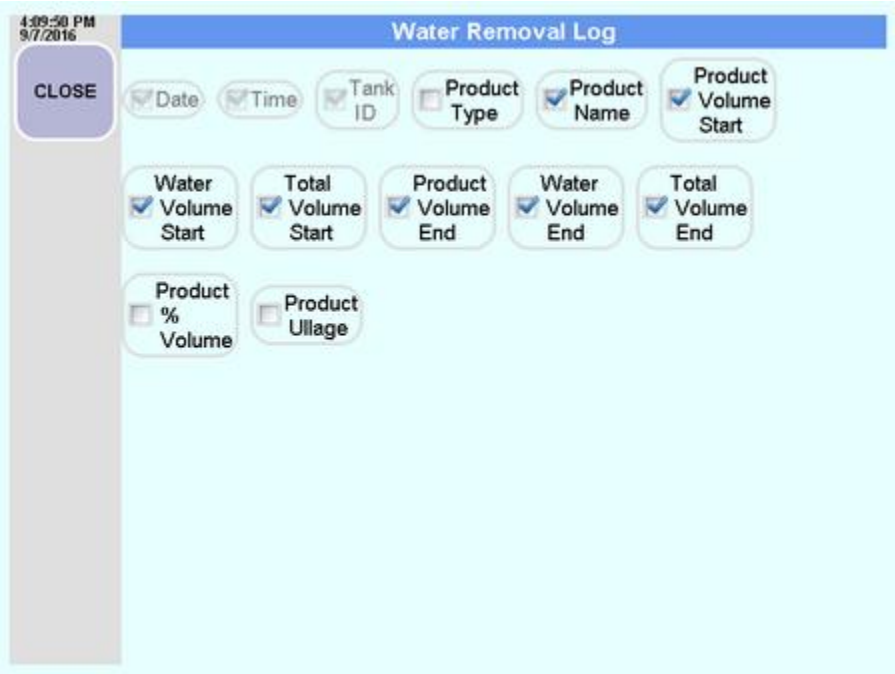
Total Volume End: The volume of all liquid, fuel and water combined, after water was removed

Product % Volume: The percent of total tank volume of all liquid, fuel and water combined, after water was removed

Product Ullage: The amount of free space after water was removed in the tank up to the defined ullage threshold as measured in gallons/liters. See Section 2.3

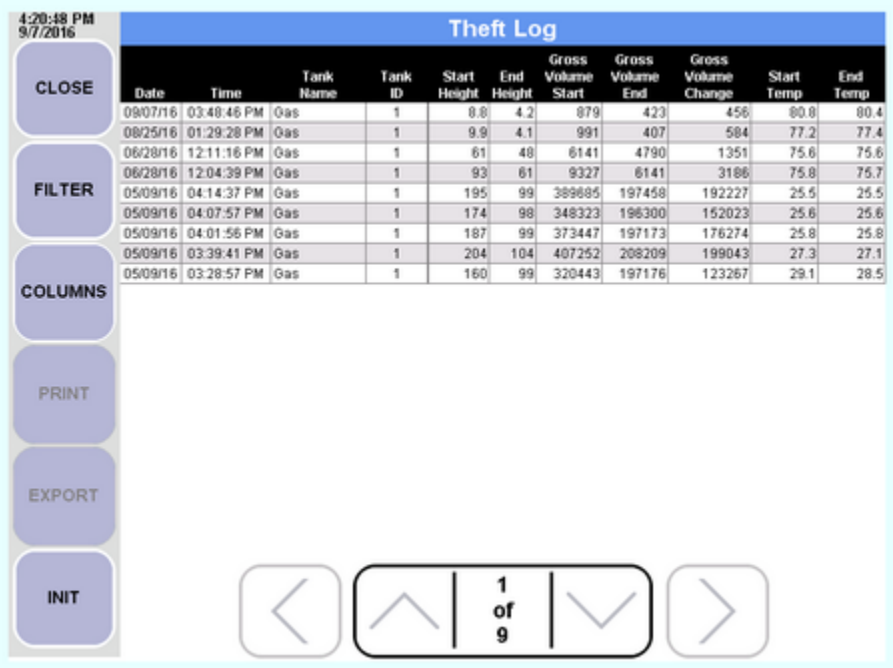


Provided filter can select a date range and/or specific Tank IDs.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.7 THEFT



Date	Time	Tank Name	Tank ID	Start Height	End Height	Gross Volume Start	Gross Volume End	Gross Volume Change	Start Temp	End Temp
09/07/16	03:48:46 PM	Gas	1	8.8	4.2	879	423	456	80.8	80.4
08/25/16	01:29:28 PM	Gas	1	9.9	4.1	991	407	584	77.2	77.4
06/28/16	12:11:16 PM	Gas	1	61	48	6141	4790	1351	75.6	75.6
06/28/16	12:04:39 PM	Gas	1	93	61	9327	6141	3186	75.8	75.7
05/09/16	04:14:37 PM	Gas	1	195	99	389685	197458	192227	25.5	25.5
05/09/16	04:07:57 PM	Gas	1	174	98	348323	196300	152023	25.6	25.6
05/09/16	04:01:56 PM	Gas	1	187	99	373447	197173	176274	25.8	25.8
05/09/16	03:39:41 PM	Gas	1	204	104	407252	208209	199043	27.3	27.1
05/09/16	03:28:57 PM	Gas	1	160	99	320443	197176	123267	29.1	28.5

Date: Date the theft ended

Time: Time the theft ended

Tank Name: The name assigned to the tank. See Section 2.4

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Product Type: The Product Type assigned to the tank. See Section 2.4

Start Height: The total liquid level in the tank at the beginning of the theft

End Height: The total liquid level in the tank at the end of the theft

Gross Volume Start: The total volume of liquid in the tank at the beginning of the theft

Gross Volume End: The total volume of liquid in the tank at the end of the theft

Gross Volume Change: The total change in volume liquid as a result of the theft

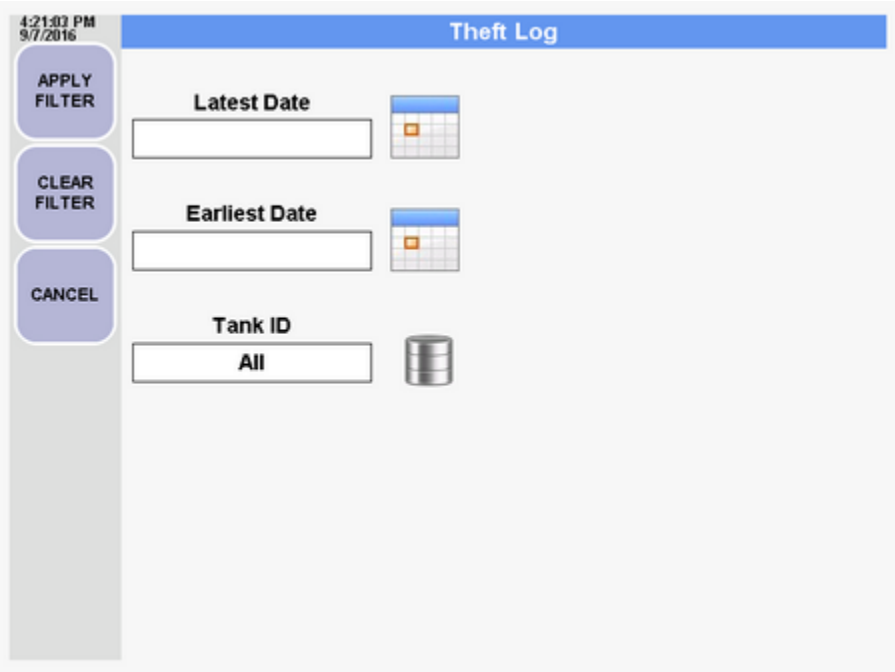
Net Volume Start: The total temperature-compensated of volume of liquid in the tank at the beginning of the theft

Net Volume End: The total temperature-compensated volume of liquid in the tank at the end of the theft

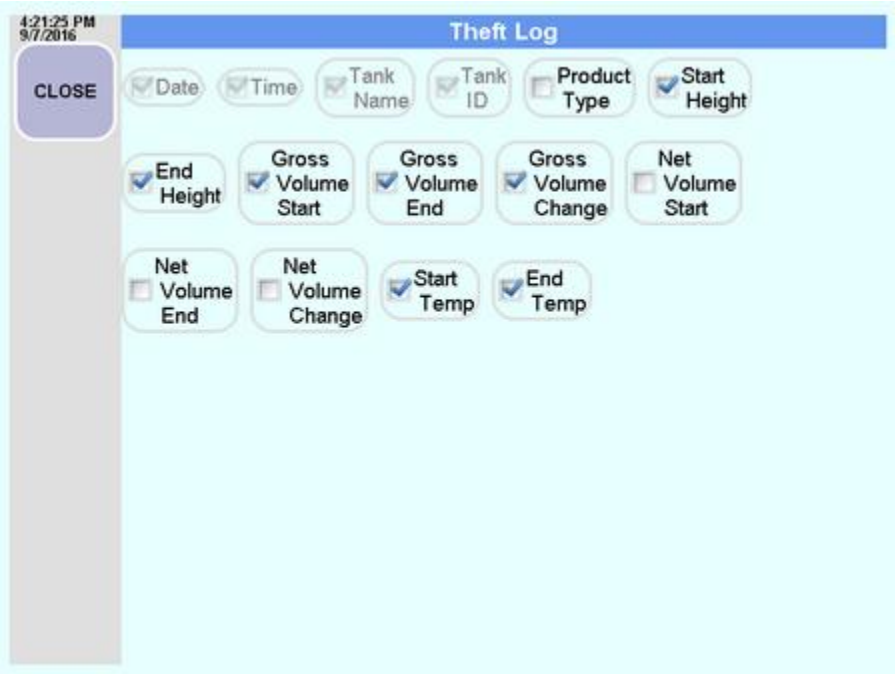
Net Volume Change: The total change in temperature-compensated volume of liquid in the tank at the beginning of the theft

Start Temp: The average liquid temperature at the beginning of the theft

End Temp: The average liquid temperature at the end of the theft

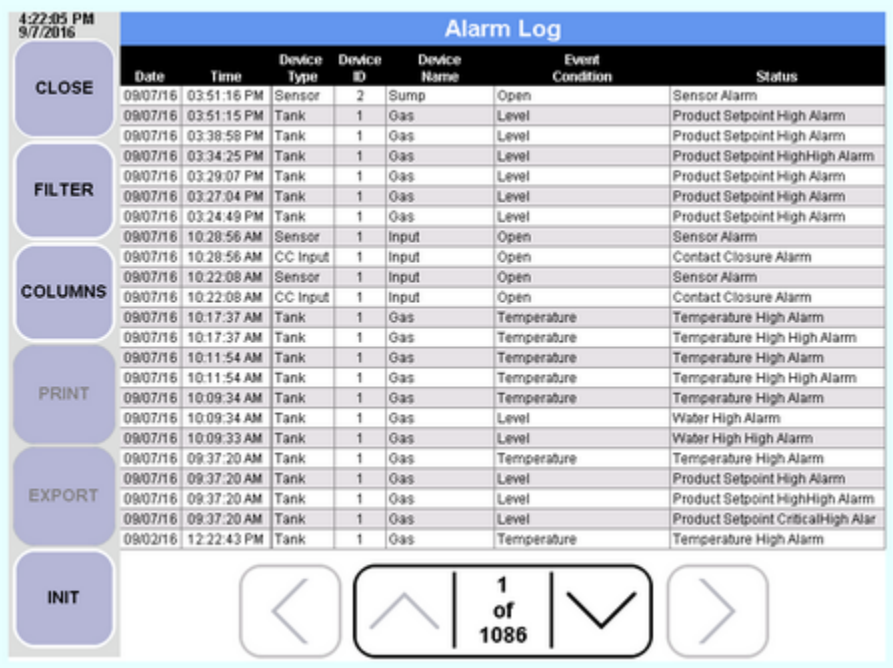


Provided filter can select a date range and/or specific Tank IDs.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.8 ALARM



Date: Date the alarm occurred

Time: Time the alarm occurred

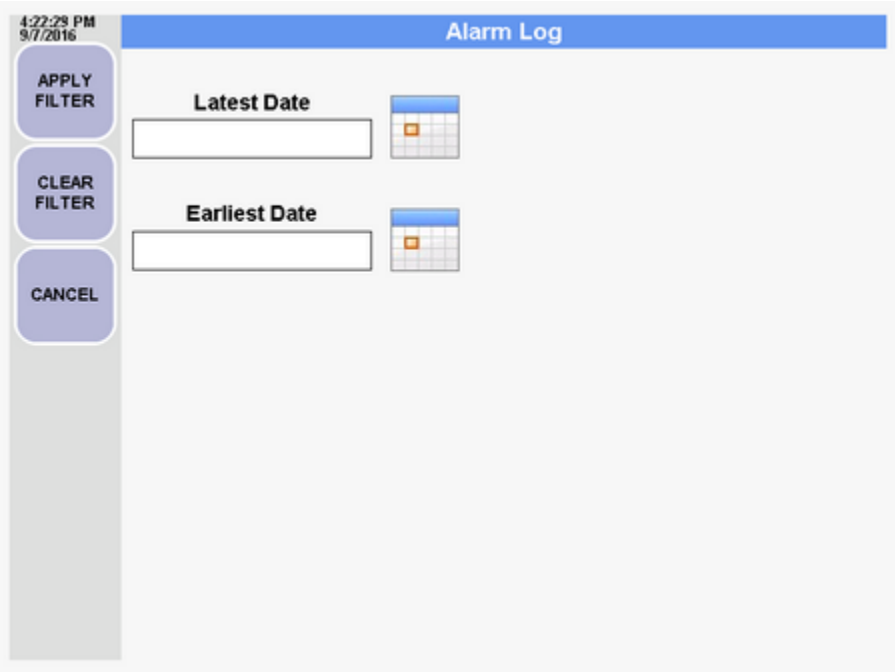
Device Type: Includes, Tank, Sensor, and CC Input

Device ID: The ID number of the Device Type in alarm

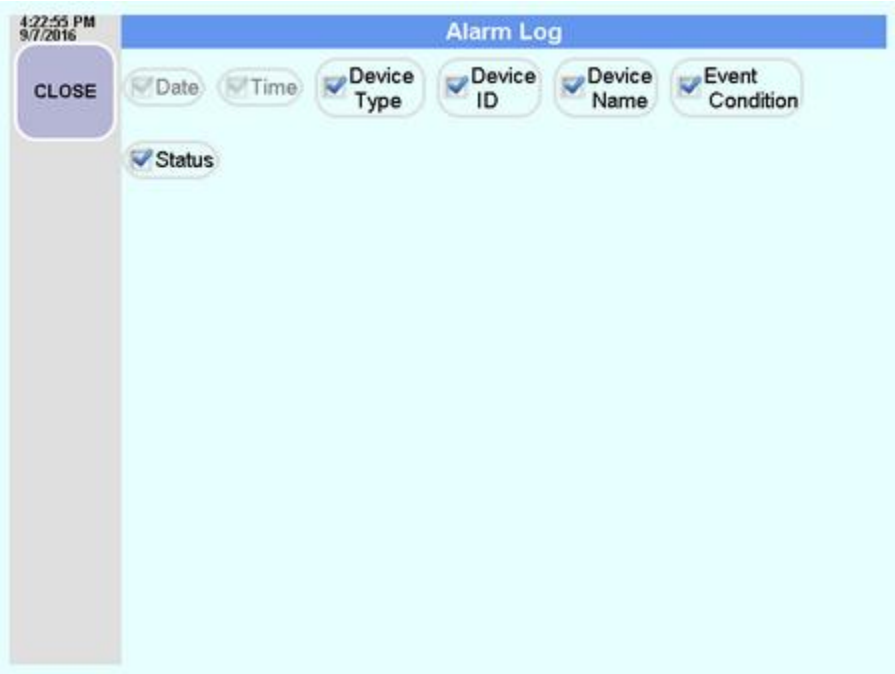
Device Name: The name assigned to the Device Type in alarm

Event Condition: The category of alarm

Status: Detailed description of the alarm



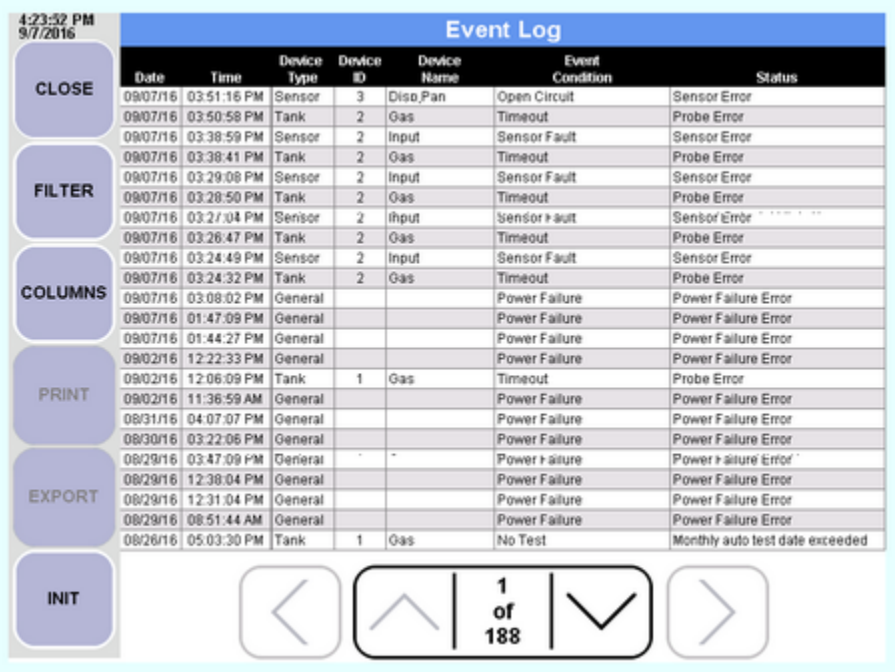
Provided filter can select a date range.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.9 EVENT

The probe map/system setup below should be completed by the electrical installer as each probe,



Date	Time	Device Type	Device ID	Device Name	Event Condition	Status
09/07/16	03:51:16 PM	Sensor	3	Disp,Pan	Open Circuit	Sensor Error
09/07/16	03:50:58 PM	Tank	2	Gas	Timeout	Probe Error
09/07/16	03:38:59 PM	Sensor	2	Input	Sensor Fault	Sensor Error
09/07/16	03:38:41 PM	Tank	2	Gas	Timeout	Probe Error
09/07/16	03:29:08 PM	Sensor	2	Input	Sensor Fault	Sensor Error
09/07/16	03:28:50 PM	Tank	2	Gas	Timeout	Probe Error
09/07/16	03:27:04 PM	Sensor	2	Input	Sensor Fault	Sensor Error
09/07/16	03:26:47 PM	Tank	2	Gas	Timeout	Probe Error
09/07/16	03:24:49 PM	Sensor	2	Input	Sensor Fault	Sensor Error
09/07/16	03:24:32 PM	Tank	2	Gas	Timeout	Probe Error
09/07/16	03:08:02 PM	General			Power Failure	Power Failure Error
09/07/16	01:47:09 PM	General			Power Failure	Power Failure Error
09/07/16	01:44:27 PM	General			Power Failure	Power Failure Error
09/02/16	12:22:33 PM	General			Power Failure	Power Failure Error
09/02/16	12:06:09 PM	Tank	1	Gas	Timeout	Probe Error
09/02/16	11:36:59 AM	General			Power Failure	Power Failure Error
08/31/16	04:07:07 PM	General			Power Failure	Power Failure Error
08/30/16	03:22:06 PM	General			Power Failure	Power Failure Error
08/29/16	03:47:09 PM	General			Power Failure	Power Failure Error
08/29/16	12:38:04 PM	General			Power Failure	Power Failure Error
08/29/16	12:31:04 PM	General			Power Failure	Power Failure Error
08/29/16	08:51:44 AM	General			Power Failure	Power Failure Error
08/26/16	05:03:30 PM	Tank	1	Gas	No Test	Monthly auto test date exceeded

Date: Date the event occurred

Time: Time the event occurred

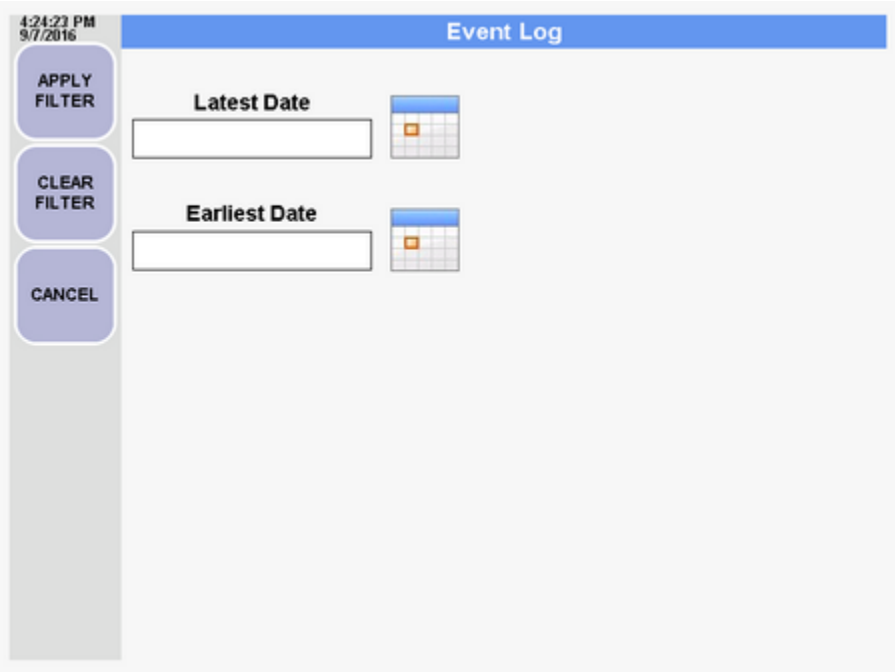
Device Type: Includes, Tank, Sensor, and CC Input

Device ID: The ID number of the Device Type causing the event, if applicable

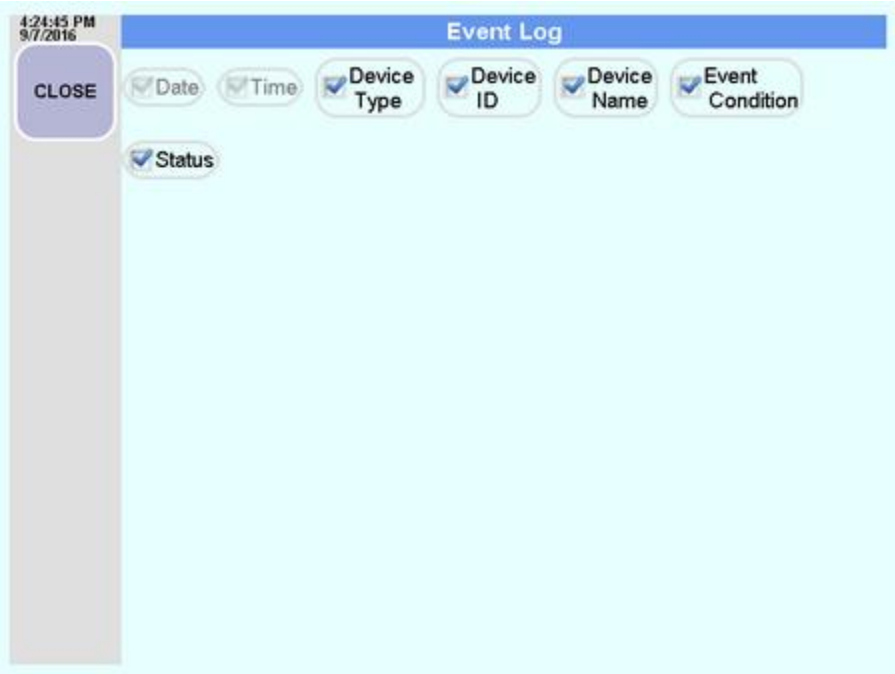
Device Name: The name assigned to the Device Type causing the event, if applicable

Event Condition: The category of event

Status: Detailed description of the event



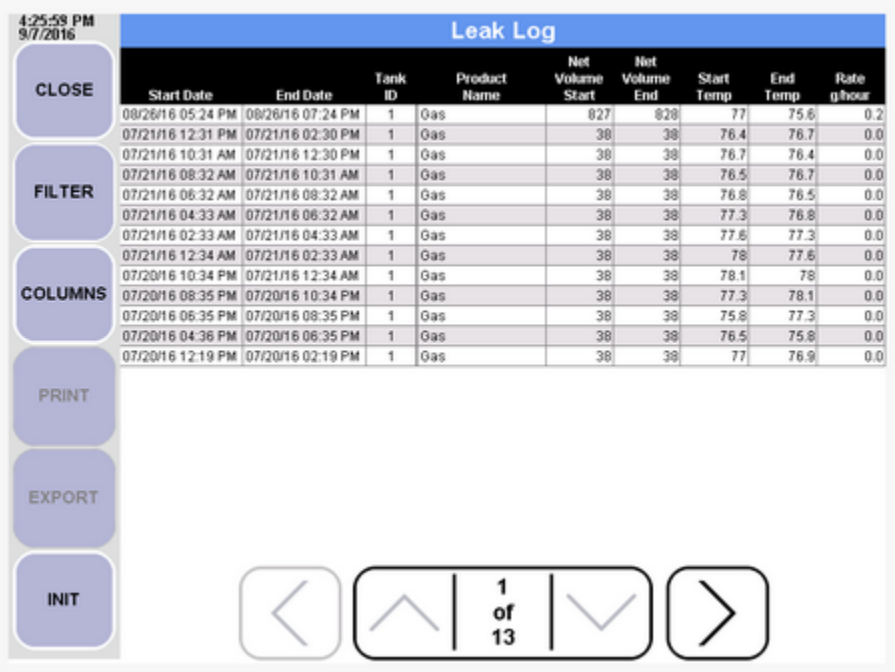
Provided filter can select a date range.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.10 TANK LEAK/LEAK SUMMARY

Note: The Leak Summary Log contains a subset of the Tank Leak Log data including Start and End Date, Tank ID, Product Type, Product Name, Slope, and Result. The latest passing test per tank for all previous months are represented. If no passing test exists for a specific month, the latest fail is recorded. Otherwise both Tank Leak and Leak Summary are functionally equal.



Start Date	End Date	Tank ID	Product Name	Net Volume Start	Net Volume End	Start Temp	End Temp	Rate g/hour
08/26/16 05:24 PM	08/26/16 07:24 PM	1	Gas	827	828	77	75.6	0.2
07/21/16 12:31 PM	07/21/16 02:30 PM	1	Gas	38	38	76.4	76.7	0.0
07/21/16 10:31 AM	07/21/16 12:30 PM	1	Gas	38	38	76.7	76.4	0.0
07/21/16 08:32 AM	07/21/16 10:31 AM	1	Gas	38	38	76.5	76.7	0.0
07/21/16 06:32 AM	07/21/16 08:32 AM	1	Gas	38	38	76.8	76.5	0.0
07/21/16 04:33 AM	07/21/16 06:32 AM	1	Gas	38	38	77.3	76.8	0.0
07/21/16 02:33 AM	07/21/16 04:33 AM	1	Gas	38	38	77.6	77.3	0.0
07/21/16 12:34 AM	07/21/16 02:33 AM	1	Gas	38	38	78	77.6	0.0
07/20/16 10:34 PM	07/21/16 12:34 AM	1	Gas	38	38	78.1	78	0.0
07/20/16 08:35 PM	07/20/16 10:34 PM	1	Gas	38	38	77.3	78.1	0.0
07/20/16 06:35 PM	07/20/16 08:35 PM	1	Gas	38	38	75.8	77.3	0.0
07/20/16 04:36 PM	07/20/16 06:35 PM	1	Gas	38	38	76.5	75.8	0.0
07/20/16 12:19 PM	07/20/16 02:19 PM	1	Gas	38	38	77	76.9	0.0

Start Date: The date and time the test was started

End Date: The date and time the test was completed

Tank ID: The Tank ID number, not Tank Hardware Channel number, assigned to the documented tank. See Section 2.4.

Product Type: The Product Type assigned to the tank. See Section 2.4

Product Name: The name assigned to the tank. See Section 2.4

Net Volume Start: The total temperature-compensated of volume of liquid in the tank at the beginning of the test

Net Volume End: The total temperature-compensated volume of liquid in the tank at the end of the test

Start Temp: The average liquid temperature at the beginning of the test

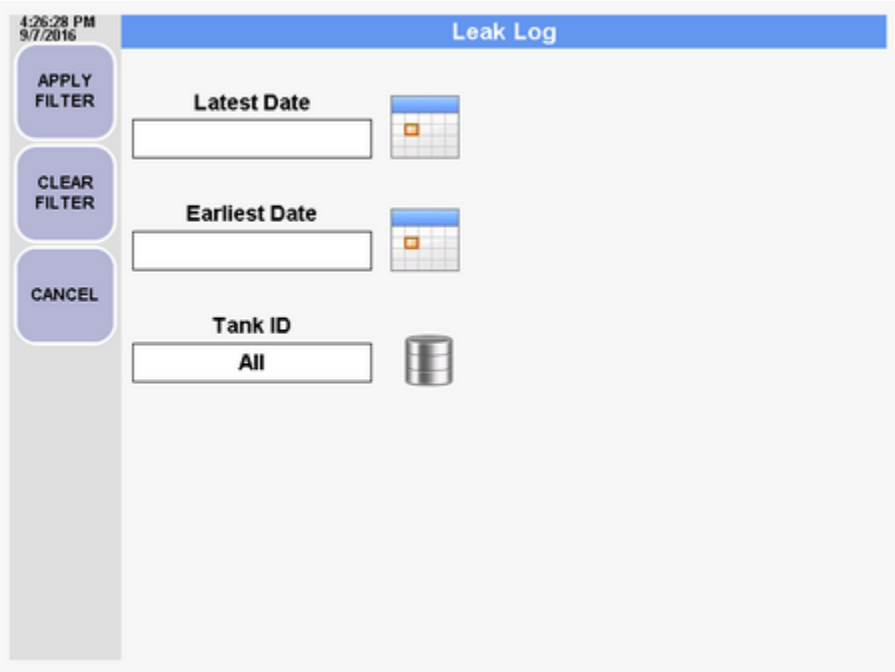
End Temp: The average liquid temperature at the end of the test

Rate g/hour: The minimum detected loss that qualifies as a leak. See section 2.8

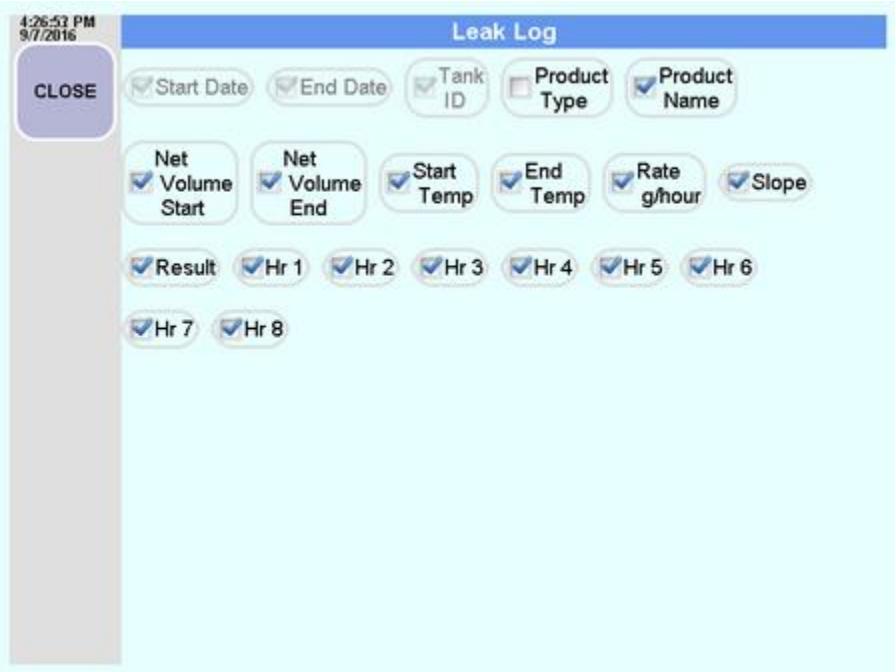
Slope: The actual average change in volume observed at the completion of the test

Result: Pass or Fail

Hr: The average cumulative change in volume at the end of each hour.

