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: LC2000 Series Leak/Point-Level Alarm Console
Model Number(s): LC2000 Series
Product Type: Secondary Containment Leak/Overfill Alarm
Rule(s) citation that registration is being requested within Chapter 62-761 (UST), and/or 62-762 (AST), Secondary Containment Leak Detection/Overfill Prevention Alarm
F.A.C.: Write a brief description of equipment registration request including product limitations:

LC2000 Series Secondary Containment Leak Detection and Overfill Alarm Console used with the following Pneumercator leak sensor models ES825-100F/XF/CF, ES825-200F/XF, LS600LDxx Series, LS610, RSU80x Series, RSU810;
and with the following point-Level Overfill sensors: LS600 Series

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- 917	✓		
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 LC2000 Series is suitable for secondary containment leak detection and overfill prevention for both AST and UST 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

Jonathan Levy
Digitally signed by Jonathan Levy
DN: cn=Jonathan Levy, o=Pneumercator Co., Inc., ou, email=jlevy@pneumercator.com, c=US
Date: 2025.03.19 22:36:49 -04'00'
Signature (right click to sign)

03/20/2025
Date

For Department Use Only:

Date Application Received: 03/20/2025 Application complete: Yes: [X] No: [ ]

EQ- 917 Date of complete or incomplete letter sent: 03/24/2025 Date Equipment Requires Renewal: 03/24/2030

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

Department of Environmental Protection

2600 Blair Stone Road ♦ Tallahassee, Florida 32399-2400

DEP Form: 62-761.900(9)
Form Title: Storage Tank Equipment Registration Form
Effective Date: January 2017
Incorporated in Rule 62-761.850, F.A.C.

Storage Tank Equipment Registration Form

Fill out completely

General Information

Company Name: Pneumercator Co., Inc.
Contact Name: Jonathan Levy
Company Address: 1785 Expressway Dr. N.
City: Hauppauge, NY
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Contact Number: 631-293-8450
Product Name: LC2000 Series Leak/Point-Level Alarm Console
Model Number(s): LC2000-Series
Product Type: Secondary Containment Leak/Overfill Alarm
Rule(s) citation within Chapter 62-761, or 62-762, F.A.C. that registration is being requested:
Secondary Containment Leak Detection/Overfill Prevention Alarm

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

LC2000 Series Secondary Containment Leak Detection and Overfill Alarm Console used with the following Pneumercator leak sensor models: ES825-100F/XF/CF, ES825-200F/XF, LS600LDxx Series, LS610, RSU80x Series, RSU810;
and with the following Point-Level Overfill sensors: LS600 Series

Information Checklist

		Yes	No	N/A
1.	Third-party Certification by a Nationally Recognized Testing Laboratory?	✔		
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.	Installation instructions included?	✔		
5.	Technical information and drawings included?	✔		
6.	Annual Operability Testing Requirements (Rules 62-761.700, 62-762.701, & 62-762.702 F.A.C.)?	✔		
7.	Compatible with fuel blends containing >10% ethanol or >20% biodiesel?	✔		
8.	Has the product been approved or registered in other countries or states? (If so provide list)	✔		
9.	Any requirements for company-certified installers or trainers?	✔		
10.	Was this product(s) previously approved or registered by the Department?	✔		
	If yes, please specify the Equipment Number: **EQ- 705**	✔		
11.	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@dep.state.fl.us, or documents can be sent to FDEP, Division of Waste Management, 2600 Blair Stone Road, MS 4560, Tallahassee, FL 32399.

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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		6-3-19
Printed Name and Title	Signature	Date

For Department Use Only:

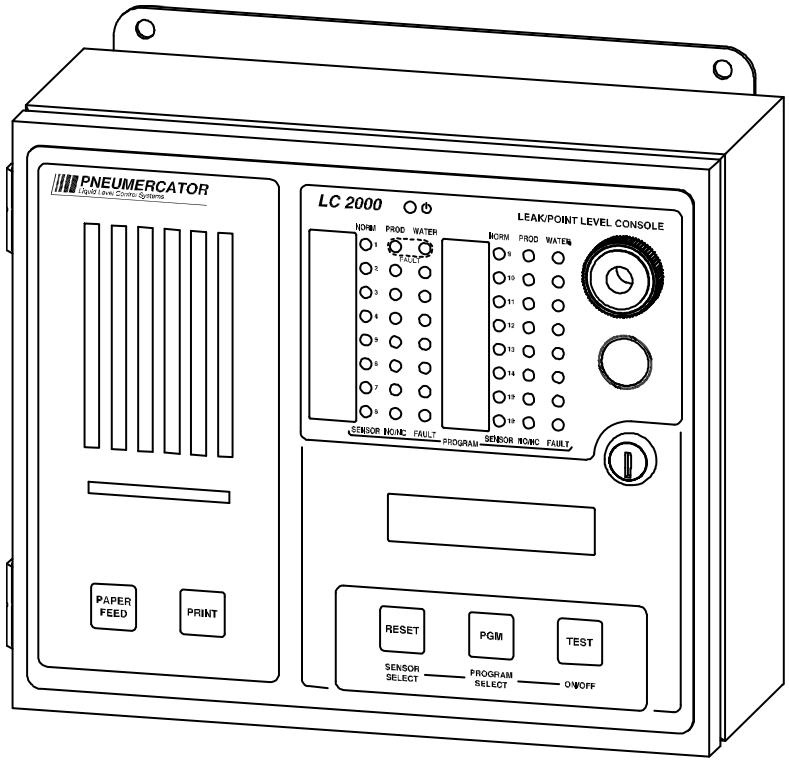
Date Application Received: 6/3/2019-Renew by 6/3/2024
Application complete: Yes: ✔ No:

EQ- 917
Date of complete or incomplete letter sent: 6/3/2019
Date of entry to the DEP Equipment Registration List: 6/3/2019

PNEUMERCATOR
Liquid Level Control Systems

LEAK/POINT
LEVEL ALARM
CONSOLE

INSTALLATION MANUAL



DRAWING NO. 20068 REV. N/C

MODEL LC2000

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 LC2000 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 LC2000 is a fully integrated secondary containment leak detection and point-level alarm system that will interface to all of the TMS series sensor model types, including discriminating and non-discriminating electronic or mechanical secondary containment leak sensors as well as single and multi-point level float sensors. The system is available with a capacity of 4, 8, 12 or 16 sensor inputs. Figure 1-1 shows a typical block diagram of how a system should be configured for installation, providing a general overview of the possible combinations of sensors, remote alarms and other optional equipment that may be required for the specific installation. Note that a detailed wiring diagram can be found in Section 3 of this manual.

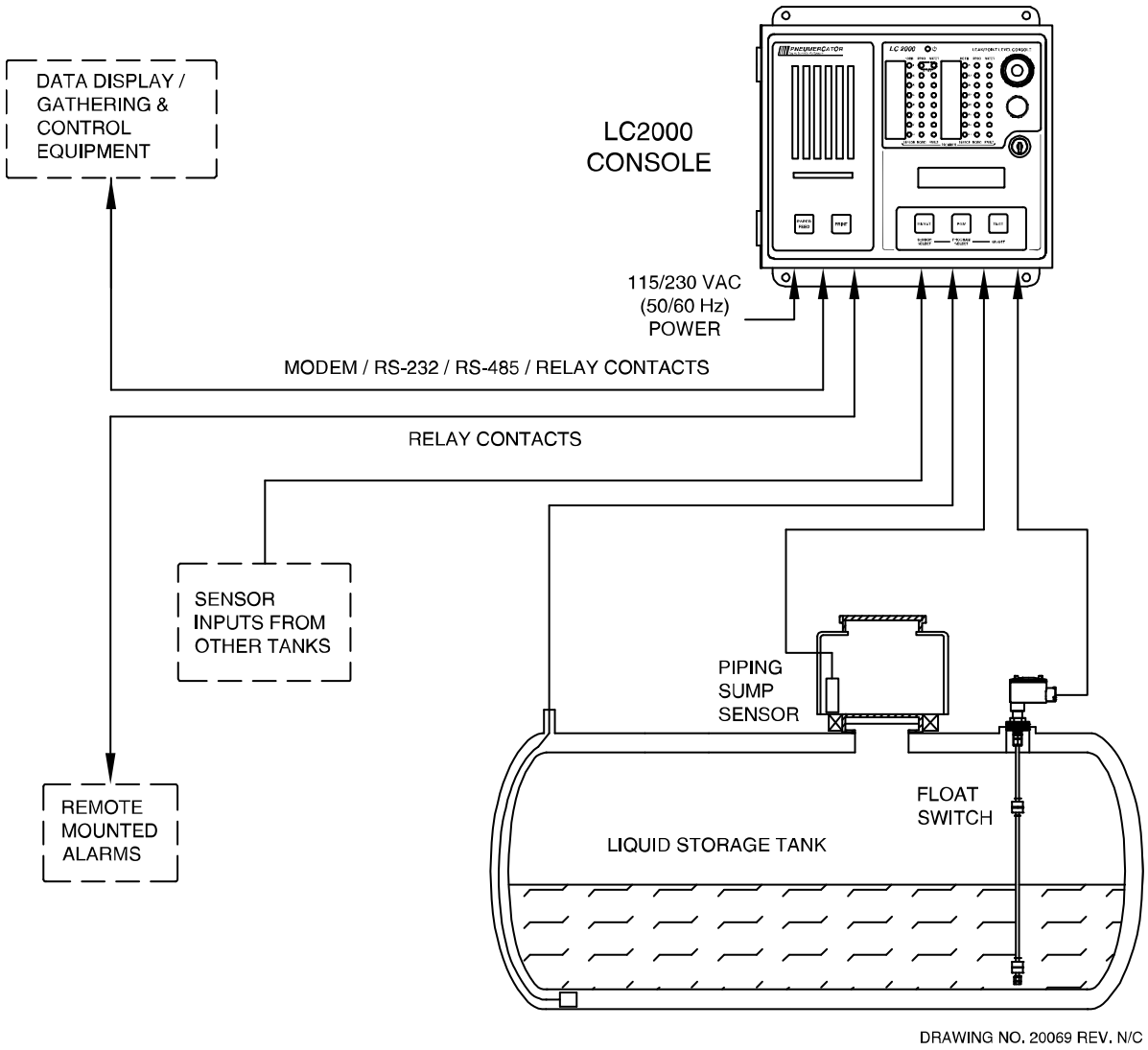


Figure 1-1 - Typical System Block Diagram

1.2 CONTROL CONSOLE DESCRIPTION

Figure 1-2 illustrates the standard LC2000 outline and dimensions. All standard configurations are equipped with either 4, 8, 12 or 16 sensor inputs, 1 RS-232 serial port, 1 RS-485 serial port, 2 Fully programmable relay outputs/2 dry contact closure inputs and NEMA 12 enclosure. Additional relays, printer and various communications option card(s) may also be installed.

The front panel of the LC2000 is available in four different configurations as listed below:

LC2000-1... Console without display or printer
LC2000-2... Console with display, no printer
LC2000-3... Console with display and internal printer
LC2000-4... Console with display and internal printer w/autowinder

⚠ 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 LC2000 console enclosure is NEMA 12-rated for indoor installation. An optional NEMA 4/4X 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.

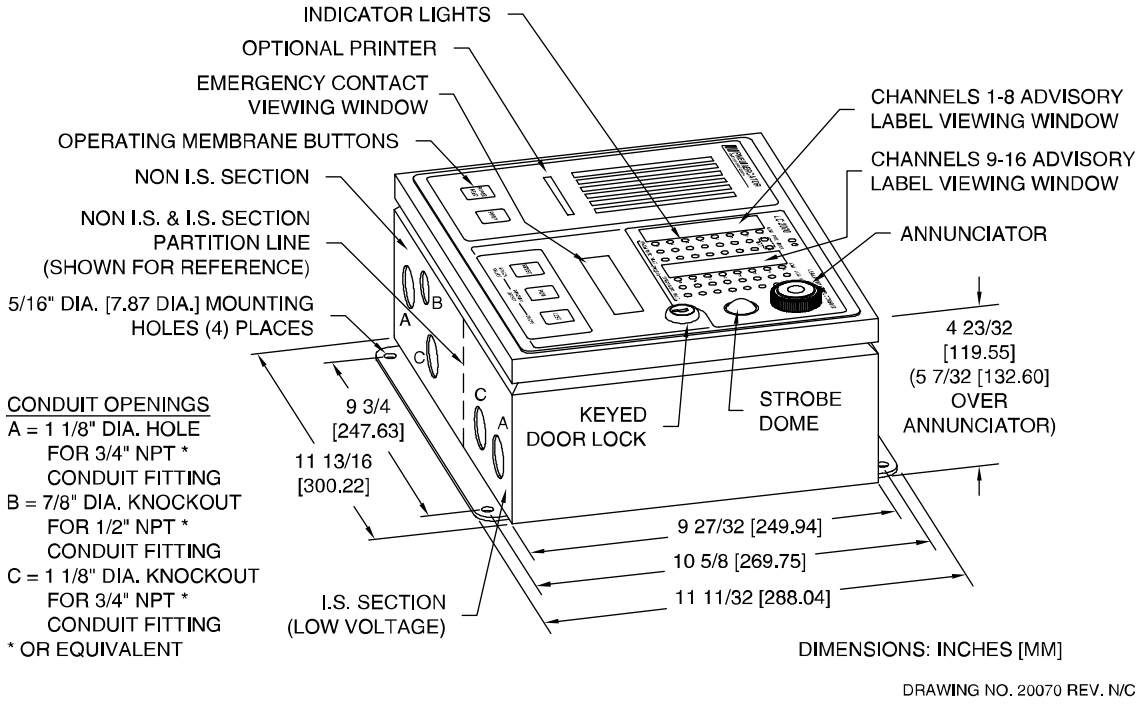


Figure 1-2 - LC2000 Console Outline

⚠ 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.

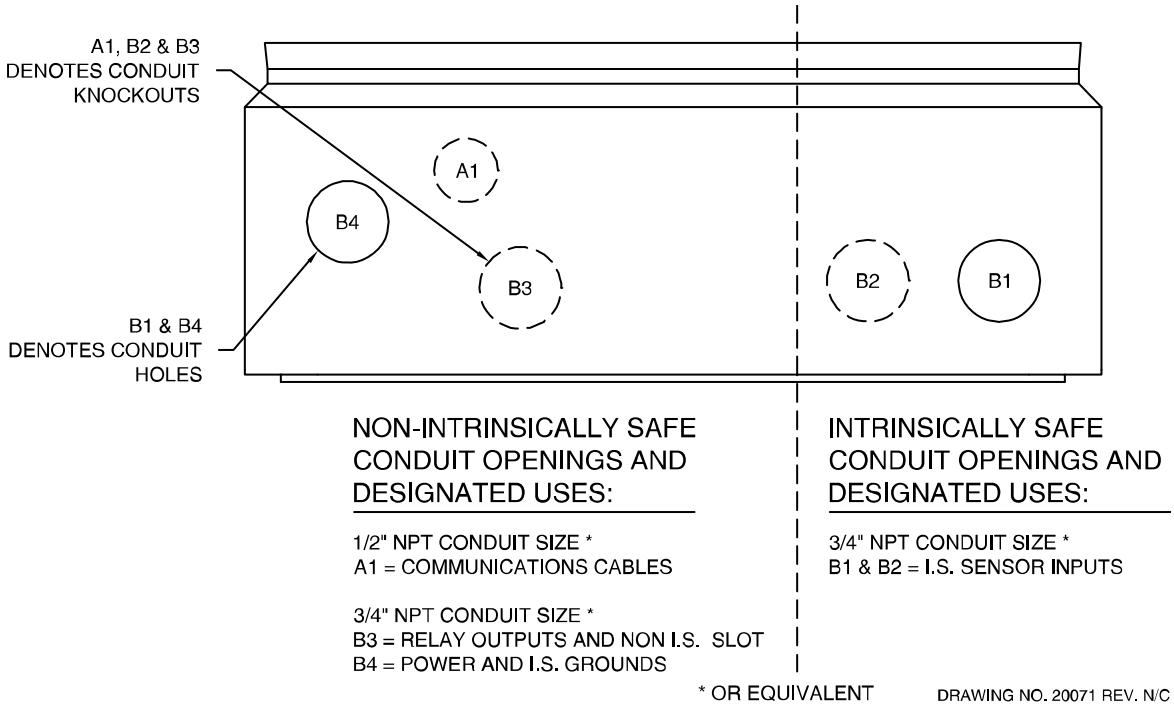


Figure 1-3 - LC2000 Designated Conduit Locations

1.3 AVAILABLE SENSOR TYPES

As described in Section 1.1, the LC2000 will interface to all of the TMS series sensor model types, including discriminating and non-discriminating electronic or mechanical secondary containment leak sensors as well as single and multi-point level float sensors. Figures 1-4 through 1-8 show five (5) typical sensor types offered by Pneumercator. Other non-Pneumercator mechanical types may be used; however, their use with LC2000 should be approved prior to attempting to wire them into the system.

