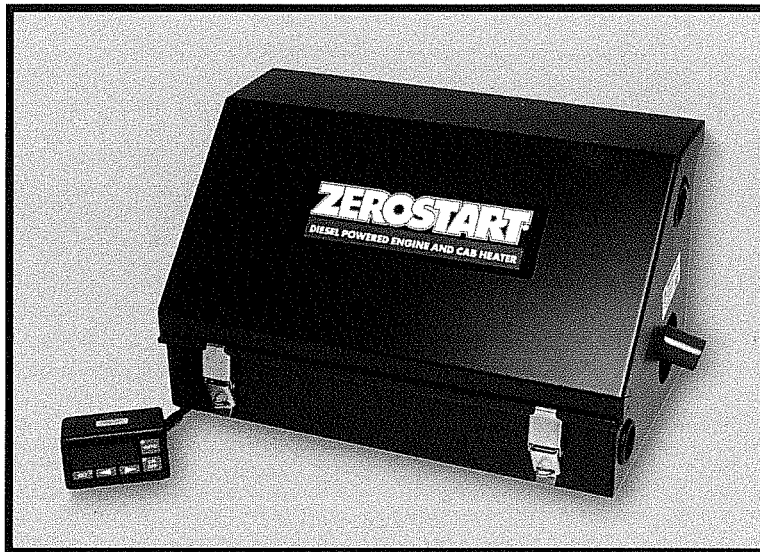


ZEROSTART[®]

COLD WEATHER STARTING PRODUCTS

Diesel Powered Engine & Cab Heater



Maintenance Manual

EXPLANATION OF SAFETY MESSAGES



DANGER: This symbol indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING: This symbol indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION: This symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or property damage.

READ MANUAL COMPLETELY BEFORE PROCEEDING

Preventive Maintenance

The following items should be checked during routine vehicle inspections:

- ✓ Battery and ground connections
- ✓ Coolant hose condition and connections
- ✓ Fuel line condition and connections
- ✓ Exhaust system condition and connections
- ✓ Tightness of coolant hose clamps and fuel line fittings
- ✓ Mounting connections and vibration isolators
- ✓ Air inlet (air inlet should be free of debris)
- ✓ Enclosure lid clamps

Extended Shutdown

Run the system once a month and allow the system to reach shutdown temperature during extended periods of non-use; this will prevent fuel varnishing and corrosion.

Component Replacement

Consult TROUBLESHOOTING SECTION before replacing components. The troubleshooting section aids in the identification of failed components. Instructions are provided with replacement components.

Contents - Maintenance Manual

Cab Air Sensor	17
Continuous Operation	6
Coolant Sensor	17
Controller Wiring Diagram	21
Description of Major System Components	4
Description of System Operation	4
Exploded View Diagram	22
Start Cycle	5
System Calibration	17-19
System Wiring Diagram	20
Trouble Codes	7-8
Troubleshooting	7-16

System Overview

CAUTION

DO NOT DISCONNECT POWER WHILE SYSTEM IS OPERATING

Removing power during operation does not allow system purge cycle—resulting in excessive heat buildup and possible component damage.

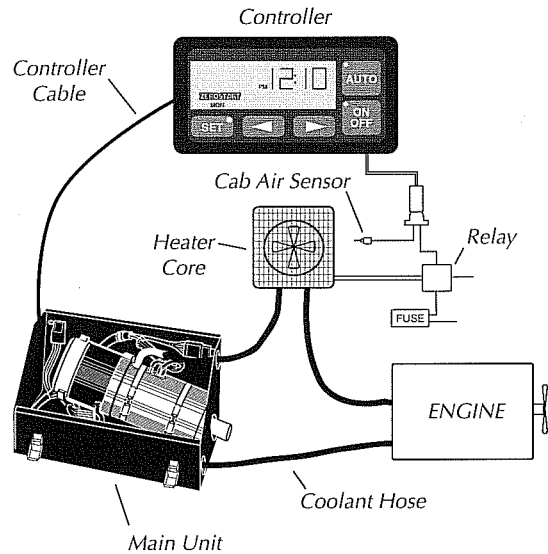
Description of System Operation

The following describes the operation of the ZeroStart® system, including the start cycle, continuous operation, and shut down. An overview of the cab air system is also included.

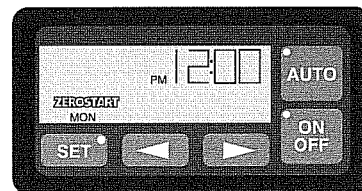
Major Components

The ZeroStart system consists of three major subsystems: the heating unit, the controller, and the cab air system (if installed).

The heating unit burns diesel fuel to create heat, which is transferred to engine coolant through the heat exchanger. The coolant is circulated through the engine and heater core by the system water pump.

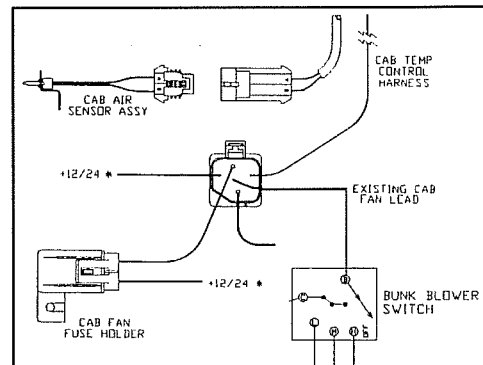


The controller operates the system, and monitors system performance. The controller can be operated manually by using the ON/OFF key, or programmed to operate automatically.