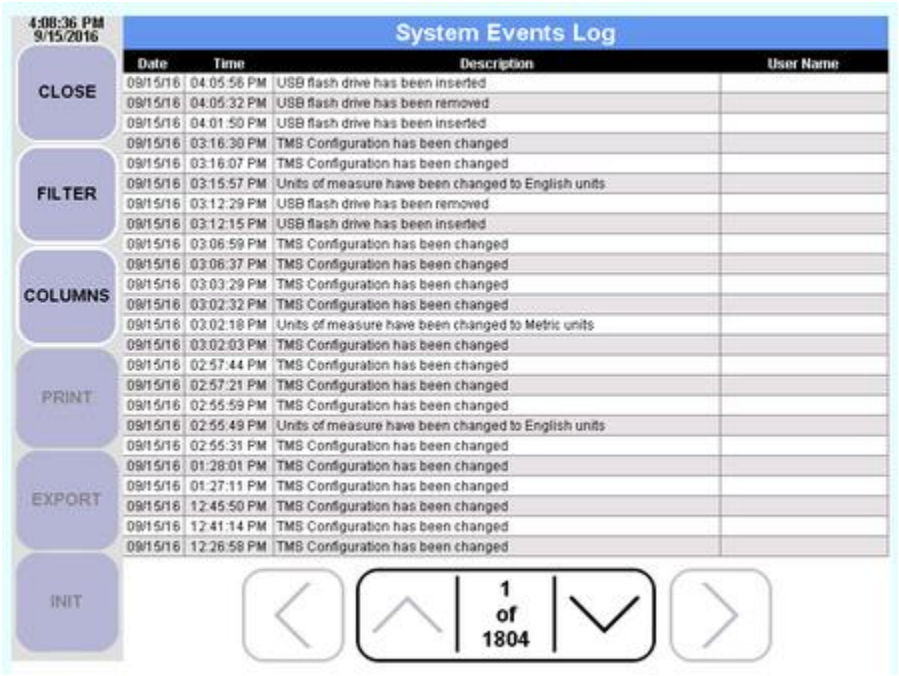


Provided filter can select a date range and/or specific Tank IDs.



Individual columns may be disabled by unchecking box. Grayed out values cannot be disabled.

3.11 SYSTEM EVENTS



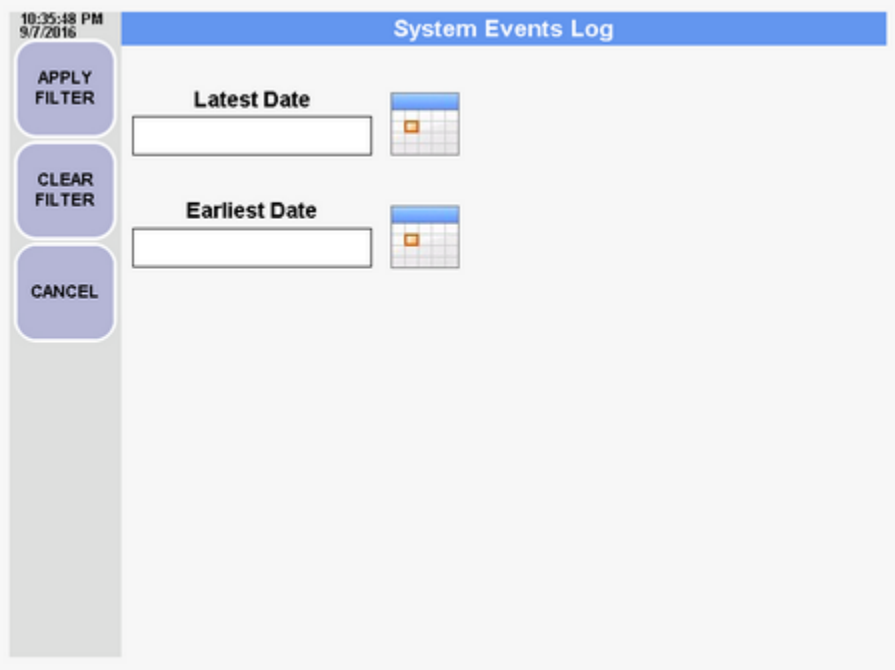
Date	Time	Description	User Name
09/15/16	04:05:56 PM	USB flash drive has been inserted	
09/15/16	04:05:32 PM	USB flash drive has been removed	
09/15/16	04:01:50 PM	USB flash drive has been inserted	
09/15/16	03:16:30 PM	TMS Configuration has been changed	
09/15/16	03:16:07 PM	TMS Configuration has been changed	
09/15/16	03:15:57 PM	Units of measure have been changed to English units	
09/15/16	03:12:29 PM	USB flash drive has been removed	
09/15/16	03:12:15 PM	USB flash drive has been inserted	
09/15/16	03:06:59 PM	TMS Configuration has been changed	
09/15/16	03:06:37 PM	TMS Configuration has been changed	
09/15/16	03:03:29 PM	TMS Configuration has been changed	
09/15/16	03:02:32 PM	TMS Configuration has been changed	
09/15/16	03:02:18 PM	Units of measure have been changed to Metric units	
09/15/16	03:02:03 PM	TMS Configuration has been changed	
09/15/16	02:57:44 PM	TMS Configuration has been changed	
09/15/16	02:57:21 PM	TMS Configuration has been changed	
09/15/16	02:55:59 PM	TMS Configuration has been changed	
09/15/16	02:55:49 PM	Units of measure have been changed to English units	
09/15/16	02:55:31 PM	TMS Configuration has been changed	
09/15/16	01:28:01 PM	TMS Configuration has been changed	
09/15/16	01:27:11 PM	TMS Configuration has been changed	
09/15/16	12:45:50 PM	TMS Configuration has been changed	
09/15/16	12:41:14 PM	TMS Configuration has been changed	
09/15/16	12:26:58 PM	TMS Configuration has been changed	

Date: Date the incident occurred

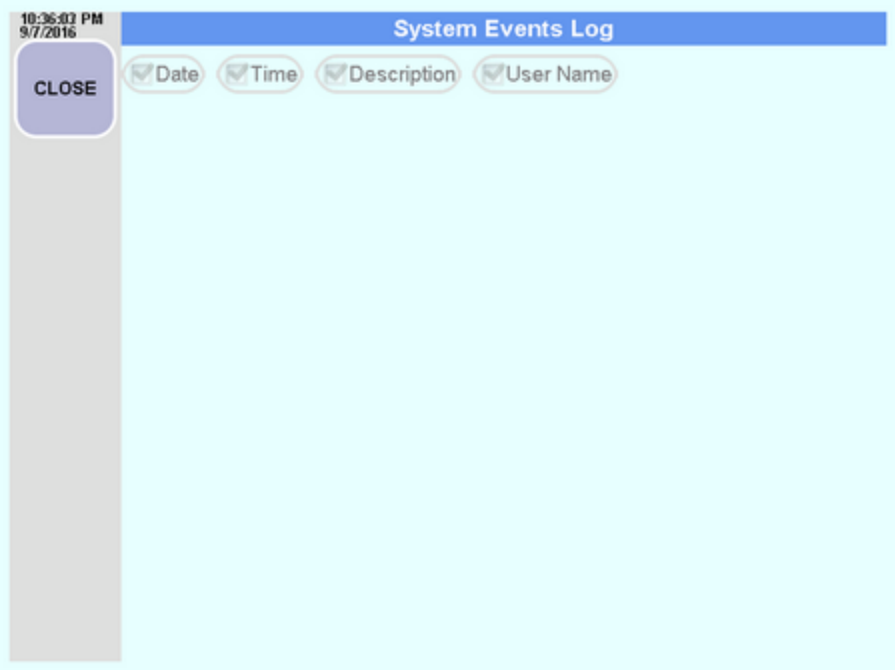
Time: Time the incident occurred

Description: A description of the incident

User Name: The name of the user responsible for the security event.



Provided filter can select a date range.



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PNEUMERCATOR TMS SERIES

LIMITED WARRANTY

TMS Series

Pneumercator, here and after referred to as **PCO**, warrants its **TMS Series** family of products to be free of defects in material and workmanship for a period of **Twelve (12) months** from date of Operation or **Fifteen (15) months** from date of invoice, whichever comes first.

During the warranty period on the **TMS Series**, **PCO,** or factory third party independent representatives will repair or replace the product at the location where it is installed at no additional cost to the customer.

Packages must be inspected upon receipt for damage, missing parts, and/or manuals. **PCO** must be contacted by telephone immediately with a description of damaged or missing parts so replacements can be sent. Written details must be sent within **thirty (30) days.**

Pneumercator will not be responsible for shipping charges incurred by the customer.

Warranty repair coverage invoices will be paid if **all** the following conditions are met:

- PCO has acknowledged and authorized warranty work to be done by issuing a *Warranty Repair Number*.
- Start-up Service technician has been trained by PCO
- Warranty start-up form has been submitted to PCO
- Technician fills out and submits a PCO "Service Report"
- Parts (if any) used are returned to PCO with a proper WRGA (*Warranty Return Goods Authorization)*
- Returned parts are found to be defective.

Repair time will be paid according to PCO document "Standard Warranty Labor Charge Schedule"

If the Warranty Registration/Start up Check List has been completed and returned on file with the factory and the product is installed in accordance with the specific PCO Operation Product Manual, PCO will activate and meet warranty criteria as described above. Warranty criteria shall be voided if any product has been subjected to misuse, negligence, damage from acts of nature (lightning, wind, rain, etc.) or is in violation of the products design intent, disregard to warnings, installations, modified or repaired by unauthorized personnel or improperly installed. Given that the third party independent contractor has installed the equipment in accordance with the specific product installation manual, and followed all precautions, PCO will fulfill the terms stated in our warranty obligation.

Under no circumstances does the warranty provide a remedy in excess of the equipment. No other expressed or implied warranty is given by PCO. PCO shall not be liable for consequential damages or any expenses incurred by the user.

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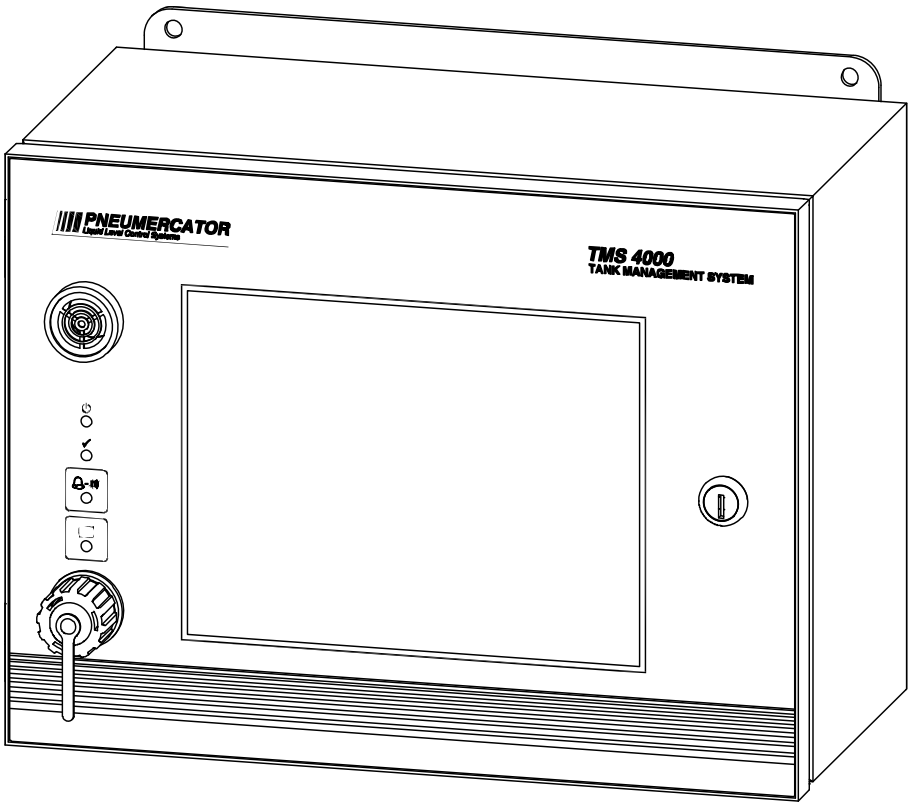
Liquid Level Control Systems
1785 Expressway Drive North, Hauppauge NY 11788
(631) 293-8450 Fax (631) 293-8533

PNEUMERCATOR
Liquid Level Control Systems

MULTI TANK
MONITORING
SYSTEM

INSTALLATION MANUAL



DRAWING NO. 20208 REV. A

MODEL TMS4000

1785 EXPRESSWAY DRIVE NORTH
HAUPPAUGE, NY 11788

TEL: (631) 293-8450
FAX: (631) 293-8533
http://www.pneumercator.com

Note: A separate OPERATING MANUAL is available, but NOT required for TMS4000 installation.

TABLE OF CONTENTS

⚠ IMPORTANT SAFETY INFORMATION

This manual contains instructions for installing electrical hardware in explosion hazard areas.
The following warnings must be considered to be in compliance with accepted codes.
Any inquiries about this manual, or to return defective equipment should be directed to:

PNEUMERCATOR COMPANY
1785 EXPRESSWAY DRIVE NORTH
HAUPPAUGE, NY 11788
Attention: Technical Services
TEL: (631) 293-8450
FAX: (631) 293-8533
TOLL FREE: (800) 209-7858
www.pneumercator.com

⚠ WARNING

Installation must be in strict accordance with this manual as adopted from the following codes:
- ISA RP12.6, "Installation of intrinsically Safe Instrument Systems in Class I Hazardous Locations."
- UL - Underwriters Laboratories
- NFPA 70, "National Electric Code."
- NFPA 30A, "Automotive and Marine Service Station Code."
FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

⚠ WARNING

Alteration, modification or replacement with non-factory components could impair the intrinsic safety of this equipment, void the warranty and void the UL Listing. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

SECTION 1 – PRODUCT DESCRIPTIONS

1.1 GENERAL SYSTEM OVERVIEW

The TMS4000 is a fully integrated tank monitor system that combines level measurement with precision in-tank leak detection and external sensors for secondary containment. Figure 1-1 shows a typical block diagram of how a system should be configured for installation. This diagram is not a detailed wiring diagram, which is found in Section 3 of this manual. Figure 1-1 is to guide the installer in planning the actual installation, and give a general overview of the possible combinations of TANKS, LEVEL PROBES, EXTERNAL SENSORS, and OPTIONAL equipment that may be required for a typical installation. Figure 1-1 shows only one (1) tank with three (3) sensors: however, TMS4000 can monitor up to 48 tanks and 48 sensor combinations. Refer to the specific design drawing for the customer's actual site for complete site-specific details on how many tanks and sensors are specified.

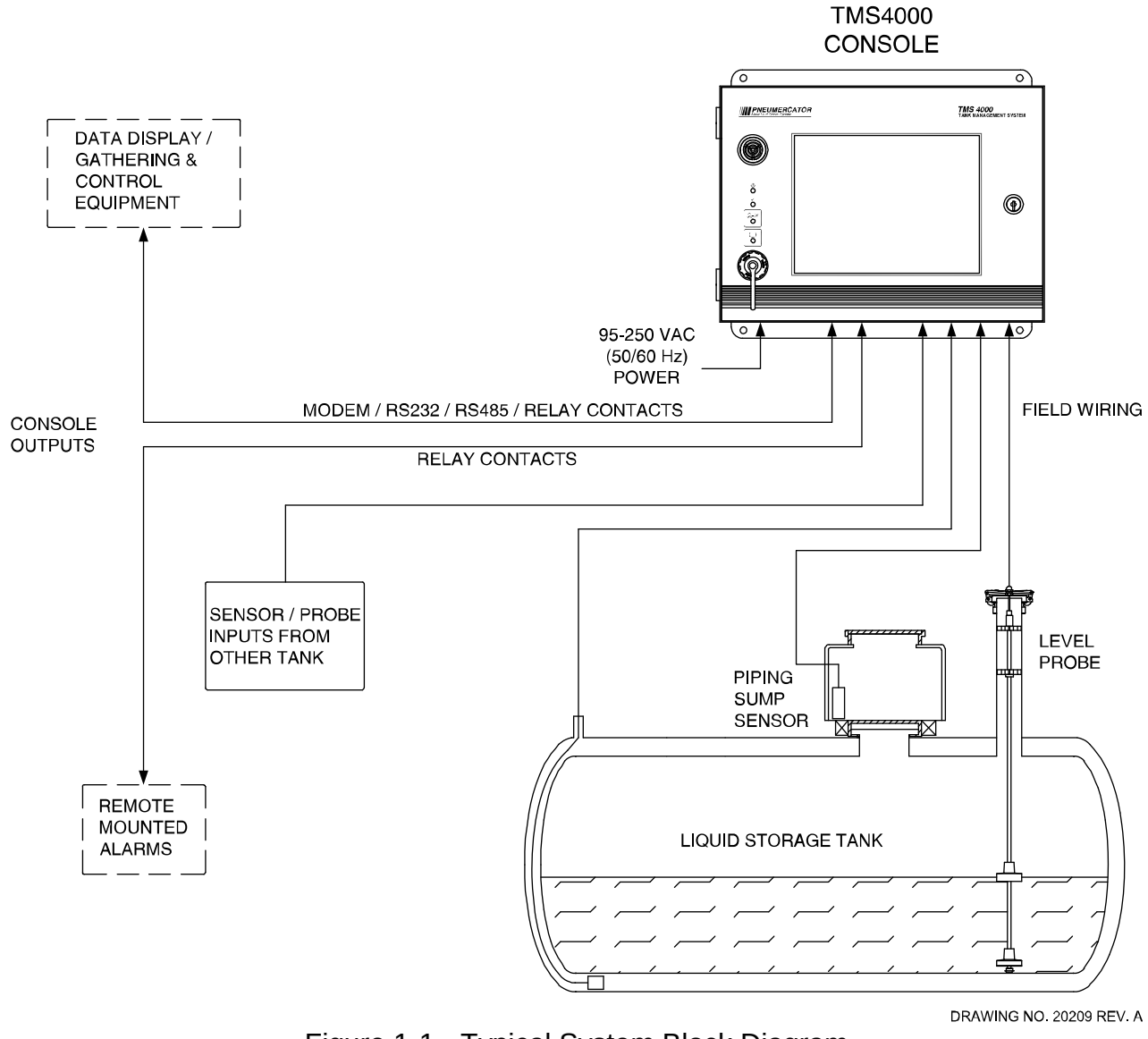


Figure 1-1 - Typical System Block Diagram

1.2 CONTROL CONSOLE DESCRIPTION

Figure 1-2 illustrates the standard TMS4000 outline and dimensions. All standard configurations are equipped with a 4 Mag. Probe/8 Leak Sensor Card, two (2) RS-232 Serial Port, RS-485 Serial Port, 10/100 Base-T Network Interface, and NEMA 12 enclosure. There are eight (8) basic configurations available:

Model Number	Display	Printer	External USB
TMS4000-1	No	No	No
TMS4000-2	Yes	No	No
TMS4000-3	Yes	Impact	No
TMS4000-5	Yes	Thermal	No
TMS4000-6	No	No	Yes
TMS4000-7	Yes	No	Yes
TMS4000-8	Yes	Impact	Yes
TMS4000-A	Yes	Thermal	Yes

⚠ WARNING

Installation MUST be done by qualified personnel familiar with local wiring codes and explosion hazard electrical safety practices. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

The standard TMS4000 console enclosure is NEMA 12-rated for indoor installation. An optional NEMA 4X enclosure is available for outdoor installation. Confirm enclosure rating on the approval label located on the exterior, left-hand side of the enclosure before installation outdoors. See Figure 1.2 below for mounting flange locations and dimensions.

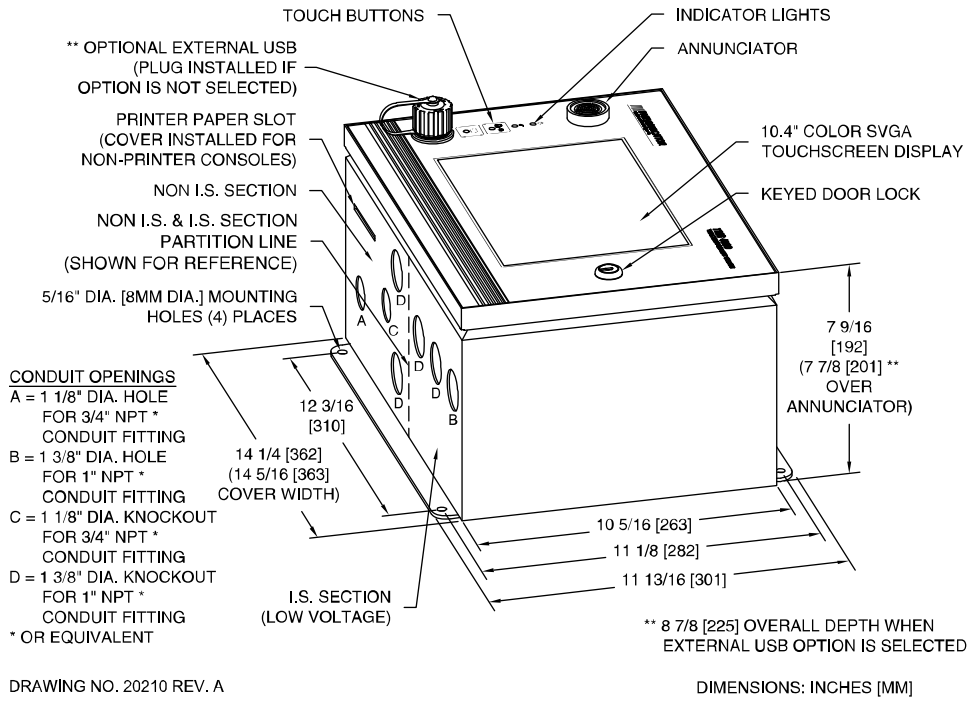


Figure 1-2 - TMS4000 Console Outline

⚠ WARNING

The console is designed for Ordinary Location, Non-Hazardous installation only, as defined by Underwriters Laboratories (UL) and the National Electrical Code (NEC). DO NOT install where flammable vapors may be present. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

The console should be located in an area that is easily accessible to the personnel responsible for operation and maintenance of the system. Metal conduiting is recommended and may be required by local codes. All outdoor conduits must be watertight.

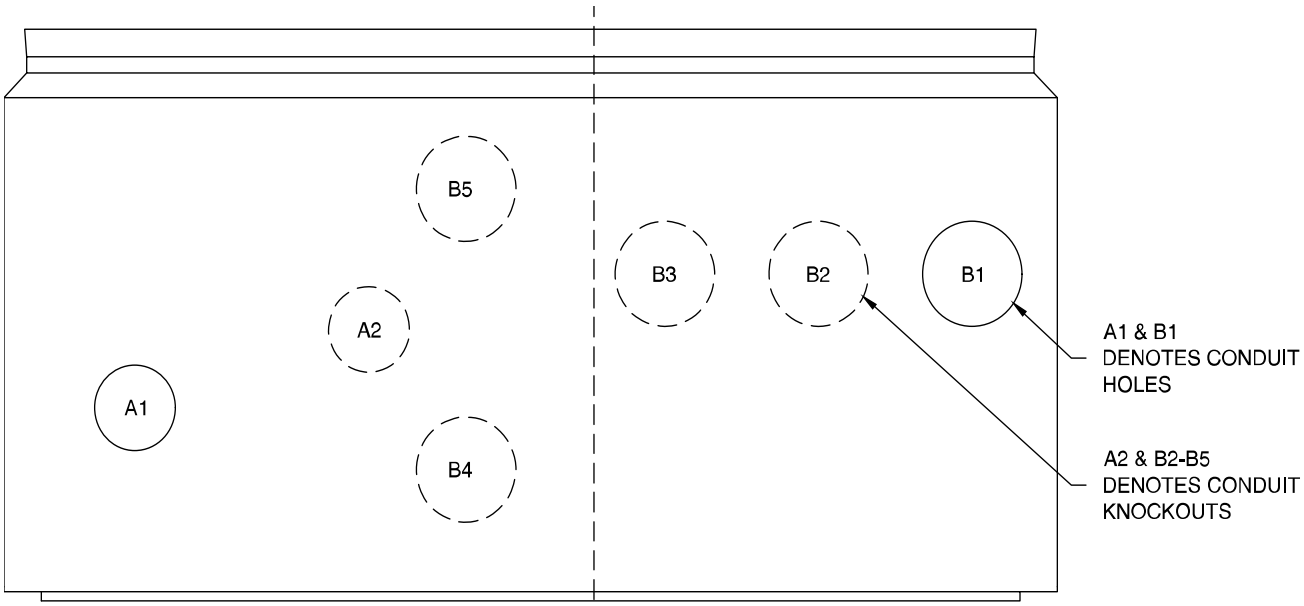
All conduit entries are provided on the bottom of the enclosure. Remove conduit knockouts only for those entries being used. If a knockout is removed but the entry will not be used, it must be sealed with an appropriate plug.

⚠ WARNING

Do not drill or modify enclosure. Use only knockouts provided. FAILURE TO COMPLY WILL VOID WARRANTY AND MAY PRESENT A SAFETY HAZARD RESULTING IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

⚠ WARNING

Conduit entries must only be used for their designated purpose in order to assure safe operation and to maintain safety certification. FAILURE TO COMPLY WILL VOID WARRANTY AND MAY PRESENT A SAFETY HAZARD RESULTING IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.



NON-INTRINSICALLY SAFE CONDUIT OPENINGS AND DESIGNATED USES:

3/4" NPT CONDUIT SIZE *
A1 = POWER AND I.S. GROUNDS
A2 = COMMUNICATIONS CABLES

1" NPT CONDUIT SIZE *
B4 = NON I.S. SLOT 1
B5 = NON I.S. SLOT 2

INTRINSICALLY SAFE CONDUIT OPENINGS AND DESIGNATED USES:

1" NPT CONDUIT SIZE *
B1 = I.S. SLOT 1
B2 = I.S. SLOT 2
B3 = I.S. SLOT 3

* OR EQUIVALENT

DRAWING NO. 20211 REV. N/C

Figure 1-3 - TMS4000 Designated Conduit Locations

1.3 LIQUID LEVEL PROBE DESCRIPTION

TMS4000 can be supplied with four (4) types magnetostrictive level probes:

Model MP450S – Inventory management and EPA-compliant in-tank leak detection on Single-wall USTs.
Model MP451S – Inventory management on tanks 18' – 24'
Model MP452S – Oil/Water separator tanks 1' – 18'
Model MP46xS Series – Flex probe for low ceiling clearance or bulk storage tanks up to 70'

The following installation instructions cover the MP45xS Series. The MP461SC is covered in Bulletin 159 and the rest of the MP46xS Series is covered in Bulletin 219.

Figure 1-4 shows the standard MP450S probe with dimensions and specifications. Note the standard probe requires a 4-inch female NPT tank fitting, and is supplied with a 6-foot cable; it does not include the RISER CAP, which must be ordered separately. Before installing, verify the model number matches the tank size intended, and that any accessories are available on site.

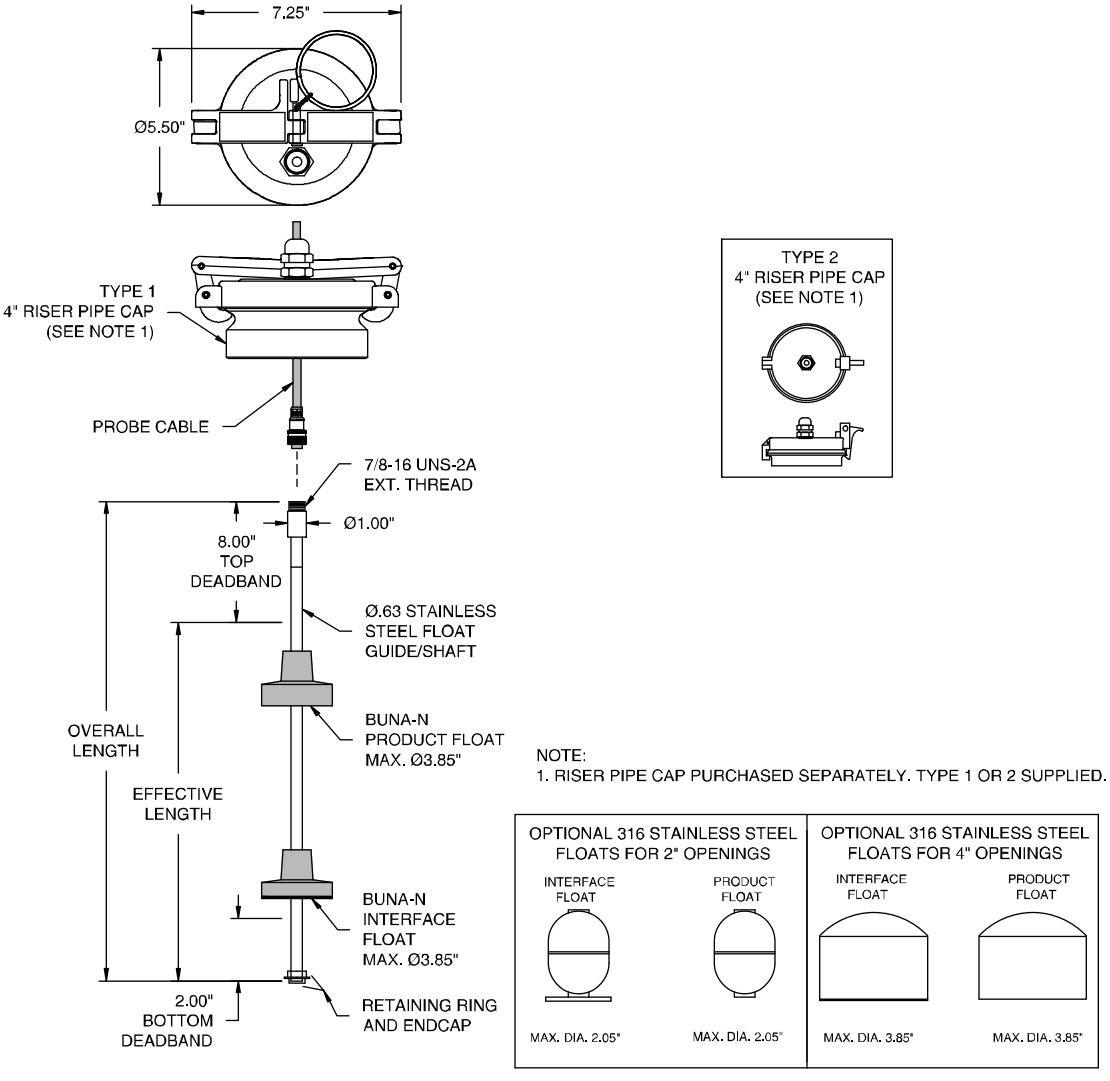


Figure 1-4 - Liquid Level Probe Outline

1.4 LIQUID LEAK SENSOR DESCRIPTION

TMS4000 can be integrated with a variety of liquid sensors used for monitoring secondary containment areas around tanks and pipes. The maximum is 40 sensors depending on the overall job configuration; check the specific job design drawings for the actual number and type specified. Figures 1-5 through 1-8 show four (4) typical sensor types provided by Pneumercator with their most typical applications. Other non-Pneumercator models may be used; however, their use with TMS4000 should have been approved before attempting to wire them into the system.

