OPW

A DOVER COMPANY

VAPORSAVER

Vaporsaver 1

Start-Up and Trouble Shooting Manual

99-50505 08APR2009

ATTENTION:

READ AND UNDERSTAND THIS IMPORTANT SAFETY INFORMATION BEFORE BEGINNING WORK

This product is to be installed and operated near the highly combustible environment of a gasoline storage tank and gasoline dispensing. It is essential for your safety and the safety of others that you carefully read, understand, and follow the warnings and instructions in this manual. Failure to do to so could result in danger to life and property including death, serious injury, explosion, fire or electric shock.

Failure to install this product in accordance with the instructions and warnings in this manual as well as failure to follow the requirements of the National Electric Code, national, state, and local codes will result in voiding warranties of this product.

Only OPW trained and certified technicians are to install and start-up the system. An OPW trained and certified technician shall start-up the system only after careful inspection of the installation, and completion of the start-up check list.

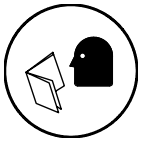
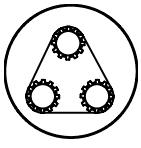
Installation, start-up, system maintenance and troubleshooting must be performed by qualified, certified service technicians. Certified technicians must be able to provide proof of certification at any time. Certification number is required for any start-up form to be completed or accepted by OPW as well for warranty purposes. Technicians requesting technical support on the Vaporsaver that do not have the necessary proof of certification will be referred to a certified service technician.

It is your responsibility to install this product in accordance with the instructions and warnings in this manual.

www.opw-fc.com

Safety Symbols

The following safety symbols may be used throughout this manual to alert you to important precautions and safety hazards that may arise during the installation and operation of this product.

	**ELECTRICITY** A potential shock hazard exists. High voltage is supplied to and exists in this device.		**TURN POWER OFF** Turn power off to the device and its accessories when installing and servicing the unit. Live power creates a potential spark hazard.
	**EXPLOSIVE** Gasoline and its vapor are extremely explosive if ignited.		**NO POWER TOOLS** Sparks from electric power tools can ignite gasoline and its vapors.
	**FLAMMABLE** Gasoline and its vapors are extremely flammable.		**NO PEOPLE IN THE AREA** Unauthorized people in the work area during installation and service of the device create a potential for personal injury.
	**NO SMOKING** Gasoline and its vapors can be ignited by sparks and embers of burning cigarettes.		**READ ALL RELATED MANUALS** Read, understand and follow all instructions, warnings and requirements before you begin work.
	**NO OPEN FLAMES** Open flames from sources like lighters, matches, etc. can ignite gasoline and its vapors.		**USE SAFETY BARRICADES** Unauthorized people or vehicles in the work area create a potential for injury and danger to property. Always isolate your work area by using safety cones, barricades, etc.
	**PINCH RISK** Stay clear. Keep hands and tools away from rotating machinery and moving parts.		**ROTATING MACHINERY** Stay clear. Keep hands and tools away from rotating machinery.

WARNING: Installation and operation of this product must comply with all national, state and local electrical and safety codes and regulations.

WARNING

The User Interface enclosure must be installed in a non-Hazardous location. Explosion or fire resulting in serious injury or death, or property loss or damage could occur if the User Interface is installed in a Hazardous location.

Do not install User Interface enclosure in any combustible or explosive atmosphere (Do not install in Class 1, Division 1 or Division 2; Class IIA, Zone 0, Zone 1, or Zone 2).

WARNING

The Control System is to be installed near locations where highly flammable and explosive vapors and liquids may be present. Risk of fire, explosion, serious injury or death.

You are working in an area where vehicle traffic may occur. Always block off the work area during installation and service to protect yourself and others.

Do not use power tools that can generate sparks if there is a risk of flammable or explosive vapors or liquids being present.

Table of Contents

1.0 Introduction

WARNING: Only OPW trained and certified technicians are to start-up and service the system. An OPW certified technician shall start-up the system only after careful inspection of the installation, and verification and completion of the start-up check list.

Do not power up the system unless a complete start-up inspection is completed by an OPW certified technician.

1.1 Control System Description

The OPW Vaporsaver reduces hydrocarbon emissions from a gasoline refueling facility by controlling the storage tank pressure. Tank pressure management is achieved by releasing air from the storage tanks, while recycling the gasoline (petrol) vapor. The recycling that takes place accomplishes three benefits. First, by returning vapor to the storage tank in a supersaturated form, evaporative emissions are greatly reduced. Second, during the recycling process, liquid gasoline is created and returned to the storage tank. Third, by releasing the air (and saving the gasoline), the pressure in the storage tank is reduced, and vapor emissions to the atmosphere due to venting or fugitive emissions become insignificant.

Pressure in the storage tank will rise due to thermal and pressure affects of the day, by the introduction of air from filling vehicles (larger pressurization occurs with ORVR equipped vehicles), or from Stage I deliveries.

Without the OPW Tank Pressure Management System:

- Ingested air from vehicles can evaporate the liquid product, and cause an increase in UST pressure.
- Increased pressure from all sources will be released from the USTs to the atmosphere through leaks in the vapor piping, components, and P/V vents.

1.2 Normal Operating Conditions

1. The Control System turns on when the UST pressure increases to approximately +0.4 mbar gage (+0.15 inches of water column) pressure.
2. It turns off in the following conditions
    a. When UST pressure is reduced to approximately -2.5 mbar gage (-1.0 inches of water column) vacuum.
    b. The Control System is also designed to only operate 10 minutes continuously. After a 10 minute run, the Control System shuts down for 2 minutes, and will start again if tank pressure requires it. This allows the separator to drain returning liquid product to the storage tank. As well as not allowing the Control System to run excessively if the vapor space has significant leaks.
3. The Residue (fresh air being released from the Control System) is continuously monitored for the presence of hydrocarbons to ensure it is below the allowable limit.
4. The Vaporsaver, when installed and operated as designed, is approved by TUV (minimum 97% efficiency) and CARB. It will allow any Stage II Vapor Recovery System to meet both the ORVR compatibility and the CARB emissions requirements.
5. The Vaporsaver can be used with any Stage 2 vapor recovery system with A/L ≤ 1.10.

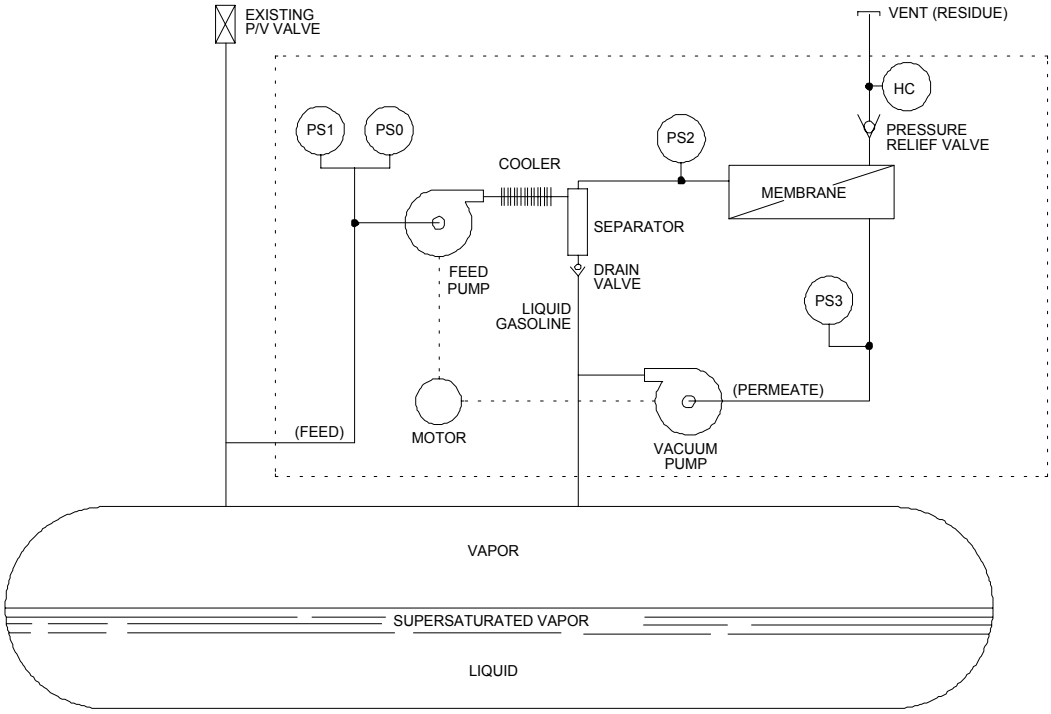
6. There are many variables that influence how long the Vaporsaver will operate per day at any given site. These variables include:
    a. Station dispensing volume
    b. Number and duration of Stage I deliveries
    c. Fuel vapor pressure
    d. Fuel temperature
    e. Barometric pressure and temperature
    f. Vapor tightness of the Stage I and Stage II Systems
    g. Storage tank ullage
7. The amount of operating time per day can vary from station to station, as well as from day to day at the same station. A seemingly significant variation from day to day should not be a concern. The Vaporsaver is self-monitoring; if a fault arises, an alarm will sound.

2.0 Operation

As pressure in the storage tank rises, the pressure sensor monitoring the tanks will start the Vaporsaver Control System.

1. The feed pump draws the vapor/air (saturated vapor) mixture from the storage tank.
2. The vapor/air flow is pressurized.
3. The feed vapor stream temperature rises as a result of the pressurization.
4. The heated vapor stream passes through a cooler.
5. The cooler reduces the vapor stream to ambient temperature.
6. The cooling process causes liquid gasoline to condense.
7. The vapor/air mixture and liquid gasoline go to a separator.
8. The liquid gasoline is removed from the vapor/air mixture and stored for return to the storage tank.
9. The remaining vapor/air flow proceeds to the membrane.
10. The membrane material has two sides; a pressure (feed) side and a vacuum (permeate) side.
11. As hydrocarbon molecules pass along the membrane pressure side, they absorb into the membrane material.
12. Air molecules are not absorbed by the membrane surface on the pressure side, and are released from the Control System as clean air (residue).
13. The pressure differential between the pressure side and the vacuum side cause the hydrocarbon molecules to be drawn through the membrane material.
14. The vacuum pump returns the supersaturated gasoline vapor (permeate) to the storage tank where some of it will condense into liquid gasoline.
15. When the pressure in the storage tank is reduced a preset level, the Control System is shut down and put into stand-by mode waiting for the pressure to rise again.
16. The separator valve is then opened, and the stored gasoline liquid in the separator is returned to the UST.

