Quality Petroleum Equipment
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PLC-5000 Electronic Line Leak Detection

Contact the factory with facility details for a site specific quote.

The PLC-5000 Line Monitoring System performs annual line testing at the 0.1 gallon per hour level, monthly testing at the 0.2 gallon per hour level and hourly monitoring at 3 gallons per hour. The system consists of two primary components, a Central Control Node and a Leak Detector Node.

- Thermal expansion / contraction detection and compensation
- Tests volumetrically, not by pressure decay
  - Higher precision, less false alarms!
  - High head pressure and high bleed-back, **No Problem!**
- Turbine staging for manifolded lines
- Control valve integration
  - Backup Generators
  - Marina Facilities
  - Train Fueling Depots
  - Loading Racks
- Alarms can be provided through various means
  - To Building Automation Systems
  - To Cell Phones via Text Message
  - To ATG monitors

Mission critical override capabilities make the PLC-5000 system ideal for mission critical facilities such as Hospitals, Data Centers, Schools, Jails, Defense & Public Safety Facilities, or wherever Generators, Boilers and/or Emergency Power are required.

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Evaluation of:
PLC-5000 Site Controller with Automatic Electronic Line Leak Detection The 98 LD-2000 and 98 LD-2000 PLC Mechanical Line Leak Detectors

Final Report

PREPARED FOR

Vaporless Manufacturing, Inc.

May 20,1998

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Vaporless Manufacturing, Inc.

Quality Petroleum Equipment
Solutions for Over 30 Years

PLC-5000 Electronic Line Leak Detection Installation & Operation Manual

Rev 01/01/17

I. System Concept

The PLC-5000 Electronic Line Leak Detection System monitors and detects leaks in closed piping systems. Specifically, it is designed to meet Environmental Protection Agency (EPA) guidelines for pressurized fuel delivery systems.

The system is configured as a distributed control network composed of elements referred to as nodes. Each electronic node is capable of performing a specific task. The central control node functions as the master node in the network.

The basic function of the Central Control Node (CCN) is to monitor for product dispensing requests, monitor the activity of each of the remote Leak Detector Nodes, and determine the operation of the submersible pumps or turbines. Also, in the event of a detected leak or other error condition, the CCN will issue appropriate alarms.

The basic function of the Leak Detector Node (LDN) is to monitor pressure in the distribution line and communicate the status of the line to the CCN.

The following statements outline the basic operation of the shut-down control system:

1. With power applied, the system is active and monitors for dispensing requests and alarm conditions.

2. Upon receiving an authorization signal for fuel dispensing, the CCN will power the correct relay, starting the appropriate pump(s).

3. The system will perform a 3 gph leak test after the last authorization is removed, and continuously monitor line pressure when there is no authorization. If the pressure falls below a predetermined level (selectable) the system performs a 3gph test. Upon authorization, the system performs a 3 gph test. If the LDN determines that proper line pressure has been achieved, it will communicate this status to the CCN.

4. If proper line pressure is not achieved, a 3 gph leak failure exists. Under this condition the CCN will de-energize the pump contactor and an appropriate alarm will be issued. This action represents one of the full shut-down modes of the system.

5. When requested, the CCN node will also conduct precision leak testing at levels of 0.1 gph and 0.2 gph.

PLC-5000 SYSTEM FEATURES

- Automatic fuel line re-pressurization – this prevents the formation of vapor pockets in the line during periods of line inactivity
- Line leak monitoring
- Manual bypass switches – mission critical sites require the ability to deliver fuel during emergency conditions
- Sequence turbine control for manifold applications
- Supports multiple control valves with ON/OFF delay timing
- Pressure failure alarm detection
- Full shutdown of pump activity when alarm condition is detected
- Pump contactor control in response to an authorization signal
- Ability to disable the re-pressurization cycle based on time-of-day – available to provide quiet time for precision tank testing
- Printer
- Building management integration (optional)
- Remote Reset (optional)
- Touch screen interface (optional)

3 GPH LEAK DETECTION

The EPA's regulations require operators to test for leaks on a routine basis (40 CFR Part 280, Subpart D). The regulations require that underground piping must be equipped with an automatic line leak detector that will alert the operator to the presence of a leak by restricting or shutting off the flow of fuel through the pipe or by triggering an auditory or visual alarm. This test is designed to detect the presence of very large leaks, which may occur between the more accurate regularly scheduled monthly monitoring tests or annual line tightness tests.

The standard requires that a leak greater than 3 gph must be detected within one hour of its occurrence. When there is non-dispensing quiet time, the PLC-5000 System meets and exceeds these requirements (continuous monitoring).

PRECISION LEAK DETECTION

In addition to catastrophic (large) line leak detection requirements the EPA regulations also require the periodic testing for much smaller leaks. The PLC-5000 ELLD System provides for precision leak detection at levels of both 0.1 gph and 0.2 gph. Statistically based test regimes have been developed to monitor for and report leak rates referenced to the EPA standard of 0.1 gph at 45 psi. When a leak is detected, the quantified result of the test is presented to assist in the troubleshooting process.

Fundamental to the operation of the precision leak detection system, it is known that a specific volume of fuel must leave the distribution line for the pressure in the line to move from a specific higher pressure to a specific lower pressure. This volume is known as the *resilience constant*, measured in milliliters. Since the volume is dependent on line characteristics including: length, flexibility, flex connectors, etc., it must be measured for each line at a site.