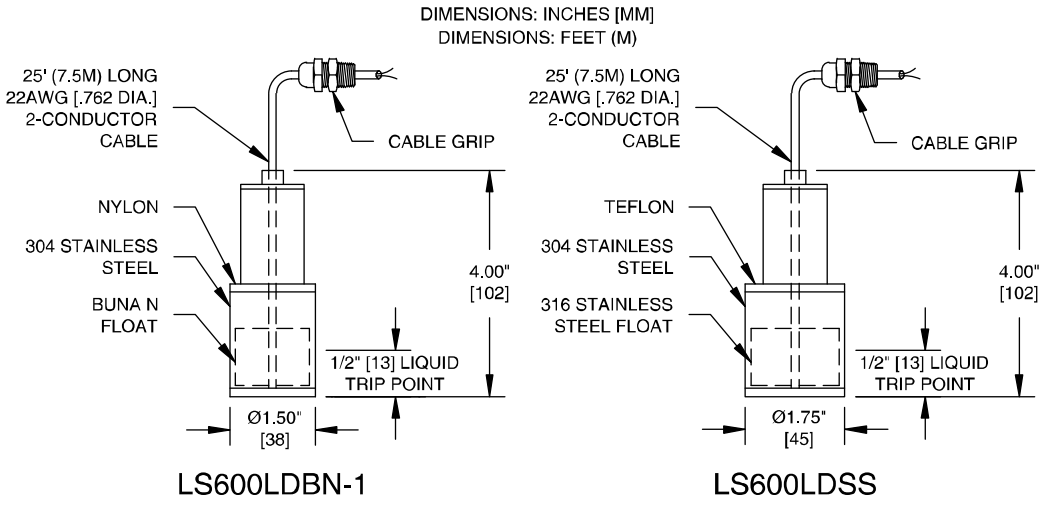


Figure 1-5 – LS600 LD Series

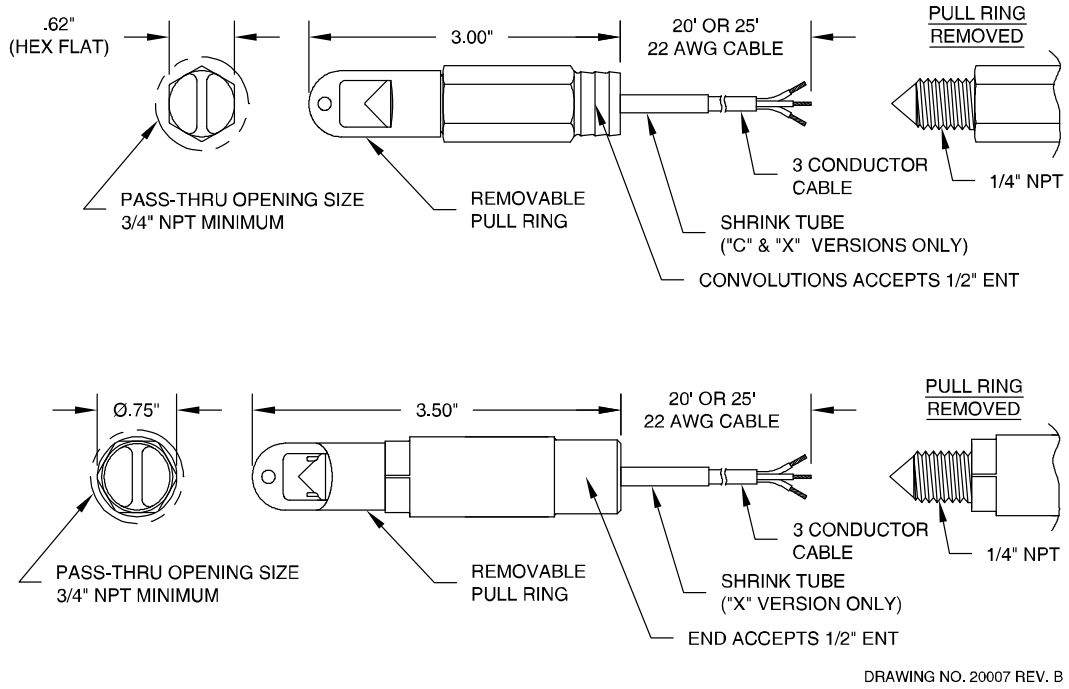


Figure 1-6 – ES825 Series

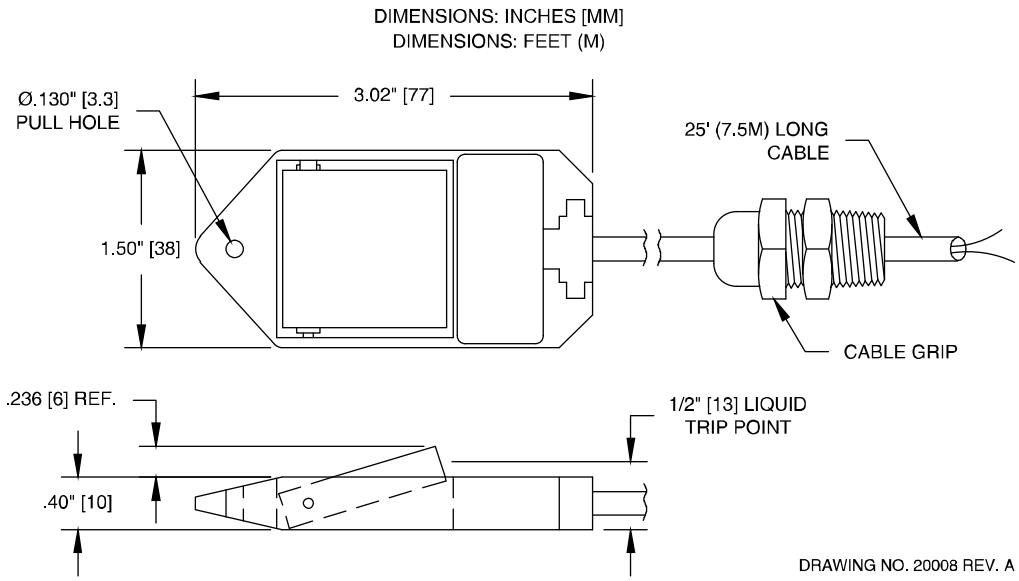


Figure 1-7 – LS610

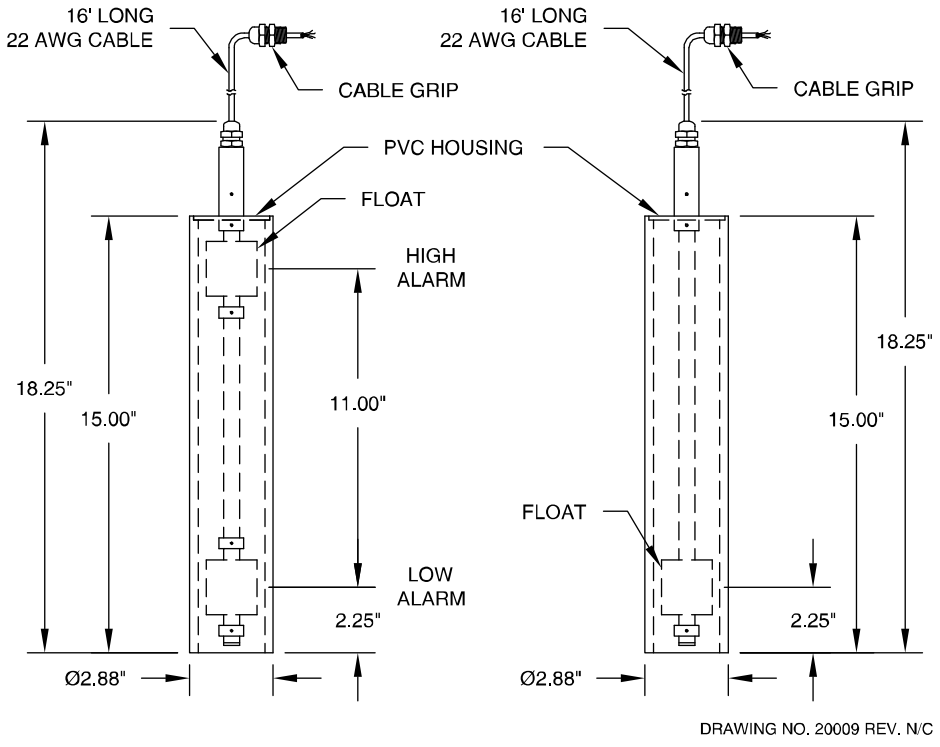


Figure 1-8 – RSU800

SECTION 2 – INSTALLATION DETAILS

2.1 INSTALLATION CHECKLIST

⚠ WARNING

Do NOT apply power to the TMS4000 until its installation has been checked and found to be in accordance with these instructions; National Electric Code; Federal, State and Local codes; and other applicable safety codes. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

The following points should be reviewed in preparation for installation, and again when installation is complete.

1. Review Figure 3-1 to ensure that all of the safety/wiring requirements have been met.

2. Check that all equipment at job site matches the DESIGN DRAWING SPECIFICATIONS for the tank sizes and control features required.

3. The console should be located as close as possible to the demarcation point of the hazardous area. **Never mount inside the hazardous area.**

4. POWER to the console should be properly wired to a DEDICATED 120/240 VAC CIRCUIT BREAKER. No other equipment can be powered from the same circuit breaker as the TMS.

5. System cannot be connected to equipment that uses or generates more than 250 volts with respect to earth.

6. All TMS grounds must be terminated at the GND BUSS BAR in the same service panel as TMS power. A grounding rod, coldwater pipe or other connection should not be used. Refer to Figure 3-3 for illustrated details.

7. The magnetostrictive probe inputs and the sensor inputs are two different intrinsically safe circuits and must be installed in separate cables or in one cable which has suitable insulation. Refer to NEC Article 504-30 (b) or CEC Appendix F6.3 for additional information.

8. **Do not drill or modify enclosure.** Use only knockouts provided. Failure to comply will void warranty and may present a safety hazard.

9. I.S. cabling should be selected from the Cable Selection Chart in Figure 3-2. Each probe or sensor wire/cable run SHOULD NOT EXCEED THE MAXIMUM DISTANCE RATING ON THE CABLE SELECTION CHART. Color-coding or numbering is highly recommended.

10. WATERPROOFING FIELD WIRE SPLICES using factory supplied splice kits is required for proper system operation.

2.2 CONTROL CONSOLE INSTALLATION

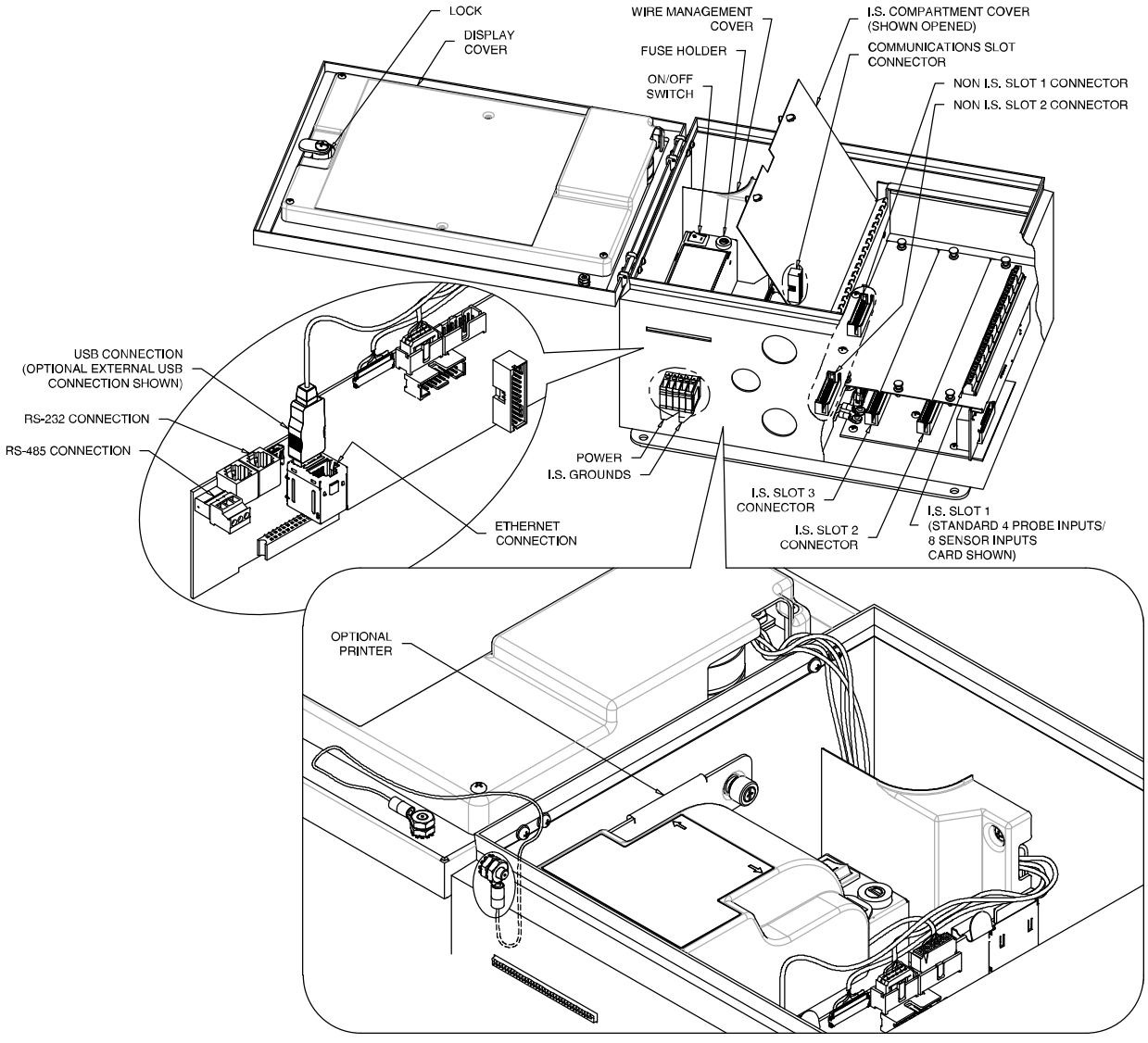
The console is the center of operations for any tank monitor system therefore its location should be selected for the operators' convenience, or as specified on the DESIGN DRAWINGS.

Select a flat wall surface and prepare it with four wall-mounting inserts to accept up to 1/4-inch size bolts. Allow sufficient room for door to open and for conduit runs to enter ONLY THE CONSOLE BOTTOM. See Figure 1-2 for console dimensions.

Note that the console is divided into two electrical areas:

NON INTRINSICALLY SAFE (LEFT SIDE) for Power and Control	INTRINSICALLY SAFE (RIGHT SIDE) for Probe/Sensor signals

Figure 2-1 shows the console interior, again indicating the power and signal separation. THIS SEPARATION MUST BE MAINTAINED when conduits are connected. Refer to Section 3 for electrical conduit and wiring.



DRAWING NO. 20212 REV. A

Figure 2-1 - Control Console Interior

2.3 LEVEL PROBE INSTALLATION IN UNDERGROUND TANKS

Installing the magnetostrictive level probe underground is similar for both STEEL and FIBERGLASS tanks. Refer to Figure 2-2. The tank top must be equipped with an access MANHOLE containing a probe RISER PIPE and WATERTIGHT ELECTRICAL JUNCTION BOX supplied by the installer; the junction box should be sized to handle ONLY PROBE AND MANHOLE LEAK SENSOR cable splices for wiring to the console. The manhole should be at least 18 inches in diameter and a height suitable for the tank burial depth. The riser should be 4-inch pipe opening (2 and 3-inch for optionally available probes). The tank opening must be fitted with a schedule 40 RISER PIPE cut to length to provide the minimum height of 18 inches shown measured from the TANK TOP (ID) to the probe's RISER CAP. The level probe's electronic housing will reside "inside" the riser. The riser top should be NPT male threaded and allow a clearance of at least 6 inches to the underside of the manhole cover. This will provide enough space for the riser cap and probe cable. For riser caps not supplied by Pneumercator, the cap must have a 1/2-inch NPT tapped hole for probe cable passage.

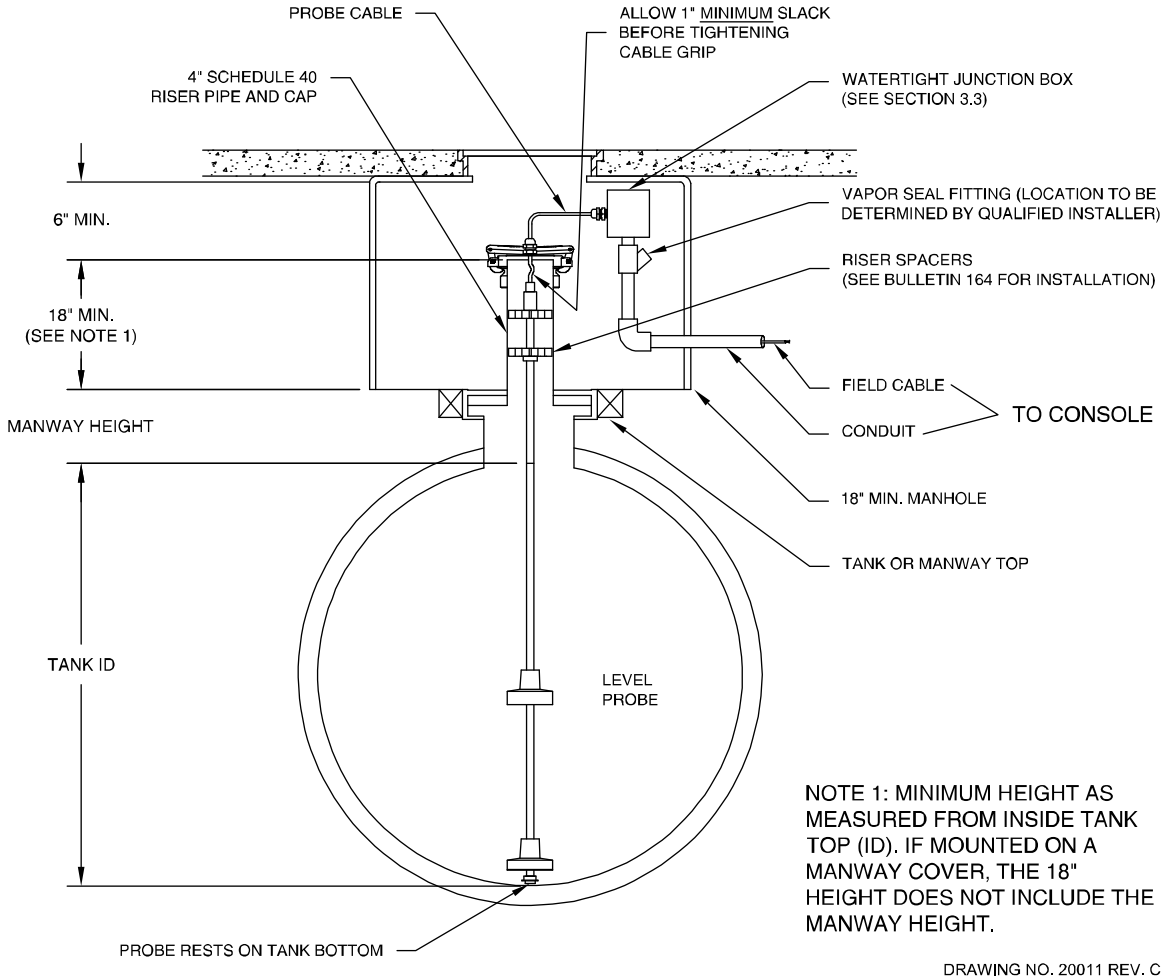


Figure 2-2 - Level Probe Installation - Underground Tank

ASSEMBLY INSTRUCTIONS - RISER MOUNTED MODEL:

MP42xS	
MP45xS	MP55xS

IMPORTANT! ALL of the following requirements must be met;

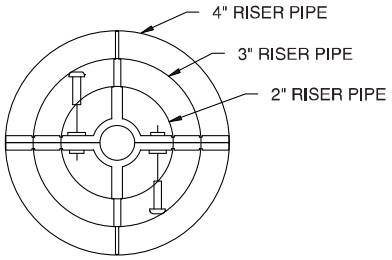
- Probe length does not exceed 15 feet.
- Tank does not contain chemicals, solvents or heated products where standard PVC leader cable is used.
- Tank does contain chemical, solvent or heated products where chemical/heat resistant probe assembly and leader cable are used and confirmed to be compatible with stored product.
- Tank is not pressurized.

Questions? Contact Technical Support at (800) 209-7858

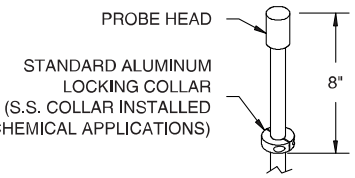
FOR INSTALLATION AND WIRING SEE TMS MANUAL

1 Confirm you were supplied the correct number of floats (1 or 2). A Probe P/N with "21" or "25" suffix requires DUAL (2) floats while "11" or "15" suffix requires a SINGLE (1) float. Contact Pneumercator immediately if supplied Probe and number of floats do not match.

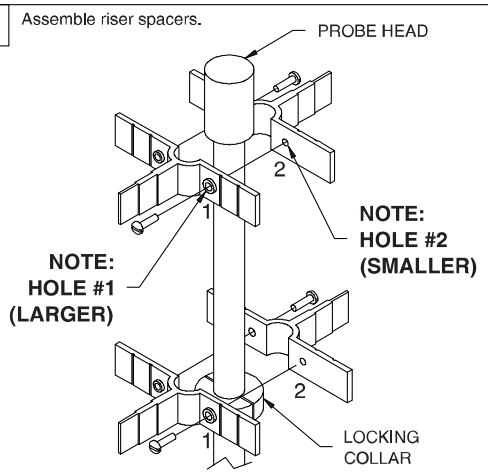
2 Trim spacers for the desired schedule 40 riser pipe diameter.



3 Verify that the bottom of the locking collar is located 8" from the top of the probe head and confirm that collar is secured.

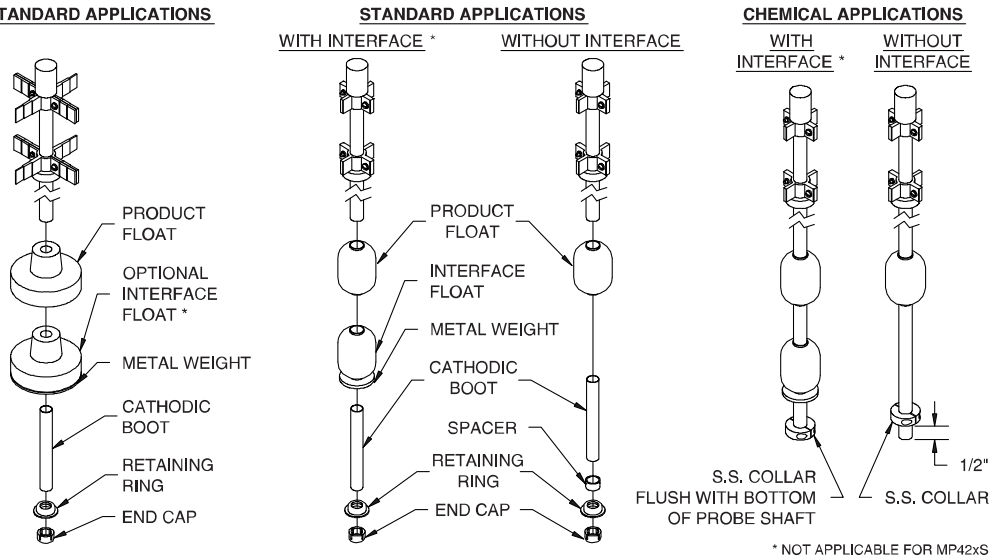


4 Assemble riser spacers.



NOTE: AT THIS POINT MODEL MP452S/MP552S ASSEMBLY IS COMPLETE. PROCEED TO STEP 5 TO COMPLETE ASSEMBLY FOR ALL OTHER MODELS.

5 **4" RISER MOUNTING ASSEMBLY** **2" RISER MOUNTING ASSEMBLY**



* NOT APPLICABLE FOR MP42xS

PNEUMERCATOR Liquid Level Control Systems

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Figure 2-3 - MP45xS Probe Assembly Instructions - Riser Mount

Install the level probe in the UNDERGROUND TANK as follows:

1. Select the correct probes for the tank. Match the model number with tank internal dimensions per Figure 1-4.

2. Assemble the probe per Bulletin 164 shown in Figure 2-3.

3. Slowly lower probe into tank opening until probe's FOOT REST is on the tank bottom. The probe should be vertical with both centering spacers totally supported within the riser pipe.

4. Feed the probe cable through the underside of the riser cap cord grip supplied. Keep the grip loose so cable can be flexed. Leave enough slack beneath the cap so the probe rests on the tank bottom, and above the cap to reach the electrical junction box in the manhole.

5. Prepare riser pipe and cap with pipe dope or suitable compound, and carefully mate them together.

6. Tighten the cable cord grip on top of the riser cap to ensure a WATERTIGHT SEAL.

7. Route the probe cable to the manhole junction box and complete the electrical installation in accordance with Section 3.

2.4 LEVEL PROBE INSTALLATION IN ABOVEGROUND TANKS

NOTE: For tanks located inside buildings or vaults, or under outdoor containment shelters:

Rigid Level Probes models MP450S, MP451S, & MP452S require tank headroom clearance at least equal to overall probe length for insertion and removal. See Figure 1-4 for probe dimensions.

There are two methods of installing the level probe in aboveground tanks shown in Figures 2-4 and 2-5. The choice is dictated by the actual fitting supplied integral to the probe.

The standard method shown in Figure 2-4 uses a RISER PIPE mounted on top of the tank to support the probe; similar to an underground tank installation. The optional method shown in Figure 2-5 employs a REDUCER FITTING to support the probe.

Risers and reducers are SUPPLIED BY THE INSTALLER.

2.4.1 RISER PIPE METHOD FOR ABOVE GROUND TANKS

Tank openings must be fitted with a schedule 40 RISER PIPE cut to length to provide the minimum height of 18 inches shown measured from the TANK TOP to the probe's RISER CAP. Both of the level probe's centering spacers will reside "inside" the riser.

The riser top should be NPT male threaded and allow a clearance of at least 6 inches to the underside of any roof cover that may be added after probe installation. This will provide enough space for the riser cap and probe cable. For riser caps not supplied by Pneumercator, the cap must have a 1/2-inch NPT tapped hole for probe cable passage.

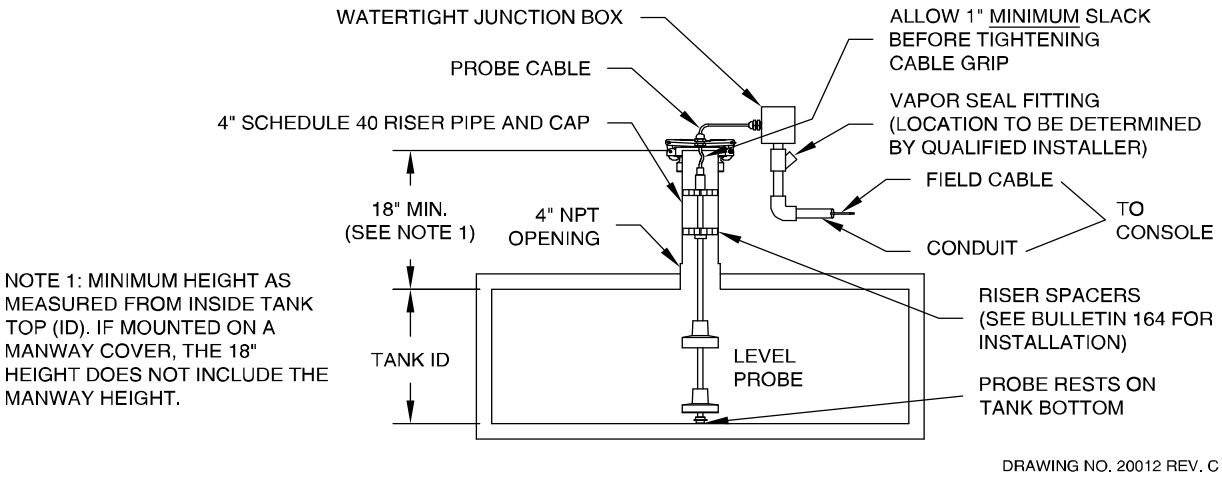


Figure 2-4 - Riser Pipe Mounting Aboveground Tanks

Install the level probe per Figure 2-4 as follows:

1. Select the correct probe for the tank. Match the model number with tank internal dimensions per Figure 1-4.

2. Assemble the probe per Bulletin 164 shown in Figure 2-3.

3. Slowly lower probe into tank opening until probe's FOOTREST is on the tank bottom. The probe should be vertical with both centering spacers totally supported within the riser pipe.

4. Feed probe cable through the underside of the riser cap cord grip supplied. Keep the grip loose so cable can be flexed. Leave enough slack beneath the cap so the probe rests on the tank bottom, and above the cap to reach the electrical junction box.

5. Prepare riser pipe and cap with pipe dope or suitable compound, and carefully mate them together.

6. Tighten the cable cord grip on top of the riser cap to ensure a WATERTIGHT SEAL.

7. Route the probe cable to the junction box and complete the wiring installation in accordance with Section 3.

2.4.2 BUSHING OR FLANGE MOUNT METHOD FOR ABOVE GROUND TANKS

This method is employed for large vertical tanks and heated, pressurized, or chemical applications but may also be used for standard 2, 3 and 4-inch openings when it is not desired to enclose the electronic housing within a pipe riser. The level probe will "hang" inside the tank at a fixed position supported by the tank-mounting fitting.

Because the probe is fixed to the mounting fitting, it is critical during installation to allow a 1-INCH BOTTOM CLEARANCE between the probe's FOOT REST and tank bottom or strike plate. This will prevent the probe touching the tank bottom during tank expansion and contraction. The 1-inch clearance dimension is standard and has been properly accounted for in the probe's manufacture.

The customer must supply an appropriate mounting fitting to mate with the tank opening, if less than 2 inches, to accommodate the PK2-DM Direct Mount Probe Kit. Assembly is as illustrated in Figure 2-6.

