PROHEAT®

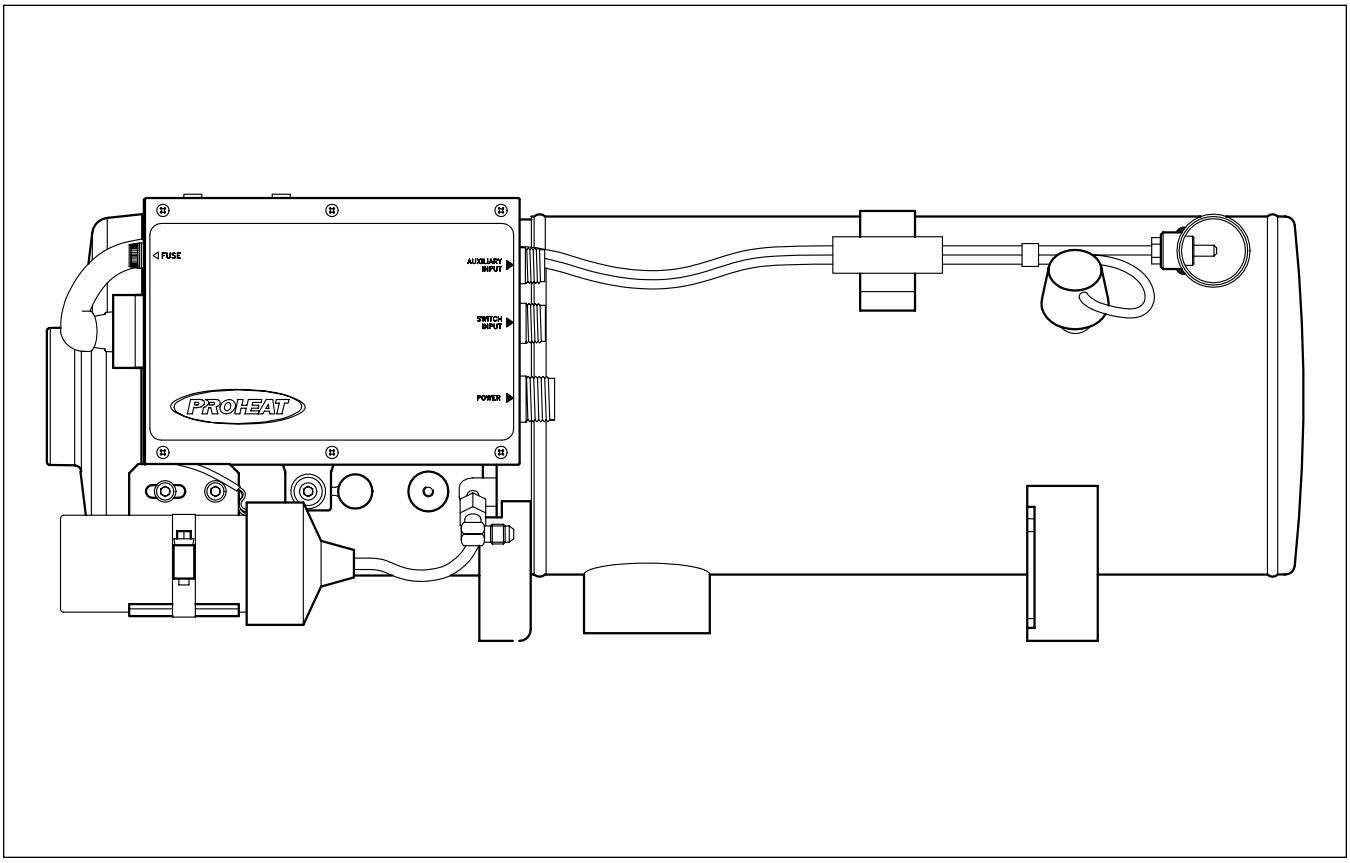
SERVICE MANUAL

BRAVO 80

CONTENTS

INTRODUCTION

Model: BRAVO 80



This manual is provided to assist in the trouble shooting and maintenance of the PROHEAT heater. PROHEAT heaters are designed to be used on any diesel equipped vehicles including: trucks, buses (school, transit and coach), construction equipment, off road equipment, military equipment and cargo.

PROHEAT heaters are used in the following applications:

(1) Engine Block Heat – PROHEAT will preheat an engine block to ensure reliable starting in cold weather. At the same time it may be used throughout the year to reduce the wear associated with cold starts.

(2) Supplemental Heat (engine running) . PROHEAT can be used while the vehicle is operating to provide supplemental heat for the coolant system.

3) Cargo Heat– PROHEAT can supply heat to individual compartments as a stand-alone heating system, or through supplemental heat in an existing heating system.

(4) Marine – Marine applications typically involve the engineering and installation of a complete hot-water heating system of which PROHEAT is only one component. Teleflex recommends that only an expert in marine hot-water heating systems install a PROHEAT for marine applications.
It is the installers responsibility to ensure that the installation complies with all applicable regulations.

1.0 TECHNICAL SPECIFICATIONS

MODEL	HEAT OUTPUT Kw (BTU/hr)	VOLTS Nominal (range)	CURRENT Amps (range)	FUEL RATE l/hr (US Gal/hr)
BRAVO 80	24 (80,000)	24 (20 – 30)	4 (3 – 4.5)	2.7 (0.70)

Ignition Type: .....Electronic Spark Ignition

Fuel Types:.....DF-1, DF-2, Arctic

Coolant Cycle Temperature:.....150˚ to 185˚F (65˚ to 85˚C) @ heater

Weight:.....73 lbs. (33kg)

Operating Temperature Range:.....-40˚ to +122˚F (-40˚ to +50˚C)

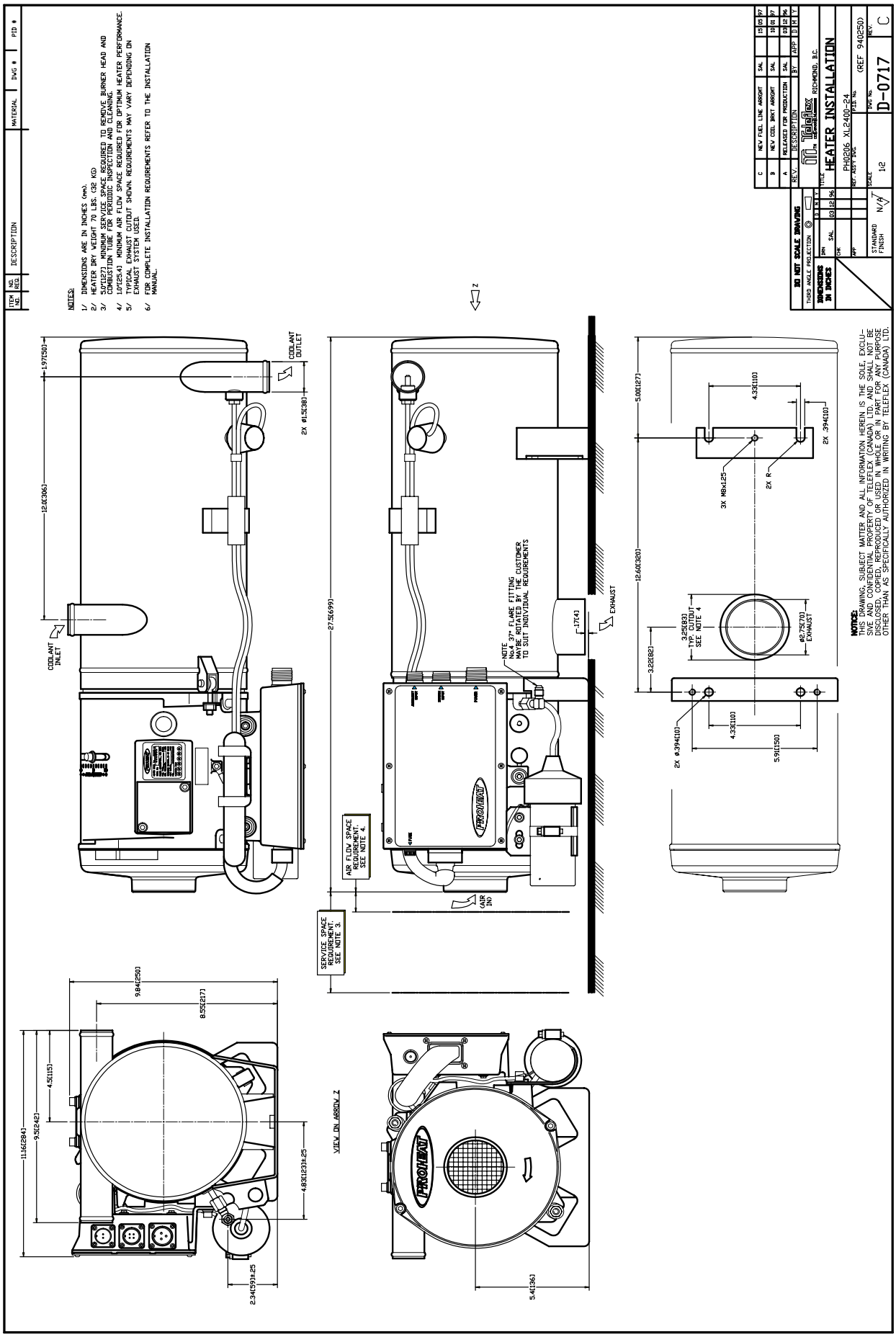
Heat Exchanger Capacity:.....2.33 quart U.S (2.4 litre)

Min Recommended Coolant Capacity: .. 6 gal U.S (22 litre)

Heater Dimensions: ..... See page 2-1

WARNING

Do not use gasoline



Heater Dimensions BRAVO 80

3.0 PRINCIPLE OF OPERATION

GENERAL DESCRIPTION

1. Blower

Combustion air is provided by an impeller style fan to supply approximately 90% of the combustion air. The fan impeller is driven by the blower motor. The speed of the blower motor is checked once per minute to ensure proper operation. There is an external adjustment for combustion air but it should not be necessary to adjust combustion air under normal circumstances.

2. Fuel System

The fuel system consists of a FDU (Fuel Delivery Unit) and an air compressor.

3. FDU (Fuel Delivery Unit)

The FDU consists of a Fuel Gear Pump, Fuel Regulator, Nozzle and Fuel Shut-off Solenoid.

Fuel Pump

A gear pump supplies low pressure fuel to the fuel regulator. The gear pump is driven by the blower motor and contains a recirculation system so that no return line is required.

Fuel Regulator

The fuel regulator reduces the fuel, supplied by the fuel pump at low pressure, to atmospheric pressure. Siphoning action from the nozzle, caused by the compressor air, draws fuel from the regulator. Without this siphoning there is no fuel flow.

Fuel Nozzle

The fuel nozzle is an air aspirating type spray nozzle. The compressed air flows through the nozzle at high speed creating a venturi effect. This siphons fuel from the regulator and combines it with the air creating an atomized mist which is sprayed into the combustion chamber.

Fuel Solenoid

The fuel solenoid is a normally closed device that unless activated, prevents fuel flow to the nozzle.

4. Compressor

A diaphragm type air compressor supplies air to the fuel nozzle.

5. Ignition System

The ignition system consists of an automotive style ignition coil and ignition electrodes. The spark and ground electrodes are located near the nozzle just out of the air-fuel spray path. During the ignition sequence the spark jumps the electrode gap igniting the air-fuel mixture. Spark duration is 30 seconds although as long as fuel is provided ignition is instantaneous. The ignition coil and spark electrode are connected by a high tension lead. The spark energy goes through the ground electrode and the burner head ground wire back to the battery.