Measuring the resilience constant is only the beginning. Precision leak detection in a distribution system is a complicated affair. Since gasoline and diesel fuels are not ideal fluids, that is, they can significantly expand and contract with temperature, the protocols of leak detection must deal with many variables. These variables include the magnitude of the resilience constant, measurement error associated with the resilience constant, the size of the leak (if any is present), the thermal conditions encountered by the fuel transferring from the storage tank to the distribution line, the thermal transfer characteristics of the distribution line, which is influenced by the type of line material, depth of burial, moisture content of the surrounding soil, type of soil and ambient temperature, and the EPA requirements of reporting results at better than a 95% probability of detecting the leak and less than 5% probability of declaring a leak when the actual leak rate is less than the detection threshold. The protocols in the PLC-5000 deal with these issues.

LINE PRESSURE REGULATION

In a dispensing system, provision must be made to limit the pressure in the line. This is necessary for two reasons. First, excessive pressure may create a leak by blowing out seals or rupturing fittings. Second, some types of dispensing nozzles will not open under high line pressure conditions.

Contained within the LDN is a solenoid operated valve which under system control can shunt fuel from the pressurized line back to the tank. Following a dispensing operation, the shunt valve is used to reduce line pressure to a set point that is determined by the system components. For example, the static set-point for a 30 to 35 psi pump would normally be 24 psi, the standard at which the system default is set. A commercial, high pressure system running 125 psi would perform more optimally with an 85 psi static pressure. Low pressure pumps may require 15 psi static levels. All this is available, adjustable in the PLC-5000 set-up.

The solenoid operated valve is also used to reduce excessive line pressure caused by thermal expansion of fuel in the line. The adjustable set-point is used to adjust line pressure test starting pressures for electronic line leak testing.

Third Party Evaluation

Ken Wilcox Associates conducted tests to verify the performance of the PLC-5000 Full Shut-down System. Results of the tests are presented in their report titled *Evaluation of PLC-5000 Site Controller with Automatic Electronic Line Leak Detection with the 98 LD-2000 and 98 LD-2000 PLC Mechanical Line Leak Detectors; Final Report, May 20, 1998.*

Quoting from the Conclusions:

- The Vaporless PLC-5000 Line Leak Detection System exceeds the EPA performance requirements for hourly testing and annual line tightness testing.

- In the monthly monitoring/annual line tightness test mode, the probability of detection of a 0.1 gph leak is 100% and the probability of false alarm on a tight line is 0%.

Questions regarding this evaluation should be directed to Vaporless Manufacturing.

Application Approvals

The PLC-5000 Full Shut-down System has been approved by specific localities for application within their jurisdiction. Questions regarding regulation and application should be directed to Vaporless Manufacturing, Inc.

Safety Approval

The PLC-5000 family of Leak Detector Nodes has been designed for operation in Class I, Division 1, Group D hazardous environments by Underwriters Laboratories. The product is UL508A labeled and listed under Industrial Control Panels Relating to Hazardous Locations.

II. Installation and Wiring – Central Control Node

INTRODUCTION

This section presents specific information regarding the function, physical characteristics and installation of the Central Control Node (CCN). The basic function of the CCN is to monitor for product dispensing requests, monitor the activity of each of the remote Leak Detector Nodes, and issue commands for the operation of the pumps. Also, in the event of a detected leak or other error condition, the CCN will issue appropriate alarms.

The Central Control Node can manage the operation of up to four Leak Detector Nodes. A CCN functions as the master node in the network.

Additional CCNs and LDNs can communicate with each other, providing line leak detection to sites with many tanks and pumps.

One option available with the CCN is to monitor the fluid level of all tanks through the VMI Precision Depth Sensor or "read" the tank level information from another manufacturer's tank monitor and start the pump in the tank with the highest level of fuel.

GENERAL FUNCTION

The model PLC-5000 Central Control Node is capable of simultaneously monitoring and controlling up to four product channels. In its role as the master node in the network, the CCN receives requests for dispensing operations, directs the appropriate turbine to start / stop, monitors for proper line pressure conditions, controls precision test protocols, and issues alarms when error conditions exist. The CCN is the heart of the PLC-5000 Full Shut-down System.

The application software that directs the actions of the controller resides in the non-volatile memory coupled to the microcontroller. This custom software is not available to the user for modification.

The CCN has a universal power input. Standard is 110 VAC single phase 60 Hz. If power supply is different, VMI can be reconfigured for low voltage upon advanced notification / specification.

PACKAGING

The CCN is packaged in a custom enclosure that meets NEMA1 standards. It is not designed to operate in a hazardous environment.

The enclosure is provided with mounting holes which allow it to be secured to a wall or mounting board with screws. Holes are provided on all sides for conduit connections.

Controller is pre-wired in the enclosure. All I/O connections are made via DIN rail mounted terminal blocks.

INPUT AND OUTPUT SIGNALS

Multiple classes of signals or devices can be connected to the controller — power mains, dispensing authorization requests, flow switches, pressure switches and remote controlled devices such as line shut-off solenoid valves. Each of these signals or types of devices will be

addressed in the following paragraphs.

The CCN should be located so that it is not only accessible by the operator, but is also in the vicinity of the signals that must be connected to the controller. As each of the signals and device types are discussed, a better understanding of the preceding statement will be developed.