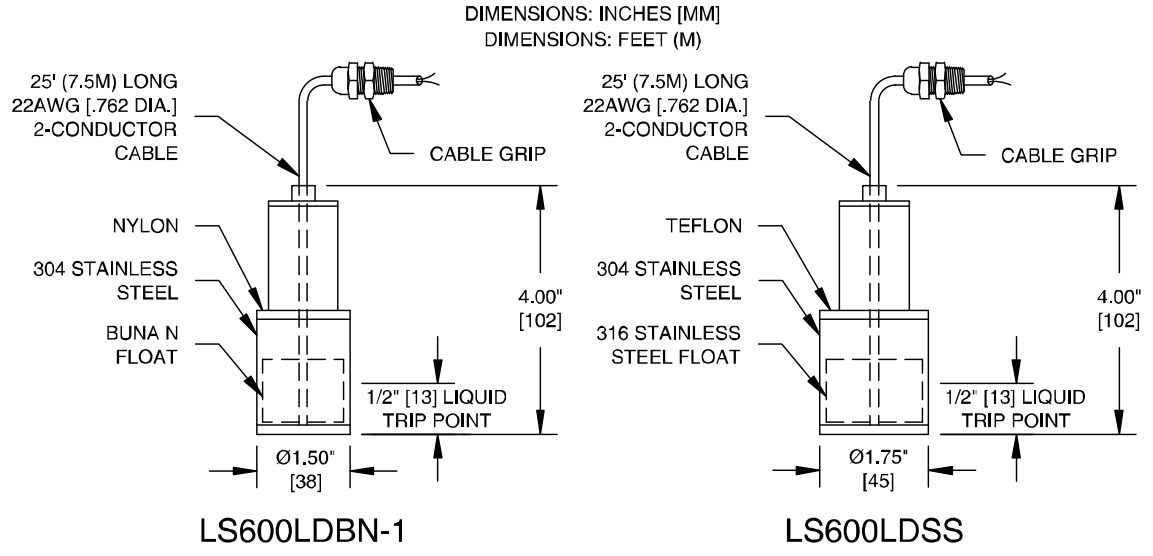


Figure 1-4 – LS600 LD Series

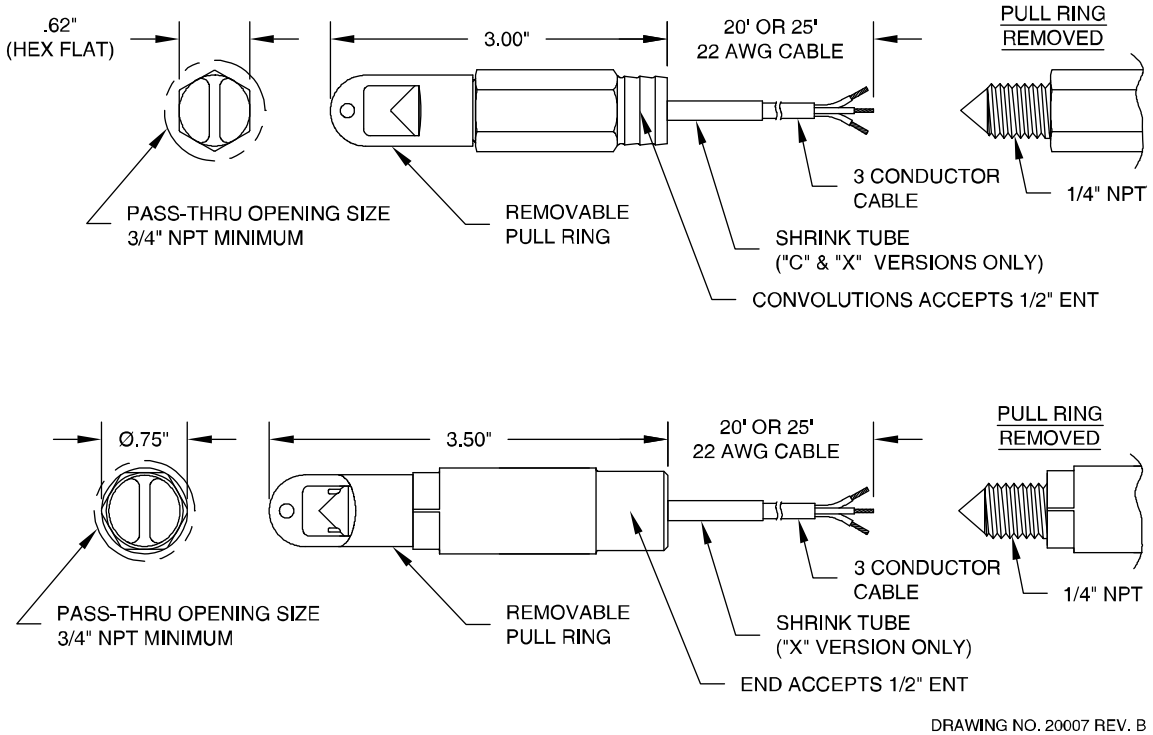


Figure 1-5 – ES825 Series

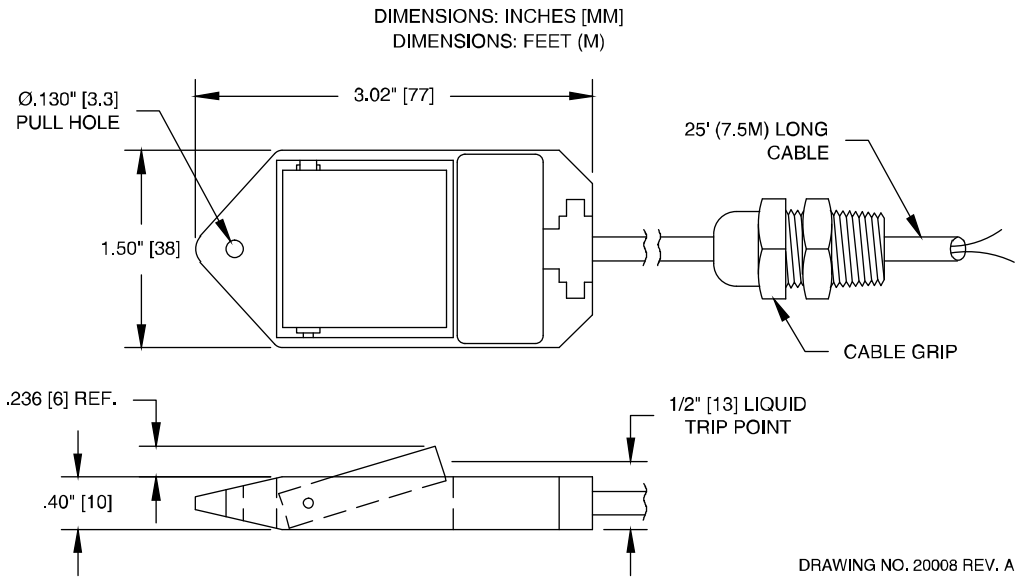


Figure 1-6 – LS610

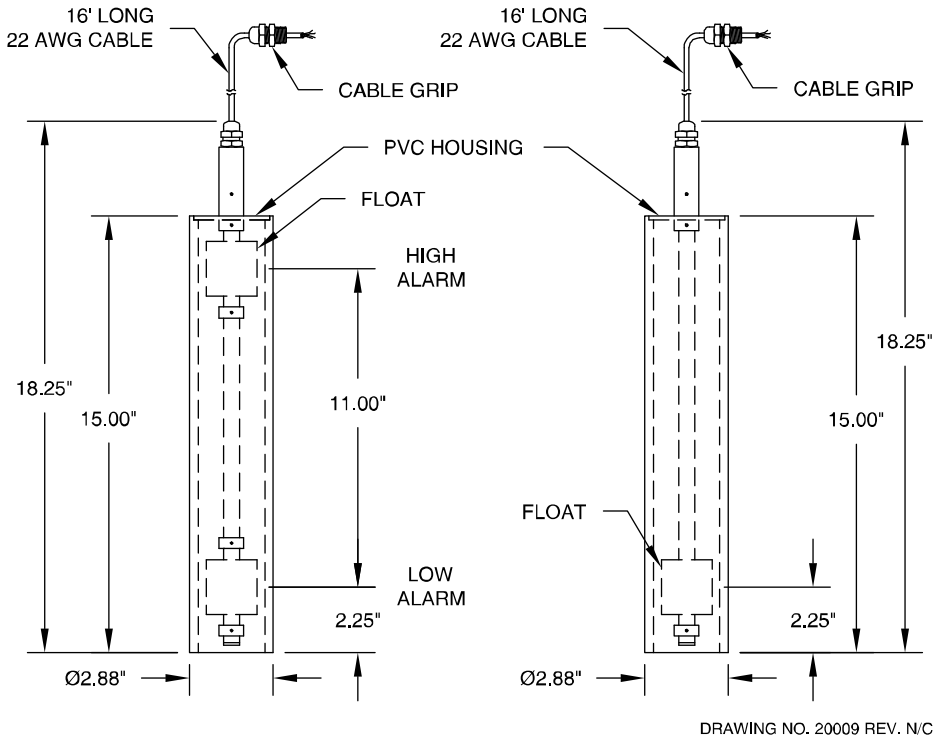


Figure 1-7 – RSU800

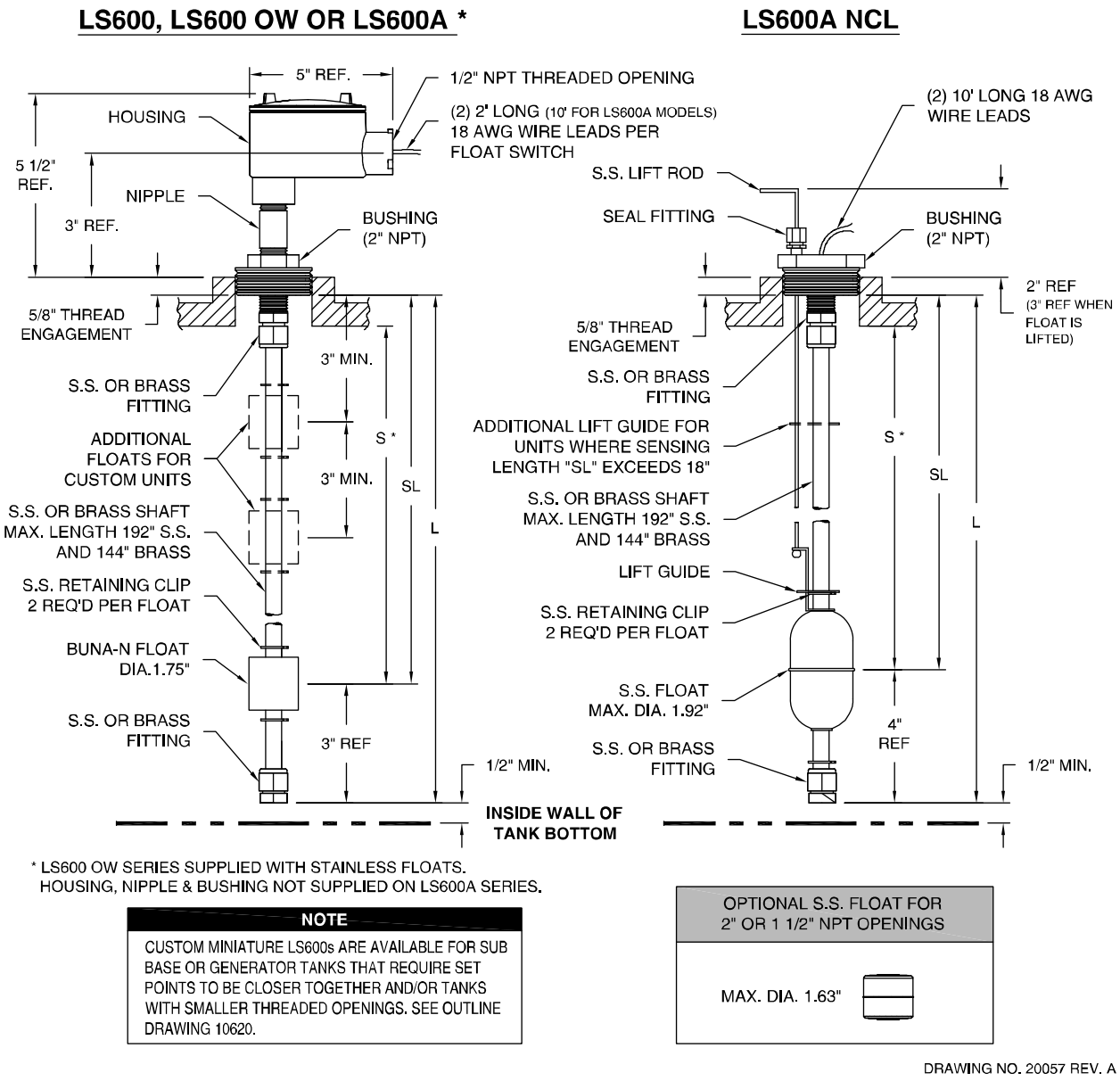


Figure 1-8 – LS600

SECTION 2 – INSTALLATION DETAILS

2.1 INSTALLATION CHECKLIST

⚠ WARNING

Do NOT apply power to the LC2000 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 LC.

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

6. All LC2000 grounds must be terminated at the GND BUSS BAR in the same service panel as LC2000 power. A grounding rod, coldwater pipe or other connection should not be used. Refer to Figure 3-3 for illustrated details.

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

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

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

2.2 CONTROL CONSOLE INSTALLATION

Console location should be selected for the operator's convenience, or as specified on the DESIGN DRAWINGS. DO NOT install the console in a hazardous-classified location.

⚠ 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.

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)	INTRINSICALLY SAFE (RIGHT SIDE)
for Power, Relay Control and Communications	for Sensor Inputs

Figure 2-1 shows the console interior, again indicating intrinsically safe and non-intrinsically safe separation. **THIS SEPARATION MUST BE MAINTAINED**. Also, conduits containing sensor wiring may **NOT** be co-mingled with **ANY** other wiring, regardless of voltage. Refer to Section 3 for electrical conduit and wiring.

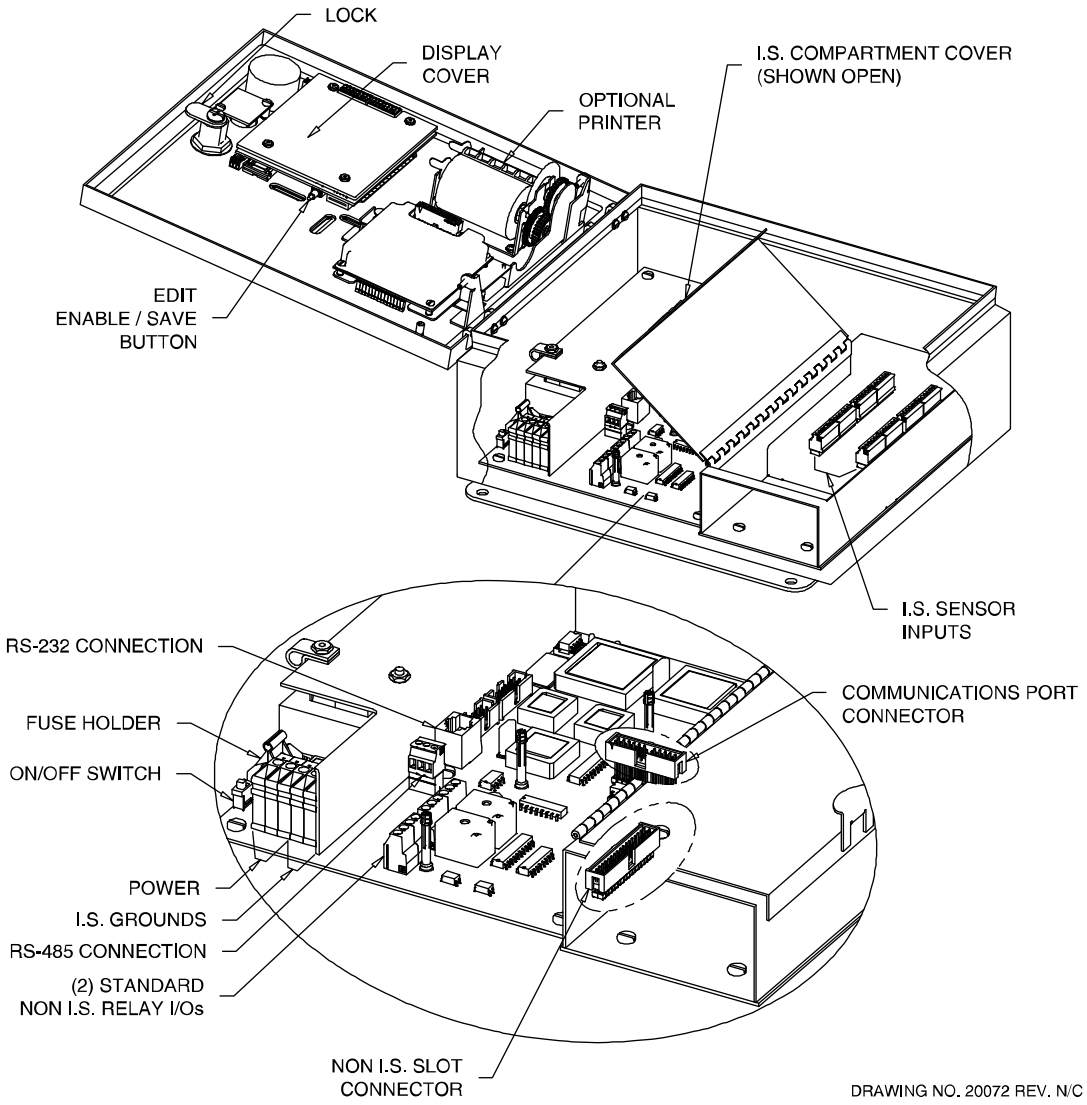


Figure 2-1 - Control Console Interior

2.3 SENSOR INSTALLATION - GENERAL

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 sensors, switch actuation may be factory set for either NORMALLY OPEN or NORMALLY CLOSED.

NOTE: For convenience, installation information for most sensors is provided in the following sections. However, it is recommended that the installer refer to the installation instructions provided with each sensor for more detailed or possibly more current information.

2.3.1 LEAK SENSOR INSTALLATION IN STEEL AND VAULTED TANKS

Check the specific design drawings for the job, or choose the sensor type desired from Figures 1-4 and 1-5. Install sensor per Figure 2-2 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.

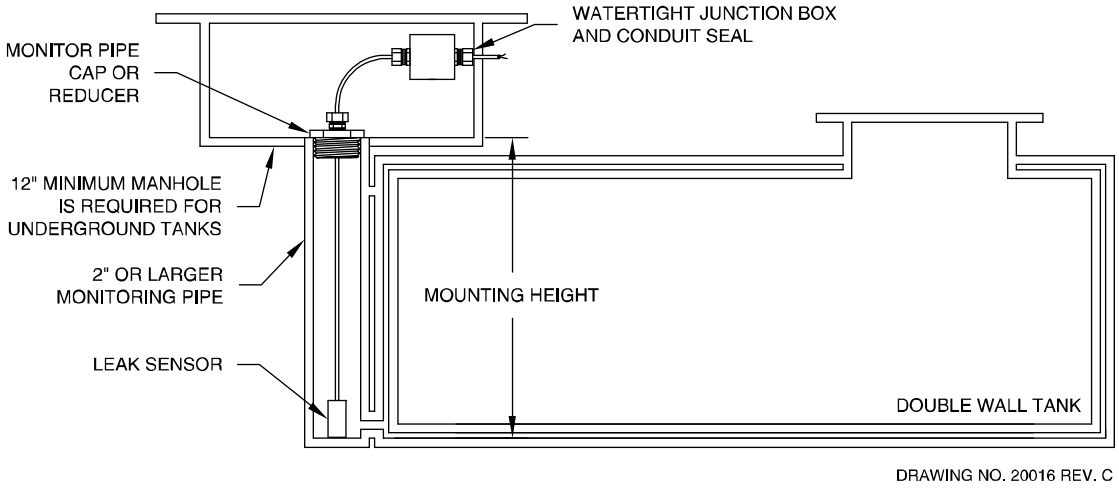


Figure 2-2 - Leak Sensor Installation - Steel Vaulted Tanks

2.3.2 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 1-4 and 1-5. Install sensor per Figure 2-3 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.