6. Flame Sensor

The flame sensor photo-electrically measures the intensity of the flame. It is the flame sensor that signals to the PCM that the heater is burning properly. The Flame Sensor is located on the FDU.

7. Combustion Tube

The combustion tube contains an air swirler which mixes the air/fuel mist from the nozzle with the combustion air provided by the blower. The combustion tube also provides a chamber for the air/fuel mixture to burn and directs the hot gases to recirculate through the heat exchanger fins.

8. Heat Exchanger

A welded assembly which circulates coolant around the hot combustion gases. The coolant absorbs the heat from the hot combustion gases. Coolant temperature will typically rise 10˚ to 15˚F (6˚ to 8˚C) in temperature as it passes through the heat exchanger, depending on the coolant flow rate.

9. Coolant Pump (OEM Supply)

The coolant pump circulates the engine coolant through the heater. An impeller style pump is recommended because of its low current draw and free flow during engine operation. Many applications already have a coolant pump in the coolant system and no additional heater coolant pump is required. If the external coolant pump requires more than five amps of current, a relay must be used and power must be provided separately for the pump. If no connection from the heater to a coolant pump or relay is made, a component substitution plug must be connected to the coolant pump connector of PCM (Proheat Control Module) wire harness to satisfy the PCM diagnostics.

10. Temperature Sensor

The temperature sensor measures the coolant temperature at the outlet port of the heat exchanger. This sensor signals the heater to cycle on when the coolant is less than 150˚F (65˚C) and cycle off when the coolant reaches 185˚F (85˚C.)

11. Overheat Breaker

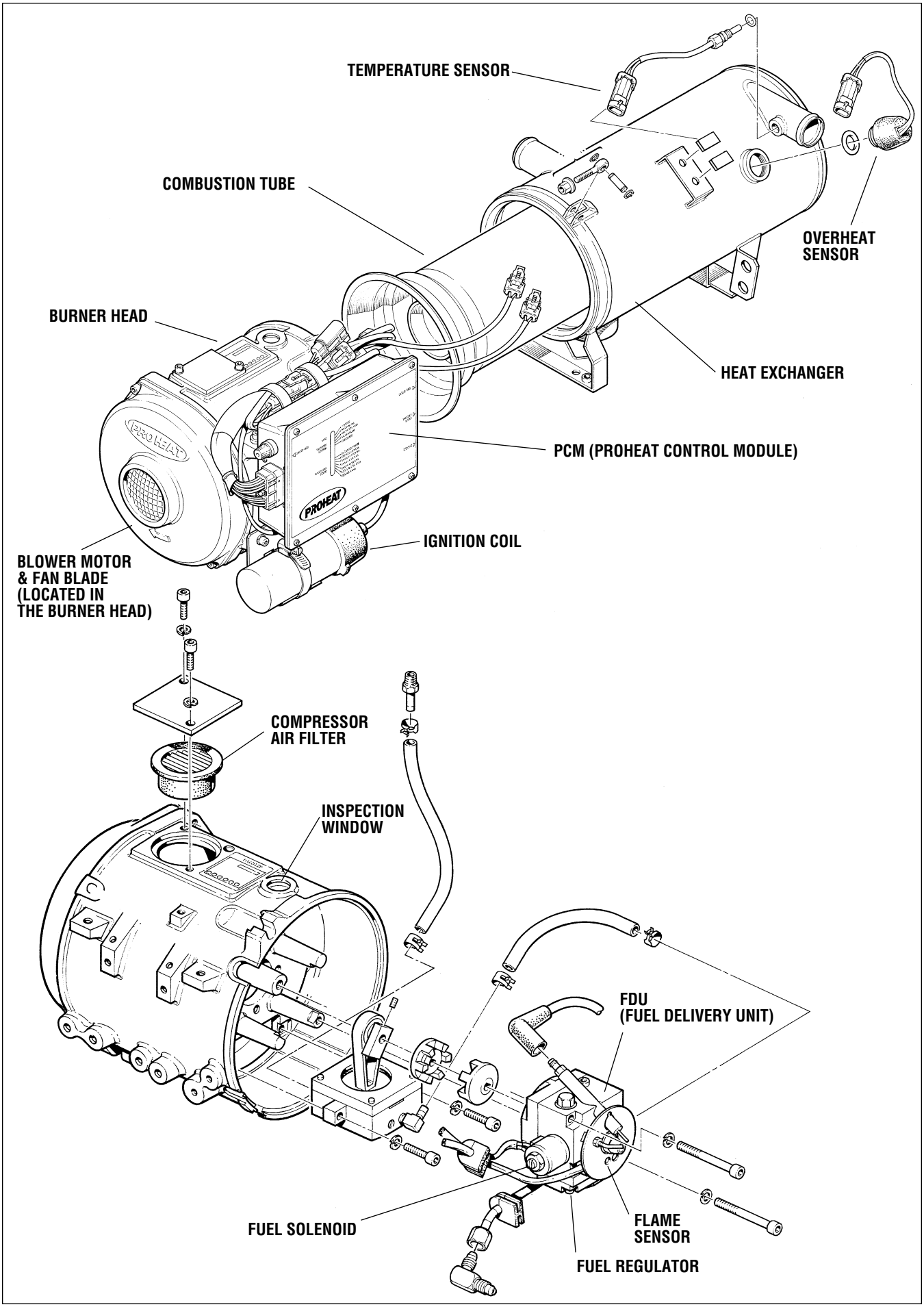
The overheat breaker protects the heater from damage should it be operated without coolant. When the temperature of the inner jacket of the heat exchanger reaches 286˚F (141˚C), the breaker trips and the heater shuts down. Once tripped the breaker must be reset by pushing down on the red button (located under the rubber cap). A heater with coolant but no coolant flow will generally result in a coolant flow error, not an overheat error.

12. PCM (Proheat Control Module)

The PCM controls all aspects of heater operation and utilizes microprocessors to monitor operating conditions and sensors and control outputs to components. It has powerful diagnostics to assist in trouble shooting (see Trouble Shooting section). One of the key features is the PCM Diagnostic Display Panel on the front of the controller which has LEDs to indicate function errors or component faults. The error codes are also flashed at the toggle switch or indicator light connected to the switch input. The controller “reads” supply voltage and limits operation from 20± 1V to 30± 1 volts.

11. Inspection Window

Located on top of the burner head. Used for visual inspection of the flame and ignition.


TEMPERATURE SENSOR
COMBUSTION TUBE
OVERHEAT SENSOR
BURNER HEAD
HEAT EXCHANGER
PCM (PROHEAT CONTROL MODULE)
IGNITION COIL
BLOWER MOTOR & FAN BLADE (LOCATED IN THE BURNER HEAD)
COMPRESSOR AIR FILTER
INSPECTION WINDOW
FDU (FUEL DELIVERY UNIT)
FUEL SOLENOID
FLAME SENSOR
FUEL REGULATOR

NORMAL OPERATING SEQUENCE

Switch On

The PCM “ON” LED will light. If the coolant temperature is above 150˚F (65˚C) the PROHEAT goes to **Standby**. If the coolant temperature is below 150˚F (65˚C) the PROHEAT goes to **Precheck**.

Precheck

The controller performs a short self diagnostic check. This takes several seconds, checking components for proper ranges, short circuits and open circuits. If there are no problems indicated, the PROHEAT goes to **Ignition**.

Ignition

The blower motor and coolant pump start first, followed by the ignition spark, and fuel solenoid. The ignition electrode sparks for 30 seconds but combustion is usually established instantly. After the ignition period is complete and the Flame Sensor sees a good flame, the PROHEAT goes to **Full Output** .

Full Output

The PROHEAT runs at Full Output until the coolant temperature reaches 185˚F (85˚C) at the PROHEAT outlet. At this time, the PROHEAT shuts the flame off and goes to **Purge**.

Purge

The fuel solenoid shuts off immediately. The blower motor and coolant pump continue to run. After 3 minutes, the blower motor stops and the PROHEAT goes to **Standby**.

Standby

The coolant pump continues to circulate the coolant throughout the system (see auxiliary Input section for alternative operating modes). When the coolant temperature drops to 150˚F (65˚C), the cycle repeats starting at **Precheck**.

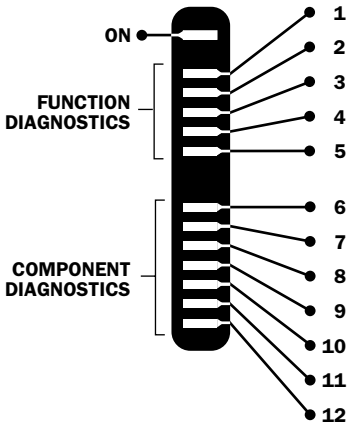
Switch Off

If PROHEAT is in Ignition or Full Output, it will Purge first, then shut “OFF”. If PROHEAT is in Standby, it will shut “OFF” immediately.

Note: The PROHEAT will Purge for 3 reasons:

- the coolant reaches 185˚F (85˚C)
- there is a function or component diagnostic error *(See Troubleshooting & Repair page 4-1)*
- the PROHEAT is operating in Ignition or Full Output when it is shut “OFF”

4.0 TROUBLE SHOOTING & REPAIR



The trouble shooting guide is divided into four sections:

Function Diagnostic Codes:

LED's displayed on the function section of the PCM diagnostic panel are usually the result of a vehicle system or installation problem.

Component Diagnostic Codes:

LED's displayed on the component section of the PCM diagnostic panel indicate an electrical problem with the wiring to that component, within the component itself or in that particular component's circuit on the PCM.

NOTE: The PCM can display two or more diagnostic codes at the same time.

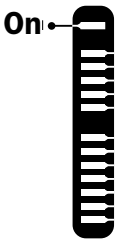
Components (No Diagnostic Code):

This section includes the compressor, fuel pump, fuel regulator, nozzle, electrode gap and PCM fuse.

Operational Problems:

Problems that are not specifically described in the Function or Component sections.

IMPORTANT
Proheat will always attempt to start twice. This means that when the PCM detects a diagnostic code it will shut down the heater. The heater will purge for three minutes. If the coolant temperature is below 150˚F (65˚C) the heater will attempt to restart. If the coolant temperature is above 150˚F (65˚C) the heater will wait until the temperature drops below 150˚F (65˚C) and then attempt to restart. ALWAYS LET THE HEATER ATTEMPT TWO CYCLES. THE PCM WILL THEN INDICATE WHAT IT THINKS IS WRONG.



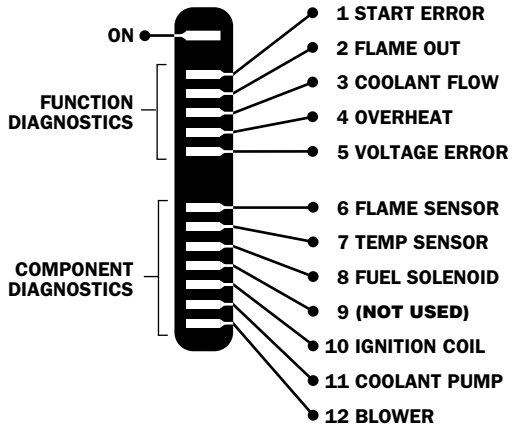
A CONTINUOUSLY FLASHING “ON” LED ON THE PCM DIAGNOSTIC PANEL INDICATES A PROBLEM IN THE PCM MICROPROCESSOR.