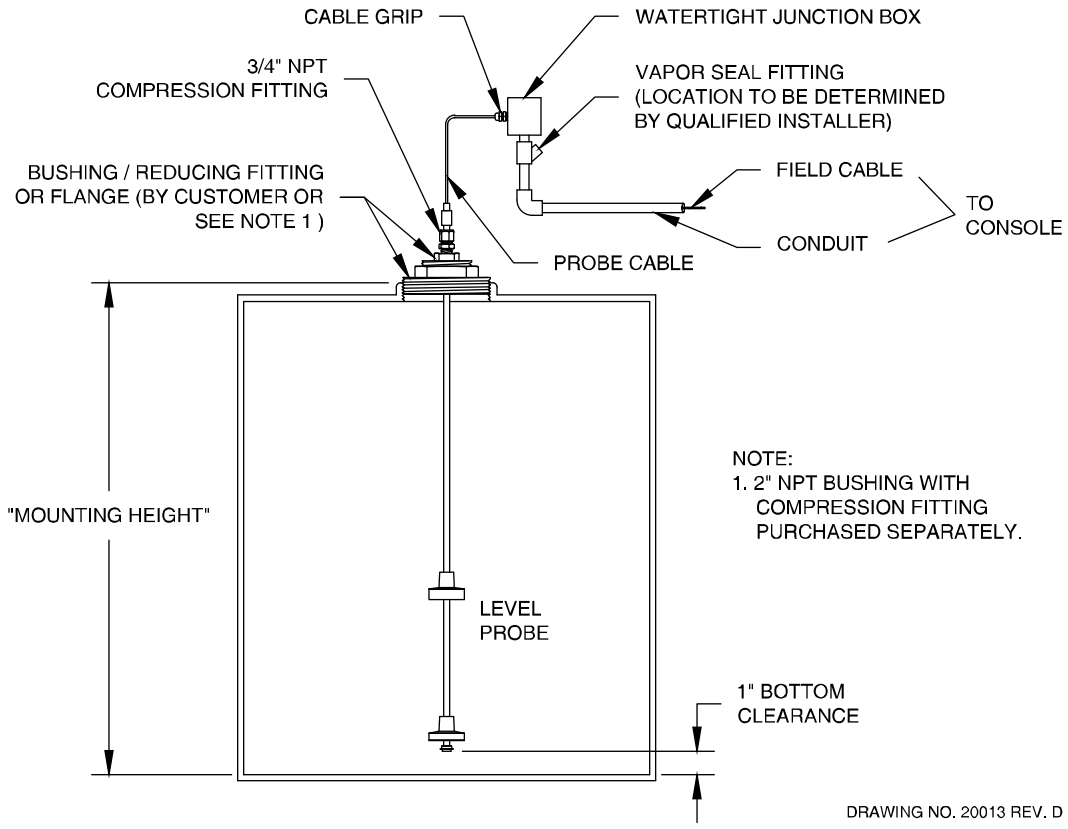


Figure 2-5 - Reducer Fitting or Flange Mounting for Aboveground Tanks

Install the level probe per Figure 2-5 as follows:

1. Select the correct probe for the tank. Match the model number with the tank internal dimensions per Figure 1-4.
2. Remove the probe from its shipping container. Remove all packing material.
3. Slowly lower the probe into tank opening. The probe should be vertical with its electronic housing totally visible above the tank fitting. When the probe touches the bottom, screw the bushing into the tank. DO NOT tighten the compression fitting at this time. Mark the shaft and lift the probe up 1 INCH.

ASSEMBLY INSTRUCTIONS - DIRECT MOUNTED MODEL:

MP42xS	
MP45xS	MP55xS

Applies to the following installations;

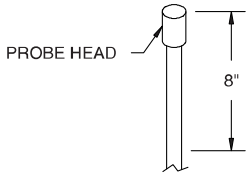
- Probe lengths exceeding 15 feet.
- Chemical, solvent or heated tanks using standard PVC leader cable.
- Pressurized tanks. Consult with Technical Support for pressure limits.

Questions? Contact Technical Support at (800) 209-7858

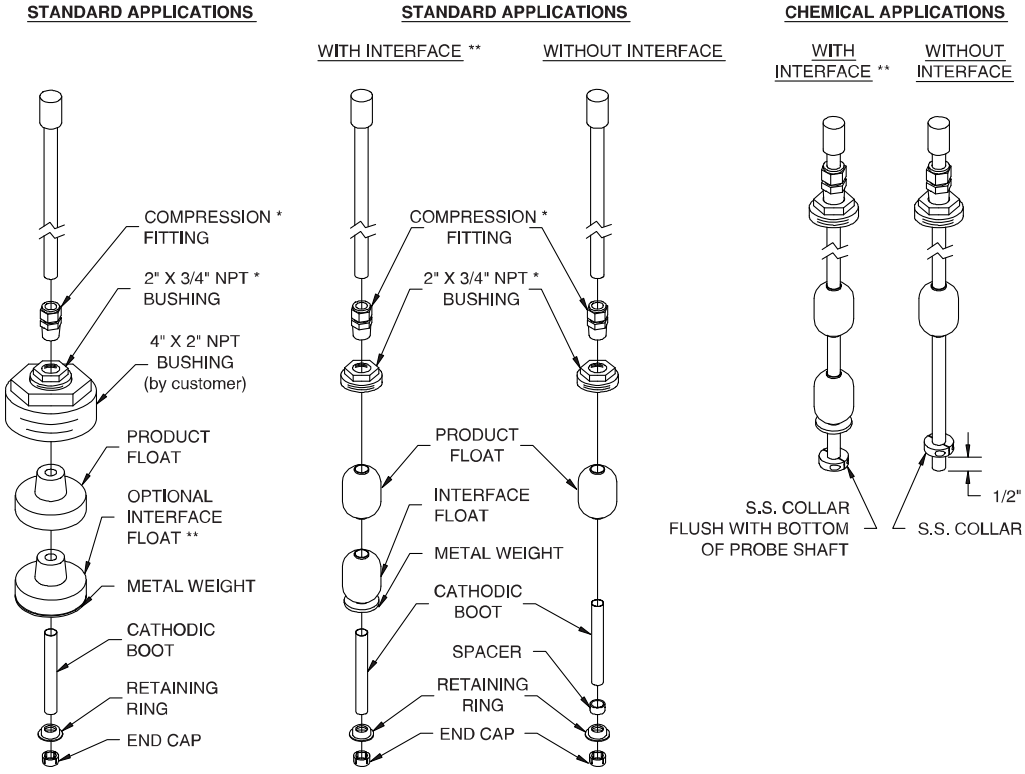
FOR INSTALLATION AND WIRING SEE TMS MANUAL

1 Confirm you were supplied the correct number of floats (1 or 2). A Probe P/N with "21" or "25" suffix requires DUAL (2) floats while "11" or "15" suffix requires a SINGLE (1) float. Contact Pneumercator immediately if supplied Probe and number of floats do not match.

2 The top of the probe is an ungageable deadband. Verify that the probe is of sufficient length so that the float's magnet will not travel into this deadband.



3 **4" DIRECT MOUNTING ASSEMBLY** **2" DIRECT MOUNTING ASSEMBLY**



* PURCHASED SEPARATELY FROM PNEUMERCATOR AS MODEL NO. PK2-DMx.
** NOT APPLICABLE FOR MP42xS

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Figure 2-6 - MP45xS Probe Assembly Instructions - Direct Mount

4. Tighten the cable connector on top of the probe housing to ensure a WATERTIGHT SEAL.

5. Route the probe cable to the junction box and complete the wiring installation in accordance with Section 3

EXTERNAL LEAK SENSOR INSTALLATION

The interstitial or double-wall space of steel tanks and vaulted tanks as well as many other secondary containment areas can be fitted with either DISCRIMINATING or NON-DISCRIMINATING leak sensors. Also, for float type non-discriminating sensors, switch actuation may be factory set for either NORMALLY OPEN or NORMALLY CLOSED.

2.5 LEAK SENSOR INSTALLATION IN STEEL AND VAULTED TANKS

Check the specific design drawings for the job, or choose the sensor type desired from Figures 1-5 and 1-6. Install sensor per Figure 2-7 as follows:

1. Remove the watertight CORD CONNECTOR supplied by sliding it off the sensor cable.

2. Thread the watertight CONNECTOR into the top of a 2" by 1/2" reducer bushing or monitor pipe cap pre-tapped for a 1/2" NPT hole. (The use of any standard monitor cap from 2" to 4" pipe size is recommended. The cap or reducer bushing IS NOT SUPPLIED with the sensor and must be provided by the installer).

3. Measure the "MOUNTING HEIGHT" from top to bottom of monitoring pipe.

4. Feed the sensor cable through the watertight CONNECTOR from the BOTTOM SIDE of the REDUCER (or CAP) fitting to a cable length suitable for the MOUNTING HEIGHT; or to allow sensor to rest on the monitor pipe bottom; or as required by local codes. Cable may be cut or extended to proper length.

5. Re-tighten the CORD CONNECTOR to fix the sensor cable length.

6. Mate the REDUCER or CAP to the top of the monitor pipe. Tighten the CONNECTOR to ensure a WATERTIGHT SEAL.

7. Route the sensor cable to the junction box and complete the wiring installation in accordance with Section 3.

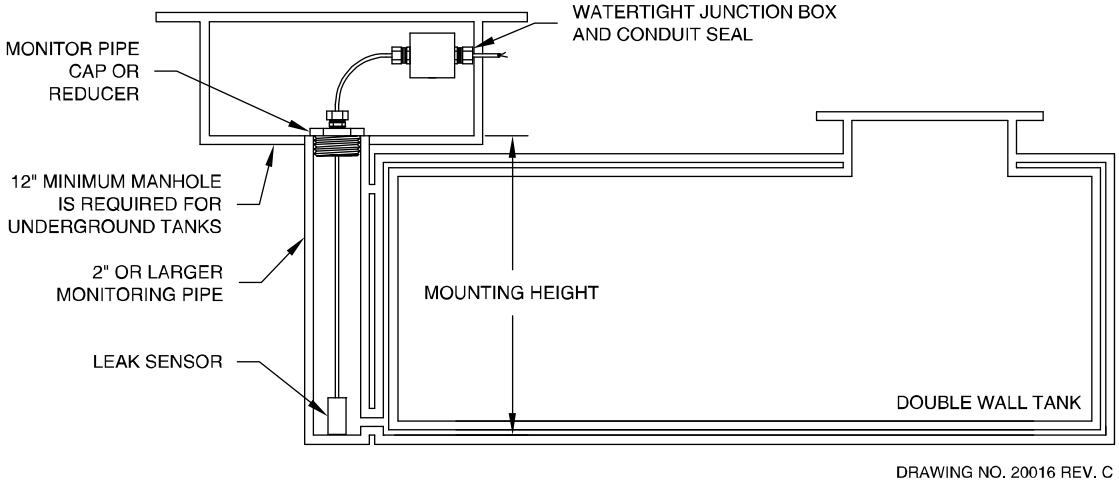


Figure 2-7 - Leak Sensor Installation - Steel Vaulted Tanks

2.6 LEAK SENSOR INSTALLATION IN PIPING SUMPS AND DISPENSER PANS

Check the specific design drawings for the job, or choose the sensor type desired from Figures 1-5 and 1-6. Install sensor per Figure 2-8 as follows:

1. Measure the "MOUNTING HEIGHT" from conduit or junction box to the bottom of the SUMP (or MANHOLE, VAULT or DISPENSER PAN).

2. Feed the sensor cable through the watertight CONNECTOR to length suitable for the MOUNTING HEIGHT; or to allow sensor to rest on the containment bottom; or as required by local codes. Feed an additional 12 inches past the CONNECTOR for splicing inside the junction box; cable may be cut to proper length.

3. Thread the CONNECTOR into the WATERTIGHT JUNCTION BOX and tighten the CONNECTOR cord grip over the cable to insure a WATERTIGHT SEAL. The sensor should rest on the containment floor or as required by local codes.

4. Complete the wiring installation in accordance with Section 3.

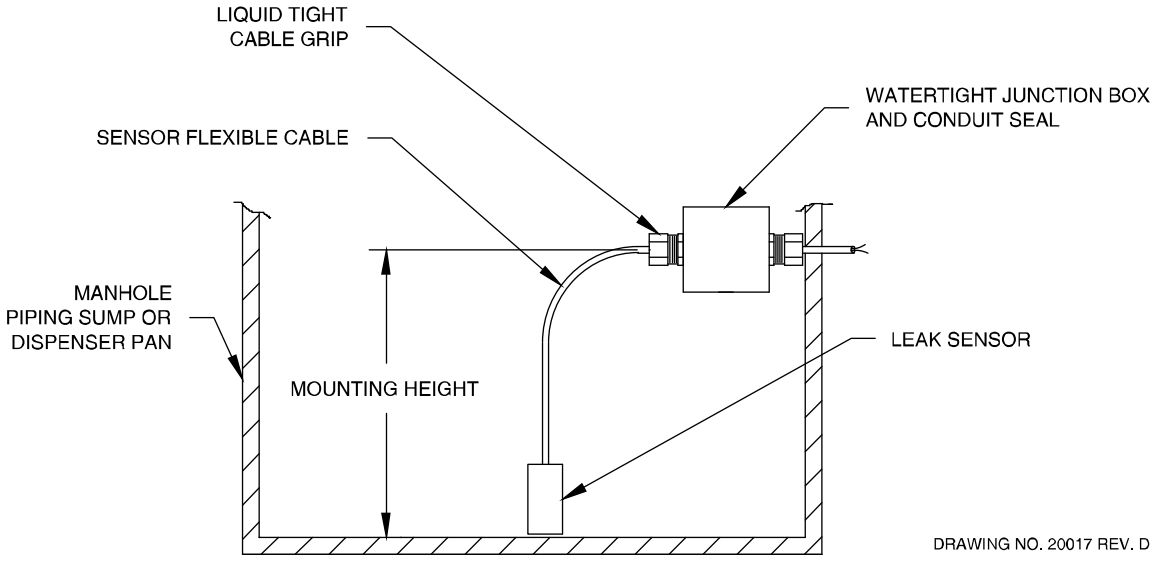


Figure 2-8 - Leak Sensor Installation in Piping Sumps, Manholes, and Dispenser Pans

2.7 LEAK SENSOR INSTALLATION IN FIBERGLASS TANK ANNULUS

The annular space of fiberglass tanks can be fitted with either a "DRY ANNULUS" type sensor, models ES825 (Figure 1-6) and LS610 (Figure 1-7), or a "WET RESERVOIR" sensor model RSU800 (Figure 1-8). The wet reservoir is also referred to as the HYDROSTATIC METHOD. Check the specific design drawings for the job, or choose the type sensor desired from Figures 1-6 through 1-8. Install sensor per Figures 2-9 or 2-10.

Instructions per Figure 2-9, DRY ANNULUS SENSOR:

1. Calculate the sensor cable's MOUNTING LENGTH from tank size data so the sensor rests at tank bottom; or use the following method.

   Determine the cable's MOUNTING LENGTH by adding the cable measurement M from the table at the right to the RISER HEIGHT. Mark the cable at that length. **DO NOT CUT THE CABLE.**

2. Remove the watertight CORD CONNECTOR supplied by sliding it off the cable.

3. Thread the CONNECTOR into the top of a 2" by 1/2" reducer bushing or riser pipe cap pre-tapped for a 1/2" NPT hole. (The use of any standard monitor cap from 2" to 4" pipe size is recommended. The cap or reducer bushing IS NOT SUPPLIED with the sensor and must be provided by the installer).

4. At riser top, attach the annular space PULL CORD (this is part of the tank supplier's pre-installed accessories) to the sensor's PULL HOLE.

CABLE MEASUREMENT FROM END OF SENSOR

Tank Dia.	Cable M
4 Feet	81 in.
6 Feet	118 in.
8 Feet	150 in.
10 Feet	194 in.
12 Feet	222 in.

5. Pull the free end of the PULL CORD out of the riser while feeding the sensor into the riser and through the annular space until the sensor is at the bottom centerline of the tank. The MOUNTING LENGTH MARK should be about 5 INCHES above the open riser. Adjust its position as necessary and, without disconnecting the PULL CORD, coil its excess inside the riser pipe.

6. Feed the sensor cable through the BOTTOM of the riser cap (or bushing), and through the CORD CONNECTOR while positioning cap over the riser pipe. Mate riser and cap.

7. Tighten CONNECTOR over the cable to ensure a WATERTIGHT SEAL.

8. Complete the wiring installation in accordance with Section 3.

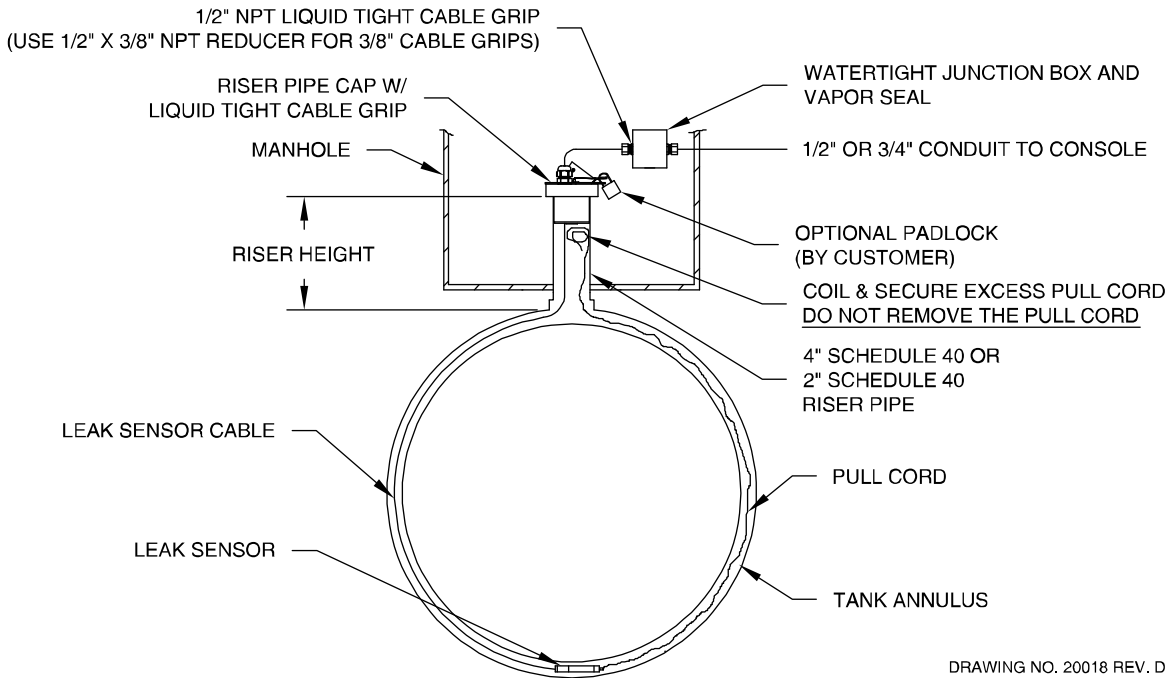


Figure 2-9 - Dry Leak Sensor Installation in Fiberglass Tanks

2.8 HYDROSTATIC LEAK SENSOR INSTALLATION IN FIBERGLASS TANK RESERVOIRS

The model RSU800 sensor uses a dual float that senses a HIGH and LOW liquid level within the reservoir. If a tank leak occurs through either wall of the DOUBLE-WALL tank the liquid level in the reservoir changes. When it reaches the upper or lower limits of the sensor a contact closure is transmitted to the control console.

Instructions per Figure 2-10, HYDROSTATIC LEAK SENSOR:

1. The tank reservoir should be fitted with a 4 inch RISER PIPE and CAP, supplied by THE INSTALLER. The riser should be at least 12 inches long as measured from the reservoir opening. The riser cap may be any standard type, but as a minimum it should have a 3/8" NPT tapped hole to accept the CORD GRIP CONNECTOR SUPPLIED BY PNEUMERCATOR, or contain its own suitable cord grip. (An alternate method is to drill and tap the wall of the riser pipe). The use of a riser cap with a VENT TUBE is only recommended where local installation requires one.

2. If the riser cap does not contain its own cord connector, thread the PNEUMERCATOR SUPPLIED CONNECTOR into the tapped hole using sealing compound as required. (Alternately, the CONNECTOR may be threaded into the sidewall of the riser).

3. Slowly lower the sensor into the riser until it rests on the reservoir bottom. The top portion should extend into the riser pipe for support from tipping over. The liquid level in the reservoir should be at about 7 inches up the sensor's height for optimum performance. (See Figure 1-8 for float travel set point limits).

4. Feed the sensor cable through the BOTTOM of the riser cap (or pipe wall), and through the CORD CONNECTOR. Leave just enough slack inside the riser pipe so the sensor remains on the bottom, and will not tip over.

5. Mate the riser and cap; tighten the CONNECTOR over the cable to ensure a WATERTIGHT SEAL.

6. Complete the wiring installation in accordance with Section 3.

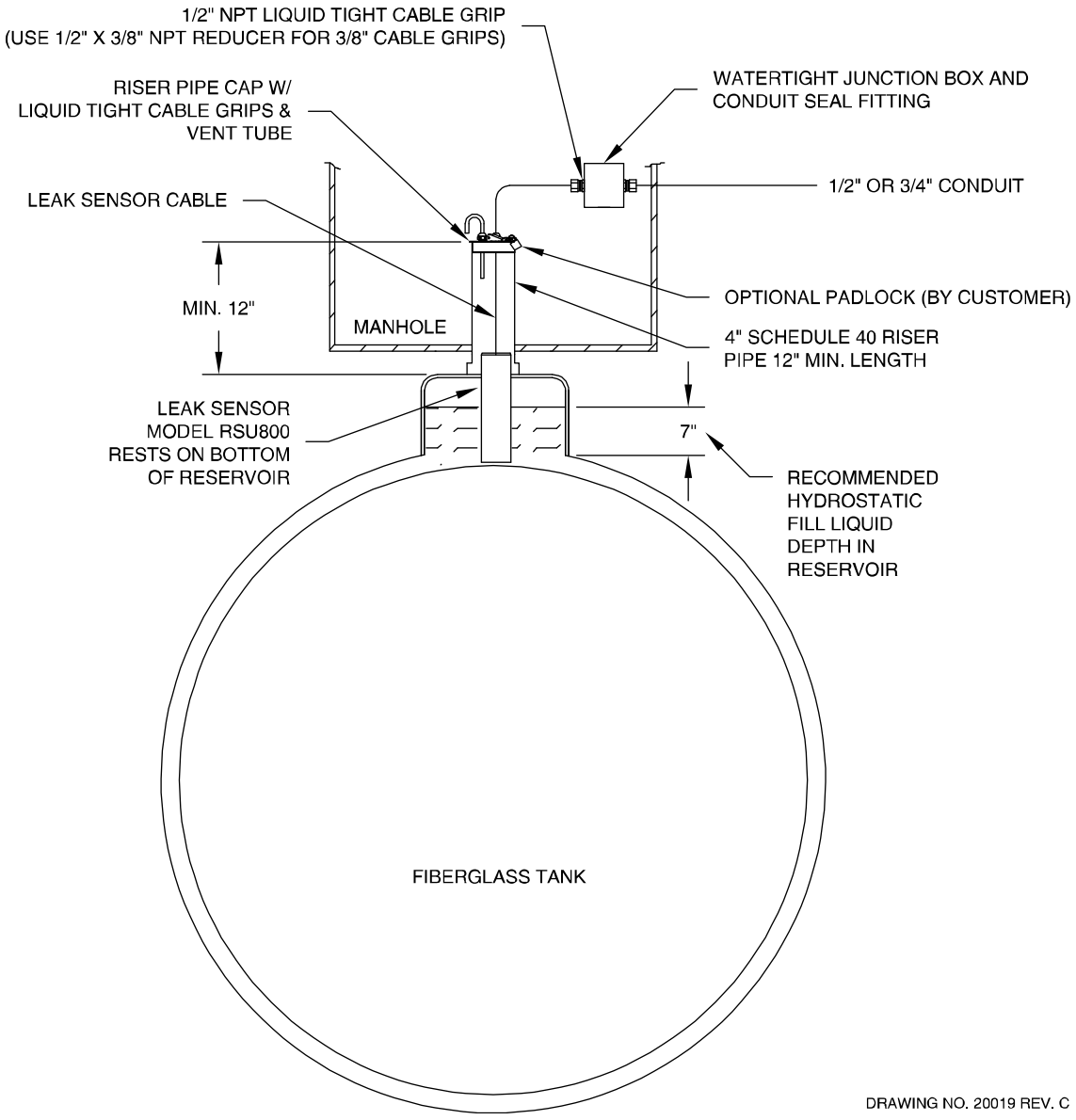


Figure 2-10 - Hydrostatic Leak Sensor Installation in Fiberglass Tanks

SECTION 3 WIRING INSTALLATION AND DIAGRAMS

⚠ CAUTION

Liquid level probes and leak sensors connected to the TMS4000 are usually installed in explosion hazard areas typical of hydrocarbon fuel tanks. For these applications, it is CRITICAL that electrical conduit and wiring be installed by qualified installers familiar with all provisions of the National Electrical Code relating to equipment intended for use in EXPLOSION HAZARD areas. The primary concern is to maintain physical separation between intrinsically safe and non-intrinsically safe wiring by running separate conduit attached to the control console at the designated knockouts. ALL conduits carrying probe and sensor wiring into the hazardous area MUST be fitted with standard vapor seal-off fittings at all field junction boxes and again where the conduit first enters the non-hazardous area. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

3.1 SYSTEM INTRINSIC SAFETY WIRING

Figure 3-1 is a typical System Wiring Diagram that must be followed when running conduit and wires between the HAZARDOUS TANK area and the NON-HAZARDOUS CONSOLE area. This follows UL and other codes for proper installation.

PROBE AND SENSOR WIRING INSTALLATION. Refer to Figures 1-3 through 1-8 for console conduit openings and specific probes/sensors that will be wired into the TMS4000 system. Install wiring as follows:

1. Install 1" rigid conduit from all probe and sensor areas to the TMS4000 console.

⚠ CAUTION

All probe and sensor wiring from the TMS4000 console may be run in the same conduit. NO OTHER WIRING MAY BE RUN IN THESE CONDUITS. NEVER RUN POWER WIRES IN THESE CONDUITS. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

2. At appropriate locations along the conduit runs (see Figures 2-2, 2-4, 2-5 through 2-10) install watertight couplings and approved VAPOR SEAL-OFF fittings.

3. At each probe/sensor location install a WATERTIGHT ELECTRICAL JUNCTION BOX. Allow enough room around the probe/sensor tank fitting for proper installation of the probe/sensor and all conduit/junction box fittings, and for later removal if necessary.

4. Attach the conduit at the TMS4000 console ONLY to the 1" conduit knockout located on the bottom RIGHT SIDE. Use NEMA 4 fittings for outdoor locations.