Power Requirements
The CCN should be put on a dedicated (minimum) 15A breaker. All outputs are fused at 5A. Idle current draw, including LDN, is less than 0.5A.

Authorization Input Signals
Authorization is the term for the signal that represents a fuel request. When the signal is active the channel is authorized to start a pump.

The authorization signal may be of any voltage from 60 to 230 volts AC or DC.

Alarm Outputs
Two levels of alarms may be generated by the PLC-5000 Full Shut-down Controller. These are termed *caution* and *service*. A caution alarm represents a warning that an error condition has been detected, but it is not of sufficient importance to shut-down the pump. A service alarm represents an error condition of sufficient importance to warrant the shut-down of the pump.

These alarms are communicated in several ways. Active alarms are indicated on the display, while a record of past alarms may be presented on the display or printout.

Remote Controlled Devices
In addition to controlling the relay of the dispensing pump, several other devices may be controlled by the PLC-5000.

Variable speed turbines are designed to adjust their speed, and therefore the available volume of fuel, depending on the perceived demand. These pumps are actuated by an authorization supplied by the PLC-5000 and are driven by a controller supplied with the turbine.

In some applications it is desirable to have a solenoid activated shut-off valve located in the distribution line. Even with the turbine running, this valve must be opened to allow the delivery of fuel. The CCN output will control this solenoid valve.

INSTALLATION
The CCN is packaged in an enclosure meeting the NEMA1 standard. In its standard configuration, it is not designed to operate in a wet or hazardous environment. As indicated in the preceding discussion, the unit should be located in a manner so that it is both accessible by the operator and in the vicinity of the signals that must be connected to the controller.

Following is a general outline of the installation procedure for the CCN. Some modification may be required to deal with issues presented by a specific application or site. It is the responsibility of the installer to provide an appropriate installation which meets National Electrical Code and local code requirements.

1. Select a location for mounting the unit with attention to the availability of power mains and authorization signals.

TECHNICAL NOTE — In accordance with the NEC, and to keep it out of hazardous vapor, the unit should be mounted at least three feet above the floor

2. The enclosure is provided with mounting holes which allow it to be secured to a wall or mounting board using screws.

3. Holes are provided on all sides for conduit connections.

4. Determine the sources for the power and authorization signals. If other signals need to be connected to the controller, determine their location. Develop a conduit system connecting to the enclosure that will properly convey these power and signal wires. Conform to local electrical code requirements.

TECHNICAL NOTE — Power to the CCN should be provided through a circuit breaker independent of the fuel turbine breakers. If connected through a turbine breaker, turning off that particular product breaker will result in the shut-down of the entire dispensing system. If an independent breaker is not available, power may be obtained through another breaker unrelated to the turbines

WIRING DETAILS

High Voltage Wiring

A. Must enter enclosure in the high voltage (left side) area. Knockouts are provided.

B. The PLC-5000 comes with multipurpose (Bypass-Off-Auto) rocker switches pre-wired on the front door of the enclosure. Turbine Run lamps (green) & Product Alarm lamps (red) function independently of rocker switch position.

C. High voltage wiring connects to the DIN rail terminal block strip.

D. All connections should be 12 – 14 AWG.

E. Power Mains

1. The enclosure requires one dedicated 120V circuit at 15A or 20A.

2. HOT connects to fused terminal L1 – HOT.

3. Neutral connects to fused terminal N – NEUT.

4. Ground must be connected to GROUND. Ground must be connected to ensure proper performance of the controller. Checking that GROUND is actually attached to a GROUND is required.

5. The VMI Control Systems come with advanced design characteristics that minimize the effects of poor main grounds and transient noise. However, good design may not overcome all of the problems of a poorly grounded site, or a site with a high amount of transient “noise” voltage. If problems are known to exist or encountered during installation, contact VMI about the need for power line conditioning or filtration.

AC Outputs

1. All outputs provide a switched hot.
2. Each output can supply no more than 2A.
3. Turbine Outputs

   Turbine outputs cannot drive the pump directly. The turbine output should be wired to the: 1) tank gauge's Auth input or
   2) the turbine contactor

   If the site has dispenser sump sensors or submersible sump sensors that trigger turbine shutdown, the VMI turbine outputs should become the tank monitor's authorizations. In this manner, the pump starting and stopping is subject to the site sensors. E-stop can be wired per Enclosure / Site wiring diagram.

Alarm Outputs

Alarm outputs are provided per product or turbine depending on site configuration. These can be wired to either ATG alarm inputs or separate annunciators.

AC Inputs

1. All AC inputs require a switched hot.
2. Each AC input draws only 20mA.
3. Authorization inputs

Typically, one input per product. Different options are available per site configuration.

Wiring diagrams located at end of this document.

III. Installation and Wiring – Leak Detector Node

INTRODUCTION

This section presents specific information regarding the function, physical characteristics and installation of the Leak Detector Node (LDN). The basic function of the LDN is to monitor pressure in the distribution line and communicate the status of the line to the Central Control Node (CCN).

Up to four Leak Detector Nodes may be present in the network controlled by a single Central Control Node. An LDN functions as a slave node in the network

GENERAL FUNCTION

An LDN monitors the pressure of only the single distribution line to which it is connected.

PACKAGING

The LDN is packaged in a custom, explosion proof and water-tight enclosure designed to function in a Class I, Division 1, Group D hazardous environment. It is the responsibility of the installer to provide an appropriate configuration which meets National Electrical Code and local code requirements.