VAPORSAVER 1 CONTROL SYSTEM
OPERATION SCHEMATIC



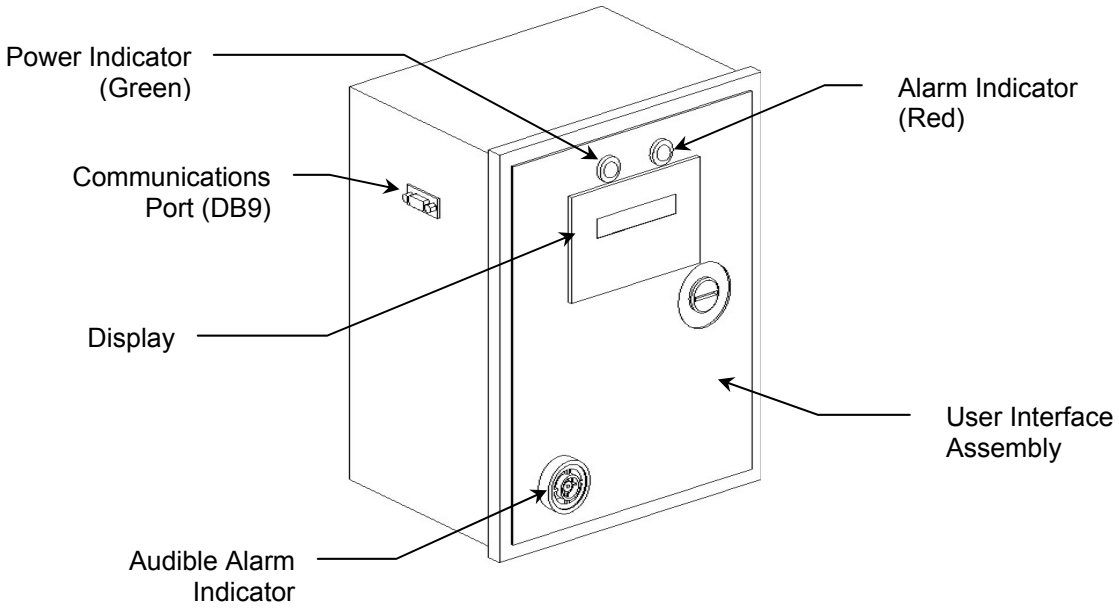
NOTE: ONLY VAPOR LINES SHOWN

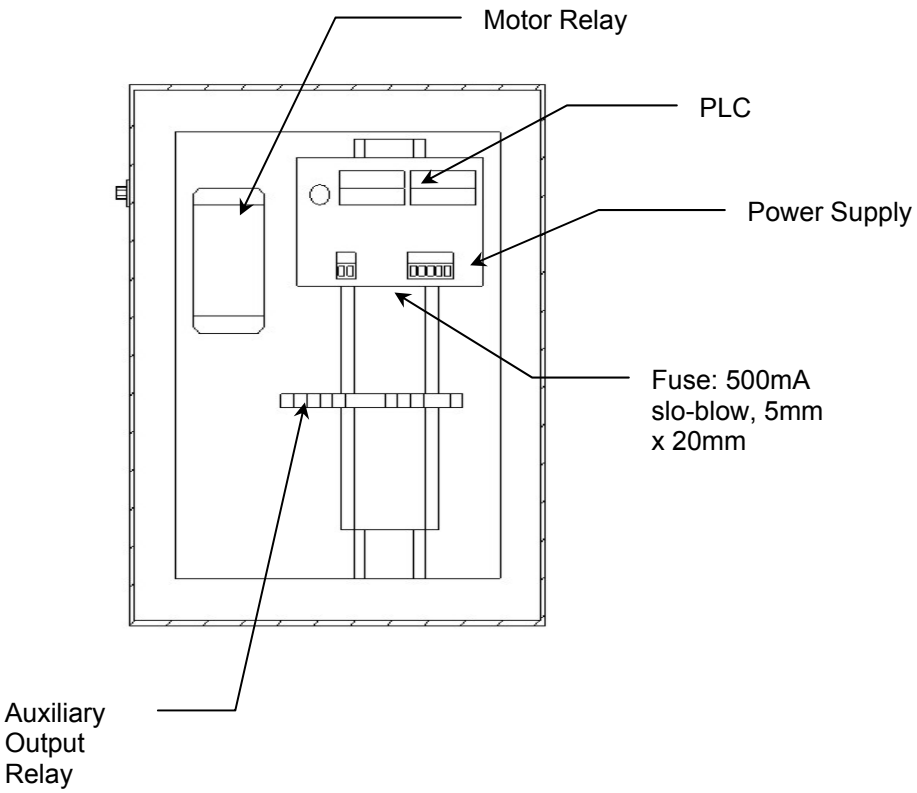
MD-VR020

3.0 Component Identification

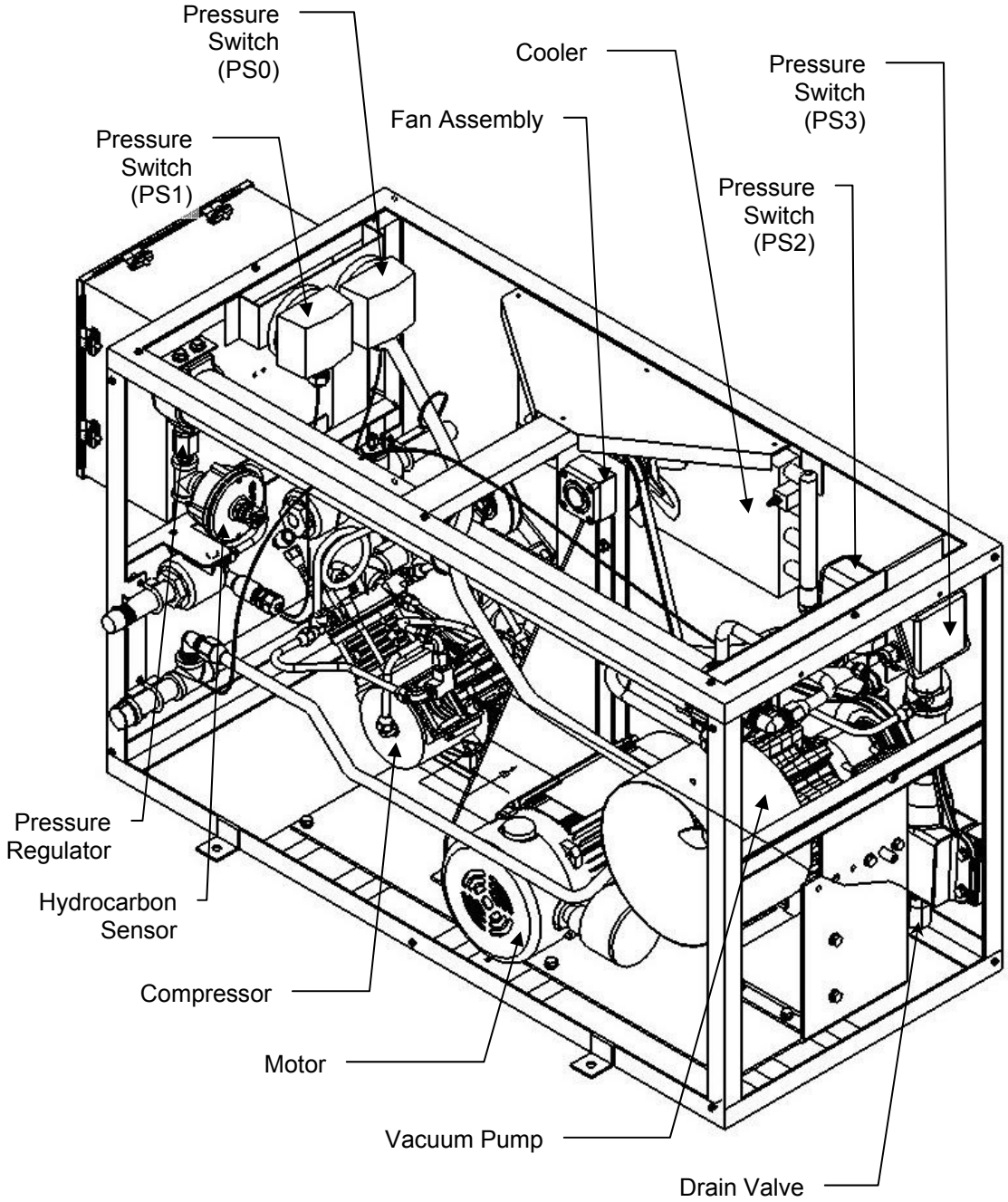
The Vaporsaver 1 consists of two major components: The User Interface and the Control System. The User Interface is the logic center of the system. It allows for interaction with the system for monitoring system status information, setting initial site configuration, and accessing recorded system history. The Control System is the active tank pressure management component.

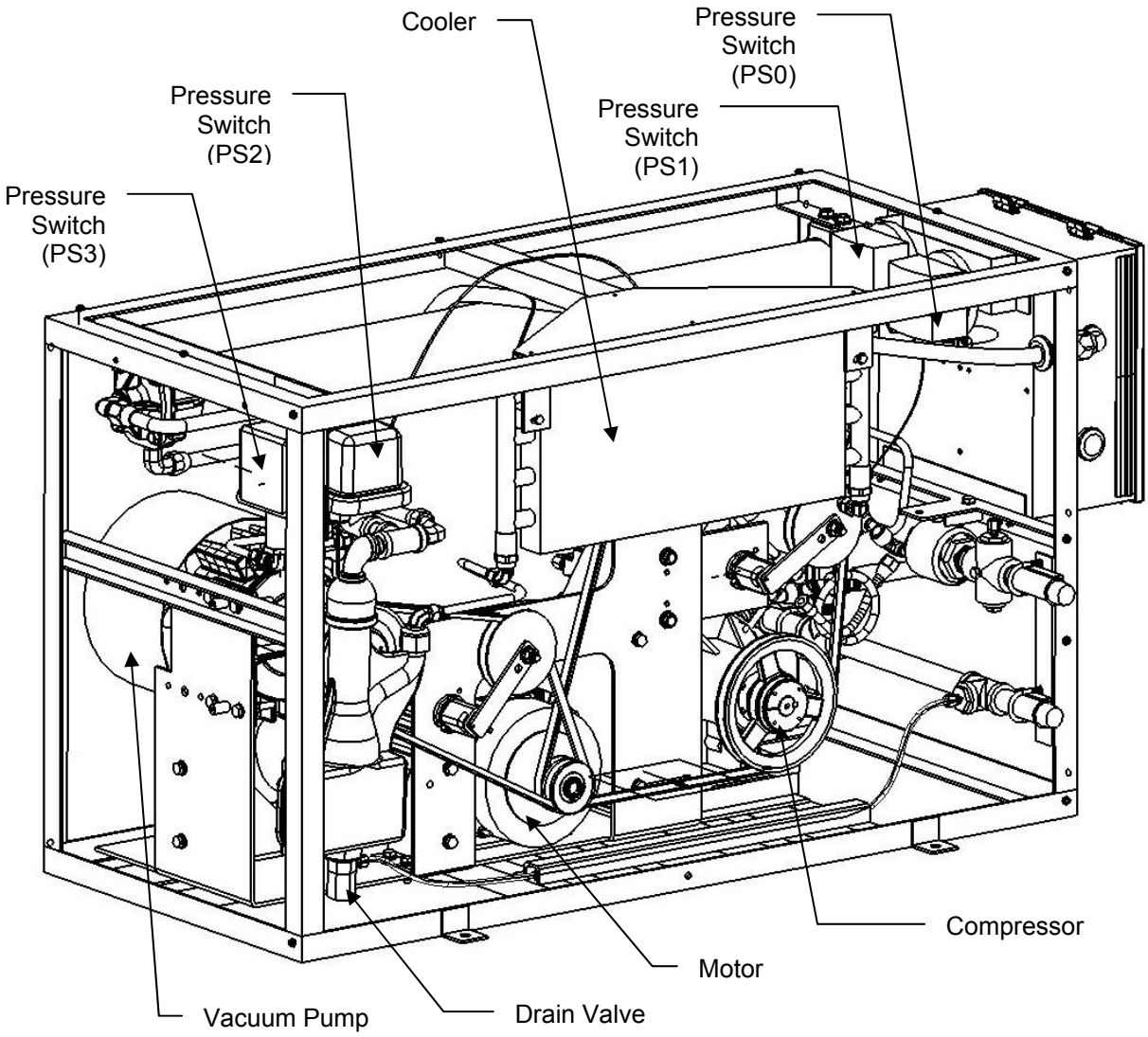
3.1 User Interface




Motor Relay
PLC
Power Supply
Fuse: 500mA
slo-blow, 5mm
x 20mm
Auxiliary
Output
Relay

3.2 Control System



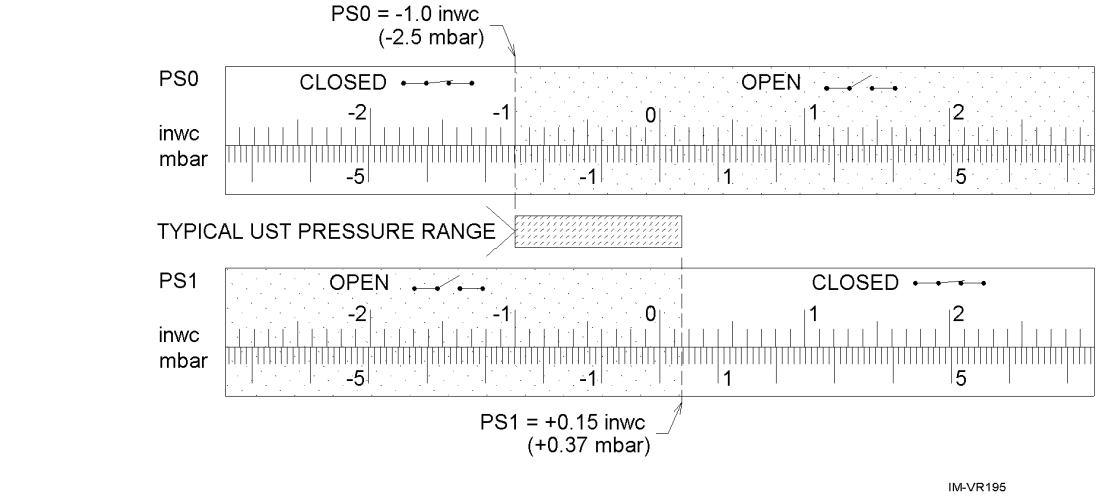

Cooler
Pressure Switch (PS0)
Pressure Switch (PS2)
Pressure Switch (PS1)
Pressure Switch (PS3)
Compressor
Motor
Vacuum Pump
Drain Valve