Check: PCM Function

a) Switch the heater off. Reset the PCM by disconnecting the power connector for 10 seconds and then re-connecting. Normally the PCM "ON" LED will flash once when power is restored. If the "ON" LED flashes continuously, replace the PCM.

FUNCTION & COMPONENT DIAGNOSTICS

The microprocessor in the PCM continually monitors the PROHEAT system. If the internal diagnostics discover a problem, a LED will be lit on the PCM diagnostics panel. A remote indicator light or the Proheat timer red 'ON' light will repeatedly flash a diagnostic code separated by a pause. The number of flashes correspond to the numbered diagnostic code (eg. 5 flashes indicates a VOLTAGE ERROR. *See diagram below for a complete list of error flash codes)*
Refer to the troubleshooting section to assist in diagnosing.



CODE NO.	TYPE OF DIAGNOSTIC	NO. OF FLASHES
1	Start	1
2	Flame Out	2
3	Coolant Flow	3
4	Coolant Overheat	4
5	Voltage (High/Low)	5
6	Flame Sensor	6
7	Temperature Sensor	7
8	Fuel Solenoid	8
9	(Not used)	9
10	Ignition Coil	10
11	Coolant Pump	11
12	Blower (Combustion)	12

Function Display Panel Detail & Diagnostic Codes

1 Start Error

A START ERROR code indicates that the flame sensor did not see a flame during the 30 second ignition period.

If the Start Error is displayed, reset the PCM by switching the heater OFF and then ON. Let the heater attempt and finish two start cycles. Observe the heater operation either through the inspection window and/or by listening to the combustion process.

Symptom: **A flame is visible**

The heater shuts down after the 30 second ignition period.

Check: **Flame Sensor**

a) Check the flame sensor as per test procedure. *(See page 4-9)*

Symptom: **No flame (spark is visible)**

The spark continues for the 30 second ignition period.
The heater shuts down after the 30 second ignition period.

Check: **Fuel System**

a) Is there sufficient fuel in the tanks or has the fuel gelled?
b) Is there an air leak in the fuel system?
c) Is there a restriction in the fuel system or is the fuel filter plugged?
d) Is the fuel pump operating?
e) Is the fuel regulator defective? (*page 4-23*)
f) Is the compressor functioning? (*page 4-18*)
g) Is the fuel solenoid functioning? *(page 4-12)*
h) Is the nozzle plugged?

NOTE: If there is no flame, a spark and/or spark reflection should be visible through the inspection window.

Symptom: **Heater is Backfiring**

Backfiring is usually caused by a severe restriction of combustion air or air in the fuel line.

Check: **Combustion Air Flow**

a) Is there a restriction at the blower inlet or in the exhaust system?
b) Has the combustion air adjustment on the burner head been moved or come loose?

Check: **Fuel System**

a) Fuel level
b) Is there an air leak in the fuel system?

Symptom: **No visible flame**

No spark

The heater shuts down after the 30 second ignition period.

Check: **Ignition System**

a) Check for a poor electrical connection between the ignition coil and the high tension lead.

b) Check for a poor electrical connection between the electrode and the high tension lead.

c) Check the coil harness wires and connections to the coil.

d) Check the coil. *(See page 4-14)*

e) Check the heater ground wire for damage and corrosion.

f) Check the spark electrode gap.

g) Check spark electrode. **Do not over-tighten the set screw for the ignition electrode as this may result in a cracked ceramic insulator resulting in a failed spark.**

2 Flame Out

A Flame Out code indicates that a flame was established but was not maintained. If at any time during the run mode the flame sensor does not see a flame, the ignition spark is switched on immediately. If the flame is not re-established within 10 seconds the heater will shut down and the Flame Out diagnostic will be displayed. The heater will go into the purge mode and attempt to re-start in 3 minutes if the coolant temperature is below 150˚F (65˚C).

A FLAME OUT code indicates that there was ignition and therefore there was a spark. Flame Out or a combination of Flame Out and Start Error are usually an indication of an interruption in fuel flow.

Symptom: **Combustion hesitation**

Smoking

Coughing heater

Check: **Fuel System**

a) Is there sufficient fuel in the tanks or has the fuel gelled?

b) Is there an air leak in the fuel system?

c) Is there a restriction in the fuel system or is the fuel filter plugged?

d) Is the fuel pump operating?

e) Is the fuel regulator defective? (*page 4-23*)

f) Is the compressor functioning? *(page 4-18)*

g) Is the fuel solenoid functioning? *(page 4-12)*

h) Is the nozzle plugged?

3 Coolant Flow

A COOLANT FLOW code is displayed when the coolant temperature reaches 185˚F (85˚C) in less than one minute after ignition.
This indicates that the coolant flow is severely restricted or blocked.

Check: Coolant Flow

a) **Coolant Lines**: Are the coolant lines large enough? Are there restrictions or blockages in the coolant lines? Are the hose clamps tight? (Loose clamps could lead to air intrusion and loss of coolant pump prime.)

b) **Shut-off Valves**: Are there any valves in the system that could shut off the coolant flow? Is there an alternative flow path when the valves are closed? Are these valves properly controlled?

c) **Fittings**: Fittings must not be restrictive. Avoid using 90˚ fittings where possible and keep the number of fittings to a minimum.

d) **Coolant Flow Direction**: The PROHEAT **MUST** be plumbed so that the coolant pump is pumping the coolant in the same direction as the engine coolant pump. PROHEAT can be used when the engine is running.

e) **Coolant Pump**: Does the pump function properly? (page 5-13)

f) **Coolant System Capacity**: The coolant system should contain at least 22 liters of coolant

g) **Heater Location**: If the heater is the high point or is in a local high point within the coolant system, an air trap may occur. Similarly, if the coolant pump is in a local high point within the coolant system it may loose its prime.

4 Overheat

An OVERHEAT code is displayed when the overheat breaker has tripped, shutting the heater down. This occurs if the heater has been started with little or no coolant in the heat exchanger. Thermos Switch trips at 286˚F (141˚C).

Check: Coolant System

a) Is there coolant in the system?

b) Determine if there is a blockage or air in the system.

The breaker contains a normally closed thermo switch. When the thermo switch reaches the preset temperature, the contacts open, instantly shutting the heater down. It can not be restarted until the breaker is manually reset.

Caution

Do not reset the Overheat breaker until the cause of the overheat condition has been determined.

The overheat breaker is reset by removing the rubber cap on the top of the breaker and pressing the red reset button underneath. If the breaker will not reset, allow the heater to cool.

Test Procedure:

a) Disconnect the Overheat Breaker connector from the PCM wire harness

b) Connect a multimeter (adjusted to measure resistance) to the overheat breaker connector (*See Figure 4-1*). The sensor should be normally closed. Only if the sensor has tripped should it be open open circuit. Breaker resistance when closed should be less than 1 ohm. (Ensure your measuring device is capable of measuring this low resistance before replacing the overheat breaker based on this test.)

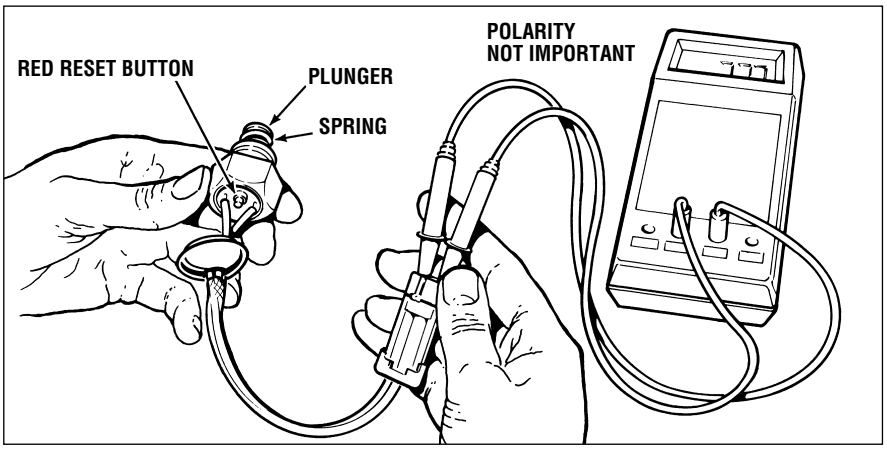


Figure 4-1 Overheat Sensor Test

5 Voltage Error

A VOLTAGE ERROR code indicates that the supply voltage to the heater is out of the normal operating range.

Operating Range: 24 volt heater – 20.0 to 30.0 volts ± 1 volt.

Heater Voltage Measurement

The positive terminal of the ignition coil is always hot relative to the heater chassis ground as long as power is connected to the heater. This is the supply voltage to the heater.

Test Procedure (See figure 4-2, page 4-8):

a) Locate the rubber boot on the end of the ignition coil and peel it back to expose the positive and negative terminals.

b) Select the DC volts range of a multimeter. The positive lead of the multimeter should be attached to the positive stud of the coil lead. The negative lead of the multimeter should be attached to the heater chassis ground.

c) Measure the heater voltage at the ignition coil while the heater is turned off.

d) Measure the heater voltage at the ignition coil while the heater is running.

Heater voltage must remain within the specified range. Poor connections may show full voltage under no load conditions but not under full load. If the voltage at the ignition coil is more than one volt less when the heater is running than when it is turned off, check the vehicle battery connections, wire gauge and the power connection at the controller and harness.

If the measured voltage is higher than the specified range then check the voltage regulator on the vehicle.

Note: If the vehicle batteries are marginal, starting the vehicle while the heater is running may:

a) Drop the voltage enough to cause a voltage error.
b) Cause random component errors (brown out).

Switch the heater to “OFF” and then back “ON” at the toggle switch to clear any errors. If the problem continues, load test the batteries to confirm their condition.

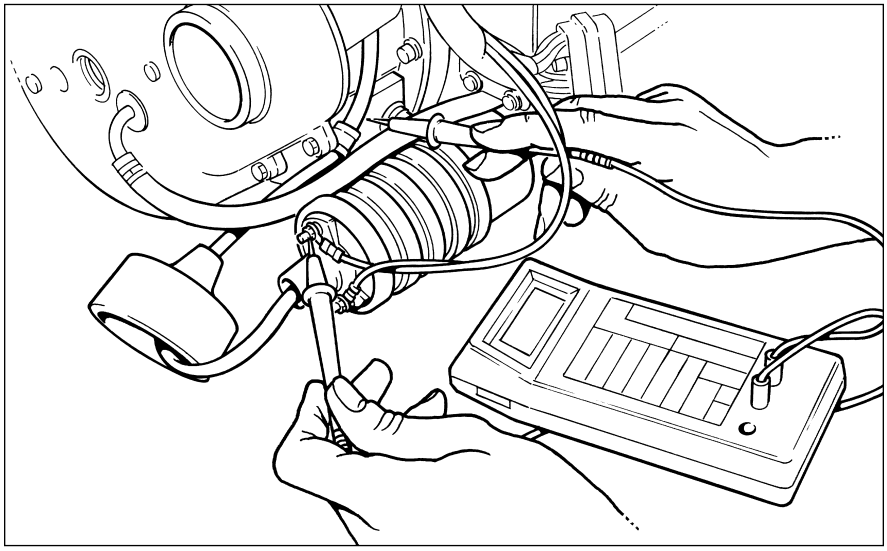


Figure 4-2 Heater Voltage Measurement

6 Flame Sensor

A FLAME SENSOR code indicates an electrical short circuit in the flame sensor wiring, within the Flame Sensor itself or in the PCM Flame Sensor circuit.
The PCM does not check for an open circuit on this component.
A Flame Sensor open circuit failure will show up as a Start Error.
A Flame Sensor diagnostic can also indicate a problem with flame shut off.