PRESSURE SENSING AND SHUNT VALVE

Because the system performs its function by monitoring pressure during fuel delivery and quiet times, it is necessary to have a pressure connection from the line. As the LDN contains a solenoid operated valve, which under system control shunts fuel from the pressurized line back to the tank, a vent line is also required. The vent line can be connected direct to tank top or into a fuel return line.

OVERRIDE FUNCTION

In certain mission critical applications, line leak detection override is necessary. For example, if a line release develops during a catastrophe and fuel is required to feed a hospital's emergency power generation system.

The override function may be used to bypass the functions of the LDN for emergency fueling situations or when an electronic system failure has disabled the control system. The override function may also be used to provide a means of troubleshooting and system testing to prove the function of various sub-systems.

With the CCN front panel switch toggled in the Auto position, the LDN will operate in its normal mode. With the switch toggled in the Bypass position, the LDN will be in the override mode. While in the override mode, the authorization power will be shunted to provide power directly to the: 1) the tank gauge's Auth input or 2) the turbine contactor. The tank gauge's Auth input or the coil of the turbine contactor will be energized directly from the CCN without regard to line pressure data provided by the LDN. This means that the turbine will run whenever an

authorization is supplied to the CCN. Line pressure data from the LDN will be ignored by the CCN.

When in the override mode, the system will be incapable of detecting certain alarm conditions. This is considered to be a temporary situation which will be corrected by the timely replacement or repair of the defective elements within the system. It is the responsibility of the operator and technician to ensure timely service.

INSTALLATION PROCEDURE

Due to the different methods of installation, VMI does not include a mounting kit for the Leak Detector Node. Evaluate the application and determine the best means of mounting the LDN securely using (2) to (4) 3/8" ¼-20 bolts in the (4) ¼-20 bolt holes provided.

The fuel inlet and outlet connections of the Leak Detector Node are 3/8" NPT. Pressurized fuel from the supply line should be plumbed to the port market P on the LDN. The return, port V, should be a non-pressurized line terminating in the headspace of the UST.

In order to prevent debris from clogging the internal pressure sensor or the solenoid of the LDN, a small pore, large surface area fuel filter should be placed in the pressure line.

Teflon tape should not be used on threaded fittings into the LDN. Do not use pipe dope on the leading edge threads of pipe fittings that thread into the LDN. Pipe dope and Teflon tape may clog the pressure sensor or the solenoid valve of the LDN.

The ½" nipple for the wire-way is not to be turned to keep the wire seal intact.

(6) 14 awg THHN or equivalent shall be pulled through a dedicated conduit to return the LDN wiring back to where the VMI Central Control Node will be mounted. Connection information shall be included with the delivery of the control panel.

Menu and Programming

Before proceeding with the Set-up and Programming
Insure the breakers for the pumps connected to this system are OFF.
Preconfigured software may authorize a pump.

GENERAL

The PLC-5000 is an electronic interface that acts as a motor controller. There are variations of PLC-5000 controllers that manage from 1 to 8 pumps and control valves.

The PLC-5000 series is able to identify line pressure from the LDN-5106 Leak Detector Node. We also determine if the leak detector test that is run in response to low pressure completes with a pass. An Alarm is initiated at a failure to pressurize the line or due to a 3GPH line leak.

FRONT PANEL

Alarm and Run notification lights are displayed on the front of the PLC-5000 Central Control Node. There are also multi-position switches mounted on the front panel.

The 3 Positions are

- AUTO- The system is intended to perform all normal functions.
- OFF- The output is disconnected. The pump will not run during an authorization request or line repressurizations.
- OVERRIDE- The PLC-5000 electronics are completely circumvented, placing the system to respond to authorizations as if the PLC-5000 were not in the system. There are no automated line checks or repressurizations.

The PLC-5000 CCN Controller protrudes through the front of the electrical box. In the center there is a 2-line display, the displayed messages are listed below. There are 8 buttons or stick pins (4 on each side) that may be used to program site specifics or initiate specific functions. The pin uses and functions follow.

DISPLAY

The CCN 2-line display presents system status:

- Line 1 reports 3 pieces of information
  - Product #, Turbine #, Pressure
  - For example, it may display

    `P=1 T=1 PRES=29.6`
  - `P`= Product Number
    - P=1, 2, 3, or 4
  - `T`= Turbine Number
    - T=1, 2, 3, or 4
  - `PRES`= Line Pressure
- Line 2 displays State or Process and Alarm Status

- States:
  - WAIT — Idle, no current activity.
  - STANDBY — Internal time delay process. Part of dispense sequencing.
  - MONITOR — Controller monitoring for line pressure to build to dispenser pressure before advancing to DISPENSE.
  - DISPENSE — Authorization is present, line pressure is high, actively dispensing product.
  - VALVE — Non-testing pressure relief. Such as to relieve thermal expansion.
  - ALARM — Alarm, shutdown for product / channel in alarm.
  - REPRESSURE — Non-testing line repressurization. Such as to repressurize due to thermal contraction.
  - TEST HIGH PRES 0 — Repressurization during 3gph, 0.2gph, and 0.1gph testing.
  - TEST DROP PRES 0 — Venting to high pressure point during 3gph, 0.2gph, and 0.1gph testing.
  - TEST HOLD PRES A — Monitoring pressure for 3gph leak test.
  - TEST HOLD PRES 0 — Monitoring pressure for 0.2gph or 0.1gph leak test.
  - TEST HIGH PRES 1 — Next cycle of precision testing repressurization.
  - TEST DROP PRES 1 — Next cycle of venting to high pressure point during precision testing.
  - TEST HOLD PRES 1 — Next cycle of monitoring pressure for precision leak test.