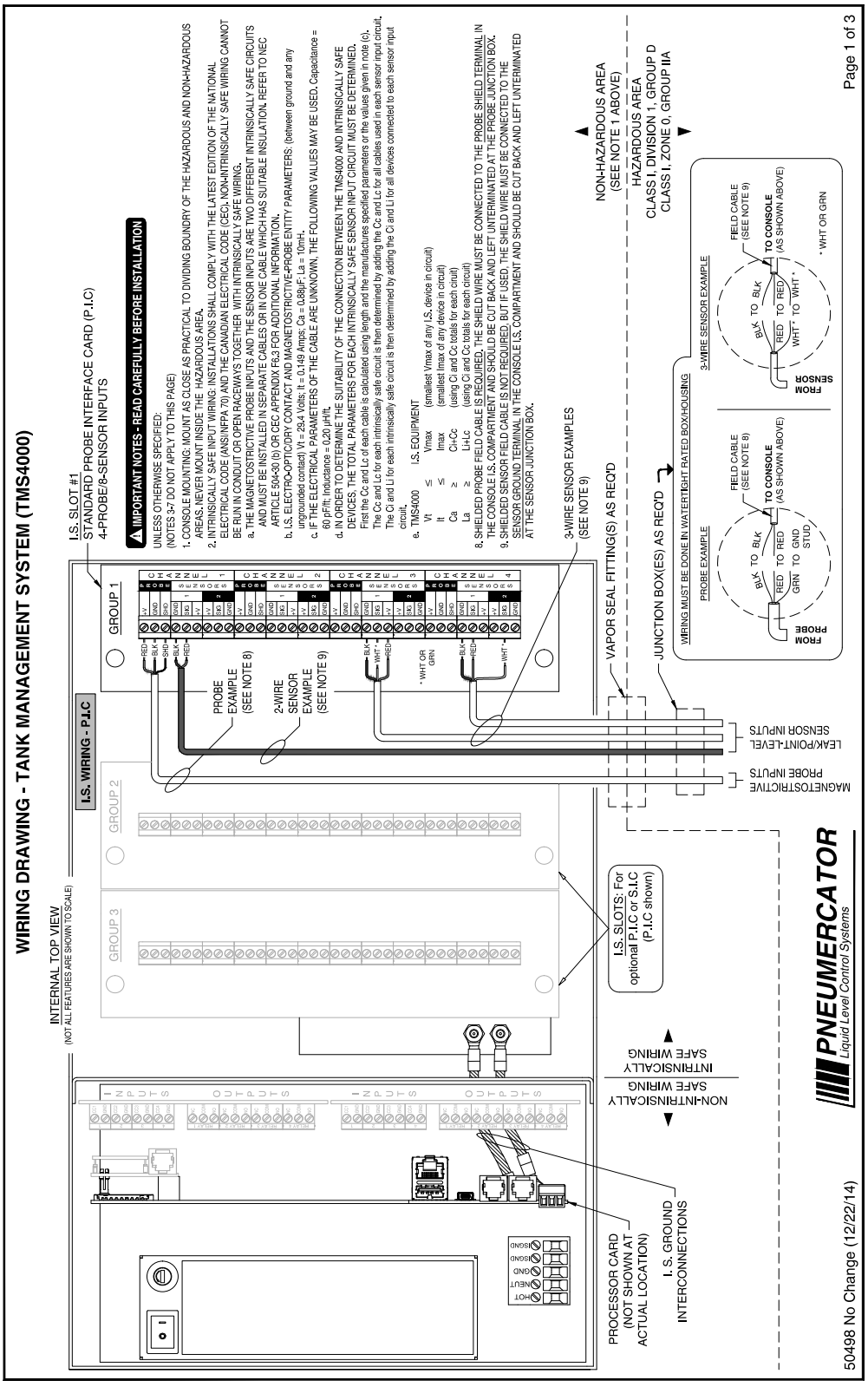


Figure 3-1a - Intrinsically Safe Wiring Diagram - 4 Probe/8 Sensor Card

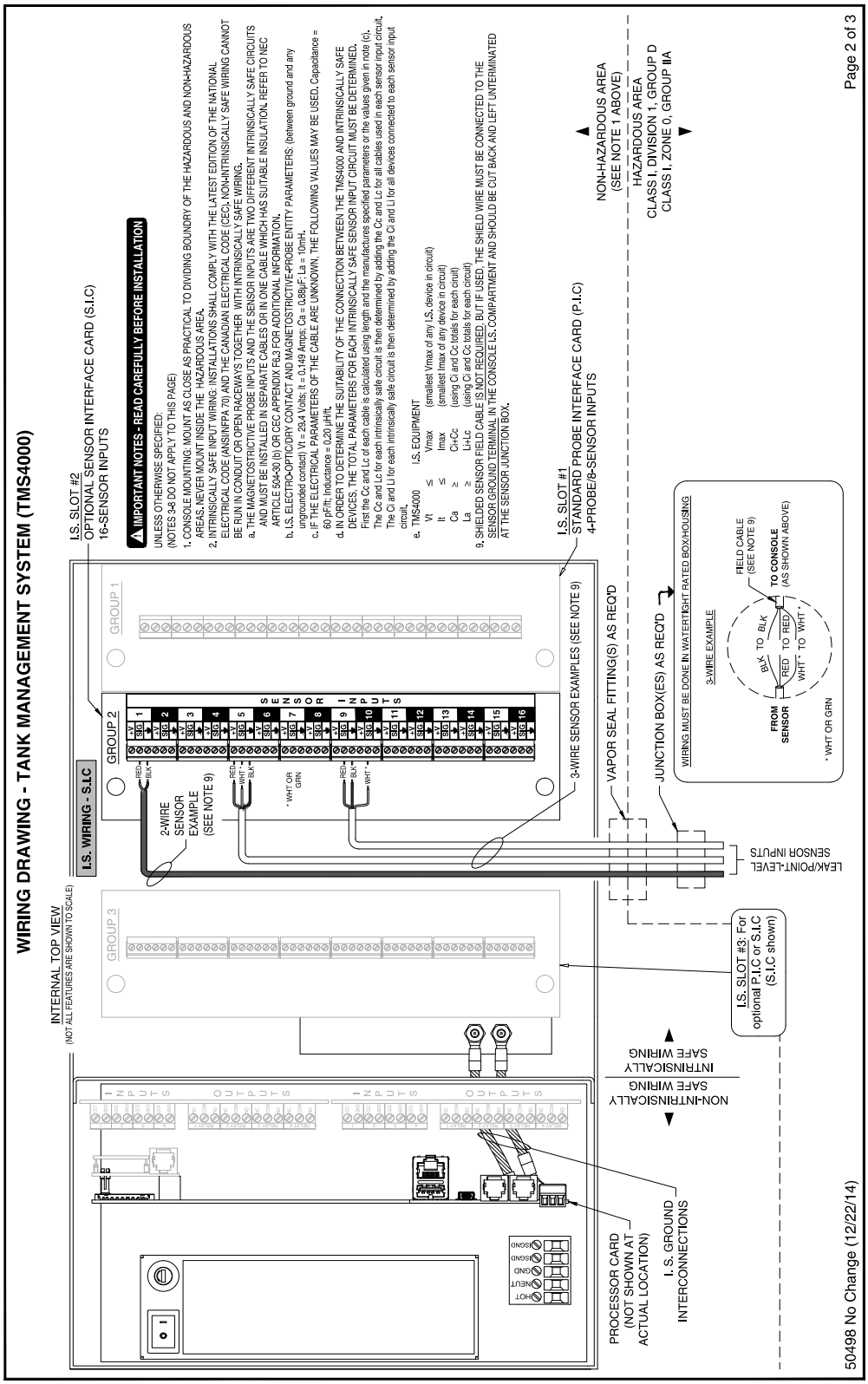


Figure 3-1b - Intrinsically Safe Wiring Diagram - 16 Sensor Card

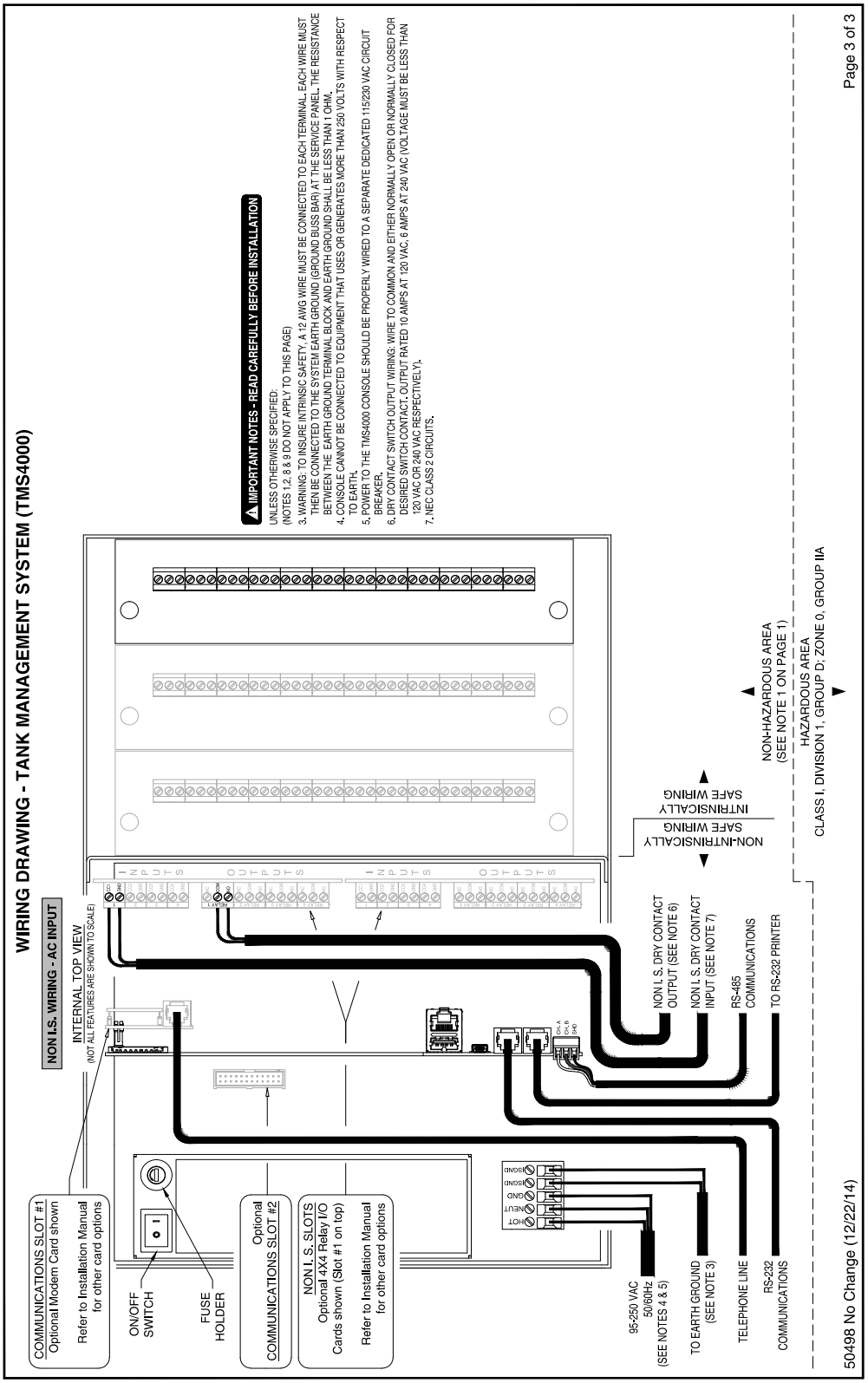


Figure 3-1c - Non-Hazardous Wiring Diagram

CABLE SELECTION GUIDE FOR INTRINSIC SAFETY

TYPE (SEE NOTE 2)	MANUFACTURERS BELDEN	MANUFACTURERS ALPHA	COLOR CODE	GROUP C TOTAL LENGTH FEET (SEE NOTE 3)	GROUP C CHANNEL MAXIMUM LENGTH FEET (SEE NOTE 4)	GROUP D TOTAL LENGTH FEET (SEE NOTE 3)	GROUP D CHANNEL MAXIMUM LENGTH FEET (SEE NOTE 4)
MAG.PROBE MP450, MP460 (PAT,7100 series)							
S	8441	-	BLK / RED	5300	3000	12000	3000
S	8761	2401C	BLK / CLR	9200	4600	16000	4600
S	82761	-	BLK / RED	9200	4600	16000	4600
S, B	83552	-	BLK / WHT	6000	3000	12000	3000
3-WIRE OPTO-SENSOR ES825 series, ES820-100 (ELS-1100)							
NS	8443	1173C	BLK / RED / GRN (BELDEN) BLK / RED / WHT (ALPHA)	2700	2700	11300	5500
S	9608	6327	BLK / RED / WHT	2600	2600	11000	5500
S	-	2403C	BLK / RED / WHT	3800	3800	16000	5500
S, B	83553	-	BLK / REDIWHT	2700	2700	11000	5500
4-WIRE OPTO SENSOR ES820-200 (ECS-1100)							
NS	8444	1174C	BLK / RED / WHT / GRN	2700	2700	11300	5500
S	9609	6328	BLK / RED / WHT / GRN	2600	2600	11000	5500
S	-	2404C	BLK / RED / WHT / GRN	4000	4000	16000	6500
S, B	83554	-	BLK / RED / WHT / GRN	2800	2800	11000	5500

NOTES:

1.) ALL CABLES SPECIFIED HAVE A NOMINAL PAIR INDUCTANCE OF 0.2uH / FT.

2.) TYPE SPECIFIERS
NS = NON-SHIELDED
S = SHIELDED
B = DIRECT BURIAL (IF ALLOWABLE PER LOCAL CODES)

3.) TOTAL LENGTH:

MAG. PROBES – TOTAL COMBINED CABLE LENGTH FOR ALL MAG. PROBES CONNECTED TO THE SAME INTERFACE CARD.
LEAK SENSORS – TOTAL COMBINED CABLE LENGTH FOR ALL LEAK SENSORS CONNECTED TO THE SAME INTERFACE CARD.

4.) CHANNEL MAXIMUM LENGTH: MAXIMUM CABLE LENGTH PER MAG. PROBE OR SENSOR.

5.) FOR OPTO-SENSORS, SHIELDED CABLE IS NOT REQUIRED, BUT IF USED IN THE APPLICATION, THE SHIELD MUST BE CONNECTED TO "SHD" TERMINAL IN CONSOLE I.S. COMPARTMENT.

Figure 12C-Wiring Chart.eps 07-05-05

Figure 3-2 - Intrinsically Safe Cable Selection Guide

5. Pull properly marked 2 to 4 conductor wiring (depending on probe/sensor configuration) for each probe/sensor through the conduit leaving at least 24 inches excess at both console and junction box ends for final connections. The field wires must be resistant to hydrocarbon liquids; type THHN or MTW, 22 AWG is recommended. Use Belden Cable part number 8441, or equivalent 2-conductor shielded cable, for the magnetostrictive probes only. This cable can be supplied by PNEUMERCATOR as part number CW1-0500.

6. Fill all conduit VAPOR SEAL-OFF FITTINGS with approved filling compound and tighten all conduit fittings.

7. Splice all probe/sensor wires to the respective conduit wires at each WATERTIGHT JUNCTION BOX. (See Figure 3-4 for a recommended procedure). Maintain correct color-coding and polarity between wires.

8. Connect probe/sensor wires to the TMS4000 INPUT TERMINALS following Figure 3-1. Maintain correct polarity between wires and respective terminal points.

9. Probes and sensors should be logically identified as to location and type and recorded on the probe map provided in this manual, SECTION 3.6.

⚠ CAUTION

Probe and sensor wires are to be connected ONLY to the designated input terminals of the INTRINSIC SAFETY compartment. Do NOT allow probe/sensor wires to cross over into the non-intrinsically safe section. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

3.2 POWER WIRING INSTALLATION.

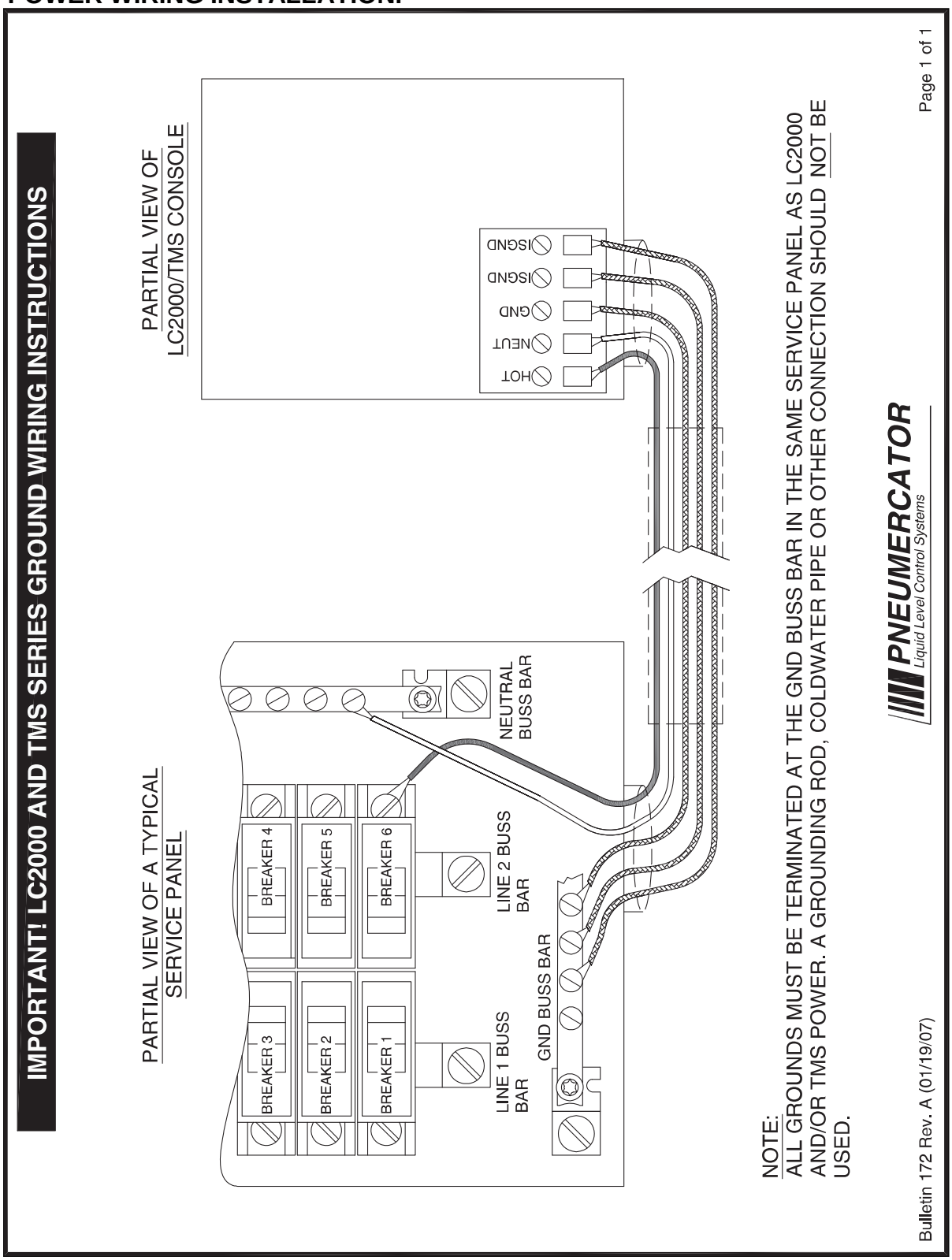


Figure 3-3 - TMS AC Power Wiring

3.3 PROBE/SENSOR WIRING & SPLICES.

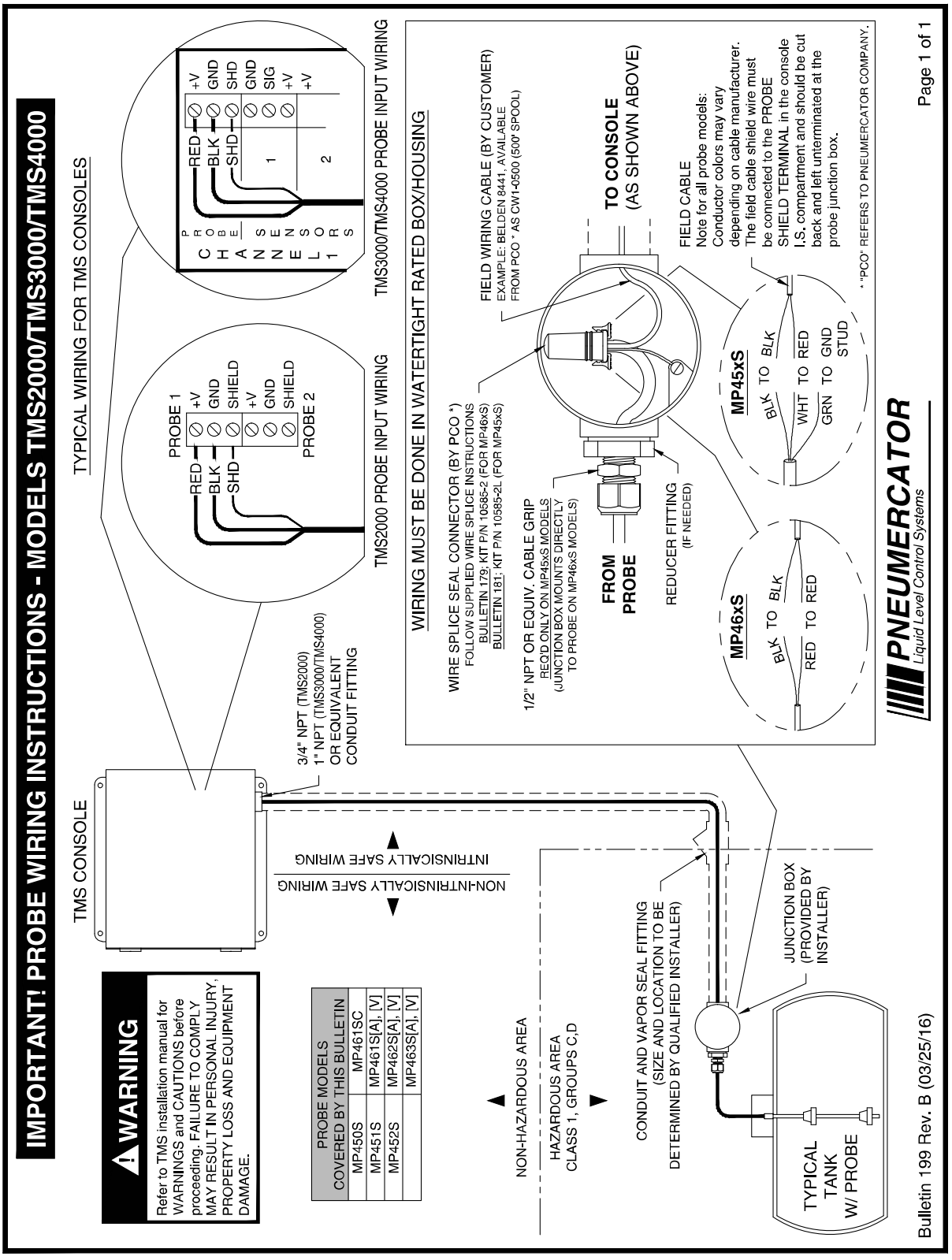


Figure 3-4 - MP45xS Cable Splice and Wiring

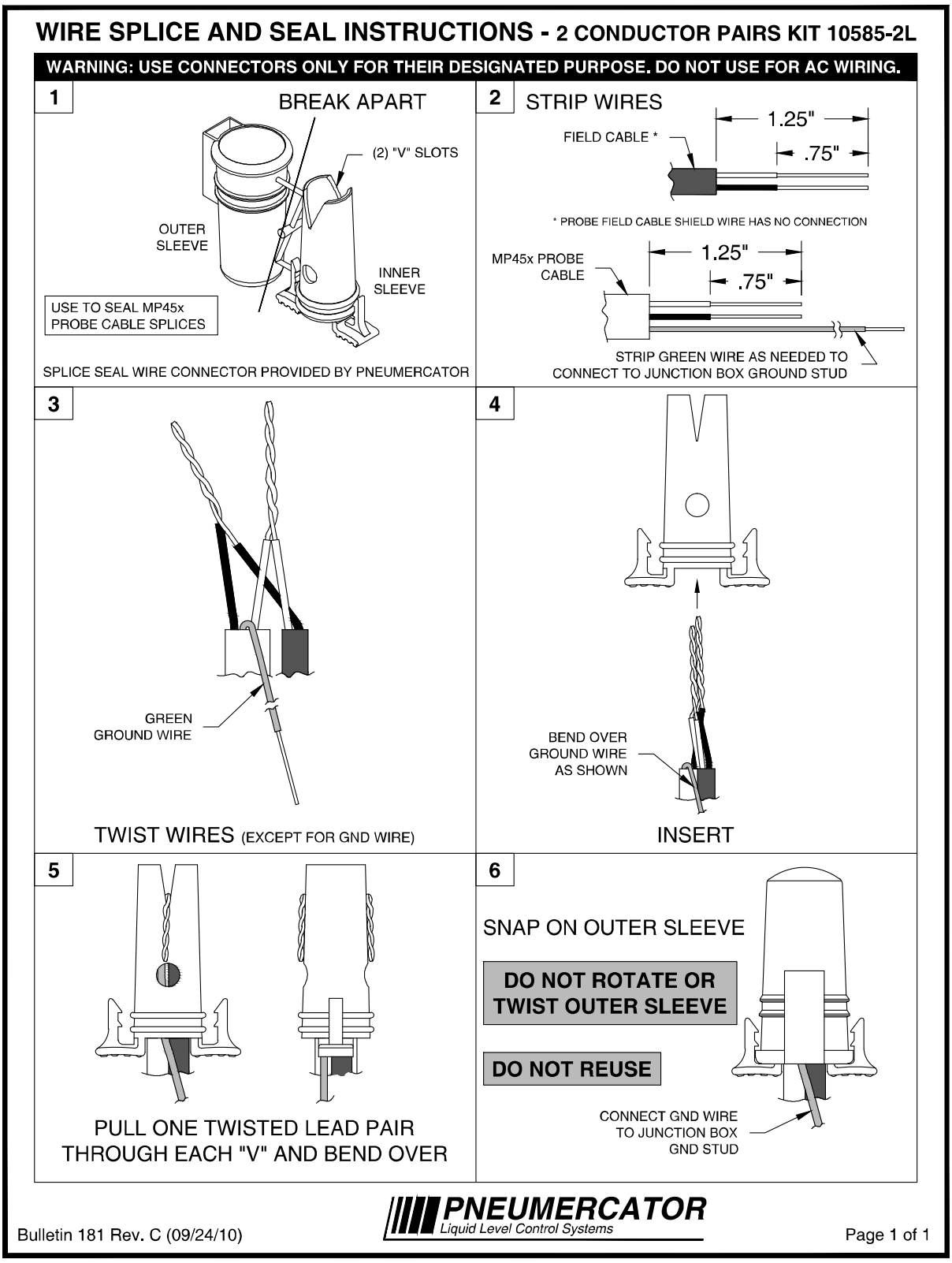
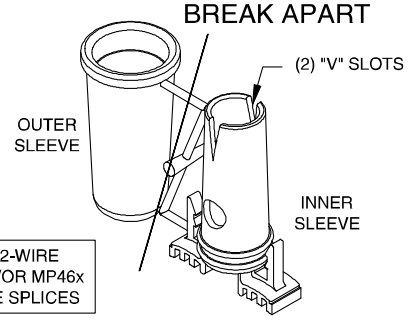


Figure 3-5 - MP45xS Splice Kit Instructions

WIRE SPLICE AND SEAL INSTRUCTIONS - 2 CONDUCTOR PAIRS KIT 10585-2

WARNING: USE CONNECTORS ONLY FOR THEIR DESIGNATED PURPOSE. DO NOT USE FOR AC WIRING.

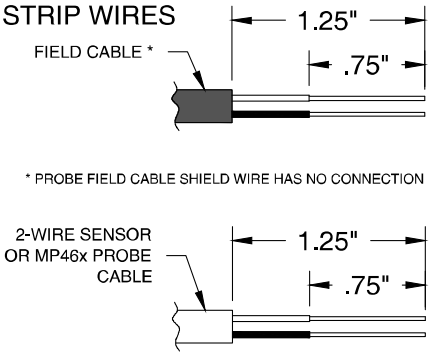
1



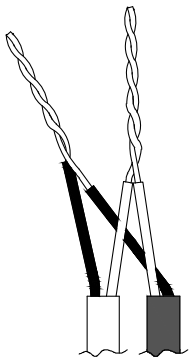
USE TO SEAL 2-WIRE SENSOR AND/OR MP46x PROBE CABLE SPLICES

SPLICE SEAL WIRE CONNECTOR PROVIDED BY PNEUMERCATOR

2 STRIP WIRES

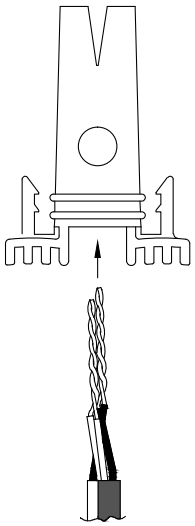


3



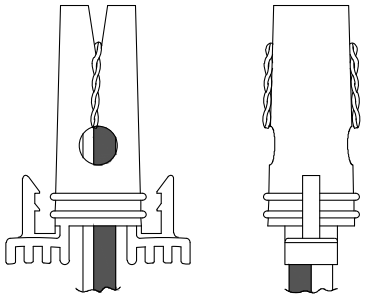
TWIST WIRES

4



INSERT

5

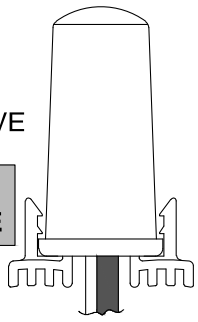


PULL ONE TWISTED LEAD PAIR THROUGH EACH "V" AND BEND OVER

6

SNAP ON OUTER SLEEVE

DO NOT ROTATE OR TWIST OUTER SLEEVE



DO NOT REUSE

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Figure 3-6 - MP46xS and 2-wire sensor Splice Kit Instructions

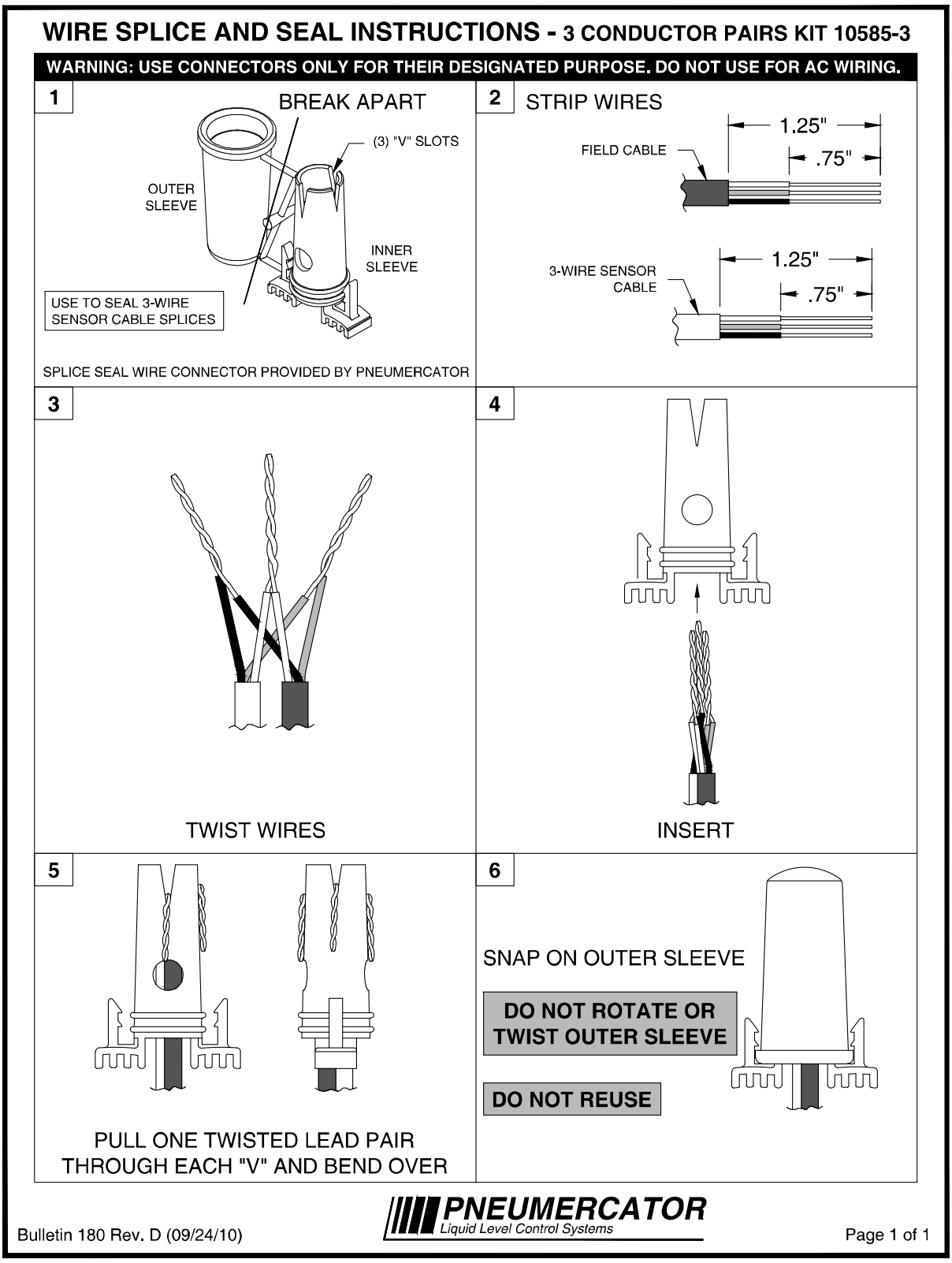

Figure 3-7 - 3-wire sensor Splice Kit Instructions

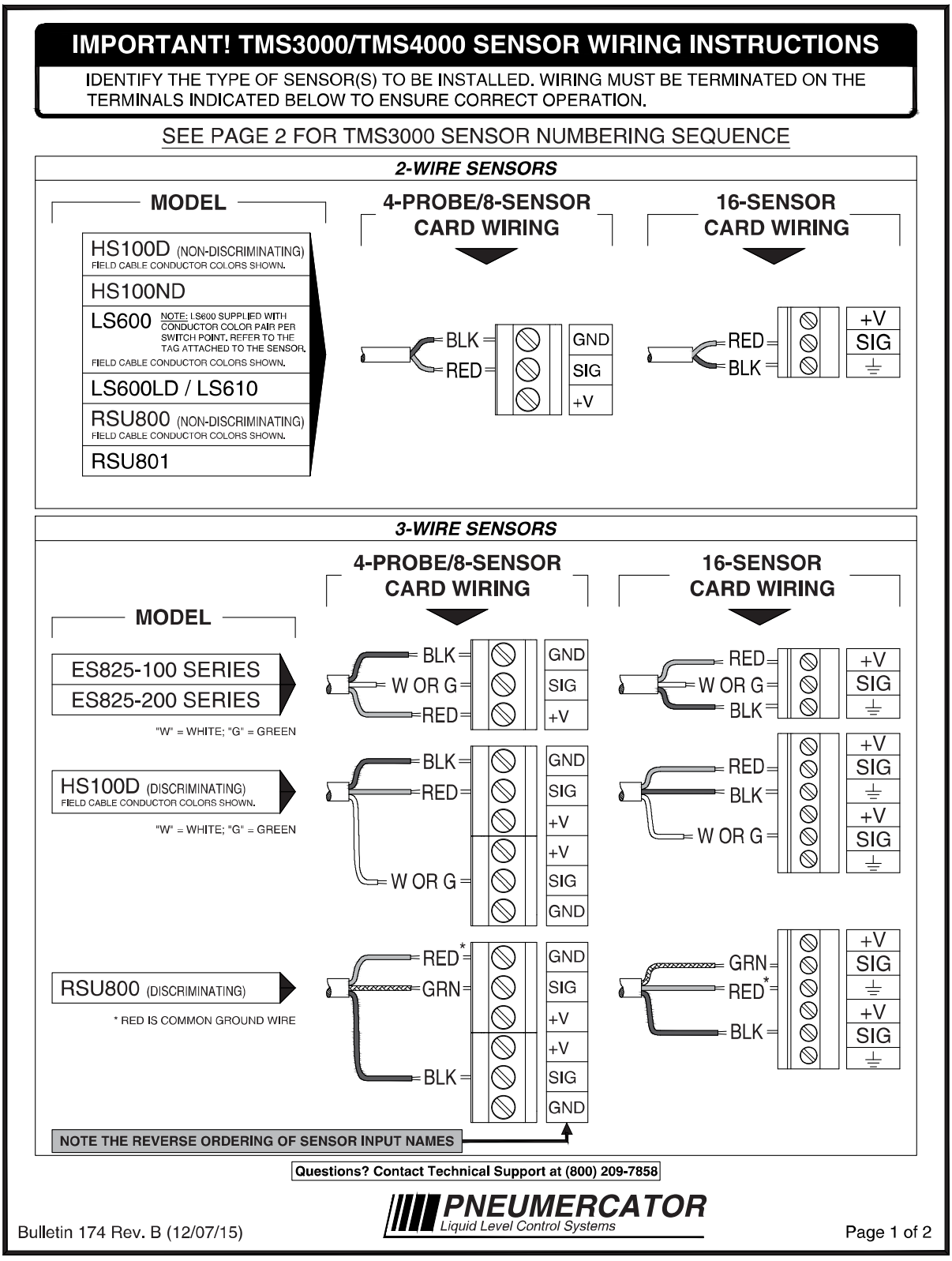

Figure 3-8a - TMS4000 sensor wiring

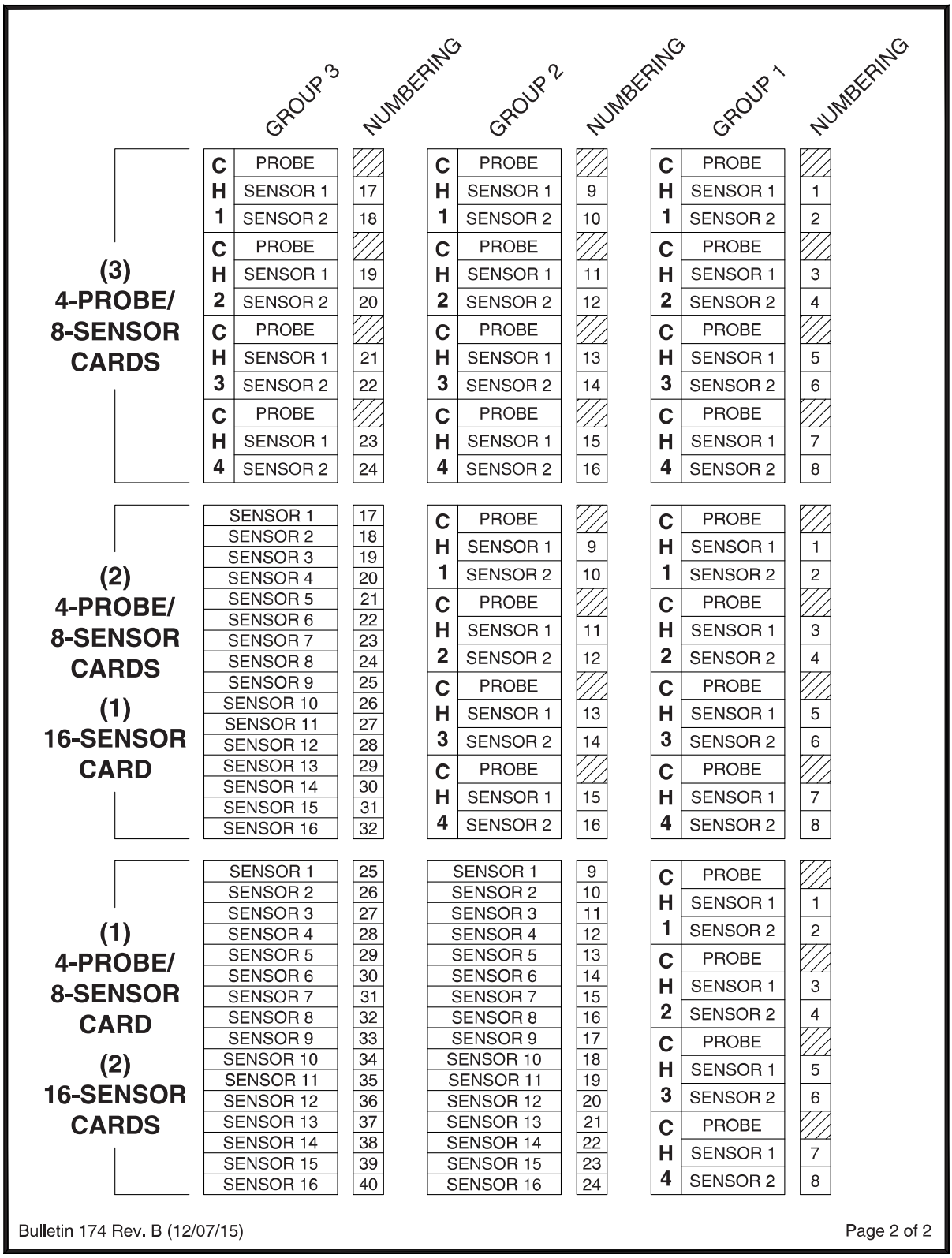

Figure 3-8b - TMS4000 sensor wiring

3.4 PROGRAMMABLE RELAY OUTPUTS/CONTACT CLOSURE INPUTS

The TMS4000 provides dry contact closure inputs and relay contact closure outputs that are user-programmable via the console front panel or most TMS communications interfaces. Each input is programmable for relay control and alarm functions as well as remote relay acknowledgement or gating functions. Inputs may also be programmed to monitor submersible pump or generator activity in conjunction with the TMS Series AUTO LEAK TEST mode. Each relay output is programmable to trigger on any combination of events, including in-tank leak, theft, product or water setpoints, leak or point level sensor alarm, contact closure input or system error. Additionally, relays are individually programmable for failsafe mode; delayed shutoff mode and a latching mode for pump up/down functions. Typical relay applications include remote annunciation, pump and siphon break/flow control valve operation, and other user-defined switch closure inputs. These relays also provide a simple and straightforward interface to most programmable logic controllers, building management systems, and similar input monitoring devices.

