REMEDIATION SERVICES, INT'L

Phoenix S.A.V.E.™ System

Operations & Maintenance Manual, Version 8.xx

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Operator Safety

1. Make sure that all guards, shields and shrouds originally installed on the machine are properly in place and in good working order.
2. Make sure that the fire suppression system is properly charged.
3. The unit is to be operated by one person only. Keep everyone except authorized personnel away, while the machine is operating.
4. Never touch the exhaust system, its support assembly, or the exhaust duct.
5. Keep hands away from moving parts while the unit is running.
6. Operate machine in adequately ventilated areas only. Carbon monoxide is a dangerous gas that can cause serious injuries or death.
7. Use extreme caution when handling Liquid Propane Gas (LPG) fuel and store the LPG in approved containers only.
8. Wear ear protection when operating equipment or in immediate area of the unit.
9. Be sure that the machine housing is bolted to the transporter before moving.

Area Control And General Safety

1. Smoking is prohibited, at all times, in venting area.
2. Start up and maintenance personnel will keep a fire extinguisher readily available at all times.
3. When the machine is being started or being serviced, access to the machine and the work area will be limited to maintenance personnel ONLY in order to reduce the possibility of physical injury to visitors or the public.
4. The operator or maintenance technician is responsible for keeping unauthorized person(s) out of the area. Authorized visitor(s) will be instructed to remain clear of Remediation Unit until they have been briefed on safety.
5. When the unit is operating unattended, it must be secured on all sides by a chain link fence, cement block wall or other security barrier. The door to the area will be securely locked.

In The Event Of An Emergency

REMEDIATION SERVICE, INT'L knows of no circumstance associated with the vapor recovery operations of this device that could result in the need for evacuation of the area, other than an the alternate fuel source leak.. Only occurrences not associated with the vapor recovery operation such as fire in an adjacent building, a nearby automobile collision or a natural disaster might necessitate evacuation.

Maintenance personnel, if present and time allows, shall carry out the following steps in the event of an emergency:

1. Turn off engine ignition.
2. Turn off all electronic monitoring equipment.
3. Close valves on propane tank.
4. Disconnect engine from extraction well.
5. Ensure that the public remains at least 50 feet from area.

Otherwise, follow the steps below:

1. Press the EMERGENCY STOP button.
2. Shut off supplemental fuel (Liquid Propane Gas and/or Natural Gas Lines).
3. Vacate the area.
4. Ensure that the public remains at least 50 feet from area.

In An Extreme Emergency

1. Vacate the area and seek any necessary assistance.
2. Perform the above functions only as the operator's personal safety and the general public safety allow.

Chapter

2

WARRANTY INFORMATION

Limited Warranties

Manufacturer warrants the equipment against defective parts or workmanship for a period of six months from the date of delivery, provided that Buyer engages Manufacturer, at Buyer's own expense, to perform an on-site functional test and user orientation prior to initial system operation. Engines, sparks plugs, wires, filters, catalytic converters, accessory items, etc. may have useful lives that are shorter than the warranty period, depending upon physical conditions which exist during use of the product. Warranty claims for parts, which have failed due to a shortened useful life, will not be honored under this warranty. Manufacturer's liability under this warranty is limited to repairing or, at Manufacturer's sole option, replacing the equipment which meets the defective parts and workmanship criteria. All repairs shall be performed at RSI's office, and Buyer shall be responsible for shipment of the equipment to and from RSI's office. In the event repairs are required during the warranty period as a result of the failure of Buyer to perform the minimum periodic maintenance prescribed by Manufacturer, Buyer agrees to pay for such maintenance service and parts at Manufacturer's then current rates.

This warranty shall be void as to any equipment damaged or rendered unusable by the willful act, negligence, tampering, or modification by persons other than Manufacturer, including such damage caused by the use of auxiliary equipment not provided by Manufacturer. Manufacturer assigns to Buyer the benefits of any warranties or guarantees provided to Manufacturer by the manufacturer(s) of any of the equipment components.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ALL OTHER WARRANTIES (WHETHER WRITTEN, ORAL OR IMPLIED) INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

BASE UNIT COMPONENTS

Chapter

3

BASE UNIT COMPONENTS

Alternator & Battery

The alternator used on the RSI I.C. engine is a single wire system with an built-in voltage regulator. Because the alternator is such an important component in the electrical system, it is recommended that the performance of the alternator be monitored. At every service, monitor the voltage output of the alternator. If a continuous drop in voltage is noticed, it is recommended that the alternator be replaced. Replacing the alternator prior to failure reduces the risk of damage to other components and unnecessary downtime. The battery installed with your I.C. engine is specified to exceed the requirements of the standard operating parameters of the electrical system.

Note ! The Alternator is manufactured to RSI specifications. Do not replace the alternator with anything except an official RSI Alternator.

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Automatic Oil Level Regulator

The engine is equipped with a reservoir, and an automatic valve maintains proper engine oil level for extended unmanned operation. The V3 or V4 must be placed in a level position for this component to operate correctly.

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TROUBLESHOOTING – SEE PAGE 43
AND SEE MURPHY SHUTDOWN CONDITIONS, APPENDIX B

Carburetor

The RSI designed Phoenix 1000 carburetor system is controlled by the Phoenix 1000 S.A.V.E. Controller. The carburetor is unique in design in that it allows for two fuel sources and two air sources to be blended in such a way that the engine will always favor the waste stream over the alternate fuel (propane or natural gas) while at the same time maintaining a given RPM and controlling emissions.

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Catalytic Converter

The catalytic device installed is an automotive type with non-replaceable monolithic elements. This device requires no maintenance; however it will need to be replaced periodically. For example, although the manufacturer states that a 4,000-hour operating life is achievable, replacement may be necessary much earlier due to certain site conditions.

The Catalytic Converter has five distinctive components:

1. Pre-Cat Temperature Gage – This device measures the Exhaust Temperature before the exhaust reaches the Catalytic Converter.
2. Catalytic Converter.
3. Post-Cat Temperature Gage – This device measures the Exhaust Temperature after the exhaust has passed through the Catalytic Converter.
4. Two Pre-Cat Sample Ports – These ports allow for measurement of the Exhaust Pressure and or emissions before the exhaust reaches the Catalytic Converter.
5. Post-Cat Sample Port – This port allows for measurement of the Exhaust Pressure and or emissions after the exhaust reaches the Catalytic Converter.

Recommendations!

RSI suggests monitoring the exhaust temperature, pre and post catalyst, under a "static" condition in order to establish and document the engine's Normal readings.

A "static" condition is defined as:

1. the engine is warmed up and running at the Set Point RPM,
2. the Exhaust Temperature is at its stable operating temperature (greater than 650 degrees °F), and
3. no well gases are being processed. (Insure the RSI V3 or V4 is disconnected from any and all wells before taking readings).

If the Automotive Catalytic Converter is operating properly, the conversion/oxidation of CO, NO_x and VOC from the engine will cause a slight temperature rise across the catalyst. In other words, the temperature at the Post-Cat Temperature Gage will be higher than the temperature at the Pre-Cat Temperature Gage.

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Controller

The designed Phoenix 1000 Controller is a microprocessor based engine air/fuel ratio controller with data logger and telemetry functions. The engine and all related components and modules are totally controlled by the Controller system.

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TROUBLESHOOTING – SEE PAGE 47
OTHER RESOURCES – SEE \RSI MANUALS\PHOENIX HOST SOFTWARE

Controller Compartment Cooling & Filtering

The controller compartment houses the Phoenix Controller, the Breakout PCB, the optional Modem, cables and other optional electronic components. The compartment is cooled separately from the main engine compartment through the use of a muffin fan. Separate air/particulate filtering is provided by use of a foam automotive style filter.

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Electronics

Each engine includes a state-of-the-art Phoenix Controller for monitoring and process control of the remediation process. Optional data acquisition and storage, remote valve control, remote start/stop, and remote telemetry features are also available. The interconnect system is comprised of a Breakout PCB and an additional Power Distribution PCB which uses D-connector, keyed power connector and terminal block connections.

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Engine

The I.C. engine is an industrial version 460 C.I.D. Ford Model LSG-875, modified and remanufactured to RSI specifications. The engine is totally controlled by the Phoenix 1000 S.A.V.E. Controller computer system. The engine serves as both a vacuum pump and as a means of destroying hydrocarbon vapors removed from the soil. The internal combustion engine is a specially manufactured industrial type capable of being co-fired by propane or natural gas. Halogenated compounds and chlorinated chemicals are not appropriate for destruction with the RSI I.C.E. The engine is outfitted with an emission control system, including a catalytic converter, fully automated controller/carburetor system with proportioning valves for continuous automated control of well vapors, alternate fuel and dilution air. The engine is equipped with an automotive style muffler for noise control; an automatic oil level device and automotive type cartridge filters.

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Engine Cooling

Engine cooling is accomplished through the use of an oversized radiator cooling system to insure safety and long life. There is an overflow reservoir installed for checking the coolant level and filling the radiator. A standard 160 degree automotive thermostat comes installed in the engine.

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Fire Suppression System (Automatic)

One (1) automatic **Kidde IND 21** Dry Chemical Suppression System, with two (2) rate compensated thermostats and manual actuator are included in the Base Model. The Kidde IND 21 Dry Chemical Suppression System includes a standard dual nozzle distribution system.
The system is intended for use as fire suppression equipment on heavy-duty vehicles that are used in both "on-road" and "off-road" applications. The system consists of:

1. one stored pressure cylinder which contains 21 pounds of tri-class (ABC) dry chemical extinguishing agent,
2. manual and electric activating devices for discharge of the agent, and
3. an arrangement of flexible hoses and nozzles which delivers the fire suppressing agent to the engine compartment.

The dry chemical is not toxic. However, combustion gases from fire are poisonous and must not be inhaled. The Dry Chemical Kidde Ind 21 Fire Control system will discharge automatically when specific events occur. For example, the Fire Control system will automatically discharge if the temperature in the Engine Compartment rises faster than the pre-determined rate set in the system or reaches a higher than allowable temperature. However, if a fire is detected anywhere in the unit, do not wait for the internally supplied system to discharge automatically. Pull the safety pin out of the electro-mechanical actuator and strike hard (pushing inward) on the actuator knob. Leave the unit and stand by with a portable extinguisher.

Caution: Do not attempt to open the engine compartment until the Fire Department arrives, or the housing has cooled down and no signs of fire exist.

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TROUBLESHOOTING – SEE PAGE 53
OTHER RESOURCES - \VENDOR MANUALS\KIDDE FIRE CONTROL MANUAL

Flow Measurements

The Phoenix Controller estimates the extracted Well, Dilution Air, and Supplemental Fuel Flow. The Phoenix Controller displays the estimated scfm (standard cubic feet per minute) rate in the status window. A more accurate flow device is available for all process flows as an option. The Velocity Probe Interface Kit and Flow Box are connected between the well and the Phoenix Controller. The actual well volume readings are d isplayed and recorded in the Phoenix Controller. See Flow Box Manual for complete information.

OTHER RESOURCES - \RSI SOFTWARE\PHOENIX FLOW BOX TECHNICAL MANUAL
- \VENDOR MANUALS\UNITED SENSOR PROBE

Frame And Housing

Unitized frame and housing of heavy gauge sheet metal, with "slide-in/slide-out" engine capability. Cabinetry and certain other components are powder coated for durability and appearance. The cabinets feature large lockable access doors for easy maintenance and operation. The cabinet has been designed to achieve the best balance between service capability, noise reduction and security.

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Propane/Natural Gas Flow Meter

A positive displacement totalizing mechanical flow meter is installed on the unit to mechanically measure fuel usage. An optional Magnetic Reader is also available. This Magnetic Reader electronically senses the fuel flow rate. The information is displayed and recorded in the Phoenix Controller.

Spark And Flame Arrester

A spark arrester is installed on the engine exhaust to protect the well gas source from any flash back from the engine. There is an additional flame arrester pad located in the carburetor adaptor plate located between the carburetor and intake manifold. There are two types used depending upon system configuration. One that is mounted inside the intake manifold adaptor housing which is used for standard units, and the the other that is self-contained and installed in between the intake manifold and the carburetor. The second one is used for units that operate under load (i.e. generator or load modules are installed).

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Supplemental/Alternate Fuel Control System

The V3 and V4 models are plumbed to use both Propane (LPG) and Natural Gas fuels depending on your preference. . The Phoenix Auto-Fuel Control system is an electro-mechanical system that manages the flow of the fuel and air to the engine. The Phoenix 1000 S.A.V.E. Controller automatically adjusts the supplemental fuel flow to compensate for changing influent hydrocarbon concentrations and maintains an air/fuel ratio at or near stoichiometric combustion. The goal of the Supplemental Fuel Control system is to provide the minimum amount of alternative fuel needed so that the engine favors contaminants drawn from the well.

Supplemental fuel may be either Liquid Propane Gas (LPG), or Natural Gas delivered at 7"-10" H_2O pressure. **Consult RSI for any other type of fuel configurations.**

Liquid Propane Gas (LPG)
Use liquid withdrawal LPG tanks with no pressure regulator. The V3/V4 unit is equipped with a propane regulator/vaporizer system that will convert liquid propane to vapor and reduce pressure to specified operating conditions. Do not draw liquid propane fuel from bottom tank fittings because oil and other contaminants may be present, and may void part or all of the warranty. Insure that propane tank is emptied and cleaned prior to installation. An external 3/8" propane male NPT fitting is provided for ease of connection to a supplemental propane fuel source.

Natural Gas
Natural gas can also be used with RSI V3 and V4 remediation systems. The natural gas fuel is supplied to the RSI V3/V4 engine through an existing 1" female NPT three-way ball valve/engine. The natural gas supply must be regulated to approximately 1/4 psi, or 7" - 10" H2O WC (household) pressure. Flow is controlled by a normally closed solenoid valve. The customer supplies the natural gas and pipe fittings needed to connect to the RSI unit.

Important !
THE PROPANE OR NATURAL GAS SUPPLY LINE MUST BE CLEARED OF ANY AND ALL DEBRIS BEFORE USE. THE LEADING CAUSE OF FAILURE IN THE LPG VAPORIZER IS "DIRTY" FUEL. WHEN SELECTING AN LPG FUEL SUPPLIER, INSIST THAT THE STORAGE TANK BE NEW, OR THAT THE STORAGE TANK BE CLEANED AND FREE OF OIL. THE STORAGE TANK MUST PROVIDE TOP LIQUID DRAW FITTINGS. MAKE SURE THAT THE SUPPLIER DELIVERS LPG FUEL WHICH IS FREE OF OIL. MAJOR ENGINE DAMAGE CAN OCCUR FROM "DIRTY" PROPANE. THE WARRANTY ON THE ENGINE AND RELATED COMPONENTS IS VOID WHEN HEAVY DEPOSITS OF PROPANE OIL ARE FOUND IN THE FUEL SYSTEM.

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OTHER RESOURCES – \VENDOR MANUALS/IMPCO MANUAL

Well Gas Filter Housing And Water Trap

The system includes a well gas filter and small (1 gallon) water trap with high-level shutoff switch. Larger capacity tanks for Dual-Phase Extraction and condensate knockouts are available as an option. An auto-drain feature is available as an option on all models. For more information, see the section on Optional Components.

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Well Gas Hose

A 2"x 15' well gas vacuum hose is supplied for connecting the well gas filter housing to the extraction manifold. Hose connection to the well gas filter housing is via a 2" male cam-lock located on one end of the hose. The other hose end is connected to the plumbing manifold supplied by the customer via a 2" female cam-lock connection.

Chapter

4

OPTIONAL COMPONENTS

BASE UNIT/OPTIONS DIMENSIONS	V3		V4	
	SIZE	LBS	SIZE	LBS
Base Unit - Dimensions	13'5"L x 6'4"W x 5'5"H	2260#	17'5"L x 6'4"W x 5'5"H	4420#
With Spray Aeration Module	17'5"L x 6'4"W x 8'0" H	3210#	23'5"L x 6'4"W x 8'0" H	5370#
With Cat Ox Module	17'5"L x 6'4"W x 8'0" H	3245#	23'5"L x 6'4"W x 8'0" H	5405#
With Spray Aeration & Cat Ox Modules			27'5"L x 6'4"W x 8'0" H	6355#
GenSet Module		+ 580#		+ 580#
Load Blower Assembly Module		+ 490#		+ 490#
Stand (If no Transporter is used.)		+ 185#		+ 185#
Transporter, Single Axle	13’L	540#	13’L	540#
Transporter, Dual Axle (Note 1)	17’L	740#	17’L	740#
Transporter, Triple Axle (Note 2)	23’L 27’L	940# 1140#	23’L 27’L	940# 1140#

Note 1: Equipped with either surge or electric brakes
Note 2: Available with electric brakes only

Air Compressor Module

This option is an engine driven air compressor capable of delivering 12.4 scfm of air at 100 psi. This module is commonly used to provide compressed air to downwell pneumatic pumps.

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Air Injection On/Off Valve Control

This option provides “ON/OFF” valve control using a 12-volt external relay control unit. The option will control up to 16 injection points (wells) and can be controlled either locally or remotely as desired. The user supplies the Solenoid valves.

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Cat-Ox Module

The patented RSI S.A.V.E.™ II high flow catalytic oxidizer module (CAT-OX) is unique in that it uses the waste heat of an internal combustion engine to pre-heat an industrial catalyst for the destruction of hydrocarbon vapors recovered from contaminated soil. This differs from conventional catalytic oxidizer systems, as they require auxiliary fuel for catalyst pre-heating. The engine also provides power for the positive displacement blower and generates electricity for the instrument panel, control valves, and the controller. No outside electrical connections are required to operate the RSI S.A.V.E.™ II high flow CAT-OX.

The S.A.V.E.™ II CAT-OX is an exciting addition to the S.A.V.E.™ family which, under certain conditions, can triple the well flow rate capacity of the base system and increase the destruction rate of hydrocarbons with virtually no additional operating cost. The S.A.V.E.™ II CAT-OX has two oxidizers operating individually and in parallel with each other, not in series (either/or) as conventional thermal/catalytic oxidizers do.

The S.A.V.E.™ II CAT-OX has been designed to mount on the end of the optional dual axle trailer that also houses the base S.A.V.E.™ system. The moisture knockout tank is a stand-alone device and is not mounted to the trailer. It is connected via 3" well gas hose to the intake of the positive displacement blower. The cabinet is built with space needed to mount the additional components necessary in operating the CAT-OX. All new S.A.V.E.™ systems can accept a CAT-OX module and its related components at a later date, if desired.

The S.A.V.E.™ II high flow CAT-OX was developed as an addition to the existing internal combustion engine based vapor recovery and water treatment system known as the S.A.V.E.™ System, and does not operate on a stand-a-lone basis. The patented base S.A.V.E.™ Systems are developed to extract gasoline and its vapors from the soil and groundwater. The four, six or eight cylinder internal combustion engines use recovered gasoline vapors as fuel. If insufficient fuel is available, auxiliary fuel such as propane or natural gas is supplemented to achieve the correct air/fuel ratio for complete combustion to occur. The mechanical work produced by the engine supplies power to all components and produces waste heat utilized by the CAT-OX.

The catalyst used in the S.A.V.E.™II CAT-OX is made up of a high cell density ceramic or metal substrate that has been coated with platinum group metals. The ceramic or metal substrate provides the support and surface area needed by the catalyst to provide high volumetric activity, low-pressure drop, and long service life. The catalyst was designed for high solvent oxidation efficiency with superior resistance to deactivation.

The heat produced by the exhaust of the engine is utilized by the CAT-OX to pre-heat the internal catalyst. The waste exhaust heat mixes with a pre-heated vapor stream extracted from the soil via a positive displacement blower. A heat exchanger pre-heats the incoming vapor using the CAT-OX stack effluent. The combined exhaust and vapor pass through an industrial catalyst where the unburned hydrocarbons are oxidized creating a temperature rise across the catalyst. The products of oxidation, carbon dioxide and water are then discharged to the atmosphere.

The total flow rate through the CAT-OX is a function of the exhaust heat as well as hydrocarbon concentration and its heating values. At a low concentration of hydrocarbons (less than 2% LEL of fresh gasoline) less heat is available from the combustion of the hydrocarbons to pre-heat the inflow vapor stream and maintain required temperature in the CAT-OX, therefore, the total flow must decrease to achieve operational equilibrium. If the hydrocarbon concentration is higher than 25% LEL, then the well flow rates will be reduced to insure over heating conditions do not occur.

Weathered hydrocarbons generally have a lower heating value which, when passed through the catalyst, produces a lower temperature rise than the same concentration of fresh hydrocarbons. The concentration of hydrocarbons and/or flow rate must be decreased when treating a vapor stream with a high heating value, as the post-catalyst temperature may reach its high limit because of a higher temperature rise across the catalyst. This is accomplished automatically using the Phoenix 1000 CAT-OX Controller.

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OTHER RESOURCES - \VENDOR MANUALS\JOHNSON-MATTHEY

Dual-Phase Extraction (DPE) Autodrain Module

This module is used for projects that require free product and/or groundwater removal in conjunction with high vacuum, Dual-Phase soil venting and groundwater extraction process. This module may also be used to store, and then discharge condensate that accumulates during the normal system operation. The Dual-Phase Extraction/Treatment module consists of a Vacuum Knockout Tank, Discharge Pump, Water Level Controls, and On/Off Relays (Safety Shutoff Switches) for process flow control.

The Dual-Phase Extraction (DPE) module with the auto-drain feature was introduced by RSI as a means to accomplish two separate tasks:

1. First, simply as an auto drain system to remove unwanted condensate from the process automatically. It works by separating entrained liquids that condense from the extracted air/fuel soil vapor during the normal soil vapor extraction (SVE) process. The "vapor phase" is directed into the internal combustion engine (ICE) for oxidation purposes, and the liquids are held inside the holding tank of the DPE module. Once the liquid inside the holding tank reaches a predetermined level, a pump (capable of overcoming the ongoing high vacuum SVE process) is turned on to discharge the liquid to a holding tank or an oil water separator, pending further treatment. If only water is present in the DPE tank, (in other words, no free floating product is present), the DPE module may discharge its contents directly into RSI's Spray aeration module for further treatment. Normally this process creates minimal amounts of liquid, for example 10 to 20 gallons per day.

2. A second use for the RSI DPE module is to purposely remove both liquids and vapors from the subsurface by applying a high vacuum to a one inch (1") diameter or smaller extraction "stinger" pipe located inside a groundwater/vapor extraction well. The high vacuum on the extraction pipe causes an increase in air velocity, which in turn "lifts" the liquid along with the vapor at varying rates, anywhere from 1 gpm (gallon per minute) to 10 gpm depending, upon site conditions and well construction. The "vapor phase" is directed into the internal combustion engine (ICE) for oxidation purposes, and the liquids are held inside the holding tank of the DPE module. Once the liquid inside the holding tank reaches a predetermined level, a pump (capable of overcoming the ongoing high vacuum SVE process and the rate of liquid influx) is turned on to discharge the liquid to a holding tank or an oil water separator, pending further treatment. If only water is present (in other words, no free floating product is present), the DPE module may discharge its contents directly into RSI's Spray aeration module for further treatment. If product is present, it must be removed first (usually by an oil water separator), and then the remaining dissolved contaminants can be treated by the Spray Tank Module.

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Genset Module

The GenSet Module consists of a direct drive generator powered by the onboard Natural Gas/Propane engine that is in turn controlled by the Phoenix Control System. The Genset Module provides a source of AC power for local and/or distributed power generation.

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OTHER RESOURCES - \VENDOR MANUALS\MARATHON ELECTRIC

Inlet And Exhaust Flow Measurement

The Phoenix Controller estimates extracted well, dilution air, and supplemental fuel flow and shows estimated scfm (standard cubic feet per minute) rate via the computer/processor display. It does so based on carburetor valve positions in relation to engine manifold vacuum.

A more accurate flow device is available for all process flows as an option and the information is displayed and recorded in the Phoenix Controller. The optional Flow Box module (hardware and software) provides exact measurements of the extracted well flow(s) based on established parameters such as atmospheric pressure, line pressure, temperature and pipe size. The RSI Flow Box hardware, when coupled with the pressure differential velocity probe, provides the ability to:

1. Measure the static line pressure, pressure differential, and temperature in a given flo w of gases
2. Compute the flow rate in various sizes of pipe corrected to standard cubic feet per minute (scfm) based on certain constants and measurements taken by the pressure differential velocity probe, and
3. Redefine the parameters/constants such as pipe size, moisture content, molecular weight of the flowing gases, and altitude/elevation for each of the flows monitored by the RSI Flowbox.