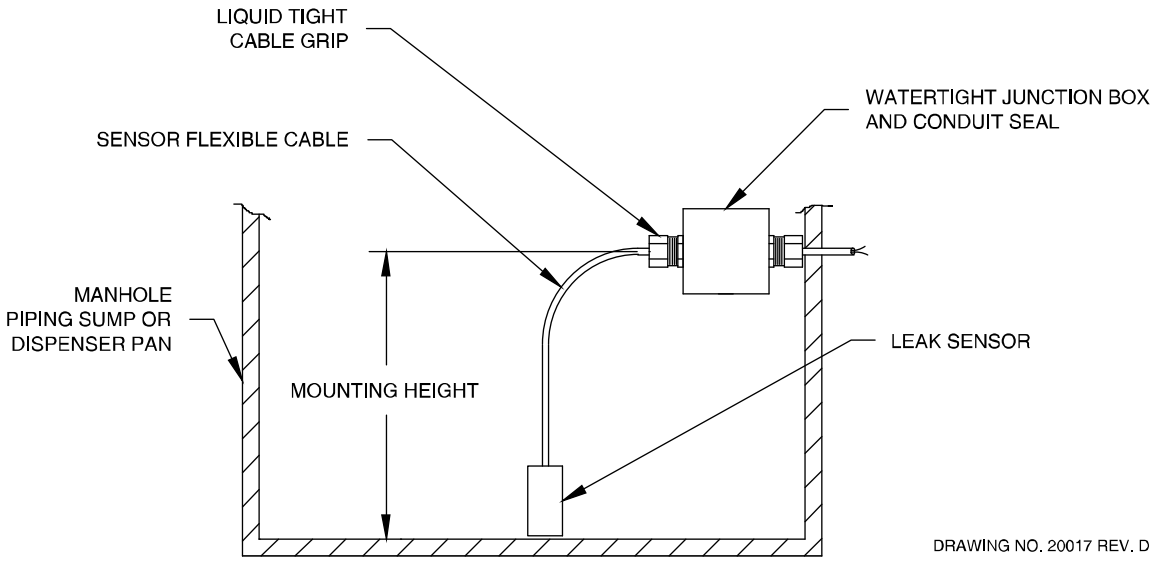


Figure 2-3 - Leak Sensor Installation in Piping Sumps, Manholes, and Dispenser Pans

2.3.3 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 1-5) and LS610 (Figure 1-6), or a "WET RESERVOIR" sensor model RSU800 (Figure 1-7). 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 1-5 through 1-7. Install sensor per Figures 2-4 or 2-5.

Instructions per Figure 2-4, 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.

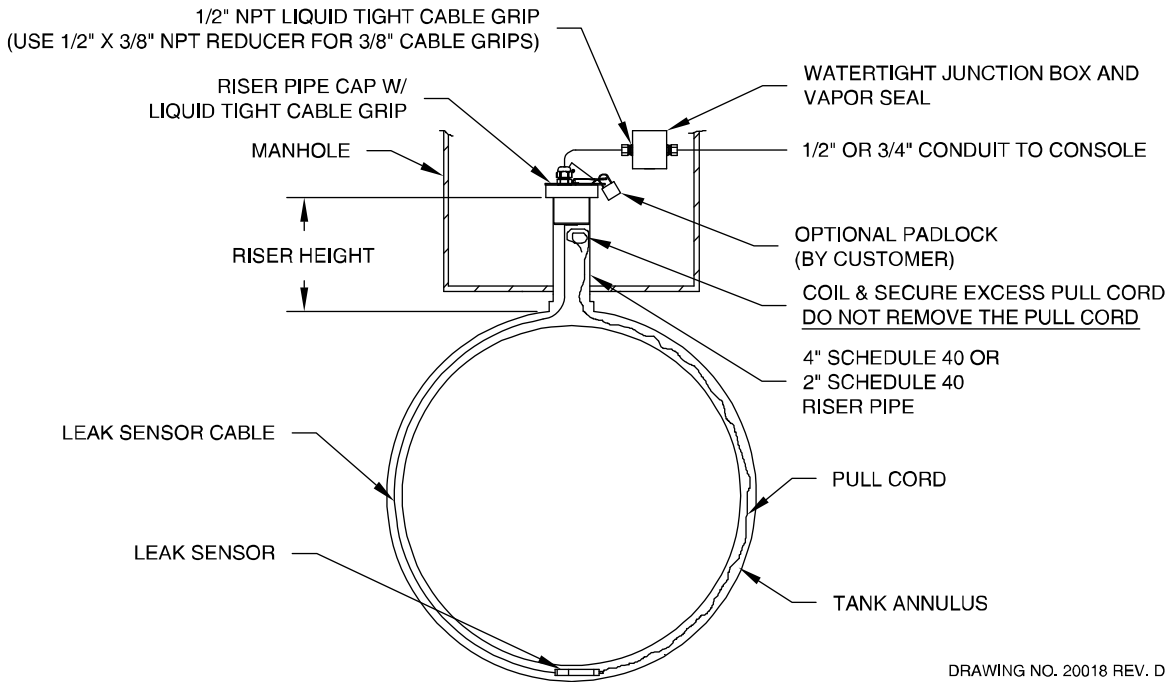


Figure 2-4 - Dry Leak Sensor Installation in Fiberglass Tanks

2.3.4 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 2-5, 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 1-7 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.

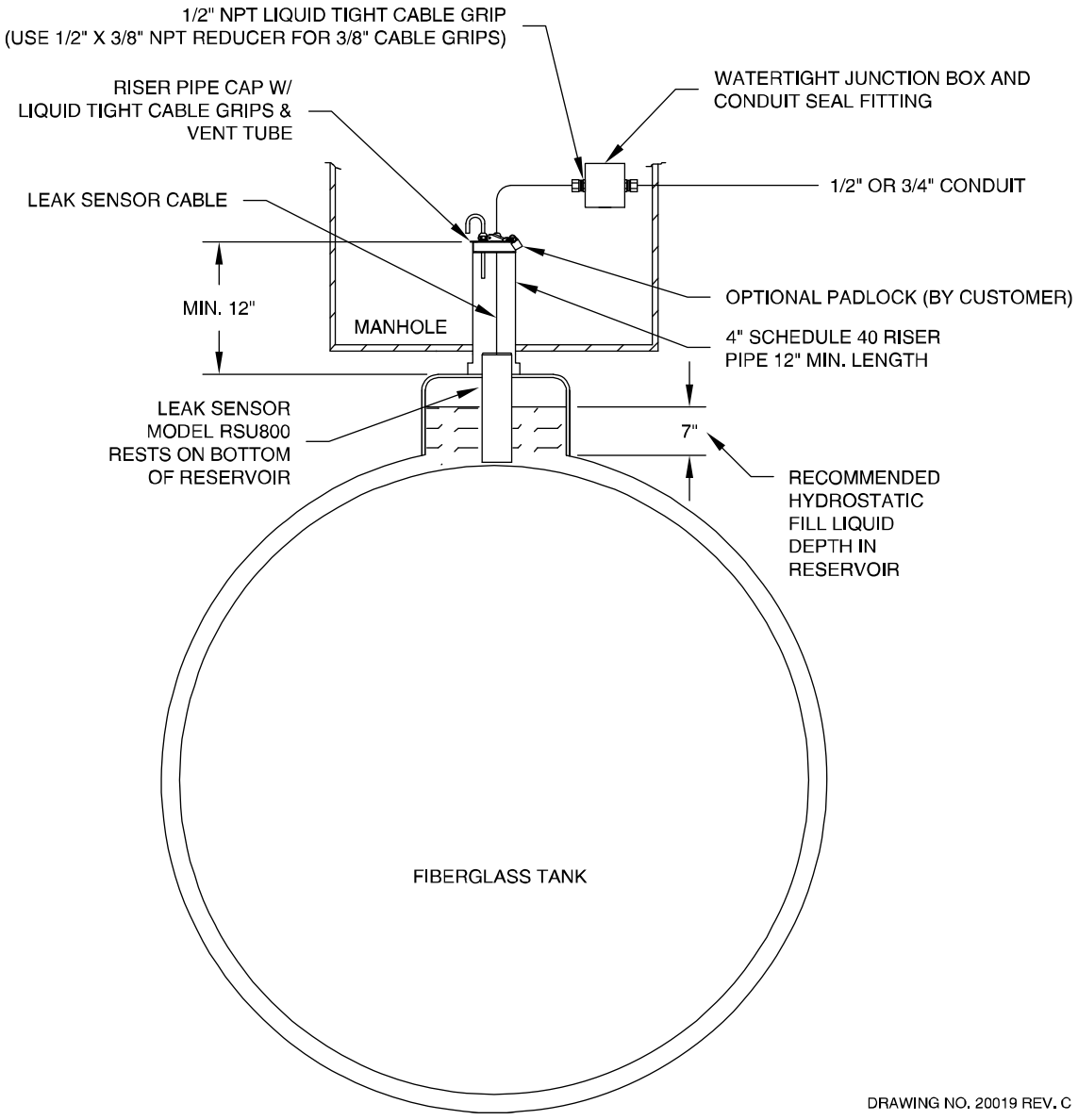


Figure 2-5 - Hydrostatic Leak Sensor Installation in Fiberglass Tanks

SECTION 3 – WIRING INSTALLATION AND DIAGRAMS

⚠ CAUTION

Sensors connected to the LC2000 are usually installed in explosion hazard areas typical of liquid 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 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 (SENSOR WIRING)

Figure 3-1 illustrates wiring installation requirements that must be followed in order to establish and maintain an intrinsically safe installation. Careful attention must be given to maintaining mechanical segregation between intrinsically safe and non-intrinsically safe wiring throughout the installation.

SENSOR WIRING INSTALLATION. Refer to Figures 1-4 through 1-8 for console conduit openings and specific sensors that will be wired into the LC2000 system. Install wiring as follows:

1. It is recommended that the conduit runs be mapped out prior to installation for best efficiency. The LC2000 provides two ¾" knockouts, each designated for up to eight (8) sensor cables. Rigid conduit is recommended, but local codes may have less stringent requirements.

⚠ CAUTION

All LC2000 sensor wiring may be run in the same conduit. NO OTHER WIRING MAY BE RUN 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 through 2-5) install watertight couplings and approved VAPOR SEAL-OFF fittings.

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

4. Attach the conduit at the LC2000 console ONLY to one of the two ¾" conduit knockouts located on the bottom RIGHT SIDE designated for the sensors. Use NEMA 4 weathertight fittings for outdoor locations.

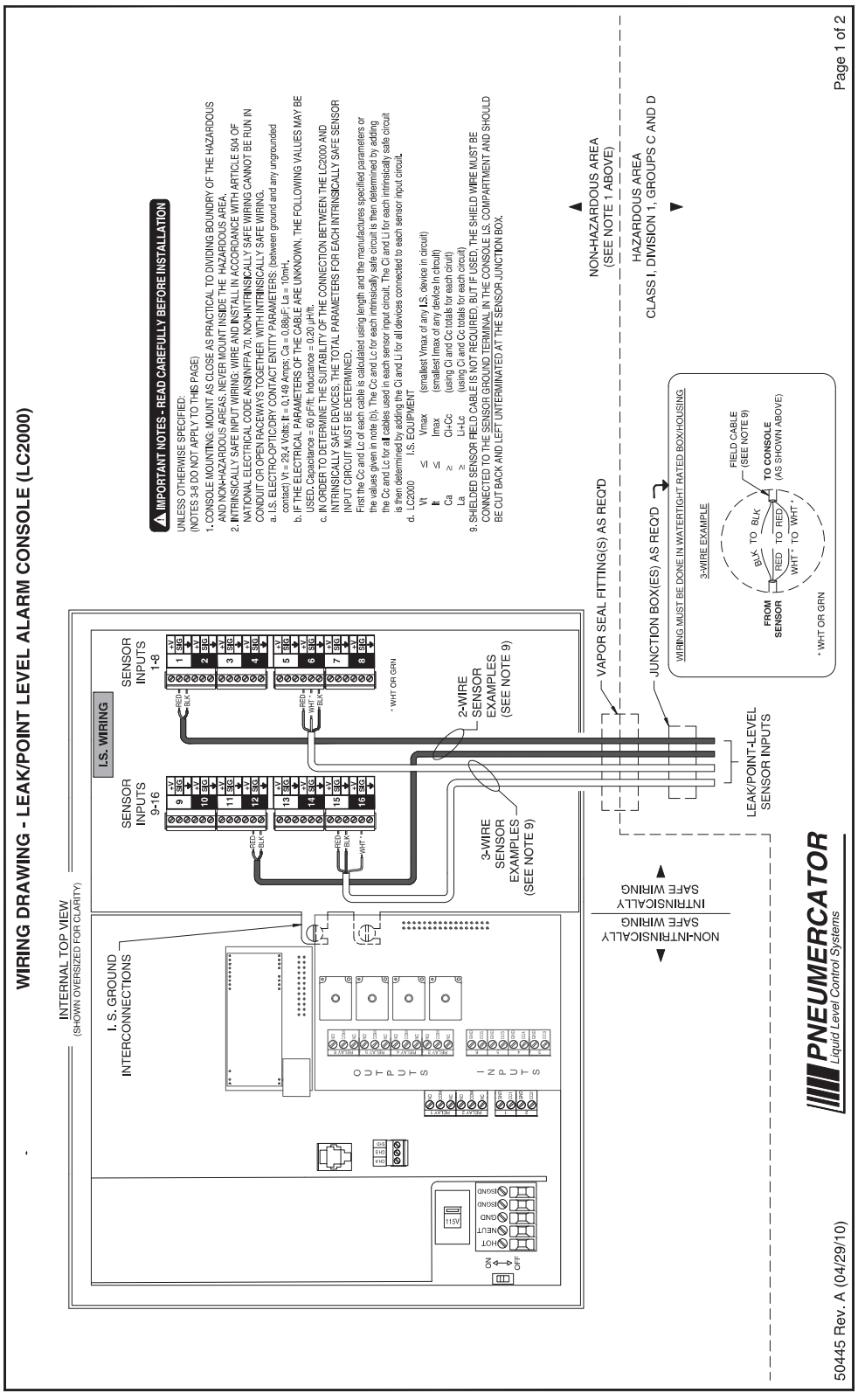


Figure 3-1a - Intrinsically Safe Wiring Diagram

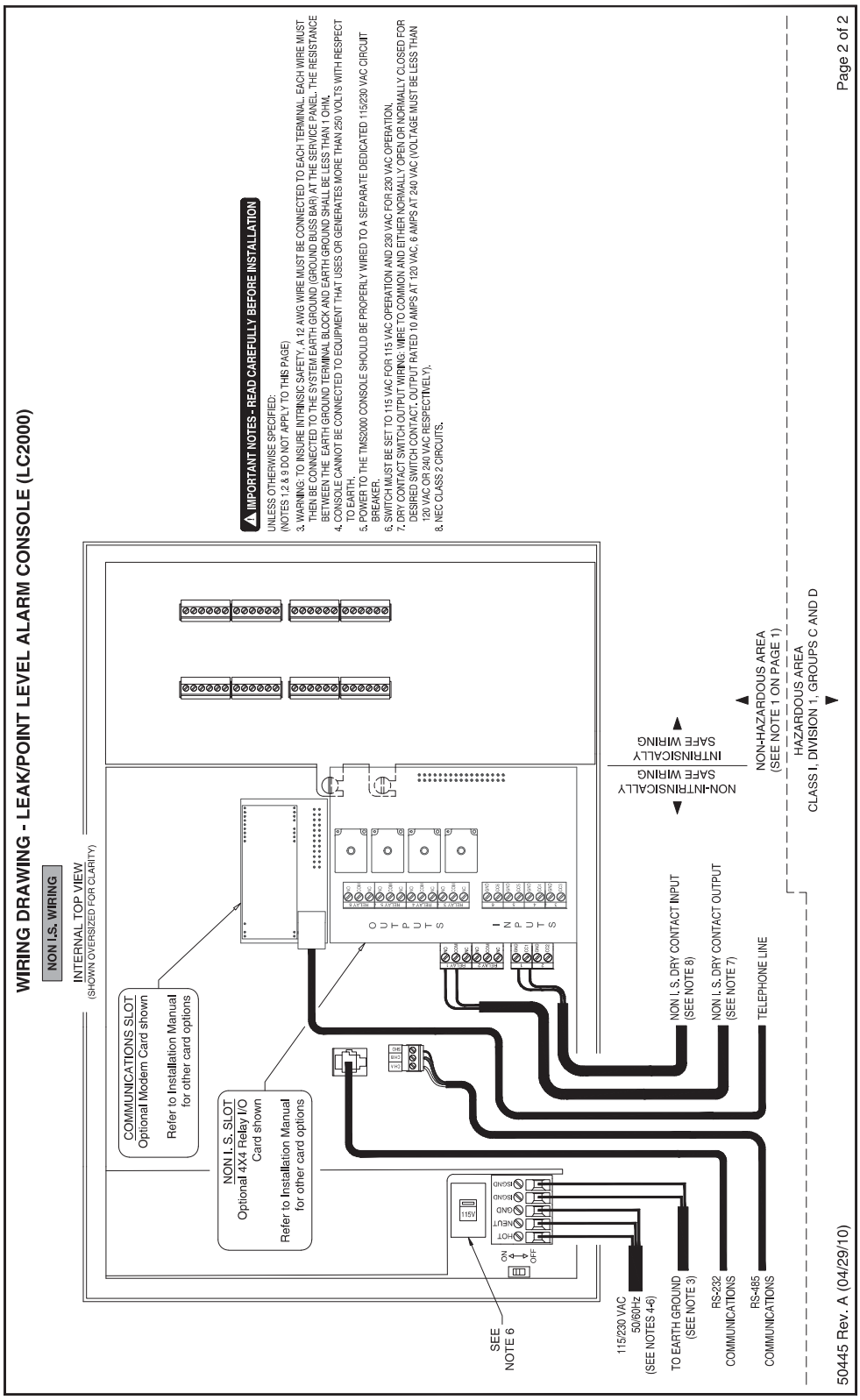


Figure 3-1b – Non-Hazardous Wiring Diagram

CABLE SELECTION GUIDE FOR INTRINSIC SAFETY

TYPE (SEE NOTE 2)	MANUFACTURERS BELDEN	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)
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

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:

LEAK SENSORS - TOTAL COMBINED CABLE LENGTH FOR ALL LEAK SENSORS

4.) CHANNEL MAXIMUM LENGTH: MAXIMUM CABLE LENGTH PER 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.

LC2000 Cable Selection Guide.eps 01-17-07

Figure 3-2 - Intrinsically Safe Cable Selection Guide

5. Pull properly marked 2 or 3 conductor cable (depending on sensor requirements) for each 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.

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

7. Splice all 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 sensor wires to the LC2000 INPUT TERMINALS following Figure 3-1. Maintain correct polarity between wires and respective terminal points.

