



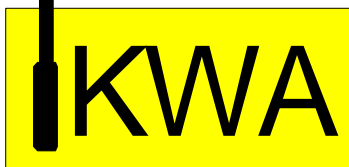
Evaluation of the Pneumercator Model LS600/LS600A Series and Model LS600/LS600A NCL Series Float Sensors

for use with the
Pneumercator LC1000 and LC2000 series Alarm Panels,
PC1000 series Pump Controllers and
TMS Series Tank Management Systems

Final Report

PREPARED FOR:
Pneumercator Co., Inc.

April 5, 2008



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PREFACE

This report presents the results of an independent third-party evaluation of the Pneumercator Model LS600/LS600A and LS600/LS600A NCL float switches when connected to the Model LC1001 Liquid Level Control System. The evaluation was conducted by Ken Wilcox Associates, Inc. using procedures described in the standard protocol "Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Liquid Level Sensors", September 1996. The 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.

Although every effort was made to assure that this testing meets the requirements for Alternative Testing as described by the federal EPA, Ken Wilcox Associates, Inc. makes no claims that the evaluation will be accepted by any or all regulatory agencies. The test procedures are listed with the National Workgroup on Leak Detection Evaluations (NWGLDE) ¹ and meet the federal EPA requirements for Alternate Test Protocols as described in the forward to all of the standard EPA protocols for evaluating leak detection methods.²

This report was prepared by Dr. Ken Wilcox, Ken Wilcox Associates, Inc. Technical questions regarding this evaluation should be directed to Mr. Jon Levy, Pneumercator Co. Inc., at 1 (631) 293-8450.

KEN WILCOX ASSOCIATES, INC



H. Kendall Wilcox, Ph.D., President
April 5, 2008

¹ In 1994, the EPA established the National Work Group for Leak Detection Evaluations which consists of a group of State and Federal Regulators that review leak detection evaluations, new evaluation protocols, and other issues affecting the leak detection and underground storage tank industry.

² "Standard Test Procedures for Evaluating Leak Detection Methods," EPA/530 UST-90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

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SECTION 1. BACKGROUND

The federal Environmental Protection Agency (EPA) has provided a series of documents¹, which describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.² The requirements for evaluating liquid level sensors were not, however, included in those documents. It has therefore been necessary to develop independent methods for evaluating the performance of these systems. The objective is to provide an evaluation procedure which will provide testing which is at least as rigorous as those described for other types of leak detectors. At a minimum the evaluation method must determine the minimum liquid threshold for which a liquid level sensor will alarm.

To achieve this objective, the applicable sections of standard EPA protocols have been adapted to the specialized requirements of liquid level sensors. The test procedures followed in this evaluation are the KWA document "Alternative Test Procedures for Evaluating Leak Detection Methods: Liquid Level Sensors" September 1996. The procedures described in this document meet the requirements specified by the EPA for alternative test protocols and they were based on the procedures described in the EPA protocols. Additionally, the test procedures are listed with the National Workgroup on Leak Detection Evaluations (NWGLDE).³

¹ "Standard Test Procedures for Evaluating Leak Detection Methods," EPA/530 UST-90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

² 40CFR Part 280, Subpart D.

³ In 1994, the EPA established the National Work Group for Leak Detection Evaluations, which consists of a group of State and Federal Regulators that review leak detection evaluations, new evaluation protocols, and other issues affecting the leak detection and underground storage tank industry.

SECTION 2. DESCRIPTION OF THE EQUIPMENT

The LS600 Series float switches are typically used in above and below ground liquid storage tanks for point level alarm and pump control applications. The float switches are used with systems such as the Pneumercator LC1000 and LC2000 series Alarm Panels, PC1000 series Pump Controller, TMS series Tank Management System or any monitor that accepts dry contact switches to actuate audible or visual alarm indicators or relay controls. The NCL manual lift model has the advantage of providing a means for lifting the uppermost float to verify operation without removing the switch assembly from the tank.

Any of the LS600 Series switches can be configured at the factory for normally open or normally closed. A variety of combinations of float lengths, multiple floats and mounting assemblies are available.

2.1. Model LS600/LS600A Float Switch

The Model LS600/LS600A Float Switch is an on/off sensor that detects the presence of fluid in a containment or reservoir device. If the liquid level in the containment rises above the threshold of the sensor, an alarm condition is generated which is detected by the Alarm Console which displays a visual and audible alarm. If sufficient liquid is removed from the sensor, the alarm will reset. The float tested in this evaluation was constructed from Buna N.

2.2 Model LS600/LS600A NCL Float Switch

The Model LS600/LS600A NCL Float Switch is an on/of sensor that is similar to the LS600/LS600A. The float for this evaluation was constructed of stainless steel and was equipped with the manual lift feature.

The Pneumercator brochure for the various float switches has been provided in Appendix A. All of them operate similarly to the two switches tested in this evaluation.