Electronic Controller

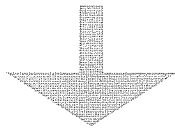
The cab air system is wired directly into the existing heater core fan, and turns the fan on and off to maintain a stable interior temperature. The temperature is monitored and controlled by the controller.



Start Cycle

When the ZeroStart® system is activated, and the coolant temperature in the heat exchanger is below 135°F (57°C), the unit will start combustion to create heat. If the coolant temperature is above 135°F (57°C), heat is not required, and only the system water pump runs to circulate warm coolant, when the temperature drops below 135°F (57°C), combustion will start. The following describes the start cycle:

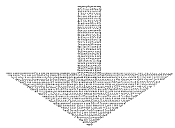
Glow plug preheats for 25 seconds.



Combustion air fan starts.



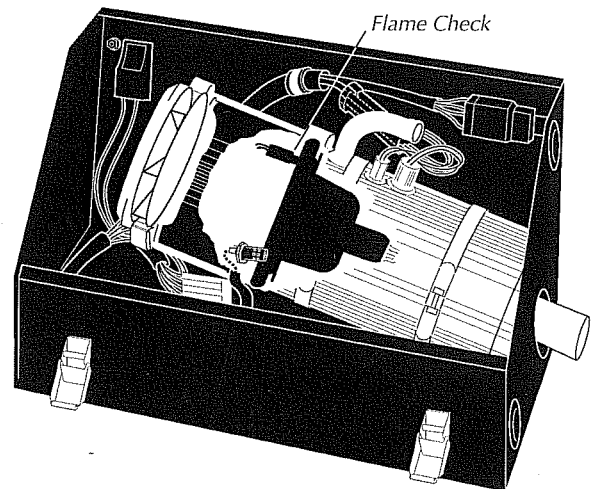
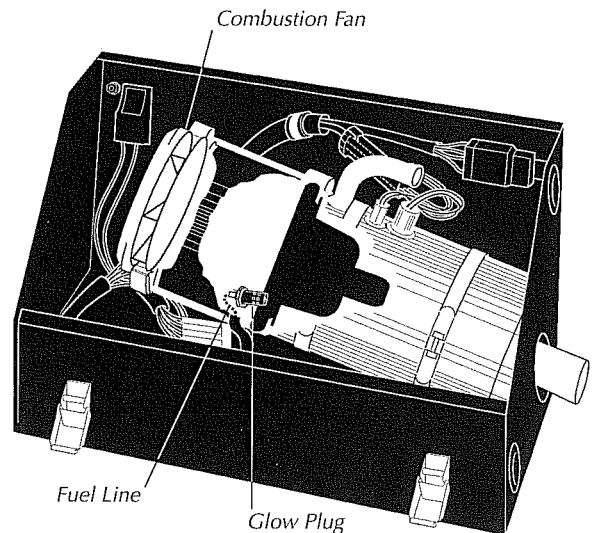
Fuel pump starts 2 seconds after combustion fan.



Fuel is delivered through the hot glow plug. During the first 60 seconds, the fuel pump is cycled on/off (click, click, pause, click sound). During continuous operation, the fuel pump cycles at a steady 4 cycles/second.



Glow plug is turned off when flame check senses stable flame. Combustion air fan and fuel pump continue to run (unit is in continuous operation).



NOTE: If unit does not establish a stable flame during the first start cycle, it will automatically attempt a second start cycle by repeating the steps listed above.

System Overview

Continuous Operation

CAUTION

DO NOT DISCONNECT POWER WHILE SYSTEM IS OPERATING

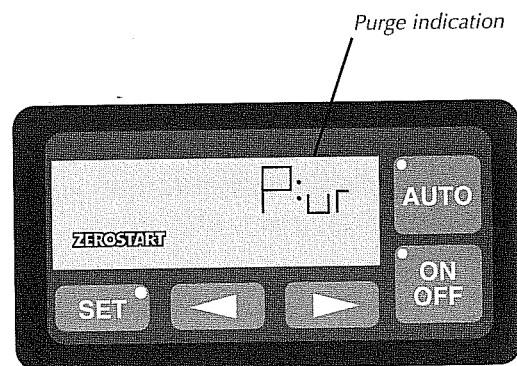
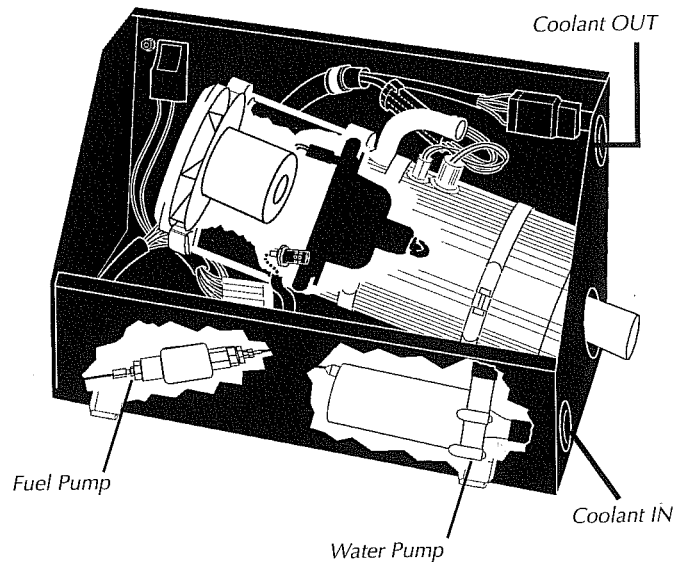
Removing power during operation does not allow system purge cycle—resulting in excessive heat buildup and possible component damage.