The RSI Flow Box Host Software (FBHost Software) provides the ability to:

1. Read process gas flows (in scfm) , gas temp eratures, line pressures and pressure differential for each flow measured, two per flow box, and
2. Receive and record all pertinent data into the Phoenix Controller for future download via a unique graphical user interface and PHHost Software.

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OTHER RESOURCES - \VENDOR MANUALS\UNITED SENSOR

Load Module

The load module comes in one of three designs: electric (requires generator), air (requires PTO), or hydraulic. The customer need determine which approach is most appropriate. In all forms, its basic function is to add “load”, or in other words, make the engine work harder than it does at idle RPM. This results in the engine requiring more fuel, and therefore more air. In general, it increases the system’s BTU throughput capacity directly in proportion to how much load is added. The operator has full control over the amount of load that can be added, or taken away.

Electric based load banks consist of the Genset module, plus an electrical automatic load bank. The load bank consists of varying sizes of heating elements, usually placed in front of the engine’s radiator fan for cooling purposes. The load bank allows the operator to determine the kW elements that are on at any given time and at the same time will automatically switch off load in favor of demand from another source such as a down well pump or area lighting as the case may be.

Air based units are simply large Roots RAI 68 positive displacement blowers made to discharge air at a high back pressure so as to add mechanical load to the engine.

The Hydraulic Load Module is by far the most favored approach. Loading the system is accomplished by adding a hydraulic pump driven by the existing engine, where hydraulic oil is pumped through a closed loop system consisting of a hydraulic oil reservoir tank, an air to liquid heat exchanger, a filter, a primary control valve and various other control valves. The total number of valves depends upon system configuration. All manually operated valves are preset at the factory for specific operating conditions and should not be adjusted without first consulting the manufacturer for guidance.

OTHER RESOURCES - HYDRAULIC LOAD MODUL E/..\VENDOR MANUALS\ROOTS URAI BLOWERS ..\VENDOR MANUALS\MARATHON ELECTRIC

Oil/Water Separator

The Oil/Water Separator module is available on a skid or trailer mounted as a pre-processing stage for the water systems. These are slant ribbed coalescing separator and skimmer units used to remove hydrocarbon based free product from the water stream.

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OTHER RESOURCES - \VENDOR MANUALS\MILTRONICS
\VENDOR MANUALS\PARKSON SEPARATOR

Positive Displacement Blower Module

Various models of Positive Displacement Blowers capable of injecting/extracting various amounts of air at varying pressures are available. The Positive Displacement Blower requires either the PTO or Genset Module options.

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OTHER RESOURCES – \VENDOR MANUALS\ROOTS POSITIVE DISPLACEMENT BLOWER

Power Take-Off (PTO)

Power Take-Off units are available with each engine to provide mechanical power to PD blowers, compressors and pumps.

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Project Manager Proportional Valve Control

This option provides Proportional Valve Control for up to 16 extraction points (Wells) and can be either locally or remotely controlled as desired.

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Spray Aeration Module

A specialized groundwater treatment system consisting of a Spray Aeration Tank, Water Circulation Pump, Water Level Controls, Liquid To Liquid Heat Exchanger (Electrical Heating Elements available as an option), Spray Nozzle and On/Off Solenoids for process flow control.

RSI's patented Spray Aeration system uses the same principles as conventional air stripper technologies. However the RSI Phoenix System enhances the stripping process:

1. by maximizing the surface area between groundwater and air using a finely atomized spray, and
2. by the introduction of heat and vacuum.

These improvements greatly enhance RSI's ability to remove contaminants from groundwater.

The Internal Combustion Engine (ICE) generates a vacuum. That vacuum lowers the overall operating pressure and enhances the transfer of organic contaminants from the groundwater to the Air Phase.

The Waste Heat generated by the Internal Combustion Engine (ICE) is used to increase the temperature of the contaminated groundwater. The higher temperature increases the transfer rate of the contaminants from the groundwater to the Air Stream (Air Stripping phase).

Water level in the Spray Aeration tank is maintained between 34 gallons and 55 gallons. The water in the Spray Aeration Tank is constantly re-circulated through a spray nozzle at 70 to 80 gallons per minute (gpm) with a backpressure of 15 to 30 psi. Actual values will depend upon Spray Tank Vacuum while in use.

An example of how a balanced process works is as follows:

1. If the flow rate from the ground is 10 gpm, then statistically the Phoenix unit will process 10 gallons of water 7 to 8 times through nozzle in the Spray Aeration Tank. If the flow rate from the ground is decreased, then the influent (contaminated groundwater) remains in the Tank longer and makes more passes through the nozzle in the Spray Aeration Tank.
2. Therefore, a flow rate of 5 gpm delivery rate will produce 14 to 16 passes through the nozzle in the Spray Tank, a flow rate of 2.5 gpm will allow 32 passes, and at 1 gpm about 64 passes..
3. Water is also discharged from the Spray Aeration Tank using the same pump used for re-circulating the Contaminated Water. Water is discharged from the Spray Tank by opening and closing a Solenoid Valve that is in turn controlled by the Float Control System. When the Solenoid Valve is opened, the re-circulating pump discharges a minimum of 10% of its flow capacity out of the Spray Aeration Vessel while continuing to process the remaining water.

Optimum performance can be achieved if:

- the water temperature is maintained at a minimum of 110 degrees °F,
- the Spray Tank Vacuum is maintained at 12" to 15" Hg, and
- the airflow though the Spray Aeration Tank is maintained at a minimum of 10 scfm.

If more airflow is dedicated to the air stripping process, removal efficiency will increase, but at the same time will limit the amount of process flow from the soil venting process.

MAINTENANCE – SEE PAGE 74
TROUBLESHOOTING – SEE PAGE 156
OTHER RESOURCES – \VENDOR MANUALS\ ***SEE FOLDERS LISTED BELOW*

\ASCO VALVE **\MURPHY PRODUCTS**
\BETE **\PERMBERTHY**
\MILTRONICS **\PRICE PUMP**
\SHERTECH

Telemetry/Modem

MAINTENANCE - \RSI MANUALS\PHOENIX HOST SOFTWARE
TROUBLESHOOTING MODEM – SEE PAGE 54

Transporter

A specialized heavy tubular frame single axle trailer with 2" ball (5000 lb. rated) and spare tire is available. A dual axle trailer with 2-5/16" ball (7000 lb. rated), with surge or electric brakes, is available as an alternative to the single axle trailer. A triple axle trailer with 2-5/16" ball (10,000 lb. rated) with electric brakes only is also available on special orders.

MAINTENANCE – SEE PAGE 82
OTHER RESOURCES - \VENDOR MANUALS\TRAILRITE MANUAL

Well Gas Condensate Vessel (Larger Capacity Options)

The standard model V3 and V4 systems include a well gas filter and small (1 gallon) water trap with high-level shutoff switch. Larger capacity tanks for Dual-Phase Extraction and condensate knockouts are available as an option. Extra capacity 30 gallon holding tanks which connect to the outlet of the standard well filter via a hose are mounted on a skid, pallet or set onto the ground. Trailer or skid mounted pre-knockout tanks can be installed for water collection before the standard well filter. An auto-drain feature is available as an option on all models.

MAINTENANCE – SEE PAGE 82
TROUBLESHOOTING – SEE PAGE 58

Chapter

5

SYSTEM OPERATION

Phoenix Engine Control System

The operating and maintenance procedures outlined in this manual are intended as guidelines to assist the operating personnel in the day-to-day operation and maintenance of this remediation unit and equipment. Operating personnel should always follow proper safety procedures in accordance with both industry safety standards and their own company safety policies when proceeding with operation, maintenance and repair of the equipment. This manual is neither designed nor intended as a substitute for safe operating procedures which must be followed while implementing the operation procedures outlined in this manual. It is assumed that operation and maintenance personnel are qualified and experienced. The primary responsibility for safety in the operation and maintenance of this system is with the owner-operator and the personnel conducting the maintenance and operation.

Phoenix System Components

The Phoenix Engine Control System consists of the following components:

a. Automatic Carburetor
b. Phoenix 1000 S.A.V.E.™ Controller (Control Panel)
c. Breakout PCB Interface
d. Servo (“Tank”) Valve (provided with optional spray aeration tank module)

Overview

The Phoenix Engine Control System (Controller) is designed to optimize cleanup from vapor extraction wells and optimize run time by automatically adjusting alternate fuel, dilution air, and process well valves. In Phoenix Engine Control Systems, which include the spray aeration module, the vacuum applied to the spray aeration tank is also managed by the Controller and the Servo (“Tank”) Valve to enhance the water treatment process.

The Phoenix Engine Control System (referred to as “Controller”) starts the engine running on a combination of air supplied through the Dilution Air Valve and Alternate Fuel (either LPG or Natural Gas) valve. The Controller continues to provide a mixture of Dilution Air and Alternate Fuel during the idle and warm-up periods. After the warm-up period has passed, and after the pre-cat temperature (the exhaust temperature before entering the Catalytic Converter) reaches 600 degrees °F, the system will automatically switch to “RUN” mode. Once the exhaust temperatures stabilize and a minimum two-minute period has lapsed, the Controller will switch to “O_2” Mode and then automatically begin opening the process/well inlet valve.

The Controller makes whatever adjustments are needed to maintain the set RPM and to hold a near stoichiometric fuel ratio in the engine. This means that while the well/process flow valve is opening, the Controller constantly adjusts the Alternate Fuel Inlet Valve (from the LPG or Natural Gas sources) and the Dilution Air Inlet Valve. If the well is very rich with high concentration of hydrocarbons, the Alternate Fuel Valve (from the LPG or Natural Gas sources) will eventually close to a predetermined minimum valve position. Once the fuel inlet valve reaches its minimum valve position, it causes the Well Valve to stop opening. On the other hand, if the process stream contains only a small amount of hydrocarbons, the Control system will close the Dilution Air Valve to a predetermined minimum valve position where it to will cause the well valve to stop opening. As the well conditions change, the system will continuously adjust the Valves (Well/Tank Valve, Air Fuel Valve and Dilution Valve) to maintain the maximum flow from the Well/Tank source while maintaining a correct air-fuel mixture.

If an optional Spray Aeration Tank (Air Stripping module) has been added to the unit, the Servo ("Tank") Valve must be present.. On these enhanced units, a Servo Valve (labeled "VAC" valve on the controller's display) is connected to the Controller. The quantity of air coming from the Well is controlled in order to maintain a certain vacuum on, and air flow from, the Spray Aeration Tank. The Controller has a "Set Point" value that is entered into the system during the initial start-up or installation of the system. During operation, the system compares the "Set Point" value for the spray tank vacuum stored in the controller with the actual Spray Aeration Tank vacuum reading and will open and close the Spray Aeration Tank valve (Servo Valve), as needed to maintain tank vacuum at the programmed set point. For more information, refer to Phoenix Set Points.

Servo ("Tank") Valve

The Servo ("Tank") Valve is a standard one-inch gate valve with a box containing a servomotor instead of a manual adjustment handle. The Servo "Tank" Valve is connected to the Controller Electrical Interface panel at the 9-pin connection labeled "Spray Tank Vacuum Control Valve" using a cable with connector as shown in Figure 2. The Servo ("Tank") Valve is installed upstream of any flow/vacuum measuring devices to insure accurate flow and vacuum measurements.

Automatic Carburetor

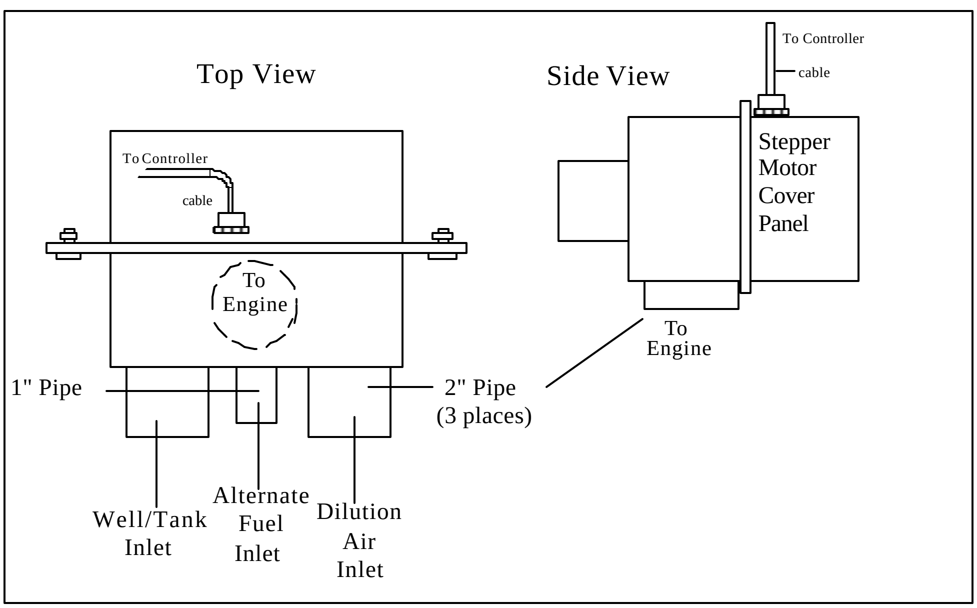


Figure 1. The Automatic Carburetor

Carburetor Interfaces

The automatic carburetor has five connection points: four pipe fittings and an electrical connector.

Hose/Pipe Connections

The carburetor, as depicted in Figure 1, is physically mounted to the Engine Intake Manifold in an upright position as shown in Figure 1 - side view. Three (3) Two -inch (2") pipe fittings are connection to the engine via vacuum rated, gasoline resistant hose at the following points:

- to the carburetor,
- to the Well/Tank
- to the Dilution Air Inlets

A one-inch (1") hose/pipe is used to connect the engine to the Alternate Fuel Inlet using gasoline resistance hose. The carburetor will accept either Propane (LPG) or Natural Gas.

Electrical Connections

There are also three stepper motors that control individual valves at the Dilution Air Inlet, Alternate Fuel Inlet and at the Well/Tank Inlet (process flow). The electrical connection between the Carburetor and the Phoenix Controller is a hard-wired pigtail cable with a 15-pin male connector and a separate ground wire that grounds the shielded cable. The cable is connected to the controller as shown, and the ground should be connected to the chassis of the controller to insure any electrical "noise" from the ignition system is filtered and sent to ground. The Carburetor is connected to the Controller Electrical Interface panel at the 15-pin connection labeled "Carburetor" as shown in Figure 2.

Phoenix 1000 S.A.V.E.™ Controller

The Phoenix 1000 S.A.V.E.™ Controller ("Controller") can be viewed from two perspectives.

1. The Controller Electrical Interface board at the bottom of the Controller is depicted in Figure 2.
2. The Controller Front Panel on the face of the Controller is depicted in Figure 3.

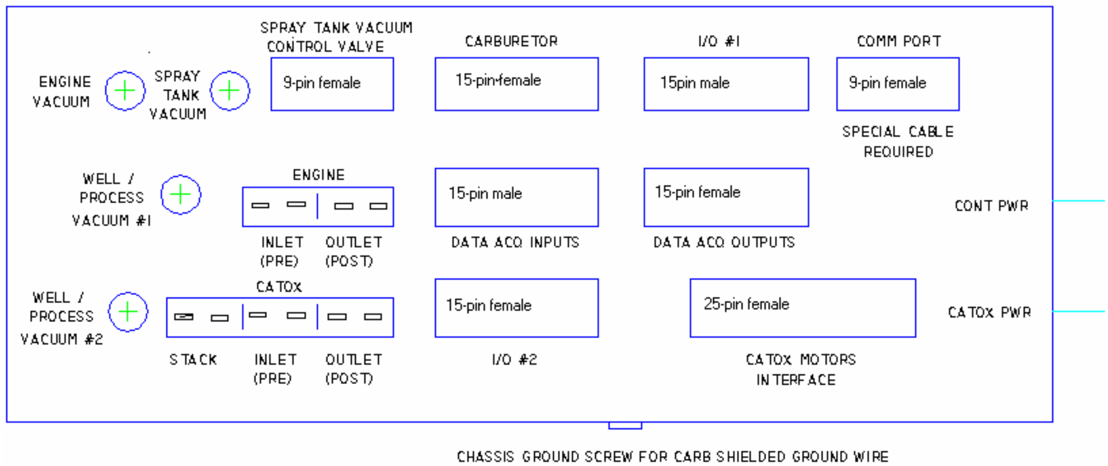


Figure 2. Controller Electrical Interface (bottom view)

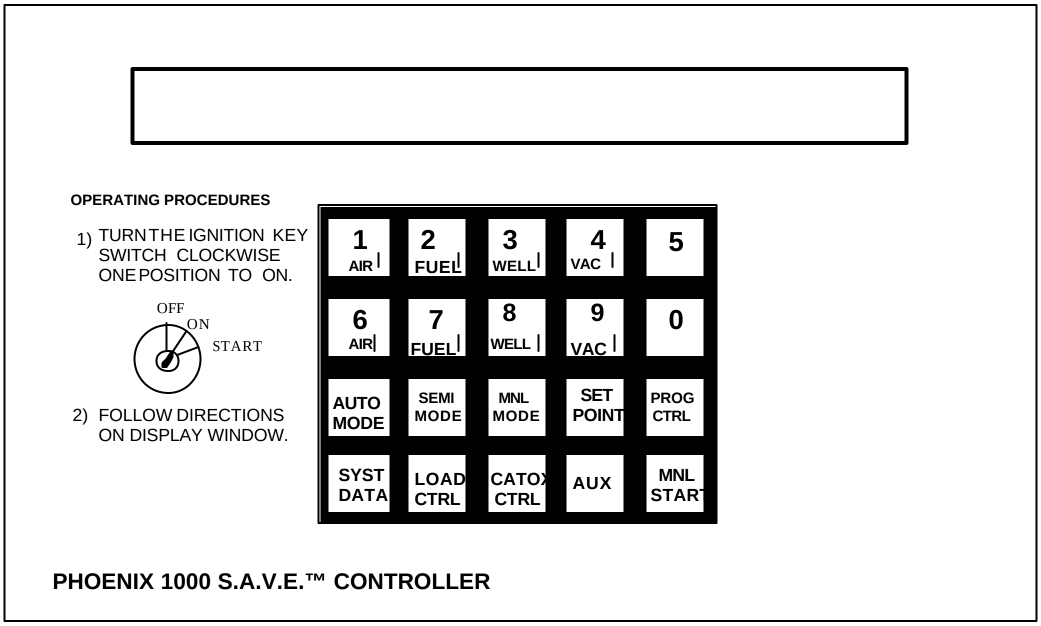


Figure 3. The Controller Front Panel

Controller Interfaces

The following are the standard interfaces normally found on the Controller Electrical Interface.

1. One power cable connection to the breakout board
2. Two type K thermocouple connections
3. Three vacuum hose interfaces
   a. Well Gas Filter housing for measurement of the well vacuum
   b. Engine Manifold vacuum
   c. Spray Aeration Tank vacuum
4. Six serial cable interfaces to the breakout board
5. Carburetor
6. Modem or Data Transfer Port

Enhanced Controller Electrical Interface

Enhanced Controllers include additional interfaces as follows:

a. One additional power cable with connection to the breakout board,
b. Two additional serial cable interfaces to the brake out board,
c. Three additional type K thermocouples, and
d. One additional vacuum hose interface.

Breakout Board

The Breakout Board routes most all wiring to the appropriate devices. Please refer to the "Breakout Board Drawing" in the section #8 for complete details. All cable connector interfaces should be mechanically secured by tightening the two threaded fasteners. The controller power connector(s) are connected to the Breakout Board as labeled.

System Start-Up

Following are the recommended start-up instructions:
The Phoenix Controller Front Panel includes a two line - forty-character Text Display Window and a 20-key entry pad (refer to Figure 3) above. The Text Display Window on the Phoenix Controller Front Panel shows system status and key operating parameters while the system is running. The keypad is used to make system Mode changes and to change critical operating parameters (See Set Point Mode and Program Control).

Note: Normal operation, including Murphy safety switch shut down, is suspended while the system is in Set Point or Program Mode. The system must be returned to one of the three operating modes (Automatic, Semi-Automatic and Manual) for continued operation. The system will automatically default to the previous operating Mode if an operating mode is not selected within 1 minute. For safety purposes, the system will automatically default to AUTO Mode after two minutes if system is left in Manual or Semi Automatic Mode.

Daily Power Up

Follow these steps if the default Set Points has not been previously entered or if changes to those Set Points are required.

1. To turn the system on, turn the key switch clockwise one position to "ON" (refer to Figure 4 above.). The initial display will show the following message:

PLEASE ENTER ACCESS CODE _ _ _ _ (four-digit)
To Continue With System Operation

2. Enter the Operator Pass Code or Project Manager Pass Code to proceed. The operator's pass code default is 1234 unless changed by the Project Manager. The display will briefly show the following message:

PHOENIX S.A.V.E. CONTROLLER
SERIAL #xxx VERSION #8.xx DATE xx/xx/xx

3. If a modem is not connected to the controller, the display will show:

Modem not connected or not turned on
Press 0 to skip or any key to retry

4. If a modem is connected, or the "0" key is depressed as described above, the display will show:

S.A.V.E. System Controller
TURN KEY TO START or SELECT FUNCTION

Note: If this is initial start up, please push the "SET POINT" button to input operating parameters (refer to section V following).

5. If ready to begin operation, turn the key to the "START" position as shown in figure 3.. This will cause the normal Engine Start Sequence. The key will spring back to the "ON" position similar to a normal vehicle ignition switch. On initial power up, the system must calibrate to set the proper valve positions. During calibration, the following message will show:

Calibration in Progress......
Please Wait ...20…19...18...17... all the way to 0
(Enhanced controllers start counting down at 40 seconds instead of 20 shown)

Note: Enhanced controllers require an additional 40 seconds to initialize valve positions after calibration.

6. The controller will then briefly display:

Calibration Complete

Note: System Status Message may not be visible in all instances due to the controller's upgraded processing speed.

7. If all access doors equipped with Safety Door Interlocks are not closed, the controller will display:

Please Check Engine Compartment Doors
Press Any Key To Continue

8. After all necessary access doors are closed, and a key is depressed, the start-up process will resume.

The system will attempt to start the engine a selectable number of times. Usually the engine will start on the first attempt. While cranking, the following display will show:

CAUTION	**STARTING ENGINE**	**CAUTION**
CAUTION	**Attempt #1**	**CAUTION**

If the engine starts, the display will switch to the normal AUTO display screen (shown below), the status will be "IDLE", and then display "Run" when running rpm and other predetermined criteria are met. If it fails, the system will repeat the start sequence the selected number of times.

Operation

Following is information that is important to the on-going operations of the unit:

Modes of Operation

Automatic Mode

The Automatic Mode will maintain the engine RPM and hold the proper air/fuel ratio for steady running. The system always defaults to the automatic mode during system start up. If the mode was changed to another setting, the system can be re-set to Automatic Mode by pressing the "Auto Mode" button on the keypad as shown in Figure 2. If the key is turned to "start" as described in the Start-Up section of the manual, the unit will automatically start in the "Auto Mode".

In the Automatic Mode and after a predetermined warm up period, the well valve continuously attempts to open to a maximum position that will allow smooth running. This takes place after "O2" mode is reached (when proper exhaust temperatures are achieved) and the baseline "snapshot" is saved into memory. As the Well Valve opens, the air and fuel valves open or close as necessary to maintain engine RPM and a stoichiometric air fuel ratio.

Note: System Status Message may not be visible in all instances due to the controller's upgraded processing speed.

IMPORTANT: The Well Valve will not open if:

a. The RPMs are oscillating beyond the predefined RPM
b. The Engine Manifold Vacuum is below the predefined Manifold Vacuum Set Point (see Program Control Menu)
c. The Valve positions are beyond the predefined Minimum or Maximum Set Point (see Program Control Menu)
d. The exhaust temperature for the pre-cat is below the predefined Minimum Set Point for the pre-cat temperature of 600 degrees °F (see Set Point Menu)
e. Either temp probe is above the predefined limit of 1100 degrees °F (see Program Control Menu), or is not reached a stable condition, or
f. The Well Vacuum has reached the Maximum Set Point (see Set Point Menu).

The Automatic Mode display window shows the status for the key parameters sample shown below:

RPM	AUTO	Flow	AIR	FUEL	WELL	Evac	W/Vac
xxxx	02	scfm	xxx	xx.x	xxx	xx.x	xxx

All estimated flows are expressed in "SCFM", Well Vacuum is expressed in inches of water (H_2O), and Engine Manifold Vacuum is expressed in inches of mercury (Hg). If flow box is installed, the well flow measurement is actual and not estimated.