Symptom: Flame Sensor code appears in Precheck

Check: Flame Sensor

a) See Flame Sensor Test Procedure on page 4-9.

Note:

The flame sensor is an optical device which “sees” the flame. If the sensor lens is dirty or has an open circuit, it cannot "see" the flame and results in either a START ERROR or a FLAME OUT.

Symptom: Flame Sensor code appears in Purge

If the flame sensor still "sees" a flame 10 seconds after the purge period starts, a flame sensor code is displayed and the blower motor is shut off. This is a safety feature in the event of a failed or obstructed fuel shut-off solenoid.

Check: Flame Shut off

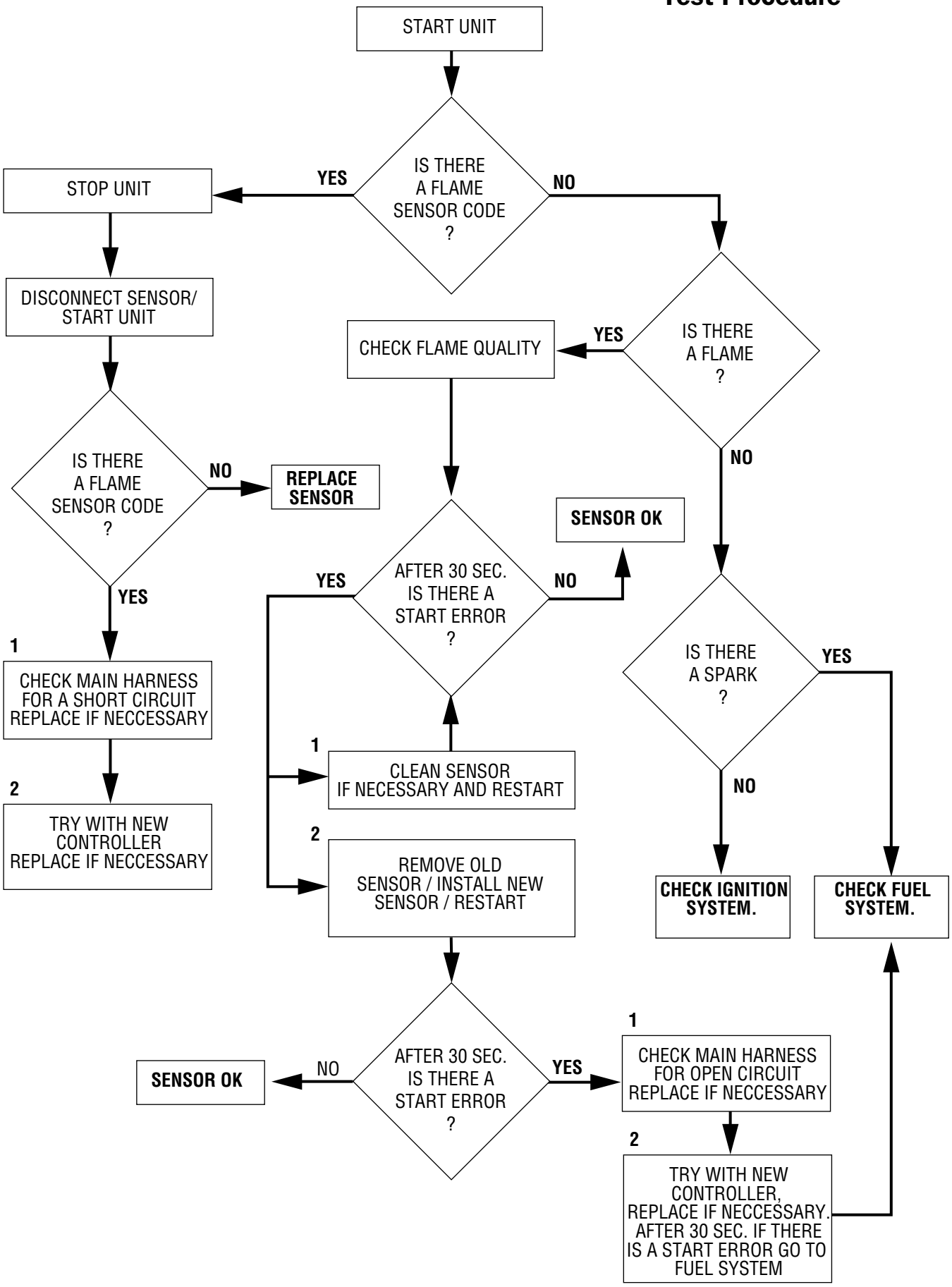
Test Procedure

a) Start the heater and allow a flame to continue for three minutes

b) Disconnect the fuel solenoid connector without turning off the heater.

c) Does the flame extinguish immediately? If not, check the fuel solenoid. *(See page 4-12)*

Flame Sensor Test Procedure



7 Temp Sensor

A TEMPERATURE SENSOR code indicates an electrical open or short circuit in the wire harness, within the Temperature Sensor itself or in the PCM Temperature Sensor circuit.

WARNING

The PROHEAT chassis is grounded from the controller . Ensure the ground is securely connected. Failure to ensure a proper ground may result in electrical shock.

Symptom: **Heater shut down (CODE INDICATED)**

Check: **Temperature Sensor & wiring**

a) Inspect Temperature Sensor harness for loose and/or corroded connectors

b) Inspect for worn or abraded wires in the wire harness

c) Test the sensor. *(See figure 4-3)*

Test Procedure:

a) Connect a multimeter, adjusted to measure resistance, to the temperature sensor.

b) Measure the sensor resistance versus temperature. Refer to graph. *(See figure 4-4)*

Symptom: **Heater shut down (CODE INDICATED)**
Temperature Sensor and wire harness test OK

Check: **PCM**

a) Isolate the PCM Temperature Sensor circuit using the component substitution plug (TFX Part #982526).

Replace the PCM if the temperature sensor code remains on after starting the heater with the substitution plug in place of the component.

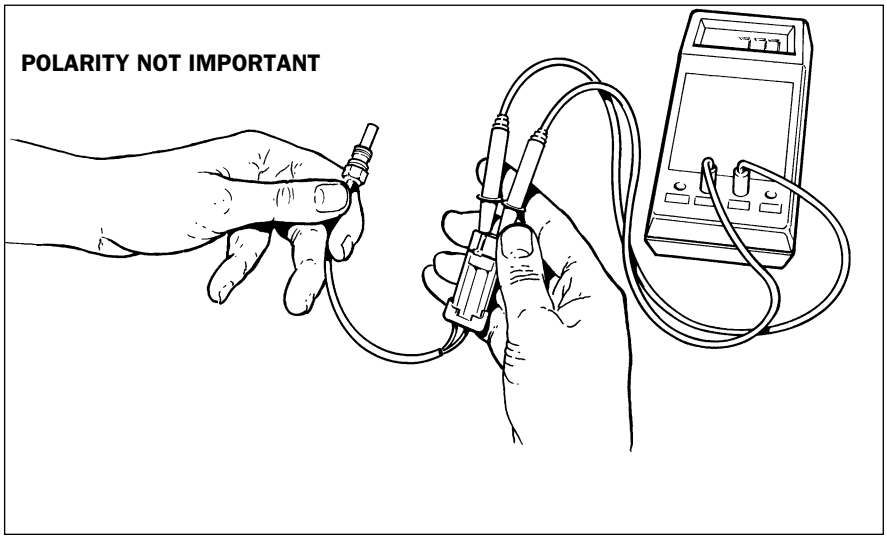


Figure 4-3 Temperature Sensor Test

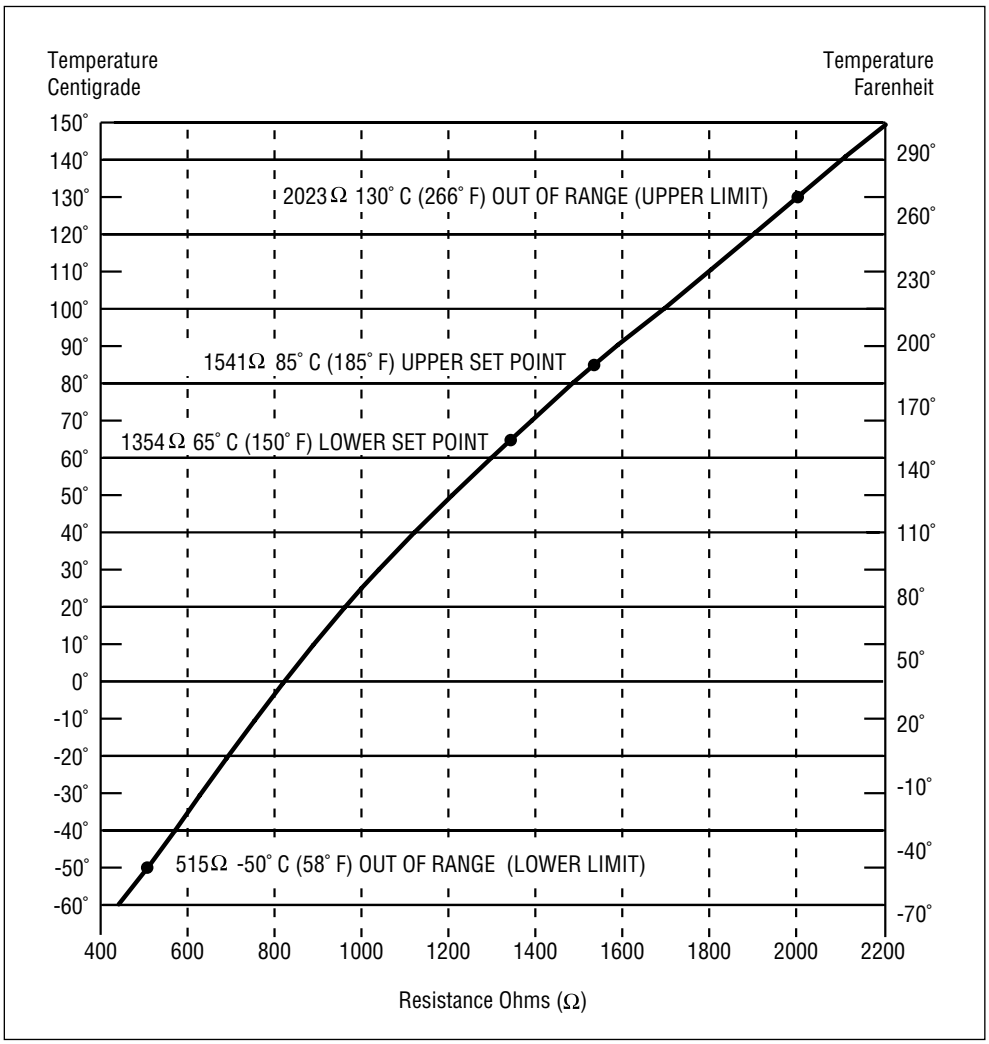


Figure 4-4 Coolant Temperature Sensor Graph

NOTE:

Room temperature	20˚C (70˚F)	Resistance 950Ω
Boiling water	100˚C (212˚F)	Resistance 1700Ω

8 Fuel Solenoid

A FUEL SOLENOID code indicates an electrical open or short circuit in the wire harness, within the Fuel Solenoid coil itself or in the PCM Fuel Solenoid circuit.
This component is positive side switched.