Once the ZeroStart® unit has completed a start cycle, it is in continuous operation. Heat is transferred to the coolant through the heat exchanger. When the unit reaches 100°F (38°C), the water pump is turned on and coolant is circulated through the system.

When the unit reaches 185°F (85°C), the fuel pump is shut off and combustion is stopped. The water pump continues to circulate coolant until the temperature drops to 135°F (57°C). At 135°F (57°C), the unit starts combustion as described above. This cycle is repeated until the system is shut off.

Every time the system stops combustion, the letters "Pur" appear on the controller screen. This indicates the system is purging. During the purge cycle, the water pump and combustion air fan run for 2 min 15 sec to purge exhaust gases and cool the combustion chamber. At the end of the purge cycle the controller displays the current time.

The system also purges when it detects a potential problem, and displays a trouble code.



 **CAUTION**

**THIS TROUBLESHOOTING SECTION IS INTENDED AS AN AID
IN THE DIAGNOSIS OF THE ZEROSTART SYSTEM**

Improper maintenance can result in personal injury or component damage. For component repair or replacement procedures, refer to the appropriate section of this manual or contact Phillips and Temro Industries Inc., (800) 328-6108 (U.S. & Canada).

This section is divided into three categories: Problem, Probable Cause, Solution Approach.

The controller assists in problem troubleshooting by providing trouble codes to the user or mechanic. The trouble codes indicate what type of failures have occurred, and can be used in conjunction with this guide for fast and effective repair of the system.

Each time a detectable electrical failure occurs with the system, the user is notified of the fault by the presentation of a trouble code on the display of the controller. The trouble codes can be cleared and the system reset by pressing the SET key. Once reset, the system can be put back into operation.

If the problem that created the trouble code persists, or has not been repaired, the trouble code will be displayed again when the system is activated. In addition to the initial display of a trouble code when a fault occurs, the last five trouble codes are stored in memory and can be recalled in the order in which they occurred.

There are a total of 10 trouble codes:

001	Low Voltage	006	Cab Air Sensor Circuit
002	Failed Start Attempt	007	Combustion Air Fan Motor Circuit
003	Loss of Flame During Operation	008	Control Module Malfunction
004	High Temperature Cut Out	009	Water Pump Circuit
005	Coolant Sensor Circuit	00F	Fuse Circuit

As stated above, a trouble code can indicate a failed component, or result from a broken wire or a poor ground connection. Trouble codes that are intermittent can indicate a component is beginning to wear, or improper installation.

Whenever a trouble code is displayed, the red "SET LIGHT" will be on. To reset the controller, press the set key. The trouble code will be stored in memory and the clock display will return. Before restarting the system, the cause of the problem should be identified and corrected. If this is not done, and the system is restarted, the system will shut down and display the same trouble code. If the system is restarted and the trouble code does not reappear, the circuit or component related to the trouble code should be checked.

Troubleshooting

To recall trouble codes stored in memory, perform the following. NOTE: The most recent trouble code is displayed first as "1:0", with "5:0" being the oldest trouble code.

Trouble code order
Trouble code

To recall trouble codes from memory:

PRESS	OPTIONS	SELECT (Using Keys)
SET	AUTO TEMP TIME RUN TIME TROUBLE CODE	TROUBLE CODE
SET	1:00 through 5:00	Advance and reverse through trouble codes as required.
SET		

Troubleshooting Guide—Based on Trouble Codes

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Trouble Code 001 Low Battery Voltage	Low Battery Voltage	Measure battery voltage. Voltage must be greater than 10.5 VDC for 12-volt systems, or 21.5 VDC for 24-volt systems. If battery voltage is low, charge the batteries.
	Poor power/ground connections	Measure the voltage supplied to the controller at the control cable connector—pins 1(+) & 2-3(-). Compare this voltage with the voltage measured at the battery terminals. A difference in these voltage measurements greater than 0.3 VDC indicates poor power/ground connections. Locate fault and repair.
	Temporary short	Trouble code may be the result of a voltage spike sent through the electrical system. Reset the controller by pressing the SET key and check for normal system operation.
Trouble Code 002 Failed Start Attempt	Not enough heat generated by the glow plug.	Check the resistance of the glow plug. Measure glow plug resistance between the spade terminal and the hex bolt portion of the glow plug body. At room temperature the resistance should be 0.7 to 0.8 ohms. Replace glow plug if out of range. Inspect the glow plug for carbon buildup and/or distortion of the coil element. The glow plug coil element should be centered in the housing, and free of carbon buildup. Remove carbon buildup and center coil element in housing, being careful not to damage element. If the coil is damaged or worn replace the glow plug.