The Murphy safety inputs are fully functional in the Auto Mode. If a Murphy input shuts the system down, the appropriate Murphy message will appear in the STATUS display of the Control Panel and the system will not attempt to restart the engine. In the Auto Mode, spontaneous engine failures that are not associated with a known fault will initiate the restart sequence. For a description of fault conditions, see "Murphy System Shutdown Conditions/Status Display in the Appendix. For a description of the Restart Sequence, please refer to Start-Up procedures.

Semi-Automatic Mode

IMPORTANT: The "SEMI" mode key should only be used for troubleshooting the system by a qualified RSI technician. Units left to operate in any mode other than "AUTO" are subject to damage and may cause injury. The Controller will automatically switch back to Auto Mode after two minutes of no activity.

The Semi-Automatic Mode is identical to the Automatic Mode except that the Well Valve is operated manually from the Controller Front Panel. The Semi-Automatic Mode is selected by pressing the "Semi Mode" button on the Controller Front Panel keypad as shown in Figure 2 above. The Semi-Automatic mode shows the following typical display:

RPM	SEMI	FLOW	AIR	FUEL	WELL = xxx	TANK = xxx
xxxx	RUN	Scfm	x.x	x.xx	(3? ,8?)	(4? ,9?)

The well valve is gradually opened by pressing the "3" key and gradually closed by pressing the "8" key. Air and fuel valve positions are adjusted by the system to achieve the optimum setting given a fixed well position. The Murphy system is functional during operation in the Semi-Automatic mode.

Manual Mode

IMPORTANT: The "MANUAL MODE" key should only be used for troubleshooting the system by a qualified RSI technician. Units left to operate in any mode other than "Auto" are subject to damage and may cause harm. The Controller will automatically switch back to AUTO Mode after two minutes of no activity.

The Manual Mode of operation is selected by pressing the "MNL MODE" button on the keypad of the Phoenix Controller Front Panel as shown in Figure 3 above and allows the user to operate the valves manually. This offers the greatest flexibility for defining Setup and Operating parameters. However the "MNL MODE" is very sensitive to prevailing conditions because it is unable to compensate for variations. The manual display is as follows:

RPM	AIR= xxx	FUEL= xxx	WELL= xxx	VAC= xxx
xxxx	(?1 ,6?)	(?2 ,7?)	(?3 ,8?)	(?4 ,9?)

The 1, 2, 3, and 4 buttons increase (open) valve positions for air, fuel, well, and tank/vac valve respectively while the 6, 7, 8, and 9 buttons decrease (close) the valve openings.

Starting the Unit in Manual Mode

For trouble shooting purposes, the unit may be started in the "manual mode". To do so, repeat steps one through four as described above in "Daily Power up". When reaching the screen/prompt:

S.A.V.E. System Controller
TURN KEY TO START or SELECT FUNCTION

Press the "MNL MODE". Another screen prompt will follow saying:

System not calibrated
TURN KEY TO Continue

The system will then begin its calibration sequence as describe above, however the system will not attempt to start at the end of the calibration countdown.

Once the system is done calibrating, press the number "5" key on the keyboard. This will command the air and fuel valve to open to their predetermined position. Then, by pressing and holding down the "MNL START" key on the controller, the engine will begin to turn over and start, providing the initial air and fuel positions are set correctly and the system is in good working order. Once the system is running at or near its programmed RPM, press "AUTO MODE" and the controller will take over future operation.

IMPORTANT: Stop pressing the MNL START key after 5 seconds or after the engine starts, which ever occurs first, otherwise damage to the starter and or battery will occur. The Controller will automatically switch back to Auto Mode after two minutes of no activity.

Load Ctrl

The "LOAD CTRL" button is not functional at this time.

Cat Ox Ctrl

The "CAT-OX Ctrl" button is functional if a CAT-OX module is present and if the Phoenix Controller is the "Enhanced" model. See the separate "CAT-OX Operations Manual" for more details. If an Enhanced Controller is installed, but no "CAT-OX" module is present, some data fields are still displayed such as temperature readings, vacuum readings, LEL readings and certain valve positions. The display screens are as follows:

Cat-Ox Main Screen

1 = CatOx AUTO	3 = CatOx MNL
2 = CatOx Data	4 = Reserved

Cat-Ox Option 1 Auto

AIR = xx.x%	WELL = xx.x%	BBP = xx.x%	HBP = xx.x%
LEL = xx.x%	IN = xxxxF	OUT = xxxxF	STACK = xxxxF

Cat-Ox Option 2 Data

Well Flow = xxxscfm		Well Vacuum = xxx in H20	
LEL = xx.x%	IN = xxxxF	OUT = xxxxF	STACK = xxxxF

Cat-Ox Option 3 Manual

AIR = xx.x%	WELL = xx.x%	BBP = xx.x%	HBP = xx.x%
(?1 . 6?)	(?2 . 7?)	(?3 . ,8?)	(?4 . 9?)

Aux Button

Main Menu

1 = Run Summary	3 = Set Time	5 = Time Code
2 = CLR History	4 = Set Date	6 = Tare Flow

The "**AUX**" button is used to:

1. **Run Summary**. Selecting "1" on the Main Menu causes the following information to be displayed: last fault, number of system stalls from last start up and display elapsed time of controller.

Fault: xxx	#Stalls:xxx
Elapsed Time: xxx:xx:xx	

a. **Clear History**. Selecting "2" on the Main Menu causes the following information to be displayed.

Press DATA Key to Clear History Data Press Any Key to Continue

b. **Set Time**. Selecting "3" on the Main Menu causes the following information to be displayed.

Enter Current 24 hr Time (hh : mm)

c. **Set Date**. Selecting "4" on the Main Menu causes the following information to be displayed.

Enter Current Date (mm – dd – yy)

d. **Enter Time Code**. Selecting "5" on the Main Menu causes the following information to be displayed. Contact RSI for assistance if prompted by the Phoenix Controller for data entry.

Contact RSI For Time Extension Code

e. **Flow Tare functions**. Selecting "6" on the Main Menu causes the system to automatically tare the Flow Box (for use with RSI Flow Box option).

Sys Data

The "**SYS DATA**" button is used to select one of eight menu choices as follows:

1 = Valve	3 = Eng/Batt	5 = Flow/VAC	7 = Water
2 = Well	4 = Temp/O_2	6 = Proj Mgr	8 = History

a. Valve. Selecting "1" on the SYS DATA Menu causes the following information to be displayed. The information is the same as "Auto" mode, except the window also displays Air, Well and Fuel Valve positions, Engine Manifold Vacuum and Well Vacuum settings which are used to estimate the corresponding displayed flows when not measured by the optional RSI flow box.

mode	AIR = xxx	FUEL = xxx	WELL = xxx	WVAC = xxx
xxxx	cfm = xxx	xx.x	xxx	EVAC = xx.x

Note: The number values for valve positions do not relate to any operating parameters other than the trend of valves opening and closing. For example: At sites with tight soils, the Well Valve may read 300 because of high vacuum, whereas at a sandy site the Well Valve position may be displayed as 100. Regardless of the readying, both valve positions may be providing the same flow rate. Computed Flow rates are based upon the valve opening and pressure differential. As a result, RSI recommends the use of independent measurements devices supplied by others, or recommends the RSI Flow Velocity Probe and Flowbox Interface option.

b. **Well**. Selecting "2" on the SYS DATA Menu causes the following information to be displayed. The display provides estimates of BTU/Hr and the ppmV of the extracted process stream gasses, and provide cumulative volumes of processed Dilution Air and processed Extracted Vapor from the process stream, and cumulative volumes for Supplemental fuel.

TOTAL WELL	Gas:xxxx00	BTU/Hr: xxxx00	ppmV
VOLUME	x100 : AIR = XXXX	FUEL = XXXX	WELL = XXXX

BTU 1/hr. Estimate:

To estimate the BTU/Hr content in the well, the system first measures the Supplemental Fuel usage (energy in BTUs) while the engine is running at its nominal operating condition with the well/process valve completely closed. Under this condition, all of the energy must be coming from the makeup/alternate fuel source which is either LPG or Natural Gas. The BTU/Hr content of the makeup/alternate fuel can be measured with reasonable accuracy because the energy content per cubic foot of propane and natural gas are well known. For Propane, we use 2520 BTU per cubic foot at atmospheric pressure and room temperature. Natural Gas values vary by region, however, we use 1000 BTU/cubic foot is as an average. This measurement will be labeled "snapshot" in the system's Datalogged information.

Note: To insure an accurate "snapshot", it may be necessary to disconnect the Well Hose and drain the Moisture Knockout Tank to make sure no well gas is being processed by a leaky Valve in the carburetor.

As the well/process valve opens, combustible gasses begin to feed the engine while the required alternate fuel adjusts. The only two sources of energy to run the engine are the alternate fuel and the well. Therefore, any BTU/Hr content not being supplied by the makeup/alternate source must be coming from the well. The estimated BTU/Hr from the well is simply the initial BTU/Hr measurement (adjusted for increased/decreased energy demand due to load changes and or inert gasses in the extracted process gasses simulating a load change), less the present makeup fuel flow, in scfm, multiplied by its BTU per cubic foot content.

PPMv Estimate:
The estimate of ppmV equivalent gasoline in the well flow is the BTU/Hr well content divided by the BTU's per cubic foot of vaporized fresh gasoline (to get cubic feet of gasoline per hour), divided by the total well flow, in cubic feet per hour (to get the fuel to air ratio), multiplied by one million.

Note: The system does not estimate ppmV below 2000 because estimation error increases as the well combustible contents decrease. In particular, the estimate becomes very sensitive to the initial engine starting condition.

a. **Eng/Batt**. Selecting "3" on the SYS DATA Menu causes the following information to be displayed: Oil Pressure, Battery Voltage and Coolant Temperature;

Oil Pressure = xxx psi	Battery = xx.x V
Coolant Temp = xxx deg	Reserved

b. **Temp/O2.** Selecting "4" on the SYS DATA Menu causes the following information to be displayed: Pre and Post Temperature of automotive catalyst and filtered/unfiltered O2 sensor feedback data;

Pre – CAT Temp = xxx deg F	O_2 SENSOR = xxxx
Post CAT Temp = xxx deg F	O_2 SENSOR = xxxx

c. **Flow/VAC**. Selecting "5" on the SYS DATA Menu causes the following information to be displayed: Vacuum and Flow data from optional velocity probes/Flow Interface Option Box.

scfm	F2 = xxx	F3 = xxx	F4 = xxx	F5 = xxx	F6 = xxx
Inches H_20	V2 = xxx	V3 = xxx	V4 = xxx	V5 = xxx	V6 = xxx

d. **Project Manager.** Selecting "6" on the SYS DATA Menu causes the following information to be displayed.

Select Project Manager Manifold Manifold # = _

1. Typing a "1" in the window displayed above will cause the following new display. Project Mgr Display – Main 1.

Project Manager	1 = Valve Positions
Manifold #x	2 = Solenoid Operation

2. Project Mgr Display – Main 2

PROJ MGR #1 = xxx	#2 = xxx	#3 = xxx	#4 = xxx
MNFLD 3x (?1 . 6?)	(?2 . 7?)	(?3 . ,8?)	(?4 . 9?)

3. Project Mgr Display – Option 1, Positions

Project Manager #x	Solenoid: xxx
Project Manager #x	Solenoid: xxx

4. Project Mgr Display – Option 2, Solenoid Operations

e. **Water**. Selecting “7” on the SYS DATA Menu causes the following information to be displayed. The Display Water treatment system data, including recirc (recirculation) pressure, recirc(recirculation) water temperature, S.A.V.E.™ System Tank Vacuum and Tank Valve positions, and cycle counts for Spray Aeration and DPE processes.

Water: Press = xxx	Temp = xxxF	TANK VALVE = xxx
Cycle Cnt: #1 = xxx	#2 = xxx	Tvac = xx.x in Hg

f. **History**. Selecting “8” on the SYS DATA Menu causes the following information to be displayed. Manually insert current system data and status into Datalogger memory to record a specific event at a specific date and time.

Save Current State in History? Press 1 for YES, Any other key to SKIP

Set Point Mode

The Set Points listed below are numeric parameters that effect the system operation and are adjustable by the user. They are saved in the Phoenix Controller memory even when the power is off so that there is no need to enter the menu unless a change in setup is required.

Note: Normal operation is automatically suspended while you are in the Set Point menu.

To change the Set Point selections/options:

a. Upon providing power to the controller, follow the on screen instructions until display reads “Turn Key to Start, or select function”. When this is displayed, press the "SET POINT" button on the Phoenix Controller Front Panel. The Controller Text Window will display the first Set Point “Running RPM” followed by a number of underscores.

Note: Pressing the "SET POINT" button without entering information will cause the Controller to display the next Set Point setting without changing the value of the current "SET POINT".

b. Using the keypad, type or enter a number with the correct number of digits to change the current Set Point setting. Leading zeros must be entered to complete an input.

Note: If an error is made during entry, press the "SET POINT" button to erase the entry and try again.

c. When all digits are input, the new number will be saved automatically and the display will automatically move to the next Set Point setting.
d. Continue to press the “SET POINT” button to loop through all of the menu selections.
e. To exit the menu, press any other Mode button. The System must be returned to one of the three operating modes (Automatic, Semi-Automatic or Manual) for continued operation.

Note: The system will automatically return to the previous operating mode if there is no keypad activity for one (1) minute.

Set Point Function and Normal Values

The following paragraphs describe the function of each set point and offers normal values.

Running Rpm

Default Settings	***Comments***
1800 to 2000 RPM	4-digits, all numeric are required. Always restart the system when changing this setting.

The Running RPM Set Point is the RPM that the system will normally operate at. Higher settings will increase total flow slightly. However, too high a Set Point could decrease engine life while too low of a Set Point value may cause carbon build up on the heads and result in bad emissions. A typical setting is 1800 to 2000 RPM. Units equipped with generators must be operated at 1800 RPM.

> **Note:** Always restart the system when changing this setting. Changing this setting after the system has gone into O_2 mode without restarting the engine will negatively affect the BTU/PPMv estimates.

Max Engine Well Vacuum (In H_2O)

Default Settings	Comments
300 inches of H_2O	3-digits, all numeric are required. Setting this parameter at "300" inches H_2O effectively means there is "no upper limit" on the Well Vacuum..

The *Max Engine Well Vacuum* sets the maximum limit for the vacuum pressure applied to the Well stated in inches of water. The default setting is 300 inches of H_2O. This value is beyond the system's vacuum capacity; the setting of 300 for this parameter value effectively means "no upper limit". This feature is used when it is necessary to control the amount of vacuum placed on the wells, for example, to control groundwater upwelling or mounding.

Max Cat-Ox Well Vacuum (In H_2O)

Default Settings	Comments
180 inches of H_2O	3-digits, all numeric are required. Setting this parameter at "180" effectively means there is "no upper limit" on the Blower Vacuum..

The *Max CatOx Well Vacuum* sets the maximum limit for the vacuum pressure applied to the Well from the CatOx module in inches of water. The default setting is 180 inches of H_2O. This value is beyond the blower's vacuum capacity. Therefore, setting the CatOx Well Vacuum at 180 effectively means "no upper limit". This feature is used when it is necessary to control the applied blower vacuum placed on the well because of groundwater upwelling.

Data Save Interval (Minutes)

Default Settings	Comments
60 minutes	All numeric entry are required. This setting instructs the system to save data at specific intervals specified in minutes.

The *Data Save Interval* is the frequency in minutes that data is recorded to the Datalogger feature of the Phoenix Controller. The Datalogger will store a maximum of 700 recorded events. This includes “sample” events along with scheduled intervals. A normal setting is 60 minutes, which allows for approximately one month of data to be stored (prior to overwriting the oldest data) when operating 24/7.

Program Control

The Program Control settings are Pass Code protected and cannot be changed unless the appropriate Security Access Code has been entered. The default pass code is 5, 6, 7, 8, and along wit the system access code, is changeable by project manager.

Generally speaking, the Program Control Set Points are not changed unless load, elevation, climate conditions, or other variables are causing difficulty starting the engine. Changes to Program Control settings should be made only by an authorized service contractor or by RSI personnel. Program Control Set Points should be recorded for future reference.

For more information on acceptable Program Control settings, see Phoenix 1000 Menus and Default Programming Values.

Program Control Mode

The Program control settings listed below are numeric parameters that effect the system operation and are adjustable by the user. They are saved in the Phoenix Controller memory even when the power is off so that there is no need to enter the menu unless a change in setup is required.

> **Note:** Normal operation is automatically suspended while you are in the Program Control Mode.

To change the Program Control selections/options:

a. Upon providing power to the controller, follow the on screen instructions until display reads “Turn Key to Start, or select function”. When this is displayed, press the "PROG CTRL" button on the Phoenix Controller Front Panel. The Controller Text Window will display the first setting called “Selected Data Set” followed by a number of underscores.

> **Note:** Pressing the "PROG CTRL" button without entering information will cause the Controller to display the next setting without changing the value of the current entry.

b. Using the keypad, type or enter a number with the correct number of digits to change the current PROG CTRL setting. Leading zeros must be entered to complete an input.

> **Note:** If an error is made during entry, press the "PROG CTRL" button to erase the entry and try again.

c. When all digits are input, the new number will be saved automatically and the display will automatically move to the next PROG CTRL setting.
d. Continue to press the "PROG CTRL” button to loop through all of the menu selections.
e. To exit the menu, press any other Mode button. The System must be returned to one of the three operating modes (Automatic, Semi-Automatic or Manual) for continued operation.

> **Note:** The system will automatically return to the previous operating mode if there is no keypad activity for one (1) minute.

Program Control Set Points/General Programming

Selected Data Set = _ (Single-Digit Entry)

Selected Data Set: This heading refers to pre-defined groups of values that have been grouped together in sets for ease of programming.

Data Set values:

0 = No default parameter values are written. Each parameter value must be manually set.
1 = Use when process flow inlet concentrations exceed 60,000 ppmV.
2 = Use when process flow inlet concentrations are between 30,000 ppmV and 60,000 ppmV.
3 = Use when process flow inlet concentrations are less than 3,000 ppmV.
4 = Use when RSI S.A.V.E™ Spray Aeration module is in use.

> **Note:** This change does not take effect until the Controller is turned off and then back on.. Re-start the system by following Shutdown procedures and then re-starting the unit using the Start-Up procedures. After initial reboot, return the *Selected Data Set* parameter value to 0. The changes made by changing the data set value will remain. For more information on acceptable Program Control settings, see Phoenix 1000 Menus and Default Programming Values.

Idle RPM = _ _ _ _ (Four-Digit Entry)

Idle RPM is the target RPM value for normal engine operation during idle period. Changes to this value may require changes to the Air Initial Position valve setting and the Fuel Initial Position Valve settings as described below. For more information on acceptable Program Control settings, see Phoenix 1000 Menus and Default Programming Values.

Air Initial Position = _ _ _ (Three-Digit Entry)

Air Initial Position describes the actual incremental air valve opening value of the carburetor for the starting sequence. This setting is automatically increased by 25% of its previous setting when choosing the natural gas option (see below) instead of propane (default). This setting is rarely changed, unless idle RPM as described above is changed, or a major shift in elevation takes place.

Fuel Initial Position =_ _ _ (Three-Digit Entry)

Fuel Initial Position describes the actual incremental fuel valve opening value of the carburetor for the starting sequence. This setting is automatically increased by 25% of its previous setting when choosing the natural gas option (see below) instead of propane (default). This setting is rarely changed, unless idle RPM as described above is changed, or a major shift in elevation takes place.

For more information on acceptable Program Control settings, see Phoenix 1000 Menus and Default Programming Values.

Min Tank Vacuum (Inches Hg) = _ _ (Two-Digit Entry)

Min Tank Vacuum should be set at 12 inches Hg (Mercury) if the S.A.V.E spray aeration module is present, otherwise this parameter should be set to 22 inches Hg. This value is beyond the system's vacuum capacity; the setting of 22 for this parameter value effectively means "no limit". If a water treatment system is present, the setting of 12 maintains the spray aeration tank vacuum at or about 12" Hg. It does so by opening and or closing the spray tank VAC valve as necessary to maintain the tank vacuum at the desired set point. The spray tank VAC valve is connected to the vapor flow from the extraction process. The maximum amount of vacuum that can be placed on the soil venting extraction process is limited to the spray tank vacuum set point. In the default setting of 12, this means a maximum of 12 inches of Hg of applied engine vacuum can be placed on the SVE and/or SAVE processes. The spray tank vacuum will stabilize prior to allowing any SAVE process to begin. Default is for the standard (base) model is 22 inches Hg (Mercury). Default for the Min Tank Vacuum with S.A.V.E.™ Spray Aeration module option is 12 inches Hg (Mercury).

Target Oxygen (Target O_2) = _ _ _ _ (Four-Digit Entry)
Target Oxygen is a factory preset value performed at time of initial start-up. Consult RSI before changing this value. Minor changes to this setting will increase or decrease the effluent emissions depending on specific site conditions. Default value is 1800.

KFRRunO_2 = _ _ _ (Three-Digit Entry)
KFRRunO_2 is a factory preset value performed at time of initial start-up. Consult RSI before changing this value. Default value is 35.

Number Of Restart Attempts = _ (Single-Digit Entry)
Number of Restart Attempts establishes the number of times that the engine will try to start following an engine stall or when the key is first turned on and moved to the start position. This input will normally be set to 0, therefore disabling this feature. Please check with local governing agency to determine if automatic restart is acceptable prior to engaging this option. Default value is "0".

Remote Start= _ ("1"=Enable, "0"=Disable) = _ (Single Digit Entry)
Remote Start feature may be enabled or disabled with this parameter setting. Consult local governing agency to determine if remote start is acceptable prior to enabling this option. Default value is "0".

Fuel Ratio Loop= _ ("0"=Demod, "1"=O2 At T) = _ (Single Digit Entry)
Fuel Ratio Loop is a factory preset value performed at time of initial start-up. Consult RSI before changing this value. Default value is "1".

Fuel Type= _ ("1"=Natural Gas, "0"=Propane) = _ (Single Digit Entry)
Fuel Type tells the controller which fuel source you are using. Default value is "0".

Modem Speed= _ ("0"- 2400, "1"=4800, "2" =9600)=_ (Single Digit Entry)
Modem Speed 0 = 2400; 1 = 4800; 2 = 9600 -- Default setting is 9,600. This sets the speed at which the controller communicates with the target modem. Slower setting may be required for cellular connection or bad landline phone lines.

Number Of Cylinders= _ ("4", "6", "8") = _ (Single Digit Entry)
The *Number of Cylinders* is set to match the number of cycles in the engine, 4, 6 or 8.

Emergency Phone Field #1 - Area Code= _ _ _ (Three-Digit Entry)
Emergency Phone field #1- Area Code is the area code for the 1st telephone number to be contacted should the RSI system stall or go off-line. Enter 000 for a local call in lieu of the area code.

Emergency Phone Field #1 - Prefix = _ _ _ (Three-Digit Entry)
Emergency Phone field #1 - Prefix is the prefix for the 1st telephone number to be contacted should the RSI system stall or go off-line. Enter 000 to disable this feature.

Emergency Phone Field #1 = _ _ _ _ (Four-Digit Entry)
Emergency Phone field #1 - 4 Digits is the remainder of the 1st telephone number to be contacted should the RSI system stall or go off-line.

Emergency Phone Field #2 - Area Code = _ _ _ (Three-Digit Entry)
Emergency Phone field #2 - Area Code is the area code for the 2nd telephone number to be contacted should the RSI system stall or go off-line. Enter 0 for a local call in lieu of the area code.

Emergency Phone Field #2 - Prefix = _ _ _ (Three-Digit Entry)
Emergency Phone field #2 - Prefix is the prefix for the 2nd telephone number to be contacted should the RSI system stall or go off-line. Enter 0 to disable this feature.

Emergency Phone Field #2 - = _ _ _ _ (Four-Digit Entry)
Emergency Phone field #2 - 4 Digits is the remainder of the 2nd telephone number to be contacted should the RSI system stall or go off-line.

System Access Code= _ _ _ _ (Four-Digit Entry)
System Access Code is the Pass Code required to gain access to system for routine operation. *The default value is 1234.*

Control Menu Access Code = _ _ _ _ (Four-Digit Entry)
Control Menu Access Code is the Pass Code required to gain deeper access to the system for changing Control Menu parameter values. During system Set-Up, the Access is normally changed to another, unique code for Supervisor Access only. This change is to protect the Program Code for basic system settings from accidentally being changed. See your System Administrator/System Supervisor or an RSI Technician to make changes to this Access Code or related changes to its sub-menu of options.