Both TMS4000 I/O expansion slots can accept optional Contact Closure Input/Relay Contact Output I/O Cards in 4 Input/4 Relay Output, 8 Input/8 Relay Output or 16 Relay Output Card configurations. The optional 4 Input/4 Relay Output Card is illustrated in Figure 3-9 below.

⚠ CAUTION

Relay output and contact closure input terminals are located on the NON-INTRINSICALLY SAFE side of the console. ALL wiring to these terminals MUST enter through the designated conduit opening. Refer to FIGURE 1-3. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

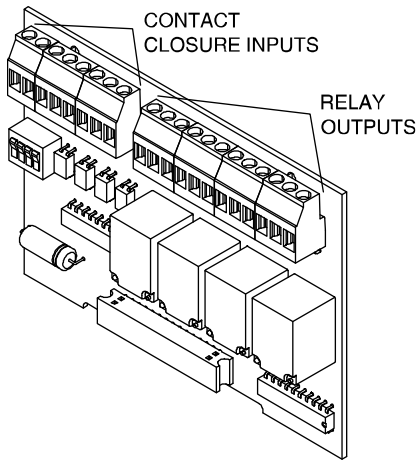

Figure 3-9 - Relay Output/Contact Closure Input Layout
(Optional 4 Relay Output/4 Contact Closure Input Expansion Card shown)

3.5 DATA COMMUNICATIONS WIRING

The console's non-intrinsically safe side is equipped with five (5) communications ports that are assigned as follows:

Two (2) for external EIA RS-232 Interface to externally mounted computers or modems.

One (1) for external EIA RS-485 Interface to externally mounted PNEUMERCATOR smart peripheral control devices.

One (1) for external 10/100 Base-T Network access for LAN/WAN applications.

One (1) for use with an optional communications expansion board.

Figure 3-10 shows the locations of these ports.

⚠ CAUTION

All communication terminations are located in the NON-INTRINSICALLY SAFE side of the TMS4000 console. ALL wiring to these terminals MUST enter the designated conduit opening. Refer to FIGURE 1-3. FAILURE TO COMPLY MAY RESULT IN PERSONAL INJURY, PROPERTY LOSS AND EQUIPMENT DAMAGE.

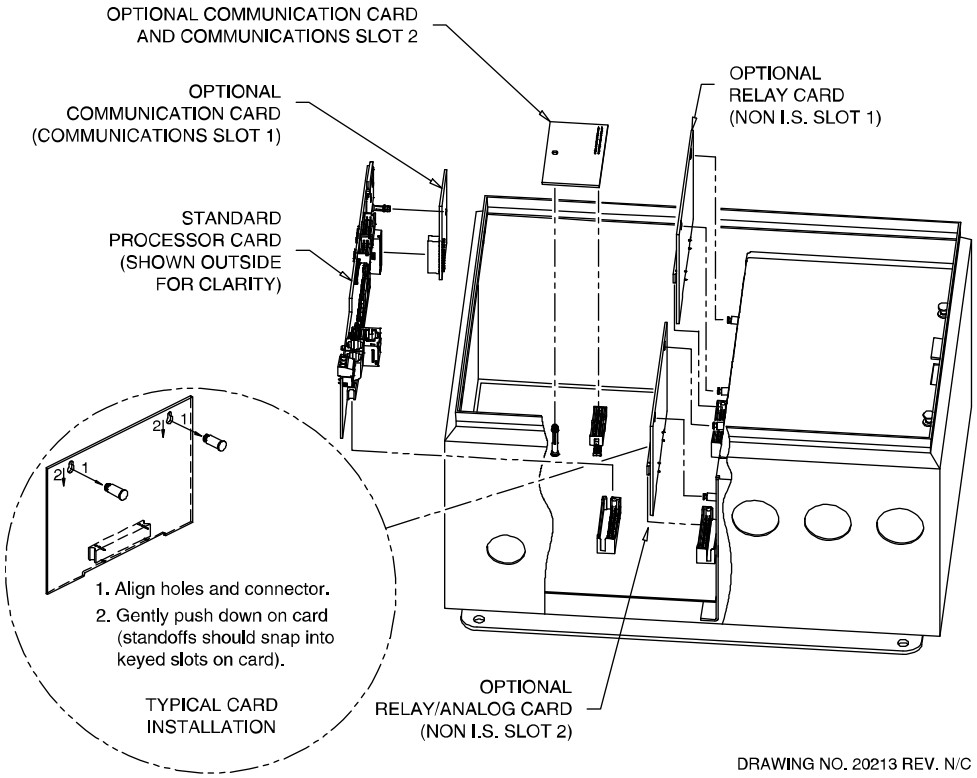

Figure 3-10 - Non-Hazardous Expansion Option Installation

3.6 PROBE MAP/SYSTEM SETUP

The probe map/system setup below should be completed by the electrical installer as each probe, sensor and control output function is wired to the TMS4000 system. This will provide the equipment operator a means of identifying each field device for proper system setup programming and use. The PROBE MAP should be adhered to or kept near the TMS4000 console.

PROBE MAP/SYSTEM SETUP

TANK	PRODUCT	SP 1	SP 2	SP 3
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

CHNL	LEAK INPUT USAGE	SENSOR
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
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26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

CHNL	AUX/SWITCH INPUT USAGE	SENSOR
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

RELAY	ALARMS	USAGE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
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12		
13		
14		
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PNEUMERCATOR TMS SERIES

LIMITED WARRANTY

TMS Series

Pneumercator, here and after referred to as **PCO**, warrants its **TMS Series** family of products to be free of defects in material and workmanship for a period of **Twelve (12) months** from date of installation or **Fifteen (15) months** from date of invoice, whichever comes first.

During the warranty period on the **TMS Series**, **PCO,** or factory third party independent representatives will repair or replace the product at the location where it is installed at no additional cost to the customer.

Packages must be inspected upon receipt for damage, missing parts, and/or manuals. **PCO** must be contacted by telephone immediately with a description of damaged or missing parts so replacements can be sent. Written details must be sent within **thirty (30) days.**

Pneumercator will not be responsible for shipping charges incurred by the customer.

Warranty repair coverage invoices will be paid if **all** the following conditions are met:

- PCO has acknowledged and authorized warranty work to be done by issuing a *Warranty Repair Number*.
- Start-up Service technician has been trained by PCO
- Warranty start-up form has been submitted to PCO
- Technician fills out and submits a PCO "Service Report"
- Parts (if any) used are returned to PCO with a proper WRGA (*Warranty Return Goods Authorization)*
- Returned parts are found to be defective.

Repair time will be paid according to PCO document "Standard Warranty Labor Charge Schedule"

If the Warranty Registration/Start up Check List has been completed and returned on file with the factory and the product is installed in accordance with the specific PCO Installation Product Manual, PCO will activate and meet warranty criteria as described above. Warranty criteria shall be voided if any product has been subjected to misuse, negligence, damage from acts of nature (lightning, wind, rain, etc.) or is in violation of the products design intent, disregard to warnings, instructions, modified or repaired by unauthorized personnel or improperly installed. Given that the third party independent contractor has installed the equipment in accordance with the specific product instruction manual, and followed all precautions, PCO will fulfill the terms stated in our warranty obligation.

Under no circumstances does the warranty provide a remedy in excess of the equipment. No other expressed or implied warranty is given by PCO. PCO shall not be liable for consequential damages or any expenses incurred by the user.

Distributed by:

PNEUMERCATOR
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Evaluation of the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series Magnetostrictive Probe and 4 inch floats for Monthly Monitoring for 0.1 gal/h on Underground Storage Tanks up to 20,000 gallons

Final Report Version 2

PREPARED FOR:

Pneumercator
1785 Expressway Drive North
Hauppauge NY 11788

September 14, 2020

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Preface

This report describes testing conducted on the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series magnetostrictive probe and 4 inch floats. This evaluation meets the requirements of the U.S. Environmental Protection Agency for Automatic Tank Gauging Systems for Monthly Monitoring for 0.1 gal/h leaks. This system can be installed on underground storage tanks up to 20,000 gallons in volume. The forms contained in this report are based on data collected using the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The statistics included in this report were calculated by Dr. Jairus Flora and the report was prepared by Craig D. Wilcox, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to Jonathan Levy, at (631) 293-8450.

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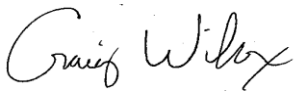

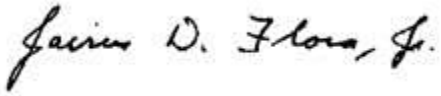

Craig Wilcox, President, KWA, Inc.
September 14, 2020

Jairus D. Flora, Jr., Ph.D.
September 14, 2020

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Section 1.0 Introduction

The Environmental Protection Agency requires that all tank testing equipment be capable of meeting certain performance standards. Automatic Tank Gauging Systems (ATGS) for monthly testing, are required to be capable of detecting leaks of 0.2 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time. An ATGS can also be evaluated to the 0.1 gal/h standard for monthly monitoring which requires the ATGS to be capable of detecting leaks of 0.1 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time.

To assure that tank testing methods meet either the 0.1 or 0.2 gal/h performance standards, the EPA requires that each method be evaluated using prescribed protocols. The TMS4000 Series Automatic Tank Gauging System with MP450 Series (also known as 7100 series) magnetostrictive probe with a 4 inch float was evaluated according to the newly developed EPA protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems”, May 2019 following the 0.1 gal/h standard.

Section 2.0 Overview of Evaluation Method

The EPA ATGS protocol provides for several alternative approaches to the evaluation of ATGS's. The standard approach utilizing testing at a specialized test facility was used for this evaluation. For this option, the evaluation is conducted under controlled conditions. Since the system operates as an ATGS, the water sensing function of the ATGS was evaluated according to the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The EPA test procedures introduce four main factors that may influence the test results: Size of leak; amount of product in the tank; temperature differentials; and tank deformation. This is accomplished by testing at different product levels under various conditions where product of different temperatures is added to a partially filled test tank.

Testing was conducted using the manufacturer's normal test routine. The TMS4000 Series ATG was installed per the manufacturer's installation specifications. The TMS4000 console was programmed to conduct tests by Ken Wilcox Associates. The leak rate reported by the TMS4000 console was compared to the actual volume of product removed from the tank. A statistical analysis of the data was used to determine the performance characteristics of the test method.

In addition to the measurement of product levels, the equipment must also be capable of detecting an incursion of water into the tank. A series of tests are required to determine the minimum detection level and sensitivity of the Pneumercator TMS4000 ATG to water level changes. This testing was conducted by mounting the MP450 Series magnetostrictive probe in a test stand. Known volumes of water were added to a cylinder containing the probe assembly. The measured level changes were compared with independently measured level changes and the differences were statistically analyzed to determine the precision of the tester.

Section 3.0 Description of the TMS4000 Series console

The system used in the evaluation was the Pneumercator TMS4000 Series ATG with a MP450 Series magnetostrictive probe with a 4 inch float. The MP450 series probe is also referred to as the 7100 series probe. The TMS4000 console is part of the TMS4000 Series that also includes the TMS4000M. The only difference between the TMS4000 and TMS4000M console is the size of the touchscreen and the capacity of probes and sensors. The results of this evaluation are applicable to each of the consoles in the TMS4000 Series. A more complete description of the Pneumercator TMS4000 ATG features have been provided on the appropriate EPA description forms in Attachment A.

The Pneumercator TMS4000 ATG consists of a console that houses probe interfaces and a microprocessor to process level and temperature data from a magnetostrictive probe. The processed data includes product level, water level, product temperature, gross volume, net volume, percent volume and ullage, as well as other programmable functions such as automatic in-tank leak start times and set point alarm levels. The same information can be printed on the internal printer on the TMS4000 ATG.

The MP450 Series magnetostrictive probe with a 4 inch float probe operates on magnetostrictive principles to measure product and water levels in the tank. The temperature of the product is determined from five thermistors located in the magnetostrictive probe. Product levels and temperatures are combined and processed in an algorithm by the microprocessor in the console. A large number of sensors using various operating principles can be attached to the controller.

Section 4.0 Description of the Testing Location

The Pneumercator TMS4000 ATG was evaluated at the Fuels Management Research Center (FMRC) located in Grain Valley, Missouri. The FMRC includes one 20,055 gallon and two 13,767 gallon Xerxes FRP underground storage tanks. Numerous access ports are available for installation of test equipment.

Product temperature differentials are achieved by circulating product through external heat exchangers, which are heated by a glycol solution or cooled using a Freon chiller, before product is returned to one of the three tanks. Product deliveries are simulated by transferring product from one tank to another using positive displacement pumps at delivery rates up to 140 gal/min.

Leaks are generated using a variable speed peristaltic pump. Fuel is pulled from the tank, collected in a container for the duration of the leak and weighed at the conclusion of each test. The leak rate is determined from the volume of fuel and the duration of the leak.

This evaluation was conducted on the test tank with a volume of 13,767 gallons. The Pneumercator TMS4000 ATG is approved for use on tanks up to a nominal capacity of 20,000 gallons.

Section 5.0 Leak Detection Test Results

The Pneumercator TMS4000 ATG was programmed to conduct leak detection testing according to the manufacturer's normal procedures. There were a total of 24 leak detection tests that were conducted between 50% and 95% product volume for this evaluation. Included in the 24 evaluation tests were 12 tests performed at 90-95% volume and 12 tests at 50% product volume. There were also 4 optional lower level tests that were performed with the fuel level at 20% volume to verify the systems capability at a level lower than 50%. A summary of the test results for the Pneumercator TMS4000 ATG is shown in Table 1.

Table 1 - Pneumercator TMS4000 ATG

Test No.	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	0.7	0.1	0.087	0.103	0.016
2	0.7	0	0	0	0
3	0.7	0.05	0.052	0.064	0.012
4	0.7	0.2	0.161	0.169	0.008
5	10.1	0	0	0.055	0.055
6	10.1	0.1	0.098	0.125	0.027
7	10.1	0.2	0.159	0.186	0.027
8	10.1	0.05	0.05	0.076	0.026
9	-10.0	0.1	0.082	0.071	-0.011
10	-10.0	0	0	-0.018	-0.018
11	-10.0	0.05	0.043	0.033	-0.01
12	-10.0	0.2	0.166	0.15	-0.016
13	-1.8	0.1	0.111	0.115	0.004
14	-1.8	0.2	0.163	0.164	0.001
15	-1.8	0.05	0.05	0.065	0.015
16	-1.8	0	0	0.027	0.027
17	10.1	0.1	0.113	0.208	0.095
18	10.1	0	0	0.016	0.016
19	10.1	0.05	0.051	0.077	0.026
20	10.1	0.2	0.171	0.158	-0.013
21	-10.1	0.1	0.093	0.043	-0.05
22	-10.1	0.05	0.055	0.041	-0.014
23	-10.1	0	0	0.025	0.025
24	-10.1	0.2	0.172	0.154	-0.018

Low Level Tests(not included in evaluation statistics)

25	NA	0.05	0.051	0.036	-0.015
26	NA	0.1	0.107	0.107	0
27	NA	0.2	0	-0.002	-0.002
28	NA	0	0.208	0.163	-0.045

Calculation of P_D and P_{FA} for Monthly Monitoring

Table 2 summarizes the results for the Pneumercator TMS4000 ATG that were obtained for a threshold of 0.1 gal/h. All of the results were calculated for Pneumercator TMS4000 ATG using the procedures specified in Section 5 of the EPA ATGS protocol. Nominal Leak rates of 0, 0.05, 0.1, and 0.2 gal/h were induced for the evaluation following the requirements for the 0.1 gal/h performance standard. The results from the 4 lower level tests that were performed with the fuel level at 20% are not included in the final statistics located in table 2.

Table 2.

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.1 gal/h
Threshold	0.05 gal/h
Variance	0.000824
MSE	0.000916
Standard deviation	0.028713 gal/h
Bias	0.009583 gal/h
t(bias)	1.635106
Significant Bias?	Not Significant (P=0.1156)
PFA (%) (using 0.05 as threshold)	4.75%
PD (%) (using 0.05 as threshold)	95.25%
Minimum threshold for 5% PFA	0.0492 gal/h
Minimum Detectable Leak Rate at 95% using the Minimum threshold	0.0984 gal/h
Minimum Detectable Leak Rate for 95% using 0.05 gal/h as threshold	0.09921 gal/h
Test Parameters	
Maximum Tank Size	20,000 gallons
Average Stabilization Time (1st Test of pair)	8 hours 20 minutes
Average Data Collection Time	8 hours
Maximum Temperature Differential	12.66 degrees F
Effects of Tank Level	Sig (P=0.02788 var) NS (P=0.934 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

The results shown in Table 2 for the Pneumercator TMS4000 ATG meets the requirements of the federal regulations for Monthly Monitoring with 0.1 gal/h leaks with a P_D of 95% or greater and P_{FA} of 5% or less for tight tanks.

Size of Tank

Testing for Monthly Monitoring was conducted on a tank with a nominal capacity of 13,767 gallons. The tank was 120 inches in diameter and 322 inches long. Tanks of up to 1.5 times this volume or a nominal capacity of 20,000 gallons may be tested by the Pneumercator TMS4000 ATG.

Maximum Allowable Temperature Difference for Monthly Monitoring

There were 6 simulated fuel deliveries for the 24 tests used to calculate the Monthly Monitoring results. The temperature of the product that was transferred to the tank during the ATGS testing ranged from -10.1 deg F to 10.1 deg F. The standard deviation of these temperatures was 8.44 deg F. Using the EPA formula of 1.5 times the standard deviation of the temperature differences present during the evaluation, the maximum allowable temperature difference between product delivered and product in the tank is ±12.66 deg F.

There was no indication that any of these temperature differentials caused any problems for the Pneumercator TMS4000 ATG as long as the appropriate stabilization times were allowed before testing. A one-way analysis of variance was used to compare the three sets of temperature data (0, -10.1, and +10.1 deg F). The F-Test was 8.73 with 2 and 21 degrees of freedom, giving a P-value of 0.002 or 0.2%, which was statistically significant. The mean differences were -0.014 gph, 0.0104 gph, and 0.0324 gph for -10.1, 0, and +10.1 deg F, respectively. The results indicate that the temperature compensation for the Pneumercator TMS4000 ATG may not be sufficient.

Average Waiting Time After Filling

The waiting time after receiving product into the test tank was 8 hours and 20 minutes.

Average Data Collection Time Per Test

The tests times for each test were 8 hours therefore the average data collection time for this evaluation for each test was also 8 hours.

Product Levels

For this evaluation, the testing was conducted with nominal product levels of 20%, 50% and 90-95% of the tank capacity. The results from the testing at 20% were performed only to verify the systems performance at the lower level and were not included in the final statistics of the report. A t-test was used to test whether there was a difference at the 5% significance level in the bias for the Pneumercator TMS4000 ATG for the 50% and 90% product levels (t = 0.083, t-critical = 1.71; P=0.934), showing that there was not a statistically significant difference in the average difference between the measured and induced leak rates at the 50% level compared to the average difference in the measured and induced leak rates at the 90% level.

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the two tank levels (50% and 90%) (F = 4.086; F-critical = 2.818; P=0.0279 two-sided), showing a difference in the variability.

The combined results at the 50% and 90% tank levels were compared to the results at the 20% tank level. A t-test was used to test whether there was a difference at the 5% significance level between the bias in the results at the 20% level and those at the other levels. The results were: t-statistic=1.664 P=0.1081 (2-sided), hence no significant difference in the bias for the lower tank level.

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the tank levels (50% and 90%) compared to the lower tank level of 20% (F =1.913; F-critical = 8.643; P=0.671 two-sided), showing no significant difference in the variability between the lower level and the others.. Thus, the performance at the 20% level was comparable to that at the combined 50% and 90% level.

Minimum Threshold

The minimum threshold that will result in a false alarm rate of 5% is also included in Table 2 as 0.0492 gal/h. A threshold less than the minimum threshold will result in a false alarm rate of greater than 5%.

Minimum Detectable Leak Rate

The minimum leak rate for the Pneumercator TMS4000 ATG that can be detected (MDL) with a probability of 95% (using the minimum 5% threshold of 0.0492 gal/h) is also summarized in Table 2 as 0.0984 gal/h. The minimum detectable leak rate using a threshold of 0.05 gal/h was also calculated and is shown in Table 2 as 0.9921 gal/h.

Section 6.0 Water Sensor Test Results

The water tests were conducted under laboratory conditions by adding known volumes of water to a reservoir containing the probe assembly. Sufficient diesel fuel to cover the water float was added before the tests were conducted. Independently measured level changes were compared with the measured level changes reported by the Pneumercator TMS4000 ATG. The point at which the water was first detected was determined, followed by incremental additions of water to determine the resolution of the water sensor. The results of the water sensor tests have been summarized in Table 2.

Minimum Detectable Water Level

At the 95% confidence level, the minimum detectable water level (MDWL) was determined using the procedures described in the ATGS protocol. The MDWL estimates the minimum level of water that the sensor can detect at least 95 % of the time. The mean values at which water can be detected are summarized in Table 2. The MDWL is 0.488 inches.

Minimum Water Level Change

The minimum water level (MLC) change that the water sensor can detect (after the MDWL is reached) was also provided. This information is also summarized in Table 2. The minimum detectable water level change on the MP450 Series magnetostrictive probe with a 4 inch float was found to be 0.488 inches. The minimum detectable water level change was found to be 0.124 inches.

Section 7.0 Conclusions

The following conclusions are based on the results of the testing described in this report.

1. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float exceeds the EPA 0.1 gal/h performance requirements for Monthly Monitoring of underground storage tanks.

2. The Probability of Detection (P_D) for a leak of 0.10 gal/h with a threshold of 0.05 gal/h exceeds the USEPA requirements for a P_D of 95% or higher for Monthly Monitoring.

3. The Probability of a False Alarm (P_{FA}) on a tight tank with a threshold of 0.05 gal/h exceeds the USEPA requirements for a P_{FA} of 5% or less for Monthly Monitoring.

4. Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks with a product level at or above 20%.

5. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks up to a nominal capacity of 20,000 gallons.

Attachment A

EPA Forms for the Pneumercator TMS4000 ATG with MP450 Series magnetostrictive probe with a 4 inch float for Monthly Monitoring on Underground Storage Tanks up to 20,000 gallons

Results of U.S. EPA Standard Evaluation
Automatic Tank Gauging System (ATGS)

This form tells whether the automatic tank gauging system (ATGS) described below complies with the performance requirements of the federal underground storage tank regulation. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems." The full evaluation report also includes a form describing the method and a form summarizing the test data. Tank owners using this leak detection system should keep this form on file to provide compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

ATGS Description

Name Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Version number TMS4000 ATG and MP450 series probe with a 4" float

Vendor Pneumercator

1785 Expressway Drive North
(street address)

Hauppauge	NY	11788	U.S.A.	(631) 293-8450
(city)	(state)	(zip)	(country)	(phone)

Evaluation Results (see Tables below for summary of Evaluation Results)*

This ATGS, which declares tank to be leaking when the measured leak rate exceeds the threshold of 0.05 gallon per hour, has a probability of false alarms [P_{FA}] of 4.75%.

The corresponding probability of detection [P_D] of a 0.10 gallon per hour leak is 95.25 %.

The minimum water level (threshold) in the tank that the ATGS can detect is 0.488 inches.

The minimum change in water level that can be detected by the ATGS is 0.124 inches. (provided that the water level is above the threshold).

Therefore, this ATGS (X) does ( ) does not meet the **federal** performance standards established by the U.S. Environmental Protection Agency (0.10 gallon per hour at P_D of 95% and P_{FA} of 5%), and this ATGS (X) does ( ) does not meet the **federal** performance standard of measuring water in the bottom of the tank to the nearest 1/8 inch. *Tables 1 summarizes all of the performance data that was evaluated in this project.*

Table 1. Summary of Results

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.1 gal/h
Threshold	0.05 gal/h
Variance	0.000824
MSE	0.000916
Standard deviation	0.028713 gal/h
Bias	0.009583 gal/h
t(bias)	1.635
Significant Bias?	Not Significant (P=0.1156)
PFA (%) (using 0.05 as threshold)	4.75%
PD (%) (using 0.05 as threshold)	95.25%
Minimum Threshold for 5% PFA=	0.0492 gal/h
Minimum Detectable Leak Rate for 95% using the Minimum Threshold	0.0984 gal/h
Minimum Detectable Leak Rate for 95% using 0.05 gal/h as threshold	0.09921 gal/h
Test Parameters	
Maximum Tank Size	20,000 gallons
Average Stabilization Time (1st Test of pair)	8 hours 20 minutes
Average Data Collection Time	8 hours
Maximum Temperature Differential	12.66 degrees F
Effects of Tank Level	Sig (P=0.0278 var) NS (P=0.9354 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

Test Conditions During Evaluation (identical for all floats)

The evaluation testing was conducted in a 13,767 gallon ( ) steel (X) fiberglass tank that was 120 inches in diameter and 322 inches in length.

The temperature difference between product added to fill the tank and product already in the tank ranged from -10.1 deg F to 10.1 deg F, with a standard deviation of 8.44 deg F.

The tests were conducted with the tank product levels 20% and 90 % full.

The product used in the evaluation was diesel fuel.