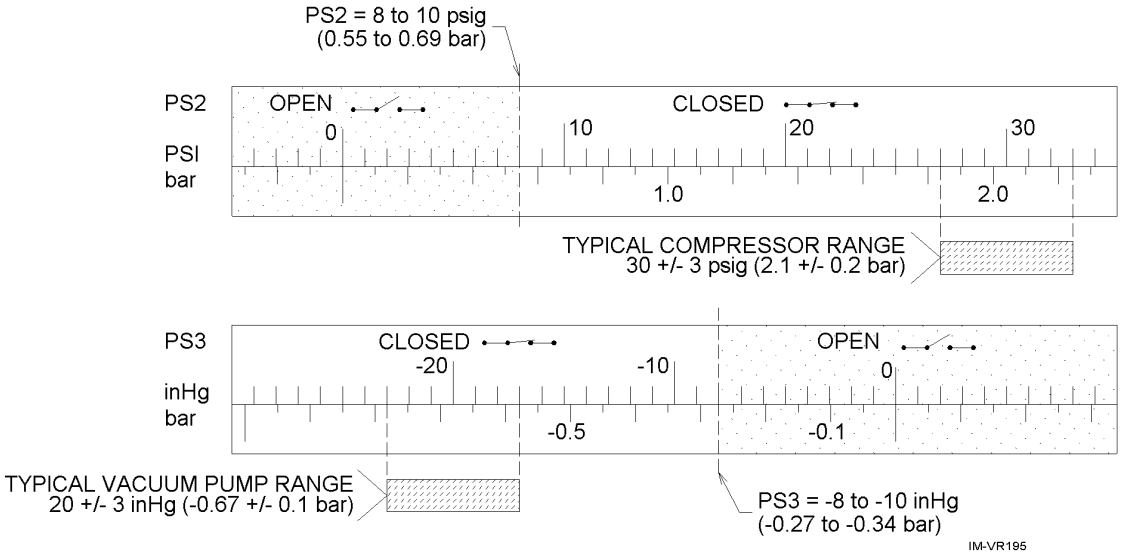
3.3 Operating Pressures and Pressure Settings

Typical internal operating pressures of the system are:

- Compressor (feed) = 30 psig +/- 3 psig (2.1 bar +/- 0.2 bar)
    - Early systems operate at 25 psig +/- 3 psig (1.7 bar +/- 0.2 bar)
- Vacuum (permeate) = -20 inHg +/- 3 inHg (-0.67 bar +/- 0.1 bar)

Pressure Switch	Wire Connections	Set Pressure
PS0(A)	COM – N/O	-1.0 inwc (-2.5 mbar)
PS1(A)	COM – N/O	+0.15 inwc (+0.37 mbar)
PS2(A)	COM – N/O	8 to 10 psig (0.55 to 0.69 bar)
PS3(A)	COM – N/C	-8 to -10 inHg (-0.27 to -0.34 bar)





4.0 Control System Piping

WARNING

The Control System is to be installed near locations where highly flammable and explosive vapors and liquids may be present. Risk of fire, explosion, serious injury or death.

You are working in an area where vehicle traffic may occur. Always block off the work area during installation and service to protect yourself and others.

Do not use power tools that can generate sparks if there is a risk of flammable or explosive vapors or liquids being present. Open piping to the gasoline storage tank will be emitting dangerous, flammable and potentially explosive vapors. Do not smoke or have open flames in areas near open piping.

4.1 General Piping Guidelines

1. When checking the installation of a Vaporsaver, the main rule for piping is that the Control System should pull from and return to different locations of the vapor system.
2. It is important that return piping connections are separated from the inlet piping connections, so the permeate return vapors cannot be drawn directly back into the inlet piping. This will maximize the vapor and fuel recovered.
3. All aboveground piping must be schedule 40 galvanized; only use pipe that is internally and externally corrosion protected.
4. All pipes must have slope away from the Vaporsaver Control System directed to the storage tanks.
   Minimum slope: 10 mm/1 meter (0.5°, 1/8" per foot).
   Recommended slope: 20 mm/1 meter (1°, 1/4" per foot).
5. Feed piping should remain a minimum of DN50 (2" NPT) from the Control System inlet connection to the connection to the storage tank (or storage tank vents).
6. Residue piping (clean air vent) should remain a minimum of DN40 (1-1/2" NPT).
7. Return piping should remain a minimum of DN40 (1-1/2" NPT) until it returns to the storage tank. Some special installations may allow smaller return pipe to be used; consult OPW Technical Support for installation review and approval.
8. For maintenance purposes, it may be desired to install a DN50 (2”) ball valve. Ensure that the valve has a 50mm (2”) flow opening and is approved for gasoline use. NEVER OPERATE THE VAPORSAVER WITH THE SERVICE VALVES CLOSED; damage to the Vaporsaver will occur. It is highly recommended that the valve handles are removed to avoid tampering.
9. See Installation Manual supplied with system to verify necessary piping details before starting system.

5.0 Electrical Requirements

WARNING

This system uses lethal voltages and operates in areas where flammable vapors and liquids may be present.

Serious injury or death from electrical shock, fire, or explosion may result if the power is on during installation.

Turn power off, lockout and tag power to the unit while installing the system.

Read and understand all instructions in this manual and all applicable requirements of the National Electric Code, federal, state and local codes and regulations, as well as other all other applicable safety codes.

5.1 Power Requirements

System Type	ATEX (00-50003, 00-50004)	UL (00-50001, 00-50002, 00-50006)	KHK (00-50005)
User Interface			
Voltage	100-240 VAC 50/60 Hz	100-240 VAC 50/60 Hz	100-240 VAC 50/60 Hz
Phase	1	1	1
Amp	0.5	0.5	0.5
Control System (motor)			
Voltage	380-415 VAC, 50 Hz 440-480 VAC, 60 Hz	230 VAC, 50 Hz 208-230 VAC, 60 Hz	200 VAC, 50 Hz, 200-220 VAC, 60 Hz
Phase	3	1	3
Hp (kW)	1.8 kW	2.4 Hp	2.2 kW
FLA	3.0 amps, 50 Hz 2.6 amps, 60 Hz	9.5 amps, 50 Hz 9.0-8.3 amps, 60 Hz	8.7 amps, 50 Hz 8.4-7.8 amps, 60 Hz
Motor Contactor			
Coil Voltage (ATEX only)	220-230 VAC, 50 Hz 230-240 VAC, 60 Hz	N/A	N/A
Coil Voltage (KHK only)	N/A	N/A	100-110 VAC, 50 Hz 110-120 VAC, 60 Hz
Contact Rating (ATEX and KHK)	230 VAC,3-ph,2.2kW 400 VAC,3-ph,4 kW 480 VAC,3-ph,5 hp	N/A	230 VAC,3-ph,2.2kW 400 VAC,3-ph,4 kW 480 VAC,3-ph,5 hp

For ATEX and KHK systems, refer to the specific electrical interconnect drawings in the Installation Manual that accompanied the system for motor contactor requirements.

1. The User Interface has internal fuse: 500 mA (slow-blow), 250 V, 5mm x 20mm. The fuse is to only be replaced by qualified and certified technicians. Do not substitute fuse for any other size or rating.
2. Follow all requirements by the national, state, and local, authorities and regulations.
3. The Vaporsaver 1 main power should be controlled by the facility's main Emergency Shut-Off system.
4. **SPECIAL NOTE FOR 3-PHASE MOTORS**: Ensure that motor rotation is correct the first time the unit is powered. If the motor rotation is incorrect exchange any two of the 3-phase conductors. If reverse rotation is noted, **immediately** power off the unit and correct wiring. Reverse rotation can cause internal damage to the vacuum pump.
5. **SPECIAL NOTE FOR 50/60 Hz OPERATION**: Each Control System can be supplied as 50 Hz or 60 Hz. Different pulleys are used to compensate for different motor speeds.

5.2 Control System Electrical Hook Ups

1. System overload circuit breaker shall be sized for power load based on national and local requirements.
2. Wiring between the User Interface and the Control System shall be as follows.
    a. Always follow national and local electrical regulations.
    b. All wiring to be gasoline and oil resistant with 600 V insulation.
    c. Wiring for the 24 VDC control signals shall be minimum 1.0 mm^2 (18 AWG).
    d. Two ground wires shall be run from the Control System junction box to the load center ground; one is for equipment ground, and the second is for a dedicated Intrinsically Safe Barrier ground. Both ground wires must be minimum 3.3 mm^2 (12 AWG). Proper grounding for the Intrinsically Safe Barrier is crucial for safe operation of the Barriers.
    e. Both the motor power wiring and the signal wiring can be routed in the same conduit provided all wiring is rated gasoline and oil resistant wiring with 600 V insulation.
    f. Wiring for motor shall be minimum 3.3 mm^2 (12 AWG); sizing must comply with requirements for motor load and wiring distance. **Larger gage wire may be necessary** based on conductor length and voltage supplied by load center.
    g. Many electrical codes recommend a maximum conductor voltage drop of 3%, and note that with a conductor voltage drop of 5%, most devices should operate with acceptable efficiency. It should be noted that with a conductor voltage drop of 5%, motor starting capabilities are reduced, and difficult starting may occur. But, always remember that lower conductor voltage drop is always better for motor starting and operating efficiency; so whenever possible **use the 3% conductor voltage drop**.

Conductor Length and Size Guide

Maximum conductor length is the total length of the conductor from the load center through the User Interface to the motor.

Maximum Conductor Length (1-Phase)

Voltage		208	208	230	230
% Voltage Drop		3%	5%	3%	5%
AWG	mm^2	Feet (meters)			
12	3.3	91(28)	151 (46)	100 (30)	167 (51)
10	5.3	144 (44)	240 (73)	159 (48)	265 (81)
8	8.4	229 (70)	382 (116)	254 (77)	423 (129)

Maximum Conductor Length (3-Phase)

Voltage		200	200	230	230	400	460
% Voltage Drop		3%	5%	3%	5%	3%	3%
AWG	mm^2	Feet (meters)					
14	2.1					506 (154)	671 (205)
12	3.3	139 (42)	231 (70)	178 (54)	297 (91)	805 (245)	1068 (331)
10	5.3	220 (67)	365 (111)	283 (86)	471 (144)	1279 (390)	1697 (517)
8	8.4	351 (107)	585 (178)	450 (137)	751 (229)	2037 (620)	2702 (824)

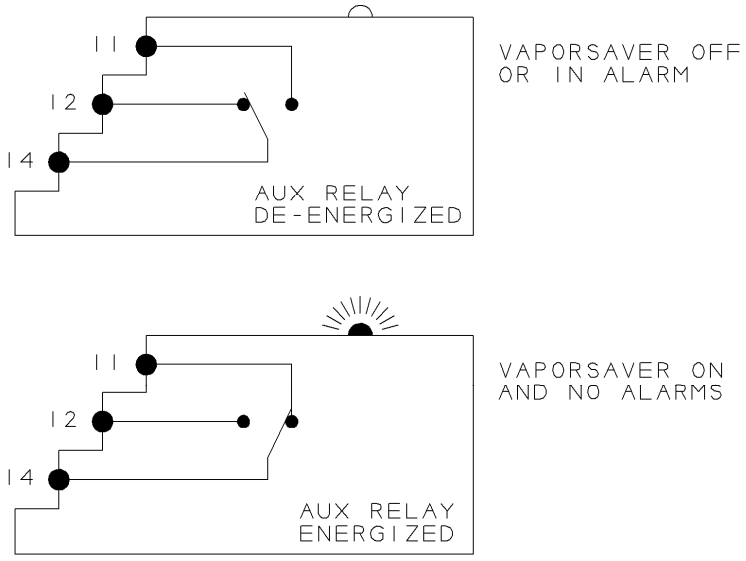
Notes:

- These tables are based on 140% of nameplate ratings, if national or local authority will allow voltage drop conductor length calculations based on load ampacity rating of 125% of motor nameplate, multiply the maximum length in the table by 1.12 to get the new maximum conductor length.
- For 3-phase voltages over 380 volts, 2.1 mm^2 (14 AWG) can be used if:
    - local electrical regulations allow for it to be used in motor applications and for the motor ratings stated on the motor name plate, and
    - the voltage at the motor and the running amps of the motor are within the limits stated on the motor nameplate, and
    - motor starting difficulties are not present.