- TEST HIGH PRES 2 — Next cycle of precision testing repressurization.
- TEST DROP PRES 2 — Next cycle of venting to high pressure point during precision testing.
- TEST HOLD PRES 2 — Next cycle of monitoring pressure for precision leak test.
- TEST HIGH PRES 3 — Next cycle of precision testing repressurization.
- TEST DROP PRES 3 — Next cycle of venting to high pressure point during precision testing.
- TEST HOLD PRES 3 — Next cycle of monitoring pressure for precision leak test.
- SENSOR OUT — Communication loss with Leak Detector Node.

- AL= Alarm Status
  - AL= Y = Yes, N = No

PUSH BUTTONS

The buttons on the sides of the CCN are:

Left Side	Right Side
MENU	UP ARROW ▲
TEST/TIMERS	CLEAR
PRINT	ENTER
RESET	DOWN ARROW ▼

- MENU- Used to enter and scroll through Categories, or to back out of a sub Category. Each Category and their options will be discussed below.
- TEST/TIMERS- Use to initiate 0.2 gph and 0.1 gph precision tests.
- PRINT- Brings up the printer submenu. Use up and down arrows to select from four print options: Alarm Log, Test Log, System Log, and System Configuration.
- RESET- This button is VERY IMPORTANT, WILL RESET ALARMS.
  - EXAMPLE: If it appears Regular is not pumping, that Product should show:

```
P=1 T=1  PRES=0
PRES ALARM  AL=Y
```

- For the Product that is in Alarm - not pumping- it is important to have customers using the product stop dispensing. The line cannot be "cleared" if nozzles of the fuel in question are still open. *Other customers may continue to fuel*.
- Push the RESET pin. All is displayed, press ENTER to clear All Alarms. The pump will come on, trying to pressurize the line. The display will show MONITOR if pressure returns. Allow customers to return to fueling.
- If the Alarm returns such as

```
P=1 T=1   PRES=0
PRES ALARM  AL=Y
```

  - Insure no one is attempting to fuel with the product. Push the RESET pin. All is displayed, press ENTER to clear All Alarms. If MONITOR does not return to the screen, call for service.

- UP Arrow — Increase a numeric value. If max value is reached, numbers will roll over to lowest value. Holding down the button will speed up the counter.
- DOWN Arrow — Decrease a numeric value. If min value is reached, numbers will roll over to highest value. Holding down the button will speed up the counter.
- CLEAR- — Resets a numeric value to original setting.
- ENTER- — To choose a value or setting.

CONFIGURATION

Before proceeding, it is important to determine if the PLC-5000 you are using is preconfigured or not.

When the CCN boots it will show the following screen:

```
PLC-5000
Version 3.XX
```

If the unit is not configured this message will stay on the screen after 10 seconds. If this is what shows on your screen, follow from MENU next.

If the unit is configured, the boot screen will display for about 10 seconds and then move to the Home Screen. The home screen will look something like this:

```
P=1 T=1   PRES=29.6
WAIT       AL=N
```

This screen will rotate through all active products and channels showing the status of each. If the home screen appears on the CCN, Move down to 2nd MENU below.

MENU

The MENU button is used to enter specific information about the station and how it is to operate. When the MENU button is pushed, a Category will be displayed. The first Category needed is SITE CONFIGURATION. The Category and response is listed below.

Push MENU – RUN TIME SETUP	
Push MENU – REPRESSURE DISABLE TIME	
Push MENU – SUMP SENSOR SETUP	
Push MENU- PRESSURE SETUP	Set Min run pressure per Product
	Set Test High Pressure per product
	Test Low Pressure per Product
Push MENU- TEST SETUP	Set number of repressure retries
	Set number of 3gph retries
	Alarm action – per product, per channel
	Set flow switch delay
Push MENU – SET DATE/TIME?	
Push MENU – SITE CONFIGURATION	Normal Station Configuration
Push ENTER – NUM OF TURBINES PRODUCT 1 #	This is the Category, the 2nd line is the fill-in Product = 1, Push the UP Arrow to enter 1 as the number of pumps for Product 1
Push ENTER – NUM OF LEAD TURB PRODUCT 1 #	Define how many turbines can be master
Push ENTER-NUM OF LDN PRODUCT 1 #	Define number of LDNs per product
Push ENTER – NUM OF RUN TURB PRODUCT 1 #	Max number of turbines (lead or not) desired to run at a time

```
Push ENTER - ROTATE TURBINES? Select rotating or fixed lead
             PRODUCT 1    #   turbine

Push ENTER - NUM SUCTION CV   0 is the default, leave at 0
             PRODUCT 1    0

Push ENTER - NUM PRESSURE CV  0 is the default, leave at 0
             PRODUCT 1    0

Push ENTER - NUM DISPENSER CV 0 is the default, leave at 0
             PRODUCT 1    0

Push ENTER - NUM OF TURBINES  This has moved back to get
             PRODUCT 2    #   the same information on
                              Product 2.
                              Push the UP Arrow to enter 1
                              for the number of pumps for
                              Product 2
```

Pushing ENTER will cycle through subsequent Channels

Push MENU to return back to the Default screen, showing the normal scrolling screen such as:

```
P=1  T=1  PRES=29.6
WAIT      AL=N
```

2ND MENU

All must complete **2nd Menu**

The MENU button is used to enter specific information about the station and how it is to operate. When the MENU button is pushed, a Category will be displayed.