Symptom: Heater shut down (CODE INDICATED)

Check: Fuel Solenoid coil & wiring

a) Inspect Fuel Solenoid harness for loose and/or corroded connectors

b) Inspect for worn or abraded wires in the wire harness

c) Test Fuel Solenoid. *(See figure 4-5)*

Test Procedure:

a) Disconnect the fuel solenoid from main harness.

b) Connect a multimeter , adjusted to measure resistance, to the fuel solenoid. If the resistance is between 100 ohm and 180 ohm the solenoid is OK. If it reads outside this range, replace the solenoid.

Symptom: Flame Out and/or Start Error code (NO FUEL SOLENOID CODE INDICATED)

Check: Fuel Solenoid

a) Test the mechanical operation of the fuel solenoid.

b) Check for contamination in the Fuel Solenoid plunger.

Test Procedure:

a) Disconnect and remove the fuel solenoid from the FDU (Fuel Delivery Unit).

b) Operate the Fuel Solenoid remotely by connecting to a 24 volt source. Feel and listen to the operation while applying and removing power.

Note: Ensure the voltage used is within the normal operating range of the fuel solenoid.

Symptom: **Heater shut down (CODE INDICATED)**
Fuel Solenoid coil and wire harness test OK

Check: **PCM**

a) Isolate the PCM Fuel Solenoid coil circuit using the component substitution plug (TFX Part #982526). Replace the PCM if the fuel solenoid diagnostic remains on after starting the heater with the substitution plug in place of the component.

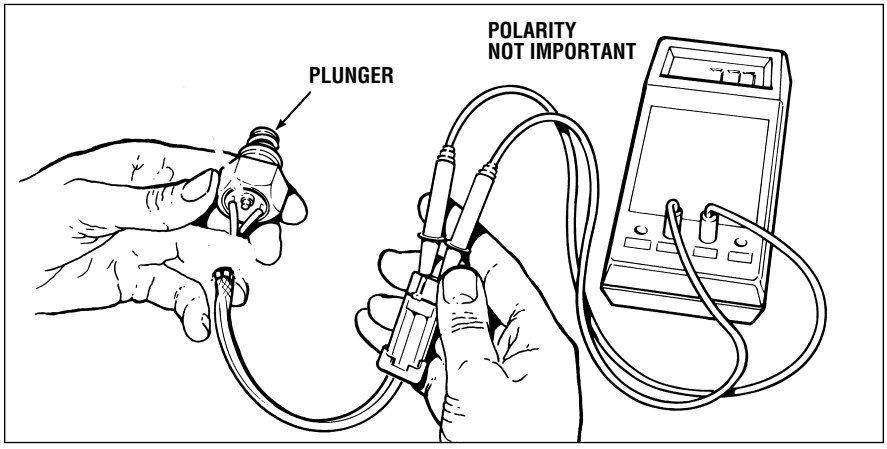


Figure 4-5 Fuel Solenoid Test

Diagnostic code 9 is not used on the Proheat model 80 Series heater.

10 Ignition Coil

An IGNITION COIL code indicates an electrical short or open circuit in the wire harness, within the Ignition Coil itself or in the PCM Ignition Coil circuit.
This component is negative side switched.

Symptom: **No spark at electrode (CODE INDICATED)**

Check: **Coil & wiring**

a) Inspect the Coil harness for loose and/or corroded connections.

b) Inspect for worn or abraded wires in the wire harness.

c) Test the Coil.

Test Procedure:

a) Use a multimeter to measure the resistance across the positive and negative terminals. The resistance should be between 0.2 and 1 ohm. If the measurement is outside this range, replace the coil. *(See figure 4-8)*

Symptom: **No spark at electrode (NO CODE INDICATED)**
15 amp Fuse blown in PCM.

Check: **Coil and wiring**

a) Measure from coil positive terminal to coil secondary terminal.

b) Check coil positive wire for short to chassis ground.

Symptom: **No spark at electrode (CODE INDICATED)**
Coil and wire harness test OK

Check: **PCM**

a) Replace PCM

WARNING

The PROHEAT chassis is grounded from the controller . Ensure the ground is securely connected. Failure to ensure a proper ground may result in electrical shock.

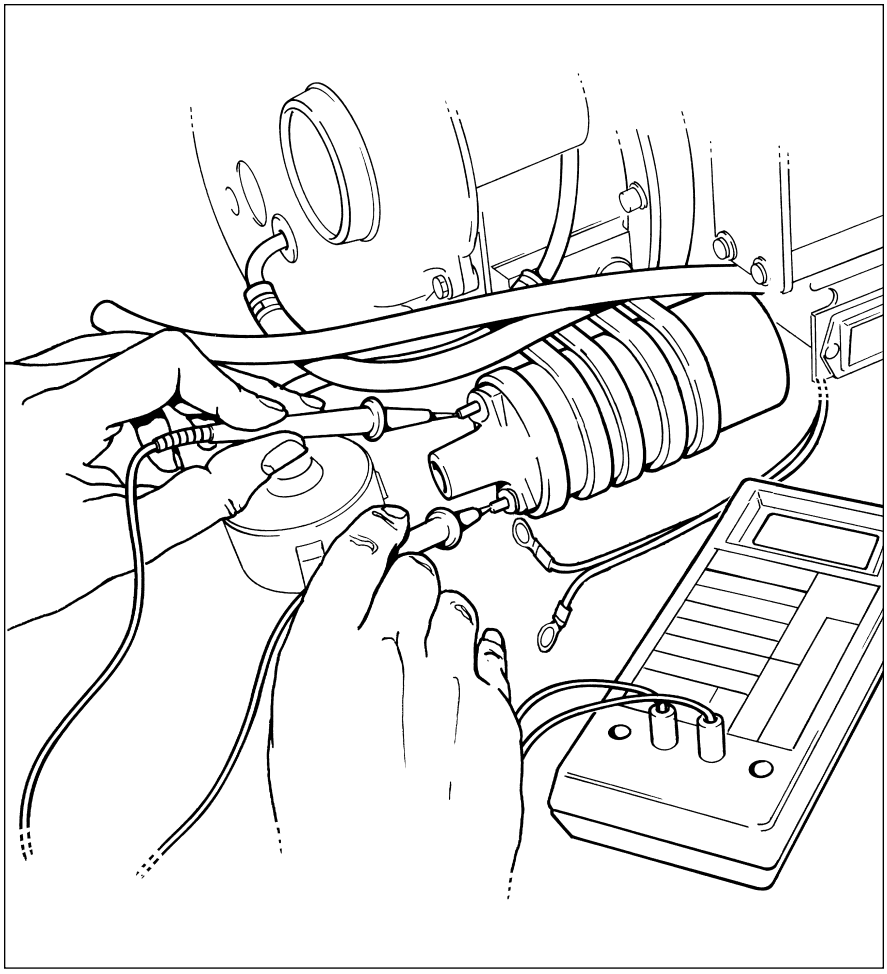


Figure 4-8 Ignition Coil Test

11 Coolant Pump

The BRAVO 80 Heater does not have a coolant pump provided with the unit. Instead the heater is provided with a component substitution plug. If a coolant pump error occurs, check substitution plug connection and wire harness for open or short circuits. Check any OEM coolant pump or relay wiring that has been made to the coolant pump connection.

Test procedure:

a) Use a multimeter to measure the resistance across the leads of the substitution plug. Polarity is not important. If the resistance is "open circuit" or 0 ohm (short circuit) then replace the substitution plug.

12 Blower

A BLOWER code indicates an electrical short or open circuit in the wire harness, within the motor itself or in the PCM Blower circuit.
This component is negative side switched.

NOTE: The PCM performs an RPM check on the motor. This feature regularly measures the blower RPM and will indicate a code should it fall below the necessary speed to maintain sufficient air/fuel combustion mixture.

CAUTION

The blower motor is deigned to be activated only by the "Soft-Start" PCM circuits and damage may occur to the motor if connected directly to a power source such as a battery.

Symptom: **Heater shut down (CODE INDICATED)**

Check: **Blower motor & wiring**

a) Inspect the Blower harness for loose and/or corroded connectors.

b) Inspect for broken or abraded wires in the wire harness.

c) Test blower motor.

Test procedure:

a) Use a multimeter to measure for an open or short circuit across the positive and negative terminals. *(See figure 4-8)*

CAUTION

Repeated replacement of the fuse or using incorrectly rated fuses without correcting the problem can damage the PCM.

Symptom: **Heater shut down (NO DIAGNOSTIC INDICATED)**

15 amp Fuse blown in PCM (See Fuse Blown Test Procedure, page 4-21)

Check: **Blower electrical and mechanical function**

a) Measure for short circuit between blower motor body and the positive wire.

b) Check for seized and/or worn bearings.

NOTE

When a blower fails, the combustion chamber must be checked for carbon build up and cleaned if necessary.

Symptom: **Blower turning slowly (CODE INDICATED) The PCM regularly measures the RPM of the motor. If it falls below the necessary RPM required to maintain combustion, a diagnostic will be displayed.**

Check: **Blower electrical and mechanical**

a) Is fan blade rubbing or loose on the shaft?

b) Test Blower motor.

Test procedure:

a) Use a multimeter and test lead (TFX Part #967632) to measure for voltage and current.

Symptom: **Heater shut down (CODE INDICATED)**

Blower motor and wire harness test OK

Check: **PCM**

a) Isolate the PCM Blower circuit using the component substitution plug (TFX Part # 984643). Replace the PCM if the Blower diagnostic remains on after starting the heater with the substitution plug in place of the component.