THESE TABLES ARE ONLY TO BE USED AS A REFERENCE.
ALWAYS VERIFY AND FOLLOW NATIONAL AND LOCAL ELECTRICAL REGULATIONS.

5.3 Auxiliary Output Relay

1. The User Interface is equipped with an Auxiliary Output Relay for external monitoring of the Vaporsaver system. It is located on the main terminal block.
2. When the Vaporsaver is powered and operating normally, the Aux Relay is energized (green LED on Aux Relay is lit). When the Vaporsaver is either powered off, or is in Alarm, the Aux Relay is de-energized.
3. Aux Relay contact rating: 240V, 6A with 4000V isolation.



5.4 Control Signals

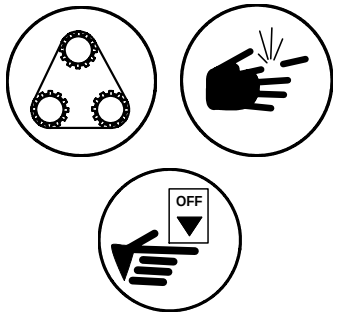
1. All of the input (PS0, PS1, PS2, PS3, HC, TS) and output (motor relay coil) control signals are 24 VDC. Verification of these signals can be verified by measuring the voltage between the signal channel and 0 VDC (0V terminal).
2. If measuring voltage directly on the pressure switches, the voltage will be 24 VDC if switch is open and 0 VDC if switch is closed.
3. If measuring voltage at the User Interface terminal block, or the Control System enclosure terminal block, the voltage will be 24 VDC if the switch is open and between 1 and 2 VDC when the switch is closed. This small voltage is attributed to the resistance in each pressure switch circuit introduced by the wiring and the Intrinsically Safe barriers. Voltage at User Interface for the low voltage signals must be below 2.4 VDC in the switch closed state for the signal to be accepted by the PLC.
4. The hydrocarbon sensor is power by an intrinsically safe power supply. Input to the Intrinsically Safe power supply is 24 VDC, and the output must be 6.0 – 6.5 VDC; some I.S. power supplies have the small adjusting screw on the front of the power supply to increase the output voltage if necessary. Power is always applied to the HC sensor. The HC sensor output channel switches 24 VDC just like the pressure switches.

5.5 Motor Thermal Overload Switch (TS)

1. In the event the motor is failing or the load is too great (failing pumps, over tight belts…), the motor internal thermal switch can open to protect the motor from damage or an unsafe failure.
2. On UL Systems the TS is electrically in series with the motor relay coil. If the motor overheats, the TS will open, causing the motor relay to de-energize. The PLC will continue to have a motor output signal (Y3) until the system goes into COMP and/or VAC Alarms.
3. On ATEX and KHK systems, the motor thermal switch is completely internal to the motor and does not connect to the motor relay coil. Therefore, the TS wire is jumpered to 0V either at the Control System main electrical enclosure, or in the User Interface enclosure.

6.0 User Interface

WARNING



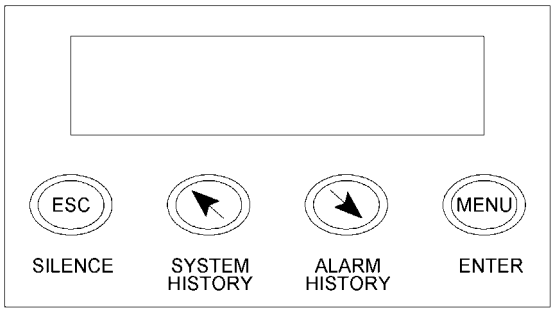
Rotating machinery. Keep clear of the Control System when powering up or resetting the unit. The unit will start automatically. Be sure all covers are in place when power is applied to unit, starting or resetting the unit. Risk of serious injury.

Always power off system when performing maintenance or service. Unit starts automatically. Risk of serious injury.

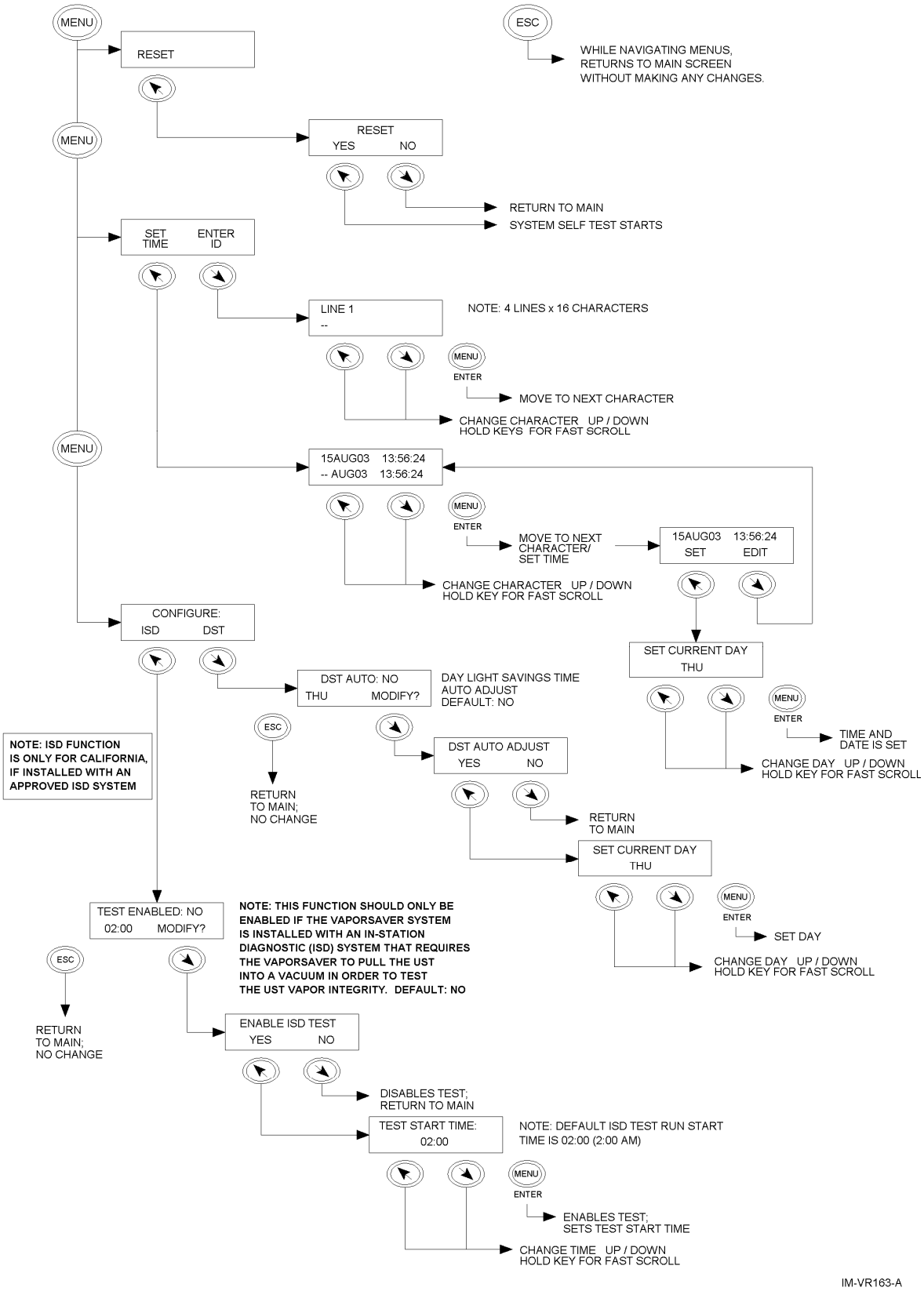
6.1 Initial Set-up and Navigation

1. When first installed, the following information should be installed in the User Interface:
    a) Station identification
    b) Current date
    c) Current time
    d) Daylight savings time enable/disable
    e) In Station Diagnostics test enable/disable (ONLY for use in California with CARB Enhanced Vapor Recovery In-Station Diagnostic systems)
2. From main screen press MENU twice to get to the set-up menus.
3. There are menus that will apply only to very specific types of installations in very specific locations. If there is no explicit regulation, do not enable features that are not required.

Display Overview



Initial Set-up Navigation



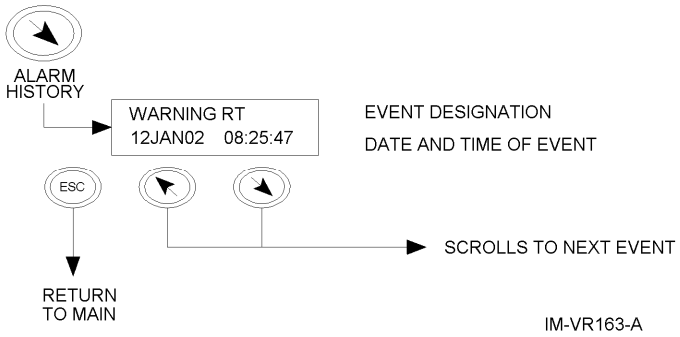
6.2 System and Alarm History Access

To limit access to system operational data to only trained personnel, some software versions have a multi-key sequence to access the 'System History' and 'Alarm History' information. If the software version is not known, start by attempting to access the information by the Basic Method; if unable to access information, try the Multi-key Method.

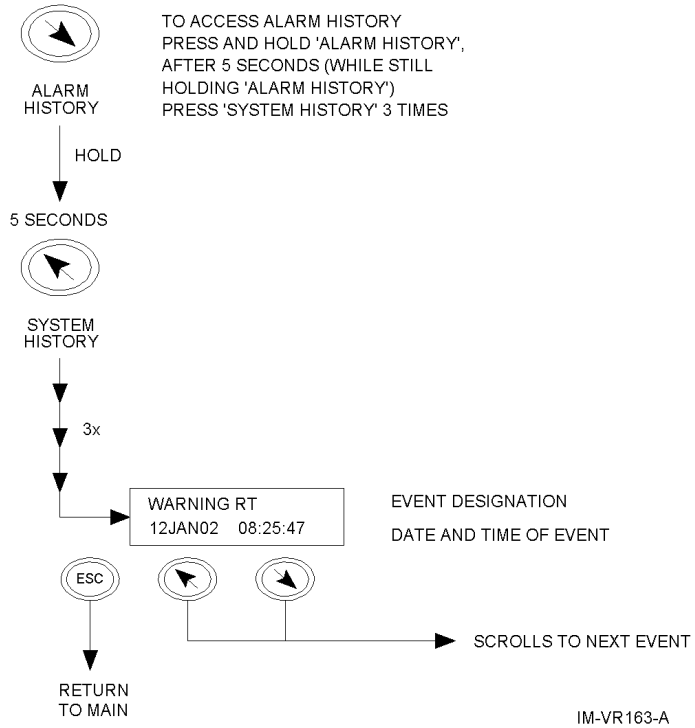
Alarm History provides access to the last 50 events: Alarms, Warnings, Resets, and Clock Changes.

System History provides access to the last 365 days of operating data: Daily Run Time (DRT) and Daily On Time (ON).