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
<p>Trouble Code 002 Failed Start Attempt</p>	<p>Not enough fuel delivered to establish stable combustion.</p>	<p>Turn the system on and check fuel pump for mechanical operation. If operational, the fuel pump cycles (you will hear a “clicking” sound) at a rate of four cycles per second. The pump will cycle on/off during the start cycle. NOTE: Coolant temperature must be below 135°F/57°C for system to start.</p> <p>If the fuel pump is functional, check for air in the fuel line (fuel pump may have lost prime). Check fuel line connections for tightness and deterioration and repair/tighten as required.</p> <p>If fuel pump is not functional, check fuel pump for power signal. Disconnect connector at fuel pump and test if the signal is delivered during the start cycle. The green wire is ground; the yellow wire should test 12/24VDC-4 cycles/sec. If no signal is present, check connections back to the controller and determine where signal is lost. Repair or replace components as necessary.</p> <p>If signal is being delivered, fuel pump is defective and must be replaced.</p>
	<p>Not enough air delivered to establish stable combustion.</p>	<p>Turn the system on and check fan motor for mechanical operation. If operational, check the RPM of the fan wheel. If fan RPM is not greater than 6000 RPM, check the voltage delivered to the fan motor at the fan motor connector. If voltage is less than 11/22VDC, check battery voltage and connections back to controller and determine where voltage is lost, and repair as necessary. NOTE: System must be below 135°F (57°C) for system to start. If fan motor is receiving proper voltage and is running below 6000 RPM, the fan motor is defective and should be replaced.</p> <p>If fan system is not being energized, check all connections back to the controller and determine where power is being lost. Repair or replace components as necessary. If fan system is mechanically and electrically sound, check for blockage in the burner head, heat exchanger, and exhaust tube. Remove blockage and fix cause.</p>

Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Trouble Code 002 Failed Start Attempt	Flame check did not register stable combustion.	Check connections to flame check. If all connections are proper, remove flame check from the burner head and check resistance. The resistance should be approximately 5 megohms when pointed at a light source and go open (infinite resistance) in complete darkness. Replace if out of specification.
Trouble Code 003 Loss of flame during operation	Not enough fuel provided to maintain stable combustion	<p>Turn the system on and check fuel pump for mechanical operation. If operational, the fuel pump cycles (you will hear a "clicking" sound) a rate of four cycles per second. The pump should cycle on/off during the start cycle. Note: Coolant temperature must be below 135°F/57°C for system to start.</p> <p>If the fuel pump is functional, check for air in the fuel line (fuel pump may have lost prime). Check fuel line connections for tightness and deterioration and repair/tighten as required.</p> <p>If fuel pump is not functional, check fuel pump for power signal. Disconnect connector at fuel pump and measure if the signal is delivered during the start cycle. The green wire is ground; the yellow wire should test 12 or 24VDC @4 cycles/sec. If no signal is present, check connections back to the controller and determine where signal is lost. Repair or replace components as necessary. If signal is being delivered, fuel pump is defective and must be replaced.</p>
	Not enough air delivered to establish stable combustion.	<p>Turn the system on and check fan motor for mechanical operation. If operational, check the RPM of the fan wheel. If fan RPM is not greater than 6000 RPM, check the voltage delivered to the fan motor at the fan motor connector. If voltage is less than 11/22VDC, check battery voltage and connections back to controller and determine where voltage is lost; repair as necessary. NOTE: System must be below 135°F (57°C) for system to start. If fan motor is receiving proper voltage and is running below 6000 RPM, the fan motor is defective and should be replaced.</p> <p>If fan system is not being energized, check all connections back to the controller and determine where signal is being lost. Repair or replace components as necessary. If fan system is mechanically and electrically sound, check for blockage in the burner head, heat exchanger, and exhaust tube. Remove blockage and fix cause.</p>

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
<p>Trouble Code 004 High Temperature Cut-out</p>	<p>Open circuit in high-temp switch circuit.</p>	<p>Reset the system using the SET key. Start the system using the ON/OFF key. If the 004 trouble code reappears, the high temperature cut-out switch has not reset. This indicates two possibilities:</p> <ul style="list-style-type: none"> >The system is still warmer than 200°F (93°C) and the needs to cool for the high temp switch to reset. >The high-temp switch is out of calibration and is shutting down the system prior to reaching the coolant sensor set point of 185°F (85°C). <p>Check for system voltage (+12 VDC/24 VDC) at the green wire of the 7-pin connector between the unit harness and the control cable on the box harness side. If no voltage exists, the high-temp switch is still open and the unit needs to cool before the high-temp sensor can reset. If voltage does exist, check for voltage on the same wire at the other end of the cable on the controller side of the connector. If voltage does exist, the controller is malfunctioning and needs to be replaced. If voltage does not exist, find the break in the wire and repair.</p> <p>If the unit is cool (less than 135°F/57°C) and the high-temp switch has not reset, the high temp switch needs to be replaced.</p> <p>If the 004 trouble code appears on a regular basis and is due to opening of the high-temp switch, the switch needs to be replaced. If the 004 trouble code appears on a regular basis, and the high-temp switch is good, there are three potential causes.</p> <ul style="list-style-type: none"> >The engine operating temperature is high enough (greater than 210°F/99°C) to trip the high-temp switch. This will generate a 004 trouble code if the system is turned on while the engine temperature is above this point. >The coolant sensor is out of calibration, allowing the system to pass the set point of the high temp switch (see page 17 for coolant sensor calibration information). >The high-temp switch is out of calibration and is shutting down the system prior to reaching the coolant sensor set point. <p>To test the high-temp switch, create a hot water bath of 200°F (93°C) and submerge the high-temp switch. The high-temp switch should not open. If the high-temp switch opens at this temperature, it should be replaced.</p>

Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Trouble Code 005 Coolant Sensor Circuit [See page 17 for data]	Open circuit in coolant sensor circuit.	<p>Check resistance between ground and the violet wire of Coolant Sensor Circuit the control cable at the controller connector.</p> <p>CIRCUIT IS NOT OPEN (continuity to ground) Reset the controller by pressing the "SET" key, and start the system with the "ON/OFF" key. If unit starts and the trouble code does not reappear, there is an intermittent open/short in the system. Verify connector and ground connections.</p> <p>CIRCUIT IS OPEN (no continuity to ground) An open circuit exist in the coolant sensor circuit. Trace down fault and repair/replace components as necessary. Start the system with the "ON/OFF" key and verify trouble code does not reappear.</p> <p>If the system will not reset, continues to return a 005 trouble code, and you continue to measure continuity, the controller is defective and should be replaced. Refer to the page M-17 for coolant sensor calibration check.</p>
Trouble Code 006 Cab Air Sensor Circuit	Open circuit in cab air sensor circuit.	<p>Check resistance between ground and the white wire of Cab Air Sensor Circuit in the control cable at the controller connector.</p> <p>CIRCUIT IS NOT OPEN (continuity to ground) Reset the controller by pressing the "SET" key, and start the system with the "ON/OFF" key. If unit starts and the trouble code does not reappear, there is an intermittent open/short in the system. Verify connector and ground connections.</p> <p>CIRCUIT IS OPEN (no continuity to ground) An open circuit exists in the cab air sensor circuit. Trace down fault and repair/replace components as necessary. Start the system with the "ON/OFF" key and verify trouble code does not reappear.</p> <p>If the system will not reset, continues to return a 006 trouble code, and you continue to measure continuity, the controller is defective and should be replaced.</p>

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Trouble Code 007 Fan Motor Circuit	Failed fan motor	Apply power to the fan motor at the fan motor connector and check for proper operation (connector has blue and pink wire). If operational, move on to next probable cause. If failed, replace fan motor.
	Open Circuit in fan motor circuit	<p>Verify that 12 VDC or 24 VDC is present at the positive input to the fan motor at the fan motor connector (pink wire is positive).</p> <p>If voltage is not present, check all connections leading to this point and determine where the circuit is broken. If the positive side of the circuit is correct, check continuity of the ground side of the circuit all of the way back to the controller. Repair connections as required to provide continuity.</p>
	Controller Malfunction	If voltage is provided to the fan motor, the fan motor has been verified operational, and both the power and ground connections are correct, the controller has failed and needs replacing.
Trouble Code 008 Controller Malfunction	Component failure in controller	<p>Reset the controller using the "SET" key. If controller will not reset, remove power, wait two minutes, reprogram the controller and perform initial programming.</p> <p>Activate the system with the "ON/OFF" key. If the system operates, and the trouble code does not reappear, the problem is intermittent. If the trouble code repeats itself, the controller has failed and needs replacement.</p>
Trouble Code 009 Water Pump Circuit	Failed water pump	Apply power to the coolant pump at the coolant pump connector (connector has blue(+) & brown(-) wires); check for proper operation. If operational, move on to next probable cause. If pump is not operational, it has failed and needs replacing.
	Open Circuit in water pump circuit	<p>Verify that 12 VDC or 24 VDC is present at the positive input to the coolant pump at the coolant pump connector (blue wire is positive).</p> <p>If voltage is not present, check all connections leading to this point and determine where the circuit is broken. If the positive side of the circuit is correct, check continuity of the ground side of the circuit all of the way back to the controller. Repair connections as required to provide continuity.</p>

Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Trouble Code 009 Water Pump Circuit (continued)	Controller Malfunction	If voltage is provided to the water pump, the water pump has been verified operational, and both the power and ground connections are correct, the controller has failed and must be replaced.
Trouble Code 00F Fuse Circuit	Blown Fuse	Check both the 7.5 and 30 amp fuses and replace if failed. The 7.5 amp fuse protects the fan motor, fuel pump and water pump. The 30 amp fuse protects the glow plug circuit.
	Open Circuit	Verify that 12 VDC or 24 VDC is present at the red input to the fuse holder. If voltage is not present, check all connections leading to this point and determine where the circuit is broken. Repair connections to provide continuity.

Troubleshooting Guide—Based on Operational Symptoms

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Excessive white smoke during start cycle	Poor main power/ground connections	Excessive white smoke during start cycle indicates that the glow plug is not providing adequate heat to completely burn the fuel delivered. Check the main power and ground connections at the battery/ZeroStart unit for corrosion and tightness. Verify that connections are clean and securely fastened. Start unit using the "ON/OFF" key to determine if power and ground connections corrected problem. If not, proceed to next probable cause.
	Worn Glow Plug	Remove glow plug and inspect internal resistance coil for the following. If any of these conditions are present, the glow plug should be replaced: >Excessive carbon buildup between resistance coil and housing (some carbon may be removed). Any damage to the resistance coil while removing carbon buildup will degrade glow plug performance. >Distortion of the coil element, or contact between the coil element and the outer housing (coil element can be straightened, but any damage to coil element will degrade glow plug performance).