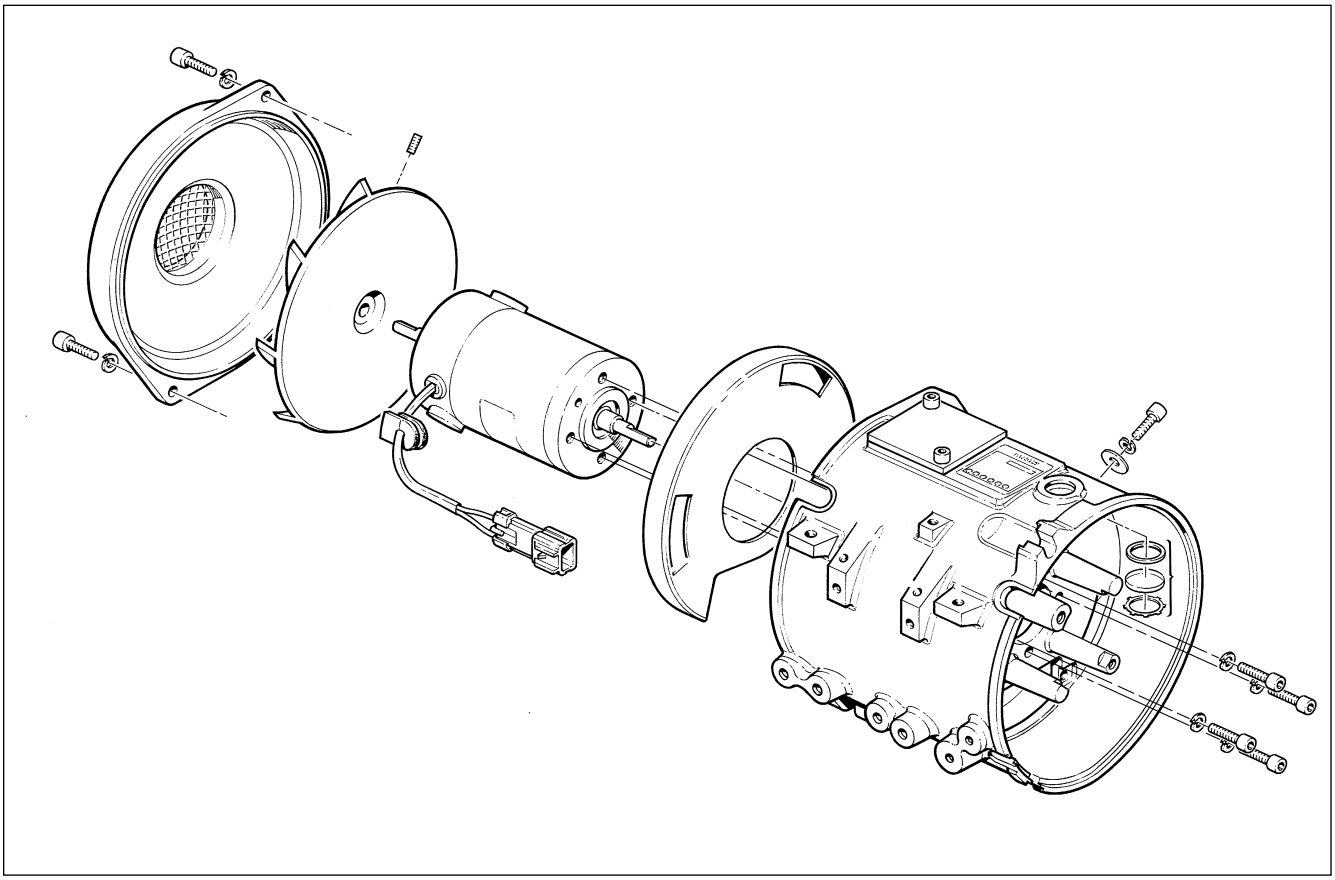


Figure 4-9 Blower Motor Test

COMPONENTS (NO DIAGNOSTIC)

Compressor

Test procedure:

a) Disconnect the overheat breaker and temperature sensor connectors and remove the burner head. Also disconnect the fuel solenoid. This will cause the PROHEAT to go directly to purge when started and ensures that no combustion will occur.

b) Remove the air hose from fuel delivery unit and connect the pressure test gauge (P/N PK0060) between the compressor outlet and fuel delivery unit.

c) Start the PROHEAT and read the nozzle air pressure from the gauge.

The pressure should be approximately 3.5 psi at 24 volts. A pressure lower than the performance limits suggests a plugged filter, blocked or kinked compressor intake hose, a loose compressor set screw on the blower motor shaft or a damaged compressor. A pressure higher than performance limits suggests a plugged nozzle or port within the fuel delivery unit.

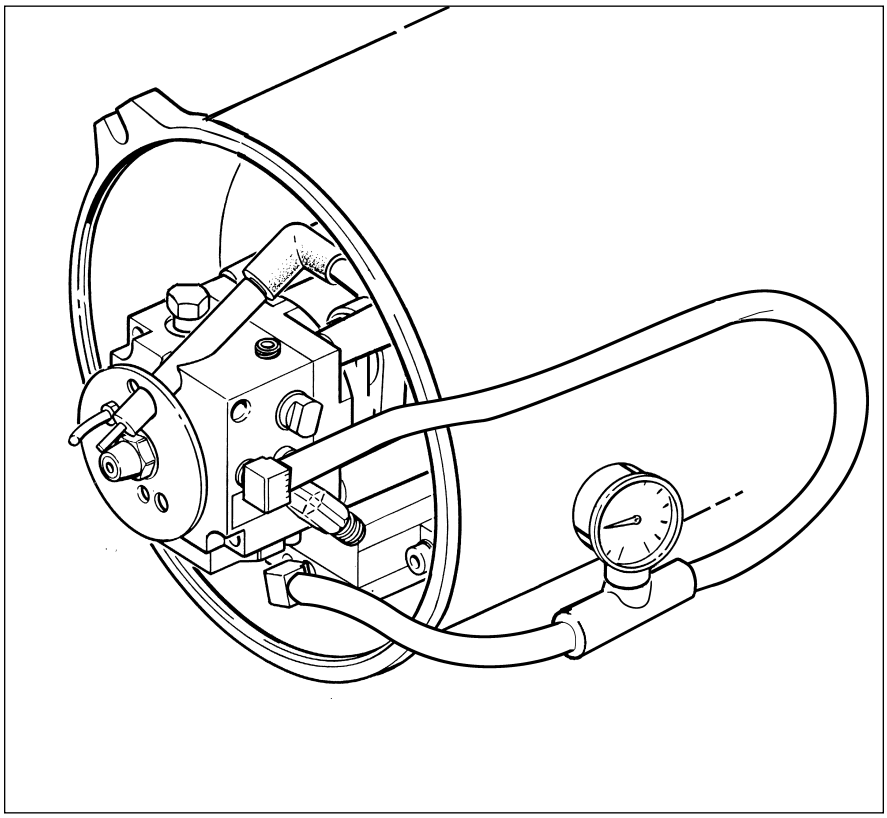


Figure 4-10 Air Pressure Test

Fuel Pump

Test procedure:

a) Disconnect the overheat breaker and temperature sensor connectors and remove the burner head. Also disconnect the fuel solenoid. This will cause the PROHEAT to go directly to purge when started and ensures that no combustion will occur. Leave the fuel line connected to the burner head.

b) Remove the o-ring plug from the fuel pump and connect the pressure test gauge P/N PK0067. *(see figure 4-11)*

c) Start the PROHEAT and read the fuel pressure from the gauge while ensuring that the blower motor is running.

d) Check for any fuel leaks from any part of the fuel delivery unit.

The pressure should be approximately 9 psi but any positive pressure of fuel will allow the heater to run correctly. A fuel pressure lower than 1 psi or higher than 17 psi suggests a faulty relief valve. A pressure of 0 psi suggests a missing or stripped motor shaft coupler or seized fuel pump.

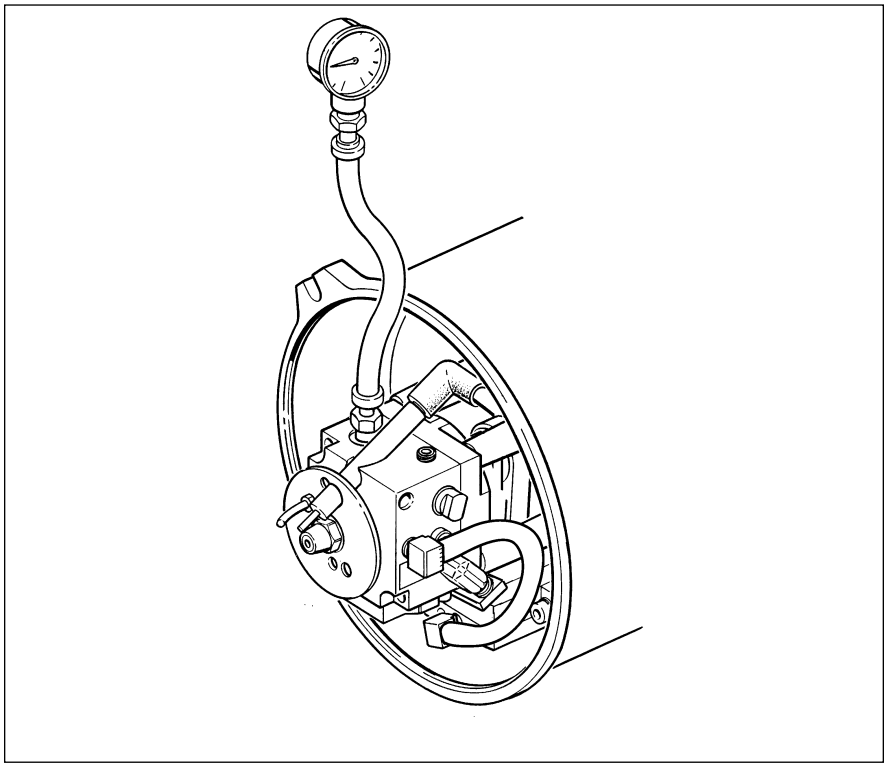


Figure 4-11 Fuel Pressure Test

Electrode Gap

Check the electrode gap while the burner head is removed from the heat exchanger. Gap should be as per diagram. *(See figure 4-11)*

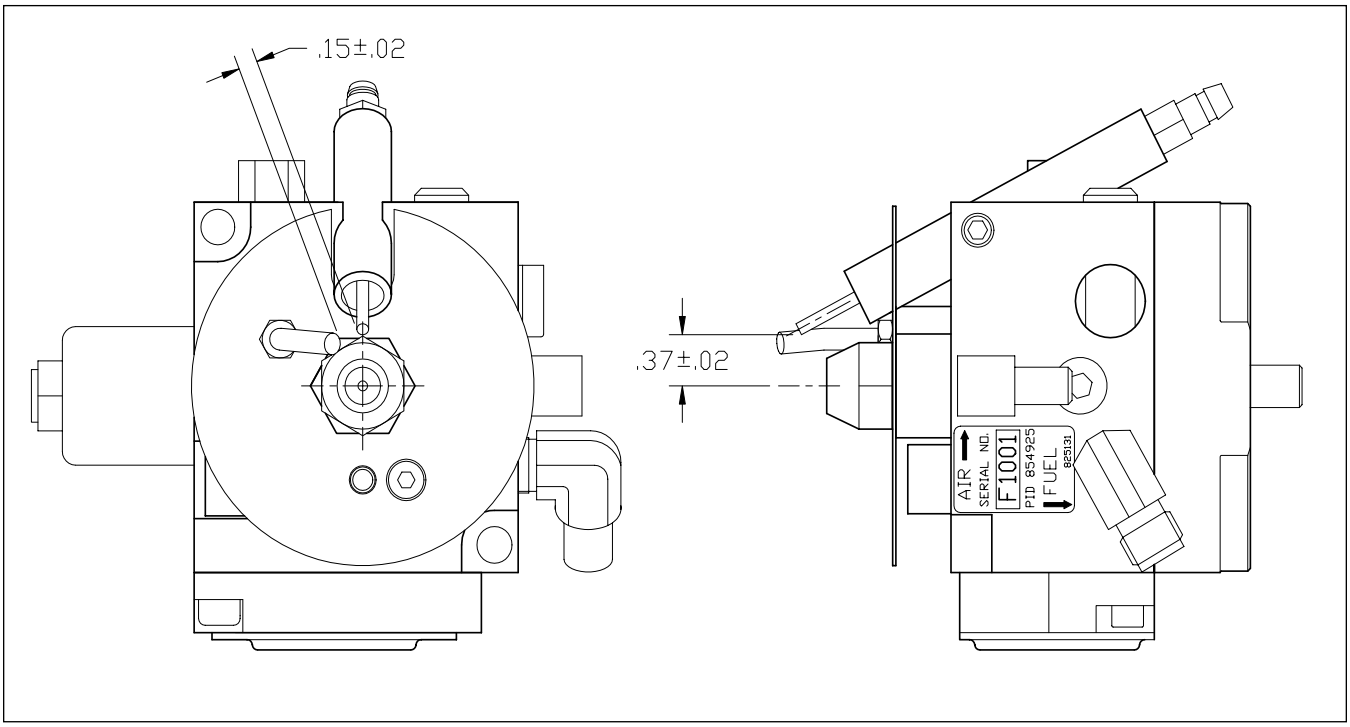


Figure 4-12 Electrode Gap

Fuse

If, when the heater is switched on, the heater does not run and the "ON" light does not light, check the fuse in the controller. The fuse will blow if there is a short to ground in a positive lead or internally for the following components:

- ON/OFF switch
- Air Compressor
- Ignition Coil
- Coolant Pump
- Blower Motor
- Flame Indicator Harness

Caution

Repeated replacement of the fuse or using incorrectly rated fuses without correcting the problem, can damage the Proheat Control Module (PCM).