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

⚠ CAUTION

Sensor wires are to be connected ONLY to the designated input terminals of the INTRINSIC SAFETY compartment. Do NOT allow 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

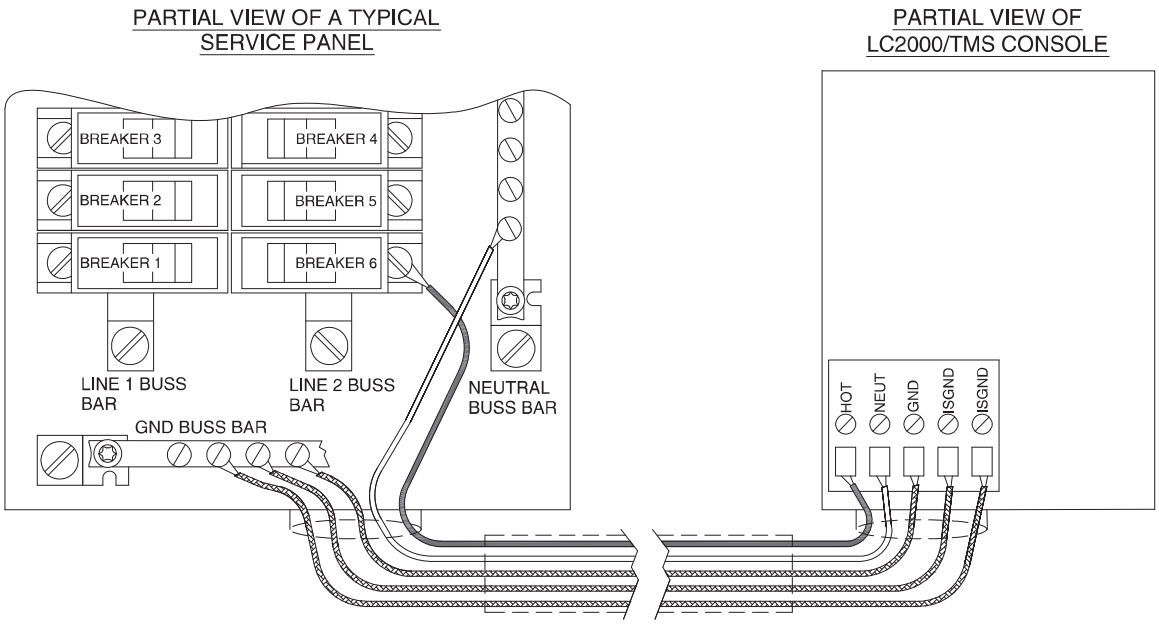
1. Confirm that the 115/230 VAC selector switch in the LC2000 is set correctly.

2. The LC2000 **MUST** be wired to a dedicated circuit breaker for intrinsically safe applications. This is an NEC code requirement for intrinsically safe apparatus. Wire in accordance with Figure 3-3 LC2000 AC WIRING.

3. The TWO (2) Intrinsically Safe (IS) grounds designated on the AC terminal block MUST be connected to EARTH GROUND at the service panel providing AC power. Connection must be made using 12AWG wiring providing a resistance to ground no greater than 1 ohm. Refer to Figure 3-3 LC2000 AC WIRING.

4. HOT, NEUTRAL, GND and the two IS GROUNDS should be run in the same ¾" conduit.

IMPORTANT! LC2000 AND TMS SERIES GROUND WIRING INSTRUCTIONS



NOTE:
ALL GROUNDS MUST BE TERMINATED AT THE GND BUSS BAR IN THE SAME SERVICE PANEL AS LC2000 AND/OR TMS POWER. A GROUNDING ROD, COLDWATER PIPE OR OTHER CONNECTION SHOULD NOT BE USED.

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Figure 3-3 – LC2000 AC Power Wiring

3.3 SENSOR WIRING & SPLICES

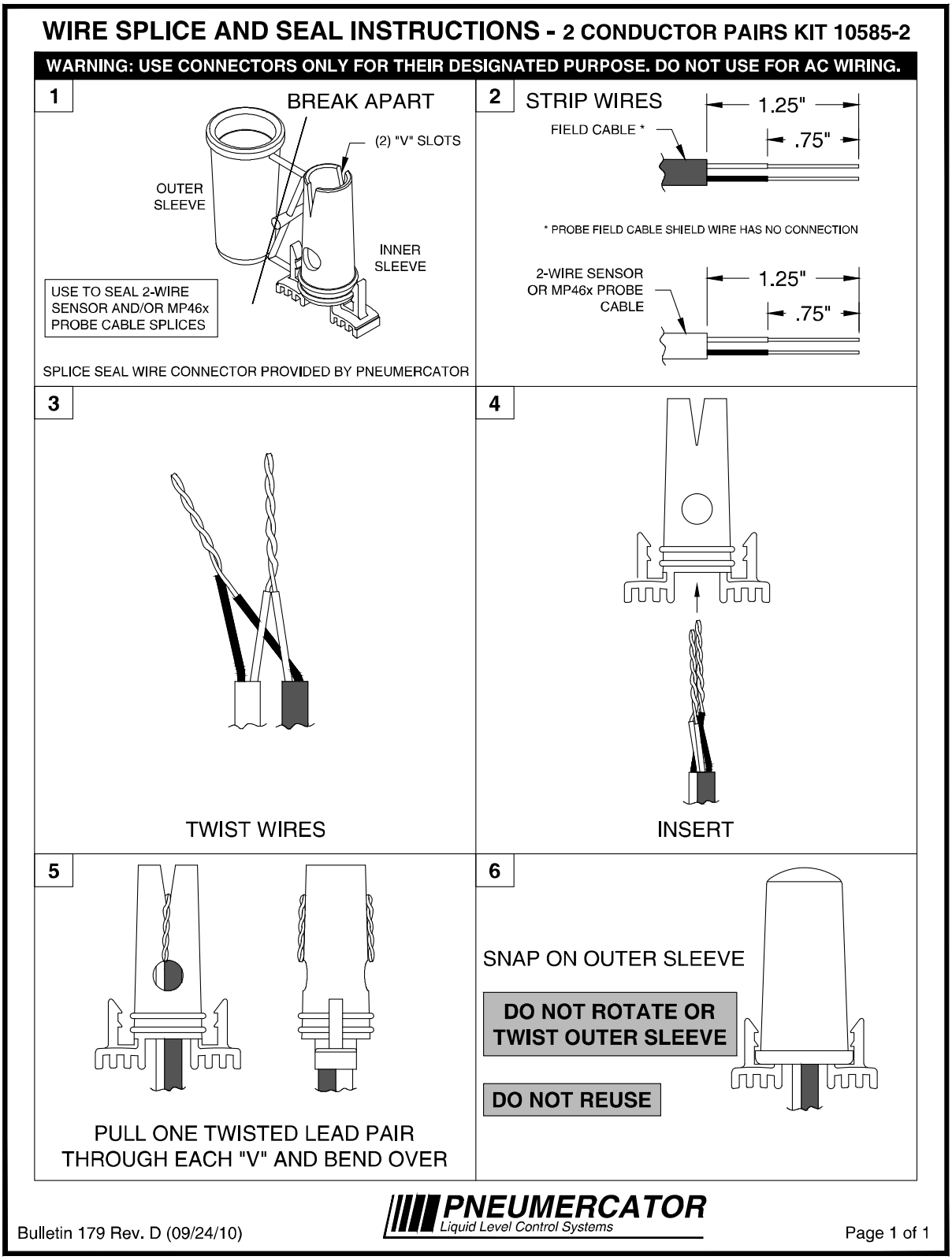
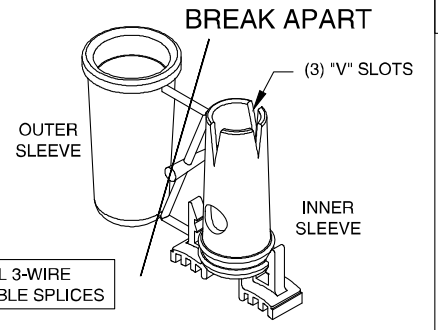


Figure 3-6 - 2-wire sensor Splice Kit Instructions

WIRE SPLICE AND SEAL INSTRUCTIONS - 3 CONDUCTOR PAIRS KIT 10585-3

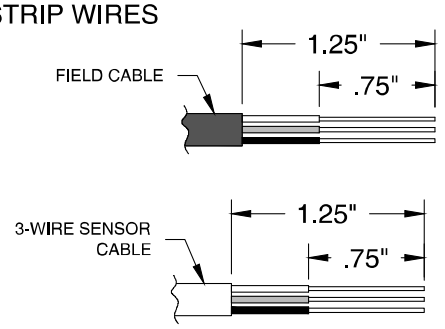
WARNING: USE CONNECTORS ONLY FOR THEIR DESIGNATED PURPOSE. DO NOT USE FOR AC WIRING.

1

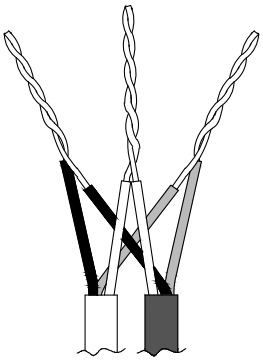


SPLICE SEAL WIRE CONNECTOR PROVIDED BY PNEUMERCATOR

2 STRIP WIRES

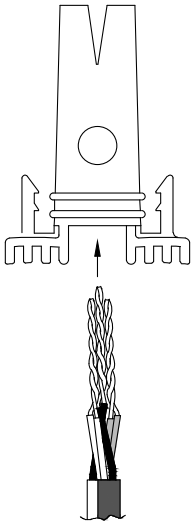


3



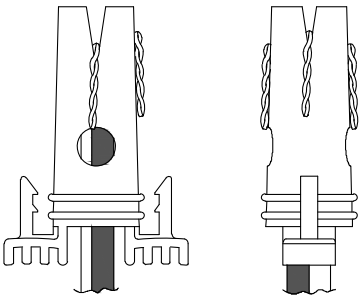
TWIST WIRES

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

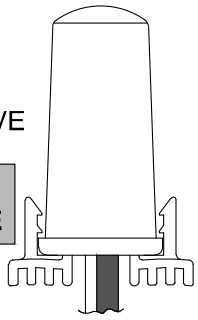


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Figure 3-7 - 3-wire sensor Splice Kit Instructions

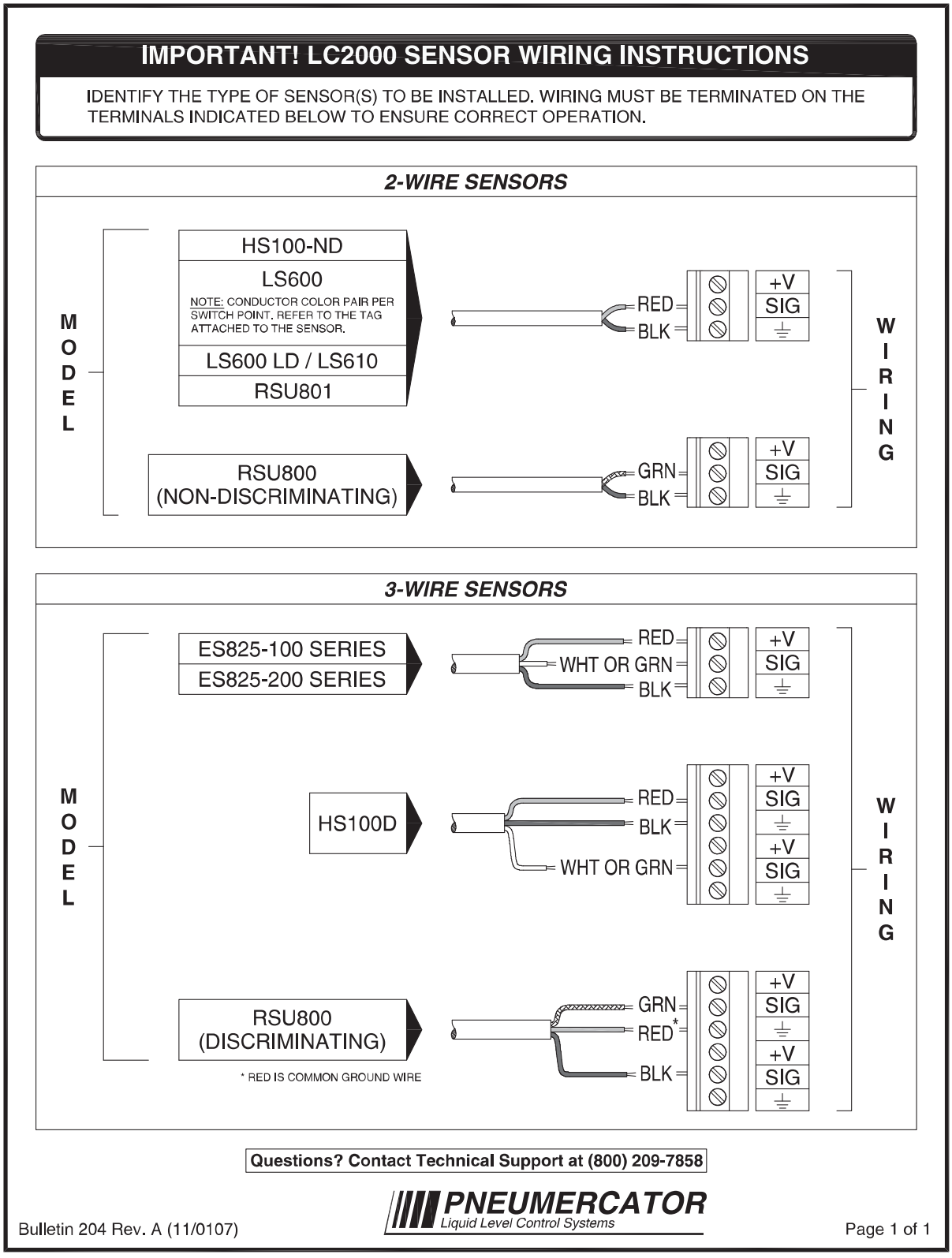

Figure 3-8 - LC2000 sensor wiring

3.4 PROGRAMMABLE RELAY OUTPUTS/CONTACT CLOSURE INPUTS

The LC2000 provides dry contact closure inputs and relay contact closure outputs that are user-programmable via TMSComm communications interface. Each input is programmable for relay control and alarm functions as well as remote relay acknowledgement or gating functions. Each relay output is programmable to trigger on any combination of events, including leak or point level sensor alarm, contact closure input or system error. Additionally, relays are individually programmable for failsafe mode; delayed shutoff, latching for pump up/down controls. 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.

The standard LC2000 includes two (2) dry contact closure inputs and two (2) relay contact closure outputs as illustrated in Figure 3-9 below. Also shown is an optional 4 Input/4 Relay Output Card. An optional 8 Input/8 Relay Output Card or 16 Relay Output Card are also available.

⚠ 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.

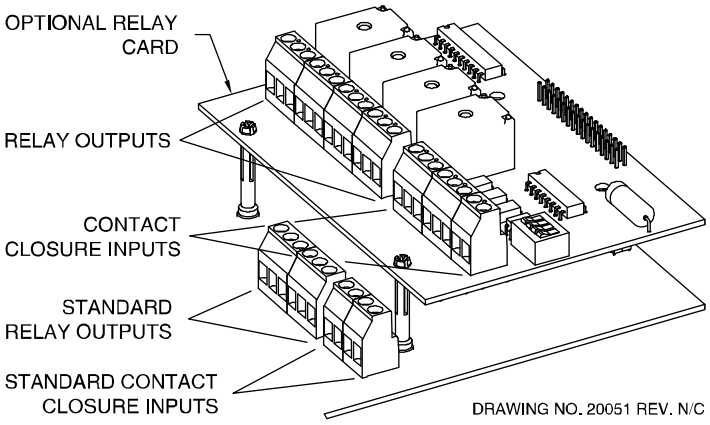

Figure 3-9 - Relay Output/Contact Closure Input Layout
(Optional 4 Relay Output/4 Contact Closure Input Expansion Card shown)

3.5 DATA COMMUNICATIONS WIRING

The non-intrinsically safe area is equipped with three (3) communications ports that are assigned as follows:

One (1) EIA RS-232 Interface to remote computer, PLC or external modem.

One (1) EIA RS-485 Interface to remotely located PNEUMERCATOR smart peripheral devices.

One (1) for use with an optional communications interface card. Available options include modem, fax/modem, Ethernet TCP/IP, ModBus RTU, LonWorks (w/gateway).

Figure 3-10 shows the locations of these connections.

⚠ CAUTION

All communication terminations are located in the NON-INTRINSICALLY SAFE side of the LC2000 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.

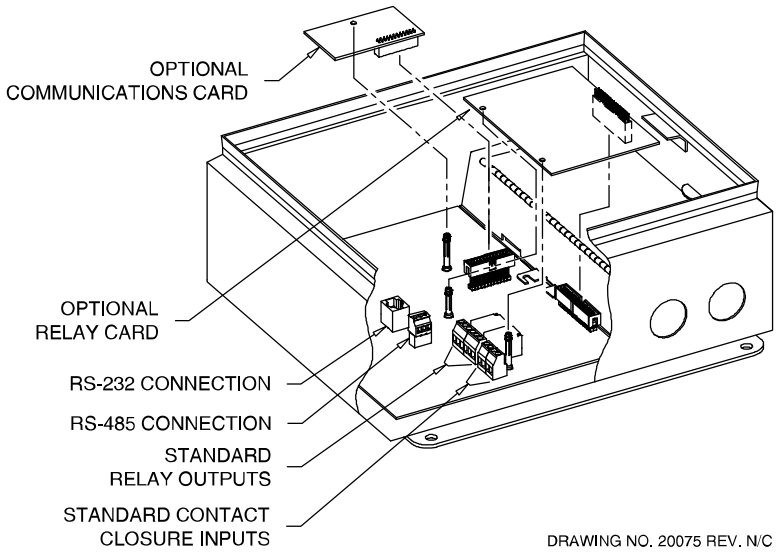

Figure 3-10 - Non-Hazardous Expansion Option Installation

3.6 LABEL INSERT CARRIER INSTRUCTIONS

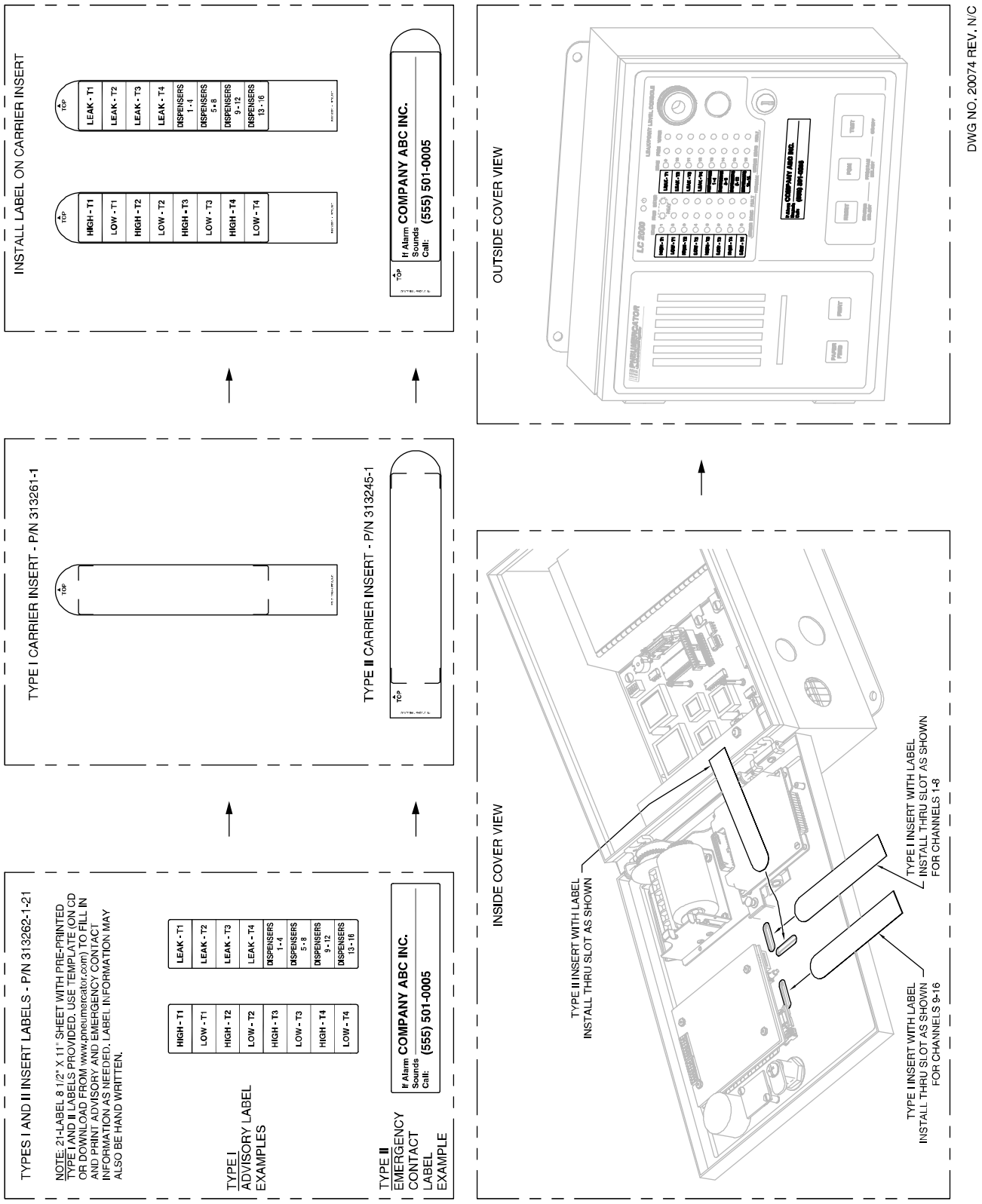

Figure 3-11 – Label Insert Carrier Instructions

3.7 INPUT/OUTPUT MAP

The INPUT/OUTPUT MAP below should be completed by the electrical installer as each sensor or contact closure input and relay control output function is wired to the LC2000 system. This will provide the equipment operator a means of identifying each field device for proper system setup programming and maintenance. The INPUT/OUTPUT MAP should be kept with the LC2000 console.