For additional details, see Phoenix Host Software manual
and Flow Box manual

Phoenix 1000 Menus and Default Programming Values – Version 8.XX

Set Point Menu Options

Phoenix 1000 Set Point Menu	8-Cyl	6-Cyl	4-Cyl	DESCRIPTION / NOTES
SET POINT MENU				Requires Menu Access or Customer Override Code
Running RPM	1800	1800	2000	Changing this setting may affect system performance unless other settings are modified.
Max Engine Well Vacuum (in H_20)	300	300	300	Well valve will not open past H2O set point
Max CatOx Well Vacuum (in H_20)	190	190	190	Well valve will not open if Well VAC is above the set point
Data Save Interval (minute)	60	60	60	Data save at 60 will save 27 days of data. Clear History before changing this setting.
Total for Menu				

Program Control Menu

CONTROL MENU	8-Cyl	6-Cyl	4-Cyl	Requires Menu Access or Customer Override Code
Selected Data Set	0	0	0	0=none, all custom; 1=Data Set 1, 2=Data Set 2, etc.
Idle RPM	1800	1800	1800	Changing this setting may also affect initial air and fuel valve positions described below
Air Initial Position	90	50	40	Adjust to site specific conditions, i.e. climate, elevation, load and fuel type.
Fuel Initial Position	85	55	35	Adjust to site specific conditions, i.e. climate, elevation, load and fuel type.
Min Tank Vacuum (inches Hg)	23	23	23	Set at 14 if water treatment system is present
Target O_2	1800	1800	1800	Should always remain at factory settings if present in programming
KFRRun O_2	35	35	35	Should always remain at factory settings if present in programming
Number of Restart Attempts	1	1	1	Automatic restart or remote start feature is subject to local governing agencies.
Remote Start Enable / Disable	0	0	0	Change as required
Fuel Ratio (0=Demod, 1=O2 @ Temp)	1	1	1	Should always remain at factory settings if present in programming
Fuel Type (0=Propane, 1=Natural Gas)	0	0	0	Set to appropriate setting
Modem Speed (0=2400, 1=4800, 2=9600)	2	2	2	May need to reduce modem speed for cellular. Must be at 9600 for DSD 1000 transfer
Number of Cylinders (4,6,8)	8	6	4	Set to appropriate setting
Emergency Phone #1 Area Code	0	0	0	Change as required, 0 for area code means local call
Emergency Phone #1 Prefix	0	0	0	Change as required, 0 for prefix means don't dial
Emergency Phone #1 4 Digits	0	0	0	Change as required
Emergency Phone #2 Area Code	0	0	0	Change as required
Emergency Phone #2 Prefix	0	0	0	Change as required
Emergency Phone #2 4 Digits	0	0	0	Change as required
System Access Code	1234	1234	1234	Change as required to protect entry into system operation
Control Menu Access Code	xxxx	xxxx	xxxx	Change as required to protect entry into customer access control menu

Phoenix-1000 Default Settings 7.xx and earlier releases

Series 7.xx Set Point Menu

START OF SET POINT MENU	Scale Factor	8-Cylinder	6-Cylinder	4-Cylinder
Idle RPM	1 bit / RPM	1800	1800	1800
Idle Time (sec)	1 bit / sec	60	60	60
Running RPM	1 bit / RPM	1800	1800	2000
Warm-up Time (sec)	1 bit / sec	60	60	60
Max Well Opening (%)	1 bit / %	100	100	100
Tank Vacuum (inches Hg)	1 bit / in. Hg.	10	10	10
Manifold Vacuum (inches Hg)	1 bit / in. Hg.	12	12	12
Engine Cranking Time (sec)	1 bit / sec	7	7	7
Number of Cylinders (4,6,8)	1 bit / Cyl	8	6	4
Max RPM Shutdown/Restart	1 bit / RPM	3000	3000	3000
Printer Enable (0=Off, 1=On)	0 = off, 1 = on	0	0	0
Fuel Type (0=Propane, 1=Natural Gas)	0 = Pro, 1 = NG	0	0	0
END OF SET POINT MENU				

Series 7.xx Program Control Menu

START OF PROGRAM CONTROL MENU	Scale Factor	8-Cylinder	6-Cylinder	4-Cylinder
Modem Speed (0=2400, 1=4800, 2=9600)	N/A	2	2	2
Data Save Interval (minute)	1 bit / min	60	60	60
Data Print Interval (minute)	1 bit / min	10	10	10
Number of Restart Attempts	1 bit / attempt	1	1	1
Air Initial Position	1 bit / step	90	50	40
Fuel Initial Position	1 bit / step	85	55	35
Fuel Max Start Position	1 bit / step	95	65	45
Startup Fuel Valve Step Rate	1 bit / step	20	20	20
Well Valve Increment (steps)	1 bit / step	20	20	20
Max AIR Opening	1 bit / step	150	150	150
Max FUEL Opening	1 bit / step	150	150	150
Delta RPM Limit for Well Dec	1 bit / RPM	100	100	100
Max DRPM for Well Valve Dec	1 bit / RPM / sec	600	300	150
Max VAC Opening	1 bit / step	300	300	300
KRPM	gain	125	125	125
KDRPM	gain	50	50	35
KVacuum	gain	10	10	10
Target Air/Fuel Mix	1 bit / %	100	100	100
Demodulator Amplitude	1 bit / step	2	2	1
Emergency Phone #1 Area Code	N/A	0	0	0
Emergency Phone #1 Prefix	N/A	0	0	0
Emergency Phone #1 4 Digits	N/A	0	0	0
Emergency Phone #2 Area Code	N/A	0	0	0
Emergency Phone #2 Prefix	N/A	0	0	0
Emergency Phone #2 4 Digits	N/A	0	0	0
Emergency Phone #3 Area Code	N/A	0	0	0
Emergency Phone #3 Prefix	N/A	0	0	0
Emergency Phone #3 4 Digits	N/A	0	0	0
Access Code	N/A	1234	1234	1234
Access Code (Verify)	N/A	1234	1234	1234
END OF CUSTOMER ACCESS CONTROL MENU				

Chapter

6

TROUBLESHOOTING

Overview

This guide is not intended to solve problems down to the lowest level, but rather to get to the basic sub-component or engine part that is replaceable in the field. Solving problems is generally best accomplished by the "divide and conquer" approach; that is to systematically rule out the largest system elements first and then work down to smaller and smaller sub-components until you get to a part that can be replaced. As a basic example, suppose that the controller and carburetor have been replaced and the same problem remains. You must now look at the engine and its systems. The battery, starter, and starter solenoid can be quickly ruled out as the problem if the engine cranks during the start sequence or when the "start" button is pressed. Similarly, low engine oil is easily identified as the problem if the system shows an "oil pressure" alarm and the dipstick shows no oil. This is a very simple case, but remember that it often pays to eliminate the obvious things first.

For testing and troubleshooting, always disconnect the soil venting extraction (SVE) hoses from the well gas filter housing (allowing fresh air to enter the carburetor) and discontinue all other treatment processes (i.e. water treatment, Dual-Phase extraction, etc.). In other words, take away all variables so that we are strictly testing the engine and the Phoenix Control System under static conditions.

Some problems with proper operation could be the result of auxiliary equipment connected to the system. Power take off (PTO) driven components may cause erratic loading, or rapidly changing well flow concentration may also cause unstable conditions. Systems with large generators and switching loads could cause large RPM transients or even engine stalls. Remove or disengage these pieces of auxiliary equipment before proceeding with testing.

Note: First determine the unit ID #, and the software version and serial number of the controller. The Phoenix Controller at power up will display its software version and serial number. The unit ID # is located on the cabinet. Record this information for future reference. Be prepared to give information to RSI service technician when asked.

Air Compressor Module

The compressor is producing excessive noise:

1. Shut I.C. engine off.
2. Check compressor pulley to ensure tightness of drive belt and to find excessive movement in pulley drive shaft.
3. Check inlet filter for oil or moisture damage.
4. Disconnect oil return hose from compressor at the engine block. Inspect the return port on the engine block to see if the port appears blocked. Place loose end of return hose into a container that is secured and away from the engine block or any moving parts.
5. Start the I.C. engine while monitoring the container fed by the oil return hose. Let the I.C. engine run for 15 to 30 seconds and then turn it off.
6. If oil has moved through the compressor and started to fill the container, the lubrication system is operational.
7. The compressor needs to be rebuilt.

The air output pressure is low:

1. Check the pressure relief valve located on the output manifold of the compressor. If this check valve has been activated, reset and check output pressure again.
2. Check inlet filter for oil or moisture clogging.
3. Disconnect the hose from the output of the compressor. Connect a new or known good in-line pressure gage to the output of the compressor and reattach the output hose to the outlet of the pressure gage.
4. Compare the pressure readings to previous low readings.
5. If pressure is still low, the compressor needs to be rebuilt.

The air output of the compressor has excessive oil:

1. Disconnect the output hose, holding tank and any other down line components from the output of the compressor.
2. Attach a new, clean hose to the compressor and install an in-line filter to the other end of the hose. Be sure that the filter doesn't restrict air enough to trigger the compressor's pressure relief valve.
3. The outlet of the filter can be left open or reattached to the rest of the air system. Start the I.C. engine and run for 30 to 60 minutes.
4. Inspect the in-line filter for oil contamination

   Note: All Bendix air compressors will have some oil contamination, even when new.
5. If the filter has excessive oil contamination, the compressor needs to be rebuilt.
6. If the filter doesn't exhibit excessive oil contamination, the oil contamination may be in existing lines or holding tank. Inspect all components of the air system for an oil source.

Air Injection On/Off Valve Control

The air injection valve fails to operate when given a command:

1. Disconnect the non-operational valve from the control circuit.
2. Attach the valve leads to another control circuit and test that circuit control to see if the valve is operating correctly.
3. If there are two valves attached to the control circuits, and one is operational and the other not, exchanging the connections of the two valves with one another and testing both valves, will indicate whether the problem is in the valve or the control circuit.
4. Inspect the Air Injection Control PCB and cable for any damage or broken wires. If damage is found and is repairable by a company technician, repair and retest circuit.
5. If no damage is found or the damage is too extensive for on-site repair, the control circuit must be sent to RSI for repair or replacement.

Alternator & Battery

The most obvious and frequent problem associated with the battery and alternator charging system is the engine will not turn over when given a start command. This can occur because the battery is dead due to internal failure associated with the construction of the battery or it can occur due to a failed charging system. All batteries installed by RSI into remediation systems are sealed, heavy-duty commercial grade batteries that do not require fluid refills.

The engine fails to turn over when given a start command mode. (See also: Engine in this Troubleshooting section.)

1. Check the battery voltage in the controller display to ensure it is 12.4 volts DC to 13 volts DC.
2. Attach a voltmeter to the terminals of the battery and try to start the I.C. engine. Check the voltmeter to see if the voltage drops below 11 volts while a load is being applied.

   Note: A weak battery will not necessarily indicate a low voltage until a load is applied to the output.
3. Replace the battery with a known good battery with full charge.
4. Try to start the I.C. engine with the new battery. If the I.C. engine starts and runs well, this indicates that the battery was low but further tests can be performed to determine what may have caused this condition.

The engine fails to turn over when given a start command after the battery has been replaced:

1. Monitor the starter located at the rear of the engine to see if the starter is getting any current. The starter may vibrate, hum, emit smoke or some other indication that shows current is flowing to it. Carefully check to see if the casing is getting hot.
2. Using a clamp-on ammeter, measure the current draw through the starter cable. The current draw through this circuit should be 300 amps DC +/- 10%.

3. If the current draw is higher than normal, the starter motor is probably damaged and should be replaced. Step #5 can still be performed to ascertain whether the I.C. engine is the problem.
4. If the current draw is lower than normal the starter windings are open and the motor must be replaced.
5. If the starter is trying to turn but can't turn the engine over, the starter is failed and needs to be replaced. There is a minor chance that the I.C. engine itself is frozen and will not allow the starter motor to turn it. This can be determined by removing the starter from the I.C. engine and grounding the starter chassis to the engine through the use of a jumper cable and trying to start the engine again. If the starter motor turns freely there may be a problem in the engine. It is still possible that the starter is failed and doesn't have the power to turn the engine over as it should. Using a clamp-on ammeter during this test will indicate whether the starter is fully operational or not (see step #2 above).

   💣 **Caution: The amount of current drawn from a battery to start the I.C. engine has the ability to burn skin and cause cardiac arrest. Do not allow persons to contact electrical wires or contacts while troubleshooting these circuits.**
6. Install a known good starter and retest the system by starting the I.C. engine once again.
7. If the starter is not showing indications of trying to tum the engine over, the problem could be either the starter motor or the starter solenoid.
8. Connect the positive probe of a voltmeter to the output terminal of the starter solenoid. (This is the terminal that connects to the starter motor.) Connect the negative probe of the voltmeter to chassis ground and try to start the engine. When the start signal is applied to the starter solenoid, the voltmeter should indicate approximately 12 volts DC is being applied to that terminal through the solenoid.
9. Voltage at the output of the solenoid indicates that the solenoid is operational and the starter motor has failed. No voltage at the output of the solenoid indicates that the solenoid has failed. Replace the appropriate components and retest the system to see if the I.C. engine will start.

Testing the alternator charging system:

1. Attach a voltmeter to the terminals of the system battery and check voltage. The charging voltage from the alternator should be 13.7 volts DC, approximately 1 volt DC above a static battery voltage reading.
2. Using a clamp-on ammeter, check the charging current in the lead between the alternator and the battery. The charging current should be 25 amps DC.
3. If the voltage or current readings are low from the alternator, the alternator should be replaced.

Automatic Oil Level Regulator

The I.C. engine crankcase is running out of oil and the oil reservoir is not refilling it automatically through the automatic oil level regulator.

1. Verify that the oil in the crankcase is a minimum of one quart below the full mark on the dipstick.
2. Verify that there is oil in the reservoir feeding the automatic oil level regulator.
3. Verify that the PCV system is operating correctly.
4. Loosen the mounting bolts on the regulator mounting bracket and slowly move the regulator upwards. Oil should flow through the regulator when it senses a low level condition.
5. If oil does not flow, remove the automatic oil level regulator assembly from the engine compartment, taking care not to release oil from the reservoir. Clean regulator and hoses or replace as necessary.
6. Reinstall the assembly and retest. If the automatic system doesn't fill the engine crankcase, replace the oil regulator and retest.

Carburetor

In order to properly troubleshoot the carburetor, it is important to understand the system's program. The Phoenix Controller and carburetor start the engine running on dilution air and alternate fuel through an idle and warm-up period. After the predetermined warm-up period and after the pre-cat temperature reaches 600 degrees °F, the system will automatically switch to "O_2" mode (from it's start-up mode referred to as "Demod" mode). Then, after exhaust temperatures stabilize, it will slowly begin opening the well/tank valve connected to the process flow.

As the well/tank valve is opening, the controller constantly adjusts all of the other carburetor valves to maintain the set RPM and to hold a near stoichiometric fuel ratio in the engine. The system continuously increases the well/tank valve while adjusting the alternate fuel and dilution air inlet valves as necessary. If the well is very rich (high concentration of hydrocarbons), the alternate fuel valve will eventually close to a **minimum valve position**, causing the well valve to stop opening. Or in the case of a process stream with minimal hydrocarbons, the control system will close the dilution air valve to a predetermined minimum valve position, again, stopping the well valve from opening further.

The well/tank valve will continue to open until one of several possible events occurs. For example, either the alternate fuel or the dilution valves completely opens or closes beyond a predetermined set point, the RPM strays too far from the set point, the engine vacuum drops below its set point, or the rate of change of the RPM exceeds a predetermined level. As the well conditions change, the system will continuously adjust to maintain the maximum flow from the well/tank while maintaining proper air-fuel mixture.

IMPORTANT:

The well valve will not open if:

1. RPMs are oscillating beyond the predefined "hard-coded" amount;
2. The engine manifold vacuum is below the predefined "hard-coded" manifold vacuum set point;
3. The valve positions are beyond the predefined "hard-coded" minimum or maximum set point;
4. The exhaust temperature for the pre-cat is below the predefined "hard-coded" minimum of 600 degrees °F;
5. Either temp probe is above the predefined "hard-coded" limit of 1150 degrees °F;
6. The maximum well vacuum is reached as programmed (see set point menu).

Carburetor Test Methods

There are three methods for testing the carburetor, assuming that the controller is operational. Method 1 should be used if the engine is running or can be started in spite of the suspect carburetor. If the engine will not run, use either Method 2 (if the engine has a hard time turning over - low battery) or Method 3 (if the engine still cranks OK).

Method 1 (engine running):

1. Place the controller in the Manual mode and note the engine RPM. Note the Air, Fuel, and Well valve positions.
2. Increase the Air valve position up to 20 counts, then step it back. Note the RPM fluctuation.
3. Increase the Fuel valve position up to 5 counts, then step it back. Note the RPM fluctuation.
4. Increase the Well valve position up to 40 counts, then step it back. Note the RPM fluctuation.

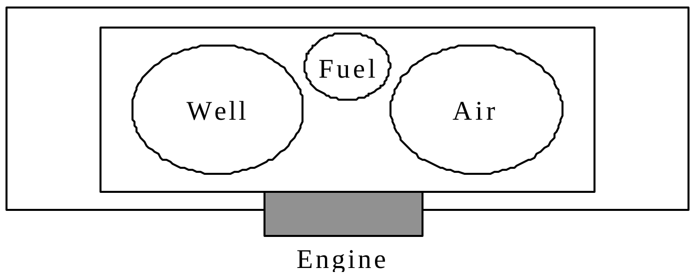
   In each of the three valve movements, the engine RPM should change, either up or down, but return to the original RPM when the valve is returned to its original position. If no change is observed on one or more of the three valves, the carburetor is likely at fault. Remove the carburetor and verify the fault by testing again using Method 2, below:

Method 2 (engine off, controller on):

1. Turn off the makeup fuel source.
2. Place the controller into the Manual Mode.
3. Remove the flex hose from the carburetor inlets (three).
4. Observe the valves either visually or by feel by placing a pencil or rod on the ball.
5. One at a time, open and close the three valves. If any one of the three valves shows no movement, the carburetor is probably at fault. Remove the carburetor and repeat the test to visually confirm results.

Please keep in mind that valve movement is in very small increments and difficult to detect.(see below values for each step).

6. If the valves move, repeat step 5 above, however place a slight load on the valve (finger pressure is fine) to see if the valves can move under load. This will simulate 20” Hg (Mercury) vacuum load on the valve when the engine is running. If valve clicks, but does not move, replace carburetor.



Drawing of valve orientation

- Expect the Air valve to move 1/8” for a valve position change of 128 increments.
- Expect the Well valve to move 1/16” for a valve position change of 128 increments.
- Expect the Fuel valve to move 1/32” for a valve position change of 128 increments.

Method 3 (engine turning over, controller on):

1. Turn off the makeup fuel source.
2. Remove the flex hose from the fuel inlet or from the fuel solenoid.
3. Place the controller into the Manual Mode.
4. Close all three valves by pressing the “0” key to Calibrate.
5. Crank the engine (use manual start key) for three seconds and note the engine vacuum (approx. 12 inches Hg).
6. Open the Air valve to a position around 100.
7. Crank the engine for three seconds and note a lower engine vacuum (< 3 inches Hg).
8. Again, Calibrate the three valves by pressing “0” key.
9. Open the Well valve to a position around 200.
10. Crank the engine for three seconds and note a lower engine vacuum (< 3 inches Hg).
11. Again, Calibrate the three valves by pressing “0” key.
12. Open the Fuel valve to a position around 400.
13. Crank the engine for three seconds and note a lower engine vacuum (< 5 inches Hg).

Note: If any of the above steps do not result in the described outcome, the carburetor will need to be removed. With the carburetor in hand, repeat the “Method 2” tests described above to be certain of the fault.

Cat-Ox Module

The patented RSI S.A.V.E.™ II high flow catalytic oxidizer module (CAT-OX) is unique in that it uses the waste heat of an internal combustion engine to pre-heat an industrial catalyst for the destruction of hydrocarbon vapors recovered from contaminated soil. This differs from conventional catalytic oxidizer systems, as they require auxiliary fuel for catalyst pre-heating. The engine also provides power for the positive displacement blower and generates electricity for the instrument panel, control valves, and the controller. No outside electrical connections are required to operate the RSI S.A.V.E.™ II high flow CAT-OX.

The S.A.V.E.™ II CAT-OX is an exciting addition to the S.A.V.E.™ family which, under certain conditions, can triple the well flow rate capacity of the base system and increase the destruction rate of hydrocarbons with virtually no additional operating cost. The S.A.V.E.™ II CAT-OX has two oxidizers operating individually and in parallel with each other, not in series (either/or) as conventional thermal/catalytic oxidizers do.

The S.A.V.E.™ II CAT-OX has been designed to mount on the end of the optional dual axle trailer that also houses the base S.A.V.E.™ system. All new S.A.V.E.™ systems can accept a CAT-OX module and its related components at a later date, if desired.

A complete manual exists for this module, however some of the features may be used to record data during operation of the standard V3 and V4 units. As such, the following is a brief troubleshooting guide for some of the operating functions of the Cat-Ox Module. Please refer to the complete manual for additional information.

Do not attempt to change the program or set points of any components unless authorized by RSI. For more detailed direction when working on each component, please refer to the individual operator/owners manuals.

LEL Sensor (Optional)
Displaying A Negative Number:

1. Calibrate the sensor following the procedure outlined in the GasTech Calibration Kit.
2. Replace catalytic bead detector as per GasTech Operations manual.

Displaying Questionable Values:

To calibrate the existing controllers if displayed values are questionable, connect thermocouples to another temperature recording device and observe the reading. Make sure that the second recording device can accept a type K thermocouple.

1. If no correlation in values exists, the problem is in the controller. Contact RSI.
2. If values correlate, change thermocouple probes and again measure temperature with the existing controller and confirm with the second recording device.

Sporadic, Jumpy, Or Below Normal Temperature Displays:

This may indicate a short in the thermocouple wires. The temperature displayed on the thermocouple will occur at the short.

> **Caution: It is imperative that this is corrected or the controllers will not operate under actual temperatures measured in the CAT-OX resulting in the overheating and/or sintering of the catalyst.**

1. Disconnect the thermocouple wires from the probe and the controller and check for continuity. If the wires have no continuity then a short is not present. Repair or replace the wire if a short is found

Catalytic Converter

There are three methods to help identify a problem with the automotive Catalytic Converter.

1. If the Post-Cat Temperature Gage reading is the same or lower as the Pre-Cat Temperature Gage, the automotive Catalytic Converter may need to be replaced. If the Automotive Catalytic Converter is operating properly, the conversion/oxidation of CO, NOx and VOC from the engine will cause a temperature rise across the catalyst. In other words, the temperature at the Post-Cat Temperature Gage will be higher than the temperature at the Pre-Cat Temperature Gage once the pre-cat temperature reaches a minimum of 600 degrees F.
2. The pressure drop across the Catalytic Converter can be measured. To determine whether there is a problem with the exhaust pressure, subtract the Post-Cat pressure reading from the Pre-Cat pressure reading.

   Pre-Cat pressure reading (xx psi)
   -- Post-Cat pressure reading (xx psi)
   Pressure drop >1.5 psi

   If the pressure differential between the Pre-Cat pressure reading and the Post-Cat is more than 1.5 psi , the converter is clogged and needs to be replaced.

   Note: Let the engine warm-up prior to testing.
3. It is also helpful to compare current operating parameters to previously taken measurements ("baseline" or "snapshot" samples taken under static conditions). If these readings are taken (and recorded) at regular intervals, it will be easier to see what, if any, changes have taken place over time. Use the chart below to establish baseline values for the Catalytic Converter during operation.

Controller

Checking the Phoenix-Controller:

1. Turn off the alternate fuel source.
2. Power up the controller by turning the key switch.
3. The "S. A. V. E. System" - - "title message should appear for about 5 seconds.
4. If no modem is detected, another message will show - press the "0" key…" to go on.
5. After pressing The "Turn key to start or select function" message should appear.
6. Press the "Set Point" key.
7. Check the values in the Set Point menu by pressing the "SET" key and stepping through the programming options. Review the entries against the default values listed in the operations manual. If any of the values are wildly different for unexplained reasons, the controller may have experienced a low battery problem that scrambled its memory. Try resetting the original values and running the system.
8. Check the values in the control menu by pressing the "PROG CTRL" key and stepping through the programming options. Review the entries against the default values listed in the operations manual. If any of the values are wildly different for unexplained reasons, the controller may have experienced a low battery problem that corrupted the memory. Try resetting the original values and running the system.
9. Disconnect the system carburetor connector from the controller. Using another carburetor or a carburetor simulator, individually operate the Air, Fuel, and Well valves assuring that each one moves. If one or more of the valves does not operate, the controller has a fault and will need to be replaced.