Push MENU – `RUN TIME SETUP`

Push ENTER – `RESILIENCY VALUE`
`PRODUCT 1 ####`
Then enter the Resiliency Value, up to 9999 ml
Push and hold the UP Arrow or the DOWN Arrow to increase or decrease the value.
Read Line Resiliency and Testing in the LDT-890 installation instructions

Pushing ENTER will cycle back through for subsequent Products.

After all Products have been programmed:

Push MENU - `REPRESSURE DISABLE TIME`
Used to program a time period when repressurization is disabled for tank test quite time.

Push ENTER – `DIS START HOUR PRODUCT 1 ##`
Use the UP and DOWN ARROWS to adjust the start time hour (24 hr clock)

Push ENTER – `DIS END HOUR PRODUCT 1 ##`
Use the UP and DOWN ARROWS to adjust the end time hour (24 hr clock)

Pushing ENTER will cycle back through subsequent Products. After all Products have been programmed:

Push MENU – `SUMP SENSOR SETUP`
Sump Sensor Menu.

Push MENU – `SET DATE/TIME`

Push ENTER – `SET DATE YEAR = ####`
Use the UP and DOWN ARROWS to adjust the current year

Push ENTER – `SET DATE MONTH = ##`
Use the UP and DOWN ARROWS to adjust the current month

Push ENTER – `SET DATE DAY = ##`
Use the UP and DOWN ARROWS to adjust the current day

Push ENTER – `SET TIME` Use the UP and DOWN ARROWS to adjust the current hour (24 hour clock)

`HOUR = ##`

Push ENTER – `SET TIME` Use the UP and DOWN ARROWS to adjust the current minute

`MINUTE = ##`

Push MENU – `SITE CONFIGURATION` Normal Station Configuration

Push MENU

```
P=1 T=1  PRES=29.6
WAIT      AL=N
```

This concludes the setup of the PLC-5000. The above screen should rotate through the active products.

MANUAL OVERRIDE SWITCHING

When the Line Pressure / Flow Alarm Pilot Light is illuminated, it is an indication of failure to build line pressure / failure to detect flow. This may be due to many mechanical or electrical problems including:

- Line leak
- Pump motor failure
- Motor starter contactor failure
- Low Fuel

Contact factory for additional diagnostics help

IV. Calibration and Testing

RESILIENCE CONSTANT MEASUREMENT

One of the features of the PLC-5000 System is its ability to perform standard and precision leak detection tests at levels of 3.0, 0.2 and 0.1 gph. Fundamental to the operation of the leak detection system, it is known that a specific volume of fuel must leave the line for the pressure in the line to move from a specific higher pressure to a specific lower pressure. This volume is known as the *resilience constant,* measured in milliliters. Since the volume is dependent on line characteristics, it must be measured for each line at a site.

The following procedure is provided as a guide to determining the line's resilience constant. This procedure assumes:

- The installation of the PLC-5000 ELLD.
- The use of the Vaporless Model LDT-890 Leak Detector Tester.

1. Disable PLC-5000 Repressure Cycle

With power applied to the CCN, disable repressurization function by setting REPRESSURE DISABLE TIME from 00 to 23.

2. Power Off

Turn off the circuit breaker providing power to the product under test. This is done to prevent the accidental starting of the pump while the line is open in the following steps. Power may remain on the CCN, however, it is acceptable if power is also disconnected from the module.

3. Install LDT-890 Test Unit

Select the dispenser at the highest point of the delivery system for the selected product. If there is no elevation difference, select the dispenser farthest from the pump.

CAUTION: Eye protection required during the calibration process.

4. Carefully remove the plug from the test port on the impact valve. Caution: There may be pressure in the line.

5. Install the 18" whip hose supplied with the test unit. The application of thread sealing compound is recommended.

6. Connect the quick disconnect coupler on the hose from the test unit to the whip hose.

7. Set the test unit selector to the PRESSURE STEP TEST position.

8. Power On

Turn on the circuit breaker for the product under test. If power had been disconnected from the CCN, restore power to the controller.

9. **System Purge**

Authorize the dispenser. The pump should start running. On the right-hand pressure gauge of the LDT-890, watch for the pump to achieve operating pressure.

10. Check all connections for leaks. Correct any fault conditions.

11. With the large beaker (1000 ml) under the LDT-890 discharge port, set the selector to the DISPENSER NOZZLE position. Purge the tester of air by allowing 800 to 1000 ml of fuel to flow into the beaker. After purging the LDT-890, set the selector back to the PRESSURE STEP TEST position.

12. Purge the dispenser line by running several gallons of fuel into an approved safety container.

13. Resilience Constant Measurement
Remove the dispenser authorization. The pump should stop running. Unless there are fault conditions such as a leak or significant thermal contraction, the LDN should vent pressure down to the high pressure point where line pressure will stabilize.

14. With the large beaker under the LDT-890's discharge port, move the selector counterclockwise to GPH TEST. Fuel will begin to flow through the LDT-890 discharge hose.