INPUT/OUTPUT MAP

INPUT #	SENSOR FUNCTION	SENSOR NAME
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

INPUT #	CONTACT CLOSURE(CC) INPUT FUNCTION	CC NAME
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

RELAY#	RELAY FUNCTION	RELAY NAME
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		

PNEUMERCATOR LC SERIES

LIMITED WARRANTY

LC Series

Pneumercator, here and after referred to as **PCO**, warrants its **LC 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 **LC 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.

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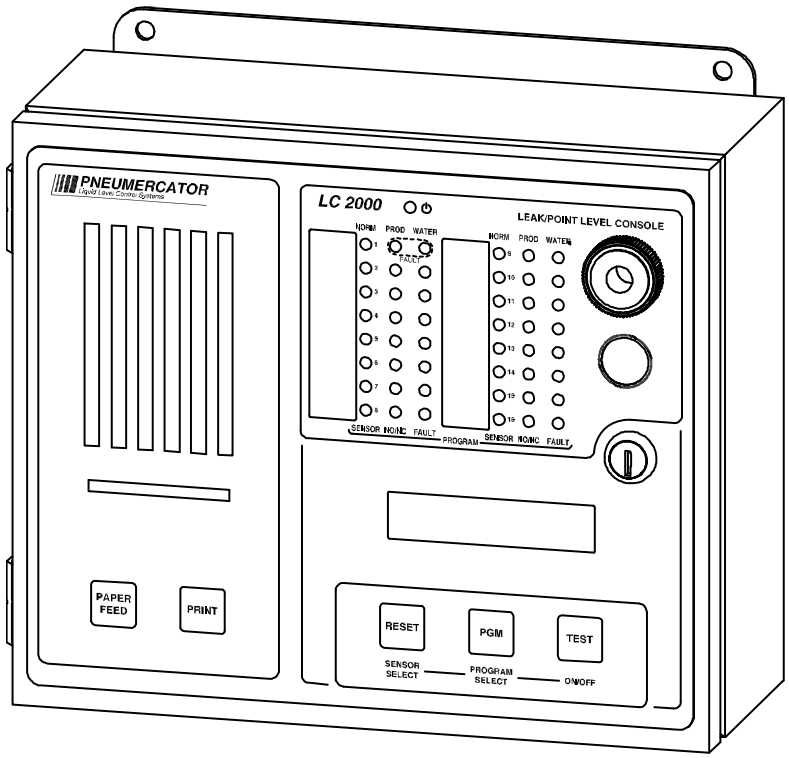
PNEUMERCATOR
Liquid Level Control Systems

LEAK/POINT
LEVEL ALARM
CONSOLE

OPERATION MANUAL



DRAWING NO. 20068 REV. N/C

MODEL LC2000

1785 EXPRESSWAY DRIVE NORTH
HAUPPAUGE, NY 11788

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

TABLE OF CONTENTS

⚠ WARNING

This product is wired to sensors installed in hazardous, explosive environments. Initial application of AC power to this system should occur only after complete verification of safe, proper installation by authorized Pneumercator-certified service personnel. Failure to do so may result in serious injury and/or property loss.

This manual is intended to be used for instruction on operation and basic sensor programming of the LC2000 using it's front panel controls, display and optional printer. Much more extensive programming is available using the TMSComm communications software provided on CD ROM.

SECTION 1 – SYSTEM OVERVIEW

1.0 GENERAL

The LC2000 series Leak and Point Level Alarm Console offers essentially all of the sensor-related features of the TMS series Tank Management Systems, and will interface to all of the same sensor model types, including discriminating and non-discriminating electronic or mechanical secondary containment leak sensors as well as single and multi-point level float sensors. All sensor inputs can be programmed for either alarm or relay control applications, including time delay, conditional logic and latching functions for pump/valve controls. Optional printer and numerous communications options are also supported.

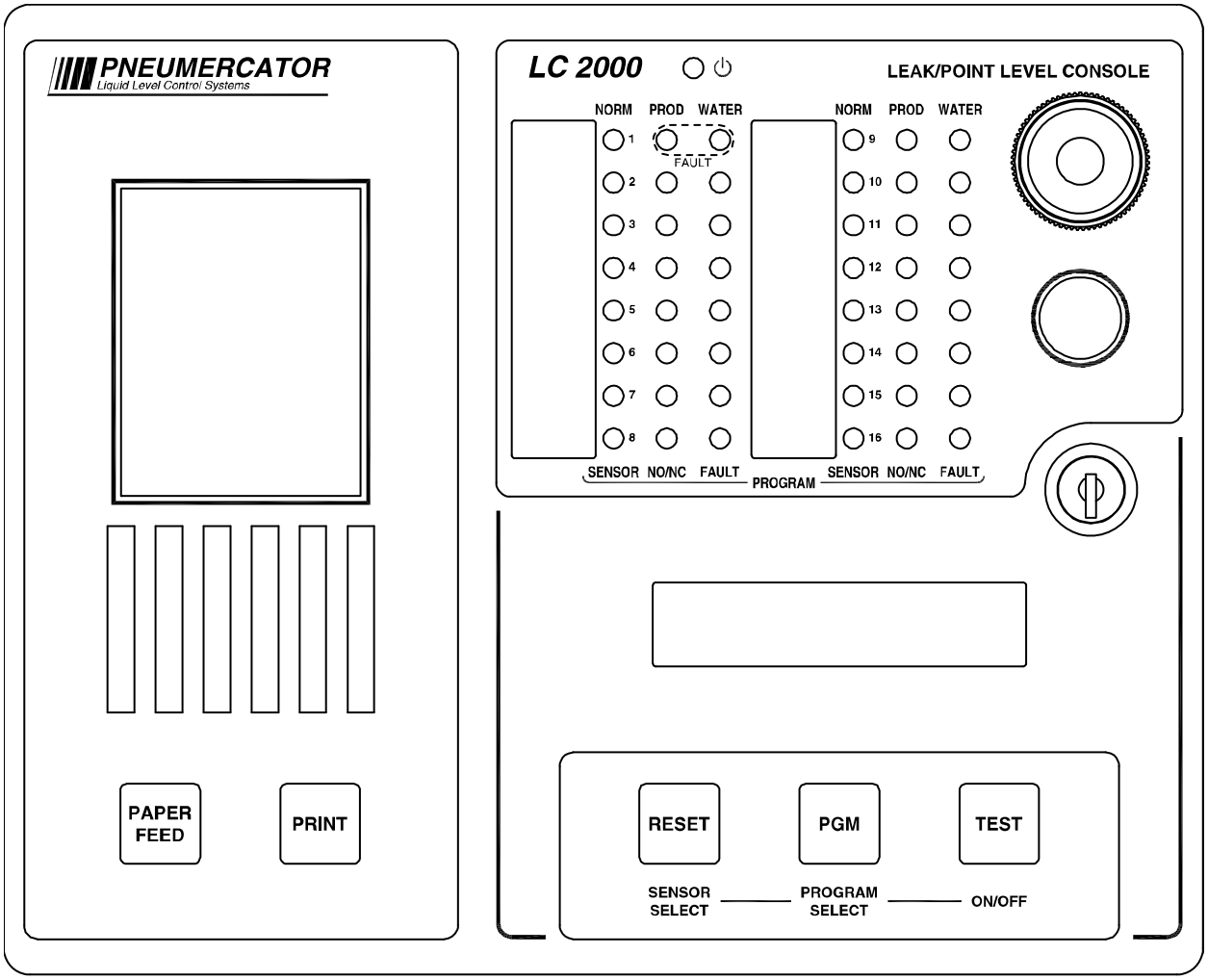
1.1 FRONT PANEL DESCRIPTION

The front panel of the LC2000 is available in four different configurations as listed below:

LC2000-1... Console without display or printer
LC2000-2... Console with display, no printer
LC2000-3... Console with display and internal printer
LC2000-4... Console with display and internal printer w/autowinder

This manual describes operational procedures pertaining to -2, -3, and -4 consoles. The LC2000-1 "Black Box" Remote Acquisition Unit is described in a separate Pneumercator document for operating the LC2000 using TMS Communicator.

As illustrated in Figure 1-1 below, the LC2000 front panel consists of an array of green, yellow and red LED indicators for sensor status, power LED, audible alarm annunciator, ultra-bright summary alarm LED strobe (optional), membrane pushbutton controls, security lock, and optional printer with or without autowinder.



DWG NO. 20078 REV. N/C

Figure 1-1 – Front Panel View

1.2 DISPLAY

The front panel display consists of an array of 4, 8, 12 or 16 groups of ultra-high intensity green, yellow and red LED indicators for sensor state and basic configuration status, green power LED and optional ultra-bright summary alarm LED strobe. Operating in the normal or VIEW mode, sensor LEDs indicate NORMAL and ALARM conditions for non-discriminating sensors or NORMAL, PRODUCT and WATER alarm conditions for discriminating sensors. Sensor and wiring FAULT conditions are also indicated for sensors having Pneumercator's exclusive supervised wiring feature. The optional summary alarm flashing strobe is activated for any new alarm condition and can be programmed to de-activate on front panel RESET, or persist until the alarm condition is removed. See figure 1-2 below.

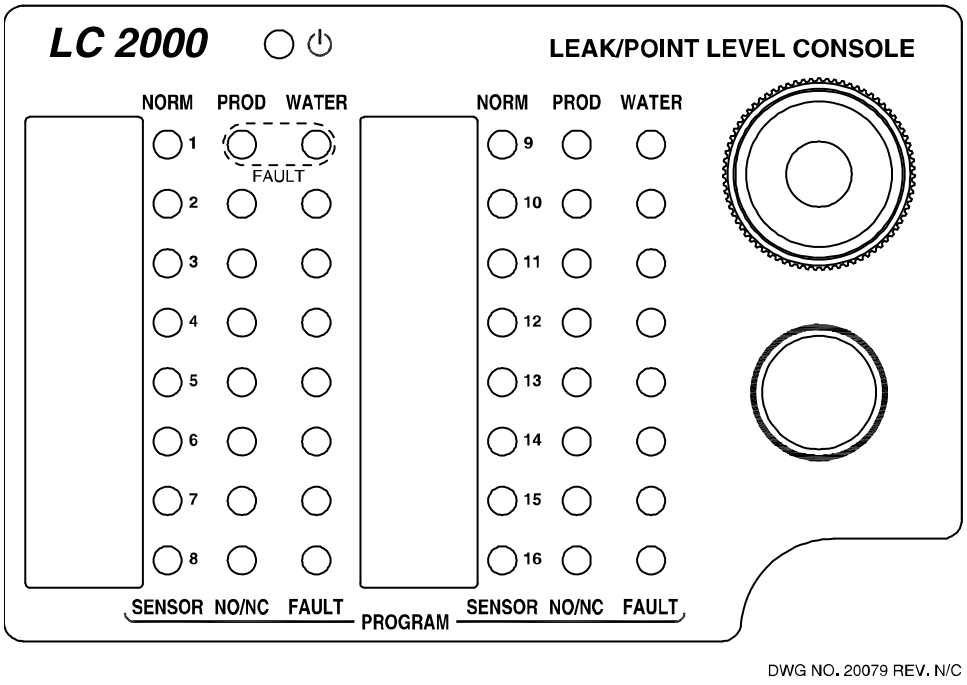


Figure 1-2 - LC2000 LED Layout

1.3 PUSHBUTTON LAYOUT

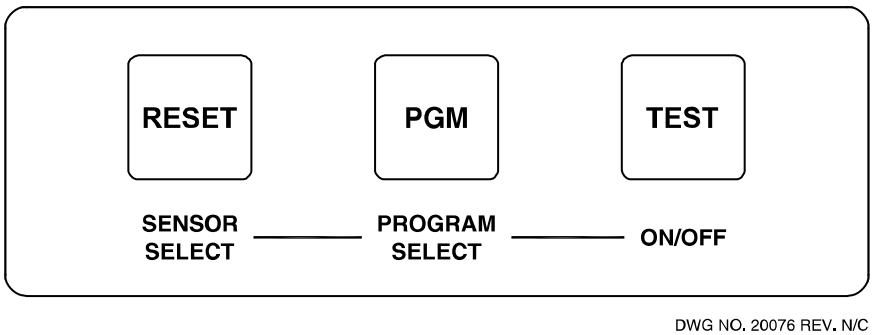


Figure 1-3 – Pushbutton Layout

1.4 EDIT ENABLE/SAVE BUTTON

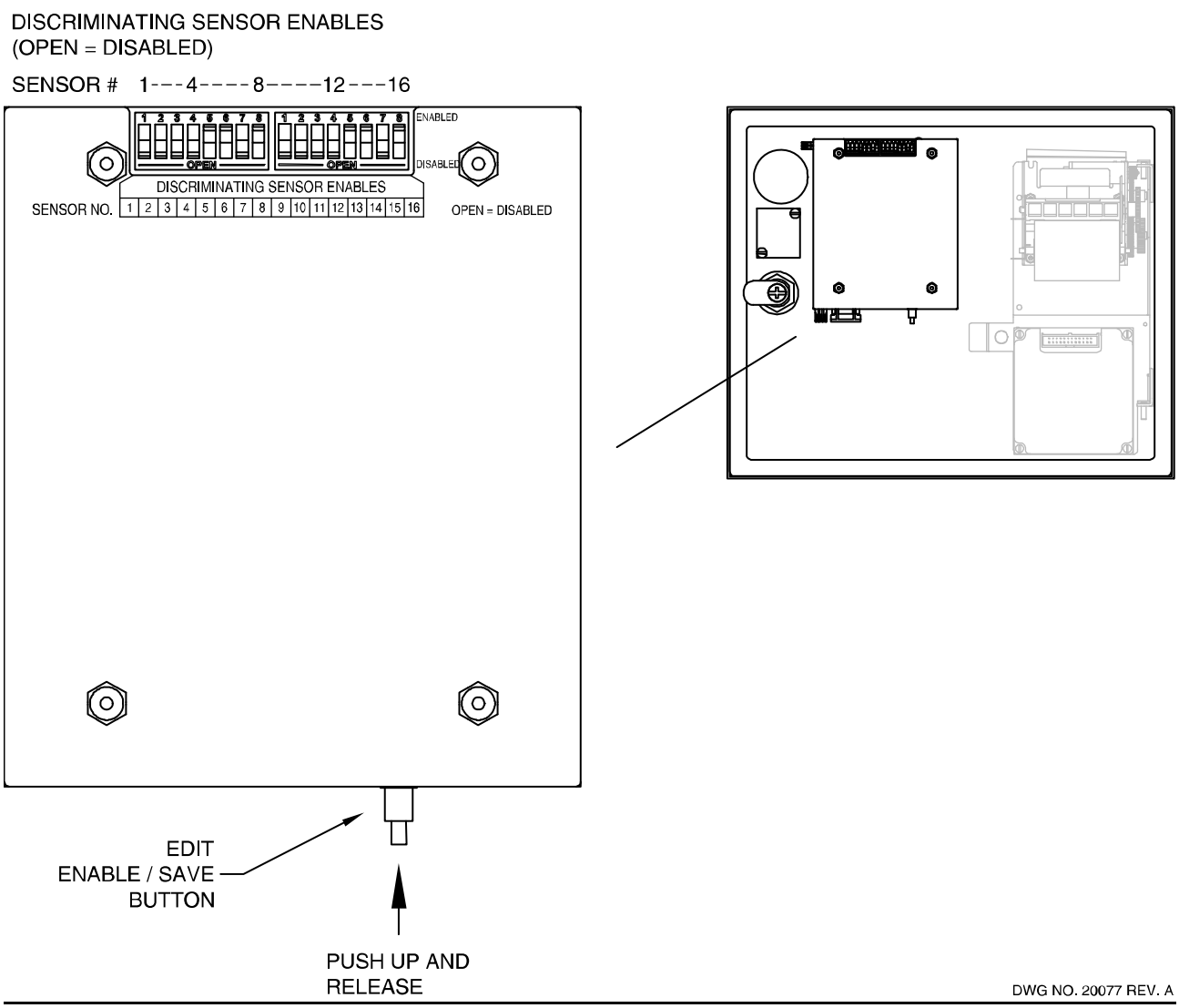


Figure 1-4 – Edit Enable/Save Button

SECTION 2 – OPERATION

2.0 OVERVIEW

The LC2000 has two operational modes, VIEW(normal) and PROGRAM, offering the following functions;

VIEW Mode:

- Display of current sensor statuses and audible annunciation of alarm conditions
- Front panel acknowledgement of alarm conditions
- Testing of front panel display and audible alarm
- Viewing of basic sensor programming information
- Printing of current sensor status report and Alarm/Event logs (if equipped with optional printer)
- Initialization of logs and system configuration programming

PROGRAM Mode:

- Viewing/Programming of basic sensor configuration (Note: More extensive programming must be performed using the supplied TMSComm software)
- Printing of sensor-only or complete system configuration reports

2.1 VIEW MODE

Pushbutton Operation:

- **RESET** acknowledges the front panel horn, changes blinking new alarm LEDs to steady “on” and turns off strobe if so programmed. All programmed relay FP acknowledges are also activated.
- **TEST** turns on all LEDs, strobe and double beeps horn.
- **PGM** (recall) displays basic sensor programming.
- Combined **TEST** and **RESET** enters PROGRAM mode. (See Section 2.2)
- **PRINT** generates a CURRENT SENSOR STATUS Report.
- Press and hold **PRINT** for 1 second to generate an Alarm and Event Log Report.
- **PAPER FEED** advances printer paper.
- Initialize all LC2000 logs – Press and hold **EDIT ENABLE/SAVE** pushbutton for at least 10 seconds while in VIEW mode. LC2000 will beep 3 times to confirm operation.
- Initialize LC2000 configuration – Press and hold **EDIT ENABLE/SAVE** and **RESET** pushbuttons for at least 10 seconds while in VIEW mode. LC2000 will beep 3 times to confirm operation. **WARNING! This operation will clear all user-programmed configuration data and set factory defaults.**

LED Operation:

1. During start-up, all LEDs blink while loading configuration, followed by a display, LED strobe and beeper check.
2. During VIEW mode, green = NORMAL, red = ALARM or PRODUCT ALARM, yellow = WATER ALARM and red and yellow = FAULT. Alarms and faults blink until acknowledged.
3. During PGM recall mode, LEDs indicate basic sensor programming. Refer to table PROGRAM Mode LED Indicators for details.