A reverse polarity connection connection at the battery will also cause the fuse to blow. This will not harm the controller.

Check: **Heater wiring**

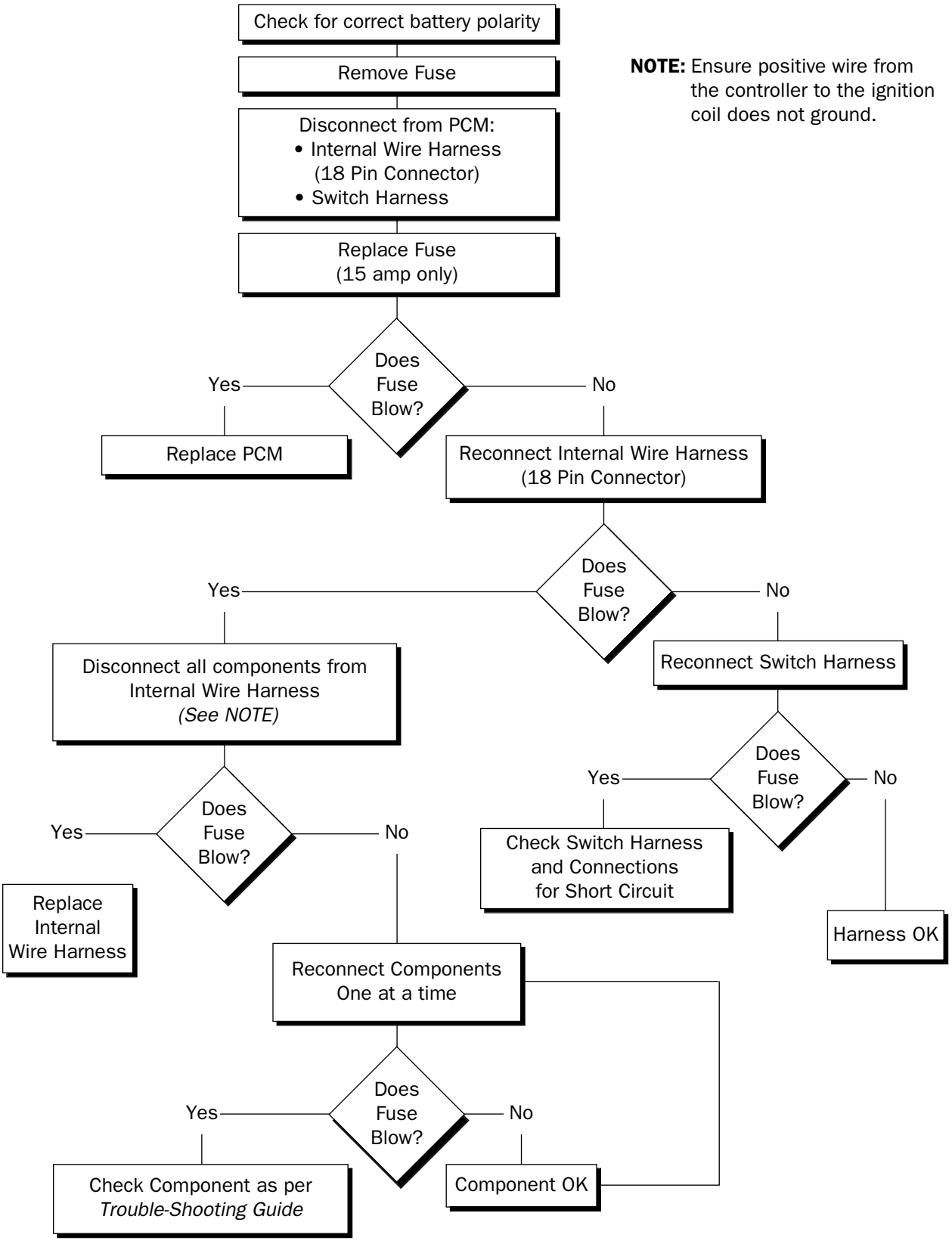
a) Check polarity of battery connections.

b) Test the internal wire harness for short circuits.

The following page describes the test procedure for a blown fuse with power connected and the PROHEAT switched off.

Fuse Blown Test Procedure with Power Connected and Proheat Switched Off

NOTE: Ensure positive wire from the controller to the ignition coil does not ground.



Nozzle

The nozzle (and the compressor) regulate the fuel air mixture. A set orifice size allows a certain amount of fuel and air to flow through the distributor of the nozzle. Problems in the nozzle can cause poor burning. This will be indicated by START ERROR or FLAME OUT code on the PCM display panel.

Check: Nozzle

a) Inspect the nozzle for blockage.

b) Clean or replace nozzle as necessary.

Nozzle Cleaning Procedure:

a) Remove the nozzle from the fuel block . Blow the remaining fuel out of the passage. You should be able to see down the center of the nozzle when held up to a light source. If it is blocked then it can be disassembled (there are three pieces) for cleaning. Note that debris can be lodged in the air passage slots of the nozzle as well. Use a pin to remove debris from the nozzle.

b) Lubricate the O-ring on the nozzle with diesel fuel prior to re-installing it in the FDU.

NOTE: Cleaning the nozzle does not always remove the restriction. If, after the nozzle has been disassembled and cleaned and the heater still does not operate properly, replace the nozzle with a new one. The restriction does not have to completely block the flow of the fuel/air mixture, a partial blockage will cause the heater to malfunction.

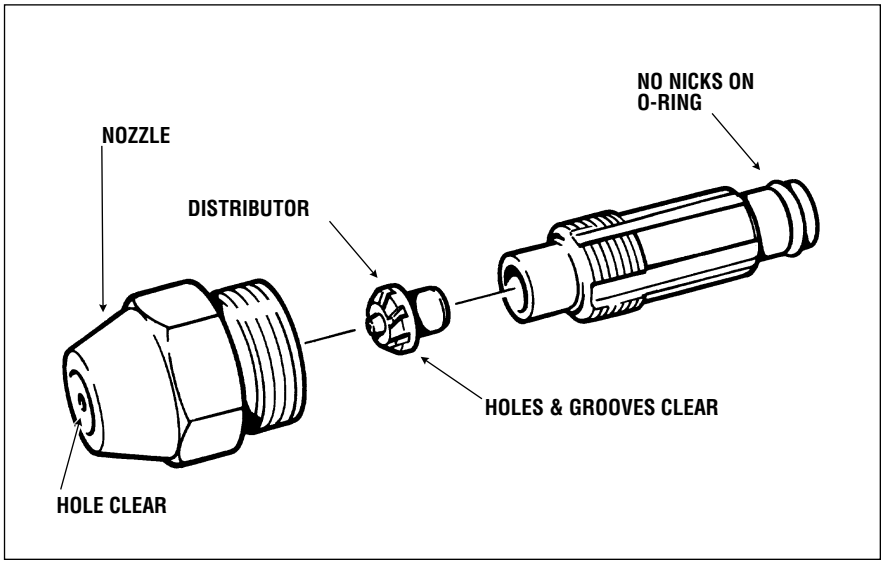


Figure 4-13 Fuel Nozzle Detail

Fuel Regulator

The fuel regulator reduces the fuel pressure supplied by the fuel pump from approximately .6 bar (9 psi) to atmospheric pressure. Compressed air flowing through the nozzle creates a venturi effect which siphons fuel from the regulator. If the compressed air flow through the nozzle stops, the regulator closes, shutting off the fuel flow.

Check: Fuel Regulator

a) Ensure that the vent hole in the regulator is not plugged.

b) Ensure that all fuel line connections and clamps are tight.

NOTE: Should a fuel regulator fail, the combustion chamber must be checked for carbon build up and cleaned as necessary.

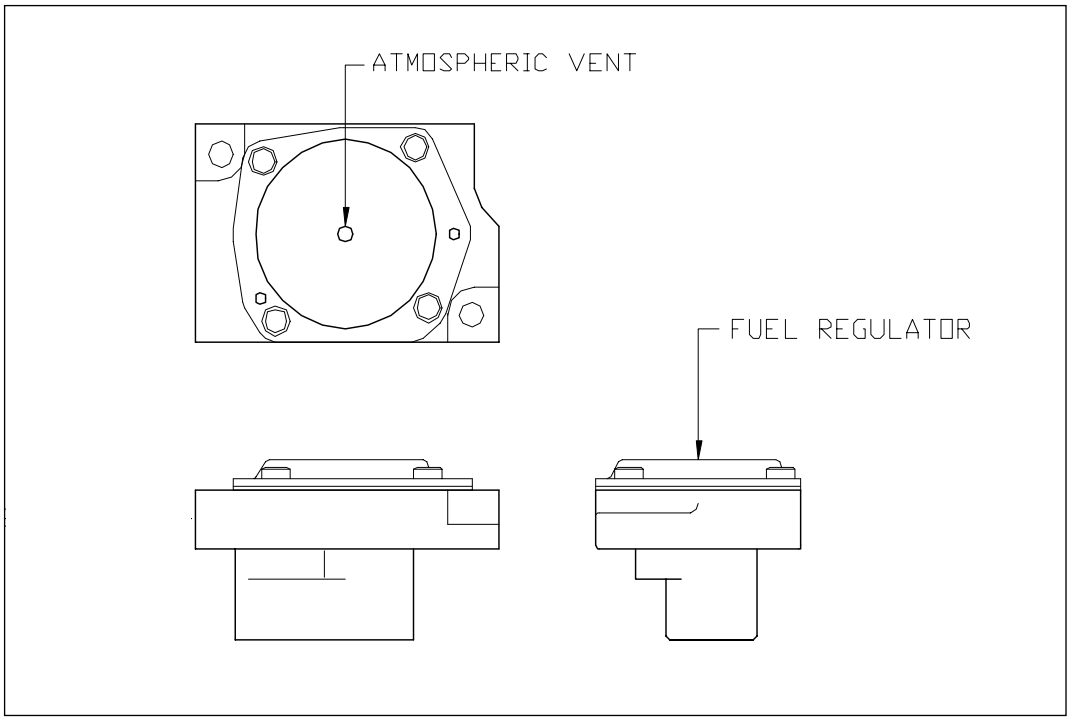


Figure 4-14 Fuel Regulator

OPERATIONAL PROBLEMS

COMPLAINT

Smoking exhaust
Smelly exhaust fumes

These symptoms are usually an indication of an extremely rich air/fuel mixture.

Check:

a) Is the blower functioning? Is the air inlet restricted?
b) Is the compressor functioning? *(See page 4-18)*
c) Is this a new heater? New heaters may smoke for 15 minutes as oil is burned off the exhaust pipe.