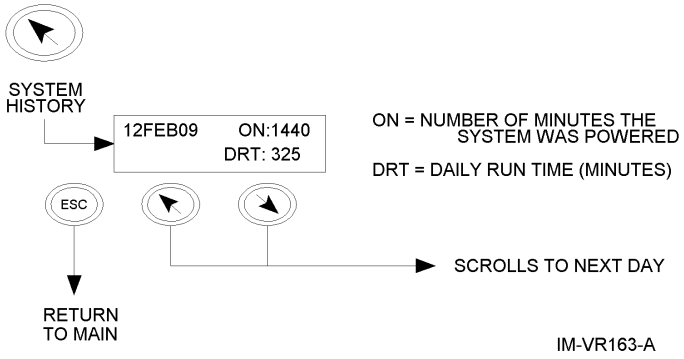
Basic Method (Alarm History)



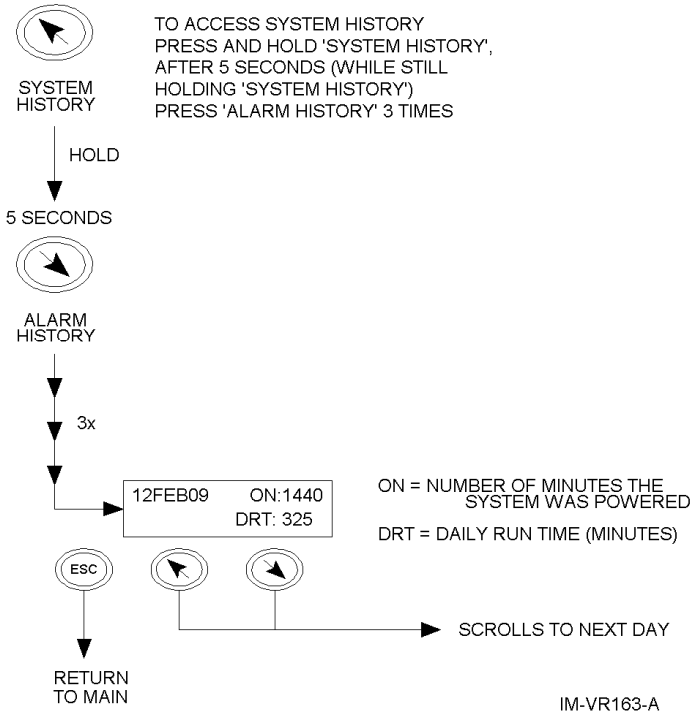
Multi-key Method (Alarm History)



Basic Method (System History)



Multi-key Method (System History)



6.3 Start-up/Self-Test

1. Each time the power to the Vaporsaver is cycled ON or the system is RESET, it will go through a Self Test for up to 180 seconds. It will display:

SYSTEM SELF TEST **PLEASE WAIT ###**	Control System is performing a self diagnostic (display shows timer)

2. During this time, the Control System will run and verify proper operation of all of the components. If there is a problem, the Control System will shut down and the User Interface will sound an alarm and display the alarm condition.

During a self-test, a timer will be shown on the front display. Once the motor relay is energized, the timer will start. The motor will operate for 120 seconds. Below is the self-test sequence.

Timer	Actions
0	Motor starts (motor relay closes)
60	PS2 (X2 on) and PS3 (X3 on) must be closed by timer = 60 seconds and remain closed until motor stops.
60	HC must be closed (X4 on) for at least 10 continuous seconds between self-test timer 60-120 seconds.
120	Motor stops (motor relay opens)
120 – 180	PS2 and PS3 must open (X2 and X3 off) within 60 seconds of the motor deactivation.

If any of the above conditions are not met, the system will alarm and indicate the problem area.

6.4 Normal Operation

Once the Self Test is successfully completed, the User Interface displays a continuous scrolling screen showing the following information.

SYSTEM NORMAL **DATE TIME**	Operational Status Current Date and Time
TRT xxxxxx HRS **DRT xxxx MIN**	Total Run Time since installed (hours) Daily Run Time so far current day (minutes)

6.5 Alarms and Their Causes

1. When an error has occurred in the operation of the Control System, the User Interface will sound a buzzer and the display will change from SYSTEM NORMAL to the appropriate error code. The station operator should then call for service.
2. **The alarm buzzer does <u>not</u> indicate a safety emergency.** If the Control System is not functioning properly, an alarm will sound, and the Control System will shut down to a safe mode.
3. The Vaporsaver is equipped with self-test capabilities to minimize false alarms.
4. Some local authorities may require notification of the local Air Quality District in the event of an alarm.
5. If more then one alarm occurs at the same time, the most recent will appear first, then the previous one, until all the current alarms are shown.

Comp Alarm

1. During a “System Self Test”, if PS2 is not activated within 60 seconds of the motor starting.
2. During “System Normal” operation, is PS2 is not activated within 60 seconds of the motor starting on 15 consecutive run cycles.

Vac Alarm

1. During a “System Self Test”, if PS3 is not activated within 60 seconds of the motor starting.
2. During “System Normal” operation, is PS3 is not activated within 60 seconds of the motor starting on 15 consecutive run cycles.

HC Alarm

1. During a “System Self Test”, if HC is not activated for 10 continuous seconds between 60 and 120 seconds of the Self Test Timer.
2. During “System Normal” operation, if HC is not activated for 60 continuous motor running minutes.

PR Warning

1. During a “System Self Test”, if PS2 and/or PS3 do not open within 60 seconds of the motor relay opening.
2. During “System Normal” operation, if PS2 and/or PS3 do not open within 110 seconds of the motor relay opening.

RT Warning

1. Seven consecutive days of run time greater than 1140 minutes.

Note: Warnings do not shut the System down, but a certified service technician should be called to investigate the abnormal behavior.

Comm Error or PLC Not Running

1. This is a result of the PLC and Display losing communications.
2. Generally caused by a failure in the cable between the PLC and the display or incompatible programs in the PLC and Display.
3. Verify “RUN/PROG” switch on PLC is on “RUN”
4. Verify green “RUN” LED on PLC is lit.

6.6 Silencing Alarms

1. Once an alarm is triggered, the User Interface will emit an audible tone with a visual indication. This indicates that the Vaporsaver requires immediate attention. Service should be called.
2. Once the alarm has been noted, and the appropriate action has been taken, the alarm SILENCE button can be pushed to silence the alarm.
3. The red alarm indicator will remain flashing until the Vaporsaver is serviced and reset by a trained technician.

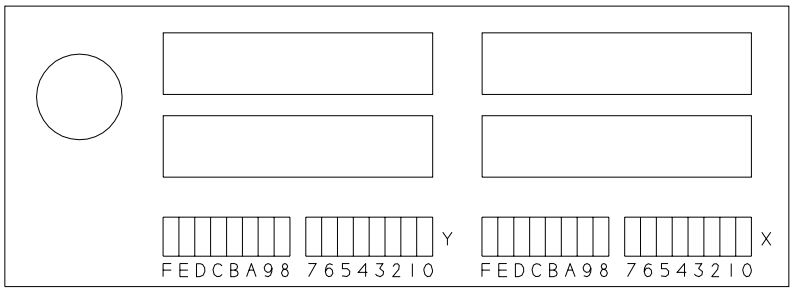
6.7 Resetting Alarms

1. The alarm should only be reset by factory trained personnel.
2. When the System is reset, the Control System will start running. Be sure there are no people or tools inside or near the unit.
3. Press the MENU button.
4. Press the RESET button.
5. Press the YES button.
6. If the Control System completes the Self Test without any problems, the display will return to SYSTEM NORMAL.

6.8 Controller I/O and LED Identification

This section describes the operation of each LED on the Controller Module (PLC). The LEDs are arranged in four arrays. The two “X” arrays are system inputs (labeled 0-F). The two “Y” arrays are system outputs and diagnostics (labeled 0-F).

PLC Overview



PLC Inputs: X0-XF

Signal	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	HC	PS3	PS2	PS1	PS0
Channel	XF	XE	XD	XC	XB	XA	X9	X8	X7	X6	X5	X4	X3	X2	X1	X0

PLC Outputs: Y0-YF

Signal	N/C	VAC Alarm	2 Minute Stand-by	RT Warning	PR Warning	HC Alarm	COMP Alarm	N/C	N/C	N/C	N/C	Aux Relay	Motor Relay	Buzzer	Power Light	Alarm Light
Channel	YF	YE	YD	YC	YB	YA	Y9	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0

LED Operation

LED	Signal	LED ON	LED OFF
X0	PS0 (Stop)	PS0 closed	PS0 open
X1	PS1 (Run)	PS1 closed	PS1 open
X2	PS2 (Comp)	PS2 closed	PS2 open
X3	PS3 (Vac)	PS3 closed	PS3 open
X4	HC sensor	HC sensor low; HC low %	HC sensor high; HC high %
X5 - XF	N/C		
Y0	Alarm Light	Alarm light on	Alarm light off
Y1	Power Light	Power light on	Power light off
Y2	Buzzer	Buzzer on	Buzzer off
Y3	Motor Relay	Motor relay energized	Motor relay not energized
Y4	Aux Relay	System Normal	Loss of power or Alarm
Y5 – Y8	N/C		
Y9	Comp Alarm	COMP Alarm	System Normal
YA	HC Alarm	HC Alarm	System Normal
YB	PR Warn	PR Warning	System Normal
YC	RT Warn	RT Warning	System Normal
YD	Standby	2 minute standby active	System Normal
YE	Vac Alarm	VAC Alarm	System Normal
YF	N/C		

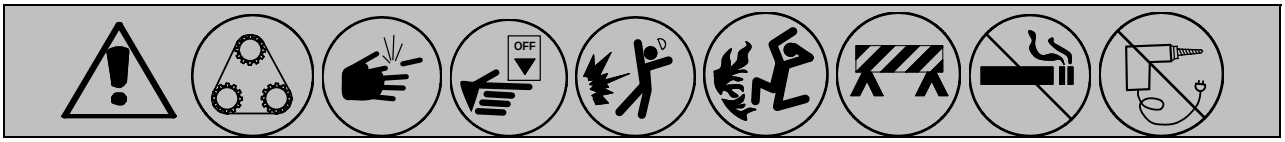
6.9 Communications

1. The Vaporsaver User Interface has a DB9 serial communications port located on the left side of the enclosure. This can be use to download the System History and Alarm History reports to a computer using any standard terminal emulation program (e.g. HyperTerminal or Procomm).
2. Local Communications Settings:
    a. Data bits: 8
    b. Parity: none
    c. Stop bits: 1
    d. Flow Control: Xon/Xoff (software flow control)
    e. Max speed: 9600 bps
3. Report Download:
    a. Once communications are successfully established, press the ESC key and a COMMAND prompt will appear.
    b. All communication commands must be entered in ALL CAPS (followed by ENTER).
    c. Enter report download command; there are different commands depending on the software version (note: if software version is not known, try one command, and if no data is downloaded, try other command.
        - MRH (motor run history)
        - SD (send data)

Example Report

EL DORADO HILL76 1020 SARATOGAWAY ELDORADOHILLS,CA 916-555-1234	Station header information
18SEP02 05:48:46 TRT 545	Date and time of report generation System Total Run Time (hours)
SYSTEM HISTORY DATE ON DRT 18SEP02 349 5 17SEP02 1440 133 16SEP02 1440 146 15SEP02 1440 154 14SEP02 1440 302 13SEP02 1440 117	Last 365 day of the following: Date, System ON time, and Daily Run Time (minutes)
ALARM HISTORY DATE EVENT 09SEP02 13:44:17 RESET 09SEP02 12:09:33 COMP 06SEP02 13:09:50 RESET 06SEP02 13:06:58 VAC 06SEP02 11:43:16 RESET 06SEP02 11:30:11 CLOCK	Last 50 Events (Alarms, Resets, and Clock changes) Date and Time of Event, and Event designation Date/time: ddmmmyy hh:mm:ss