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Excessive blue smoke during start or running	Fuel Pump out of calibration	Excessive blue smoke at start up, or while running, may be the fuel pump delivering too much fuel (running rich). Check the calibration of the fuel pump per the pages 18-19 of this manual.
	Blockage in enclosure, air intake burner head, or combustion chamber	Excessive blue smoke at start up, or while running, may be the result of blockage to intake air. Check the openings in the unit enclosure and the intake for the combustion air for obvious blockage. Check for blockage in the burner head, heat exchanger, and exhaust tube. Remove blockage and fix cause.
	Worn, or slow running fan motor	Turn the system on and check fan motor for mechanical operation. If operational, check the RPM of the fan wheel. If fan RPM is not greater than 6000 RPM, check the voltage delivered to the fan motor at the fan motor connector. If voltage is less than 11/22VDC, check battery voltage and connections back to controller and determine where voltage is lost; repair as necessary. NOTE: System must be below 135°F (57°C) for system to start. If fan system is mechanically and electrically sound, and fan motor is running at low RPM it should be replaced.
Combustion stops prior to 185°F (85°C) (as sensed at unit)	Defective coolant sensor	If the system stops combustion prior to the shut-off temperature, typically indicated by engine not feeling "hot" when combustion stops, the coolant sensor is defective. Check the calibration of the coolant sensor per page 17 of this manual. Replace the coolant sensor if out of specifications. If coolant sensor is within specifications, and all electrical connections are sound, the controller is defective and should be replaced.
Water pump runs below 100°F (38°C) (as sensed at unit)	Defective coolant sensor	The water pump is turned on when the coolant temperature reaches 100°F/38°C. If the water pump runs prior to the coolant reaching this temperature, the coolant sensor may be defective. Check the calibration of the coolant sensor per the instructions in this manual. Replace coolant sensor if it is out of specifications. If coolant sensor is within specifications, and all electrical connections are sound, the controller is defective and should be replaced.

Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTION APPROACH
Controller display “blanks out” when starting vehicle	Poor power/ground connection	<p>The controller display “blanking out” or the green back light dimming when starting the vehicle can be caused by one or more of the following: [NOTE: Some of the following items may require vehicle repair.]</p> <ul style="list-style-type: none">>Inadequate, loose, or corroded controller power/ground connections.>Weak or old vehicle batteries.>Engine starter motor beginning to fail and drawing excessive current.>Power/ground not directly connected to battery terminals.
Controller will not allow access to cab air temperature setting	Defective cab air sensor	<p>The cab air temperature setting not being accessible by pressing the “SET” key is caused by one or more temperature setting of the following:</p> <ul style="list-style-type: none">>Poor ground connection>Defective cab air sensor>Defective controller <p>Verify that the cab air sensor ground is proper. If this does not solve the problem, check the calibration of the cab air sensor. Replace cab air sensor if out of specification. If neither of these repairs eliminates the problem, the controller is defective and must be replaced.</p>

Coolant Sensor and Cab Air Sensor

The coolant and cab air sensor are thermistors. Their electrical resistance changes with temperature. The controller measures the resistance of these sensors and operates the system based on these inputs. If the sensors are out of calibration, the operation of the system is operating on false information and the defective component must be replaced.

To check the calibration of these sensors, you will need an accurate thermometer, an ohm meter, and water bath that can be heated through the temperature range tested. Place the sensor and thermometer in the water bath, and measure the sensor resistance as the water is heated. The measured resistance values and water bath temperatures should correspond with the values listed below. If they do not, the sensor is defective.

Temperature °F	Temperature °C	Sensor Resistance
-40	-40	346000
-31	-35	249900
-22	-30	182300
-13	-25	134200
-4	-20	99660
5	-15	74650
14	-10	56360
23	-5	42880
32	0	32870
41	5	25510
50	10	19960
59	15	15740
68	20	12500
77	25	10000
86	30	8054
95	35	6528
104	40	5323
113	45	4366
122	50	3601
131	55	2987
140	60	2489
149	65	2085
158	70	1755
167	75	1484
176	80	1260
185	85	1074
194	90	919.2
203	95	789.8
212	100	681.1
221	105	589.4
230	110	511.7
239	115	445.8
248	120	389.6
257	125	341.7

System Calibration

High Temperature Switch

To test the high-temp switch, create a hot water bath of 200°F (93°C) and submerge the high-temp switch. The high-temp switch should not open. If the high-temp switch opens at this temperature, it should be replaced.

Fuel Pump Calibration

To calibrate the fuel pump, you must use the fuel pump calibration kit, part number 380-8001 (790-2635). The fuel pump is calibrated to fuel delivery at the rate of 10ml/minute. The fuel flow rate is adjustable to obtain the required rate of 10ml/minute. Perform the following steps to calibrate the fuel pump.

Fuel Pump Calibration Verification

NOTE: Use fuel pump calibration test kit #380-8001(790-2635).



WARNING

FAN WILL ACTIVATE DURING THIS PROCEDURE. KEEP CLEAR OF FAN INTAKE TO AVOID INJURY.