SECTION 3. 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 vertical cylinder test container in which liquid (water, diesel fuel, gasoline or motor oil) was slowly added or removed with a peristaltic pump. Liquid was added or removed until an alarm occurred or shut off. The level was measured with a micrometer with a resolution of 0.001 inches.

Threshold Determination

Liquid was added to the test cylinder containing the sensor until the sensor alarmed. The level of liquid at the alarm point was recorded. This procedure was repeated a total of 6 times for each liquid. This threshold is expected to be only slightly different than for each liquid due to the density differences.

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 six tests conducted for each product type is reported as the detection time. In the case of on/off float switches this time is very short.

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 six tests conducted for each product type is reported as the fall time.

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..

SECTION 4. TEST RESULTS

The Test results for the LS600/LS600A and the LS600/LS600A NCL Float Switches are contained in Table 1. The actual test data has been provided in Attachment A.

Lower Detection Level (Threshold)

The sensors were tested for their ability to detect liquids at the alarm levels. The level where the sensor resets was also measured.

Precision (Standard Deviation)

Six replicates were conducted for each liquid level for each float. The standard deviation was determined from these replicates.

Detection Time

The sensor alarms within several seconds after the threshold was reached. This will be true for any liquid in the reservoir. The detection time was less than one second for all types of liquid.

Fall Time

The sensor stops alarming within one second after the level drops below the reset level for the sensor system. This will be true for any liquid in the reservoir.

Specificity

This sensor will respond to any liquid after its threshold is exceeded. Water, diesel fuel, unleaded gasoline and motor oil (20W-50) were used in this evaluation. The actual threshold levels were slightly different due to differences in density of the liquids.

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.

Table 1. Results for Pneumercator LS600/LS600A and LS600/LS600A NCL Float Sensors

Model LS600/LS600A (all measurements in inches)

Water

Parameter	Alarm On	Alarm Off
Mean	2.965	3.124
Stdev	0.0044	0.0080
Threshold	2.984	3.159

Diesel

Parameter	Alarm On	Alarm Off
Mean	2.996	2.766
Stdev	0.0046	0.0104
Threshold	3.016	2.812

20W-50 Motor Oil

Parameter	Alarm On	Alarm Off
Mean	3.202	2.977
Stdev	0.0022	0.0042
Threshold	3.211	2.996

Gasoline

Parameter	Alarm On	Alarm Off
Mean	3.106	3.316
Stdev	0.007	0.010
Threshold	3.136	3.359

Model LS600/LS600A NCL (all measurements in inches)

Water

Parameter	Alarm On	Alarm Off
Mean	4.879	4.485
Stdev	0.0112	0.0101
Threshold	4.928	4.529

Diesel

Parameter	Alarm On	Alarm Off
Mean	4.902	4.614
Stdev	0.0514	0.0180
Threshold	5.129	4.693

20W-50 Motor Oil

Parameter	Alarm On	Alarm Off
Mean	4.842	4.560
Stdev	0.0088	0.0102
Threshold	4.881	4.605

Gasoline

Parameter	Alarm On	Alarm Off
Mean	5.123	4.845
Stdev	0.007	0.004
Threshold	5.153	4.862

SECTION 5. DISCUSSION AND CONCLUSIONS

The data obtained in this evaluation is representative of the two float switches that were provided. Other float switches would be expected to operate with similar precision, but with different thresholds depending on the construction of the sensor.

The Series LS600x float switches operate in accordance with their stated design parameters. The float switches are available in a wide variety of lengths, multiple floats, float types and mounting configurations. The response time is less than 1 second and can be configured for operation as either normally open or normally closed. They will respond to any of the liquids that are normally encountered in AST and UST applications. They can also be connected to any console that is capable of a response to on/off Switches.

Attachment A

**Results Forms for the Pneumercator Float Switches
Model LS600/LS600A Series and
Model LS600/LS600A NCL Series Float Sensors**

Results of U.S. EPA Alternative Evaluation

Liquid Level Sensor

This form documents the performance of the liquid level sensor described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's requirements for alternative protocols. 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 Series LS600x Float Switches for use with the Pneumercator LC1000 and LC2000 series Alarm Panels, PC1000 series Pump Controller and TMS Series Tank Management Systems

Version number(s) Models LS600/LS600A and LS600/LS600A NCL were tested

Vendor Pneumercator Co., Inc.

(Name of Manufacturer)

120 Finn Court

(Address)

Farmingdale, NY 11735 1 (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

Note: If the test data can be presented in a more appropriate manner, the evaluator may select to present the information below in a data table, which can be attached to these forms.