15. Monitor 2-3 repressure cycles to determine the high pressure and low pressure points. Once the high pressure and low pressure point have been determined, capture the fuel discharged between these two points. This is the Resilience Constant measurement.

16. Measure the Resilience Constant several times. Average out the measurements to determine the value to be entered into the CCN.

    Depending on the measured volume, the use of the small (250 ml) beaker may provide more accurate measurements. The averaging of several consecutive samples is necessary to accurately determine the Resilience Constant volume.

17. Return the LDT-890 4-way selector to PRESSURE STEP TEST to stop the flow of fuel.

18. Reference Menu and Programming section to enter the Resilience Constant volume into the CCN.

Perform Leak Detector 3 GPH Test
This completes the Resilience Constant measurement procedure and set-up of the CCN. To insure proper installation and system calibration, a 3 GPH leak test must be performed.

LEAK DETECTOR TEST AT 3 GPH
Whether the PLC-5000 is fitted to a new installation or retrofit to an existing site, a catastrophic (3gph at 10psi) leak detection test must be performed.

The following statements outline a procedure for testing the operation of the PLC-5000. This procedure assumes the use of the Vaporless Model LDT-890 Leak Detector Tester to perform this task.

The following procedure assumes no knowledge of the operation of the LDT-890 and therefore details each step of the process. The operation manual supplied with the LDT-890 provides additional information and should be consulted by the technician.

1. Install LDT-890 Test Unit
If the LDT-890 has not been installed, follow steps 1 through 12 in the procedure outlined under Resilience Constant Measurement. This procedure should result in the dispenser being authorized, the pump running, and the repressure cycle being disabled.

2. Leak Calibration
With the large beaker (1000 ml) under the LDT-890 discharge port, set the selector to the CALIBRATE GPH position. Fuel will begin to flow into the beaker.

3. The object of the next step is to calibrate the fuel flow from the test unit to the rate of 3 gallons per hour at 10 psi pressure at the discharge. This specification meets the requirements of the EPA regarding leak rate testing.

4. The procedure is performed as follows:
Adjust the fuel flow using the left-hand knob labeled CALIBRATE ORIFICE. Adjust the pressure on the left-hand pressure gauge to 10 psi using the right-hand knob labeled CALIBRATE PRESSURE.

Turn the ORIFICE knob counterclockwise to increase flow and clockwise to decrease flow.

Turn the PRESSURE knob counterclockwise to reduce pressure and clockwise to increase pressure.

First, adjust the flow using the ORIFICE knob and then adjust the gauge pressure using the PRESSURE knob. It is important to perform the procedure in this order.

5. Using the small beaker (250 ml), collect a sample of fuel over a 30 second interval. The flow is properly adjusted when 95 ml are collected in 30 seconds. This volume is equivalent to a rate of 3 gallons per hour at 10 PSI. Repeat the procedure outlined in step 4 until the correct volume of fuel is collected in the specified time.

6. Set the selector to the PRESSURE STEP TEST position and remove the dispenser authorization.

7. Reduce Line Pressure to Zero
With the large beaker under the LDT-890 discharge port, set the selector to the DISPENSER NOZZLE position. Fuel will begin to flow into the beaker. After the reading on the right-hand pressure gauge falls to zero, set the selector to the PRESSURE STEP TEST position.

8. Read Operating Pressure
Authorize the dispenser. The pump will start running. Watch for the pump to achieve operating pressure as seen on the right-hand pressure gauge. Note this pressure reading and then remove the authorization from the dispenser.

9. Return to the CCN and re-enable system repressurization.

10. 3 GPH Leak Test
With the authorization present the pump is running. Move the LDT-890 selector to the GPH TEST position. A 3 gph leak has been introduced to the system. Remove the authorization.

11. On the right-hand pressure gauge watch for pressure cycling. Pressure will fall to the low pressure point, then the pressure will rise as the PLC-5000 energizes the turbine. Pressure will cycle a number of times for the system to determine a true line leak as opposed to thermal contraction.

12. After numerous pressure cycles, the pressure gauge will fall to 0psi. Set the LDT-890 selector to PRESSURE STEP TEST and return to the CCN to confirm the system is in Alarm.

This successfully completes the PLC-5000 3GPH test.

Disconnect LDT-890 Test Unit

1. Turn off the appropriate power breaker to prevent accidental starting of the turbine while the line is open during the following steps.

2. Turn the selector to the Dispenser Nozzle position and verify pressure reading on the right-hand pressure gauge is zero.

3. Disconnect the quick disconnect coupler attaching the test unit to the whip hose.

4. Remove the whip hose from the test port and install the original plug. The application of thread sealing compound is recommended.

Full System Operation

Turn on the power breaker. Reset to clear Alarm at the CCN. This completes the test procedure. The product is now under the control of the PLC-5000 System.

After setup and testing is complete, print a system configuration and leave a copy inside the panel.