1. Disconnect **glow plug connector** below air hood (Green Wire).
2. Disconnect **flame check connector** below air hood (Black & Brown Wire).
3. Attach jumper wire provided in kit to **brown wire terminal** of **flame check connector** on enclosure harness—**not to wires entering air hood**. Attach other end of jumper to chassis ground.
4. Remove outlet hose from ZeroStart® fuel pump.
5. Attach fuel hose supplied in kit to **fuel pump outlet**. Secure with clamps provided.
6. Place the other end of fuel hose into a container to catch fuel (container should be directly next to graduated cylinder supplied in kit).
7. Press the ON/OFF key on the controller; wait for fuel pump to start (approximately 25 sec).
8. Allow fuel pump to run for **one minute**. With fuel pump running, place fuel hose in graduated cylinder and allow pump to run for **exactly two minutes**.
9. After exactly two minutes of pumping time has elapsed, remove the fuel line from the cylinder and read the fuel level in the cylinder at the bottom of the meniscus (see diagram on page 19). The graduations are in .2 milliliter increments. **A properly calibrated fuel pump will deliver 20 ml (+/- .4 ml) during the two-minute test period.**
10. If the fuel rate is not in spec, calibrate using the procedure on the next page.
11. Reconnect ZeroStart fuel line to fuel pump (to remove the snapper clamp, displace jaws sideways—these clamps are reusable).
12. Remove jumper wire and connect glow plug and flame check connectors.

Fuel Pump Calibration Procedure

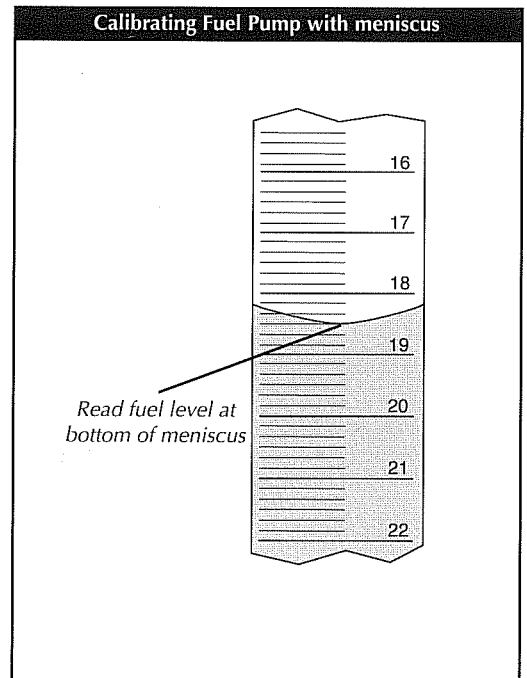
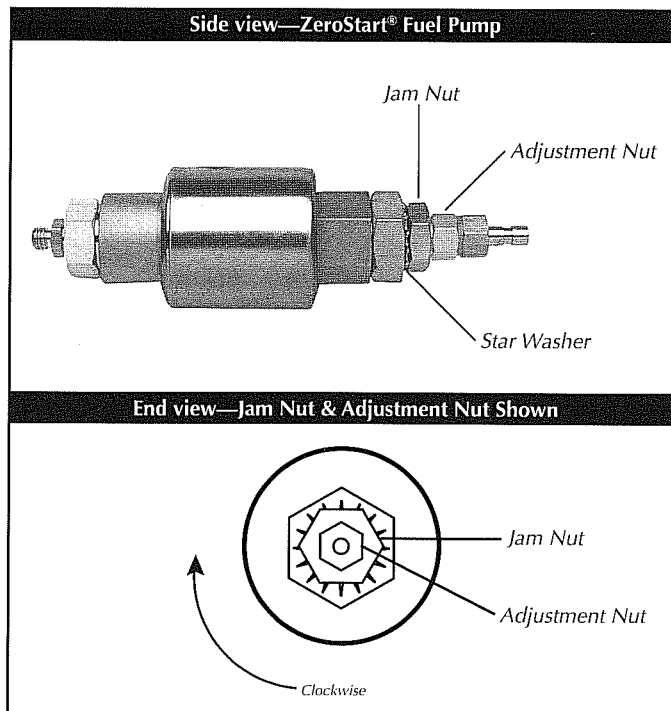
Fuel flow of the fuel pump can be adjusted. Before adjusting pump, use the procedure under FUEL PUMP CALIBRATION VERIFICATION to determine if adjustment is required. Pump should be calibrated while mounted in enclosure. If pump is removed, it must be reinstalled in the exact position as originally installed.

To adjust pump, loosen the jam nut above the star washer (see illustrations below). Turn the outlet fitting (10mm) counterclockwise to increase the flow volume. To decrease the flow volume, turn the fitting clockwise. Adjustments should be made in fractions of a turn, 1/8th revolution or less to be most accurate. After each adjustment, tighten the jam nut and repeat the FUEL PUMP CALIBRATION VERIFICATION procedure.