2.2 PROGRAM MODE

1. Enter PROGRAM mode by first pressing and holding **TEST** to enter DISPLAY CHECK mode, followed by **RESET** (while still holding **TEST**). After two seconds the LC2000 will beep twice, indicating transition to PROGRAM mode. The display will now show basic sensor programming information as indicated by the orange lettering on the front panel.
2. Initial entry into PROGRAM mode: First SENSOR ENABLE LED blinks 3 times, then goes to programmed state, i.e. ON for enabled, OFF for disabled.
3. Press TEST/**ON-OFF** to enable/disable selected item(**EDIT ENABLE**/SAVE button must be pressed once after entering PROGRAM mode). If selected item is SENSOR ENABLE and item is set to DISABLE, then all associated LEDs are turned off. See PROGRAM Mode LED Indicators table below for programming selections.
4. Press PGM/**PROGRAM SELECT** until the “beep” to advance to the right to the next program item. If the selected sensor is DISABLED, pressing PGM/**PROGRAM SELECT** until the “beep” will not advance to the right, and instead, the SENSOR ENABLE LED will blink 3 times, then retain its current state, which would be OFF.
5. Press and immediately release PGM/**PROGRAM SELECT** (w/o beep) to recall the currently selected LED item. Associated LED will blink 3 times and return to currently programmed state.
6. DISCRIMINATING SENSOR mode is selected via dip switches on the back of the display board. See FRONT PANEL SENSOR PROGRAMMING table below. **IMPORTANT!** Dip switch programming of DISCRIMINATING SENSOR enables will not take affect until an EDIT SAVE operation is performed. Also, programming DISCRIMINATING SENSOR enables via dip switches must be enabled in the LC2000 configuration file (Factory Default).
7. Edits are saved by pressing **EDIT** ENABLE/**SAVE** button.
8. **PRINT** generates a SENSOR CONFIGURATION Report.
9. Press and hold **PRINT** for 1 second to generate a complete configuration report.

PROGRAM Mode LED Indicators		
SENSOR ENABLE	**NORMALLY OPEN/CLOSED (NO/NC)**	**FAULT DETECT ENABLE**
OFF - DISABLED	OFF - NC	OFF - DISABLED
ON (2 Fast Blinks) ALARM INPUT	ON - NO	ON - ENABLED
ON (3 Slow Blinks) RELAY CONTROL		

Front Panel Sensor Programming			
SENSOR MODEL	**NORMALLY OPEN/CLOSED (NO/NC)**	**FAULT DETECT ENABLE**	**DISCRIMINATION ENABLE**
All Float Switches w/o Fault Detection	As Built	DISABLED	OPEN
All Float Switches w/ Fault Detection	As Built	ENABLED	OPEN
ES825-100F	NO	ENABLED	OPEN
ES825-200F	NO	ENABLED	CLOSED
HS100 Series	NC	DISABLED	CLOSED

Dip Switch Programming(S1)				
	S1-1	**S1-2**	**S1-3**	**S1-4**
OPEN	-	ENABLE Front Panel Strobe Acknowledge	ENABLE Communications Security	-
CLOSED	FACTORY	DISABLE Front Panel Strobe Acknowledge	DISABLE Communications Security	FACTORY

SECTION 3 – LOGS

The LC2000 can log the occurrence of various alarm and system error conditions. These logs are stored in battery-backed memory for retrieval using TMSComm, and additionally can be manually or automatically printed with optional printer installed.

3.1 ALARM LOG

This log captures the occurrence of alarm conditions based on sensor and non-hazardous contact closure inputs programmed as alarm inputs. Inputs programmed for non-alarm functions will not be captured. The alarm log will maintain the 24 most recent alarm occurrences. All ALARM log data is available via the TMSComm communications software or optional printer. See Section 2.1 VIEW Mode for instructions on printing an alarm log report. NOTE: If optional printer is included, factory default is automatic printout on ALARM condition. The console can be programmed to disable automatic printouts, i.e. manual or demand printouts only, using TMSComm.

The following is a description of ALARM log data;

Date: Month and Day of alarm occurrence

Time: Hour and Minutes of alarm occurrence (24 hour format)

Alarm Name: Assigned sensor or contact closure name

Device ID: Sensor Input #1–16 or Contact Closure Input #1-10.

Alarm ID: Identifies alarm type SENSOR or CONTACT CLOSURE

Alarm Detail: Additional alarm information when applicable
ALARM, CLOSED, OPEN, OIL, WATER

3.2 EVENT LOG

This log captures the occurrence of system hardware and configuration-related problems. More serious problems are identified as FATAL ERROR or ERROR conditions, while others are identified as WARNING conditions. The EVENT log will maintain the 8 most recent system problem occurrences. All EVENT log data is available via the TMSComm communications software or optional printer. See Section 2.1 VIEW Mode for instructions on printing an EVENT log report. NOTE: If optional printer is included, factory default is automatic printout on EVENT condition. The console can be programmed to disable automatic printouts, i.e. manual or demand printouts only, using TMSComm.

The following is a description of EVENT log data;

Date: Month and Day of alarm occurrence

Time: Hour and Minutes of alarm occurrence (24 hour format)

Fatal Error, Error or Warning #: Two-digit error or warning identification code. See Appendix A,

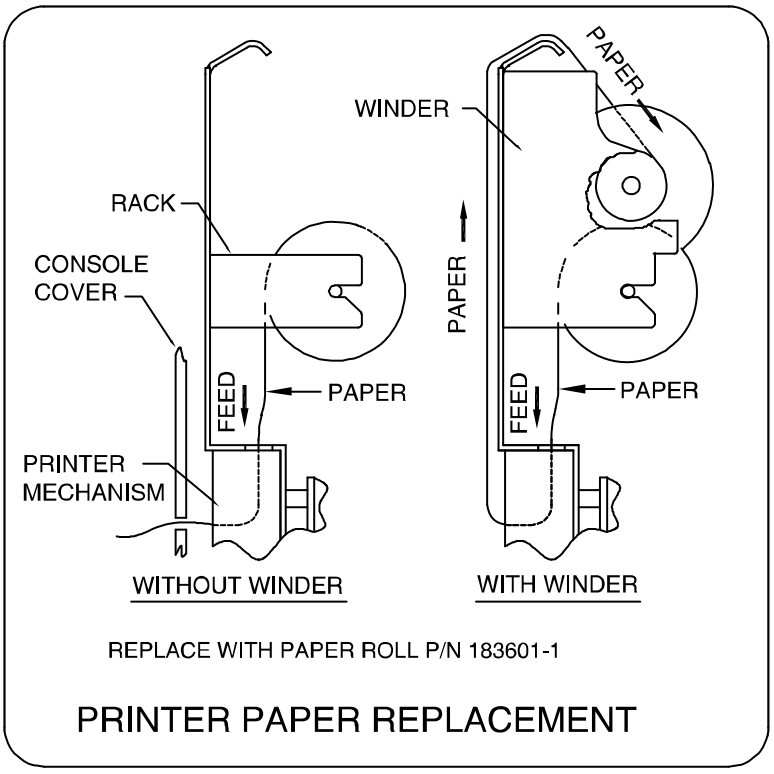
Device ID: Sensor Input #1–16 or Contact Closure Input #1-10, if applicable

Event ID: See Appendix A

Detail See Appendix A

SECTION 4 PRINTER OPERATION

4.1 PRINTER PAPER REPLACEMENT

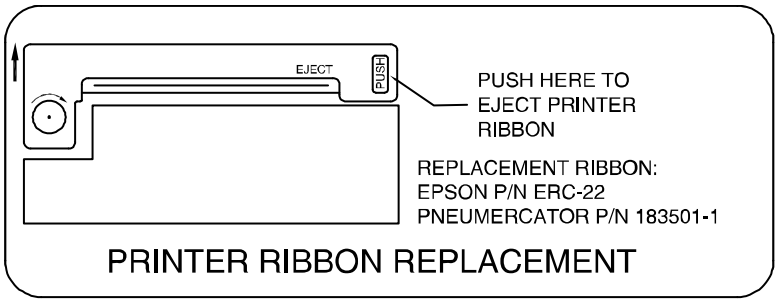


H

DWG NO. 20038 REV. N/C

Figure 4-1 – Printer Paper Replacement (No Winder)

4.2 RIBBON REPLACEMENT



DWG NO. 20039 REV. N/C

Figure 4-2 - Ribbon Replacement

APPENDIX A EVENT CONDITIONS AND CODE TABLE

Warning Conditions	Codes:	Detail:
Modem Initialization Warning	**01**	Attempt to initialize modem with no response.
Modem Command Warning	**02**	Contact Factory.
Modem Timeout Warning	**03**	One minute transmission time-out during program down loading or no response within 10 minutes.
Modem Carrier Warning	**04**	No host data line for modem or line (disconnected).
Modem Communication Warning	**05**	Receive background noise from modem that is meaningless to LC2000.
Modem No dial tone Warning	**06**	No dial tone present. Check line connection.
Header Configuration Warning	**09**	Configuration data checksum error. Check specific configuration data group for corrupted data.
Relay cc Configuration Warning	**11**	" " "
Relay Sensor Configuration Warning	**12**	" " "
Relay Status Configuration Warning	**13**	" " "
cc Configuration Warning	**15**	" " "
Sensor Configuration Warning	**16**	" " "
Modem Configuration Warning	**19**	" " "
Dial out Configuration Warning	**20**	" " "
Power Failure Warning	**21**	LC2000 acknowledges a (2) minute or greater Power Outage.

Error Conditions:	Codes:	Detail:
Boot Prom Checksum error	**01**	Boot Memory Checksum Error – This is a fatal error indicating corruption of start-up firmware. Contact Product Support.
Flash Prom Checksum error	**02**	Flash Memory Checksum Error – This is an error indicating corruption of application firmware. Re-Flash or Contact Product Support.
Flash Prom Write error	**03**	Unable to write to flash memory during flash upload. Contact Product Support
Flash Prom Erase error	**04**	Unable to erase flash memory prior to flash upload. Contact Product Support
Serial Prom Error	**05**	Communications error encountered while reading configuration memory. Check that all boards and cables are properly seated.
Fault detecting sensors		
Sensor Short Circuit error	**20**	Shorted field wiring or sensor -Fault detecting sensors only.
Sensor Open Circuit error	**21**	Open field wiring or sensor -Fault detecting sensors only.
Sensor Fault error	**22**	Open/Shorted field wiring or sensor – ES825-200F sensors only

PNEUMERCATOR LC SERIES

LIMITED WARRANTY

LC Series

Pneumercator, here and after referred to as **PCO**, warrants its **LC 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 **LC 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
Liquid Level Control Systems
1785 Expressway Drive North
Hauppauge NY 11788
(631) 293-8450 Fax (631) 293-8533

4, 8, 12 or 16-Input Discriminating/Non-Discriminating Secondary Containment Leak/Point Level Alarm Console with Printer Option

Console

- Dimensions (W x H x D): 11.8” x 11.5” x 4.75” (300 mm x 292 mm x 121 mm)
- Weight: 14 lb (6.4 kg) (w/ Printer)
- Operating Temperature: -40 ºF to 160 ºF (-40 ºC to 70 °C) w/o Printer
  -5 ºF to 140 ºF (-20 ºC to 60 °C) w/ Printer
- Humidity: 95% Non-condensing
- Enclosure Rating: Locking NEMA 12 (IP52), NEMA 4 (IP56) or NEMA 4X (IP56) (304 S.S.)
- Power Requirements: 115/230 VAC ±15% (w/o Printer) Switchable, 50-60 Hz, 20 W Max.
  8-16 VDC or 16-60 VDC Optional
- Memory: Configuration / Setup Data – EEPROM, 50 year data retention, no batteries
  Log Reports and Real-Time Clock – Lithium Battery-Backed RAM, 5-10 year data retention
- Audible Alarm: 85 db
- Summary Visual Alarm: Optional White LED Strobe Summary Alarm Indicator, Visible from 300’ (91 m)
- Display: Ultra-High Intensity Normal (Green), Product (Red) and Water (Yellow) Alarm LEDs, Green Power LED, Visible from 75’ (23 m)
- Insert Labels: Pre-Printed or User-Printable/Writeable Polyester Pocket Insert Labels and Emergency Contact Label
- Communications: RS-232 Included Standard, RJ-13 Jack
  RS-485 Included Standard, Plug-In Terminal Block (For Pneumercator Peripherals)
  Internal, Secured Modem, Fax / Modem, Ethernet Network Interface or ModBus Optional
- Sensor Capacities: 4, 8, 12 or 16 Discriminating or Non-Discriminating Sensors, Supervised Wiring Ready
- I / O, Non-Haz.: Standard: 2 Relays, 1 Form C, Rated: 10 A @120 VAC; 6 A @240 VAC, w/ 2 Opto-Isolated Inputs
  Expansion Options: (1 slot available)
  4 Relays, 1 Form C, Rated: 10 A @120 VAC; 6A @240 VAC, w/ 4 Opto-Isolated Inputs
  8 Relays, 1 Form A, Rated: 5 A @120 VAC; 5A @240 VAC w/ 8 Opto-Isolated Inputs
  16 Relays, 1 Form A, Rated: 5 A @120 VAC; 5A @240 VAC

PNEUMERCATOR Liquid Level Control Systems
Pneumercator Company, Inc.
1785 Expressway Drive North
Hauppauge, New York 11788
Tel: 631-293-8450
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http://www.pneumercator.com

Sensors

- ES825-200F — Electronic, Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular
- ES825-100F — Electronic, Non-Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular
- LS600LD — Float, Containment, Manway and Piping Sumps, Dispenser Pan
- LS600xx — Multi-Float, High / Low Level and Pump Control
- RSU800/810 — Float, Wet Annular / Reservoir
- LS610 — Float, Dry Annular
- HS100D — Polymer / Float – Wet Well, 10’ (3 m) to 25’ (7.6 m) depth
- HS100ND — Polymer – Dry Containment, 1’ (0.3 m) to 45’ (13.7 m) length

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

Remote Audible/Visual Alarms

- RA400 — Addressable (up to 16), Multi-Drop, Programmable Remote Annunciator
- RA400W — Wireless Programmable Remote Annunciator (Requires MPX200)

Certifications / Approvals

- UL/cUL Approved, File #E139464
- FCC Part 15B, Part 68
- City agency approvals pending
- Third-Party Approved, EPA-Compliant for Secondary Leak Detection

PNEUMERCATOR Liquid Level Control Systems

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

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Evaluation of the Pneumercator ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating Sensors as Liquid Level Sensors

For Use with Console Models: TMS3000 Series, TMS2000 Series, LC2000 Series

Final Report

PREPARED FOR:

Pneumercator Company

August 4, 2001
(Revised January 14, 2010)

Ken Wilcox Associates, Inc.
1125 Valley Ridge Drive, Grain Valley, MO 64029, USA
Voice (816) 443-2494, Fax (816) 443-2495
E-mail info@kwaleak.com, Web http://www.kwaleak.com

Evaluation of the Pneumercator ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating Sensors as Liquid Level Sensors

PREPARED FOR:

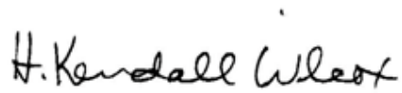
Pneumercator Company
120 Finn Court
Farmingdale, NY 11735

August 4, 2001
(Revised January 14, 2010)

PREFACE

This report presents the results of an independent third-party evaluation conducted by Ken Wilcox Associates, Inc. (KWA) on the ES825-200F/XF Discriminating Sensor and ES825-100F/XF/CF Non-Discriminating Sensor. The procedures used in the evaluation are described in the standard protocol “Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Liquid Level Sensors”, September 1996. 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 (FMRC) in Grain Valley, Missouri.
The test procedures are listed with the EPA’s National Workgroup on Leak Detection Evaluations (NWGLDE) 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. 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.

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



H. Kendall Wilcox, Ph.D., President
January 14, 2010

TABLE OF CONTENTS

SECTION 1. BACKGROUND

The federal Environmental Protection Agency (EPA) has provided a series of documents1 which describe the procedures which are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register. 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, of course, 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).

SECTION 2. DESCRIPTION OF THE EQUIPMENT

Both of the sensors described below are designed to connect to a controller system that indicates the status of the sensor.

2.1 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.

2.2 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.

SECTION 3. EVALUATION PROCEDURES

Sensors were tested using a very accurate dial micrometer system where the sensor is lowered into the liquid very slowly until alarm occurs. Displacement of the sensor is negligible since the surface area is large compared to the area of the tip.

Test Apparatus

The evaluation of this system was designed to determine if the liquid sensor operates as described by the vendor. The successful implementation of such liquid sensors requires that they be installed properly under conditions that will allow product to reach the liquid level sensor. The sensor was mounted and tested in a cylinder which contained the liquids for which this liquid sensor can be expected to encounter under normal operations. These liquids are listed in Table 1.

Table 1. Products Used for Testing Liquid Level Sensors *

1. Water
2. Unleaded Gasoline
3. #2 Diesel Fuel

* Motor fuels were obtained from commercial suppliers.

Threshold Determination

The threshold was determined by using a very accurate dial micrometer system in which the sensor was lowered into the product very slowly until an alarm occurred. Displacement of product by the sensor was negligible since the surface area was extremely large compared to the area of the tip of the sensor. The height of the product on the sensor was recorded from the dial micrometer system at the alarm level. This procedure was repeated a total of 6 times with each of the liquids in Table 1.