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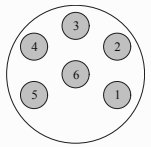
AMP, P/N - T 3402 009



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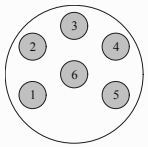


VIEW FROM SOLDER SIDE

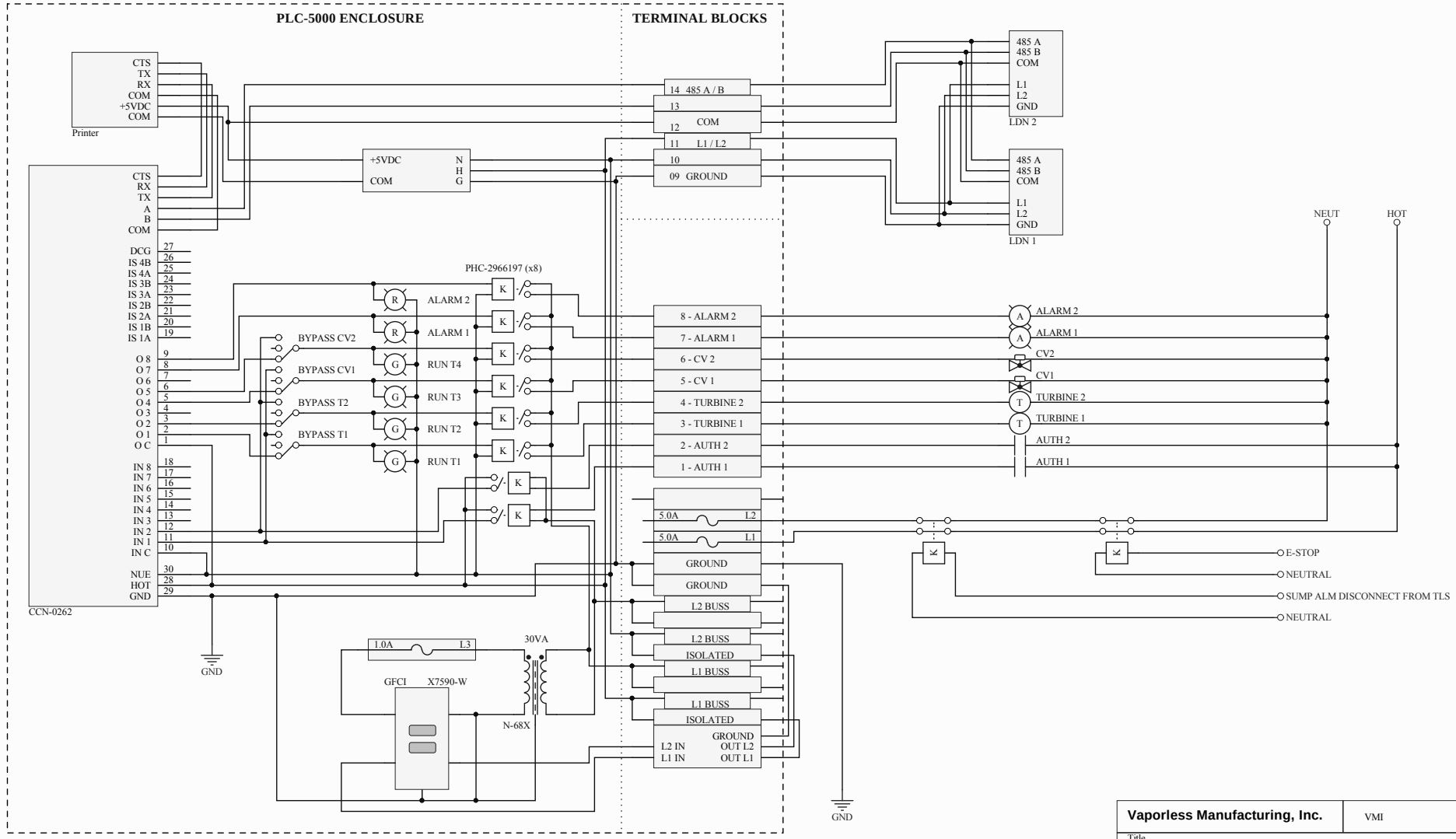
AC

PIN NUM	FEMALE	AWG		MALE 18 AWG	LDN PCB TERMINAL	FUNCTION
1	BLUE	14	THHN	BLUE	H2-2	RS-485 A
2	RED	14	THHN	RED	H2-3	RS-485 B
3	YELLOW	14	THHN	YELLOW	H2-4	RS-485 COM
4	WHITE	14	THHN	WHITE	H5-2	NEUTRAL
5	BLACK	14	THHN	BLACK	H5-4	HOT
6	GREEN	14	THHN	GREEN	H5-3	GROUND

DC

PIN NUM	FEMALE	AWG		MALE 18 AWG	LDN PCB TERMINAL	FUNCTION
1	BLACK	22	BELDEN 5500FE	BLUE	H2-2	RS-485 A
2	WHITE	22		VIOLET	H2-3	RS-485 B
3	SHIELD	22		YELLOW	H2-4	RS-485 COM
4	WHITE	14	BELDEN 5100FE	BLACK	H5-1	-12VDC
5	BLACK	14		RED	H5-5	+12VDC
6	SHIELD	14		GREEN	H5-3	GROUND

Vaporless Manufacturing, Inc.	VMI	
Title: LDN-5106 CONNECTOR PIN OUT		
Size: B	Number: NBS-007	Revision: B
Date: 4/18/2017	Sheet 1 of 1	



Vaporless Manufacturing, Inc.	VMI	
Title: PLC-5000 2 CH, UL - ENCLOSURE / SITE		
Size: B	Number: 4711-037	Revision: A
Date: 4/18/2017	Sheet 1 of 1	