If no test carburetor is available, the test will have to be run with the system carburetor using one of the methods listed in the following section. If the system carburetor is all that is available and it does not pass on all three valves, it may not be possible to determine which of the two components has failed. It is much more likely that a single nonmoving valve is a carburetor fault than a controller fault. If, on the other hand, none of the valves move, it is much more likely a controller fault.

Note: FOR ALL OTHER SYMPTOMS, PLEASE CONTACT RSI FOR SERVICE.

Controller Compartment Cooling & Filtering

The compartment is excessively hot:

1. Check the muffin fan to verify that it is operational.

2. If it is non-operational:
   a. check for broken wires or connections.
   b. Remove the muffin fan and test operation by connecting to a 12 volt DC power source with a minimum 1 amp rating.
   c. If the fan operates on this power supply, the problem is the supply to the fan in the cabinet. The fan is supplied 12 volts DC from the Project Manager connections on the system Breakout PCB located in the control cabinet. The ignition key must be on and the system in “Run” mode to test the voltage on the Breakout PCB.
   d. Using a voltmeter, check the voltage at the Project Manager’s voltage terminals on the Breakout PCB, ensuring the polarity of the probes are correct. The voltage should be 12 volts DC.

   Caution: Ensure that the probes do not touch each other or in any way “short out” original the voltages on the Breakout PCB as this could damage the controller or other parts of the system.

   e. If the voltage is correct, the connection between the muffin fan and the PCB are not making connection. Replace the wires to the fan and reconnect or replace the muffin fan.
   f. If the voltages are less than 12 volts DC, there is a problem on the Breakout PCB and it should be replaced or sent to RSI for repair.
3. If the fan is operational:
   a. Remove the air filter at the air inlet to the control cabinet and inspect for excessive dirt buildup. Replace or clean the filter as necessary and replace.
   b. Monitor the temperature in the cabinet while the filter is out to see if the temperature drops significantly. If the temperature in the cabinet remains high without the filter in place, the internal cabinet temperatures and ambient air temperatures must be evaluated to determine if there is anything that can be done to cool the controller cabinet without using refrigerated air.
   c. If the temperature drops while the filter is out of the system and increases significantly once it is put back in place, the filter should be replaced with a new one and the control cabinet monitored again.

Dual-Phase Extraction (DPE) Autodrain Module

The Dual-Phase Extraction (DPE) module with the auto-drain feature was introduced by RSI as a means to accomplish two separate tasks:

1. First, simply as an auto drain system to remove unwanted condensate from the process automatically. It works by separating entrained liquids that condense from the extracted air/fuel soil vapor during the normal soil vapor extraction (SVE) process. The “vapor phase” is directed into the internal combustion engine (ICE) for oxidation purposes, and the liquids are held inside the holding tank of the DPE module. Once the liquid inside the holding tank reaches a predetermined level at the sensor, a pump (capable of overcoming the ongoing high vacuum SVE process) is turned on to discharge the liquid to a holding tank or an oil water separator, pending further treatment. If only water is present in the DPE tank, (in other words, no free floating product is present), the DPE module may discharge its contents directly into RSI’s Spray aeration module for further treatment. Normally this process creates minimal amounts of liquid, for example 10 to 20 gallons per day.
2. A second use for the RSI DPE module is to purposely remove both liquids and vapors from the subsurface by applying a high vacuum on a small diameter (1” or less) extraction “stinger” pipe located inside a groundwater/vapor extraction well. The high vacuum on the extraction pipe causes an increase in air velocity, which in turn “lifts” the liquid along with the vapor at varying rates, anywhere from 1 gpm (gallon per minute) to 10 gpm depending, upon site conditions and well construction. The “vapor phase” is directed into the internal combustion engine (ICE) for oxidation purposes, and the liquids are held inside the holding tank of the DPE module. Once the liquid inside the holding tank reaches a predetermined level, a pump (capable of overcoming the ongoing high vacuum SVE process and the rate of liquid influx) is turned on to discharge the liquid to a

holding tank or an oil water separator, pending further treatment. If only water is present (in other words, no free floating product is present), the DPE module may discharge its contents directly into RSI's Spray aeration module for further treatment. If product is present, it must be removed first (usually by an oil water separator), and then the remaining dissolved contaminants can be treated by the Spray Tank Module.

The major components of the Dual-Phase Extraction (DPE) Module are as follows:

- Holding Tank (aka) Vacuum Vessel, Knockout Tank
- Water Discharge Pump
- Float/Water Level Switches
- Safety Shutdown Switch
- Strainer

DPE tank does not automatically drain:

1. Verify that the Milltronics Probe has power (green light on). If not, trace power supply back to its source. If 12 volts present at source and no fuses are blown inline, then replace probe.
2. Verify that there is water/product above the Milltronics Probe sensor level.
3. Verify that the Milltronics Probe is detecting water/product (yellow light on). If not, and water/product is present, clean probe with mild acid wash solution and repeat test. If it still doesn't sense the water/product, check the sensitivity switch (see Milltronics Probe manual for greater detail). If that doesn't work, replace probe.
4. If the probe appears to be functioning fine, verify that the Milltronics Probe is closing its relay (red light on).
5. If so, verify that the Milltronics Probe's closed relay is allowing 12-volt signal to pump control relay.
6. Check for 12-volt power at pump control relay. It should be energized if Milltronics Probe relay is allowing 12-volt signal. If 12 volts are present before and not after, the pump control relay is not engaged under this condition, replace the relay.
7. If the pump control relay is energized, check the pump starter relay to verify that it is engaged. If not, replace pump starter relay.
8. If pump starter relay is engaged, check pump for correct operation. (See pump manual for complete information).
9. If motor turns, but no water flow, check for obstruction is the suction side of the line (most likely the strainer), or check for broken pump shaft or broken impeller. Repair or replace as needed.
10. If pump motor is not on and power is present, repair or replace pump motor.
11. Check the Dip Switch settings on the probe to ensure that the program settings are correct.

DPE tank air flow is obstructed:

1. Ball float check valve located inside well gas filter housing located on top of DPE tank is obstructing flow. Drain water or take assembly apart, clean and return to normal operation.
2. Replace well gas filter housing filter.

> **Note:** The discharge line from the DPE pump should be plumbed so as to always allow at least three feet of head. This will stop the pump from cavatating when first turned on as caused by pockets of air in the pump housing. Because the DPE tank is under vacuum while in operation, the pump is off. It is possible that a "leaky" check valve will allow air to enter the pump housing from the discharge line when not plumbed as described, therefore causing the pump to cavitate.

Engine

Controller will not turn on

1. Check fuses on the breakout board.
2. Check for a good ground connection between the black ground wire and the negative terminal with a voltmeter.

3. Check for a 12-volt signal coming into the controller via the red power wire with a voltmeter.

The controller will not go into the "caution starting engine" mode even when the key is fully turned:

1. Check the connections on the wire from the ST terminal on the ignition key switch to the breakout board, pin # 14, “key turned in”. If no voltage is being sent, the ignition key switch is faulty. Insure the ignition key is in the “On” position.

The controller has power, but will not turn over the engine when in the "caution starting engine" mode (See also: Alternator & Battery in this Troubleshooting section)

1. Measure the battery voltage before trying to start. If it is less than 12 volts, the battery is not in good condition. If the battery drops below 11 volts or the engine starts turning but can’t turn over normally, the battery needs to be charged or needs to be replaced. The system will reset to the beginning menu if voltage drops below 8 volts.
2. Check for 12 volts at the starter solenoid port on the breakout board (pin # 9) and at the starter solenoid. If 12 volts are being sent to the starter solenoid, the problem is either the solenoid or the starter, not the controller. If 12 volts are not present, put the controller in the Manual Mode and check the voltage at the fuel solenoid coil or on the breakout board when the “mnl start” button is pressed. The voltage should match the battery voltage. If no voltage is present, check the fuses at the breakout board and check the controller fuel output as described in the “Checking the Phoenix Controller” section of this document.
3. If the battery voltage does not drop when the engine is trying to start and the engine has no response, something is wrong with the starter system. Put the controller in the Manual Mode and check the voltage at the solenoid coil when the “mnl start” button is pressed. This is done with a voltmeter. The voltage should match the battery voltage. If it does, the problem is in the solenoid or the starter motor, or the battery ground wire to chassis. If no voltage appears at the solenoid, check the fuses on the breakout board.

Engine Turns Over, But Will Not Start

1. Check fuel supply.
2. Check that all valves are open and adequate fuel supply is present. Check the propane tank or loosen the natural gas fitting (with everything turned off) to hear the gas flow. This is the most likely problem.
3. Check the fuel solenoid valve for proper operation.
4. Check the voltage at “fuel solenoid” on the breakout board, pin # 8. 12 volts should be evident at the solenoid during operation. If 12 volts are not present, put the controller in the Manual Mode and check the voltage at the fuel solenoid coil or on the breakout board when the “mnl start” button is pressed. The voltage should match the battery voltage. If no voltage is present, check the fuses at the breakout board and check the controller fuel output as described in the “Checking the Phoenix Controller” in Chapter 5 of this document.
5. Check the propane regulator and propane regulator safety vacuum lock-off for proper operation.
6. Check for incorrect initial carburetor valve positions (air/fuel mixture).

> **Note:** Go to the Checking The Phoenix Controller - Manual Mode section of the document and experiment with a variety of valve positions for air and fuel. If a successful start occurs, note the valve positions on the display and consider resetting initial air position and initial fuel position as described in Program Control above. Climate or system load may affect initial start positions, but if system has been operating properly and no site conditions have changed, the problem probably lies elsewhere. If further troubleshooting is required, go to the “Checking the Phoenix 1000 Carburetor” section of this document to isolate this potential problem. Use method 3 if possible as it is the easiest and quickest test.

7. Check for Electrical/Ignition problems -(i.e. no spark) bad coil/breakout board voltage or bad distributor. Check for correct rotation. The simplest and quickest way to check the ignition is with a timing light. As the engine cranks, the light should flash regularly. If it doesn’t flash, check power to the ignition.
8. Check distributor, cap, rotor or spark plug wires.
9. Check for vacuum leak or pinched vacuum line to propane regulator lockout.

10. Check fuel solenoid valve for correct operation (you may temporarily bypass this solenoid valve in the event propane is the alternate fuel source and a propane regulator equipped with a vacuum lock off safety device is present).
11. Check for bad coil and/or ignition module (change both items as a set).
12. Check to insure there are no intake manifold or other vacuum leaks upstream of the automatic carburetor.
13. Check the air to the engine. Ensure that there are no blockages to air passage such as a very dirty air cleaner or flame arrester. Check the carburetor air valve as described in the "Checking the Phoenix 1000 Carburetor" section of this document. Use method 3 if possible as it is the quickest.

Engine is running, but not correctly or Engine runs rough, stalls after startup, or can not obtain idle RPM:

1. Check for loose, cracked, or broken spark plug wire(s).
2. Check for fouled/broken spark plug(s).
3. Check for bad distributor, cap, or rotor.
4. Check for plugged catalytic converter.
5. Check for plugged flame arrestor.
6. Check for Fuel supply contamination or restriction.
7. Check for bad propane regulator.
8. Check for vacuum hose leak (loose fitting) at propane regulator vacuum lock off safety device.

Engine Is Stalled With No Fault Indication And Will Not Restart:

1. Check the battery. Measure the battery voltage before trying to start. If it is less than 12 volts, the battery is not in good condition. If the battery drops below 11 volts or the engine starts turning but can't turn over normally, the battery needs to be charged or needs to be replaced. The system will reset to the beginning menu if voltage drops below 8 volts.
2. Check the Ignition. The simplest and quickest way to check the ignition is with a timing light. As the engine cranks, the light should flash regularly. If it doesn't flash, check power to the ignition.
3. Check the Fuel to the Engine. By whatever means appropriate, make sure the alternate fuel source is available. Check the propane tank or loosen the natural gas fitting (with everything turned off) to hear the gas flow. This is the most likely problem.
4. Put the controller in the Manual Mode and check the voltage at the fuel solenoid coil or on the breakout board when the "MNL start" button is pressed. The voltage should match the battery voltage. If no voltage shows, check the fuses at the breakout board, check the "fuel" relay on the breakout board, and check the controller fuel output as described in the controller section below.
5. If the fuel source is there and the solenoid is operating, the problem may be in the carburetor fuel valve. Go to the carburetor check section below to isolate this potential problem. Use method 3 if possible it is the easiest and quickest test.
6. Check the Air to the Engine. Make sure that there are no blockages to air passage such as a very dirty air cleaner, plugged catalytic converter or flame arrestor. Check the carburetor air valve as described in the carburetor check section below. Use method 3 if possible it is the easiest and quickest test.

Engine Stalled with no Fault indication, but restarts and runs normally:

1. The most likely cause for this problem is the lack of makeup fuel (propane or natural gas). If the system had plenty of fuel at the time of the stall, the situation may be difficult to diagnose. A few things to look for and consider are listed below:
2. Consider a sudden change in well conditions - use the "Get History" option in the host software and then "Get Fast Buffer 1&2" data, to look at what led up to the event.
3. Check for intermittent electrical connections.
4. Check for loose screw terminals or loose wires in lugs.
5. Check for cables not well seated or not screwed to the controller.
6. Check for excessive corrosion or dirty connectors.
7. Frozen fuel, air or well lines.
8. Air cleaner has become blocked or clogged.
9. Catalytic Converter is plugged.

Engine Stalled with a "STATUS" indication:

1. Note the display/fault indication and check the appropriate engine or system fault. If auxiliary systems can be disabled without causing damage to the system, try disconnecting them and their auxiliary Murphy input and restart the engine. If the unit runs fine with the suspect system disabled, that system is likely at fault.
2. Please see "System Shutdown Conditions/Phoenix Controller Status Displays" chart in the Appendix B at the end of this document.

The Engine runs but will not achieve idle speed:

1. Check for any restriction in the fresh airflow into the automatic carburetor (dirty air cleaner, etc.). There should be no restriction in any of the plumbing upstream of the automatic carburetor in the fresh air, fuel or well lines.
2. Check for any vacuum leaks in the system.
3. Check for exhaust back-pressure. (Catalytic Converter is plugged.)
4. Check for clogged intake spark arrestor.

Engine Cooling

The cooling system for the I.C. engine consists of the radiator, hoses and the thermostat located in the engine block. Most of the systems have coolant routed to the propane lockout unit mounted on the firewall. There is an in-line thermostat mounted on the feed hose to the lockout. Some systems have coolant routed to a Spray Aeration tank mounted on the trailer. Neither the propane lockout nor the Spray Aeration tank will affect the operation of the cooling system for the I.C. engine.

If the engine temperature is suddenly reading high, there are a few possible problems that could be the cause.

1. Inspect the radiator, engine and area underneath the system for evidence of leaks. Check the coolant level in the radiator by visually checking the plastic coolant reservoir. If no leaks are found but the reservoir is low, fill to 40% full with a mixture of 50% coolant and 50% water. Restart engine and monitor temperature.
2. The radiator could be clogged internally or externally. Inspect the surface of the radiator for foreign material that could cut down the cooling capability of the radiator. Internal clogging generally does not cause the temperature to increase quickly unless the radiator has been operating in a clogged condition and suddenly can't achieve cooling capacity due to temperature changes or load changes. If internal clogs are suspected, have the radiator pressure washed and flushed. Restart engine and monitor temperature.
3. The thermostat could be stuck in the closed position. Replace the thermostat and restart engine and monitor temperature.
4. The engine could have a damaged head gasket or crack in the block or a head.
5. The engine could also be operating at a higher than normal temperature because of distributor timing. Generally the I.C. engine will not operate correctly if the timing is not adjusted correctly but if the engine has jumped time or the distributor has been adjusted for any reason, the temperatures could be above normal. This can be ascertained by the use of a timing light or emissions analyzer. Contact the RSI service department before adjusting the timing on any RSI system.

Fire Suppression System (Automatic)

There are no user serviceable components in the automatic fire suppression system. After a fire, follow the instructions found in the Walter Kiddee Fire Control System Maintenance and Service documentation available on the Product Support CD supplied with this manual. If the automatic fire suppression system failed to activate during a fire in the RSI system, contact the RSI service department immediately.

Genset Module

Caution: THE GENSET MODULE OUTPUT CAN HARM OR KILL A PERSON. PLEASE TAKE ALL PRECAUTIONS WHEN PERFORMING TROUBLESHOOTING OR TESTING SYSTEM!

For troubleshooting information concerning the Genset Module, please refer to the Troubleshooting section in the Marathon Electric Maintenance and Service documentation available on the Product Support CD supplied with this manual.

Inlet And Exhaust Flow Measurement/Flow Interface Box

The RSI Flow Box Host Software Version 2.xx ("FBHost") is another powerful software program in the suite of software programs available through RSI. (See literature and documentation regarding other software products available from RSI.) The RSI Flow Box hardware, when coupled with the pressure differential velocity probe, provides the ability to:

- Measure the static line pressure, pressure differential, and temperature in a given process flow,
- Compute the flow rate in various sizes of pipe corrected to standard cubic feet per minute (scfm) based on certain constants and measurements taken by the pressure differential velocity probe, and
- Redefine the parameters/constants such as pipe size, moisture content, molecular weight of the vapor stream, and altitude/elevation for each of the flows monitored by the RSI Flowbox..

The RSI Flow Box Host Software (FBHost Software) provides the ability to:

- Read process gas flows (in scfm) and gas temperatures, line pressures and pressure differential for each flow measured, two per flow box, and
- Receive and record all pertinent data into the Phoenix Controller for future download via a unique graphical user interface and PHHost Software.

See the Troubleshooting section in the Flow Box Interface documentation available on the Product Support CD supplied with this manual

Modem

If the modem doesn't work, replace with new. This must be purchased from RSI as it is a modified US Robotics Sportster Modem, Model 00568603 designed to run off of 12 volts DC.

Oil/Water Separator

See the Troubleshooting section in the Parkson Maintenance and Service documentation available on the Product Support CD supplied with this manual.

Project Manager Proportional Valve Control

The Project Manager valves are operated through an on-board multiplexer PCB. If one or more PM valves are not operating correctly, the problem is in the PCB or the motors that open and close the valves. If all of the valves are non-operational, the problem may be in the interconnect cable or the controller.

From the controller, try to operate each of the valves independently to decide if the problem is with all valves or not. If the system has more than one Project Manager on the system, test the second Project Manger using the controller. A failed cable between the controller and the first Project Manager could keep all valves on all Project Manager units from operating. Remove the first cable connected between the controller and the first Project Manager and swap the cables from any other Project Manager into that position and retest. If the valves begin to work, the problem is in the cable. If the Project Manager is still non-operational, the problem is either in the controller or the first Project Manager. Each Project Manager is switch selected as the first, second and so forth in the system. Contact the RSI service department for instructions on changing the switch settings in the Project Managers.

Positive Displacement Blower Module

Positive displacement blowers generally fail in only two modes. The first is when the PD blower is seized after not being operated for some time or serviced correctly by changing the fluid per the recommended schedule. The second failure mode is over-heating during operation.

The PD blower is seized:

1. Disconnect the drive belt or coupling to the PD blower. Disconnect any pipes or hoses attached to the inlet or outlet of the PD blower.
2. Try to turn the shafts of the blower by hand or with a wrench, taking care to protect the shaft from damage from the wrench.
3. If the shaft will not turn, spray a light oil such as WD-40 or Liquid Wrench into the inlet and outlet of the blower. Lightly tap on the end of the shafts with a hammer or mallet to free any rust or deposits hampering the PD blower from rotating. Repeat step 2 again to see if the blower has freed itself.

The PD blower is operating at high temperature:

1. Disconnect any pipes or hoses attached to the inlet or outlet of the PD blower.

Caution: It is imperative that anyone near the system be equipped with hearing protection!

2. Start the I.C. engine and operate the blower without any restriction on the inlet or outlet ports.
3. Monitor the temperature of the PD blower while operating without restriction. If the temperature of the PD blower is in the normal range, inspect all parts and equipment on the inlet and outlet circuits of the blower to locate blockages or restrictions.

Note: The restriction doesn't need to be complete to cause overheating. Even a slight restriction on either side of the blower will cause a problem.

4. Fix or replace suspected components that are causing a blockage or restriction and reassemble the blower system. Operate the PD blower, monitoring the temperature for overheating.
5. Check the oil level.

Spark And Flame Arrester

Spark Arrester (located on the exhaust system)

If the back pressure in the system's exhaust is excessive and not allowing the I.C. engine to breathe correctly and tests have been performed on the catalytic converter, the problem may exist in the spark arrester. If the pressure drops across the catalytic converter indicate that it is operating correctly, remove the Spark Arrester from the catalytic converter to determine if this part is at fault..

Flame Arrester (located between the engine intake manifold and the Phoenix carburetor)

If the engine is not performing correctly and there is indication that the I.C. engine is starving for air and/or fuel, the flame arrester may be fully or partially clogged. It is possible to clean this component well enough to reinstall and test the engine. If the I.C. engine operates better and doesn't starve for air or fuel after cleaning, plan on replacing the flame arrester as soon as possible.

Caution: Never operate the I.C. engine without this safety component in place!

Spray Aeration Module

The Water Sys (Water Systems) Tab in the host software or the System Data 7 in the controllers menu provides the ability to view the status of both the Spray Aeration Vacuum Extraction (S.A.V.E.™) module and the Dual-Phase Extraction module if either or both optional modules are present in the Phoenix Unit.

Vapor and/or liquids are pulled into the Dual-Phase Extraction unit by a vacuum applied to the Well. The Dual-Phase Extraction unit separates the vapor from the liquid. Depending on your configuration, the vapor is forwarded directly to the Internal Combustion Engine (ICE) where the Volatile Organic Compounds (VOC) are burned. Also depending on your configuration, the liquid in the Dual-Phase Extraction unit is either pumped to a separate storage tank or the liquid is sent to an Oil-Water Separator.

Both the optional Dual-Phase Extraction (DPE) process and the optional Spray Aeration (Air-Stripping) process are diagrammed on the Water System tab. Both the Dual-Phase Extraction module and the Spray Aeration module provide the ability to take polluted groundwater (also known as "influent") and separate the water from volatile organic compounds (V.O.C.). Both modules take the volatile organic compound (V.O.C.) vapors to the Internal Combustion Engine (I.C.E.). The I.C.E. burns and destroys the vapor containing the V.O.C. The Water Sys tab displays a diagram of both the Spray Aeration module and Dual-Phase Extraction module. Data that reflects the status of each system is presented in text boxes adjacent to the respective features as shown in the on-screen piping and instrumentation diagram. Units of measure are indicated next to the data windows. Flow arrows and descriptive notes are presented as an aid to understanding system operation.

The RSI S.A.V.E.™ (Spray Aeration Vapor Extraction/Air Stripping) module provides the ability to separate dissolved contaminants from the groundwater and treat these contaminants as a vapor that can be burned by the I.C.E.

The Spray Aeration/Air Stripping module uses a vacuum to draw the liquid into a Spray Aeration Tank. Once inside the S.A.V.E.™ Chamber, the liquid is heated using a liquid-to-liquid heat exchanger and/or optional electric heating elements. The heated liquid is then atomized under pressure using spray nozzles. Volatilization helps the water give up the contaminant. The vapor that is produced is sent to the I.C.E. where it is burned.

A re-circulating water pump and a jet pump work together to continue circulating the liquids in the Spray Aeration Chamber. To enhance and balance the process, ambient air (clean air from the surrounding area) may be added to the Spray Aeration Chamber through an Air Inlet Valve. Internal limit switches such as the High Water Level and Low Water Level switches monitor the liquid level in the Spray Aeration Chamber and provide feedback to the Phoenix Controller. The Phoenix controller is responsible for tank filling and draining sequences.

Spray Aeration Process Does Not Allow Water To Enter The Spray Aeration Tank:

1. The controller has not yet reached O_2 mode.
2. The Spray aeration tank has not yet reached it programmed vacuum set point (process will not begin until set point is reached).
3. Although the spray tank reached its vacuum set point, it has now dropped below that set point turning the water treatment system off.
4. Inlet filter to the spray tank is clogged.
5. Inlet solenoid valve is not receiving 12 volt power.
6. Inlet solenoid valve is clogged with debris.
7. Actuator on the solenoid valve needs to be replaced.