Detection Time

The time required for the sensor to respond to product levels above the sensor's threshold is the liquid level sensor's detection time. The average time to alarm for the six tests conducted for each product type is reported as the detection time.

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 liquid level 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 liquid level sensor will respond to any liquid once the sensor's threshold level has been exceeded unless the sensor has been designed otherwise. The testing conducted for this evaluation determined each sensor's specificity to water, gasoline, and diesel fuel.

SECTION 4. CALCULATIONS

Product and Water Levels
The product and water levels were measured using a very accurate dial micrometer system.

Lower Detection Limit (Threshold)
The threshold for the water detection and for the interstitial switch were calculated using the equation:

$$C = M + 4.414 * SD$$

where the C is the threshold, M is the average alarm level for each test set, and SD is the standard deviation for each data set. The tolerance coefficient for six data points (95% confidence) is 4.414.

Precision
The precision of liquid level sensors is equivalent to the standard deviation of the six liquid level measurements required to make the sensor alarm. The standard deviation is obtained from the variance, which is calculated using the equation:

$$Variance = (\sum (L - i))^2 / (n-1)$$

where n is the number of tests conducted and L is the measured liquid level required to make the sensor alarm. The standard deviation is the square root of the variance.

Detection Time
The detection time is the average time it took the sensor to alarm after the threshold was exceeded for the six tests conducted with each product type. For responses that were near instantaneous, the time has been tabulated as less than one second.

Fall Time
The fall time is the average time it took the sensor to stop alarming after the liquid level was lowered below the threshold for the six tests conducted with each product type. For responses that were near instantaneous, the time has been tabulated as less than one second.

SECTION 5. TEST RESULTS

The data and results for the ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating Sensors are contained in Tables 2 and 3.

Lower Detection Level (Threshold)
The threshold test results for the ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating Sensors for the three liquids that were tested is contained in Tables 2 and 3.

Precision (Standard Deviation)
The precision results for the ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating Sensors for the three liquids that were tested have been provided in Tables 2 and 3.

Detection Time
Both sensors alarmed immediately after the liquid level exceeded the threshold level for both product and water.

Fall Time
Both sensors stopped alarming immediately after being removed from product or water.

Specificity
Both sensors will alarm for any liquid once the threshold is exceeded. The test data shows that both sensors respond to water, gasoline, and diesel fuel.

Time to Alarm under Operating Conditions
The time for a given liquid sensor to alarm will depend upon 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 determining the volume necessary to reach the threshold of the liquid level sensor and dividing by the leak rate.

Table 2. Test Results for the ES825-200F/XF Discriminating Sensor

Product Type			
	Water Height to Alarm (in.)	Unleaded Gasoline Height to Alarm (in.)	Diesel Fuel Height to Alarm (in.)
Run No.			
1	0.466	0.402	0.400
2	0.384	0.397	0.349
3	0.424	0.394	0.301
4	0.410	0.422	0.406
5	0.365	0.435	0.401
6	0.448	0.357	0.333
Threshold - Lower Detection Limit (in)	0.416	0.401	0.365
Precision - Standard Deviation (in)	0.584	0.520	0.558
Detection Time (sec)	2.3	1.6	2.7
Fall Time (sec)	< 1 second	< 1 second	< 1 second

Table 3. Test Results for the ES825-100F/XF/CF Non-discriminating Sensor

Product Type			
	Water Height to Alarm (in.)	Unleaded Gasoline Height to Alarm (in.)	Diesel Fuel Height to Alarm (in.)
Run No.			
1	0.499	0.562	0.484
2	0.535	0.498	0.500
3	0.509	0.504	0.527
4	0.494	0.515	0.440
5	0.499	0.522	0.439
6	0.529	0.516	0.469
Threshold - Lower Detection Limit (in)	0.511	0.520	0.477
Precision - Standard Deviation (in)	0.587	0.619	0.629
Detection Time (sec)	1.1	1.4	2.1
Fall Time (sec)	< 1 second	< 1 second	< 1 second

Attachment A

Results Forms for the Pneumercator ES825-200F/XF Discriminating and ES825-100F/XF/CF Non-Discriminating 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 ES825-100F/XF/CF Non-Discriminating Liquid Sensor Version number(s) For use with the TMS3000, TMS2000 and LC2000 Series Consoles

Vendor Pneumercator Co.
(Name of Manufacturer)

120 Finn Court
(Address)

Farmingdale	New York	11735	(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 (Lower Detection Limit) - The smallest product thickness that the detector can reliably detect.

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.

Sensor Name: ES825-100F/XF/CF Non-Discriminating Sensor
Version Number(s): For use with the TMS3000, TMS2000 and LC2000 Series Consoles

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 of the Evaluation

	Product		
Parameter	**Water**	**Gasoline***	**Diesel***
Threshold - Lower Detection Limit (inches)	0.511	0.520	0.477
Precision - Standard Deviation (inches)	0.587	0.619	0.629
Detection Time (sec)	1.1	1.4	2.1
Fall Time (sec)	< 1 second	< 1 second	< 1 second

Specificity - This sensor incorporates an optical liquid sensor that will respond to any liquid after the sensor's threshold has been exceeded.

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 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)

H. Kendall Wilcox
(signature)

December 18, 2010
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

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

(816) 443-2494
(phone number)

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: ES825-200F/XF Discriminating Liquid Sensor Version number(s) For use with the TMS3000, TMS2000 and LC2000 Series Consoles

Vendor Pneumercator Co.
(Name of Manufacturer)

120 Finn Court
(Address)

Farmingdale	New York	11735	(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 (Lower Detection Limit) - The smallest product thickness that the detector can reliably detect.

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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.

Sensor Name: ES825-200F/XF Discriminating Sensor
Version Number(s): For use with the TMS3000, TMS2000 and LC2000 Series Consoles

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 of the Evaluation

	Product		
Parameter	**Water**	**Gasoline***	**Diesel***
Threshold - Lower Detection Limit (inches)	0.416	0.401	0.365
Precision - Standard Deviation (inches)	0.584	0.520	0.558
Detection Time (sec)	2.3	1.6	2.7
Fall Time (sec)	< 1 second	< 1 second	< 1 second

Specificity - 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.

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 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)

(signature)

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

August 4, 2001 (Revised January 14, 2010)
(date)

(816) 443-2494
(phone number)

Evaluation of the Pneumercator Non-Discriminating Liquid Float-Switch Sensors

Console Models: **LC1000 Series, LC2000 Series, E-14, E-29, E-700-1, LDE-700, LDE-740, TMS3000, TMS2000, TMS2000W Series**

Switch Models: **LS600 Series, LS600-LD Series, LS610**

Final Report

PREPARED FOR:

Pneumercator Company

January 22, 1996 (Revised January 14, 2010)

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1125 Valley Ridge Drive, Grain Valley, MO 64029, USA
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Evaluation of the Pneumercator Non-Discriminating Liquid Float-Switch Sensors

Console Models: LC1000 Series, LC2000 Series, E-14, E-29, E-700-1, LDE-700, LDE-740, TMS3000, TMS2000, TMS2000W

Switch Models: LS600 Series, LS600-LD Series, LS610

Final Report

PREPARED FOR:

Pneumercator Company
120 Finn Court
Farmingdale, NY 11735

January 22, 1996 (Revised January 14, 2010)

PREFACE

An independent third-party evaluation of the Pneumercator Non-Discriminating Liquid Float-Switch Sensors was conducted by Ken Wilcox Associates, Inc. using test procedures which were taken from the EPA protocol, “Standard Test Procedures for Evaluating Leak Detection Methods: “Liquid-Phase Out-of-Tank Product Detectors”, March 1990, and “Standard Test Procedures for Evaluating Leak Detection Methods: Non-volumetric Tank Tightness Testing Methods”, March 1990. The work was conducted at the Leak Detection Test Center in Kansas City, Missouri. The results of this evaluation apply to the Pneumercator console models LC1000 Series, LC2000 Series, E-14, 29, E-700-1, LDE-700, LDE-740, TMS 3000, TMS 2000 and TMS2000W when these consoles are used with the liquid float-switch sensor models LS600 Series, LS600LD Series and LS610. Technical questions regarding this evaluation should be directed to the Pneumercator Company, at (631) 293-8450.

KEN WILCOX ASSOCIATES, INC.

H. Kendall Wilcox, Ph.D., President
January 14, 2010

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SECTION 1. BACKGROUND

The federal Environmental Protection Agency (EPA) has provided a series of documents that describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register. The requirements for evaluating liquid float-switch 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, of course, to provide an evaluation procedure that will provide testing that 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 float-switch sensor will alarm.

To achieve this objective, the applicable sections of standard EPA protocols have been adapted to the specialized requirements of liquid float-switch sensors. The test procedures generally follow the procedures described in the protocol for external liquid monitors ("Standard Test Procedures for Evaluating Leak Detection Methods: Liquid-Phase Out-of-tank Product Detectors", March 1990. Since the statistical methods for analyzing the data from qualitative monitors are not provided in the external liquid monitor document, the analysis of the data was conducted similarly to that described for non-volumetric test methods ("Standard Test Procedures for Evaluating Leak Detection Methods: Non-volumetric Tank Tightness Testing Methods", March 1990).

Since none of the forms provided in either document are suitable for reporting the results of liquid float-switch sensors, the forms for the liquid-phase out-of-tank product detector were modified to fit the test results. The modified forms are contained in Attachment A of this report. The modified test procedures used are contained in Attachment B.

SECTION 2. DESCRIPTION OF THE EQUIPMENT

The basic function of the consoles is to provide both audible and visual warning alarms at the occurrence of high or low process condition via high/low level switches. The LS600 tank mounted sensing devices transmit alarm conditions by opening or closing dry switch contacts. Alarm conditions are indicated by red LED alarm lights and horn mounted on the console.

The standard liquid switch sensors used with the consoles are the Model Series LS600 liquid float-switch sensors. These switches consist of from one to four magnetic cylindrical floats mounted on a brass or stainless steel tube suspended into the top of a liquid storage tank. Each float actuates a switch when the liquid level rises or falls past the float. When the switch is actuated the alarm is activated.

Another device that can be interfaced to the consoles is the LS610, which 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.

SECTION 3. EVALUATION PROCEDURES

Test Apparatus

The evaluation of this system was designed to determine if the liquid float-switch sensors operate as described by the vendor. This is much the same as the testing procedures specified for Liquid-Phase Out-of-Tank Product Detectors. The successful implementation of such liquid float-switch sensors requires that they be installed properly under conditions that will allow product to reach the liquid float-switch sensor. Three liquids for which these liquid float-switch sensors were designed were used in the evaluation. These are shown in Table 1.

Table 1. Products Used for Testing Liquid Level Sensors *

1. Water
2. Unleaded Gasoline
3. #2 Diesel Fuel

* Motor fuels were obtained from commercial suppliers.

Threshold Determination

The threshold was measured by mounting the liquid float-switch sensor in a cylindrical container and adding product until the alarm was activated.

The liquid float-switch sensor was mounted in a small cylindrical container with the end of the liquid float-switch sensor at the bottom of the cylinder. Product was then added from a burette until the alarm was activated. The product level was calculated from the ratio of inches per ml after correcting for the displacement of fluid by the liquid float-switch sensor.

SECTION 4. CALCULATIONS

Statistical analysis

The data was analyzed using the statistical procedures described in the EPA protocol for non-volumetric methods. The P_{FA} was calculated from the equation:

$$P_{FA} = TL_1/N_1$$

where TL_1 is the number of cases where the method indicated a leak when no sample was present and N_1 is the total number of tests conducted. If no false alarms occur, the P_{FA} is zero or 0%.

The corresponding P_D was calculated from the equation:

$$P_D = TL_2/N_2$$

where TL_2 is the number of tests where a leak was detected when product was present at the threshold level and N_2 is the number of tests conducted. If a leak is detected every time a test is conducted, the P_D is 1.0 or 100%.

Detection and Fall Times

Once the threshold was determined for the liquid float-switch sensor, it was reimmersed in the product a minimum of six times to measure the detection time and the fall time. The detection time is the amount of time the detector must be exposed to the product before it responds. The fall time is the amount of time before the detector stops responding after being removed from the product.

Specificity

The specificity defines the different products that the float switches will respond to. Normally, the specificity is defined as either 100% (responds 100% of the time) or 0% (never responds) for a certain product.

Threshold

The minimum detectable liquid level (threshold) for each liquid float-switch sensor/liquid combination was calculated from the equation:

$$\text{Threshold} = \text{Mean} + 4.414 * \text{Standard Deviation}$$

where the mean is the average level for each test set. The tolerance coefficient for six data points (95% confidence) is 4.414.

SECTION 5. TEST RESULTS

The data and results for the liquid float-switch sensors are shown in Tables 2 thru 5.

Probability of Detection and Probability of False Alarm

Since there were no missed detections and no false alarms, the PD was determined to be 100% for all of the Pneumercator liquid float-switch sensors tested. There were no false alarms observed when the liquid float-switch sensor was located in the test cell without product present. The PFA was accordingly determined to be 0%.

Threshold

The threshold test results for the three liquids that were tested has been provided in Tables 2, 3, 4, and 5. When the threshold for the liquid being tested was reached, the alarm was activated.

Specificity

The specificity results are based on the same information contained in Tables 2, 3, 4, and 5. These results indicate that the liquid float-switch sensors will respond to any liquid once the threshold depth for that liquid is reached. This is consistent with the design of the Pneumercator switches.

Detection and Fall Times

The time to alarm for the liquid float-switch sensor was less than one second after the liquid level became greater than the threshold level for the switch for all wired systems, and within 65 seconds for wireless systems. Resetting the liquid float-switch sensor simply required that the product level be lowered below the threshold level for the switch.

Time to Alarm

The time for a given liquid float-switch sensor to alarm will depend upon the size and geometry of the tank or sump in which it is installed and the rate of leakage into the interstitial space. The time to alarm can be calculated by determining the volume necessary to reach the threshold of the liquid float-switch sensor and dividing by the leak rate.

Discussion

The Pneumercator systems performed with no missed detections or false alarms for all of the liquid float-switch sensors tested in this evaluation. A minimum of 18 tests (three liquids, six replicates each) were conducted for each liquid float-switch sensor

with no false alarms or missed detections. The response and fall times are immediate (less than 1 second) after the liquid level rises above the threshold level for wired systems, and less than 65 seconds for wireless systems.

Table 2. Test Results for the LS600 Series Liquid Float-Switch Sensor

Run No.	Product Type		
	Water	Unleaded Gasoline	Diesel
	Height to Alarm (in)	Height to Alarm (in)	Height to Alarm (in)
1	3.17	3.29	3.27
2	3.17	3.29	3.27
3	3.17	3.29	3.27
4	3.16	3.30	3.27
5	3.17	3.30	3.27
6	3.17	3.30	3.27
Mean (in)	3.17	3.29	3.27
Accuracy	100	100	100
Threshold (in)	3.18	3.32	3.28
Precision (Std Dev)	0.0037	0.0051	0.0025
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 3. Test Results for the LS600-LD Series Float Level Switch

Run No.	Product Type		
	Water	Unleaded Gasoline	Diesel
	Height to Alarm (in)	Height to Alarm (in)	Height to Alarm (in)
1	0.85	0.97	0.95
2	0.84	0.97	0.95
3	0.85	0.98	0.96
4	0.85	0.97	0.96
5	0.84	0.98	0.95
6	0.85	0.98	0.96
Mean (in)	0.85	0.97	0.95
Accuracy	100	100	100
Threshold (in)	0.87	0.99	0.97
Precision (Std Dev)	0.0043	0.0040	0.0027
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 4. Test Results for the LS610 Liquid Float-Switch Sensor

Run No.	Product Type		
	Water	**Unleaded Gasoline**	**Diesel**
	Height to Alarm (in)	**Height to Alarm (in)**	**Height to Alarm (in)**
1	0.40	0.42	0.42
2	0.40	0.43	0.41
3	0.40	0.42	0.41
4	0.41	0.43	0.41
5	0.40	0.43	0.41
6	0.40	0.43	0.41
Mean (in)	0.40	0.43	0.41
Accuracy	100	100	100
Threshold (in)	0.42	0.44	0.43
Precision (Std Dev)	0.0031	0.0025	0.0041
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Attachment A
Modified Results Forms for the Pneumercator Non-Discriminating Liquid Level Float Switch Sensors

Console Models: **LC1000 Series, LC2000 Series, E-14, E-29, E-700-1, LDE-700, LDE-740, TMS3000, TMS2000, TMS2000W**

Switch Models: **LS600 Series, LS600-LD Series, LS610**

Alternate Procedure
Results of U.S. EPA Standard Evaluation
Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. 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 Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection 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

Console Model(s): LC1000 Series, LC2000 Series, E-14, E-29, E-700-1, LDE-700, LDE-740, TMS3000, TMS2000, TMS2000W

Sensor Model(s): LS600 Series, LS600-LD Series and LS610 Float Level Switches

Vendor: Pneumercator Co.

120 Finn Court
(street address)

Farmingdale	New York	11735	(631) 293-8450
(city)	(state)	(zip)	(phone)

Detector output type: ( ) Quantitative; (x) Qualitative

Detector operating principle: ( )Electrical Conductivity; ( ) Thermal Conductivity; ( ) Interface Probe; ( ) Product Permeable; ( ) Product Soluble; (x) Other Float Level Switch

Detector sampling frequency: ( ) Intermittent; (x) Continuous

Evaluation Results

The detectors listed above were tested for their ability to detect a layer of liquid (hydrocarbon or water) in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product thickness that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level (Standard dev.).

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.

Console Model(s): LC1000 Series, LC2000 Series, E-14, E-29, E-700-1, LDE-700, LDE-740, TMS2000, TMS2000W
Sensor Model(s): LS600 Series, LS600-LD Series and LS610 Float Level Switches

Evaluation Results (continued)
> Compiled Test Results

Test	Gasoline	Water	Diesel
Probability of Detection	100%	100%	100%
Probability of False Alarm	0%	0%	0%
Accuracy (%)	100%	100%	100%
Bias	N/A	N/A	N/A
Precision (Std Dev)	SEE ATTACHED TABLES		
Detection Time (Wired)	<1 sec	<1 sec	<1 sec
Detection Time (Wireless)	<65 sec	<65 sec	<65 sec
Lower Detection Limit (in)	<1 second	<1 second	<1 second

Specificity Results (%)*

Commercial gasoline	100%
Synthetic gasoline	100%
Diesel fuel	100%
Jet-A jet fuel	100%
n-Hexane	100%
Toluene	100%
Xylene(s)	100%
Water	100%

* Any liquid tested in this evaluation will activate the float level switches

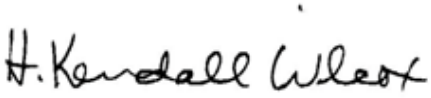
> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.

Certification of Results

I certify that the interstitial monitor 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 using the procedures described in the modified test protocol.