7.0 Control System Trouble Shooting

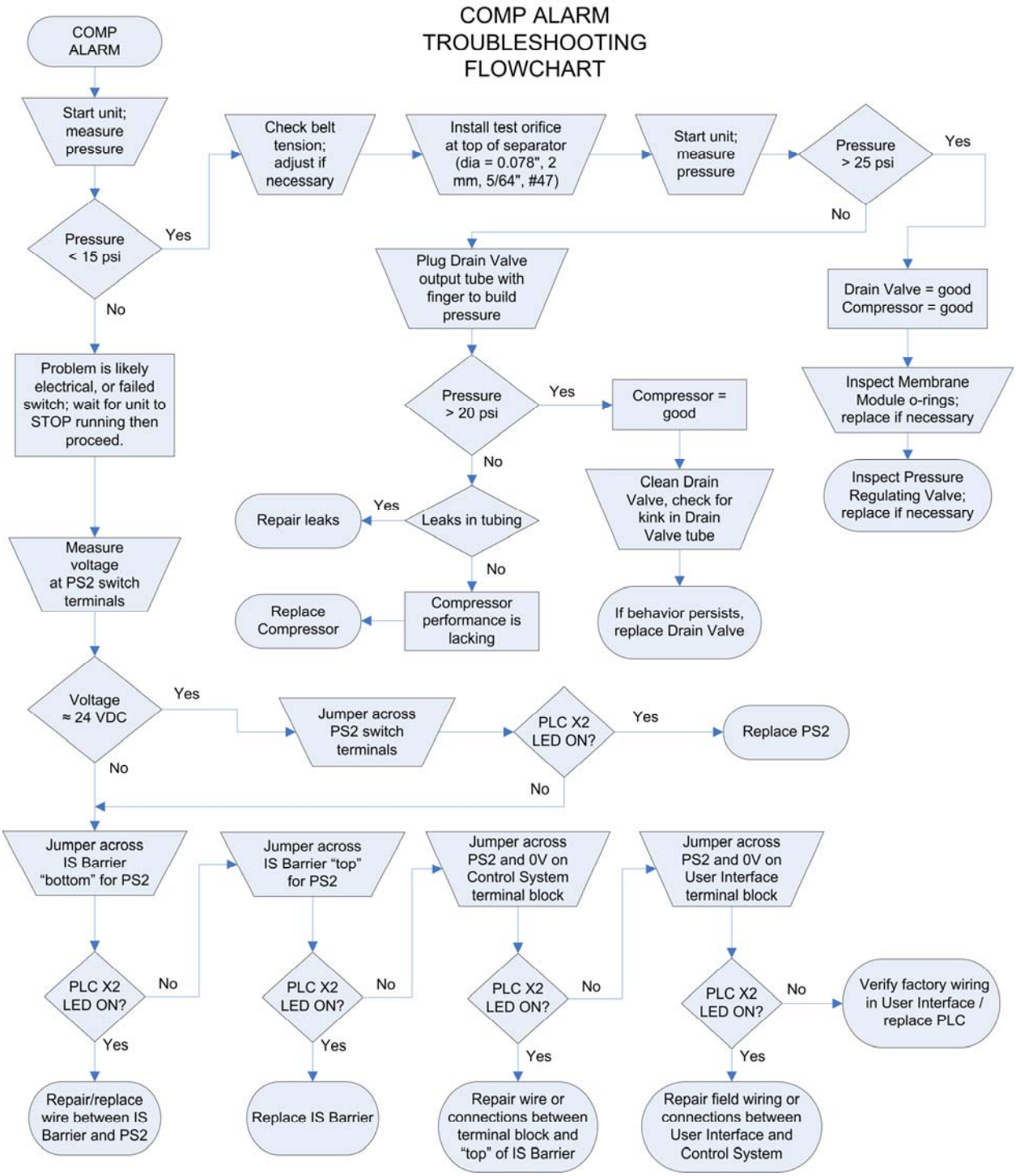


7.1 COMP ALARM (Compressor Alarm)

Compressor pressure is not sensed within the allowable time. Use pressure tap (1/4" NPT) on top of separator to install test gage (0-50 PSI or 4 bar) and measure feed pressure.

COMP Alarm

Potential Alarm Cause	**Action**	**Result**
Motor service switch OFF	Verify switch and voltage	Turn switch ON, reset system
Drive belt loose and slipping	Visual Inspection of belt tension	Adjust idler (15-20 degrees)
Drive belt failure	Visual Inspection	Replace belt
Compressor pump failure	Pump shaft not turning; Extreme belt wear	Replace pump
Drive motor failure	Motor not spinning with power applied	Check wiring, Replace relay, replace motor
Control System not holding pressure		
Separator drain valve not closing	Drain valve outlet has significant flow when greater than 5 psi	Disassemble, inspect, and clean, replace drain valve.
Leaks in Control System piping	None of the above obvious on visual inspection	Inspect at all tube and pipe joints and tighten; use soap bubble or leak detection solution to inspect all tube and pipe joints
Failure of pressure switch (PS2); failure of I.S. module	A good switch and circuit will show: when closed, approx 0 VDC across contacts; when open approx 24 VDC across contacts. Measure at switch, I.S. terminal block, and User Interface	Check wiring Check and replace switch Check and replace I.S. module
Damaged o-ring on membrane module or housing flange	Inspect o-rings on membrane module	Replace damaged o-rings


COMP ALARM TROUBLESHOOTING FLOWCHART
COMP ALARM
Start unit; measure pressure
Pressure < 15 psi
Yes
No
Check belt tension; adjust if necessary
Problem is likely electrical, or failed switch; wait for unit to STOP running then proceed.
Measure voltage at PS2 switch terminals
Voltage ≈ 24 VDC
Yes
No
Jumper across PS2 switch terminals
PLC X2 LED ON?
Yes
Replace PS2
No
Jumper across IS Barrier "bottom" for PS2
PLC X2 LED ON?
No
Yes
Repair/replace wire between IS Barrier and PS2
Jumper across IS Barrier "top" for PS2
PLC X2 LED ON?
No
Yes
Replace IS Barrier
Jumper across PS2 and 0V on Control System terminal block
PLC X2 LED ON?
No
Yes
Repair wire or connections between terminal block and "top" of IS Barrier
Jumper across PS2 and 0V on User Interface terminal block
PLC X2 LED ON?
No
Yes
Repair field wiring or connections between User Interface and Control System
Verify factory wiring in User Interface / replace PLC
Install test orifice at top of separator (dia = 0.078", 2 mm, 5/64", #47)
Start unit; measure pressure
Pressure > 25 psi
Yes
No
Plug Drain Valve output tube with finger to build pressure
Pressure > 20 psi
Yes
No
Compressor = good
Clean Drain Valve, check for kink in Drain Valve tube
If behavior persists, replace Drain Valve
Leaks in tubing
Yes
Repair leaks
No
Compressor performance is lacking
Replace Compressor
Drain Valve = good
Compressor = good
Inspect Membrane Module o-rings; replace if necessary
Inspect Pressure Regulating Valve; replace if necessary

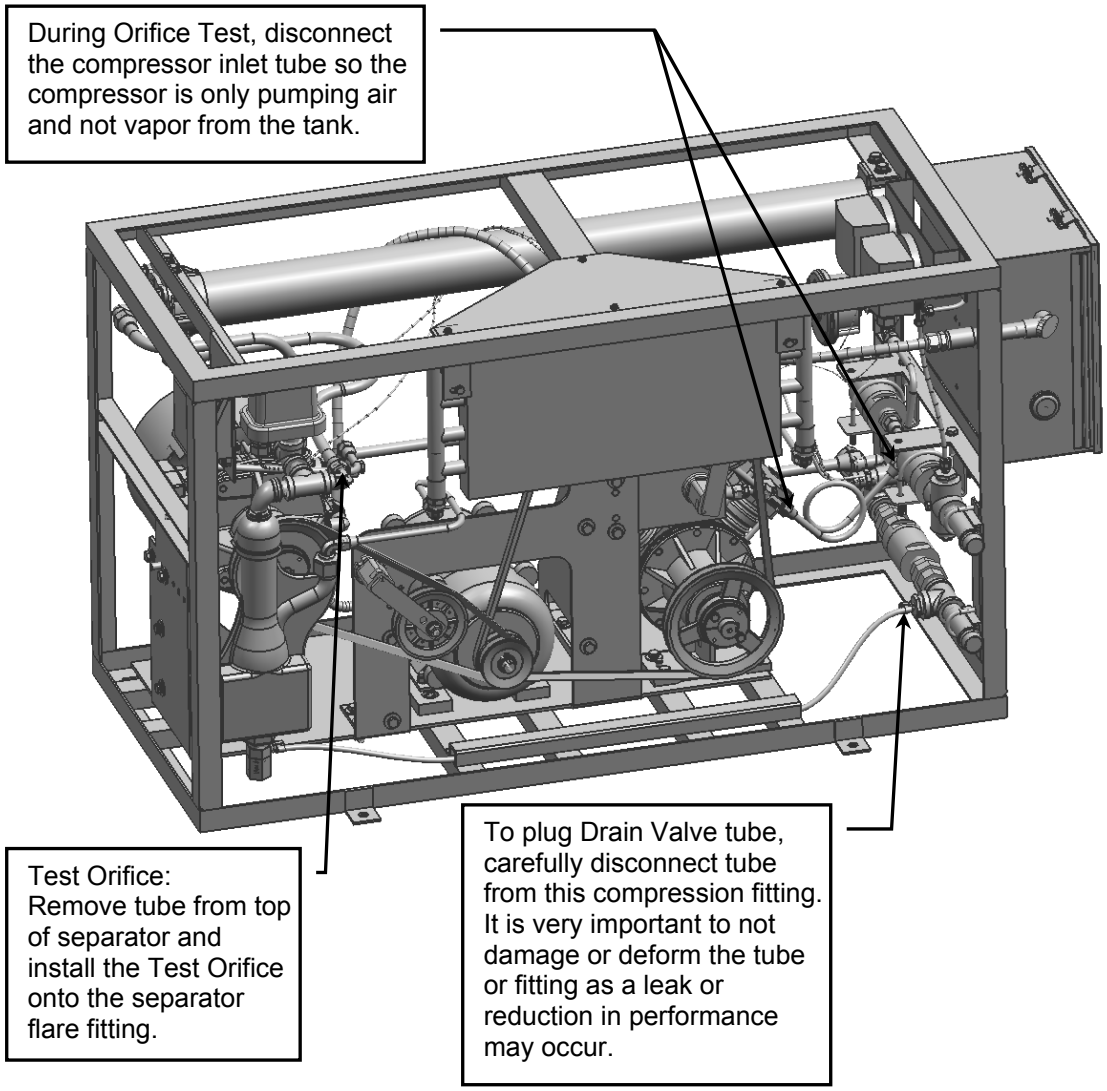
Testing Notes

This section describes one means and the necessary tools to isolate and test a compressor that is installed in a Vaporsaver control system. These tests are to aid in diagnosing compressor related alarms to either verify a compressor failure, or prove the state of a good compressor. All tests described should only be performed for short periods.

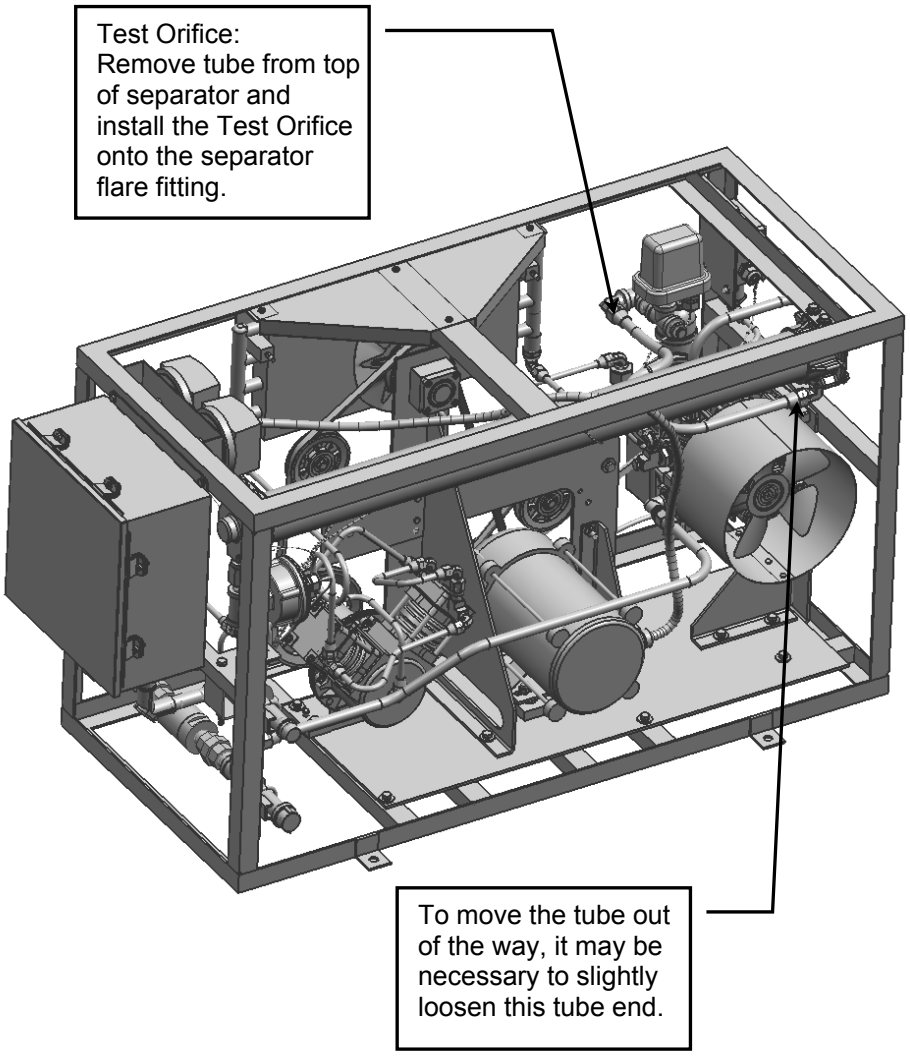
CAUTION: during these tests, gasoline vapors may be emitted; always use caution around gasoline vapors; be sure that there are no near by ignition sources before performing these tests. NEVER test when in violation of local regulations. **If tubing is removed during testing, ALWAYS be sure that all tubing in reinstalled and fittings are tight before restarting unit.**

NOTE: for these compressor tests, it is required to disconnect the compressor inlet from the gasoline storage tank so the compressor is only pumping air; pumping gasoline vapor may create a safety hazard as well as affecting the readings because of the difference in density of air and gasoline vapor; testing on air will ensure consistent results.