Spray Aeration Process Does Not Allow Water To Discharge From The Tank:
1. The controller has not yet reached O2 mode.
2. The Spray aeration tank has not yet reached it programmed vacuum set point (process will not begin until set point is reached.
3. Although the spray tank reached its vacuum set point, it has now dropped below that set point turning the water treatment system off.
4. Discharge filter to the spray tank is clogged.
5. Discharge solenoid valve is not receiving 12 volt power.
6. Discharge solenoid valve is clogged with debris.
7. Actuator on the solenoid valve needs to be replaced.
8. Pump pressure has dropped below 15 psi.

Water Pressure From The Re-circulation Pump Does Not Build Up:
1. There is no water in the spray tank, or the water level isn't at the minimum water level point.
2. There is air in the pump line and it needs to be bled out of the pump.
3. The motor isn't turning the pump shaft.
4. The pump shaft is broken.
5. The impeller is broken.
6. Pressure sender isn't working.

Vacuum Does Not Build Up In The Spray Aeration Tank
1. Vacuum set point is set too low or at zero.
2. Spray Tank is allowing air to enter from point other than Visi-Flow gage (rotometer).
3. Spray Tank Vac Valve is not 100% closed.
4. Well valve on the carburetor has not yet opened to apply vacuum.
5. Well valve hasn't opened to a point to allow enough air flow to create vacuum.

Jet Pump Doesn't Appear To Be Removing Condensate From Various Sources Causing The System To Shut Down To High Water Alarm:
1. Jet pump requires cleaning.
2. Discharge filter is causing too much of a pressure drop therefore jet pump will not work, replace/clean discharge filter.

Supplemental/Alternate Fuel Control System

Although there are two different alternate or supplemental fuels used with the RSI system, problems with the supplemental fuel control system are generally identified by troubleshooting from the carburetor back through the system. When troubleshooting a fuel supply problem, check the system in the following manner:

1. Ensure there is natural gas (7" to 10" H_20) or liquid-draw propane available at the three-way valve mounted below the propane regulator/lockout assembly. Ensure the procedure used to verify fuel is in keeping with accepted safe practices.
2. Check the fuel safety cutoff solenoid to ensure that it is operating. The solenoid is opened while the system is calibrating or operating. It is possible to ascertain if the solenoid is operating by holding the solenoid and turning the ignition key to "Calibrate" position. An audible "thunk" or "click" should be heard and the solenoid will vibrate as the plunger moves to open the passageway.
3. If there is doubt the solenoid is operational, it can be removed from the system and tested by applying 12 volts DC to the lead wires of the solenoid. It is possible to see if the plunger is operating inside the solenoid housing.

When natural gas is used as an alternate fuel:
1. Ensure the three-way valve mounted below the propane regulator/lockout assembly is positioned correctly for natural gas operation.

2. While the I.C. engine cranking to start, monitor the movement of the meter on the gas meter located inside the engine compartment. The dial should be rotating as fuel moves through the meter. Lack of movement on the meter face indicates that there is a blockage at the carburetor, the fuel safety cutoff solenoid or the three-way valve.
3. Review the troubleshooting instructions for the carburetor in this section. Disassemble the fuel feed circuit to locate the blockage in the fuel system if required.
4. Ensure proper line pressure and size.

When propane is used as an alternate fuel:

1. Ensure the three-way valve mounted below the liquid-draw propane regulator/lockout assembly is positioned correctly for propane operation.
2. Ensure the propane regulator and lockout are not frozen. This is usually obvious because the assembly will be covered in frost due to the temperature of the propane. A frozen condition indicates that the coolant from the engine is not keeping the assembly at a constant temperature. If the assembly is frozen, remove the thermostat from the coolant lines and reconnect.
3. While the I.C. engine cranking to start, monitor the movement of the meter on the gas meter located inside the engine compartment. The dial should be rotating as fuel moves through the meter. Lack of movement on the meter face indicates that there is a blockage at the carburetor, the fuel safety cutoff solenoid, the three-way valve or the propane regulator/lockout assembly.
4. Review the troubleshooting instructions for the carburetor in this section. Disassemble the fuel feed circuit to locate the blockage in the fuel system if required. Instructions for disassembling the propane regulator and lockout are located in the Troubleshooting section in the Impco Maintenance and Service documentation available on the Product Support CD supplied with this manual.

Well Gas Filter Housing And Water Trap

Housing Will Not Drain:

1. Ensure there is enough water in the housing to test the drain outlet.
2. Disconnect all of the connections attached to the drain outlet of the tank. If water flows out of the tank, there is a blockage in the fittings or hoses attached to the outlet bung of the housing.

The Optional Tank High Level Switch Will Not Activate A High Water Shutdown:

1. Inspect the wires connected to the optional high-level switch, looking for broken wires or connections.
2. Disconnect the wires that are connected to the questionable switch at the furthest connection point from the switch.
3. Using an ohmmeter, connect the probes of the meter to the ends of the wires.
4. Remove the switch from the tank and activate that switch while watching the ohmmeter. The meter should indicate continuity through the circuit. If it does show continuity, the problem is in the connection between those wires and the controller, including the Breakout PCB or any other wiring harness in the circuit.
5. If the ohmmeter doesn’t indicate continuity, remove the probes from the wires and connect them directly to the terminals of the high level switch.
6. Reactivate the switch and watch the ohmmeter for an indication of continuity. If the switch shows continuity, the problem is in the wiring and the switch is functional.
7. If the ohmmeter doesn’t show continuity, the switch is bad and should be replaced.

Water Is Drawing Through The Well Filter Housing Into The Engine:

1. Inspect the filter inside of the housing for damage to the sealing surface or the filter substrate material. Damage anywhere on the filter allows water and particulates to move through the housing without being filtered.

Well Vacuum Is High And Air Flow Through The Filter Housing Is Low:

1. Inspect the filter inside of the housing for excessive contamination that would restrict airflow. Replace if necessary.

2. Inspect inlets and outlets of filter housing for blockages. Use compressed air to blow through all ports to verify that they are clear of debris and blockages.
3. Disconnect hose to well and retest system for vacuum and flow. If the system is operating normally, the problem is in the hose or the well.

Well Gas (Larger Capacity Options)

Tank Will Not Drain:

1. Ensure there is enough water in the tank to test the drain outlet.
2. Disconnect all of the connections attached to the drain outlet of the tank. If water flows out of the tank, there is a blockage in the fittings attached to the outlet bung of the tank.

The Optional Tank High-Level Switch Will Not Activate A High Water Shutdown:

1. Inspect the wires connected to the optional high-level switch, looking for broken wires or connections.
2. Disconnect the wires that are connected to the questionable switch at the furthest connection point from the switch. This switch may be connected in parallel to the high level switch located in the well gas filter housing located on the V-3 or V-4 unit or it may be connected directly at the Breakout PCB located in the controller cabinet.
3. Using an ohmmeter, connect the probes of the meter to the ends of the wires.
4. Remove the switch from the tank and activate that switch while watching the ohmmeter. The meter should indicate continuity through the circuit. If it does show continuity, the problem is in the connection between those wires and the controller, including the Breakout PCB or any other wiring harness in the circuit.
5. If the ohmmeter doesn't indicate continuity, remove the probes from the wires and connect them directly to the terminals of the high level switch.
6. Reactivate the switch and watch the ohmmeter for an indication of continuity. If the switch shows continuity, the problem is in the wiring and the switch is functional.
7. If the ohmmeter doesn't show continuity, the switch is bad and should be replaced.

Troubleshooting Tables

Standard Controller Shutdown Alarms

Alarm Display	Full Name	Description	Cause	Controller Board	Source/ Pin#
H_2O_S	High Water Level Safety Switch grounded	Dedicated high water level switch	Ground pin for 5 sec	Cont I/O	24
AUX2	Ground signal from undefined component	Undedicated system shutdown for customer use	Ground pin for 5 sec	Cont I/O	25
FIRE	Fire, shutdown	Dedicated Fire suppression system activated	Fire sensor switch closed	Cont I/O	Software
ENG_T	Engine Coolant Temp Over Limit	Dedicated Coolant temperature monitor	Engine temperature > 210 F	DAQ Input	38
OIL_P	Low Oil Pressure	Dedicated Pressure Sender Engine oil pressure monitor	Engine oil pressure < 20	DAQ Input	39
E_CAT	Engine Post or Pre Cat Temp Over Limit	Dedicated Engine pre or post Cat temperature	Temperature > 1350 deg F	DAQ Therm	Software
V_LMT	Air or Fuel Valve Over Limit	Dedicated Valves remain above maximum level Set Point	Valve positions > switch setting	Cont I/O	Software
RPM	RPM Over Speed Over Limit	Dedicated Engine RPM exceeded Set Point	RPM > switch setting	Cont I/O	Software
REC_P	Low Recirculating Pump Pressure	Dedicated Pressure Sender Recirculating Pressure Monitor	Recirculating pressure < 3psi	DAQ Input	58
SPR_T	Spray Tank Temperature Over Limit	Dedicated Temp Sender Spray Tank Temperature Monitor	Spray Tank Water Temp > 160 F	DAQ Input	59
STALL	Engine Stalled	Engine stalled for no apparent reason	Unknown	Cont I/O	Software

Additional inputs for Enhanced Controller Only

Alarm Display	Full Name	Description	Cause	Controller Board	Source/ Pin#
BLO_T	CatOx Blower Temp	Dedicated Thermal Sender CatOx blower	Ground pin for 5 sec	CatOx I/O	54
LEL	LEL	Dedicated LEL sensor monitor	LEL > (Set Point + 10%)	CatOx I/O	53,12
C_CAT	CatOx Inlet or Outlet Temp	Dedicated CatOx inlet or outlet temperature	Temperature > 1250 deg F	CatOx Therm	Software
P1/P2	Pressure Switch	Dedicated Pressure Sender on Filters	Ground pin for 5 sec	CatOx I/O	57

Murphy System Shutdown Conditions Description & Troubleshooting

Display	Name	Description; Troubleshooting
AUX_V	AUX Volt	Auxiliary Voltage (generator)
AUX2	Aux2 Murphy	Undedicated system shutdown. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 25 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. (pin # 25 is normally 8-9 volts DC when not grounded on the break out board).
BATT	Battery	System Battery Voltage. This fault condition is caused by a hard coded software limit being exceeded, usually caused by the alternator, voltage regulator & coil (change as a set), or other electrical problem.
BLO_T	CatOx Blower Temp	Thermal switch on CatOx blower. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 54 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. (pin # 54 is normally 8-9 volts DC when not grounded on the break out board).
C_CAT	CatOx Outlet Temp	CatOx outlet temperature. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to CAT-OX overheat, check type K thermal wire(s) and connector(s) that is(are) connected to controller and to the type K temp probe(s) on the CAT-OX to make sure wire is securely fastened at both locations and no shorts exist. Replace probe(s) or repair wiring/wiring connections as necessary.
COMP_R	Compress Press	Compressor Pressure Low
E_CAT	Post Cat Temp	Engine post Cat temperature. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to automotive catalyst overheat (i.e. unburned hydrocarbons coming from the engine due to spark plug(s) fouled, spark plug wires malfunctioning, ignition timing, faulty carburetor, faulty controller, bad engine, etc.), check type K thermal wire(s) and connector(s) that is(are) connected to controller and to the type K temp probe(s) on the automotive catalyst to make sure wire is securely fastened at both locations and no shorts exist. Replace probe(s) or repair wiring/wiring connections as necessary. Also, make sure temp probes are not grounded out to exhaust system.
ENG_T	Engine Temp	Coolant temperature monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to engine overheat (i.e. bad thermostat, bad water pump, clogged radiator, etc.), check wire connected to pin # 38 on the breakout board and the temp sender on the engine to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary.
FIRE	Fire Murphy	Fire suppression system activated. This fault condition is caused by the automatic fire extinguisher system being activated. Refer to manual for service information.

Display	Name	Description; Troubleshooting
H_2O_S	Aux1 Murphy	Undedicated system shutdown. A high-level float switch activation causes this fault condition. Check all float switches to verify none are activated or switched. Replace or repair as necessary. Float switches exist in the well gas filter housing, the spray aeration tank, the DPE tank, and are wired in series to pin # 24 (normally 8-9 DC volts when not grounded) on the break out board.
LEL	CatOx LEL	LEL sensor monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to high LEL, check wire connected to pin # 53&12 on the breakout board and the LEL sender in the engine compartment to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary. See GASTECH LEL service manual for further information.
OIL_P	Oil Pressure	Engine oil pressure monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to engine low oil pressure (i.e. bad oil pump, kinked oil line, clogged oil cooler, bad engine, etc.), check wire connected to pin # 39 on the breakout board and the pressure sender on the engine to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary.
P1/P2	Delta P1/P2	Pressure switch on water filters. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 57 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. Pin # 57 is normally 8-9 VDC when ungrounded on the breakout PCB.
RECIR	Recirc Press	Recirculation Pressure Low. This fault condition is caused by a hard coded software limit being exceeded. If it happens during the initial starting sequence, it is generally a lack of pressure in the re-circulation pump. During normal operation, this is generally due to no water in the spray aeration tank caused by a faulty level probe or faulty solenoid valve, an air leak in the suction side of the pump or the pump seal is damaged. Turning the water treatment system off, via the toggle switch on the front panel, will override this input. If no spray aeration tank is present, yet problem persists, then pin #26 on the breakout PCB may be mistakenly grounded.
RPM	High RPM	Engine RPM monitor. This fault condition is caused by a hard coded software limit being exceeded, usually caused by major air fuel ratio changes due to site specific conditions.
STALL	Stalled condition	System unable to start. This fault condition is caused by a hard coded software limit being exceeded. If it happens during the initial starting sequence, it is probably due to the engine being cold. During normal operation, this is generally due to an interrupted fuel supply, faulty gas solenoid valve, propane lock off malfunction (vacuum hose came loose), or oil in the propane.
TIME	Time's up	Operational Time has expired
Vlim	Valve limit	Valve runaway. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to the engine not being able to breath (usually caused by automotive catalyst plugging causing back pressure in excess of 1.5 psi or the intake spark arrestor being plugged), ignition timing, faulty carburetor or faulty controller, then the problem probably is with the fuel supply. Check Propane for excessive oil, check vacuum hose connected to vacuum safety lock off to make sure it is securely connected, check 1" solenoid valve for correct operation.
WTEMP	Water Temp	Spray Tank Water Temp High

Phoenix-1000 Default Settings 8.xx releases

SET POINT MENU	8-Cyl	6-Cyl	4-Cyl	Description / Notes
				Requires Menu Access or Customer Override Code
Running RPM	1800	1800	2000	Changing this setting may affect system performance unless other settings are modified.
Max Engine Well Vacuum (in$H_2$0)	300	300	300	Well valve will not open past H2O set point
Max CatOx Well Vacuum (in$H_2$0)	190	190	190	Well valve will not open if Well vacuum is above the set point
Data Save Interval (minute)	60	60	60	Data save at 60 will save 27 days of data. Clear History before changing this setting.
Total for Menu				

CONTROL MENU	8-Cyl	6-Cyl	4-Cyl	Description / Notes
				Requires Menu Access or Customer Override Code
Selected Data Set	0	0	0	0=none, all custom; 1=Data Set 1, 2=Data Set 2, etc.
Idle RPM	1800	1800	1800	Changing this setting may also affect initial air and fuel valve positions described below
Air Initial Position	90	50	40	Adjust to site-specific conditions, i.e. climate, elevation, load and fuel type.
Fuel Initial Position	85	55	35	Adjust to site-specific conditions, i.e. climate, elevation, load and fuel type.
Min Tank Vacuum (inches Hg)	23	23	23	Set at 14 if water treatment system is present
Target O_2	1800	1800	1800	Should always remain at factory settings if present in programming
KFRRun O_2	35	35	35	Should always remain at factory settings if present in programming
Number of Restart Attempts	1	1	1	Automatic restart or remote start feature is subject to local governing agencies.
Remote Start Enable / Disable	0	0	0	Change as required
Fuel Ratio (0=Demod, 1=O_2 @ Temp)	1	1	1	Should always remain at factory settings if present in programming
Fuel Type (0=Propane, 1=Natural Gas)	0	0	0	Set to appropriate setting
Modem Speed (0=2400, 1=4800, 2=9600)	2	2	2	May need to reduce modem speed for cellular. Must be at 9600 for DSD 1000 transfer
Number of Cylinders (4,6,8)	8	6	4	Set to appropriate setting
Emergency Phone #1 Area Code	0	0	0	Change as required, 0 for area code means local call
Emergency Phone #1 Prefix	0	0	0	Change as required, 0 for prefix means don't dial
Emergency Phone #1 4 Digits	0	0	0	Change as required
Emergency Phone #2 Area Code	0	0	0	Change as required
Emergency Phone #2 Prefix	0	0	0	Change as required
Emergency Phone #2 4 Digits	0	0	0	Change as required
System Access Code	1234	1234	1234	Change as required to protect entry into system operation
Control Menu Access Code	xxxx	xxxx	xxxx	Change as required to protect entry into customer access control menu

Phoenix-1000 Default Settings 7.xx and earlier releases

START OF SET POINT MENU	Scale Factor	8-Cyl	6-Cyl	4-Cyl
Idle RPM	1 bit / RPM	1800	1800	1800
Idle Time (sec)	1 bit / sec	60	60	60
Running RPM	1 bit / RPM	1800	1800	2000
Warm-up Time (sec)	1 bit / sec	60	60	60
Max Well Opening (%)	1 bit / %	100	100	100
Tank Vacuum (inches Hg)	1 bit / in. Hg.	10	10	10
Manifold Vacuum (inches Hg)	1 bit / in. Hg.	12	12	12
Engine Cranking Time (sec)	1 bit / sec	7	7	7
Number of Cylinders (4,6,8)	1 bit / Cyl	8	6	4
Max RPM Shutdow n/Restart	1 bit / RPM	3000	3000	3000
Printer Enable (0=Off, 1=On)	0 = off, 1 = on	0	0	0
Fuel Type (0=Propane, 1=Natural Gas)	0 = Pro, 1 = NG	0	0	0
START OF CONTROL MENU	**Scale Factor**	**8-Cyl**	**6-Cyl**	**4-Cyl**
Modem Speed (0=2400, 1=4800, 2=9600)	N/A	2	2	2
Data Save Interval (minute)	1 bit / min	60	60	60
Data Print Interval (minute)	1 bit / min	10	10	10
Number of Restart Attempts	1 bit / attempt	1	1	1
Air Initial Position	1 bit / step	90	50	40
Fuel Initial Position	1 bit / step	85	55	35
Fuel Max Start Position	1 bit / step	95	65	45
Startup Fuel Valve Step Rate	1 bit / step	20	20	20
Well Valve Increment (steps)	1 bit / step	20	20	20
Max AIR Opening	1 bit / step	150	150	150
Max FUEL Opening	1 bit / step	150	150	150
Delta RPM Limit for Well Dec	1 bit / RPM	100	100	100
Max DRPM for Well Valve Dec	1 bit / RPM / sec	600	300	150
Max VAC Opening	1 bit / step	300	300	300
KRPM	gain	125	125	125
START OF CONTROL MENU	**Scale Factor**	**8-Cyl**	**6-Cyl**	**4-Cyl**
KDRPM	gain	50	50	35
KVacuum	gain	10	10	10
Target Air/Fuel Mix	1 bit / %	100	100	100
Demodulator Amplitude	1 bit / step	2	2	1
Emergency Phone #1 Area Code	N/A	0	0	0
Emergency Phone #1 Prefix	N/A	0	0	0
Emergency Phone #1 4 Digits	N/A	0	0	0
Emergency Phone #2 Area Code	N/A	0	0	0
Emergency Phone #2 Prefix	N/A	0	0	0
Emergency Phone #2 4 Digits	N/A	0	0	0
Emergency Phone #3 Area Code	N/A	0	0	0
Emergency Phone #3 Prefix	N/A	0	0	0
Emergency Phone #3 4 Digits	N/A	0	0	0
Access Code	N/A	1234	1234	1234
Access Code (Verify)	N/A	1234	1234	1234

Chapter 7

MAINTENANCE

Air Compressor Module

The air compressor modules are air-cooled systems driven from the engine crank pulley or a rear mounted PTO. These modules are lubricated with the engine oil lubricating system through feed and return hoses which attach at the base of the compressor. The air output attachment is made from the manifold located at the top of the compressor.

The compressor module should be inspected every 360 hours of operation for oil leaks, output pressure and oil contamination in the air output. The oil hoses should be inspected for cracks, abrasions and cuts. The hose clamps should be inspected for tightness. Vibration during operation can cause the compressor to become loose on the mounting bracket or the components of the compressor assembly to become loose enough to seep oil and leak air. All components of the compressor should be checked to ensure that bolts and screws are tightened sufficiently to prevent any such leakage.

The pressure relief valve mounted should be tested monthly to ensure safe operation of the system. This is achieved by closing the output line of the air compressor with a valve while watching a pressure gauge attached to the same output line. The pressure relief valve should release pressure at approximately 110 psi.

Alternator & Battery

It is also helpful to compare current operating values against previously taken measurements (“baseline” or “snapshot” samples taken under static conditions). If these readings are taken (and recorded) at regular intervals, it will be easier to see what, if any, changes have taken place over time. Use the chart below to establish baseline values for the Alternator during operation.

ALTERNATOR BASELINE CHART

Baseline	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Voltage												

Automatic Oil Level Regulator

The Automatic Oil Level Regulator is a self-contained assembly that only needs to be kept level with respect to the engine block and at the correct height in reference to the specified oil level within the engine oil pan. It is recommended that the face of the regulator be cleaned with glass cleaner as necessary to provide visual verification of operation.

Note: Do not attempt to adjust this device without contacting the RSI service department first.

Carburetor

The carburetor should be visually inspected monthly to ensure that the control cable is not bound, pinched or burnt. The hoses and clamps that secure the hoses to the carburetor should be checked monthly to ensure there is no leakage to the carburetor. If the carburetor has an air filter installed, the air filter should be replaced every 4000 hours of operation or sooner as required.

Catalytic Converter

The catalytic converter has no maintenance that needs to be performed, but monitoring of the efficiency is critical to the performance of the IC engine and the emissions of the entire system. A baseline chart for monitoring the operation and performance is included below.

Baseline		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	Pre-Cat												
	Post-Cat												
Pressure	Pre-Cat												
	Post-Cat												
Gases	CO												
	NOx												
	VOC												

Cat-Ox Module

100 Hour Maintenance Checks:

1. Check blower drive belt tension and wear.
2. Lubricate PTO bearings at all fittings.
3. Lubricate blower and check oil levels.
4. Check pipe mounts, brackets, and connections for security - loose piping will allow the piping to vibrate resulting in excess noise and damage.
5. Check hoses and piping for signs of wear or damage - replace if necessary.
6. Check for excess moisture accumulation in the moisture knockout tank - drain if necessary.
7. Check for excess moisture accumulation in the blower silencer - drain if necessary.
8. Check all air filter-silencer elements for particulate clogging - replace or clean elements if necessary.

Monthly Maintenance Checks:

1. Check operation of Murphy Switch - simulate over limit conditions of temperature controllers, LEL sensor, and pressure switch to shut down the machine. Ensure that programmed settings and contacts are set correctly. Only check programmed set points; do not change. If programmed set points are not correct, contact RSI.
2. Check electrically actuated valves for correct position under simulated and/or operating conditions.
3. Check component-mounting bolts for security - tighten as required.
4. Check operation of all moving parts to ensure they are free to operate and that belts are tight.
5. Check operation of the automotive catalytic converter - measure emissions reduction and temperature rise across the converter. Replace converter if not operating efficiently.
6. Check for system vacuum or pressure leaks.
7. Calibrate and adjust LEL sensor with GasTech 81-0260-02-calibration kit. Refer to Safe T Net manual for calibration description and procedure.

Note: Calibration should be performed more often if necessary.