Table 1. Results for Pneumercator LS600/LS600A and LS600/LS600A NCL Float Sensors

Model LS600/LS600A (All measurements in inches)

Water

Run	Alarm On	Alarm Off
Mean	2.965	3.124
Stdev	0.0044	0.0080
Threshold	2.984	3.159

Diesel

Run	Alarm On	Alarm Off
Mean	2.996	2.766
Stdev	0.0046	0.0104
Threshold	3.016	2.812

20W-50 Motor Oil

Run	Alarm On	Alarm Off
Mean	3.202	2.977
Stdev	0.0022	0.0042
Threshold	3.211	2.996

Gasoline

Run	Alarm On	Alarm Off
Mean	3.106	3.316
Stdev	0.007	0.010
Threshold	3.136	3.359

Model LS600/LS600A NCL (All measurements in inches)

Water

Parameter	Alarm On	Alarm Off
Mean	4.879	4.485
Stdev	0.0112	0.0101
Threshold	4.928	4.529

Diesel

Run	Alarm On	Alarm Off
Mean	4.902	4.614
Stdev	0.0514	0.0180
Threshold	5.129	4.693

20W-50 Motor Oil

Run	Alarm On	Alarm Off
Mean	4.842	4.560
Stdev	0.0088	0.0102
Threshold	4.881	4.605

Gasoline

Run	Alarm On	Alarm Off
Mean	5.123	4.845
Stdev	0.007	0.004
Threshold	5.153	4.862

Specificity – This sensor will respond to any liquid after its threshold is exceeded.

This testing was conducted with water, diesel fuel, unleaded gasoline and 20W-50 motor oil.

Additional Limitations or Considerations - Similar performance is expected of all Series LS600x sensors. Height to alarm for various configurations will be determined by

length of float switch shaft as constructed at the factory. Many options are available.

> 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 sensor was 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.

H. Kendall Wilcox, Ph.D., President
(printed name)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

H. Kendall Wilcox

(signature)

Grain Valley, MO 64029
(city, state, zip)

April 5, 2008
(date)

(816) 443-2494
(phone number)

Laboratory Data

Table 1. Test Data for the PneumercatorLS600/LS600A and LS600/LS600A NCL Float Sensors

Model LS600/LS600A NCL (Stainless Steel Float)

All measurements in inches

Water			Diesel			Lube Oil			UL Gasoline		
Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off
1	4.887	4.494	1	4.998	4.603	1	4.832	4.576	1	5.131	4.839
2	4.882	4.488	2	4.87	4.627	2	4.833	4.546	2	5.115	4.848
3	4.877	4.474	3	4.908	4.604	3	4.84	4.562	3	5.117	4.85
4	4.883	4.498	4	4.872	4.588	4	4.842	4.565	4	5.126	4.844
5	4.886	4.477	5	4.857	4.632	5	4.848	4.555	5	5.13	4.843
6	4.857	4.477	6	4.905	4.629	6	4.855	4.556	6	5.12	4.846
Mean	4.879	4.485	Mean	4.902	4.614	Mean	4.842	4.560	Mean	5.123167	4.845
Stdev	0.0112	0.0101	Stdev	0.0514	0.0180	Stdev	0.0088	0.0102	Stdev	0.0068	0.0039
Threshold	4.92803	4.529129	Threshold	5.128542	4.693159	Threshold	4.880617	4.605101	Threshold	5.153158	4.862209

Model LS600/LS600A (Buna N Float)

All measurements in inches

Water			Diesel			Lube Oil			UL Gasoline		
Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off	Run	Alarm On	Alarm Off
1	2.964	3.112	1	3.002	2.747	1	3.205	2.973	1	3.106	3.331
2	2.964	3.126	2	2.989	2.762	2	3.2	2.985	2	3.108	3.321
3	2.969	3.131	3	2.998	2.771	3	3.203	2.978	3	3.094	3.311
4	2.971	3.122	4	2.997	2.772	4	3.201	2.975	4	3.114	3.302
5	2.959	3.118	5	2.992	2.771	5	3.199	2.975	5	3.107	3.314
6	2.962	3.133	6	2.995	2.775	6	3.201	2.978	6	3.109	3.317
Mean	2.965	3.124	Mean	2.996	2.766	Mean	3.202	2.977	Mean	3.106	3.316
Stdev	0.0044	0.0080	Stdev	0.0046	0.0104	Stdev	0.0022	0.0042	Stdev	0.0067	0.0098
Threshold	2.984	3.159	Threshold	3.016	2.812	Threshold	3.211	2.996	Threshold	3.136	3.359

Attachment B

Technical Data from Pneumercator

Level Switches

LS 600

The LS 600 series liquid level float switches provide the highest degree of dependable accuracy for sensing and controlling liquid levels. They may be used with audible alarm consoles such as the Pneumercator LC 1000 or customers' own to actuate high and/or low level warning devices. The LS 600 is available with intermediate switches for control of pumps to maintain liquid levels within a predetermined range.

The LS 600 series is simple in design and operation. A magnet within each float actuates a hermetically sealed dry-reed switch. The encapsulated switches are sealed inside the sensing probe and completely protected from exposure to liquid or vapor. Float travel is restricted via the use of stops placed immediately above and below the customer specified switch operating points.

FEATURES

- One to four magnetic switch floats.
- Available in brass or stainless steel configuration.
- Each switch may be operated in either normally open (NO) or normally closed (NC) contact states.
- FM and UL approved intrinsically safe. UL approved general purpose.
- Easy installation.
- Virtually maintenance free.
- Repeatability of 1/8-inch.



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