To make a Test Orifice, use Parker 5/8" SAE 45° flare cap p/n 640F-10 and drill orifice through top of cap (0.078 inch, 2.0 mm, 5/64 inch, #47).



CAUTION: during these tests, gasoline vapors may be emitted; always use caution around gasoline vapors; be sure that there are no near by ignition sources before performing these tests. NEVER test when in violation of local regulations. **If tubing is removed during testing, ALWAYS be sure that all tubing in reinstalled and fittings are tight before restarting unit.**



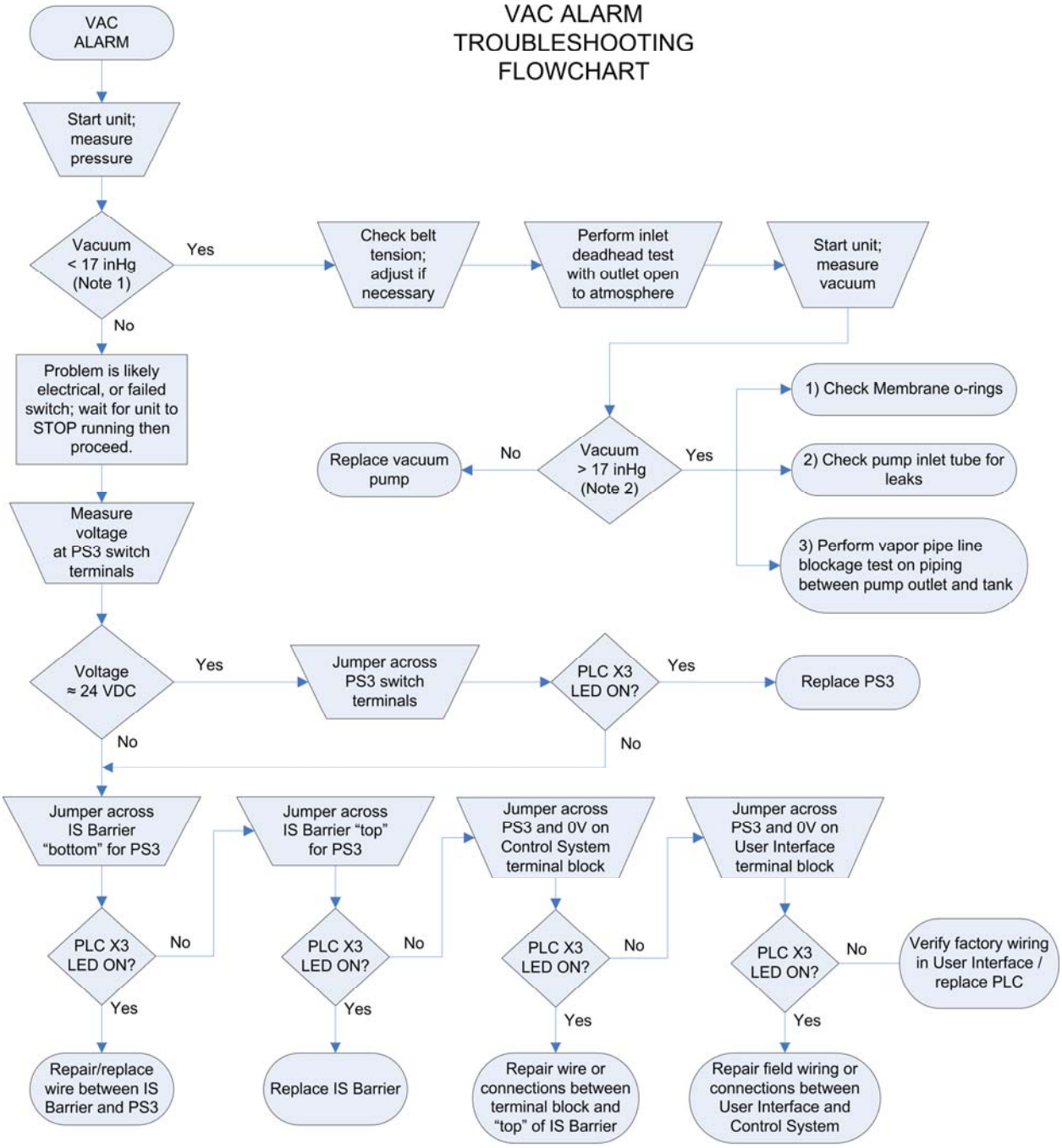
7.2 VAC ALARM (Vacuum Pump Alarm)

PS3 pressure switch does not close on three consecutive run cycles. Use pressure tap (1/4" NPT) on vacuum pump to install test gage (0-30 inHg or 0 to -1 bar) and measure vacuum.

VAC Alarm

Potential Alarm Cause	**Action**	**Result**
Motor service switch OFF	Verify switch and voltage	Turn switch ON, reset system
Drive belt loose and slipping	Visual Inspection of belt tension	Adjust idler (15-20 degrees)
Drive belt failure	Visual Inspection; Belt torn or worn	Replace belt
Vacuum pump failure	Pump shaft not turning; Extreme belt wear	Replace vanes or pump
Drive motor failure	Motor not spinning with power applied	Replace motor
Control System not holding vacuum		
Leaks in Control System piping	None of the above obvious on visual inspection	Inspect at all tube and pipe joints and tighten
Failure of vacuum switch (PS3); failure of I.S. module	A good switch and circuit will show: when closed approx 0 VDC across contacts; when open approx 24 VDC across contacts. Measure at switch, I.S. terminal block, and User Interface	Check and replace switch Check wiring Check and replace I.S. module
Damaged o-ring on membrane module or housing flange	Inspect o-rings on membrane module	Replace damaged o-rings

VAC ALARM TROUBLESHOOTING FLOWCHART



Note 1:
Vacuum < 17 inHg (-0.57 bar)
less deep vacuum; closer to atmospheric pressure; i.e. 8 inHg (-0.27 bar).

Note 2:
Vacuum > 17 inHg (-0.57 bar)
deeper vacuum; further from atmospheric pressure; i.e. 20 inHg (-0.68 bar).

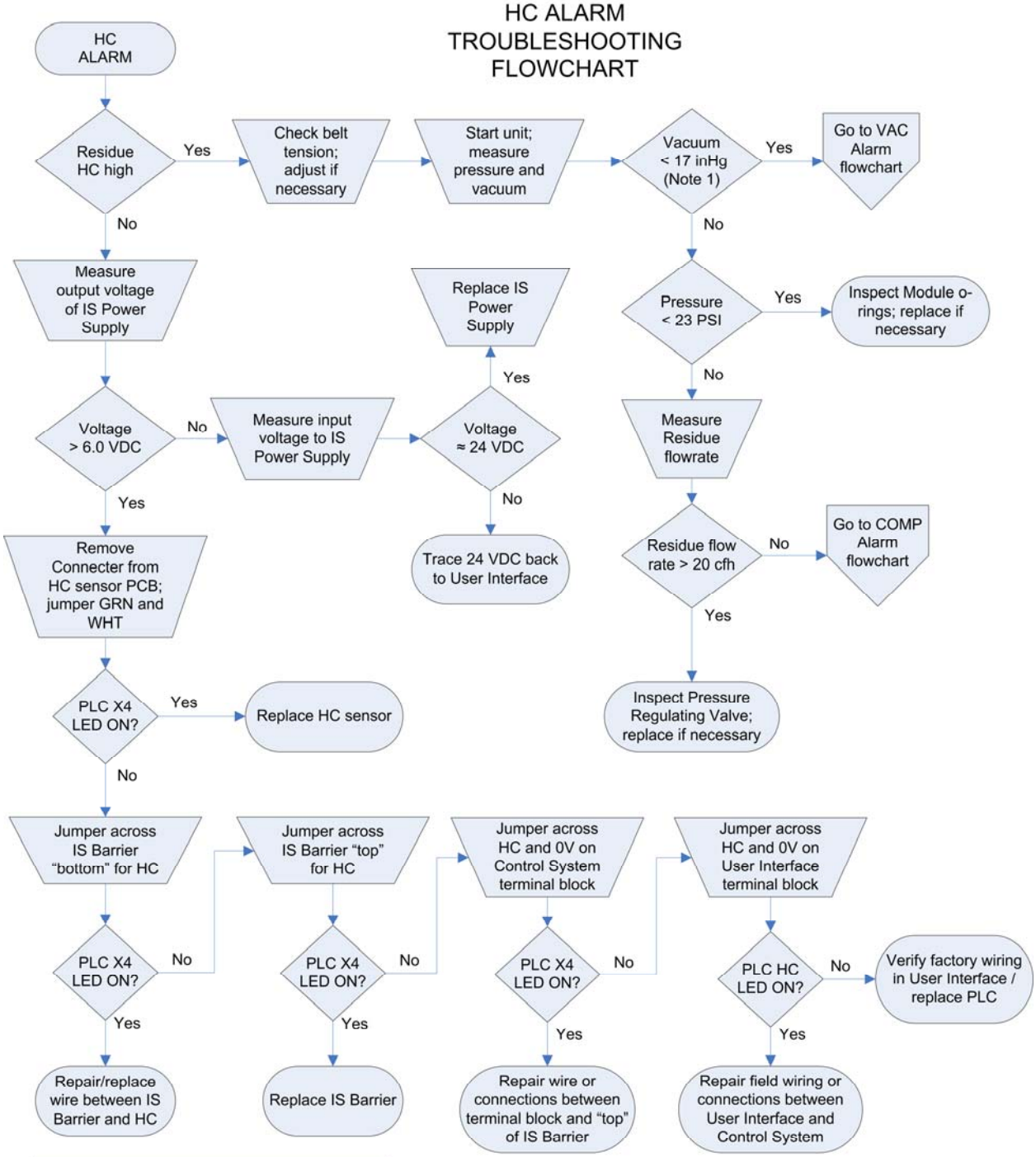
7.3 HC ALARM (Hydrocarbon Sensor Alarm)

HC sensor output shows high HC concentration for excessive time. If an HC Alarm occurs during a start-up Self-Test (and the pressures at PS2 and PS3 are good), try resetting the system several times. After a long period of non-activity of the Vaporsaver, stagnant hydrocarbon in the residue piping can linger creating a false alarm. It may take an extra Reset or two to purge out of the HC sensor. If all the other troubleshooting items referenced below do not clear a hydrocarbon sensor alarm, the only course of action is to replace the HC Sensor.

HC Alarm

Potential Alarm Cause	**Action**	**Result**
Pumps not performing as required	Check of pressure and vacuum	See Section 3.3
O-ring leak on module	Inspect o-rings on membrane module	Replace damaged o-rings
Membrane damaged	Inspect for liquid contamination. Research if recent UST overfill. Separator drain valve stuck closed.	Verify operation of all other components. Replace module if liquid contamination is present.
Membrane feed end cap loose	Inspect set screw tightness and epoxy	Replace module if feed end cap is loose or epoxy is damaged
Hydrocarbon Sensor failure	Verify last calibration date	Replace sensor Reset system

HC ALARM TROUBLESHOOTING FLOWCHART



Note 1:
Vacuum < 17 inHg (-0.57 bar)
less deep vacuum; closer to atmospheric pressure; i.e. 8 inHg (-0.27 bar).