Other Maintenance Guidelines:

1. Catalyst - Refer to the Johnson Matthey Oxidation Catalyst (OR EQUAL) Operations Manual for catalyst description, operation and maintenance.
2. Heat Exchanger - Refer to Exothermic-Eclipse Stainless Air to Air Heat Exchangers, Installation/Operation & Maintenance Guide.
3. Wiring - Check for instrument panel wiring that may have vibrated loose. The vibration of the S.A.V.E.™ System may cause wiring connections to work loose and eventually disconnect, resulting in system failure and/or electrical shorts. Thermocouple wires should also be checked for shorts and/or discontinuity. A short in thermocouple wiring can result in incorrect temperature measurement, as the controller will measure the temperature at the short.
4. Natural Gas Fuel Leaks - Natural gas or propane leaks should be avoided by checking the integrity of all piping through the application of soapy water to all joints and fittings. If a natural gas or propane odor is detected, the S.A.V.E.™ System should be immediately shut down and the source of the leak determined through the application of soapy water to the piping system. System leaks require immediate repair, as the fuel system is under constant pressure regardless of whether the S.A.V.E.™ System is operating or not. Do not attempt to determine the source of leak through the use of an open flame. If a leak is suspected or detected, properly ventilate the area prior to beginning repairs; do not turn electrical switches either on or off. Do not use electric fans or power tools and do not attempt to restart the engine until the repairs are complete and the area has been properly ventilated.
5. Gasoline Fuel Leaks - The source of vagrant gasoline vapors will usually relate to leaks within engine compartment, CAT-OX, or the connections within the manifold piping. Gasoline vapors are not prone to leaking from well connections when the S.A.V.E.™ System is operating because the system operates under vacuum. Gasoline vapors are heavier than air and will drop to the lowest possible level. Any source of ignition can cause an explosion. If a leak is suspected or detected follow the same procedures mentioned in item 4.
6. Automotive Catalytic Converters – The automotive catalytic converter located in the engine enclosure should be replaced when worn out or after 4,000 hours of operation. Proper operation of the converters may be checked by measuring the temperature differential of the sample ports located in the engine exhaust piping before and after the converter. A temperature rise should occur after the converter due to conversion of NOx, CO, and unburned hydrocarbons. If the outlet temperature is lower than the inlet, it may indicate a problem. An engine exhaust analyzer is recommended to determine whether a converter is functional by measuring the decrease of NOx CO or hydrocarbons through the converter. The converters can also be checked for excessive pressure. If there is a pressure drop across the catalyst greater than 1.5 psig at 2000 RPM it is recommended that the converters be replaced.

Note: When burning vapors from leaded fuel, converter life is shortened and should be checked at least every 500 hours. Automotive catalytic converters are readily available from RSI.

Controller

The controller should be kept as dry as possible at all times. The front panel membrane should be cleaned periodically with window cleaner to keep the membrane free of contaminants that may permeate the plastic and cause damage. When a controller is being removed or installed into a V-3 or V-4 system, the technician handling the controller should be grounded to the cabinet of the system or to an earth ground.

Note: Never touch the connectors directly unless grounded correctly.

Controller Compartment Cooling & Filtering

The controller compartment needs to stay as cool as possible during storage and operation. A muffin fan is installed in the controller compartment to move air across the controller enclosure and the breakout PCB. An air filter is mounted at the fresh air inlet to the compartment. The muffin fan should be inspected for operation every 2500 hours. Excessive noise, erratic rotation or non-operation is cause for immediate replacement. The fresh air filter should be replaced every 1440 hours.

Dual-Phase Extraction (DPE) Autodrain Module

The outside of the DPE vessel is powder coated to match the base system. The inside is coated with a 3M epoxy compound to protect the tank from rust and other contaminants. The tank is normally filled by vacuum as provided by the engine intake manifold. A periodic cleaning will keep this vessel in good working order.

A 12-volt circuit normally powers the water discharge pump. A 220 three-phase model is available on request. Discharge pressure should be monitored to determine if downstream blockages are occurring. Monitor the check valve on the discharge side of the pump and replace o-ring when necessary. Check the strainer on the suction side of the pump and clean when necessary.

> **Note:** It is very important that all connections to and from the pump are tight and allow no leakage. Any leak will cause air to enter the pump, causing it to become air-bound (cavitate). Leaks will eventually destroy the pump. The discharge from the pump should always be plumbed into the bottom portion of the holding tank. This will insure that a constant head pressure is present on the discharge stream of the pump.

The safety shutdown switch shuts down the entire process if it is activated for more than five continuous seconds. This event is usually caused by high water conditions. The safety shutdown switch should be tested routinely for correct operation and replaced when malfunctioning. The float/water level switches control the process flow. These switches should be removed prior to any acid washing of the tank, and re-installed when acid wash is complete. The strainer should be disassembled and the filter elements cleaned (or replaced) periodically.

Dual-Phase Extraction (Autodrain) Module Maintenance

See operating description in Phoenix Host Software section. For discharge pump maintenance, see manufacturer's instructions included in RSI Operations Manual. The major components of the Spray Aeration Module are as follows:

Holding Tank/Vacuum Vessel

The outside of the DPE vessel is powder coated to match the base system. A periodic cleaning will keep this vessel in good working order. The tank is normally filled by vacuum as provided by the engine intake manifold.

Water Discharge Pump

The water discharge pump is normally 12 volt, (or 220 three phase on request). Discharge pressure should be monitored to determine if downstream blockages are occurring. Check the strainer on the suction side of the pump and clean when necessary. Check the check valve on the discharge side of the pump and replace o-ring when necessary.

> **Note:** It is very important that all connections to and from the pump are tight and allow no leakage. Any leak will cause air to enter the pump, causing it to cavitate and eventually destroy the pump. The discharge of the pump should always be plumbed into the bottom portion of the holding tank to insure constant head feet of pressure is always present on the discharge stream of the pump.

Float Level Switches

The float level switch controls the process flow. These switches should be removed prior to any acid washing of the tank, and re-installed when acid wash is complete.

Safety Shutdown Switch

The safety shutdown switch shuts down the entire process if it is switched for more than 5 continuous seconds, usually caused by high water conditions. This switch should be tested routinely for correct operation and replaced when malfunctioning.

Strainer

This should be disassembled and the filter elements cleaned (or replaced) periodically.

Electronics

All electronics within the RSI V-3 and V-4 should be kept as moisture free and dust free as possible. Every three months all electrical circuitry and systems should be inspected for moisture and particle contamination. Warm, dry and oil free, compressed air blown across the circuitry should remove any moisture, dust and particles that could cause short circuits and damage. Products made specifically for keeping electrical circuits water resistant are available at most electronics stores. Contact the RSI service department if you have questions concerning the use of a specific product.

Engine

After initial start up (and after a lengthy storage), visually check the unit inside and out on a weekly basis until the first scheduled maintenance. Although certain maintenance requirements can be limited to two visits per 720/hrs, it is strongly recommended that the unit be visited every week as complications, other than maintenance, can arise from system operation. Air Quality Monitoring may be required in more frequent intervals as permit conditions dictate. Catalytic converters and filtration components may need replacement more frequently than noted, depending on site conditions.

Maintenance Schedule	Frequency
Check All Fluid Levels	Each visit
Check Battery and Battery Connections	Each visit
Check and Drain Moisture Knockout Tank	Each visit
Check Emergency Contact Switches	Each visit
Check Belts & Hoses	Each visit
Exhaust and Intake Manifold Bolts Tightened (Check torque req.)	Once at 360 hours
Oil Change/Replace Oil Filter	Every 180 to 360 hours
Spark Plugs Replaced (or sooner if fouling occurs)	Every 720 hours
Fresh Air and Well Gas Filter Replaced	Every 720 hours
Rotor & Cap Replaced	Every 2160 hours
PCV Valve Repair or Replaced	Every 2160 hours
Radiator Pressure Washed and Degreased	Every 2160 hours
Check Propane Filter	Every 2160 hours
Spark Plug Wires Replaced	Every 2160 hours
Flame Arrester Serviced or Replaced	Every 2160 hours
Coolant Changed & Radiator Flushed	Every 4320 hours
Catalytic Converters & O_2 Sensor Replaced (or sooner if fouled or plugged)	Every 4320 hours
Ignition Module and Coil Replaced (both as a set)	As needed

Note 1. See torque specifications in Operators Manual. Perform only when engine is cold.

*UPON INITIAL START-UP (AND AFTER A LENGTHY STORAGE) RSI ADVISES THAT THE USER VISUALLY CHECK THE UNIT MORE OFTEN THAN SCHEDULED MAINTENANCE EVENTS DICTATE. AIR QUALITY MONITORING AND/OR WATER DISCHARGE SAMPLING MAY BE REQUIRED IN MORE FREQUENT INTERVALS AS PERMIT CONDITIONS SPECIFY.

IMPORTANT: CERTAIN SITE CONDITIONS, SUCH AS LEADED FUELS, EXCESSIVE DUST AND TEMPERATURE EXTREMES MAY REQUIRE MORE FREQUENT SERVICING OF COMPONENTS THAN OUTLINED ABOVE. THIS MAINTENANCE SCHEDULE IS INTENDED TO PROVIDE GENERAL MAINTENANCE ADVICE AND MAY REQUIRE MODIFICATION TO FIT ACTUAL SITE CONDITIONS.

RSI SYSTEMS ARE DESIGNED TO OXIDIZE PETROLEUM HYDROCARBONS [NON-CHLORINATED HYDROCARBONS] IN THE NORMAL COMBUSTION PROCESS OF AN INTERNAL COMBUSTION ENGINE. ANY COMPOUNDS PRESENT IN THE EXTRACTED AIR STREAM OTHER THAN PETROLEUM HYDROCARBONS OR ATMOSPHERIC CONSTITUENTS MAY CAUSE DAMAGE TO THE ENGINE.

Engine Maintenance

Before working on any part in the engine compartment, turn the unit off and wait until the engine and exhaust system has cooled down sufficiently. As with any machine, care should be taken when making any check, doing any maintenance, or making any repair to avoid being injured. Improper or incomplete service could also result in the machine not working properly, which may result in personal injury or damage to the machine or its equipment. If you have any questions about carrying out any service, contact **REMEDIATION SERVICE INT'L**.

Caution: Shut off engine before adjusting, repairing, cleaning, or servicing any components. Under no circumstances should the operator or maintenance personnel attempt to clean or service the unit or its ducting system (vacuum) while the engine is running. The only exception is the performing of an ignition timing check.**

****ONLY AUTHORIZED AND TRAINED PERSONNEL are allowed to perform this task.**

Engine Oil

REMEDIATION SERVICE INT'L MODEL V3/V4 is equipped with an automatic oil level regulator and an oil reservoir.

The oil level regulator is <u>PRESET</u> at the factory to maintain the oil in the engine at the proper operating level. <u>DO NOT</u> attempt to adjust this device as overfilling or low oil level can occur.

When checking the oil level before start up, check both the dipstick and the reservoir level. Make sure the reservoir is filled cold to the proper level.

Never overfill the oil reservoir. Heat expansion may cause oil to overflow. Never fill the crankcase over the proper level indicated on the dipstick as overheating can occur.

<u>IMPORTANT</u>: Turn the reservoir valve "off" when changing oil or transporting. Make SURE the valve is "open" for normal engine operation.

<u>CAPACITIES:</u> **RESERVOIR – 8 or 12 QTS.**
CRANKCASE – 10 QTS without oil filter.*

*For good engine life and extended servicing periods, your **MODEL V3/V4** is equipped with one oil filter mounted on the block. After oil changes, run the engine for a short time and check the oil level in the reservoir to insure proper oil level.

APPROVED ENGINE OIL is a **LOW** ash oil. Some low ash oils are as follows

CHEVRON U.S.A.-		Delo 400 15W40
EXXON-		XD-3 Extra 15W40
MOBIL OIL	-	1300 Super
SHELL OIL	-	Rotella T 15W40
TEXACO INC	-	URSA Super Plus 15W40
UNION OIL	-	Guardol 15W40
VALVOLINE FLEET		15/W40

Change oil when engine is **WARM**. The oil can only be checked accurately when the machine is leveled. Do not check the oil immediately after stopping the engine, as the oil in circulation takes a few minutes to drain down into the sump. The oil should be in the "SAFE" area on the dipstick, but never below the "ADD" or above the "SAFE" mark.

The oil is to be changed according to the maintenance schedule found elsewhere in this manual.

Engine Spark Plugs

For replacement use resistive spark plugs. Proper plug gap is .040 TO .045. See Maintenance Schedule for proper intervals.

The spark plugs are to be changed according to the Maintenance Schedule found elsewhere in this manual.

Note: Some engine blocks/heads require a larger size plug with the same specification. Please verify size before replacing.

Engine Spark Plug Wires

For replacement. use resistive spark plug wires.

The spark plug wires are to be changed according to the Maintenance Schedule found elsewhere in this manual.

Engine Timing

36° BTDC (below Top Dead Center) at 1800 RPM (36° advanced).
See Maintenance Schedule for ignition timing check interval.

Engine Intake Manifold

Tighten bolts with torque wrench to 35 foot-pounds.
See Maintenance Schedule for maintenance interval

Engine Exhaust Manifold

Tighten bolts with torque wrench to 30 foot-pounds.
See Maintenance Schedule for maintenance interval

Engine Oil Filters

See Maintenance Schedule for replacement intervals

Note: One (1) filter is required at each oil change

Engine Drive Belts

Check monthly to make sure all drive belts are tight and in good condition. See Maintenance Schedule for replacement intervals.

Note: Two (2) drive belts are required to keep the water pump and fan from slipping. Always replace both belts at the same time.

Engine Air Cleaner

If the engine air cleaner is removed during repair or maintenance, make sure that it is replaced before start up to prevent engine damage.

See Maintenance Schedule for maintenance interval.

Engine Well Gas Filter

If the engine well gas filter is removed during repair or maintenance, make sure that it is replaced before start up to prevent engine damage.

See Maintenance Schedule for maintenance interval.

Engine Cooling

The radiator and hoses should be checked each time the system is started. Cracks, punctures or obvious leaks indicate the hoses should be replaced immediately. Check the hose clamp for proper tightness. The hoses and thermostat should be replaced each year as part of a preventative maintenance program. The radiator should be drained and flushed after every 4000 hours of operation. If replacing, the thermostat, it is necessary to drill two (2) $^1/_8$" holes in the thermostat. Please see the original thermostat for location.

Note: When adding or replacing coolant, use a mixture of 50%approved coolant and 50% water. Never add water or pure coolant to the system.

Fire Suppression System (Automatic)

Caution: THE SQUIB CARTRIDGE, WHICH AUTOMATICALLY ACTIVATES THE SYSTEM, IS AN EXPLOSIVE DEVICE. SEE THE MATERIAL SAFETY DATA SHEET MATERIAL DATA SHEET - CARTRIDGE), AND THE WALTER KIDDE INSTRUCTION MANUAL FOR IMPORTANT SAFE HANDLING INFORMATION.

AFTER FIRE CONTROL SYSTEM DISCHARGE

1. Find the cause of the Fire Control release.
2. Arrange to have the necessary corrections and repairs made.
3. Call a qualified fire equipment distributor and have the system recharged and reset into a normal operating condition.
4. Contact Remediation Service Int'l to reset fire shutdown settings in computer.
5. Clean the dry chemical residue by washing (cleaning) exposed surfaces thoroughly with clean, dry, low-pressure compressed air.

Note: The dry chemical agent used in this system may corrode metal surfaces. It is important to clean and remove any residue from metal surfaces as soon as possible. This compound can cause skin irritation or burns.

INSPECTION AND MAINTENANCE

Caution: THE BATTERY SHOULD BE DISCONNECTED WHEN WORKING ON THE FIRE CONTROL SYSTEM.

MONTHLY

1. Check all parts of system for physical damage, corrosion, or for loose parts and fittings.
2. Inspect the fire sensors. If they are coated with mud, grease or dirt, wipe with a clean, dry cloth. If foreign matter cannot be removed, the sensor must be replaced with a new sensor with the same rating.
3. Inspect the cylinder and gauge. The cylinder should not show any signs of mechanical damage, rust or corrosion. The nameplate must be legible. The pointer on the gauge should point to the green "Service Pressure" area on the gauge face. If the system fails to pass any of these checks or inspections, call a qualified, licensed, fire equipment service agency immediately for maintenance service.

SEMI-ANNUALLY

The following procedures must be accomplished every six months by a qualified fire protection service agency or a factory-trained representative, in accordance with the detailed procedures specified in the Factory Instruction Manual. It is the owner's responsibility to arrange and schedule these required procedures on a semi-annual basis.

1. The cylinder and valve must be disconnected from the system. The flexible piping or hoses are then blown out only with clean, dry air or nitrogen to verify that these lines are clean and free of obstruction.

2. The Nitrogen Actuation Cylinder must be removed and inspected for physical damage, rust and corrosion. It must be weighed and its weight must be within 1/2 ounce of the weight stamped on the cartridge. If the cartridge does not meet these inspection requirements, it must be replaced.

EVERY SIX YEARS
The dry chemical agent in the cylinder should be discarded and replaced with a fresh recharge of the same agent in accordance with the instructions on the nameplate of the cylinder. A qualified fire equipment distributor should only do recharging.

EVERY TWELVE YEARS
The cylinder containing the dry chemical agent must be hydro-tested by a qualified fire equipment distributor for compliance with National Fire Protection Association (NFPA) pamphlet 17. The hydro test procedure used must comply with the Compressed Gas Association (CGA) pamphlet C-6, "Standards for Visual Inspection of Compressed Gas Cylinders", and C-1, "Methods for Hydro Testing of Compressed Gas Cylinders".

If the cylinder is mechanically damaged, or has any signs of rust or corrosion, then the cylinder must be inspected and tested, as outlined above before the twelve-year interval.

Frame And Housing

The frame and housing need very little maintenance. The condition of the powdercoating should be inspected semiannually to locate areas of rust that can be cleaned and repainted. RSI carries touchup enamel that can be applied in the field to maintain protection for the metal housing. Stress fractures and cracks should be looked for during the inspection process.

Genset Module

Caution: THE GENSET MODULE OUTPUT CAN HARM OR KILL A PERSON. PLEASE TAKE ALL PRECAUTIONS WHEN PERFORMING MAINTENANCE OR SAFETY CHECKS!

The Genset module should be inspected every 360 hours. The Marathon Genset unit should be kept dry and free of dust. It is advised that the Genset unit be blown off with warm, dry oil-free compressed air if moisture or excessive dirt or dust is found on unit during inspection.

Voltage and current output should be tested per the Marathon Electric Maintenance and Service documentation available on the Product Support CD supplied with this manual. All other maintenance and service should be performed in strict adherence with that document to provide employees and service personnel with detailed safety instruction. The Marathon Electric Maintenance manual will describe the schedule and method necessary to keep the Genset module operating to specification.

Note: The Genset module must be operated at the correct RPM rating during operation, troubleshooting and maintenance checks.

Oil/Water Separator

Note: Please review all safety practices listed in section one before proceeding. This equipment must be operated and maintained only by authorized personnel who have read and understand the operator's manual, have been trained in its use, and following any and all applicable safety procedures.

Tankage
Inspect the integrity of all gaskets around the lids. Any signs of deterioration or undesired leakage should be attended to at once. Ensure that all gasket materials on flanges are in good condition to prevent any leakage problems.

Oil Removal
Oil should be drawn off regularly and not allowed to accumulate. If left unattended, the accumulated oil volume will increase to a point where it will begin to interfere with the operation of the coalescer pack.

A simple method to determine a schedule for oil removal is outlined below:

1. Determine the oil capacity of the unit.
2. Allocate an area/tank for storing and decanting the accumulated oil.
3. Arrange for the proper disposal of the oil, either by further treatment or by having a service dispose of the waste.
4. Oil is designed to flow by gravity. Check to make sure the oil can freely drain from the equipment. If the outlet gets plugged, the oil will flood the separation chamber and begin to seep into the effluent chamber.

Oil Skimmer (Sleeve Type)
Every six months (or as needed) remove and clean the oil skimmer assembly as follows:

1. Parkson recommends replacing the 0-rings every time you disassemble the oil skimmer.
2. Slide the sleeves (X2) toward the middle of the oil skimmer pipe just enough to clear the end of the wall pipe.
3. Remove the oil skimmer from the unit.
4. Slide the sleeves off the oil skimmer pipe.
5. Remove and inspect the 0-rings (X4) from the sleeve. Replace if necessary.
6. Wipe a little (sparingly) grease on the 0-rings.
7. Slide the sleeves toward the center of the oil skimmer pipe so the sleeves are even with the end of the skimmer pipe.
8. Install the oil skimmer back in the unit and line up with the wall pipe. Slide the sleeves back over the wall pipe so that the center of the sleeve is in the middle of the wall and skimmer pipe joint.
9. The oil skimmer is now ready for service.

Effulent Quality
Regularly monitor the quality of the effluent leaving the separator. If any loss in effluent quality is observed, steps should be taken to correct the problem immediately.

Coalescer Pack
Frequency of cleaning will be dependent on the characteristics of the wastewater being processed by the media. Periodic visual Inspection will determine the frequency of cleaning.

Monitor the quality of the effluent water. If the quality starts to deteriorate, this is an indication that the media may need replacement or cleaning.

Clogged Solids In The Tank
Clogged solids may be due to inert debris or biological growth within the tank. If it is biological, shock-dose the system with a chorine or biocide product. Expose the media to this solution for a reasonable amount of time to eradicate the growth. Following the biocide application, use a water stream to loosen and remove the debris from the media. If flushing in place is not enough, remove the media from the tank. Use ordinary hose to create a pressure stream. The maximum pressure so as not to damage the media is 20 psi. After biological growth has been eradicated, remove the media from service. Cleaning compounds can then be used to remove debris and hydrocarbon film that retains solids trapped in the openings. Spray the cleaning compounds directly on to the packs.

> **Note:** While the packs are out of service or being reinstalled, take precautions so as not to damage them. Mechanical damage is a result of mishandling or accident. Take extra care in handling the media.

Media Damage In The Tank
Replacement is generally recommended when the media is physically damaged or when the media openings have been plugged by sludge to the point that it is difficult or impossible to clean them. It is also prudent to investigate the cause of media damage -whether it is mechanical or chemical and to take corrective actions.

Chemical Damage In The Tank
Chemical damage is a result of the introduction of harmful chemicals in the Influent water or cleaning compounds that may have been used to flush the media of debris or clogged solids. Selected solvents harmful to the media include: benzene, toluene and chlorinated substituted organics.

The maximum tolerable temperatures of the wastewater for the following types of media are:

Media	Temperature
PVC	130^0F (60^0C)
CPVC	200F (93^0C)
Polypropylene	160F (71 C)

When replacement is required, remove the media logs from the equipment.

The slant rib coalescing media is a standard product of GLE. This is available In PVC, CPVC, polypropylene, polyethylene, carbon steel or stainless steel. When ordering, specify:

a. the material
b. the plate spacing
c. the size of the logs
d. the number of logs required

Dense Pack (If Provided)
The dense pack assembly is comprised of a 6-inch polyester reticulated foam with 20 pores per inch. The foam has a life expectancy of about 13.5 years under normal conditions. However, exposure to high temperature (150 degrees Fahrenheit or more) will degrade the foam at a much faster rate. The foam is also vulnerable to water at a high pH (10.5 and higher).

Because the openings in the foam are so fine, any solids trapped in the orifices will deteriorate the performance of the dense pack. The presence of any solids in the dense pack is in itself an indication that something is not right. Check the quality of the wastewater. There should be minimal solids carry-over by the time the water reaches the dense pack. High viscosity oils (90-150 SSU) in time will also cause clogging of the pores.

Deterioration in the quality of the effluent might be caused by the degradation of the dense pack. Check the integrity of the foam. If the foam has eroded away to a point where it is impractical to dean, replacement is the solution. If cleaning is an option, spray the foam using high-pressure clean water. If this is still not sufficient, soaking the foam in any kerosene-based solution might free any viscous oil dogging the pores of the foam.

Full preventative maintenance and service instructions are found in the Parkson Maintenance and Service documentation available on the Product Support CD supplied with this manual.

Positive Displacement Blower Module

Proper lubrication is the single most important consideration in obtaining maximum service life and satisfactory operation from any positive displacement unit. Unless operating conditions are severe, a weekly check of oil level and necessary addition of fluid should be sufficient. During the first week of operation, check the oil levels in the sumps about once a day. Check for leaks at all seams and openings.
The oil should be changed after the initial 100 hours of operation. At operating temperatures of 200 degrees F. or less, the life expectancy of high quality petroleum based oil is 2000 hours. Consistent operating temperatures above 200 degrees F. reduce the life of the lubricant by half for every 20 degrees F. above 200 F. In extremely dusty environments the oil should be changed more often.

Full preventative maintenance and service instructions are found in the Dresser/Roots Maintenance and Service documentation available on the Product Support CD supplied with this manual.

Power Take-Off (PTO)

It is important to grease (heavy bearing grease) the PTO shaft. This prevents the bearings (oil impregnated type) from drying out.

Spark And Flame Arrester

The spark arrester requires no maintenance but should be replaced after every 4000 hours of operation. The flame arrester should be checked for cleanliness every 2160 hours of operation. The flame arrester can be cleaned with a solvent or petroleum based product but the flame arrester must be blown dry before reinstallation. It is recommended that the flame arrester be replaced once it has been cleaned instead of continuing to clean and reinstalling.