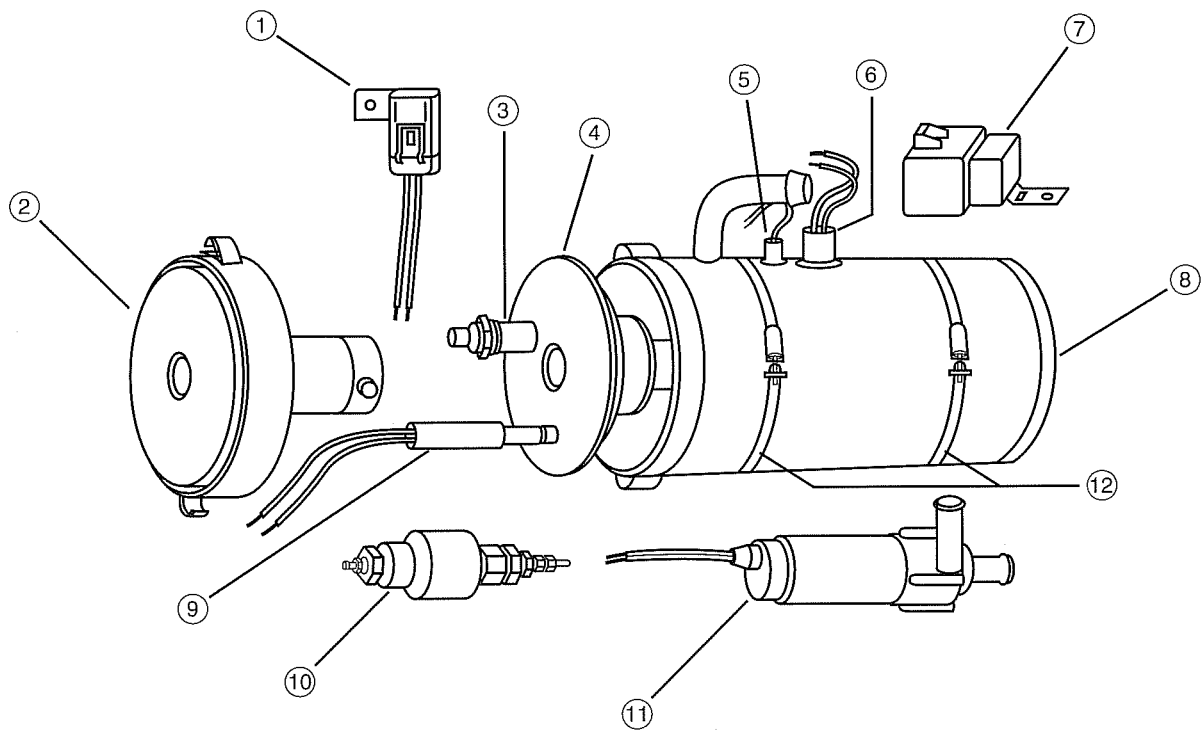
! CAUTION

DO NOT EXCEED THE RECOMMENDED FUEL FLOW RATE OF 20 MILLILITERS (+/- 0.4 ML) IN TWO MINUTES.

Fuel flow rates above or below this 20 ml can cause improper system operation and potential system damage due to higher heat output.



Exploded View Diagram



- | | |
|--------------------------------|---------------------------|
| ① Fuse Holder Cover | ⑦ Power Relay |
| ② Fan Motor Assembly | ⑧ Heat Exchanger |
| ③ Glow Plug Connector Assembly | ⑨ Flame Check Sensor |
| ④ Burner Head Assembly | ⑩ Fuel Pump |
| ⑤ Coolant Sensor | ⑪ Water Pump |
| ⑥ High Temp Switch | ⑫ Heater Body Band Clamps |

Limited Warranty

This limited warranty is expressly limited to the Company's products that have been purchased by the original consumer purchaser or for purposes of resale or use in the ordinary course of the purchaser's business. The term original consumer purchaser is defined as a person who purchases Company products for personal, family, or household use.

The Company's products are warranted against defects in materials and workmanship for a period of one year from date of purchase by purchaser. The exclusive remedy for any product found to be defective under this limited warranty consists of the repair or replacement of the defective product. This limited warranty does not apply to defects which arise from normal wear and tear, accident, misuse, abuse, neglect, mishandling, misapplication, faulty installation, modification, improper or extraordinary use or use inconsistent with any instruction or recommendation issued by the Company.

The foregoing limited warranty is exclusive and in lieu of all other warranties, whether written or oral, express, implied or statutory.

NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY. THE LIMITED WARRANTY CONTAINED HEREIN DOES NOT EXTEND TO INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THIS PRODUCT, OR ARISING OUT OF A BREACH OF THIS WARRANTY. NOR DOES THIS WARRANTY EXTEND TO THE GLOW PLUG, FUSES, OR EXHAUST TUBE OF THE PRODUCT.

To obtain performance of this limited warranty, the alleged defective product must be returned, together with reasonable proof of purchase, postage or freight prepaid, directly to:

Warranty Department
Phillips & Temro Industries Inc.
9700 West 74th Street
Eden Prairie, MN 55344

The Company will return the repaired or replaced product, postage or freight prepaid. Final determination of defects shall be made in accordance with procedures established by the Company.

This limited warranty gives the original consumer purchaser specific rights. You may have other rights which vary from state to state or province to province depending upon the location of your residence. Some states do not allow the exclusion or limitation of incidental or consequential damages.

Manufacturer's rights retained:

The Company reserves the right to make changes in design, additions or improvements to any of its products at any time without incurring any obligation whatsoever to install or replace the same or improve upon products previously manufactured.

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