Note 2:
Vacuum > 17 inHg (-0.57 bar)
deeper vacuum; further from atmospheric pressure; i.e. 20 inHg (-0.68 bar).

7.4 PR WARNING

PS2 and/or PS3 pressure switches have not reset (open) at the end of a run cycle. This warning is not a system shutdown.

Potential Alarm Cause	Action	Result
The motor relay has failed closed	Motor running continuously	Check and replace motor relay
Compressor pressure switch has failed closed	A good switch and circuit will show: when closed, approx 0 VDC across contacts; when open approx 24 VDC across contacts. Measure at switch, I.S. terminal block, and User Interface	Check and replace switch Check wiring Check and replace I.S. module
Vacuum switch has failed closed	A good switch and circuit will show: when closed approx 0 VDC across contacts; when open approx 24 VDC across contacts. Measure at switch, I.S. terminal block, and User Interface	Check and replace switch Check wiring Check and replace I.S. module

7.5 RT WARNING

This is caused by excessive run time. This warning is not a system shutdown. It is typically an indication to the station operator that the vapor space at the facility is extremely leaky or the A/L are improperly set.

Potential Alarm Cause	**Action**	**Result**
Excessive leaks in the facilities vapor piping	Verify facilities vapor tightness	Repair vapor leaks in the vapor piping and Stage I and Stage II fittings
A/L outside certified range	Verify A/L on all hose points	Repair/reset Stage II system components
Pressure switch failure (PS1)(PS0)	A good switch and circuit will show: when closed approx 0 VDC across contacts; when open 24 VDC across contacts. Measure at switch, I.S. terminal block, and User Interface	Check and replace switch Check wiring Check and replace I.S. module

7.6 PLC Error

If the red ERROR LED on the PLC is lit, this typically means that the PLC has a clock error. The normal solution is to set the clock from the User Interface and cycle the power to the unit. The software has a clock recovery routine that will typically clear the PLC error. If this does not resolve the PLC error, it may be necessary to replace the PLC.

8.0 Control System Maintenance

The OPW Vaporsaver is designed to require very little scheduled maintenance. The following table is a general guide of what is required.

8.1 Recommended Maintenance

1. Every 36 months, the Hydrocarbon Sensor must be returned to OPW for calibration. There are no serviceable parts in the Hydrocarbon Sensor. The calibration of the Sensor can be verified by checking at two locations:
    a. The Hydrocarbon Sensor has a calibration label showing the calibration due date. Remove the Control System covers to access the Sensor.
    b. A second calibration label may be located on the side of the User Interface enclosure or Control System electrical enclosure. Also, when a Sensor is replaced in the field, the replacement sensor is supplied with a new calibration label on the Sensor and a second label to be placed by the installer on the User Interface enclosure or Control System electrical enclosure.
2. Every 12 months, inspect all belts for wear and proper tension. Only replace belts with same size and type as originally installed.
2. Every 12 months, check Control System operating pressure and vacuum readings.
3. Every 12 months, visually check the Control System for overall wear issues.
4. Every 12 months check total run time (TRT). If approaching or greater than the maximum hours stated in Section 8.4 replace pumps. Verify service records to ensure pumps have not already been changed.

8.2 Repair and Maintenance Interval

The OPW Vaporsaver is designed to require very little scheduled maintenance. The following table is a general guide of what is required. Please keep in mind that in most applications a single Vaporsaver manages the tank pressure for the entire site. In some cases the Vaporsaver is the station's vehicle of compliance to ORVR and EVR regulations. Repair and maintenance of the Vaporsaver, like all equipment, is inevitable. To ensure end-users can enjoy the benefits of the Vaporsaver's operation, whether in terms of compliance or for the quantifiable savings of fuel due to eliminated vapor emissions, all precautions to minimize down time must be taken. OPW recommends that the Vaporsaver have an allowable repair and maintenance interval not to exceed 72 hours. The allowable interval for your market may vary. OPW products should be used in compliance with applicable federal, state, provincial, and local laws and regulations. The 72-hour interval was arrived at using the following worst-case scenario:

1. Alarm sounds at station, contractor dispatched
2. Contractor arrives at site, Vaporsaver diagnosed, part unavailable locally
3. OPW Cincinnati ships part via Next Day Air on a Saturday
4. Sunday part in route
5. Monday part received by contractor, repair completed

OPW has many parts stocking distributors so the scenario above, though possible, should be the exception and not the rule. It's also important to note that should a Vaporsaver shutdown for any reason the facility will default back to the PV vent valve managing tank pressures, exactly how many sites throughout the world operate today.

In California, repair and maintenance intervals are subject to the interpretation of local Air Quality Management Districts (AQMD). Please contact your local AQMD for guidance in your specific District.

8.3 General Rules for Belt Tensioning

1. Ideal belt tension is the lowest tension at which the belt will not slip under peak conditions.
2. Set idler arms to 15-20 degrees.
3. Over tensioning belts shortens pump, bearing and belt life.
4. Keep belts free from foreign material that may cause slip.
5. Never apply belt dressing, as this will damage the belt and cause early failure.
6. Only replace belts with OPW specified belt size and type.
7. Over tensioning belts places extra load on the motor. An overly tight belt can add several amps to the motor loading.
8. IMPORTANT: After changing or adjusting belts, always measure the motor full load amperage; it must be less than the full load rating of the motor.

8.4 Component Replacement

The User Interface has a totalizer (TRT: total run time since first installed) that is part of the continuous scrolling screens. This totalizer shall be used for the following maintenance/replacement items:

1. It is recommended that the compressor pump be replaced at approximately 6500 hours of operation, and is required to be replaced before 8,500 hours of operation.
2. It is recommended that the vacuum pump be replaced at approximately 10,000 hours of operation, and is required to be replaced before 12,000 hours of operation.
3. The Membrane Module may need to be replaced at approximately 15,000 hours of operation.

8.5 Spare Parts

14-40010: Drain valve
14-40015: Fan assembly
14-40200: Membrane module replacement assembly (with o-rings)
14-40300: PLC
14-40350: Display (LCD)
14-40400: Power supply (User Interface)
14-40401: I.S. Barrier (1 channel)
14-40402: I.S. Barrier (2 channel)
14-40406: I.S. Power supply
14-41002: Motor (UL, 60 Hz)
14-41003: Motor (UL, 50 Hz)
14-41033: Motor (ATEX, 60 Hz)
14-41034: Motor (ATEX, 50 Hz)
14-41035: Motor (KHK 50/60 Hz)
14-41121: Pressure switch (PS2)
14-41225: Pressure regulator
14-41240: Compresor (UL)
14-41241: Vacuum Pump (UL)
14-41267: Compressor (ATEX, KHK)
14-41268: Vacuum Pump (ATEX, KHK)
14-42700: Pressure switch (PS3)
14-44002: Hydrocarbon sensor
14-44300: Belt, compressor
14-44400: Belt, vacuum pump
14-48231: Pressure switch (PS0)
14-48230: Pressure switch (PS1)
14-55000: O-ring kit for membrane module

Contact OPW Fueling Components Customer Service or Technical Support for other available spare parts kits.

9.0 Testing Requirements

1. OPW requires that all tests listed in this section be completed to ensure that the facility meets all the necessary requirements for proper operation on the Vaporsaver.
2. All tests referenced in this document are to the current revisions of the approved procedures in California. Other states or countries may require the use of alternate approved methods. Always verify with the local authority having jurisdiction the applicability of CARB or other approved test methods.
3. To ensure proper operation of all vapor recovery components and systems (including the Vaporsaver) the entire vapor system (piping, tanks, valves, dispensers…) at a minimum must be able to pass:
    a. Pressure Decay (CARB TP-201.3)
    b. Tie Tank (CARB TP-201.3C)
    c. Dynamic Back Pressure (CARB TP-201.4)
    d. A/L (CARB TP-201.5)
    e. Always follow local authority requirements
4. During Pressure Decay Test (CARB TP-201.3), the Vaporsaver must be powered off.
5. During Tie Tank Test (CARB TP-201.3C), the Vaporsaver must be powered off.
6. During Dynamic Back Pressure Test (CARB TP-201.4), the Vaporsaver must be powered off. The Vaporsaver should not be used with any flexible vapor or vent piping.
7. During Air/Liquid (A/L) ratio testing, the Vaporsaver can be either on or off, as it has no impact on the testing. Typically the Vaporsaver is left powered to help in controlling the vapor growth associated with air ingestion and liquid return during A/L testing.
8. Other testing may be required by the local authority for other vapor system components, systems, or sub-systems:
    a. During Leak Rate of Drop Tube and Drain Valve Assembly Test (CARB TP-201.1C), the Vaporsaver can be either on or off, as it has no impact on the testing. Typically the Vaporsaver is left powered to continue controlling storage tank pressure.
    b. During Leak Rate of Drop Tube Overfill Prevention Devices and Spill Container Drain Valves Test (CARB TP-201.1D), the Vaporsaver must be powered off.
    c. During Leak Rate and Cracking Pressure of Pressure/Vacuum Vent Valves Test (CARB TP-201.1E), since the pressure/vacuum vent valve is removed from the vapor system, the Vaporsaver must be powered off.
    d. During Static Torque Test (CARB TP-201.1B), the Vaporsaver can be either on or off, as it has not impact on the testing.

Vaporsaver 1

Start-up Information

This form must be completed and submitted to and approved by OPW for activation of Warranty. Submit form to OPW Technical Services.

OPW Customer Service / Technical Services
9393 Princeton-Glendale Road
Hamilton, OH 45011
Fax: 800-421-3297

STATION INFORMATION:

Station Name and Number:					
Street Address:					
City:					
State or Province:		Zip Code:		Country:	
Station Phone:					
Station Fax:					
Contact at Station:					

PURCHASING / INSTALLATION INFORMATION:

Distributor:					
Installation Company:					
Address:					
City:					
State or Province:		Zip Code:		Country:	
Job Site Supervisor:					
Installation Certification #:					
Installation Date:					

Vaporsaver 1

START-UP INFORMATION:

Start-up Company:					
Address:					
City:					
State or Province:		Zip Code:		Country:	
Start-up Technician:					
Start-up Certification #:					
Start-up Date:					

EQUIPMENT INFORMATION:

User Interface Serial Number:	
Control System Serial Number:	
Wire Gage between Breaker and Control System:	
Wire Length between Breaker and Control System:	

	Quantity	Pressure/Vacuum Ratings
Pressure/Vacuum Vent Valves:		
Storage Tank Over Fill Prevention Type: (i.e. overfill valve, ball floats, audible alarm)		

EQUIPMENT OPERATION:

	Volts	Amps
Measured at User Interface (L1 and L2):		

	Volts	Amps
Measured at Control System (T1 and T2):		

Vaporsaver 1

START-UP CHECK LIST:

Y/N:		
		Clock is Set on User Interface
		Station Information is set in User Interface
		ISD Test Enabled (Only if Part of CARB Certified Phase II EVR System)
		Daylight Savings Enabled
		Control System starts when storage tank has pressure has reached PS1 set point
		Control System stops when storage tank has pressure reached PS0 set point
		Piping slope between Control System and vents meets requirements (1/4” per foot)
		Electrical insulation test performed (Megometer)
		NPT conversion fittings (if applicable for international installations)
		Galvanized or corrosion protected piping (internal and external corrosion protection)
		All wiring connections verified on User Interface and Control System
		Control System protection (vehicle bumper posts, fences…)

Vaporsaver 1

Submit results of the following tests:

CARB TP-201.3: Determination of 2 Inch WC Static Pressure Performance of Vapor Recovery Systems of Dispensing Facilities

CARB TP-201.3C: Determination of Vapor Piping Connections to Underground Gasoline Storage Tanks (Tie-Tank Test)

CARB TP-201.4: Dynamic Back Pressure

Exhibit 5 of the latest applicable CARB Executive Order: Determination (by Volume Meter) of Air to Liquid Volume Ratio of Vapor Recovery Systems of Dispensing Facilities

Note: The above tests can be the same tests that are performed as part of local regulation or permit conditions. Tests do not need to be repeated. The above tests do not need to be completed during the actual Vaporsaver start-up, but can be complete before or after in conjunction with the testing required by the local authority. Results of these tests must be supplied to OPW Technical Services Department. Some states may require the use of alternate approved methods. Always verify with the local authority having jurisdiction the applicability of CARB or other approved test methods.

Site Layout Diagram: