PMP Liquid Level Sensors

Solution Engineering Group File Number 190543

Submitted by:

Solution Engineering™ Group

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PMP Liquid Level Sensors
Solution Engineering Project No. 180543

Background:

Solution Engineering Group (SEG) was asked by PMP Corporation (PMP) to conduct testing on two style Liquid Level Sensors with float switches to determine the lower level detection limit of the sensors. The sensors are designated as p/n 63420 & 63460 Steel Tank Interstitial sensors and p/n 63409 Fiberglass Tank Interstitial sensors. The only difference between the 63420 and 63460 Steel Tank Interstitial sensors is cable length. The 63420 having a 16' cable and the 63460 having a 30' cable. Testing was performed using the 63460 assuming a "worst case".

Four of each type sensor were supplied along with a Veeder-Root sensor panel (Photo #'s 1-3). Three sensors of each type were tested with the fourth sensor ready if needed for testing. SEG conducted testing between 9/19/2019 to 10/1/2019.

Photo #1: Test Units Sent by PMP Corp.

Photo #2: Sensor Type 63460 for Steel Tanks

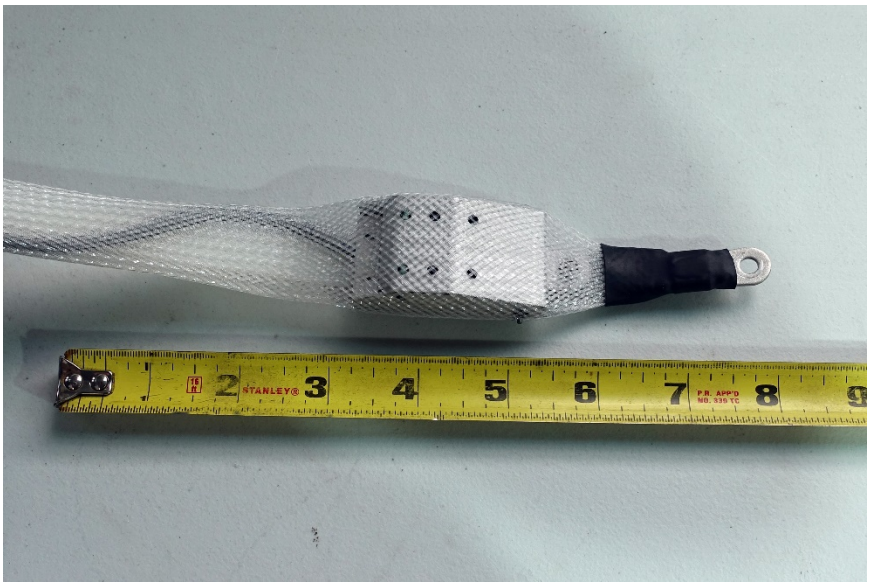


Photo #3: Sensor Type 63409 for Fiberglass Tanks

Protocol:

SEG followed the outlined by the EPA titled: EPA Standard Test Procedures for Evaluating Release Detection Methods: Volumetric and Non-volumetric Tank Tightness Testing – Liquid Phase Sensor Testing, May 2019. This protocol can be found in Appendix C.

Testing:

The following equipment was used to conduct the leak detection tests:

- Mitutoyo 6” caliper capable of measuring to 0.0005”, calibration certificate is in Appendix C.
- MC 25 ml burette with 0.1mm graduations.

- Veeder-Root TLS 350
- Veeder-Root Software Revision Level Version 11.02, #346011-100-C created – 96.09.09.10.41
- A 3.87" diameter metal cylinder with an area of 11.76 sq. in., used to test the Type 63460 Steel Tank sensors, Photo #4.
- A CNC milled nylon round tank for the Type 63460 Steel Tank sensors. This was used for the water and diesel tests on Type 63460 Steel Tank sensor, SN 19843, only. Photo #5.
- A CNC milled nylon rectangular tank for the Type 63409 sensors with an area of 11.99 sq. in. Photo #6.

Photo #4: Metal Cylinder Used for Testing

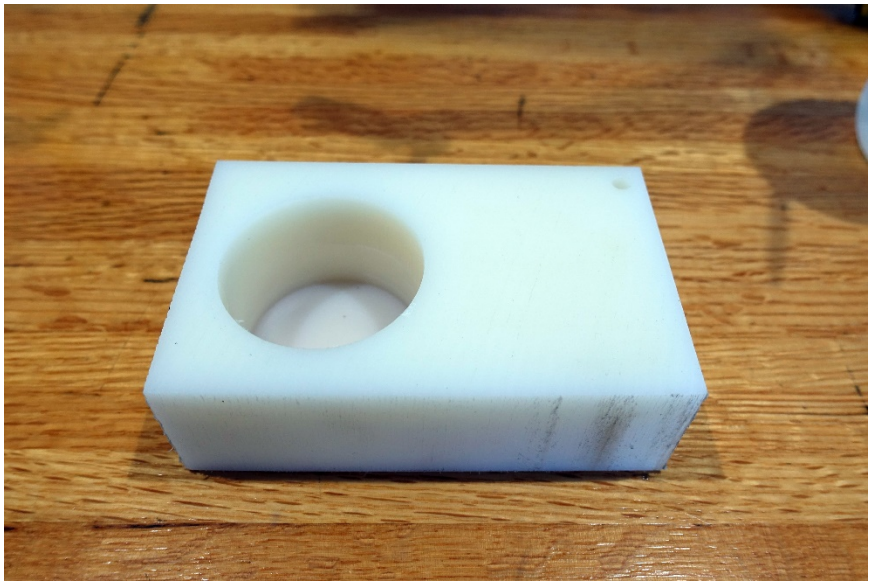


Photo #5: Nylon Round Tray Used for Testing

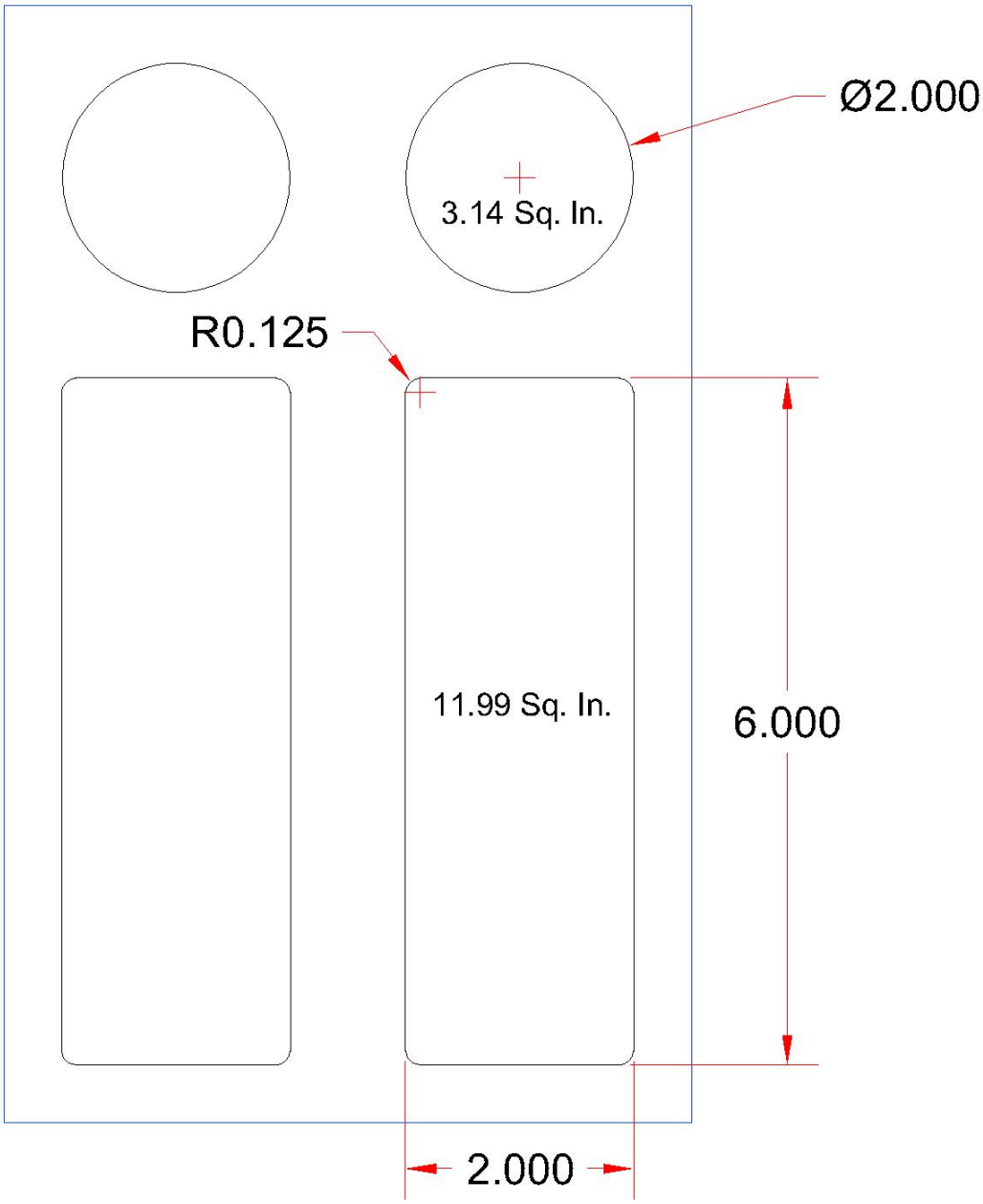
Photo #6: Nylon Tray Used for Testing

The diameter of the metal cylinder was determined by measuring the inside diameter 5 times with the Mitutoyo 6" caliper and then averaging the results. Table #1 shows the results.

Diameter of Metal Cylinder	
Measurement #	Diameter in inches
1	3.8600
2	3.8790
3	3.8685
4	3.8890
5	3.8565
Average Dia.	3.8706

Table #1

The area of the nylon trays was determined by the CAD program used to create the CNC files for manufacturing the trays, see drawing #1. Measurements of the trays show they are cut within 0.1% of the listed dimensions.



Drawing #1: Nylon Tray Dimensions from CAD Program

The goal of testing is to determine the liquid height necessary to cause the sensor to trigger an alarm signal. The metal cylinder and nylon trays restrict viewing the liquid, so it could not be measured with a ruler. Liquid height had to be determined by calculating the area of the metal cylinder. Once the area was known, the height of the liquid could be determined by knowing the volume of liquid added to the metal cylinder and nylon trays, the volume taken up by the sensor and how many milliliters are in a cubic inch. The testing was conducted using the following steps:

Step #1 – To determine the volume of the 63460 immersed sensor, the sensor was lowered into a glass beaker and product was added until the sensor triggered an alarm on the TLS unit. A line was carefully marked

on the beaker indicating the product height. The sensor was removed, lowering the liquid level. Using a burette, product was slowly added until it reached the line marking the liquid detection height. Sensor volume was calculated using all three liquids because the trigger height changed according to liquid type. A similar procedure was used for the 63409 sensors, but the test tray was used to find the volume and a pencil line was marked on the side to indicate the trigger level of the liquid. The volume needed to make up the sensor volume was recorded and is shown in the test results in Table #2 under "Volume of Sensor in Fluid (ml)".

Step #1 – A sensor was mounted onto the SEG test fixture Photo #7 & 8.

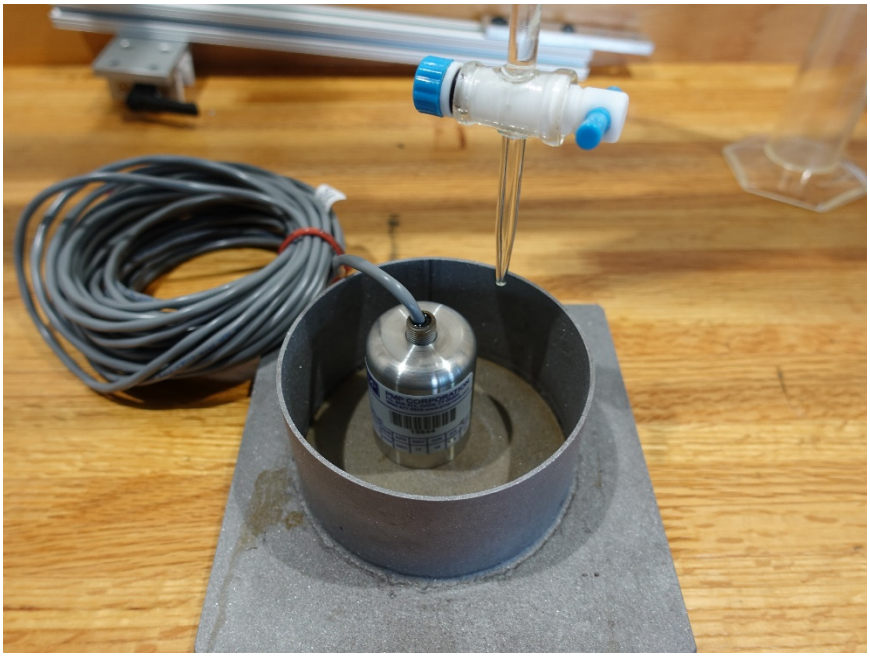


Photo #7: Type 63460 Sensor Placed for Testing

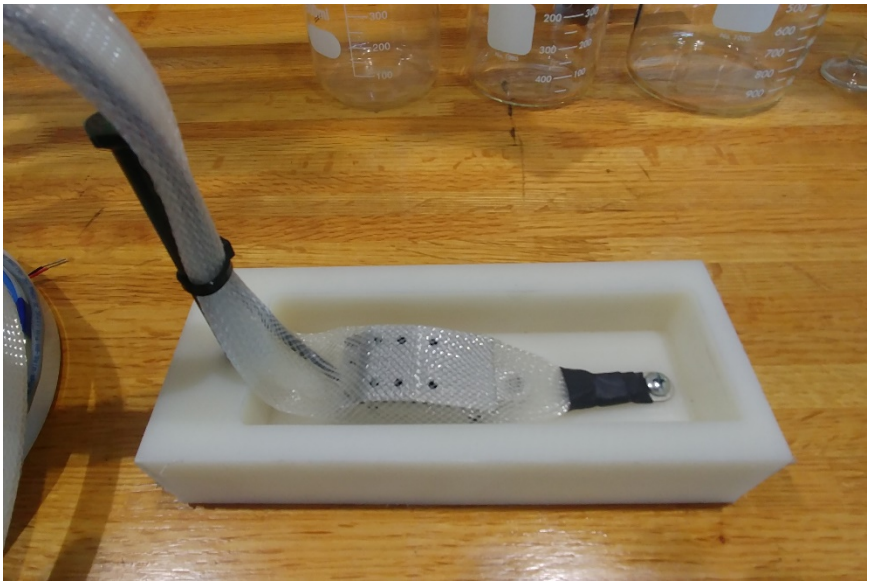


Photo #8: Type 63409 Sensor Placed for Testing

Step #3 – The beaker was replaced with the metal cylinder or nylon trays and the sensor was placed so that it either rested on the bottom of the metal cylinder (Type 63420 & 63460) or was mounted with a screw to the nylon tray (Type 63409).

Step #4 – Liquid product was added slowly for each first run to determine the alarm height for the liquid. For runs 2 through 10, liquid was added more quickly using a graduated cylinder (after being calibrated by the burette) to get near the alarm height. The burette was then used to carefully add the remaining liquid to get to the alarm height.

The total volume is shown in the test results in Table #3 as "Average Volume added to Trip for Each Sensor - Sensor Volume by Liquid".

Step #6 – Since the sensors use a float switch that is either on or off based on position, the time to alarm is immediate and no time measurements were possible. Fall time, likewise, was not able to be measured as it was immediate.

Step #7 – Step #'s 3-6 were repeated 9 times for a total of 10 test runs for each product type.

Test Results:

Detector Information:

Output type:	Qualitative
Sampling frequency:	Continuous
Operating principle:	Float Switch

The displacement volume for each style sensor is listed in Table #2.

Height to alarm for each sensor is shown in Table #3. This table shows the average of the 10 tests done on each unit. The full test tables are shown in Appendix A.

Volume Measurements by sensor type, (ml.)		
Sensor type	63460	63409
	Steel Tank	Fiberglass
Volume Water	14.4	12.4
Volume Diesel	19.7	9.7
Volume Ethanol	13.4	12.8

Table #2

Test Data Compilation																
Sensor Type	Sensor SN	Water Volume (ml)	Sensor Volume Water (ml)	Water Volume - Sensor Volume (ml)	C	L (inch)	Diesel Volume (ml)	Sensor Volume Diesel (ml)	Diesel Volume - Sensor Volume (ml)	C	L (inch)	Ethanol Volume (ml)	Sensor Volume Ethanol (ml)	Ethanol Volume - Sensor Volume (ml)	C	L (inch)
63460	19843	43.0	14.4	57.4	0.019	1.1	49.7	19.7	69.4	0.019	1.3	246.4	13.4	259.8	0.005	1.3
	19844	212.7	14.4	227.1	0.005	1.2	231.6	19.7	251.3	0.005	1.3	244.4	13.4	257.8	0.005	1.3
	19842	222.3	14.4	236.7	0.005	1.2	232.9	19.7	252.6	0.005	1.3	243.0	13.4	256.4	0.005	1.3
63409	20079	65.5	12.4	77.9	0.005	0.4	77.7	9.7	87.4	0.005	0.4	79.8	12.8	92.6	0.005	0.5
	20078	66.2	12.4	78.6	0.005	0.4	76.1	9.7	85.8	0.005	0.4	75.9	12.8	88.7	0.005	0.5
	20080	76.0	12.4	88.4	0.005	0.4	86.0	9.7	95.7	0.005	0.5	84.6	12.8	97.4	0.005	0.5

Table #3

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Test Materials:

E10 "Regular" Gasoline

Gasoline was purchased commercially from Sam's Club, containing ~~th~~10% Ethanol by volume.

Diesel

Diesel was purchased commercially from Sam's Club for testing purposes.

Water

Glacier Mist brand distilled water was purchased commercially for testing purposes.

Statistical Calculations:

Area of the metal test cylinder or nylon tray:

$$A_C = \pi r^2$$

Where A is the cross section of the cylinder and r is the radius of the cylinder.

Measured metal cylinder diameter = 3.8706" (from Table #1).

Diameter ÷ 2 = 1.935"

$$A_C = \pi \text{ x } 1.935^{2"}$$

A_C = 11.766 sq. in. for the metal cylinder.

Area determined for the nylon cylinder using the same formulas (and the CAD program) was

Ac (nylon) = 3.14 sq. in.

The area calculated for the nylon rectangular tray (by the CAD program)
A tray = 11.99 sq. in.

Height to Alarm:

$$L = (V_B + V_D) * C$$

Where L is the level at which alarm first occurs, V_B is the volume added to the container by the burette, V_D is the displacement volume of sensor at alarm level, and C is the conversion factor to convert volume to height (e.g., ml/in) for the test cylinder.

C = 1/milliliters required to fill the containers to a height of 1"

The number of milliliter's in a cubic inch is a constant having a value of 16.387 ml/in^3.

The area of the metal cylinder was calculated to be 11.766 sq. in. The volume of the metal cylinder with liquid 1" high is 11.766 in^3 (area multiplied by 1" height). Using the same calculation the volume of the nylon cylinder with 1" liquid is 3.140 in^3 and 11.990 in^3 for the nylon tray.

$$C = 1/(16.387\ ml/in^3 * 11.766\ in^3)$$

$$C = 1/192.809$$

Or

C =.00519 metal cylinder
C = .01943 nylon cylinder
C = .00509 nylon tray

So the formula for liquid height is:

$$L = (V_B + V_D) * .00519 \text{ for the metal cylinder}$$

$$L = (V_B + V_D) * .01943 \text{ for the nylon cylinder}$$

$$L = (V_B + V_D) * .00509 \text{ for the nylon tray}$$

Precision:

The precision of liquid level sensors is obtained by calculating the standard deviation of the ten liquid level measurements required to make the sensor alarm. The equation for standard deviation is:

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}}$$

Where N is the number of tests conducted for each product type, x_i represents the height to alarm data for each test and $\bar{x}$ is the mean of the height to alarm data for each test.

Appendix A has the test sheets which show the Precision (standard deviation) for the data.

Threshold (Lower Detection Limit):

The threshold is calculated from the equation:

Threshold = Mean + 3.379*STD (for ten samples)

Threshold = Mean + 3.532*STD (for nine samples)

Where the mean is the average alarm level for each test set, and STD is the standard deviation for each data set. The tolerance coefficient for six data points (95% confidence) is 4.414.

Appendix A has the test sheets which show the Threshold (Lower Detection Limit) for the data.

Appendix B has the calibration sheet for the dial caliper used to measure the metal cylinder.

Appendix C shows a copy of the EPA Protocol.

Appendix D has the official test reports for the EPA.

Appendix E has Jeff Williams and John Fildes CV's.

This concludes our report to date. Please forward any new information for review and analysis. If any conclusions change or need to be added due to new information, this report will be supplemented accordingly. Please contact us if you have any questions or need anything clarified.

Respectfully submitted,

Solution Engineering Group

John Fildes

Dr. John Fildes
Physical Chemistry
October 18, 2019

Jeff Williams
President
October 18, 2019

Appendix A:

Test Data with Precision, Mean and Threshold

Test #1, Style 63460, SN 19843					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	43.4	1	48.7	1	No Data
2	43.2	2	49.8	2	248.0
3	43.2	3	50.0	3	247.4
4	41.9	4	49.8	4	247.0
5	43.0	5	49.9	5	242.2
6	43.7	6	50.0	6	243.0
7	43.3	7	49.8	7	247.0
8	43.0	8	49.8	8	248.6
9	42.2	9	49.7	9	253.6
10	43.3	10	49.7	10	240.8
Precision (Standard Deviation)	0.01		0.01		0.08
avg.	39.1		45.2		221.8
Threshold (Lower Detection Limit)	39.1		45.2		222.1

Note: Test #1 for water and Diesel used the smaller nylon container which was replaced by the metal cylinder because the nylon was not deep enough to allow the sensor to trip.

Test #2 Style 63460, SN 19844					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	214.2	1	229.3	1	245.2
2	212.2	2	231.6	2	245.2
3	212.4	3	231.3	3	243.2
4	212.5	4	233.2	4	242.9
5	212.9	5	232.3	5	246.0
6	211.2	6	231.7	6	245.0
7	213.2	7	232.4	7	244.9
8	211.4	8	231.6	8	244.4
9	213.6	9	231.6	9	243.5
10	213.3	10	230.9	10	243.6

Standard Deviation	0.00	0.01	0.01
avg.	193.4	210.5	222.2
Threshold (Lower Detection Limit)	193.4	210.6	222.2

Test #3 Style 63460, SN 19842					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	218.9	1	231.4	1	242.4
2	221.6	2	233.0	2	243.5
3	223.0	3	233.0	3	242.8
4	221.4	4	232.0	4	244.2
5	222.1	5	233.3	5	244.6
6	223.9	6	233.4	6	243.3
7	223.1	7	233.7	7	242.0
8	221.0	8	232.4	8	242.4
9	224.2	9	233.2	9	242.3
10	224.0	10	233.3	10	242.7

Standard Deviation	0.01	0.00	0.00
avg.	202.1	211.7	220.9
Threshold (Lower Detection Limit)	202.1	211.7	220.9

Test #4 Style 63409, SN 20079					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	66.2	1	77.4	1	78.3
2	66.0	2	76.5	2	78.0
3	65.7	3	76.4	3	78.7
4	64.6	4	74.6	4	80.7
5	65.2	5	75.0	5	80.8
6	65.7	6	76.0	6	76.5
7	63.6	7	80.0	7	80.5
8	66.2	8	76.2	8	79.4
9	64.8	9	80.3	9	82.0
10	66.7	10	84.9	10	83.3

Standard Deviation	0.00	0.02	0.01
avg.	59.5	70.7	72.6
Threshold (Lower Detection Limit)	59.5	70.7	72.6

Test #5 Style 63409, SN 20078					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	77.9	1	82.0	1	77.7
2	65.0	2	71.0	2	78.8
3	62.5	3	75.1	3	76.4
4	67.9	4	74.6	4	74.3
5	61.0	5	73.0	5	71.0
6	60.0	6	75.8	6	76.7
7	70.0	7	77.5	7	74.5
8	65.3	8	76.8	8	75.6
9	65.0	9	76.7	9	77.2
10	66.9	10	78.3	10	76.3

Standard Deviation	0.03	0.02	0.01
avg.	60.1	69.2	69.0
Threshold (Lower Detection Limit)	60.2	69.2	69.0

Test #6 Style 63409, SN 20080					
Water		Diesel		Unleaded Gasoline	
Test #	Volume (mL)	Test #	Volume (mL)	Test #	Volume (mL)
1	87.3	1	85.8	1	88.7
2	72.7	2	81.7	2	85.5
3	73.9	3	82.3	3	84.7
4	71.2	4	88.8	4	85.7
5	76.3	5	86.1	5	80.9
6	75.0	6	95.0	6	83.6
7	71.0	7	87.2	7	85.4
8	73.4	8	83.9	8	87.2
9	82.6	9	84.4	9	80.2
10	76.4	10	85.0	10	83.6

Standard Deviation	0.03	0.02	0.01
avg.	69.1	78.2	76.9
Threshold (Lower Detection Limit)	69.2	78.3	76.9

Appendix B:

Mitutoyo

Certificate of Calibration

ACCREDITED
CERT. #0750-01
CALIBRATION

NAME & ADDRESS:	AMAZON.COM.DEDC LLC - MKE1 KENOSHA, WI.	CONDITION:	NEW
CODE NUMBER:	500-196-30	DESCRIPTION:	CALIPER
SERIAL NUMBER:	B17070665	CONTROL NO.:	907410
I.D. No.:	N/A	RANGE:	0.000" - 6.000"

RANGE (inches)	OUTSIDE ERROR (inches)	INSIDE ERROR (inches)
1.000	0.0000	0.0000
2.000	0.0000	0.0000
4.000	0.0000	0.0000
6.000	0.0000	0.0000
	STEP ERROR:	0.0000
	DEPTH ERROR:	0.0005

Measurement uncertainty : ± (200 + 10L) µin where L= Nominal length in inches.
This uncertainty represents an expanded uncertainty expressed at
approximately the 95% confidence level using a coverage factor of k=2.
Procedure used: CLTM-7 REV. D. "As-found" = "As-left" data.

This is to certify that the gages listed have been compared with Mitutoyo Masters, which are traceable to the National Institute of Standards and Technology, at a measuring temperature of 20° C ± 1.00° C, RH 30% to 50%.

Calibrated by: _____ Date: **AUGUST 16, 2017** Number: **Test No. 683/285541-14**

Jerry Swigost, Calibration Technician

THIS CERTIFICATE SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN PERMISSION OF THE MITUTOYO CALIBRATION LAB.

MITUTOYO AMERICA CORP. CALIBRATION LAB., 965 CORPORATE BLVD., AURORA, IL. 60502
PHONE (888) 648-8869 FAX (630) 978-6477

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Appendix C:

EPA Protocol

United States Environmental Protection Agency

Office of Underground Storage Tanks

Standard Test Procedures For Evaluating Release Detection Methods: Volumetric And Non-volumetric Tank Tightness Testing

May 2019

Liquid Detection Test In Dry Space

The tests presented in this section simulate ingress of product or groundwater into a dry environment or secondary containment, such as an interstice. Non-discriminating sensors will respond to the presence of any liquid; however, incorporate at least three initial detection liquids into the test design for the specificity calculation. Use an evaluator-chosen diesel fuel, groundwater and gasoline or alcohol blend (as applicable), then perform 10 replicate tests on each liquid. Use the most common gasoline blend or alcohol blend at the time of testing. For testing sensors intended to be used in alcohol blends that are designed to react to a change in electric potential such as capacitance and conductivity sensors, at minimum, the evaluator must test the alcohol blend, in addition, that alcohol blend with three water mixtures: 80 percent alcohol blend and 20 percent water; 60 percent alcohol blend and 40 percent water; and 30 percent alcohol blend and 70 percent water.

After placing the sensor inside the empty test vessel and activating it for data collection as per the vendor instructions, monitor the output for 30 minutes as a blank test to establish the baseline signal. Pump the product or groundwater from the graduated cylinder into the test vessel at approximately 5 mm/min. Ensure the sensor is in place to detect this ingress of liquid and react with a positive test result or not react in a negative test result.

At the completion of the tests, remove the sensor and the liquid from the test chamber. Measure the liquid volume without the sensor and then handle the liquid appropriately by treating or disposing of it properly. Rinse the sensor with water or clean it by following the vendor recommended recovery procedure; monitor the recovery time.

With most liquid level sensors, conduct the following procedure with water, non-alcohol blended gasoline, and diesel fuel. If the sensor is to be used with alcohol blends, test with the desired alcohol blend. In addition, use the identified water, alcohol, and petroleum fuel mixtures identified above for sensors designed to react to a change in electric potential. To determine the threshold and precision of a sensor, follow the steps below.

Step 1 Set up – Mount the sensor in the test vessel with a known, uniform diameter from top to bottom. Fasten the sensor securely so it is in contact via its normal orientation with the liquid test vessel bottom.

Step 2 Blank test – Activate and monitor sensor for a minimum of 30 minutes to establish a baseline.

Step 3 Conduct liquid level testing – Add liquid such as product or water to the test vessel from a burette capable of reading volume to the nearest 0.2 ml or pump liquid into the vessel at a height increase of approximately 5 mm/min. Add liquid until the sensor responds to the liquid. Allow adequate time between increments for the sensor to respond if the response time is not instantaneous. Once the sensor activates, the initial detection test is complete.

If the sensor does not activate, bring the liquid height to 20 percent higher than the vendor stated actuation height and turn off the pump. Wait for 60 minutes without detection before aborting the test. If a specific wait time is required, the initial detection test is complete after the wait time has elapsed.

Step 4 When the approximate threshold has been determined, remove the sensor, and empty the cylinder of liquid, then perform a repeat measurement.

Step 5 For subsequent measurements, add liquid quickly to just below the threshold level.

Step 6 Add liquid very slowly until the sensor responds.

Step 7 Repeat steps 3 through 5 a minimum of 10 times for each liquid.

Step 8 Record all information in an appropriate manner.

The evaluator will determine if the sensor is affected by different product. To determine the specificity of the sensor, use multiple products following the same test procedures to collect a minimum of 10 replicates to compare the performance.

Test the sensors in the types of liquids they respond to under normal operating procedures. However, liquid level sensors should respond to any liquid after the liquid level exceeds the threshold and triggers the switch contact. If the evaluator finds that the sensor does not respond to a particular liquid type, record this finding on the report forms. The thresholds may vary slightly as the product density varies for float sensors.

Product Layer Detection On Top Of Water

Some external sensors are designed specifically not to alarm with water and to detect fuel product. In this case, for non-alcohol blends, water may accumulate in the space and if fuel is present, it will collect on top of the water creating a hydrocarbon layer. Install the sensor in the test vessel as it is used with water that has a layer of product on it. Test the sensor 10 times at each test product thickness of 0.0250 centimeters (cm) or 0.0625 in; 0.32 cm or 0.125 in; and 0.64 cm or 0.25 in on two different fuel products; note that these thicknesses are 1/16 inch, 1/8 inch, and 1/4 inch, respectively. Test diesel fuel and if the sensor is to be used with alcohol blends, test with the vendor chosen alcohol blend. To determine reliability and accuracy of a sensor for a specific alcohol blend, the evaluator must evaluate the discriminatory sensor both with alcohol blend fuel that is fully in solution with water, as well as with distinct phase

Appendix D:

EPA Test Reports

Results Of U.S. EPA Alternative Evaluation
Sensors

This form documents the performance of the sensor described below. The vendor, or a consultant to the vendor, conducts the evaluation according to the U.S. EPA's requirements for alternative protocols. The full evaluation report includes a report describing the method, a description of the evaluation procedures, and a summary of the test data.

Tank owners using this release detection system should keep this form on file to prove compliance with the federal UST regulation. Tank owners should check with regulatory authorities to make sure this form satisfies their requirements.

Method Description

Name PMP Corporation Steel Tank Interstitial Sensor.

Version 63420 & 63460 Sensors are for use with Veeder-Root TLS-450 series, TLS-4 series, TLS-350 series, TLS-300 series, TLS-PC, ILS-350, Simplicity, Gilbarco EMC series, EMC Basic, EMC-PC, Red Jacket ProMax and ProPlus.

Vendor

PMP Corporation, 25 Security Drive
Street address

Avon | CT | 06001
City | State | Zip

Sensor output type Qualitiative

Sensor operating principle Float Switch

General description of the sensor These sensors employ a float switch to detect liquid in the interstitial space of double walled steel tanks.

Evaluation Results

The sensor listed above was tested for its ability to respond to a change in condition when tested in a controlled test vessel. The following parameters were determined from this evaluation.

- 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.
- Recovery 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.

Parameter	Ethanol-blended Gasoline (10 %)	Water	Diesel
Average detection height in inches	1.3	1.2	1.3
Precision in inches	.03	.01	.01
Average detection time as hh:mm:ss	<1 second	<1 second	<1 second
Recovery time as hh:mm:ss	<1 second	<1 second	<1 second

Specificity	100%	100%	100%

Limitations On The Results

Limitations specified by the vendor or determined during testing

None

Certification Of Results

I certify the sensor was operated according to the vendor's instructions. I also certify the evaluation was performed according to the standard EPA test procedure for tank tightness testing methods and the results presented above are those obtained during the evaluation.

Jeffrey S Williams
Printed name

Signature

10/18/2019
Date

Solution Engineering Group
Organization performing evaluation

Montgomery, IL 60538-1367
City, state, zip

630-701-7703
Phone number

Results Of U.S. EPA Alternative Evaluation
Sensors

This form documents the performance of the sensor described below. The vendor, or a consultant to the vendor, conducts the evaluation according to the U.S. EPA's requirements for alternative protocols. The full evaluation report includes a report describing the method, a description of the evaluation procedures, and a summary of the test data.

Tank owners using this release detection system should keep this form on file to prove compliance with the federal UST regulation. Tank owners should check with regulatory authorities to make sure this form satisfies their requirements.

Method Description

Name PMP Corporation Fiberglass Tank Interstitial Sensor.

Version 63409 Sensors are for use with Veeder-Root TLS-450 series, TLS-4 series, TLS-350 series, TLS-300 series, TLS-PC, ILS-350, Simplicity, Gilbarco EMC series, EMC Basic, EMC-PC, Red Jacket ProMax and ProPlus.

Vendor

PMP Corporation, 25 Security Drive
Street address

Avon | CT | 06001
City | State | Zip

Sensor output type Qualitiative

Sensor operating principle Float Switch

General description of the sensor These sensors employ a float switch to detect liquid in the interstitial space of double walled fiberglass tanks.

Evaluation Results

The sensor listed above was tested for its ability to respond to a change in condition when tested in a controlled test vessel. The following parameters were determined from this evaluation.

- 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.
- Recovery 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.

Parameter	Ethanol-blended Gasoline (10 %)	Water	Diesel
Average detection height in inches	0.05	0.04	0.04
Precision in inches	0.01	0.02	0.02
Average detection time as hh:mm:ss	<1 second	<1 second	<1 second
Recovery time as hh:mm:ss	<1 second	<1 second	<1 second

Specificity	100%	100%	100%

Limitations On The Results

Limitations specified by the vendor or determined during testing

None

Certification Of Results

I certify the sensor was operated according to the vendor's instructions. I also certify the evaluation was performed according to the standard EPA test procedure for tank tightness testing methods and the results presented above are those obtained during the evaluation.

Jeffrey S Williams
Printed name

Signature

10/18/2019
Date

Solution Engineering Group
Organization performing evaluation

Montgomery, IL 60538-1367
City, state, zip

630-701-7703
Phone number

Appendix E:

Jeff Williams CV

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Jeffrey S Williams

President

Professional History:

2013 – Present **President of Engineering Answers, Inc., DBA: Solution Engineering Group, Montgomery, IL.**

- Manage all facets of the operation of Solution Engineering Group, a multi-disciplinary engineering consulting company.
- Manage the test lab, including designing/fabricating test fixtures and equipment required for accident reconstruction and product testing.
- Conduct laser scanning of accident scenes and equipment.
- Create models and displays for courtroom, educational and trade show use.
- Organize, manage and assign engineering cases.

2012 – 2013 **Technologist for TGER Technologies, Bolingbrook, IL.**

- Part of the design team building a working prototype Tactical Garbage to Energy Refinery (TGER) alternative energy unit for the DOD.
- Member of the equipment fabrication team for a TGER alternative energy unit with tasks including stainless steel fabrication, pneumatic feed system design and fabrication, auger system construction/modification, high temp heating zone design & fabrication, IR sensor troubleshooting and installation and design/fabricate support systems for the skid mounted equipment.
- Set up, troubleshoot and successfully operate the TGER unit for the Department of Defense at the Aberdeen Proving Ground in Maryland.

1991 – 2012 **Technologist for Packer Engineering, Inc., Naperville, IL.**

- Team member for research projects for NASA grants and DOD that were kept within small fixed budgets including:
  - NASA SBIR metal solidification in microgravity experiments flown on the NASA microgravity jet – designed, built and operated the test fixture for 120 zero G parabolas (1 parabola = a 30 second period of micro gravity), 20 Martian G parabolas and 20 lunar G parabolas.
  - NASA SBIR Phase I liquid free fall and vaporization in lunar gravity flown on the NASA microgravity jet – designed, built and operated the test fixture for 30 lunar G parabolas.
  - NASA SBIR Phase II regolith vaporization ground based testing included designing and building a fixture to vaporize small quantities of regolith (lunar

soil) simulant. Also included inventing a slip casting method to create Thorium Oxide (radioactive) vessels as evaporation containers for the simulant. Designed and built an oven to vaporize the regolith simulant that achieved a temperature of 2352 °C (4269 °F) before the tungsten heaters degraded.
    - Aluminum and composite boat canopy prototype built for DOD SOCOM Seal rapid insertion craft.
    - USDA Biomass R&D program to construct an alternative energy unit that would turn corn stalks and yard waste into syngas for producing electricity and hydrogen fuel.
    - US Marine Corp and National Center for Manufacturing Sciences shot counter designed to count the number of shots fired from a weapon. Constructed micro electric pick up coils and magnet holders, attached them to various pistols & machine guns and conducted live fire testing.
    - DOE hydrogen storage in nonporous silicon test fixture construction.
- Designed and created hundreds of displays used as courtroom exhibits, many with time critical deadlines, scale models to full scale mock ups and sets. In some cases the displays were credited with saving millions of dollars in judgments against companies.
- Responsible for quoting project cost and managing the project budget.
- Created working displays that include features like motor driven models, pneumatically controlled fixtures, lighting, water control and motion, fog and sound.
- Produced static displays including 2-D and 3-D drawings, magnetic display boards, small scale models, full scale mock ups, cut away teaching models and furniture.
- Created prototypes of small kitchen appliances and designed a line of appliances for sale in the US.
- Photographed and took video of accident scenes, tests and displays. Set up lighting for videos and edited them into finished products.
- Consulted for Crawford Technical Services on behalf of Sears to determine the cause of power tool accidents. The investigations and subsequent reports resulted in favorable settlements for Crawford and saved hundreds of thousands of dollars in possible claims against the company.
- Testified in three trials and one deposition.
- Regularly work with AutoCAD, Master CAM, Adobe Photoshop, Adobe Premier, Microsoft Word and Excel. Able to program and operate CNC equipment.
- Mentor for STEP intern program for 8 years.

1982 – 1991 Owner/Lead Model Maker for SAW Groups, Inc., Naperville, IL.

- Lead designer and fabricator creating 2D, 3D, static, dynamic, reduced scale, 1:1 and expanded scale models and displays for use in court room trials, depositions, trade shows and sales meetings.

- Skilled with all model shop equipment, proficient in designing and build in the areas of carpentry, electrical, plumbing, finish carpentry, mechanical systems, mock ups, mold making, material selection, drafting, presentation drawings, paint systems and theater set design. Extensive knowledge in materials. Experience in photography, videography, lighting, sound and video editing.
- Managed company finances and payroll.

Education:

1984	B.S. Degree, Business Management, University of the Ozarks, Clarksville, Arkansas.
Continuing Ed.	Algebra, Calculus, Plastics Technology and AutoCAD at COD Community College, Glen Ellyn, IL.

Certifications/Memberships:

- American Society of Mechanical Engineers
- American Institute of Aeronautics and Astronautics
- National Space Society
- Association of Professional Model Makers
- Producer, Naperville Community Television, Naperville, IL.
- NASA, Johnson Space Center, Physiological Training with 25,000 foot Chamber Flight and Rapid Decompression
- Department of the Army Commendation for work done on the Tactical Garbage to Energy Refinery alternative energy project.

Publications:

- "Large Thoria Castings for Ultra-high Temperature Processing with Oxygen," Schubert, Williams, Wilks, Ende, Babcock, Meno, USACA 34th Annual Conference on Composites, Materials & Structures (ITAR restricted) 23-26 Jan 2012

- "Advances in Extraction of Oxygen and Silicon from Lunar Regolith," Schubert, Williams, Bundorf, Di Sciullo Jones, AIAA SPACE 2010, 30 Aug -2 Sept 2010, Anaheim, CA

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John Fildes, Ph.D.

Dr. Fildes has extremely strong problem-solving and analytical skills, excellent communications abilities, and decades of experience of successfully conveying, with credibility and confidence, highly technical issues to laypeople. He successfully tackles highly challenging technical problems and often sees key issues and devises approaches, which others have missed, through a combination of vast experience, extensive technical knowledge, creativity, an excellent understanding of testing and analysis, and strong project planning and management capabilities.

Professional Technical Profile

- A doctoral-level scientist who has organized, written proposals, conducted, and managed $26 million in funded projects including research, development, litigation expert witness investigations, and collaborations involving Government labs, large defense companies, and leading universities with funding from the Army, Navy, the Defense Advanced Research Projects Agency (Technology Reinvestment Program), The Great Lakes Composites Consortium, the Gas Research Institute, the Electric Power Research Institute, First Alert, ABB, Westinghouse, Bell Helicopter, the Illinois Technology Development Authority, the State of Illinois, and others.
- An expert in materials science, advanced composite materials, materials processing including process sensors and controls, materials compatibility, materials selection, protective coatings and lubricants, decorative coatings, coatings fabrication, semiconductor materials, gas sensors, tribology (the science of friction and wear), materials property modeling, corrosion, statistics, and experimental design.
- A uniquely qualified litigation expert witness whose extensive scientific experience coupled with broad experience with product and process design processes, the conduct of research and development, and innovation management, provides comprehensive insight of both the technical issues and their relation to R&D and design issues; specialization throughout his career on the role that materials contribute to the limitations and failures of products and systems.
- Formal training in chemistry, physics, thermodynamics, and materials.

Areas of Expertise

Tribology: Friction; Abrasive Wear, Adhesive Wear, Testing, Friction Measurement, Wear Prevention, Lubricants, Oil Quality Monitoring, Solid Lubricants, Hard Protective Coatings, Decorative Coatings, Paint, Electroplated Coatings, Corrosion, Electrochemical Corrosion Measurement, Ice Prevention; **Composite Materials**: Thermoset and Thermoplastic Resins and Adhesives, Design and Fabrication, Processing, Repair, Resin Transfer Molding, Vacuum Assisted Resin Transfer Molding, Autoclaving, Composites in Aircraft and the Infrastructure, Impedance Spectroscopy; **Semiconductor Materials and Devices, Sensors, and Measurement Technology**: Gas Sensors, Carbon Monoxide Detectors, Metal Oxide Semiconductors, Field Effect Transistors; **Product Design and Research and Development**: Product Design Procedures, Innovation and Innovation Management, R&D Processes and Management, Intellectual Property Creation and Management, Proposal Development, R&D Collaborations, Industrial Problem Solving; **Expert Witness Investigations**: Product Liability Investigations, Failure Analysis.

R&D and Industrial Experience

Tribology (Friction, Wear, Corrosion, and Materials Compatibility)

Dr. Fildes offers clients the ability to see problems in ways other have missed based on experience that spans broad knowledge of materials (metals, plastics, composites, ceramics, coatings), the relationship between materials processing and properties and performance, industrial problem solving and failure analysis, testing, product development and design.

- Served as the principal investigator for a multi-million dollar, multi-year project funded by the U.S. Army to analyze the failures of weapons due to abrasive wear and to evaluate coatings and lubricants and develop new friction and wear test methods for improving the functioning of weapons.
- Conducts failure analysis and diagnostics of the underlying basis for materials related performance issues with machinery and weapons systems.
- Led the failure analysis of a bearing failure in a power plant.
- Tests materials and equipment performance relative to friction, wear, and corrosion behavior.
- Developed superior methods and equipment to screen the friction, wear, and corrosion behavior of materials, coatings, lubricants, and fuels.
- Determined the reason adhesive wear testing was producing results contrary to expectations based on materials science and helped an process equipment supplier revise the test protocol and establish performance data to support a product introduction.
- Helped a client understand the reasons for galling of stainless steel components in a product fabrication machine and identified alternative materials and coatings to prevent the problem.

- Conducted R&D in plasma-assisted CVD and fabrication of diamond-like and organometallic coatings for tribological applications.
- Developed patented cutting tool wear monitors, led the automation and statistical analysis activities for a tribology lab, and conducted tribology evaluations, many technology reviews, product evaluations, and R&D strategy assessments for industrial customers and trade associations.

Composite Materials

Dr. Fildes' offers clients a comprehensive experience of composites, including fundamental properties, the relationship between processing and properties, R&D, structure design and fabrication.

- Developed advanced composite materials and their processing methods and equipment under funding from the U.S. Navy and The Great Lakes Composites Consortium and the Navy.
- Designed and demonstrated complex structures that incorporate advanced materials and model-based design methods under funding from the Special Operations Command.
- Conducted R&D on control systems for composites fabrication that incorporate artificial intelligence technology, transducers, and measurement instrumentation under funding from the Great Lakes Composites Consortium, the Army, and the Navy.
- Conducted R&D in surface science including coatings and modeling methods.
- Established and co-directed Northwestern University's federally-funded Advanced Composite Materials Intelligent Processing Center. The Center was a highly successful collaboration involving University staff and professors, Packer Technologies International, McDonnell Douglas (now part of Boeing), Production Products (a St. Louis DoD Manufacturer), the Office of Naval Research, the Naval Air Warfare Center, and the Naval Sea Warfare Center.
- Led the equipment, sensors and controls, and processing activities of the Great Lakes Composites Consortium's (GLCC) teaching factory, and oversight of GLCC's composites repair training program at the Great Lakes Naval Training Center.
- Demonstrated the use of composites in infrastructure applications under funding from the Defense Advanced Research Projects Agency in the Technology Reinvestment Program, in which only 3% of proposals were funded. Dr. Fildes organized and managed a collaboration involving Northwestern University, the University of Kentucky, and several companies to design and fabricate a composite pedestrian bridge and lift-bridge composite sidewalk panels.

- Applied inorganic resin composites for structural use under industrial funding.
- Conceived of and developed innovative composite materials approaches to ballistic armor, and as alternatives to high strength concrete.

Semiconductor Materials and Devices, Sensors, and Measurement Technology

Dr. Fildes offers clients a strong knowledge of the physics and chemistry of materials used in sensors and electronic devices, semiconductor device physics and characterization, measurement science, sensor device design, and signal processing including statistics, fuzzy logic, and neural networks.

- Co-invented with Northwestern University's Feinberg Cardiovascular Institute and Medical School of methods and instrumentation to monitor, control, and improve balloon angioplasty under industrial funding.
- Prepared the Gas Research Institute's (GRI) R&D plan for control of combustion and industrial processes, and the plan's recommendations were reflected in GRI's R&D solicitations. As part of this activity, Dr. Fildes organized an industry workshop, identified emerging technology, and established industry issues and priorities.
- Developed innovative semiconductor gas sensors under funding from The Gas Research Institute, the Electric Power Research Institute, and First Alert.

Product Design and Research and Development

Dr, Fildes offers clients experience with developing and leading design processes for structures, products, and processes, and with combining science with engineering and modern model-based design methods including use of finite element analysis.

- Led the start-up of the not-for-profit research institute that has conducted millions of dollars of highly successful Government funded projects.
- Led the startup of a model-based product design business that established a customer base of inventors, start-up product companies, and several large established companies, and established a run rate of $3 million in revenues within the first six months of operation.
- Managed a multiyear, multimillion-dollar collaboration of Northern Illinois University, the Falex Corporation, the U.S. Army's TACOOM (Detroit, Michigan), the Army's Armament Research, Development and Engineering Center (ARDEC, Picatinny Arsenal), the Army's Benet Weapons Laboratory, PM Solider Weapon, other Army program offices, and the small arms industry that has led to a thrust to establish an Army Center of Excellence in friction and wear of weapons.
- Led a group of 28 scientists (most with advanced degrees) at Northwestern University that conducted about $3 million annually of Government and industry funded research and consulting. Oversaw the group's involvement in Northwestern University's federally funded

Infrastructure Technology Institute, which included several collaborations with various state Departments of Transportation and the development of an automated pothole repair vehicle.

- Managed the design of a combustible gas analyzer.

Expert Witness Investigations

Dr. Fildes has extremely strong problem-solving and analytical skills, excellent communications abilities, and decades of experience of successfully conveying, with credibility and confidence, highly technical issues to laypeople. Current investigations involve the failure of various commercial products and the operation of chemical processes. Prior investigations include the following.

- Investigated several different issues related to possible FTC actions and potential recalls, including Li-ion battery electrochemistry and failures, overheating failures of crimp connectors, and unexpected ignition of matches.
- Investigated issues related to the properties and performance of lubricants. Provided deposition testimony.
- Investigated various corrosion incidents involving aircraft structures and brakes.
- Investigated issues related to the performance of aggregates, asphalt, and concrete used in roadways and recreation facility floors. Provided deposition testimony.
- Investigated the chemistry of cleaning products, and their use and relationship to an accident. Provided deposition testimony.
- Investigated issues related to equipment failure in a steel process.
- Investigated issues relative to the failure of plumbing components.
- Investigated the chemistry, processing, and measurement of properties of spray polyurethane foam (SPF) relative to odors and flammability. Conducted extensive testing involving foam installation, chemistry, odor, and flammability, which was used in part relative to a class action.
- Investigated the expansion and contraction properties of an engineered wood building product, modeled the performance of the product under the prevailing conditions, and provided a report and presentation in a mediation.
- Investigated the chemistry of the reprocessing of PCB containing transformer oil and the stress corrosion cracking of stainless steel equipment used in the process. Provided deposition testimony.

- Provided deposition testimony on statistical methods and sampling required to meet the Daubert standard for expert witness testimony in a condo unit repair case. Served as a consulting expert on statistical sampling and analysis methods for a case involving mediation.
- Investigated patent infringement issues involving a medical respiration device. Determined the way the alleged infringing device operated, and instrumented both devices and performed sophisticated testing that clearly established the similarities and differences in an easy to understand and compelling manner.
- Investigated the cause of the failure of a composite glider wing. Conducted a complex inspection of the severely damaged wreckage and identified the cause of the failure.
- Investigated several cases involving determination of the cause of delamination of composite helicopter blades due to manufacturing issues and thermally-induced damage to an adhesive from a repair procedure. Reviewed manufacturing logs, conducted field inspections, performed instrumented laboratory simulations of a repair procedure coupled with FEA thermal modeling, and provided deposition testimony.
- Served as a designated expert on a case involving a trade secret chemical formulation.
- Investigated the design process for determining if a steel beam saw conformed to specifications and acceptance criteria. Provided deposition testimony.
- Investigated the design process and determined why a carbon monoxide detector failed to alarm.

Employment

- **Spotlight Business Consulting LLC**, founder and President, 2015 – present. Litigation-related technical projects are conducted through (depending on the nature of the project) the **Solution Engineering Group,** **www.SolutionEngineering.com**, or **Falex Technical Investigations,** **www.FalexInvestigations.com**.
- The **Institute of Tribology and Coatings** (a 501(c)3 not-for-profit materials science research institute), 2005 to 2015, President. **ITC Experts** (a for profit science and engineering services firm), founder and President, 2007 – 2015.
- **The Packer Group/Packer Engineering**, 1997 to 2005, CEO, COO, Chief Scientist.
- **Northwestern University, Basic Industries Research Lab**, 1991 to 1997, Group Manager – Materials Processes, Manufacturing, Sensors, and Controls; Senior Research Scientist.

- **IIT Research Institute**, Director of Sensor Technology, Senior Program Manager, Senior Science Advisor.
- **The Roy C. Ingersol Research Center of the Borg-Warner Corporation**, Corporate Scientist, Senior Research Scientist, Senior Chemist.

Education

- **Virginia Polytechnic Institute and State University:** Postdoctoral Research Associate, Chemical Engineering.
- **Virginia Polytechnic Institute and State University:** Ph.D., Chemistry (Physical).
- **Georgetown University:** B.S., Chemistry.
- **Texas Instruments Learning Institute**, Design for Six Sigma Manufacturability.
- **Borg-Warner Corporation**, Research, Development, and Engineering Management Program.
- **The American Supplier Institute**, Five Day Course in Quality Engineering, Methodology, and Application, Based on the Work of Dr. Genichi Taguchi.
- **Massachusetts Institute of Technology**, Special Summer Program in Microsensors.
- **Battelle Memorial Institute**, Course in Advanced Management Practices.
- **Battelle Memorial Institute**, Course in Engineer as Manger.
- **American Vacuum Society**, Certificate of Training in An Overview of Thin Film Deposition and Etching Processes.

Other Background

- Served as a reviewer and on site visit panels in manufacturing technology for the National Science Foundation in the Engineering Research Centers Program.
- Workshop panel member for the National Materials Advisory Board.
- Invited speaker at DARPA and SAMPE workshops.
- 49 published (or in process) papers, reports, and presentations, and three patents.

Publications

J. M. Fildes, S. J. Meyers, C. P. Mulligan, and R. Kilaparti, "Evaluation of the Wear and Abrasion Resistance of Hard Coatings by Ball-on-Three-Disk Test Methods - A Case Study," Wear, 302 (2013) 1040-1049.

J. M. Fildes, S. J. Meyers, C. P. Mulligan, and R. Kilaparti, "Evaluation of the Wear and Abrasion Resistance of Hard Coatings by Ball-on-Three-Disk Test Methods - A Case Study," 19th International Conference on Wear of Materials, Portland, OR, April 2013.

J. M. Fildes, S. Meyers, R. Kilaparti, and E. Schlepp, "Improved Ball Crater Micro-Abrasion Test Based on a Ball on Three Disk Configuration," Wear 274-275 (2012) 414-422.

J. M. Fildes and S. J. Meyers, “Failure Analysis and Solutions for Abrasion Related Jamming of Weapons,” presented to the annual meeting of the National Small Arms Center, Maryland, December 2009.

J.M. Fildes, “Improved Ball Crater Micro-Abrasion Test Based on a Ball on Three Disk Configuration,” presented to ASTM Committee G02, Columbus, OH, November 2009.

J. M. Fildes and S. J. Meyers, “Bench-Scale Screening of Abrasion Resistant Advanced Coatings,” presented to the annual meeting of the National Small Arms Center Consortium, Columbia, SC, December 2008.

J. M. Fildes and S. J. Meyers, “Composites as Engineered Materials,” presented at Lewis University – FAA IA Renewal Workshop, Romeoville, IL, March 12, 2005.

J.M. Fildes, “Innovation Management,” Managing Technology Dependent Operations, D. Tijunelis and K. McKee, eds., Manufacturing Productivity Center, Chicago, 2004, Chapter 5.

J. M. Fildes and S. J. Meyers, “Composite Airframe Structures,” presented at Chicago Area Business Aviation Association Quarterly Meeting, Oakbrook, IL, November 19, 2004.

J. Dorr, J, M. Fildes, and S. J. Meyers, “Design, Fabrication, and Inspection of Composites,” presented at Organization of Flying Adjusters Annual Meeting, Key Largo, FL, September 30, 2004.

A. Nagaraj, J.M. Fildes, C.J. Davidson, M. Madden, J. Fagan, W. Berthiaume, L. Mockros, D.D. McPherson, “Characterization of Vascular Acoustic Emission During Angioplasty Using Novel Catheter-Based Sensor,” ACCIS, 1999.

A. Nagaraj, J.M. Fildes, C.J. Davidson, L. Mockros, D.D. McPherson, “Characterization of Vascular Acoustic Emission During Angioplasty Using Catheter-Based Sensor,” U.S. Patent 5,957,950, September 28, 1999.

J.M. Fildes and I.M. Daniel, “Intelligent RTM Processing of Composites,” SAMPE Proceedings, 1999.

J.M. Fildes and I.M. Daniel, “Intelligent RTM Processing of Composites,” Proceedings – “On-Line Sensing and Control for Liquid Molding of Composite Structures,” University of Delaware, 1999.

A. Nagaraj, J.M. Fildes, C.J. Davidson, M. Madden, J. Fagan, W. Berthiaume, L. Mockros, D.D. McPherson, “Characterization of Vascular Acoustic Emission During Angioplasty Using Novel Catheter-Based Sensor,” American Heart Association, 71th Scientific Session, 1998, 46, No.7.

A. Nagaraj, J.M. Fildes, C.J. Davidson, L.F. Mocros, D.D. McPherson, "In-Vivo Identification and Characterization of Angioplasty-Induced Injury Using Vascular Acoustic Emissions," J Am Coll Cardiol, 1998, 31,417-A.

J.M Fildes, Intelligent Resin Transfer Molding Technical Demonstration, Composites '98, San Antonio, Texas, October 21, 1998.

J.M. Fildes, "Sensors in Manufacturing," The CRC Handbook of Mechanical Engineering, F. Kreith, ed., CRC Press, Boca Raton, 1997, pp. 13-67-71.

J.M. Fildes, "Sensors, Controls, and Modeling of Life Cycle Effects in Autoclave Processing of Composites," Report to the Great Lakes Composites Consortium, Columbia, SC, Contract 97-05, 1997, 30 pages.

Kin Liao; Robert I. Altkorn; Scott M. Milkovich; John M. Fildes; Jose Gomez; Carl R. Schultheisz; Donald L. Hunston; L. Catherine Brinson, "Long-Term Durability of Glass-Fiber Reinforced Composites in Infrastructure Applications," Journal of Advanced Materials. 1997; 28(3): 54-63.

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J.M. Fildes, Participant in Composites Manufacturing Tooling 95 Workshop, Society of Manufacturing Engineers, Anaheim, CA, 1995.

J.M. Fildes, P. Chen, and X. Zhan, "Application of Electrochemical Impedance Spectroscopy, Color Visible Imaging, and Infrared Imaging for Non-Destructive Evaluation of Anti-Corrosion Coatings," Proceedings of Sensors Expo, 1995, pp. 381-389.

J.M. Fildes - Instructor, "Monitoring the Aging Infrastructure with Advanced Nondestructive Evaluation (NDE) Technology," Course Offered at Sensors Expo – Boston, May, 1995.

J.M. Fildes and S.M. Milkovich, "Definition of Infrastructure Markets for Composite Materials," Report to the Great Lakes Composites Consortium, Columbia, SC, Contract 93-121, 1995, 87 pages.

J.M. Fildes, Panel Member, Composites Manufacturing for Infrastructure Applications, SME Conference, Anaheim, CA, 1995.

S.M. Milkovich, R.I. Altkorn, R.H. Haidle, M.J. Neatrour, and J.M. Fildes, "In Situ Sensors for Intelligent Process Control for Fabrication of Polymer Matrix Composite Materials," Smart Sensing, Processing, and Instrumentation, J.S. Sirkis, ed., Proc. SPIE 2191, 1994, pp. 349-360.

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S.M. Milkovich and J.M. Fildes, Industrial Survey on Resin Transfer Molding, Report to the Great Lakes Composites Consortium, Columbia, SC, Contract 92-08, 1993, Volumes 1 and 2.

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J.M. Fildes, "Development of a Fixed point Field Effect CO Microsensor (Phase 1)," Report to the Gas Research Institute, Chicago, IL, Contract 5086-254-1400, 1992, 95 pages.

G. Stefanek and J.M. Fildes, "Expert Systems and Neural Networks in Food Processing," Food Safety Assessment, ACS Symposium Series, No. 484, J. Finley et al, eds., American Chemical Society, Wash., D.C., 1992, pp. 166-180.

J.M. Fildes, Real Time Process Control, Manufacturing Technology Information and Analysis Center, Chicago, IL, 1991.

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J.M. Fildes, "Intelligent In Situ Control," Invited Presentation, Workshop on Development and Application of Process Control Sensors and Sensor Based Manufacturing Systems, Defense Advanced Research Projects Agency, 1990.

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J.M. Fildes, A Critical Examination of Cutting Tool Wear Modeling, Report to Argonne National Laboratory, Tribology Program, DOE Industrial Liaison Program, November, 1986.

J.M. Fildes and R.H. Krueger, "Overview of Semiconductor Gas Sensing Devices," Proceedings of the EPA Fourth Annual Symposium on Recent Advances in the Measurement of pollutants From Ambient Air and Stationary Sources, Raleigh, NC, May, 1984.

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Dexter B. Briganti

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May 2016 **Bachelor of Science in Network Technologies**

Minor - Computer Mediated Communication
GPA: 3.6

Technical Skills:

Linnworks Order Management, Linnlive, Microsoft Excel, Word, PowerPoint; typing speed of 70 WPM

Work Experience:

Windy City Liquidation - Plainfield, IL **August 2010 to Present**

Labor and Listing Specialist

- Address around 20 customer emails and concerns daily
- Overhaul and automate inventory and sales process
- Analyze entire previous year for sales history and trends
- Train 3 teams in inventory and picture taking process
- Manage and maintain over 800 online listings
- Utilize online cloud storage for daily backup purposes
- Convey effective listing descriptions to maximize sales

Reference – Jon Walrath; Company Owner
Contact – 630-806-5099

Additional Skills

In-Depth knowledge of social media marketing platforms: Twitter, Google+, LinkedIn, and Facebook

Awards and Honors:

May 2016 Graduated as a Department Scholar in Network Technologies and earned Dean's List