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

Ken Wilcox Associates, Inc.
(organization performing evaluation)



(Signature)

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

January 14, 2010

(816) 443-2494

Test Results for the LS600 Series Liquid Float-Switch Sensor

Run No.	Product Type		
	Water	Unleaded Gasoline	Diesel
	Height to Alarm (in)	Height to Alarm (in)	Height to Alarm (in)
1	3.17	3.29	3.27
2	3.17	3.29	3.27
3	3.17	3.29	3.27
4	3.16	3.30	3.27
5	3.17	3.30	3.27
6	3.17	3.30	3.27
Mean (in)	3.17	3.29	3.27
Accuracy	100	100	100
Threshold (in)	3.18	3.32	3.28
Precision (Std Dev)	0.0037	0.0051	0.0025
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Test Results for the LS600-LD Series Float Level Switch

Run No.	Product Type		
	Water	Unleaded Gasoline	Diesel
	Height to Alarm (in)	Height to Alarm (in)	Height to Alarm (in)
1	0.85	0.97	0.95
2	0.84	0.97	0.95
3	0.85	0.98	0.96
4	0.85	0.97	0.96
5	0.84	0.98	0.95
6	0.85	0.98	0.96
Mean (in)	0.85	0.97	0.95
Accuracy	100	100	100
Threshold (in)	0.87	0.99	0.97
Precision (Std Dev)	0.0043	0.0040	0.0027
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Test Results for the LS610 Liquid Float-Switch Sensor

Run No.	Product Type		
	Water	Unleaded Gasoline	Diesel
	Height to Alarm (in)	Height to Alarm (in)	Height to Alarm (in)
1	0.40	0.42	0.42
2	0.40	0.43	0.41
3	0.40	0.42	0.41
4	0.41	0.43	0.41
5	0.40	0.43	0.41
6	0.40	0.43	0.41
Mean (in)	0.40	0.43	0.41
Accuracy	100	100	100
Threshold (in)	0.42	0.44	0.43
Precision (Std Dev)	0.0031	0.0025	0.0041
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Attachment B
Modified Test Procedure for Evaluating Liquid Float-Switch Sensors

Procedure for Testing Liquid-Float Switch Sensors

Application

This procedure applies to liquid-float switches that are used for underground storage tank applications. It does not apply to external groundwater monitoring detectors. Each sensor should be tested in the products for which they are to be used. For a typical gasoline station this would include gasoline, diesel fuel, and water.

Procedure

1. Mount the sensor in a vertical cylinder with a known, uniform diameter from top to bottom. The sensor should be securely fastened so that it is in contact with the cylinder bottom in its normal orientation.

2. Add liquid (product or water) to the cylinder from a buret capable of reading volume to the nearest 0.2 ml. Liquid should be added in increments until the sensor responds to the liquid. Adequate time should be allowed between increments for all the sensors to respond if the response time is not instantaneous.

3. When the approximate threshold has been determined, the sensor should be removed and the cylinder dried out for a repeat measurement.

4. For subsequent measurements, liquid may be added quickly to just below the threshold level.

5. Liquid should then be added very slowly until the sensor responds.

6. Steps 3 through 5 should be repeated a minimum of 6 times for each liquid.

7. Record all information in an appropriate manner.

Calculations

The cross sectional area of the test cylinder and the sensor must both be determined. The difference in cross section is used in the calculations.

The test cylinder cross section is determined from the equation:

$$A_C = \pi r^2$$

where A_C is the cross section of the cylinder and r is the radius of the cylinder.

If the geometry of the sensor is uniform, it may be possible to calculate the cross sectional area using the appropriate equations. If the geometry is irregular, the displacement of the sensor must be empirically determined before the calculations can be completed. It is usually preferable to calculate the cross section when possible.

To measure the displacement of an irregular sensor, immerse the sensor in a graduated cylinder to the alarm depth. The volumes before and after immersion should be recorded. The difference in volume (VD) is the displacement of the sensor at the threshold level. This displacement volume should be added to the test volume obtained from the burette before the calculations are conducted.

The alarm level can then be calculated from the equation:

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

where L is the level at which alarm first occurs, V_B is the volume of 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.

The threshold is calculated from the equation:

$$\text{Threshold} = \text{Mean} + 4.414*\text{STD}$$

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.

Evaluation of the Pneumercator Reservoir Sensors

Sensor Models: RSU810 Single-Float,
RSU800 Series Dual-Float

Console Models: LC1000 Series, LC2000 Series, E-700-1, LDE-700, LDE-740, TMS3000, TMS2000, TMS2000W, TMS1000 Series

Final Report

PREPARED FOR:

Pneumercator Company, Inc.

March 19, 2010

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Evaluation of the Pneumercator Reservoir Sensors

Sensor Models: **RSU810 Single-Float,**
RSU800 Series Dual-Float

Console Models: LC1000 Series, LC2000 Series, E-700-1,
LDE-700, LDE-740, TMS3000, TMS2000,
TMS2000W, TMS1000 Series

Final Report

PREPARED FOR:

Pneumercator Company, Inc.
120 Finn Court
Farmingdale, NY 11735

March 19, 2010

Preface

This report presents the results of an independent third-party evaluation of the Pneumercator reservoir sensor switches, single-point Model RSU-810 and the dual-point sensor Model RSU-800 Series. 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 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.

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) 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.

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

KEN WILCOX ASSOCIATES, INC

H. Kendall Wilcox

H. Kendall Wilcox, Ph.D., President
March 12, 2010

Table of Contents

1.0 Background

The federal Environmental Protection Agency (EPA) has provided a series of documents, which describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register. 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, of course, to provide an evaluation procedure that will provide testing that 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).

2.0 Description of the Equipment

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 RSU810 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.

3.0 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 brine, propylene glycol or ethylene glycol was added. Brine was prepared by dissolving Calcium Chloride (30% by weight) in water. The Propylene Glycol solutions were obtained by mixing 50% water and 50% Propylene Glycol. Ethylene Glycol solutions were obtained by mixing 50% water and 50% Ethylene Glycol.

Threshold Determination

A peristaltic pump was used to add or remove brine, Propylene Glycol or Ethylene Glycol from the test cylinder containing the sensor until the sensor alarmed. For each different solution the levels at alarm were measured directly with a dial micrometer. This procedure was repeated a total of 6 times for each threshold.

Detection Time

The time required for the sensor to respond to product levels above the sensor's threshold is the liquid level 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 wired systems, this time is usually very short. Since the TMS2000W wireless system has an additional worst-case 64-second delay associated with the wireless link, the detection times listed in the tables for wireless systems include this delay. The sensor response time itself is independent of whether or not the system is wireless.

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 liquid level sensor's fall time. In the case of wired systems, this time is usually very short. Since the TMS2000W wireless system has an additional worst-case 64-second delay associated with the wireless link, the fall times listed in the tables for wireless systems include this delay. The sensor response time itself is independent of whether or not the system is wireless.

Specificity

The specificity defines the different products that liquid level sensors will respond to. Most sensors will respond to virtually 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 brine, Propylene Glycol and Ethylene Glycol.

4.0 Test Results

The data and results for the Pneumercator reservoir sensors are contained in Table 1 with brine in, Table 2 for ethylene glycol and Table 3 for propylene glycol. Liquid Levels were measured directly using a precision micrometer.

Lower Detection Level (Threshold)
The sensors were only tested for their ability to detect liquid levels at the alarm levels. A total of six replicates for each liquid were obtained.

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 alarmed in less than one second after the alarm threshold was reached for all wired systems, and within 65 seconds for wireless systems. Timing was independent of the reservoir liquids tested. The signal from the sensor itself was activated in less than once second for all reservoir liquids tested and all sensor combinations.

Fall Time
The sensor stopped alarming within one second after the alarm threshold was removed for all wired systems, and within 65 seconds for wireless systems. Timing was independent of the reservoir liquids tested. The signal from the sensor itself was de-activated in less than once second for all reservoir liquids tested and all sensor combinations.

Specificity
This sensor will respond to any liquid that is compatible with the system in which it is installed. Brine, ethylene glycol and propylene glycol were used for this evaluation.

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. Test Results for the Pneumercator Reservoir Sensors with Brine

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
1	0.598	1.893	12.998
2	0.601	1.889	12.999
3	0.602	1.888	12.995
4	0.600	1.889	13.004
5	0.603	1.894	13.003
6	0.601	1.892	13.005
Average	0.601	1.891	13.001
Precision (Std Dev.)	0.0017	0.002	0.004
Threshold (in)	0.6080	1.901	13.017
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 2. Test Results for the Pneumercator Reservoir Sensors with Ethylene Glycol

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
1	0.626	2.025	13.102
2	0.629	2.02	13.095
3	0.624	2.026	13.082
4	0.628	2.021	13.097
5	0.631	2.023	13.09
6	0.627	2.024	13.088
Average	0.6275	2.023	13.092
Precision (Std Dev.)	0.0024	0.002	0.007
Threshold	0.6376	2.033	13.122
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 3. Test Results for the Pneumercator Reservoir Sensors with Propylene Glycol

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
1	0.635	2.044	13.288
2	0.643	2.045	13.28
3	0.639	2.045	13.279
4	0.636	2.04	13.28
5	0.642	2.046	13.281
6	0.634	2.039	13.286
Average	0.638	2.043	13.282
Precision (Std Dev.)	0.004	0.003	0.004
Threshold	0.654	2.055	13.298
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Attachment A

Results Forms for the Pneumercator Reservoir Sensors

Model RSU-810 and Model RSU-800 Series

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 Reservoir Sensors

Version number(s) Model RSU-810 Single-Point and RSU-800 Series Dual-Point Reservoir Sensors for use with the LC1000 Series, LC2000 Series, E-700-1, LDE-700, TMS3000, TMS2000, TMS2000W and TMS1000 Series Consoles

Pneumercator Company, 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 of the Evaluation of the Single-Point Sensor Model RSU-810 with Brine

Parameter	Low Level
Threshold Level (inches)	0.608
Precision - Standard Deviation (inches)	.0017
Detection Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec
Fall Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec

Table 2. Results of the Evaluation for the Dual Point Sensor Model RSU800 with Brine

Parameter	Low Level	High Level
Threshold Level (inches)	1.901	13.017
Precision - Standard Deviation (inches)	0.002	0.004
Detection Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec
Fall Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec

Table 3. Results of the Evaluation of the Single Point Sensor RSU810 with Ethylene Glycol

Parameter	Low Level
Threshold Level (inches)	0.638
Precision - Standard Deviation (inches)	.0024
Detection Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec
Fall Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec

Table 4. Results of the Evaluation for the Dual Point Sensor RSU800 with Ethylene Glycol

Parameter	Low Level	High Level
Threshold Level (inches)	2.03	13.12
Precision - Standard Deviation (inches)	0.002	0.007
Detection Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec
Fall Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec

Table 5. Results of the Evaluation of the Single Point Sensor RSU810 with Propylene Glycol

Parameter	Low Level
Threshold Level (inches)	0.654
Precision - Standard Deviation (inches)	.004
Detection Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec
Fall Time	
Wired Systems	< 1 sec
Wireless Systems	< 65 sec

Table 6. Results of the Evaluation for the Dual Point Sensor RSU800 with Propylene Glycol

Parameter	Low Level	High Level
Threshold Level (inches)	2.055	13.298
Precision - Standard Deviation (inches)	0.003	0.004
Detection Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec
Fall Time		
Wired Systems	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec

Specificity – These sensors will respond to virtually any liquid after its threshold is exceeded. This testing was specifically for performance using brine, Ethylene Glycol and Propylene Glycol

Additional Limitations or Considerations - 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.

> 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)

H. Kendall Wilcox
(signature)

March 12, 2010
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

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

(816) 443-2494
(phone number)

Laboratory Data

Table 1. Test Results for the Pneumercator Reservoir Sensors with Brine

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
1	0.598	1.893	12.998
2	0.601	1.889	12.999
3	0.602	1.888	12.995
4	0.600	1.889	13.004
5	0.603	1.894	13.003
6	0.601	1.892	13.005
Average	0.601	1.891	13.001
Precision (Std Dev.)	0.0017	0.002	0.004
Threshold (in)	0.6080	1.901	13.017
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 2. Test Results for the Pneumercator Reservoir Sensors with Ethylene Glycol

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
1	0.626	2.025	13.102
2	0.629	2.02	13.095
3	0.624	2.026	13.082
4	0.628	2.021	13.097
5	0.631	2.023	13.09
6	0.627	2.024	13.088
Average	0.6275	2.023	13.092
Precision (Std Dev.)	0.0024	0.002	0.007
Threshold	0.6376	2.033	13.122
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

Table 3. Test Results for the Pneumercator Reservoir Sensors with Propylene Glycol

Run No.	Single-Point Sensor RSU-810	Dual-Point Sensor RSU-800 Series	
	Height to Alarm (in)	Low Level (in)	High Level (in)
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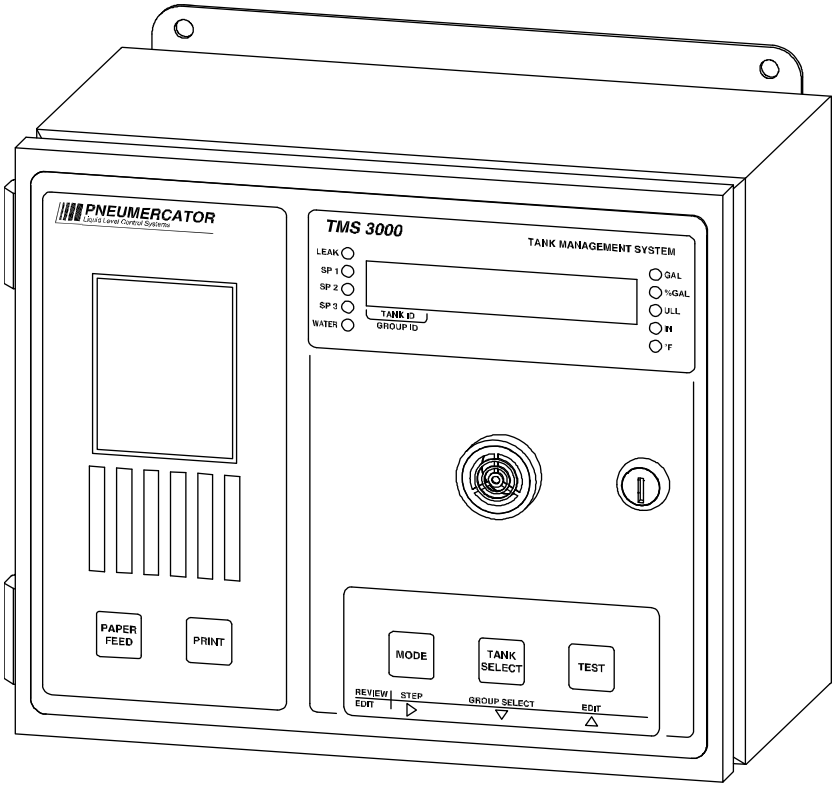
4	0.636	2.04	13.28
5	0.642	2.046	13.281
6	0.634	2.039	13.286
Average	0.638	2.043	13.282
Precision (Std Dev.)	0.004	0.003	0.004
Threshold	0.654	2.055	13.298
Detection Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec
Fall Time			
Wired Systems	< 1 sec	< 1 sec	< 1 sec
Wireless Systems	< 65 sec	< 65 sec	< 65 sec

PNEUMERCATOR
Liquid Level Control Systems

PHONE: (631) 293-8450
FAX: (631) 293-8533
www.pneumercator.com

MAINTENANCE MANUAL



DRAWING NO. 20001 REV. A

TMS Series/LC2000

1785 EXPRESSWAY DRIVE NORTH
HAUPPAUGE, NY 11788

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

This maintenance documentation presumes that the system to be tested has been installed in accordance with all current documentation for the system and has been started up by a factory certified technician. If you feel that this service has not been performed, adequately or otherwise, please contact your local authorized Pneumercator service provider to make the necessary arrangements.

The TMS Series and LC2000 products will be able to detect many conditions, including memory failure within the system, probe communication issues, and sensor wiring faults (when equipped with a Pneumercator fault detecting sensor). Reviewing and addressing any Alarm or Event conditions displayed on the TMS would be the best place to start for determining the proper functioning of the system. Inspection of all cabling for cracking or swelling and evaluating the condition of the splices will help to maintain a properly working system.

Before connecting or disconnecting ANY cables, power off the system. Once the cabling changes are complete, the system can be powered on.

While annual inspection is considered to be a good general practice, it may be required by regulation or application to perform inspections more frequently.

The following table includes a model specific list of additional points of inspection.

Model(s)	Check points
All TMS and LC2000 Systems	1. If equipped with a printer, verify there is adequate paper. Press PRINT to verify the operation of the printer. If the printout is light or blank, verify the ribbon is seated properly. If so, replace the ribbon. Note: the printout generated will include a Full Inventory and Alarm Status report which can be used for further identification of problems. 2. Press the TEST button to verify all integrated lights and horn are functioning
All TMS Systems	1. Take a stick reading of each tank for both Product and Water and confirm that the TMS Level Reading matches the stick reading. If there is a discrepancy, perform the float height offset procedure as outlined in the Quick Startup Guide. 2. If In-Tank Leak Testing is required, confirm the results show passing tests and verify the schedule.
Rigid Probes (MP45xS and MP55xS)	Remove the probe to verify there is no damage or residue buildup on the floats or probe shaft. Clean as necessary. No annual calibration required. Recalibration required only if probe or floats are replaced.

ES825-100F/ES825-300FL (non-discriminating)	Remove and inspect the sensor for physical damage. Test the sensor by placing in a nonreflective water-filled container shielded from ambient light. Verify the alarm received on the system display is as expected. Clean sensor to remove any contaminants.
ES825-200F/ES825-400FL (discriminating)	Remove and inspect the sensor for physical damage. Test the sensor by placing in a nonreflective water-filled container shielded from ambient light. Verify the alarm received on the system display is as expected. Repeat using a container filled with product. Clean sensor to remove any contaminants.
Float switch sensors: Includes: LS600, LS600LD, LS610, RSU800	Remove and inspect the sensor for physical damage or debris that may obstruct the movement of the float. Test the sensor by manipulating the float. Verify the alarm received on the system display is as expected. Clean sensor to remove any contaminants, as necessary.
HS100, HS100D	1. Flip the bottom cap upside-down to confirm the operation of the float switch 2. Refer to the documentation supplied with the sensor for proper testing procedures for the hydrocarbon sensing polymer strip. Contact Pneumercator for additional information.
HS100ND	Refer to the documentation supplied with the sensor for proper testing procedures. Contact Pneumercator for additional information.
Remote Alarms: Includes all RA and select LC1000 systems	Press the Test button associated with the remote alarm. It is also recommended to simulate an alarm on the controlling system to verify the operation of the remote alarm.
Remote Displays: Includes TD1000 and ETD1000	Confirm the display of the TMS matches what is displayed on the Remote Display. Press the Test button to confirm proper operation of the display and integrated horn.