Spray Aeration Module

The outside of the spray vessel is powder coated to match the base system. The inside is coated with a 3M epoxy compound to protect the tank from rust and other contaminants. The tank is normally filled by vacuum as provided by the engine intake manifold. A periodic cleaning will keep this vessel in good working order.

Inlet and outlet filters should be checked every 180 hours of operation or sooner depending upon the specific site water conditions. Depending on the type and volume of contamination, the filters may be cleaned or replaced as needed to keep the system fully operational.

> **Note:** It is very important that all connections to and from the water re-circulation pump are tight and allow no leakage. Any leak will cause air to enter the pump, causing it to become air-bound (cavitate). Leaks will eventually destroy the pump. The discharge from the pump should always be plumbed into the bottom portion of the holding tank. This will insure that a constant head pressure is present on the discharge stream of the pump.

On the units equipped with a spray aeration tank, the Servo Valve (labeled "vac" valve) is connected to the controller. The quantity of air coming from the well is controlled in order to maintain vacuum and air stripping flow from the spray tank. The spray tank valve ("vac" valve) will open and close based upon the actual spray tank vacuum as compared to the "set point" vacuum.

Maintenance Requirements for Hard Water Scaling Problems

Water with high amounts of total dissolved solids (TDS), such as iron, calcium, manganese, and other minerals, flocculate or "come out" of solution when using air-stripping technology causing certain maintenance conditions that need to be addressed for this pump and treat processes. This problem has been a challenge to the environmental industry since the inception. We will address one method that we are most familiar with, and that is filtration as it applies to the RSI spray aeration/air-stripper system.

RSI's spray aeration process is, for all practical purposes, an air-stripper. RSI has made several enhancements to its water treatment process over the past years, to include the minimization of the effects of TDS in the extracted groundwater. In many instances the system can be used "as is" with no additional filtration (other than provided) with simple preventative maintenance, (i.e.) quarterly mild acid baths of the various components. Other sites require more frequent maintenance intervals, and some sites must have additional filtration and/or water pretreatment, or they won't run at all. The untreated TDS interferes with the design process. On sites such as these, site-specific solutions must be considered.

If it becomes necessary to add components to the process, RSI will assist you in implementing your final design into our process. We will help in anyway possible, but are hesitant to provide an engineered solution as this is outside the realm of our expertise. It has been our experience that high TDS sites may require site-specific solutions.

Maintenance intervals are dependent upon the severity of the hard water problem. Please do not hesitate to call RSI should you have any questions or require further information.

Major Components of Spray Aeration Module

The major components of the Spray Aeration Module are as follows:

Spray Tank/Vacuum Vessel

The inside of the spray aeration vessel is coated with a 3M^{tm} "non stick" epoxy. The outside is powder coated for all weather conditions. A periodic mild acid wash will keep this vessel in good working order.

> **Note:** All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Water Pump

The water pump is used in three different, but related, processes.

a. To extract the water from the Spray Tank at a process flow rate of 70 gpm. (The Spray Tank re-circulates 90% of the extracted water back into the spray tank through multiple nozzles.)
b. To continuously route the remaining 10% of the extracted water through a filter, then through a jet pump on the suction side of the jet pump for condensate removal, and then return the fluid to the spray tank.
c. To discharge treated water from the system. Discharge pressure should be monitored to determine if downstream blockages are occurring. A periodic mild acid wash will keep this pump in good working order.

> **Note:** All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Full Cone Spray Nozzles

These nozzles atomize the water into droplets for air-stripping purposes. A periodic mild acid wash will keep this component in good working order.

> **Note:** All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Jet Pump

The jet pump is used to create a vacuum greater than the normal process flow vacuum to "drain" condensate traps throughout the entire system. A periodic mild acid wash will keep this pump in good working order. The operating pressure of the jet pump must be maintained at >12 psi for proper operation.

> **Note:** All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Float Level Switches

The high and low float level switches control the process flow. These switches should be removed prior to any acid washing of the Spray Tank, and re-installed when acid wash is complete.

Note: All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Safety Shutdown Switch

The safety shutdown switch shuts down the entire process if it is switched for more than 5 continuous seconds, usually caused by a high water conditions. This switch should be tested routinely for correct operation and replaced when malfunctioning.

Liquid to Liquid Heat Exchanger

The liquid-to-liquid heat exchanger is a copper coil with copper fins designed to dissipate waste heat from the engine coolant to the extracted groundwater. The efficiency of this heat exchanger will diminish over time, as caused by "scaling". A periodic mild acid wash (on the outside) will keep this heat exchanger in good working order.

Note: All process airflow from the Spray Aeration Tank to the engine must be turned off prior to commencing with the acid wash process.

Solenoid Valves

The solenoid valves are controlled (indirectly) by the float level switches and allow process flow in or out of the spray tank as necessary. These valves should be disassembled and cleaned periodically.

Bag Filters (100 micron)

One bag filter filters total suspended solids (TSS) from the influent water prior to the spray aeration vessel, and another filters TSS prior to discharge. They should be disassembled and the filter elements cleaned (or replaced) periodically.

Rotometers

Influent and effluent water process flow rates are measured. These flow meters should be disassembled and cleaned periodically.

Supplemental/Alternate Fuel Control System

The supplemental/alternate fuel control system is heated by the engine coolant system through feed and return hoses attached to the propane lockout unit mounted above the propane converter. This heated circuit has a thermostat mounted in-line to maintain a constant operating temperature to the lockout unit to keep the unit from freezing due to the ambient temperatures of the liquid propane used. If the lockout unit is showing indications of freezing, replace the thermostat and check the coolant flow through that unit.

Both the propane lockout and converter can be disassembled and cleaned. Repair kits are available from RSI which include gaskets, diaphragms and other minor components. It is advised that if the system is operating with propane as the supplemental fuel, the lockout and converter be cleaned and serviced semi-annually.

Transporter

Following is a basic checklist to be performed before moving the transporter/trailer unit:

1. Hitch – Check to make sure the hitch is secure and that the ball on the towing vehicle and the hitch on the Transporter are the same size. The single axle Transporter requires a 2" ball on the hauling vehicle. The dual axle Transporter requires a 2-5/16" ball on the hauling vehicle.
2. Safety Chain – Make sure the safety chain on the Transporter is properly hooked to the towing vehicle.
3. Bolts – Make sure the machine V3/V4 housing is securely bolted to the Transporter.
4. Electrical Plug – Make sure the towing vehicle is wired with towing package electrical connections and that the electrical polarity of the Transporter is the same as the towing vehicle.
5. Break Lights – Make sure Transporter break lights are illuminated when the brakes on the towing vehicle are engaged.

6. Turn Indicators – Make sure the Transporter turn indicators work properly when the turn indicators of the towing vehicle are engaged.
7. Tire Pressure – Make sure the Transporter tires are filled to the manufacturer's recommended tire pressure.
8. Spare Tire – Make sure the Transporter spare tire is on the trailer and is filled to the manufacturer's recommended tire pressure.
9. Wheel Lugs - Ten (10) wheel lugs are set at 85# torque.

Every 5,000 miles the Transporter must be inspected for the following:

1. Inspect axle bearings and lubricate or service as required.
2. Inspect tires for excessive and uneven tread wear. Verify tire inflation pressure.
3. Inspect mechanical hitch for damage or excessive wear.
4. Test brake lights and turn signals.

Well Gas Filter Housing And Water Trap

The well gas filter cartridge should be checked after every 720 hours of operation. RSI stocks the replacement cartridges for any style of well gas filter assembly. Seal gaskets and O-rings should be inspected every 720 hours and replaced annually or as needed. Hose clamps, latches and bolts should be checked for tightness every 720 hours or as needed if a vacuum leak in the well circuit is suspected.

Well Gas (Larger Capacity Options)

Post-well gas filter holding tanks and pre-knockout tanks are both used to hold excess liquids coming from the well. The outside of the vacuum vessel is powder coated to match the base system. The inside is coated with a 3M epoxy compound to protect the tank from rust and other contaminants. The tank is normally filled by vacuum as provided by the engine intake manifold. A periodic cleaning will keep this vessel in good working order. Inspection for loose fittings and rust should be performed monthly to keep the vessels in good operating condition.

MAINTENANCE SCHEDULE

Maintenance Schedule		✓	Qty.	Maintenance Schedule - Continued		✓	Qty.
Check All Fluid Levels: (add as necessary)	each visit			Oil Change/Replace Oil Filter – Shell Rotella T 15/40 w/Advanced Soot Control	Every 180 to 360 hrs*		Qt.
Coolant, (record coolant temp): (°F)	each visit		Qt.	Exhaust and Intake Manifold Bolts Torqued [Note 1]	Once at 360 hours*		
Oil, (record oil pressure): psi	each visit		Qt.	Power Take Off & PD Blower(s) Serviced	Every 360 hours*		
Record Cat Temps: Pre (°F) Post (°F)	each visit			Spark Plugs Replaced – Autolite # AUT 25	Every 720 hours*		
Check Battery Connections and voltage: (DC)	each visit			Fresh Air and Well Gas Filter Replaced	Every 720 hours*		
Check & Drain Moisture Knockout Tank	each visit			Rotor & Cap Replaced	Every 2160 hours*		
Check Emergency Contact Switches	each visit			PCV Valve Replaced	Every 2160 hours*		
Check Spray Aeration and DPE Filters. Clean or Replace Spray Aeration/DPE Filters as needed	each visit			Spark Plug Wires Replaced – 8 mm premium conductive silicon core & silicon jacket	Every 2160 hours*		
Check Belts and Hoses	each visit			Check Propane Filter – Replace If Necessary	Every 2160 hours*		
Check Spray Aeration Heat Exchanger	each visit			Flame Arrestor Serviced or Replaced	Every 2160 hours*		
Check and Clean Spray Aeration Solenoid Valves	as needed			Radiator Pressure Washed and Degreased	Every 2160 hours*		
Replace Ignition Module and Coil (as a set)	as needed			Catalytic Converters & O2 Sensor Replaced	Every 4320 hours*		
Clean Flow Measurement Devices	as needed			Coolant Changed & Radiator Flushed	Every 4320 hours*		Gal.
Spray Aeration Heat Exchanger- mild acid wash	as needed			Fire Extinguisher System Serviced	Annually		

SPECIFY BRAND, MODEL & QTY OF ALL PARTS AND MATERIALS USED:	COMMENTS:

Note 1. See torque specifications in Operators Manual. Perform only when engine is cold.

*UPON INITIAL START-UP (AND AFTER A LENGTHY STORAGE) RSI ADVISES THAT THE USER VISUALLY CHECK THE UNIT MORE OFTEN THAN SCHEDULED MAINTENANCE EVENTS DICTATE. AIR QUALITY MONITORING AND/OR WATER DISCHARGE SAMPLING MAY BE REQUIRED IN MORE FREQUENT INTERVALS AS PERMIT CONDITIONS SPECIFY.

IMPORTANT: CERTAIN SITE CONDITIONS, SUCH AS LEADED FUELS, EXCESSIVE DUST AND TEMPERATURE EXTREMES MAY REQUIRE MORE FREQUENT SERVICING OF COMPONENTS THAN OUTLINED ABOVE. THIS MAINTENANCE SCHEDULE IS INTENDED TO PROVIDE GENERAL MAINTENANCE ADVICE AND MAY REQUIRE MODIFICATION TO FIT ACTUAL SITE CONDITIONS.

RSI SYSTEMS ARE DESIGNED TO OXIDIZE PETROLEUM HYDROCARBONS [NON-CHLORINATED HYDROCARBONS] IN THE NORMAL COMBUSTION PROCESS OF AN INTERNAL COMBUSTION ENGINE. ANY COMPOUNDS PRESENT IN THE EXTRACTED AIR STREAM OTHER THAN PETROLEUM HYDROCARBONS OR ATMOSPHERIC CONSTITUENTS MAY CAUSE DAMAGE TO THE ENGINE.

Chapter

8

DRAWINGS & BILLS OF MATERIALS

APPENDICES

APPENDIX A

Standard Controller Shutdown Alarms

Alarm Display	Full Name	Description	Cause	Controller Board	Source/ Pin#
H_2O_S	High Water Level Safety Switch grounded	Dedicated high water level switch	Ground pin for 5 sec	Cont I/O	24
AUX2	Ground signal from undefined component	Undedicated system shutdown for customer use	Ground pin for 5 sec	Cont I/O	25
FIRE	Fire, shutdown	Dedicated Fire suppression system activated	Fire sensor switch closed	Cont I/O	Software
ENG_T	Engine Coolant Temp Over Limit	Dedicated Coolant temperature monitor	Engine temperature > 210 F	DAQ Input	38
OIL_P	Low Oil Pressure	Dedicated Pressure Sender Engine oil pressure monitor	Engine oil pressure < 20	DAQ Input	39
E_CAT	Engine Post or Pre Cat Temp Over Limit	Dedicated Engine pre or post Cat temperature	Temperature > 1350 deg F	DAQ Therm	Software
V_LMT	Air or Fuel Valve Over Limit	Dedicated Valves remain above maximum level Set Point	Valve positions > switch setting	Cont I/O	Software
RPM	RPM Over Speed Over Limit	Dedicated Engine RPM exceeded Set Point	RPM > switch setting	Cont I/O	Software
REC_P	Low Recirculating Pump Pressure	Dedicated Pressure Sender Recirculating Pressure Monitor	Recirculating pressure < 3psi	DAQ Input	58
SPR_T	Spray Tank Temperature Over Limit	Dedicated Temp Sender Spray Tank Temperature Monitor	Spray Tank Water Temp > 160 F	DAQ Input	59
STALL	Engine Stalled	Engine stalled for no apparent reason	Unknown	Cont I/O	Software

Additional inputs for Enhanced Controller Only

Alarm Display	Full Name	Description	Cause	Controller Board	Source/ Pin#
BLO_T	CatOx Blower Temp	Dedicated Thermal Sender CatOx blower	Ground pin for 5 sec	CatOx I/O	54
LEL	LEL	Dedicated LEL sensor monitor	LEL > (Set Point + 10%)	CatOx I/O	53,12
C_CAT	CatOx Inlet or Outlet Temp	Dedicated CatOx inlet or outlet temperature	Temperature > 1250 deg F	CatOx Therm	Software
P1/P2	Pressure Switch	Dedicated Pressure Sender on Filters	Ground pin for 5 sec	CatOx I/O	57

APPENDIX B

Murphy System Shutdown Conditions Description & Troubleshooting

Display	Name	Description; Troubleshooting
AUX_V	AUX Volt	Auxiliary Voltage (generator)
AUX2	Aux2 Murphy	Undedicated system shutdown. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 25 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. (pin # 25 is normally 8-9 volts DC when not grounded on the break out board).
BATT	Battery	System Battery Voltage. This fault condition is caused by a hard coded software limit being exceeded, usually caused by the alternator, voltage regulator & coil (change as a set), or other electrical problem.
BLO_T	CatOx Blower Temp	Thermal switch on CatOx blower. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 54 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. (pin # 54 is normally 8-9 volts DC when not grounded on the break out board).
C_CAT	CatOx Outlet Temp	CatOx outlet temperature. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to CAT-OX overheat, check type K thermal wire(s) and connector(s) that is(are) connected to controller and to the type K temp probe(s) on the CAT-OX to make sure wire is securely fastened at both locations and no shorts exist. Replace probe(s) or repair wiring/ wiring connections as necessary.
COMP_R	Compress Press	Compressor Pressure Low
E_CAT	Post Cat Temp	Engine post Cat temperature. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to automotive catalyst overheat (i.e. unburned hydrocarbons coming from the engine due to spark plug(s) fouled, spark plug wires malfunctioning, ignition timing, faulty carburetor, faulty controller, bad engine, etc.), check type K thermal wire(s) and connector(s) that is(are) connected to controller and to the type K temp probe(s) on the automotive catalyst to make sure wire is securely fastened at both locations and no shorts exist. Replace probe(s) or repair wiring/wiring connections as necessary. Also, make sure temp probes are not grounded out to exhaust system.
ENG_T	Engine Temp	Coolant temperature monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to engine overheat (i.e. bad thermostat, bad water pump, clogged radiator, etc.), check wire connected to pin # 38 on the breakout board and the temp sender on the engine to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary.
FIRE	Fire Murphy	Fire suppression system activated. This fault condition is caused by the automatic fire extinguisher system being activated. Refer to manual for service information.

Display	Name	Description; Troubleshooting
H_2O_S	Aux1 Murphy	Undedicated system shutdown. A high-level float switch being activated causes this fault condition. Check all float switches to make sure none are activated/switched. Replace or repair as necessary. Float switches exist in the well gas filter housing, the spray aeration tank, and the DPE tank, and are wired in series to pin # 24 (normally 8-9 DC volts when not grounded) on the break out board.
LEL	CatOx LEL	LEL sensor monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to high LEL, check wire connected to pin # 53&12 on the breakout board and the LEL sender in the engine compartment to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary. See GASTECH LEL service manual for further information.
OIL_P	Oil Pressure	Engine oil pressure monitor. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to engine low oil pressure (i.e. bad oil pump, kinked oil line, clogged oil cooler, bad engine, etc.), check wire connected to pin # 39 on the breakout board and the pressure sender on the engine to make sure wire is securely fastened at both locations. Replace sensor or repair wiring as necessary.
P1/P2	Delta P1/P2	Pressure switch on water filters. This fault condition is caused by a ground-switch being activated. Check all external switches connected to pin # 57 on the breakout board to make sure none are activated/switched. Replace or repair as necessary. (pin # 57 is normally 8-9 volts DC when not grounded on the break out board).
RECIR	Recirc Press	Recirculating Pressure Low
RPM	High RPM	Engine RPM monitor. This fault condition is caused by a hard coded software limit being exceeded, usually caused by major air fuel ratio changes due to site specific conditions.
STALL	Stalled condition	System unable to start. This fault condition is caused by a hard coded software limit being exceeded. If it happens during the initial starting sequence, it is probably due to the engine being cold. If the engine has been running for a period of time, it is normally due to an interrupted fuel supply, or faulty gas solenoid valve, propane lock off malfunction (vacuum hose came loose), or oil in the propane.
TIME	Time's up	Operational Time has expired
Vlim	Valve limit	Valve runaway. This fault condition is caused by a hard coded software limit being exceeded. Assuming the fault is not due to the engine not being able to breath (usually caused by automotive catalyst plugging causing back pressure in excess of 1.5 psi or the intake spark arrestor being plugged), ignition timing, faulty carburetor or faulty controller, then the problem probably is with the fuel supply. Check Propane for excessive oil, check vacuum hose connected to vacuum safety lock off to make sure it is securely connected, check 1" solenoid valve for correct operation.
WTEMP	Water Temp	Spray Tank Water Temp High

APPENDIX C

Phoenix-1000 Default Settings 8.xx releases

SET POINT MENU	8-Cyl	6-Cyl	4-Cyl	Description / Notes
				Requires Menu Access or Customer Override Code
Running RPM	1800	1800	2000	Changing this setting may affect system performance unless other settings are modified.
Max Engine Well Vacuum (in$H_2$0)	300	300	300	Well valve will not open past H_2O set point
Max CatOx Well Vacuum (in$H_2$0)	190	190	190	Well valve will not open if Well vac is above the set point
Data Save Interval (minute)	60	60	60	Data save at 60 will save 27 days of data. Clear History before changing this setting.
Total for Menu				
CONTROL MENU	**8-Cyl**	**6-Cyl**	**4-Cyl**	**Description / Notes**
				Requires Menu Access or Customer Override Code
Selected Data Set	0	0	0	0=none, all custom; 1=Data Set 1, 2=Data Set 2, etc.
Idle RPM	1800	1800	1800	Changing this setting may also affect initial air and fuel valve positions described below
Air Initial Position	90	50	40	Adjust to site specific conditions, i.e. climate, elevation, load and fuel type.
Fuel Initial Position	85	55	35	Adjust to site specific conditions, i.e. climate, elevation, load and fuel type.
Min Tank Vacuum (inches Hg)	23	23	23	Set at 14 if water treatment system is present
Target O_2	1800	1800	1800	Should always remain at factory settings if present in programming
KFRRun O_2	35	35	35	Should always remain at factory settings if present in programming
Number of Restart Attempts	1	1	1	Automatic restart or remote start feature is subject to local governing agencies.
Remote Start Enable / Disable	0	0	0	Change as required
Fuel Ratio (0=Demod, 1=O_2 @ Temp)	1	1	1	Should always remain at factory settings if present in programming
Fuel Type (0=Propane, 1=Natural Gas)	0	0	0	Set to appropriate setting
Modem Speed (0=2400, 1=4800, 2=9600)	2	2	2	May need to reduce modem speed for cellular. Must be at 9600 for DSD 1000 transfer
Number of Cylinders (4,6,8)	8	6	4	Set to appropriate setting
Emergency Phone #1 Area Code	0	0	0	Change as required, 0 for area code means local call
Emergency Phone #1 Prefix	0	0	0	Change as required, 0 for prefix means don't dial
Emergency Phone #1 4 Digits	0	0	0	Change as required
Emergency Phone #2 Area Code	0	0	0	Change as required
Emergency Phone #2 Prefix	0	0	0	Change as required
Emergency Phone #2 4 Digits	0	0	0	Change as required
System Access Code	1234	1234	1234	Change as required to protect entry into system operation
Control Menu Access Code	xxxx	xxxx	xxxx	Change as required to protect entry into customer access control menu

Phoenix-1000 Default Settings 7.xx and earlier releases

START OF SET POINT MENU	Scale Factor	8-Cyl	6-Cyl	4-Cyl
Idle RPM	1 bit / RPM	1800	1800	1800
Idle Time (sec)	1 bit / sec	60	60	60
Running RPM	1 bit / RPM	1800	1800	2000
Warm-up Time (sec)	1 bit / sec	60	60	60
Max Well Opening (%)	1 bit / %	100	100	100
Tank Vacuum (inches Hg)	1 bit / in. Hg.	10	10	10
Manifold Vacuum (inches Hg)	1 bit / in. Hg.	12	12	12
Engine Cranking Time (sec)	1 bit / sec	7	7	7
Number of Cylinders (4,6,8)	1 bit / Cyl	8	6	4
Max RPM Shutdown/Restart	1 bit / RPM	3000	3000	3000
Printer Enable (0=Off, 1=On)	0 = off, 1 = on	0	0	0
Fuel Type (0=Propane, 1=Natural Gas)	0 = Pro, 1 = NG	0	0	0
START OF CONTROL MENU	**Scale Factor**	**8-Cyl**	**6-Cyl**	**4-Cyl**
Modem Speed (0=2400, 1=4800, 2=9600)	N/A	2	2	2
Data Save Interval (minute)	1 bit / min	60	60	60
Data Print Interval (minute)	1 bit / min	10	10	10
Number of Restart Attempts	1 bit / attempt	1	1	1
Air Initial Position	1 bit / step	90	50	40
Fuel Initial Position	1 bit / step	85	55	35
Fuel Max Start Position	1 bit / step	95	65	45
Startup Fuel Valve Step Rate	1 bit / step	20	20	20
Well Valve Increment (steps)	1 bit / step	20	20	20
Max AIR Opening	1 bit / step	150	150	150
Max FUEL Opening	1 bit / step	150	150	150
Delta RPM Limit for Well Dec	1 bit / RPM	100	100	100
Max DRPM for Well Valve Dec	1 bit / RPM / sec	600	300	150
Max VAC Opening	1 bit / step	300	300	300
KRPM	gain	125	125	125
START OF CONTROL MENU	**Scale Factor**	**8-Cyl**	**6-Cyl**	**4-Cyl**
KDRPM	gain	50	50	35
Kvacuum	gain	10	10	10
Target Air/Fuel Mix	1 bit / %	100	100	100
Demodulator Amplitude	1 bit / step	2	2	1
Emergency Phone #1 Area Code	N/A	0	0	0
Emergency Phone #1 Prefix	N/A	0	0	0
Emergency Phone #1 4 Digits	N/A	0	0	0
Emergency Phone #2 Area Code	N/A	0	0	0
Emergency Phone #2 Prefix	N/A	0	0	0
Emergency Phone #2 4 Digits	N/A	0	0	0
Emergency Phone #3 Area Code	N/A	0	0	0
Emergency Phone #3 Prefix	N/A	0	0	0
Emergency Phone #3 4 Digits	N/A	0	0	0
Access Code	N/A	1234	1234	1234
Access Code (Verify)	N/A	1234	1234	1234

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