Limitations on the Results (identical for all floats)

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for installing and operating the ATGS are followed.
- The tank contains a product identified on the method description form.
- The tank is no larger than 20,000 gallons.
- The fuel level in the tank must be at or above 20%. The waiting time after adding any substantial amount of product to the tank is 8 hours 20 minutes.
- The temperature of the added product does not differ more than 12.66 degrees Fahrenheit from that already in the tank.
- The total data collection time for the test is at least 8 hours.
  - Other limitations specified by the vendor of determined during testing: None Specified

➢ **Safety disclaimer: This test procedure only addresses the issue of the ATG system's ability to detect leaks. It does not test the equipment for safety hazards.**

Certification of Results

I certify that the ATGS was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed according to one of the following:

(X) standard EPA test procedure for ATGS
( ) alternative EPA test procedure for ATGS

Craig D. Wilcox, President
(printed name)

Craig Wilcox
(signature)

September 14, 2020
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, Missouri 64029
(city, state. zip)

(816) 443-2494
(phone number)

Reporting Form for Leak Rate Data

Automatic Tank Gauging System

Method Name and Version: Pneumercator TMS4000 Series ATG with 4" float

Evaluation Period: from 07/18/2020 to 08/10/2020 (Dates)

Test No.	Date at Completion of Last Fill (m/d/y)	Time at Completion of Last Fill (military)	Data Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	Test Duration (minutes)	Level After Transfer Completed (% full)	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	7/18/2020	1220	7/18/2020	2020	0420	480	90	0.7	0.1	0.087	0.103	0.016
2	7/18/2020	1220	7/19/2020	2020	0420	480	90	0.7	0	0	0	0
3	7/18/2020	1220	7/20/2020	1230	2030	480	50	0.7	0.05	0.052	0.064	0.012
4	7/18/2020	1220	7/20/2020	2130	0530	480	50	0.7	0.2	0.161	0.169	0.008
5	7/21/2020	1210	7/21/2020	2010	0410	480	90	10.1	0	0	0.055	0.055
6	7/21/2020	1210	7/22/2020	2030	0430	480	90	10.1	0.1	0.098	0.125	0.027
7	7/21/2020	1210	7/23/2020	1220	2020	480	50	10.1	0.2	0.159	0.186	0.027
8	7/21/2020	1210	7/23/2020	2100	0500	480	50	10.1	0.05	0.05	0.076	0.026
9	7/24/2020	1540	7/24/2020	2340	0740	480	90	-10.0	0.1	0.082	0.071	-0.011
10	7/24/2020	1540	7/25/2020	2340	0740	480	90	-10.0	0	0	-0.018	-0.018
11	7/24/2020	1540	7/27/2020	1210	2010	480	50	-10.0	0.05	0.043	0.033	-0.01
12	7/24/2020	1540	7/27/2020	2110	0510	480	50	-10.0	0.2	0.166	0.15	-0.016
13	7/28/2020	1230	7/28/2020	2030	0430	480	90	-1.8	0.1	0.111	0.115	0.004
14	7/28/2020	1230	7/29/2020	1205	2005	480	90	-1.8	0.2	0.163	0.164	0.001
15	7/28/2020	1230	7/29/2020	2335	0735	480	50	-1.8	0.05	0.05	0.065	0.015
16	7/28/2020	1230	7/30/2020	1205	2005	480	50	-1.8	0	0	0.027	0.027
17	7/30/2020	2245	7/31/2020	0645	1445	480	90	10.1	0.1	0.113	0.208	0.095
18	7/30/2020	2245	7/31/2020	2200	0600	480	90	10.1	0	0	0.016	0.016
19	7/30/2020	2245	8/1/2020	1430	2230	480	50	10.1	0.05	0.051	0.077	0.026
20	7/30/2020	2245	8/2/2020	1430	2230	480	50	10.1	0.2	0.171	0.158	-0.013
21	8/3/2020	1520	8/3/2020	0120	0920	480	90	-10.1	0.1	0.093	0.043	-0.05
22	8/3/2020	1520	8/3/2020	1245	2045	480	90	-10.1	0.05	0.055	0.041	-0.014
23	8/3/2020	1520	8/3/2020	0600	1400	480	50	-10.1	0	0	0.025	0.025
24	8/3/2020	1520	8/3/2020	1440	2240	480	50	-10.1	0.2	0.172	0.154	-0.018

Low Level Tests(not included in evaluation statistics)

25	8/3/2020	1520	8/6/2020	2200	0600	480	20	not applicable	0.05	0.051	0.036	-0.015
26	8/3/2020	1520	8/7/2020	0945	1745	480	20	not applicable	0.1	0.107	0.107	0
27	8/3/2020	1520	8/8/2020	2200	0600	480	20	not applicable	0.2	0	-0.002	-0.002
28	8/3/2020	1520	8/9/2020	1900	0300	480	20	not applicable	0	0.208	0.163	-0.045

Description
Automatic Tank Gauging System

This section describes briefly the important aspects of the automatic tank gauging system (ATGS). It is not intended to provide a thorough description of the principles behind the system or how the equipment works.

ATGS Name and Version

Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Product

> Product type

For what products can this ATGS be used? (check all applicable)

(X) gasoline
(X) diesel
(X) aviation fuel
(X) fuel oil #4
( ) fuel oil #6
(X) solvents
(X) waste oil
(X) other (list) bio-diesel and ethanol blends compatible with probe floats

> Product level

What product level is required to conduct a test?

( ) greater than 90% full

( ) greater than 50% full

(X) other (specify) greater than 20% Full

Does the ATGS measure inflow of water as well as loss of product (gallon per hour)?

( ) yes

(X) no

Does the ATGS detect the presence of water in the bottom of the tank?

(X) yes

( ) no

Level Measurement

What technique is used to measure changes in product volume?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

(X) change in level of float (specify principle, e.g., capacitance, magnetostrictive, load cell, etc.) magnetostrictive

( ) other (describe briefly) _____

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

( ) single sensor, without circulation

( ) single sensor, with circulation

( ) 2-4 sensors

(X) 5 or more sensors

( ) temperature-averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

( ) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

(X) thermistor

( ) other (describe briefly) _____

If product temperature is not measured during a test, why is it not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly) _____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

(X) by computer

Procedure information

> Waiting times

What is the minimum waiting period between adding a large volume of product (i.e., a delivery) and the beginning of a test (e.g., filling from 50% to 90-95% capacity)?

( ) no waiting period

( ) less than 3 hours

( ) 3-6 hours

(X) 7-12 hours

( ) more than 12 hours

> Test duration

What is the minimum time for collecting data?

( ) less than 1 hour

( ) 1 hour

( ) 2 hours

( ) 3 hours

( ) 4 hours

(X) 5-10 hours

( ) more than 10 hours

( ) variable (explain)_____

> Total time

What is the total time needed to test with this ATGS after a delivery?
(waiting time plus testing time)

16 hours 20 minutes *(maximum test time)*

What is the sampling frequency for the level and temperature measurements?

( ) more than once per second

(X) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable (explain) _____

> Identifying and correcting for interfering factors

How does the ATGS determine the presence and level of the ground water above the bottom of the tank?

( ) observation well near tank

( ) information from USGS, etc.

( ) information from personnel on-site

( ) presence of water in the tank

( ) other (describe briefly) _____

(X) level of ground water above bottom of the tank not determined

How does the ATGS correct for the interference due to the presence of ground water above the bottom of the tank?

( ) system tests for water incursion

( ) different product levels tested and leak rates compared

( ) other (describe briefly) _____

(X) no action

How does the ATGS determine when tank deformation has stopped following delivery of product?

(X) wait a specified period of time before beginning test

( ) watch the data trends and begin test when decrease in product level has stopped

( ) other (describe briefly) _____

( ) no procedure

Are the temperature and level sensors calibrated before each test?

( ) yes

(X) no

If not, how frequently are the sensors calibrated?

( ) weekly

( ) monthly

( ) yearly or less frequently

(X) never

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

(X) actual level changes observed when known volume is added or removed (e.g., liquid metal bar) *(This is one way the Pneumercator TMS4000 ATG can be used to generate a custom tank chart)*

(X) theoretical ratio calculated from tank geometry

(X) interpolation from tank manufacturer's chart

(X) other (describe briefly) All three options are available .

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) actual sample taken for each test and Ce determined from specific gravity

( ) value supplied by vendor of product

(X) average value for type of product

( ) other (describe briefly) _____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

(X) difference between first and last data collected

( ) from data from last _____ hours of test period

( ) from data determined to be valid by statistical analysis

( ) other (describe) _____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

(X) 0.05 gallon per hour

( ) 0.10 gallon per hour

( ) 0.20 gallon per hour

() other (list) _____

Under what conditions are test results considered inconclusive?

( ) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase such as stiction

( ) other (describe briefly) _____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) water in the excavation zone

( ) large difference between ground temperature and delivered product temperature

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) _____

( ) other (describe briefly) _____

What are acceptable deviations from the standard testing protocol?

(X) none

( ) lengthen the duration of test

( ) other (describe briefly) _____

What elements of the test procedure are determined by personnel on-site?

( ) product level when test is conducted

( ) when to conduct test

( ) waiting period between filling tank and beginning test

( ) length of test

( ) determination that tank deformation has subsided

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) _____

(X) none

Evaluation of the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series Magnetostrictive Probe with 4 inch float for Monthly Monitoring for 0.2 gal/h on Underground Storage Tanks up to 20,000 gallons

Final Report Version 3

PREPARED FOR:

Pneumercator

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Hauppauge NY 11788

September 16, 2020

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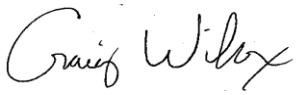
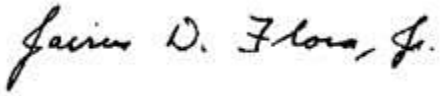
Preface

This report describes testing conducted on the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series magnetostrictive probe with a 4 inch float. This evaluation meets the requirements of the U.S. Environmental Protection Agency for Automatic Tank Gauging Systems for Monthly Monitoring for 0.2 gal/h leaks. This system can be installed on underground storage tanks up to 20,000 gallons in volume. The forms contained in this report are based on data collected using the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The statistics included in this report were calculated by Dr. Jairus Flora and the report was prepared by Craig D. Wilcox, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to Jonathan Levy, at (631) 293-8450.

KEN WILCOX ASSOCIATES, INC





Craig Wilcox, President, KWA, Inc.
September 16, 2020

Jairus D. Flora, Jr., Ph.D.
September 16, 2020

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Section 1.0 Introduction

The Environmental Protection Agency requires that all tank testing equipment be capable of meeting certain performance standards. Automatic Tank Gauging Systems (ATGS) for monthly testing, are required to be capable of detecting leaks of 0.2 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time. An ATGS can also be evaluated to the 0.1 gal/h standard for monthly monitoring which requires the ATGS to be capable of detecting leaks of 0.1 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time.

To assure that tank testing methods meet either the 0.1 or 0.2 gal/h performance standards, the EPA requires that each method be evaluated using prescribed protocols. The TMS4000 Series Automatic Tank Gauging System with MP450 Series (also known as 7100 series) magnetostrictive probe with a 4 inch float was evaluated according to the newly developed EPA protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems”, May 2019 following the 0.2 gal/h standard.

Section 2.0 Overview of Evaluation Method

The EPA ATGS protocol provides for several alternative approaches to the evaluation of ATGS's. The standard approach utilizing testing at a specialized test facility was used for this evaluation. For this option, the evaluation is conducted under controlled conditions. Since the system operates as an ATGS, the water sensing function of the ATGS was evaluated according to the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The EPA test procedures introduce four main factors that may influence the test results: Size of leak; amount of product in the tank; temperature differentials; and tank deformation. This is accomplished by testing at different product levels under various conditions where product of different temperatures is added to a partially filled test tank.

Testing was conducted using the manufacturer's normal test routine. The TMS4000 Series ATG was installed per the manufacturer's installation specifications. The TMS4000 console was programmed to conduct tests by Ken Wilcox Associates. The leak rate reported by the TMS4000 console was compared to the actual volume of product removed from the tank. A statistical analysis of the data was used to determine the performance characteristics of the test method.

In addition to the measurement of product levels, the equipment must also be capable of detecting an incursion of water into the tank. A series of tests are required to determine the minimum detection level and sensitivity of the Pneumercator TMS4000 ATG to water level changes. This testing was conducted by mounting the MP450 Series magnetostrictive probe in a test stand. Known volumes of water were added to a cylinder containing the probe assembly. The measured level changes were compared with independently measured level changes and the differences were statistically analyzed to determine the precision of the tester.

Section 3.0 Description of the TMS4000 Series console

The system used in the evaluation was the Pneumercator TMS4000 Series ATG with an MP450 Series magnetostrictive probe with a 4 inch float. The MP450 series probe is also referred to as the Pneumercator MP450 series probe. The TMS4000 console is part of the TMS4000 Series that also includes the TMS4000M. The only difference between the TMS4000 and TMS4000M console is the size of the touchscreen and the capacity of probes and sensors. The results of this evaluation are applicable to each of the consoles in the TMS4000 Series. A more complete description of the Pneumercator TMS4000 ATG features have been provided on the appropriate EPA description forms in Attachment A.

The Pneumercator TMS4000 ATG consists of a console that houses probe interfaces and a microprocessor to process level and temperature data from a magnetostrictive probe. The processed data includes product level, water level, product temperature, gross volume, net volume, percent volume and ullage, as well as other programmable functions such as automatic in-tank leak start times and set point alarm levels. The same information can be printed on the internal printer on the TMS4000 ATG.

The MP450 Series magnetostrictive probe with a 4 inch float probe operates on magnetostrictive principles to measure product and water levels in the tank. The temperature of the product is determined from five thermistors located in the magnetostrictive probe. Product levels and temperatures are combined and processed in an algorithm by the microprocessor in the console. A large number of sensors using various operating principles can be attached to the controller.

Section 4.0 Description of the Testing Location

The Pneumercator TMS4000 ATG was evaluated at the Fuels Management Research Center (FMRC) located in Grain Valley, Missouri. The FMRC includes one 20,055 gallon and two 13,767 gallon Xerxes FRP underground storage tanks. Numerous access ports are available for installation of test equipment.

Product temperature differentials are achieved by circulating product through external heat exchangers, which are heated by a glycol solution or cooled using a Freon chiller, before product is returned to one of the three tanks. Product deliveries are simulated by transferring product from one tank to another using positive displacement pumps at delivery rates up to 140 gal/min.

Leaks are generated using a variable speed peristaltic pump. Fuel is pulled from the tank, collected in a container for the duration of the leak and weighed at the conclusion of each test. The leak rate is determined from the volume of fuel and the duration of the leak.

This evaluation was conducted on the test tank with a volume of 13,767 gallons. The Pneumercator TMS4000 ATG is approved for use on tanks up to a nominal capacity of 20,000 gallons.

Section 5.0 Leak Detection Test Results

The Pneumercator TMS4000 ATG was programmed to conduct leak detection testing according to the manufacturer's normal procedures. There were a total of 24 leak detection tests that were conducted between 50% and 95% product volume for this evaluation. Included in the 24 evaluation tests were 12 tests performed at 90-95% volume and 12 tests at 50% product volume. There were also 4 optional lower level tests that were performed with the fuel level at 20% volume to verify the systems capability at a level lower than 50%. A summary of the test results for the Pneumercator TMS4000 ATG is shown in Table 1.

Table 1 - Pneumercator TMS4000 ATG

Test No.	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	0.3	0.1	0.103	0.081	-0.022
2	0.3	0.2	0.205	0.256	0.051
3	0.3	0	0	-0.003	-0.003
4	0.3	0.3	0.289	0.232	-0.057
5	10.4	0	0	0.101	0.101
6	10.4	0.3	0.253	0.355	0.102
7	10.4	0.1	0.101	0.077	-0.024
8	10.4	0.2	0.168	0.139	-0.029
9	-10.5	0.1	0.105	0.112	0.007
10	-10.5	0.3	0.273	0.235	-0.038
11	-10.5	0	0	0.001	0.001
12	-10.5	0.1	0.113	0.079	-0.034
13	0.4	0.2	0.193	0.172	-0.021
14	0.4	0.3	0.264	0.293	0.029
15	0.4	0	0	0.003	0.003
16	0.4	0.2	0.193	0.137	-0.056
17	10.8	0.1	0.104	0.197	0.093
18	10.8	0.3	0.246	0.338	0.092
19	10.8	0	0	-0.025	-0.025
20	10.8	0.2	0.181	0.17	-0.011
21	-11.2	0.1	0.108	0.088	-0.02
22	-11.2	0.3	0.276	0.256	-0.02
23	-11.2	0	0	0.021	0.021
24	-11.2	0.2	0.169	0.112	-0.057

Low Level Tests(not included in evaluation statistics)

25	NA	0	0	0.01	0.01
26	NA	0.1	0.107	0.158	0.051
27	NA	0.2	0.15	0.111	-0.039
28	NA	0.3	0.228	0.19	-0.038

Calculation of P_D and P_{FA} for Monthly Monitoring

Table 2 summarizes the results for the Pneumercator TMS4000 ATG that were obtained for a threshold of 0.1 gal/h. All of the results were calculated for Pneumercator TMS4000 ATG using the procedures specified in Section 5 of the EPA ATGS protocol. Nominal Leak rates of 0, 0.1, 0.2, and 0.3 gal/h were induced for the evaluation following the requirements for the 0.2 gal/h performance standard. The results from the 4 lower level tests that were performed with the fuel level at 20% are not included in the final statistics located in table 2.

Table 2.

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.2 gal/h
Threshold	0.1 gal/h
Variance	0.0025
MSE	0.002512
Standard deviation	0.050002 gal/h
Bias	0.003458 gal/h
t(bias)	0.3388
Significant Bias?	Not Significant (P=0.1738)
PFA (%) (using 0.10 as threshold)	2.87%
PD at 0.2 (%)(using 0.10 as threshold)	97.13%
Minimum threshold for 5% PFA	0.0857 gal/h
Minimum Detectable Leak Rate at 95% using the Minimum threshold	0.1739 gal/h
Minimum Detectable Leak Rate for 95% using 0.01 gal/h as threshold	0.1857 gal/h
Test Parameters	
Maximum Tank Size	20,000 gallons
Average Stabilization Time (1st Test of pair)	8 Hours
Average Data Collection Time	2 hours
Maximum Temperature Differential	13.43 degrees F
Effects of Tank Level	Sig (P=0.0085 var) Sig(P=0.0152 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

The results shown in Table 2 for the Pneumercator TMS4000 ATG meets the requirements of the federal regulations for Monthly Monitoring with 0.2 gal/h leaks with a P_D of 95% or greater and P_{FA} of 5% or less for tight tanks.

Size of Tank

Testing for Monthly Monitoring was conducted on a tank with a nominal capacity of 13,767 gallons. The tank was 120 inches in diameter and 322 inches long. Tanks of up to 1.5 times this volume or a nominal capacity of 20,000 gallons may be tested by the Pneumercator TMS4000 ATG.

Maximum Allowable Temperature Difference for Monthly Monitoring

There were 6 simulated fuel deliveries for the 24 tests used to calculate the Monthly Monitoring results. The temperature of the product that was transferred to the tank during the ATGS testing ranged from -11.2 deg F to 10.8 deg F. The standard deviation of these temperatures was 8.95 deg F. Using the EPA formula of 1.5 times the standard deviation of the temperature differences present during the evaluation, the maximum allowable temperature difference between product delivered and product in the tank is ±13.43 deg F.

There was no indication that any of these temperature differentials caused any problems for the Pneumercator TMS4000 ATG as long as the appropriate stabilization times were allowed before testing. A one-way analysis of variance was used to compare the three sets of temperature data (0, -11.2, and +10.8 deg F). The F-Test was 3.398 with 2 and 21 degrees of freedom, giving a P-value of 0.053 or 5.3%, which was not statistically significant at the 5% significance level. The mean differences were -0.0175 gal/h, -0.0095 gal/h, and 0.0374 gal/h for -11.2, 0, and +10.8 deg F, respectively. The results indicate that the differences in results for the 3 temperatures tested were not statistically significantly different at the 5% significance level, although it was close. Consequently, the temperature compensation for the Pneumercator TMS4000 ATG was sufficient.

Average Waiting Time After Filling

The waiting time after receiving product into the test tank was 8 hours.

Average Data Collection Time Per Test

The tests times for each test were 2 hours therefore the average data collection time for this evaluation for each test was also 2 hours.

Product Levels

For this evaluation, the testing was conducted with nominal product levels of 20%, 50% and 90-95% of the tank capacity. The results from the testing at 20% were performed only to verify the systems performance at the lower level and were not included in the final statistics of the report. A t-test was used to test whether there was a difference at the 5% significance level in the bias for the Pneumercator TMS4000 ATG for the 50% and 90% product levels (t = 2.632, t-critical = 1.71; P=0.0152 or 1.52%), showing that there was a statistically significant difference at the 5% significance level in the average difference between the measured and induced leak rates at the 50% level (-0.0226 gal/h) compared to the average difference in the measured and induced leak rates (+0.0295 gal/h) at the 90% level.

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the two tank levels (variance=0.000663 at 50% and variance = 0.00309 at 90%) (F = 4.086; F-critical = 2.818; P=0.0085 or 0.85% two-sided), showing a significant difference in the variability. The standard deviation of the differences at the 50% tank product level was 0.0257 gal/h, while the standard deviation of the differences at the 90% tank product level was 0.0555 gal/h.

The combined results at the 50% and 90% tank levels were compared to the results at the 20% tank level. A t-test was used to test whether there was a difference at the 5% significance level between the bias in the results at the 20% level and those at the other levels. The results were: t-statistic=0.789 P=0.781 (2-sided), hence no significant difference in the bias for the lower tank level. The combined mean at the 50% and 90% product levels was 0.00346 gal/h, while that at the 20% product level was -0.004 gal/h.)

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the tank levels (50% and 90%; variance=0.0025; standard deviation=0.05 gal/h) compared to the lower tank level of 20% (variance=0.00187; standard deviation=0.0432 gal/h) (F =1.339; F-critical = 8.643; P=0.932 2-sided), showing no significant difference in the variability between the lower level and the others.. Thus, the performance at the 20% level was comparable to that at the combined 50% and 90% level.

Minimum Threshold

The minimum threshold that will result in a false alarm rate of 5% is also included in Table 2 as 0.0857 gal/h. A threshold less than the minimum threshold will result in a false alarm rate of greater than 5%.

Minimum Detectable Leak Rate

The minimum leak rate for the Pneumercator TMS4000 ATG that can be detected (MDL) with a probability of 95% (using the minimum 5% threshold of 0.0857 gal/h) is also summarized in Table 2 as 0.174 gal/h.

Standard Application of the Pneumercator TMS4000 ATG

The Pneumercator TMS4000 ATG uses a standard threshold of 0.1 gal/h, so the performance using the standard threshold is reported:

The probability of a false alarm is:

PFA = 2.87%

Using the threshold of 0.1 gal/h, the probability of detection of a leak rate of 0.2 gal/h is:

PD(at 0.2 gal/h) = 97.13%

The leak rate detectable with a PD of 95% is:

Minimum 95% detectable leak rate

95% MDL = 0.186 gal/h.

Conclusion:

The standard application of the Pneumercator TMS4000 ATG meets the EPA standard of detecting a leak rate of 0.2 gal/h with at least 95% PD, while operating at a false alarm rate of no more than PFA of 5%. Thus, the system qualifies as a monthly leak detection method.

Section 6.0 Water Sensor Test Results

The water tests were conducted under laboratory conditions by adding known volumes of water to a reservoir containing the probe assembly. Sufficient diesel fuel to cover the water float was added before the tests were conducted. Independently measured level changes were compared with the measured level changes reported by the Pneumercator TMS4000 ATG. The point at which the water was first detected was determined, followed by incremental additions of water to determine the resolution of the water sensor. The results of the water sensor tests have been summarized in Table 2.

Minimum Detectable Water Level

At the 95% confidence level, the minimum detectable water level (MDWL) was determined using the procedures described in the ATGS protocol. The MDWL estimates the minimum level of water that the sensor can detect at least 95 % of the time. The mean values at which water can be detected are summarized in Table 2. The MDWL is 0.488 inches.

Minimum Water Level Change

The minimum water level (MLC) change that the water sensor can detect (after the MDWL is reached) was also provided. This information is also summarized in Table 2. The minimum detectable water level change on the MP450 Series magnetostrictive probe with a 4 inch float was found to be 0.488 inches. The minimum detectable water level change was found to be 0.124 inches.

Section 7.0 Conclusions

The following conclusions are based on the results of the testing described in this report.

1. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float exceeds the EPA 0.2 gal/h performance requirements for Monthly Monitoring of underground storage tanks.

2. The Probability of Detection (P_D) for a leak of 0.20 gal/h with a threshold of 0.1 gal/h exceeds the USEPA requirements for a P_D of 95% or higher for Monthly Monitoring.

3. The Probability of a False Alarm (P_{FA}) on a tight tank with a threshold of 0.1 gal/h exceeds the USEPA requirements for a P_{FA} of 5% or less for Monthly Monitoring.

4. Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks with a product level at or above 20%.

5. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks up to a nominal capacity of 20,000 gallons.

Attachment A

EPA Forms for the Pneumercator TMS4000 ATG with MP450 Series magnetostrictive probe with a 4 inch float for Monthly Monitoring for 0.2 gal/h on Underground Storage Tanks up to 20,000 gallons

Results of U.S. EPA Standard Evaluation
Automatic Tank Gauging System (ATGS)

This form tells whether the automatic tank gauging system (ATGS) described below complies with the performance requirements of the federal underground storage tank regulation. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems." The full evaluation report also includes a form describing the method and a form summarizing the test data. Tank owners using this leak detection system should keep this form on file to provide compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

ATGS Description

Name Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Version number TMS4000 ATG and MP450 series probe with a 4" float

Vendor Pneumercator

1785 Expressway Drive North
(street address)

Hauppauge	NY	11788	U.S.A.	(631) 293-8450
(city)	(state)	(zip)	(country)	(phone)

Evaluation Results (see Tables below for summary of Evaluation Results)*

This ATGS, which declares tank to be leaking when the measured leak rate exceeds the threshold of 0.1 gallon per hour, has a probability of false alarms [P_{FA}] of 2.87%.

The corresponding probability of detection [P_D] of a 0.20 gallon per hour leak is 97.13 %.

The minimum water level (threshold) in the tank that the ATGS can detect is 0.488 inches.

The minimum change in water level that can be detected by the ATGS is 0.124 inches. (provided that the water level is above the threshold).

Therefore, this ATGS (X) does ( ) does not meet the **federal** performance standards established by the U.S. Environmental Protection Agency (0.20 gallon per hour at P_D of 95% and P_{FA} of 5%), and this ATGS (X) does ( ) does not meet the **federal** performance standard of measuring water in the bottom of the tank to the nearest 1/8 inch. *Tables 1 summarizes all of the performance data that was evaluated in this project.*

Table 1. Summary of Results

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.2 gal/h
Threshold	0.1 gal/h
Variance	0.0025
MSE	0.002512
Standard deviation	0.050002 gal/h
Bias	0.003458 gal/h
t(bias)	0.3388
Significant Bias?	Not Significant (P=0.1738)
PFA (%) (using 0.10 as threshold)	2.87%
PD at 0.2 (%)(using 0.10 as threshold)	97.13%
Minimum threshold for 5% PFA	0.0857 gal/h
Minimum Detectable Leak Rate at 95% using the Minimum threshold	0.1739 gal/h
Minimum Detectable Leak Rate for 95% using 0.01 gal/h as threshold	0.1857 gal/h
Test Parameters	
Maximum Tank Size	20,000 gallons
Average Stabilization Time (1st Test of pair)	8 Hours
Average Data Collection Time	2 hours
Maximum Temperature Differential	13.43 degrees F
Effects of Tank Level	Sig (P=0.0085 var) Sig(P=0.0152 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

Test Conditions During Evaluation (identical for all floats)

The evaluation testing was conducted in a 13,767 gallon ( ) steel (X) fiberglass tank that was 120 inches in diameter and 322 inches in length.

The temperature difference between product added to fill the tank and product already in the tank ranged from -11.2 deg F to 10.8 deg F, with a standard deviation of 8.95 deg F.

The tests were conducted with the tank product levels 20% and 90 % full.

The product used in the evaluation was diesel fuel.

Limitations on the Results (identical for all floats)

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for installing and operating the ATGS are followed.
- The tank contains a product identified on the method description form.
- The tank is no larger than 20,000 gallons.
- The fuel level in the tank must be at or above 20%. The waiting time after adding any substantial amount of product to the tank is 8 hours.
- The temperature of the added product does not differ more than 13.43 degrees Fahrenheit from that already in the tank.
- The total data collection time for the test is at least 2 hours.
  - Other limitations specified by the vendor of determined during testing: None Specified

➢ **Safety disclaimer: This test procedure only addresses the issue of the ATG system's ability to detect leaks. It does not test the equipment for safety hazards.**

Certification of Results

I certify that the ATGS was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed according to one of the following:

(X) standard EPA test procedure for ATGS
( ) alternative EPA test procedure for ATGS

Craig D. Wilcox, President (printed name)	Ken Wilcox Associates, Inc. (organization performing evaluation)
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Reporting Form for Leak Rate Data
Automatic Tank Gauging System

Method Name and Version: Pneumercator TMS4000 Series ATG with 4" float

Evaluation Period: from 04/09/2020 to 06/01/2020 (Dates)

Test No.	Date at Completion of Last Fill (m/d/y)	Time at Completion of Last Fill (military)	Data Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	Test Duration (minutes)	Level After Transfer Completed (% full)	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	4/9/2020	1820	4/10/2020	0220	0420	120	90	0.3	0.1	0.103	0.081	-0.022
2	4/9/2020	1820	4/10/2020	1126	1326	120	90	0.3	0.2	0.205	0.256	0.051
3	4/9/2020	1820	4/11/2020	0440	0640	120	50	0.3	0	0	-0.003	-0.003
4	4/9/2020	1820	4/11/2020	2200	0000	120	50	0.3	0.3	0.289	0.232	-0.057
5	4/13/2020	1650	4/14/2020	0050	0250	120	90	10.4	0	0	0.101	0.101
6	4/13/2020	1650	4/14/2020	1302	1502	120	90	10.4	0.3	0.253	0.355	0.102
7	4/13/2020	1650	4/15/2020	1040	1240	120	50	10.4	0.1	0.101	0.077	-0.024
8	4/13/2020	1650	4/15/2020	2005	2205	120	50	10.4	0.2	0.168	0.139	-0.029
9	4/16/2020	2200	4/17/2020	0600	0800	120	90	-10.5	0.1	0.105	0.112	0.007
10	4/16/2020	2200	4/18/2020	0900	1100	120	90	-10.5	0.3	0.273	0.235	-0.038
11	4/16/2020	2200	4/20/2020	0300	0500	120	50	-10.5	0	0	0.001	0.001
12	4/16/2020	2200	4/20/2020	1140	1340	120	50	-10.5	0.1	0.113	0.079	-0.034
13	4/21/2020	1450	4/21/2020	2250	0050	120	90	0.4	0.2	0.193	0.172	-0.021
14	4/21/2020	1450	4/22/2020	1125	1325	120	90	0.4	0.3	0.264	0.293	0.029
15	4/21/2020	1450	4/23/2020	0630	0830	120	50	0.4	0	0	0.003	0.003
16	4/21/2020	1450	4/23/2020	1500	1700	120	50	0.4	0.2	0.193	0.137	-0.056
17	4/24/2020	1750	4/25/2020	0150	0350	120	90	10.8	0.1	0.104	0.197	0.093
18	4/24/2020	1750	4/25/2020	1330	1530	120	90	10.8	0.3	0.246	0.338	0.092
19	4/24/2020	1750	4/26/2020	0630	0830	120	50	10.8	0	0	-0.025	-0.025
20	4/24/2020	1750	4/26/2020	1530	1730	120	50	10.8	0.2	0.181	0.17	-0.011
21	4/27/2020	1845	4/28/2020	0145	0345	120	90	-11.2	0.1	0.108	0.088	-0.02
22	4/27/2020	1845	4/28/2020	1300	1500	120	90	-11.2	0.3	0.276	0.256	-0.02
23	4/27/2020	1845	4/29/2020	2215	0015	120	50	-11.2	0	0	0.021	0.021
24	4/27/2020	1845	4/30/2020	1258	1458	120	50	-11.2	0.2	0.169	0.112	-0.057

Low Level Tests(not included in evaluation statistics)

25	5/27/2020	1845	5/28/2020	0300	0500	120	20	not applicable	0	0	0.01	0.01
26	5/27/2020	1845	5/28/2020	1510	1710	120	20	not applicable	0.1	0.107	0.158	0.051
27	5/27/2020	1845	5/31/2020	1920	2120	120	20	not applicable	0.2	0.15	0.111	-0.039
28	5/27/2020	1845	6/1/2020	1515	1715	120	20	not applicable	0.3	0.228	0.19	-0.038

Description
Automatic Tank Gauging System

This section describes briefly the important aspects of the automatic tank gauging system (ATGS). It is not intended to provide a thorough description of the principles behind the system or how the equipment works.

ATGS Name and Version

Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Product

> Product type

For what products can this ATGS be used? (check all applicable)

(X) gasoline
(X) diesel
(X) aviation fuel
(X) fuel oil #4
( ) fuel oil #6
(X) solvents
(X) waste oil
(X) other (list) bio-diesel and ethanol blends compatible with probe floats

> Product level

What product level is required to conduct a test?

( ) greater than 90% full

( ) greater than 50% full

(X) other (specify) greater than 20% Full

Does the ATGS measure inflow of water as well as loss of product (gallon per hour)?

( ) yes

(X) no

Does the ATGS detect the presence of water in the bottom of the tank?

(X) yes

( ) no

Level Measurement

What technique is used to measure changes in product volume?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

(X) change in level of float (specify principle, e.g., capacitance, magnetostrictive, load cell, etc.) magnetostrictive

( ) other (describe briefly) _____

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

( ) single sensor, without circulation

( ) single sensor, with circulation

( ) 2-4 sensors

(X) 5 or more sensors

( ) temperature-averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

( ) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

(X) thermistor

( ) other (describe briefly) _____

If product temperature is not measured during a test, why is it not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly) _____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

(X) by computer

Procedure information

> Waiting times

What is the minimum waiting period between adding a large volume of product (i.e., a delivery) and the beginning of a test (e.g., filling from 50% to 90-95% capacity)?

( ) no waiting period

( ) less than 3 hours

( ) 3-6 hours

(X) 7-12 hours

( ) more than 12 hours

> Test duration

What is the minimum time for collecting data?

( ) less than 1 hour

( ) 1 hour

(X) 2 hours

( ) 3 hours

( ) 4 hours

( ) 5-10 hours

( ) more than 10 hours

( ) variable (explain)_____

> Total time

What is the total time needed to test with this ATGS after a delivery?
(waiting time plus testing time)

10 hours 0 minutes *(maximum test time)*

What is the sampling frequency for the level and temperature measurements?

( ) more than once per second

(X) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable (explain) _____

> Identifying and correcting for interfering factors

How does the ATGS determine the presence and level of the ground water above the bottom of the tank?

( ) observation well near tank

( ) information from USGS, etc.

( ) information from personnel on-site

( ) presence of water in the tank

( ) other (describe briefly) _____

(X) level of ground water above bottom of the tank not determined

How does the ATGS correct for the interference due to the presence of ground water above the bottom of the tank?

( ) system tests for water incursion

( ) different product levels tested and leak rates compared

( ) other (describe briefly) _____

(X) no action

How does the ATGS determine when tank deformation has stopped following delivery of product?

(X) wait a specified period of time before beginning test

( ) watch the data trends and begin test when decrease in product level has stopped

( ) other (describe briefly) _____

( ) no procedure

Are the temperature and level sensors calibrated before each test?

( ) yes

(X) no

If not, how frequently are the sensors calibrated?

( ) weekly

( ) monthly

( ) yearly or less frequently

(X) never

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

(X) actual level changes observed when known volume is added or removed (e.g., liquid metal bar) *(This is one way the Pneumercator TMS4000 ATG can be used to generate a custom tank chart)*

(X) theoretical ratio calculated from tank geometry

(X) interpolation from tank manufacturer's chart

(X) other (describe briefly) All three options are available .

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) actual sample taken for each test and Ce determined from specific gravity

( ) value supplied by vendor of product

(X) average value for type of product

( ) other (describe briefly) _____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

(X) difference between first and last data collected

( ) from data from last _____ hours of test period

( ) from data determined to be valid by statistical analysis

( ) other (describe) _____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

( ) 0.05 gallon per hour

(X) 0.10 gallon per hour

( ) 0.20 gallon per hour

() other (list) _____

Under what conditions are test results considered inconclusive?

( ) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase such as stiction

( ) other (describe briefly) _____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) water in the excavation zone

( ) large difference between ground temperature and delivered product temperature

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) _____

( ) other (describe briefly) _____

What are acceptable deviations from the standard testing protocol?

(X) none

( ) lengthen the duration of test

( ) other (describe briefly) _____

What elements of the test procedure are determined by personnel on-site?

( ) product level when test is conducted

( ) when to conduct test

( ) waiting period between filling tank and beginning test

( ) length of test

( ) determination that tank deformation has subsided

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) _____

(X) none

Evaluation of the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series Magnetostrictive Probe with 4 inch float for Monthly Monitoring for 0.2 gal/h on Underground Storage Tanks up to 30,000 gallons

Final Report Version 2

PREPARED FOR:

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Preface

This report describes testing conducted on the Pneumercator TMS4000 Series Automatic Tank Gauging System with MP450 Series magnetostrictive probe with a 4 inch float. This evaluation meets the requirements of the U.S. Environmental Protection Agency for Automatic Tank Gauging Systems for Monthly Monitoring for 0.2 gal/h leaks. This system can be installed on underground storage tanks up to 30,000 gallons in volume. The forms contained in this report are based on data collected using the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The statistics included in this report were calculated by Dr. Jairus Flora and the report was prepared by Craig D. Wilcox, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to Jonathan Levy, at (631) 293-8450.

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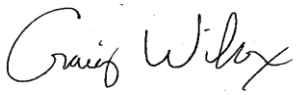

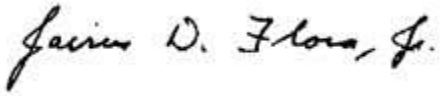

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September 22, 2020

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Section 1.0 Introduction

The Environmental Protection Agency requires that all tank testing equipment be capable of meeting certain performance standards. Automatic Tank Gauging Systems (ATGS) for monthly testing, are required to be capable of detecting leaks of 0.2 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time. An ATGS can also be evaluated to the 0.1 gal/h standard for monthly monitoring which requires the ATGS to be capable of detecting leaks of 0.1 gal/h with a probability of detection of 95% or greater. At the same time, the method must not produce false alarms (declaring a leak when the tank is tight) more than 5% of the time.

To assure that tank testing methods meet either the 0.1 or 0.2 gal/h performance standards, the EPA requires that each method be evaluated using prescribed protocols. The TMS4000 Series Automatic Tank Gauging System with MP450 Series (also known as 7100 series) magnetostrictive probe with a 4 inch float was evaluated according to the newly developed EPA protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems”, May 2019 following the 0.2 gal/h standard.

Section 2.0 Overview of Evaluation Method

The EPA ATGS protocol provides for several alternative approaches to the evaluation of ATGS's. The standard approach utilizing testing at a specialized test facility was used for this evaluation. For this option, the evaluation is conducted under controlled conditions. Since the system operates as an ATGS, the water sensing function of the ATGS was evaluated according to the newly developed EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", May 2019.

The EPA test procedures introduce four main factors that may influence the test results: Size of leak; amount of product in the tank; temperature differentials; and tank deformation. This is accomplished by testing at different product levels under various conditions where product of different temperatures is added to a partially filled test tank.

Testing was conducted using the manufacturer's normal test routine. The TMS4000 Series ATG was installed per the manufacturer's installation specifications. The TMS4000 console was programmed to conduct tests by Ken Wilcox Associates. The leak rate reported by the TMS4000 console was compared to the actual volume of product removed from the tank. A statistical analysis of the data was used to determine the performance characteristics of the test method.

In addition to the measurement of product levels, the equipment must also be capable of detecting an incursion of water into the tank. A series of tests are required to determine the minimum detection level and sensitivity of the Pneumercator TMS4000 ATG to water level changes. This testing was conducted by mounting the MP450 Series magnetostrictive probe in a test stand. Known volumes of water were added to a cylinder containing the probe assembly. The measured level changes were compared with independently measured level changes and the differences were statistically analyzed to determine the precision of the tester.

Section 3.0 Description of the TMS4000 Series console

The system used in the evaluation was the Pneumercator TMS4000 Series ATG with an MP450 Series magnetostrictive probe with a 4 inch float. The MP450 series probe is also referred to as the Pneumercator MP450 series probe. The TMS4000 console is part of the TMS4000 Series that also includes the TMS4000M. The only difference between the TMS4000 and TMS4000M console is the size of the touchscreen and the capacity of probes and sensors. The results of this evaluation are applicable to each of the consoles in the TMS4000 Series. A more complete description of the Pneumercator TMS4000 ATG features have been provided on the appropriate EPA description forms in Attachment A.

The Pneumercator TMS4000 ATG consists of a console that houses probe interfaces and a microprocessor to process level and temperature data from a magnetostrictive probe. The processed data includes product level, water level, product temperature, gross volume, net volume, percent volume and ullage, as well as other programmable functions such as automatic in-tank leak start times and set point alarm levels. The same information can be printed on the internal printer on the TMS4000 ATG.

The MP450 Series magnetostrictive probe with a 4 inch float probe operates on magnetostrictive principles to measure product and water levels in the tank. The temperature of the product is determined from five thermistors located in the magnetostrictive probe. Product levels and temperatures are combined and processed in an algorithm by the microprocessor in the console. A large number of sensors using various operating principles can be attached to the controller.

Section 4.0 Description of the Testing Location

The Pneumercator TMS4000 ATG was evaluated at the Fuels Management Research Center (FMRC) located in Grain Valley, Missouri. The FMRC includes one 20,055 gallon and two 13,767 gallon Xerxes FRP underground storage tanks. Numerous access ports are available for installation of test equipment.

Product temperature differentials are achieved by circulating product through external heat exchangers, which are heated by a glycol solution or cooled using a Freon chiller, before product is returned to one of the three tanks. Product deliveries are simulated by transferring product from one tank to another using positive displacement pumps at delivery rates up to 140 gal/min.

Leaks are generated using a variable speed peristaltic pump. Fuel is pulled from the tank, collected in a container for the duration of the leak and weighed at the conclusion of each test. The leak rate is determined from the volume of fuel and the duration of the leak.

This evaluation was conducted on the test tank with a volume of 20,055 gallons. The Pneumercator TMS4000 ATG is approved for use on tanks up to a nominal capacity of 30,000 gallons.

Section 5.0 Leak Detection Test Results

The Pneumercator TMS4000 ATG was programmed to conduct leak detection testing according to the manufacturer's normal procedures. There were a total of 24 leak detection tests that were conducted between 50% and 95% product volume for this evaluation. Included in the 24 evaluation tests were 12 tests performed at 90-95% volume and 12 tests at 50% product volume. There were also 4 optional lower level tests that were performed with the fuel level at 20% volume to verify the systems capability at a level lower than 50%. A summary of the test results for the Pneumercator TMS4000 ATG is shown in Table 1.

Table 1 - Pneumercator TMS4000 ATG

Test No.	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	-2.0	0.1	0.121	0.076	-0.045
2	-2.0	0.2	0.215	0.2	-0.015
3	-2.0	0	0	-0.012	-0.012
4	-2.0	0.3	0.301	0.282	-0.019
5	10.1	0	0	0.069	0.069
6	10.1	0.2	0.21	0.228	0.018
7	10.1	0.1	0.131	0.121	-0.01
8	10.1	0.3	0.292	0.275	-0.017
9	-10.0	0.1	0.13	0.101	-0.029
10	-10.0	0.3	0.308	0.28	-0.028
11	-10.0	0	0	-0.013	-0.013
12	-10.0	0.2	0.193	0.18	-0.013
13	-2.0	0.2	0.182	0.203	0.021
14	-2.0	0.3	0.256	0.226	-0.03
15	-2.0	0	0	-0.022	-0.022
16	-2.0	0.1	0.087	0.078	-0.009
17	10.0	0.2	0.189	0.294	0.105
18	10.0	0.3	0.247	0.302	0.055
19	10.0	0.1	0.087	0.075	-0.012
20	10.0	0	0	0.007	0.007
21	-10.2	0.1	0.092	0.018	-0.074
22	-10.2	0.3	0.251	0.204	-0.047
23	-10.2	0	0	-0.029	-0.029
24	-10.2	0.2	0.161	0.132	-0.029
Low Level Tests(not included in evaluation statistics)					
25	NA	0.1	0.085	0.058	-0.027
26	NA	0.2	0.141	0.134	-0.007
27	NA	0.3	0.244	0.218	-0.026
28	NA	0	0	0.008	0.008

Calculation of P_D and P_{FA} for Monthly Monitoring

Table 2 summarizes the results for the Pneumercator TMS4000 ATG that were obtained for a threshold of 0.1 gal/h. All of the results were calculated for Pneumercator TMS4000 ATG using the procedures specified in Section 5 of the EPA ATGS protocol. Nominal Leak rates of 0, 0.1, 0.2, and 0.3 gal/h were induced for the evaluation following the requirements for the 0.2 gal/h performance standard. The results from the 4 lower level tests that were performed with the fuel level at 20% are not included in the final statistics located in table 2.

Table 2.

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.2 gal/h
Threshold	0.1 gal/h
Variance	0.001495
MSE	0.001550
Standard deviation	0.038667 gal/h
Bias	-0.007417 gal/h
t(bias)	-0.939671 gal/h
Significant Bias?	Not Significant (P=0.357)
PFA (%) (using 0.1 as threshold)	0.83%
PD at 0.2 (%) (using 0.1 as threshold)	99.17%
Minimum threshold for 5% PFA	0.0663 gal/h
Minimum Detectable Leak Rate at 95% using the Minimum threshold	01325 gal/h
Minimum Detectable Leak Rate for 95% using 0.10 gal/h as threshold	0.1663 gal/h
Test Parameters	
Maximum Tank Size	30,000 gallons
Average Stabilization Time (1st Test of pair)	8 Hours
Average Data Collection Time	8 hours
Maximum Temperature Differential	12.69 degrees F
Effects of Tank Level	NS (P=0.096 var) NS (P=0.438 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

The results shown in Table 2 for the Pneumercator TMS4000 ATG meets the requirements of the federal regulations for Monthly Monitoring with 0.2 gal/h leaks with a P_D of 95% or greater and P_{FA} of 5% or less for tight tanks.

Size of Tank

Testing for Monthly Monitoring was conducted on a tank with a nominal capacity of 20,055 gallons. The tank that was used during the evaluation had a 120 inch diameter. Tanks of up to 1.5 times this volume or a nominal capacity of 20,000 gallons may be tested by the Pneumercator TMS4000 ATG.

Maximum Allowable Temperature Difference for Monthly Monitoring

There were 6 simulated fuel deliveries for the 24 tests used to calculate the Monthly Monitoring results. The temperature of the product that was transferred to the tank during the ATGS testing ranged from -10.2 deg F to +10.1 deg F. The standard deviation of these temperatures was 8.457 deg F. Using the EPA formula of 1.5 times the standard deviation of the temperature differences present during the evaluation, the maximum allowable temperature difference between product delivered and product in the tank is ±12.69 deg F.

There was no indication that any of these temperature differentials caused any problems for the Pneumercator TMS4000 ATG as long as the appropriate stabilization times were allowed before testing. A one-way analysis of variance was used to compare the three sets of temperature data (0, -10.2, and +10.1 deg F). The F-Test was 8.302 with 2 and 21 degrees of freedom, giving a P-value of 0.002 or 0.2%, which was statistically significant. The mean differences were -0.03275 gal/h, - 0.01638 gal/h, and 0.0269 gal/h for -10.2, 0, and +10.1 deg F, respectively. The results indicate that the TMS4000 ATG may benefit from a longer than 8 hour stabilization period after a fuel delivery that has a +/- 10 degree F or larger temperature differential.

Average Waiting Time After Filling

The waiting time after receiving product into the test tank was 8 hours.

Average Data Collection Time Per Test

The tests times for each test were 8 hours therefore the average data collection time for this evaluation for each test was also 8 hours.

Product Levels

For this evaluation, the testing was conducted with nominal product levels of 20%, 50% and 90-95% of the tank capacity. The results from the testing at 20% were performed only to verify the systems performance at the lower level and were not included in the final statistics of the report. A t-test was used to test whether there was a difference at the 5% significance level in the bias for the Pneumercator TMS4000 ATG for the 50% and 90% product levels (t = 0.937, t-critical = 1.71; P=0.359), showing that there was not a statistically significant difference in the average difference between the measured and induced leak rates at the 50% level compared to the average difference in the measured and induced leak rates at the 90% level.

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the two tank levels (50% and 90%) (F = 31.05 with 2 and 22 degrees of freedom; F-critical = 2.818; P<=0.0001 two-sided), showing a significant difference in the variability.

The combined results at the 50% and 90% tank levels were compared to the results at the 20% tank level. A t-test was used to test whether there was a difference at the 5% significance level between the bias in the results at the 20% level and those at the other levels. The results were: t-statistic=0.812 P=0.43 (2-sided), hence no significant difference in the bias for the lower tank level.

An F-test was used to test whether there was a difference at the 5% significance level in the variability of the results at the tank levels (50% and 90%) compared to the lower tank level of 20% (F =5.37; F-critical = 8.643; P=0.193 two-sided), showing no significant difference in the variability between the lower level and the others.. Thus, the performance at the 20% level was comparable to that at the combined 50% and 90% level.

Minimum Threshold

The minimum threshold that will result in a false alarm rate of 5% is also included in Table 2 as 0.0663 gal/h. A threshold less than the minimum threshold will result in a false alarm rate of greater than 5%.

Minimum Detectable Leak Rate

The minimum leak rate for the Pneumercator TMS4000 ATG that can be detected (MDL) with a probability of 95% (using the minimum 5% threshold of 0.0663 gal/h) is also summarized in Table 2 as 0.1325 gal/h. The minimum detectable leak rate using a threshold of 0.1 gal/h was also calculated and is shown in Table 2 as 0.1663 gal/h.

Section 6.0 Water Sensor Test Results

The water tests were conducted under laboratory conditions by adding known volumes of water to a reservoir containing the probe assembly. Sufficient diesel fuel to cover the water float was added before the tests were conducted. Independently measured level changes were compared with the measured level changes reported by the Pneumercator TMS4000 ATG. The point at which the water was first detected was determined, followed by incremental additions of water to determine the resolution of the water sensor. The results of the water sensor tests have been summarized in Table 2.

Minimum Detectable Water Level

At the 95% confidence level, the minimum detectable water level (MDWL) was determined using the procedures described in the ATGS protocol. The MDWL estimates the minimum level of water that the sensor can detect at least 95 % of the time. The mean values at which water can be detected are summarized in Table 2. The MDWL is 0.488 inches.

Minimum Water Level Change

The minimum water level (MLC) change that the water sensor can detect (after the MDWL is reached) was also provided. This information is also summarized in Table 2. The minimum detectable water level change on the MP450 Series magnetostrictive probe with a 4 inch float was found to be 0.488 inches. The minimum detectable water level change was found to be 0.124 inches.

Section 7.0 Conclusions

The following conclusions are based on the results of the testing described in this report.

1. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float exceeds the EPA 0.2 gal/h performance requirements for Monthly Monitoring of underground storage tanks.

2. The Probability of Detection (P_D) for a leak of 0.20 gal/h with a threshold of 0.1 gal/h exceeds the USEPA requirements for a P_D of 95% or higher for Monthly Monitoring.

3. The Probability of a False Alarm (P_{FA}) on a tight tank with a threshold of 0.1 gal/h exceeds the USEPA requirements for a P_{FA} of 5% or less for Monthly Monitoring.

4. Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks with a product level at or above 20%.

5. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float is validated for use on tanks up to a nominal capacity of 30,000 gallons.

6. The Pneumercator TMS4000ATG with MP450 Series magnetostrictive probe with a 4 inch float was found to be sensitive to temperature changes, giving significantly different readings at -10.2 degrees F and +10.1 degrees F. This suggests that a longer stabilization time may be beneficial if the fuel temperature differences from deliveries are more than +/- 10 degrees F.

Attachment A

EPA Forms for the Pneumercator TMS4000 ATG with MP450 Series magnetostrictive probe with a 4 inch float for Monthly Monitoring for 0.2 gal/h on Underground Storage Tanks up to 30,000 gallons

Results of U.S. EPA Standard Evaluation
Automatic Tank Gauging System (ATGS)

This form tells whether the automatic tank gauging system (ATGS) described below complies with the performance requirements of the federal underground storage tank regulation. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems." The full evaluation report also includes a form describing the method and a form summarizing the test data. Tank owners using this leak detection system should keep this form on file to provide compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

ATGS Description

Name Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Version number TMS4000 ATG and MP450 series probe with a 4" float

Vendor Pneumercator

1785 Expressway Drive North
(street address)

Hauppauge	NY	11788	U.S.A.	(631) 293-8450
(city)	(state)	(zip)	(country)	(phone)

Evaluation Results (see Tables below for summary of Evaluation Results)*

This ATGS, which declares tank to be leaking when the measured leak rate exceeds the threshold of 0.1 gallon per hour, has a probability of false alarms [P_{FA}] of 0.83%.

The corresponding probability of detection [P_D] of a 0.20 gallon per hour leak is 99.17 %.

The minimum water level (threshold) in the tank that the ATGS can detect is 0.488 inches.

The minimum change in water level that can be detected by the ATGS is 0.124 inches. (provided that the water level is above the threshold).

Therefore, this ATGS (X) does ( ) does not meet the **federal** performance standards established by the U.S. Environmental Protection Agency (0.20 gallon per hour at P_D of 95% and P_{FA} of 5%), and this ATGS (X) does ( ) does not meet the **federal** performance standard of measuring water in the bottom of the tank to the nearest 1/8 inch. *Tables 1 summarizes all of the performance data that was evaluated in this project.*

Table 1. Summary of Results

Basic Statistics	
Description	**Pneumercator TMS4000 ATG**
Number of Tests	24
Leak Rate	0.2 gal/h
Threshold	0.1 gal/h
Variance	0.001495
MSE	0.001550
Standard deviation	0.038667 gal/h
Bias	-0.007417 gal/h
t(bias)	-0.939671 gal/h
Significant Bias?	Not Significant (P=0.357)
PFA (%) (using 0.1 as threshold)	0.83%
PD at 0.2 (%) (using 0.1 as threshold)	99.17%
Minimum threshold for 5% PFA	0.0663 gal/h
Minimum Detectable Leak Rate at 95% using the Minimum threshold	01325 gal/h
Minimum Detectable Leak Rate for 95% using 0.10 gal/h as threshold	0.1663 gal/h
Test Parameters	
Maximum Tank Size	30,000 gallons
Average Stabilization Time (1st Test of pair)	8 Hours
Average Data Collection Time	8 hours
Maximum Temperature Differential	12.69 degrees F
Effects of Tank Level	NS (P=0.096 var) NS (P=0.438 bias)
Water Detection Mode	
Minimum Detectable Water Level (in)	0.488
Minimum Water Level Change (in)	0.124

Test Conditions During Evaluation (identical for all floats)

The evaluation testing was conducted in a 20,055 gallon ( ) steel (X) fiberglass tank that was 120 inches in diameter and 395 inches in length.

The temperature difference between product added to fill the tank and product already in the tank ranged from -10.2 deg F to +10.1 deg F, with a standard deviation of 8.457 deg F.

The tests were conducted with the tank product levels 20% and 90 % full.

The product used in the evaluation was diesel fuel.

Limitations on the Results (identical for all floats)

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for installing and operating the ATGS are followed.
- The tank contains a product identified on the method description form.
- The tank is no larger than 30,000 gallons.
- The fuel level in the tank must be at or above 20%. The waiting time after adding any substantial amount of product to the tank is 8 hours.
- The temperature of the added product does not differ more than 12.69 degrees Fahrenheit from that already in the tank.
- The total data collection time for the test is at least 8 hours.
    - Other limitations specified by the vendor of determined during testing: None Specified

➢ **Safety disclaimer: This test procedure only addresses the issue of the ATG system's ability to detect leaks. It does not test the equipment for safety hazards.**

Certification of Results

I certify that the ATGS was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed according to one of the following:

(X) standard EPA test procedure for ATGS
( ) alternative EPA test procedure for ATGS

Craig D. Wilcox, President	Ken Wilcox Associates, Inc.
(printed name)	(organization performing evaluation)
Craig Wilcox	
(signature)	Grain Valley, Missouri 64029
	(city, state. zip)
September 22, 2020	(816) 443-2494
(date)	(phone number)

Reporting Form for Leak Rate Data
Automatic Tank Gauging System

Method Name and Version: Pneumercator TMS4000 Series ATG with 4" float for 0.2 gal/h in 20K Tank

Evaluation Period: from 07/18/2020 to 08/10/2020 (Dates)

Test No.	Date at Completion of Last Fill (m/d/y)	Time at Completion of Last Fill (military)	Data Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	Test Duration (minutes)	Level After Transfer Completed (% full)	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1	6/8/2020	1605	6/9/2020	0005	0805	480	90	-2.0	0.1	0.121	0.076	-0.045
2	6/8/2020	1605	6/9/2020	1250	2050	480	90	-2.0	0.2	0.215	0.2	-0.015
3	6/8/2020	1605	6/10/2020	0730	1530	480	50	-2.0	0	0	-0.012	-0.012
4	6/8/2020	1605	6/10/2020	1610	0010	480	50	-2.0	0.3	0.301	0.282	-0.019
5	6/11/2020	2110	6/12/2020	0510	1310	480	90	10.1	0	0	0.069	0.069
6	6/11/2020	2110	6/12/2020	1410	2210	480	90	10.1	0.2	0.21	0.228	0.018
7	6/11/2020	2110	6/15/2020	2115	0515	480	50	10.1	0.1	0.131	0.121	-0.01
8	6/11/2020	2110	6/16/2020	1301	2103	480	50	10.1	0.3	0.292	0.275	-0.017
9	6/17/2020	1730	6/18/2020	0130	0930	480	90	-10.0	0.1	0.13	0.101	-0.029
10	6/17/2020	1730	6/18/2020	1230	2030	480	90	-10.0	0.3	0.308	0.28	-0.028
11	6/17/2020	1730	6/19/2020	2230	0630	480	50	-10.0	0	0	-0.013	-0.013
12	6/17/2020	1730	6/20/2020	1440	2240	480	50	-10.0	0.2	0.193	0.18	-0.013
13	6/22/2020	1530	6/22/2020	2330	0730	480	90	-2.0	0.2	0.182	0.203	0.021
14	6/22/2020	1530	6/23/2020	1430	2230	480	90	-2.0	0.3	0.256	0.226	-0.03
15	6/22/2020	1530	6/24/2020	2230	0630	480	50	-2.0	0	0	-0.022	-0.022
16	6/22/2020	1530	6/25/2020	0745	1545	480	50	-2.0	0.1	0.087	0.078	-0.009
17	6/25/2020	2102	6/26/2020	0502	1302	480	90	10.0	0.2	0.189	0.294	0.105
18	6/25/2020	2102	6/26/2020	1345	2145	480	90	10.0	0.3	0.247	0.302	0.055
19	6/25/2020	2102	6/29/2020	0400	1200	480	50	10.0	0.1	0.087	0.075	-0.012
20	6/25/2020	2102	6/30/2020	0300	1100	480	50	10.0	0	0	0.007	0.007
21	7/5/2020	0045	7/5/2020	0845	1645	480	90	-10.2	0.1	0.092	0.018	-0.074
22	7/5/2020	0045	7/5/2020	2310	0710	480	90	-10.2	0.3	0.251	0.204	-0.047
23	7/5/2020	0045	7/7/2020	0530	1330	480	50	-10.2	0	0	-0.029	-0.029
24	7/5/2020	0045	7/7/2020	1410	2210	480	50	-10.2	0.2	0.161	0.132	-0.029

Low Level Tests(not included in evaluation statistics)

25	7/5/2020	0045	7/9/2020	0950	1750	480	20	not applicable	0.1	0.085	0.058	-0.027
26	7/5/2020	0045	7/9/2020	1815	0215	480	20	not applicable	0.2	0.141	0.134	-0.007
27	7/5/2020	0045	7/10/2020	1135	1935	480	20	not applicable	0.3	0.244	0.218	-0.026
28	7/5/2020	0045	7/11/2020	1135	1935	480	20	not applicable	0	0	0.008	0.008

Description
Automatic Tank Gauging System

This section describes briefly the important aspects of the automatic tank gauging system (ATGS). It is not intended to provide a thorough description of the principles behind the system or how the equipment works.

ATGS Name and Version

Pneumercator TMS4000 ATG with MP450 series probe with 4" float

Product

> Product type

For what products can this ATGS be used? (check all applicable)

(X) gasoline
(X) diesel
(X) aviation fuel
(X) fuel oil #4
( ) fuel oil #6
(X) solvents
(X) waste oil
(X) other (list) bio-diesel and ethanol blends compatible with probe floats

> Product level

What product level is required to conduct a test?

( ) greater than 90% full

( ) greater than 50% full

(X) other (specify) greater than 20% Full

Does the ATGS measure inflow of water as well as loss of product (gallon per hour)?

( ) yes

(X) no

Does the ATGS detect the presence of water in the bottom of the tank?

(X) yes

( ) no

Level Measurement

What technique is used to measure changes in product volume?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

(X) change in level of float (specify principle, e.g., capacitance, magnetostrictive, load cell, etc.) magnetostrictive

( ) other (describe briefly) _____

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

( ) single sensor, without circulation

( ) single sensor, with circulation

( ) 2-4 sensors

(X) 5 or more sensors

( ) temperature-averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

( ) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

(X) thermistor

( ) other (describe briefly) _____

If product temperature is not measured during a test, why is it not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly) _____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

(X) by computer

Procedure information

> Waiting times

What is the minimum waiting period between adding a large volume of product (i.e., a delivery) and the beginning of a test (e.g., filling from 50% to 90-95% capacity)?

( ) no waiting period

( ) less than 3 hours

( ) 3-6 hours

(X) 7-12 hours

( ) more than 12 hours

> Test duration

What is the minimum time for collecting data?

( ) less than 1 hour

( ) 1 hour

( ) 2 hours

( ) 3 hours

( ) 4 hours

(X) 5-10 hours

( ) more than 10 hours

( ) variable (explain)_____

> Total time

What is the total time needed to test with this ATGS after a delivery?
(waiting time plus testing time)

16 hours 0 minutes *(maximum test time)*

What is the sampling frequency for the level and temperature measurements?

( ) more than once per second

(X) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable (explain) _____

> Identifying and correcting for interfering factors

How does the ATGS determine the presence and level of the ground water above the bottom of the tank?

( ) observation well near tank

( ) information from USGS, etc.

( ) information from personnel on-site

( ) presence of water in the tank

( ) other (describe briefly) _____

(X) level of ground water above bottom of the tank not determined

How does the ATGS correct for the interference due to the presence of ground water above the bottom of the tank?

( ) system tests for water incursion

( ) different product levels tested and leak rates compared

( ) other (describe briefly) _____

(X) no action

How does the ATGS determine when tank deformation has stopped following delivery of product?

(X) wait a specified period of time before beginning test

( ) watch the data trends and begin test when decrease in product level has stopped

( ) other (describe briefly) _____

( ) no procedure

Are the temperature and level sensors calibrated before each test?

( ) yes

(X) no

If not, how frequently are the sensors calibrated?

( ) weekly

( ) monthly

( ) yearly or less frequently

(X) never

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

(X) actual level changes observed when known volume is added or removed (e.g., liquid metal bar) *(This is one way the Pneumercator TMS4000 ATG can be used to generate a custom tank chart)*

(X) theoretical ratio calculated from tank geometry

(X) interpolation from tank manufacturer's chart

(X) other (describe briefly) All three options are available .

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) actual sample taken for each test and Ce determined from specific gravity

( ) value supplied by vendor of product

(X) average value for type of product

( ) other (describe briefly) _____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

(X) difference between first and last data collected

( ) from data from last _____ hours of test period

( ) from data determined to be valid by statistical analysis

( ) other (describe) _____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

( ) 0.05 gallon per hour

(X) 0.10 gallon per hour

( ) 0.20 gallon per hour

() other (list) _____

Under what conditions are test results considered inconclusive?

( ) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase such as stiction

( ) other (describe briefly) _____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) water in the excavation zone

( ) large difference between ground temperature and delivered product temperature

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) _____

( ) other (describe briefly) _____

What are acceptable deviations from the standard testing protocol?

(X) none

( ) lengthen the duration of test

( ) other (describe briefly) _____

What elements of the test procedure are determined by personnel on-site?

( ) product level when test is conducted

( ) when to conduct test

( ) waiting period between filling tank and beginning test

( ) length of test

( ) determination that tank deformation has subsided

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) _____

(X) none