Low heat output

If the heater appears to be functioning properly but the driver complains of low heat this is often indicative of a coolant flow restriction or possibly air intrusion into the fuel system. (*See section on Coolant Flow Error, page 4-5*)

Engine temperature gauge reads low

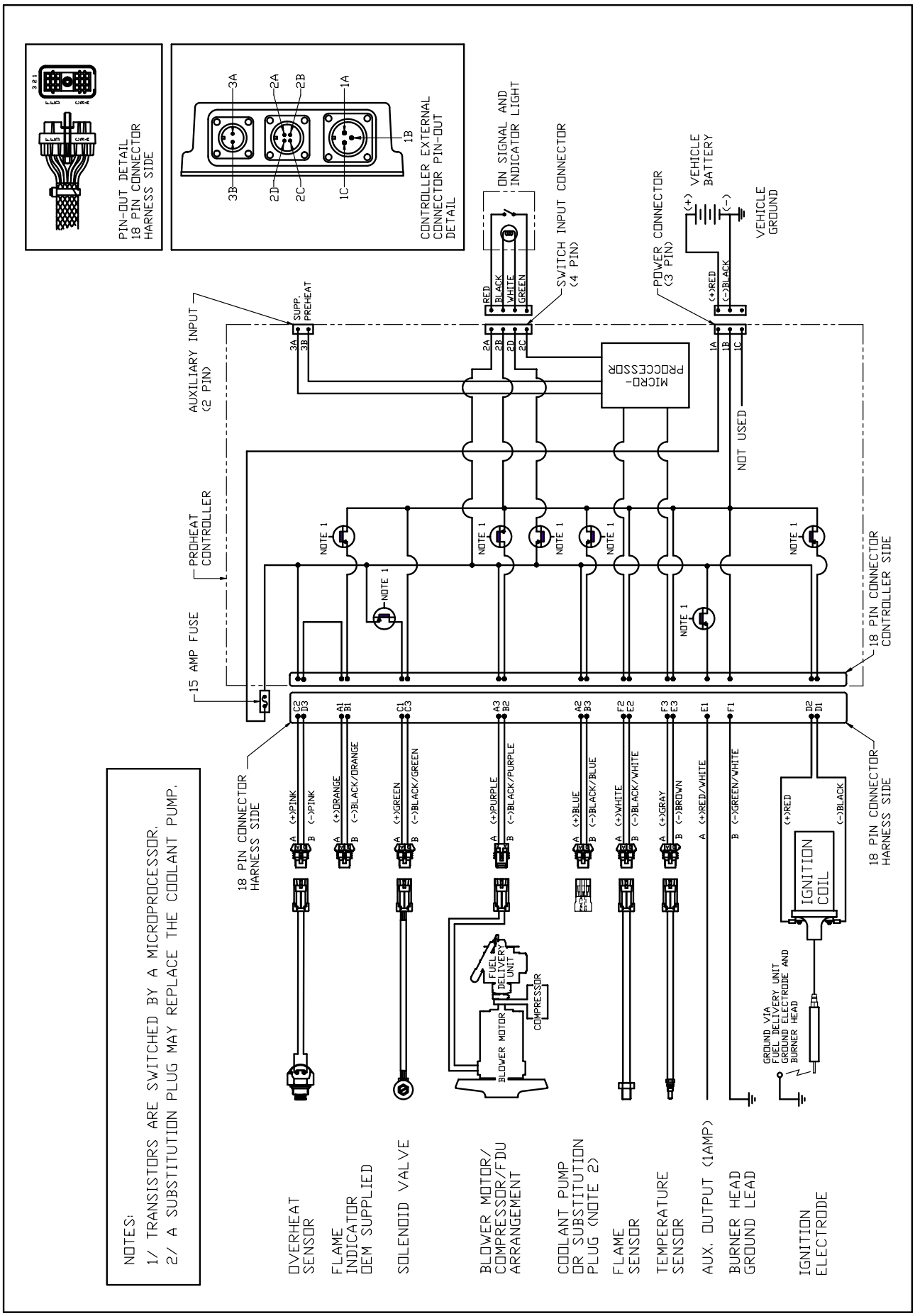
Depending on its location, the engine temperature sensor may not be directly in the path of coolant flow from the heater. In these cases the gauge may read significantly lower than actual coolant temperature.

Backfiring

Backfiring occurs when there is air in the fuel supply lines.

Check:

a) Fuel level in tank – is the pick-up submerged?
b) Air leaks – are all the fuel line clamps tight?
c) For severely restricted combustion air blockage at the blower inlet, in the combustion chamber, or in the exhaust system.


PIN-OUT DETAIL
18 PIN CONNECTOR
HARNESS SIDE
CONTROLLER EXTERNAL
CONNECTOR PIN-OUT
DETAIL
ON SIGNAL AND
INDICATOR LIGHT
SWITCH INPUT CONNECTOR
(4 PIN)
POWER CONNECTOR
(3 PIN)
VEHICLE
BATTERY
VEHICLE
GROUND
AUXILIARY INPUT
(2 PIN)
PROHEAT
CONTROLLER
15 AMP FUSE
MICRO-
PROCCESSOR
NOT USED
18 PIN CONNECTOR
CONTROLLER SIDE
18 PIN CONNECTOR
HARNESS SIDE
NOTE 1
NOTES:
1/ TRANSISTORS ARE SWITCHED BY A MICROPROCESSOR.
2/ A SUBSTITUTION PLUG MAY REPLACE THE COOLANT PUMP.
OVERHEAT SENSOR
FLAME INDICATOR OEM SUPPLIED
SOLENOID VALVE
BLOWER MOTOR/ COMPRESSOR/FDU ARRANGEMENT
COOLANT PUMP OR SUBSTITUTION PLUG (NOTE 2)
FLAME SENSOR
TEMPERATURE SENSOR
AUX. OUTPUT (1AMP)
BURNER HEAD GROUND LEAD
IGNITION ELECTRODE
BLOWER MOTOR
FUEL DELIVERY UNIT
COMPRESSOR
IGNITION COIL
GROUND VIA FUEL DELIVERY UNIT GROUND ELECTRODE AND BURNER HEAD

6.0 MAINTENANCE/TOOLS

ANNUAL MAINTENANCE

The PROHEAT heater has been designed to operate with a minimum of maintenance. Check the system annually before each heating season.

Electrical System

Check all wire harnesses for damage.
Replace if required.

Heat Exchanger & Combustion Tube

To maintain optimum heat output, clean any combustion deposits that may have accumulated on the heat exchanger fins or the combustion tube. Remove the burner head and combustion tube to access the inside of the heat exchanger. Use a wire brush to loosen the deposits and compressed air to blow them out.

Exhaust System

Check the exhaust system carefully. Make sure the exhaust pipe is vented safely away from the vehicle. Check the pipe for dents, restrictions or severely corroded areas. Replace the exhaust pipe and clamps if necessary. Ensure the exhaust pipe clamp is tight.

Fuel Filter

Remove and inspect fuel filter. Clean or replace as required

Air Inlet

Check the combustion air inlet screen for restrictions. Clean as required.

Compressor Air Filter

The air compressor is fitted with an inlet air filter to ensure clean air is supplied to the nozzle. Replace annually or more often if dusty conditions are encountered.

Cooling System

Check all heater hoses and connections for signs of leakage or damage. Repair or replace as required.

Fuel System

Check the fuel system for damaged fuel lines or leakage. Make sure all fittings and hoses are secure and air tight.

Vehicle Batteries

Check the condition of the batteries and the power connections. The heater will not function properly with weak batteries or corroded connections.

Operation Test

Run the system for at least 15 minutes or until the heater cycles off and then on again.

MAINTENANCE TOOLS

COMPONENT SUBSTITUTION PLUG

ITEM	PART#	QTY	DESCRIPTION
1	982526-1	1	Component Substitution Plug This plug can be used in place of a component or to test component or PCM function

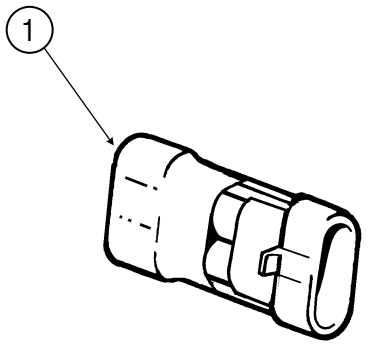


Figure 12

REMOTE ON/OFF SWITCH

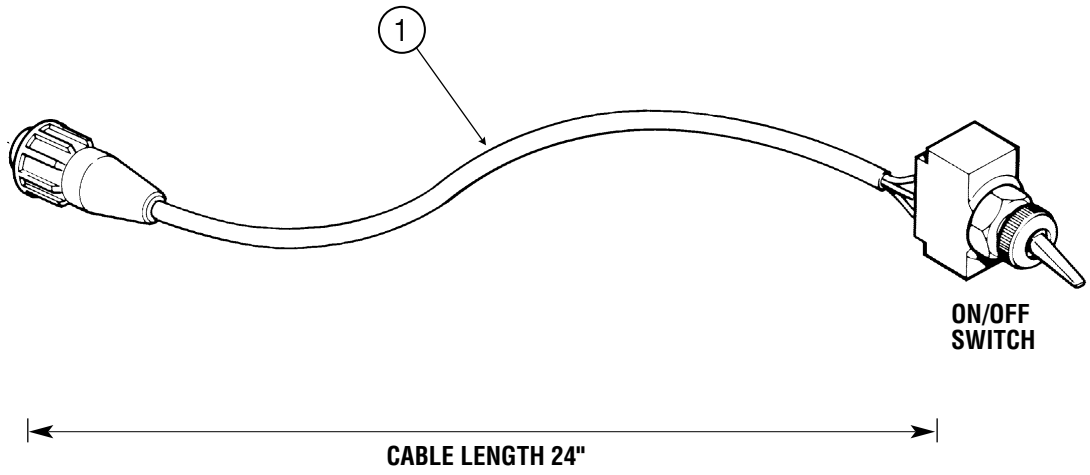
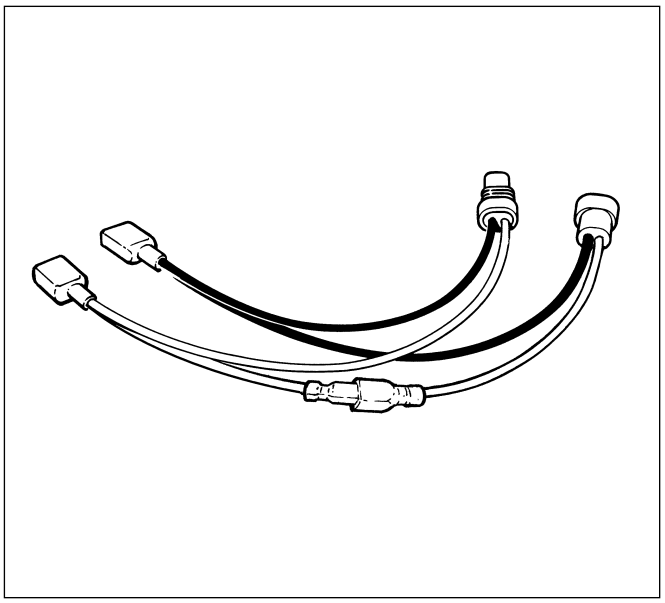


Figure 13

ITEM	PART#	QTY	DESCRIPTION
1	952925	1	Switch Lead. Remote On/Off This switch lead allows the user to switch the Proheat ON & OFF at the furnace.

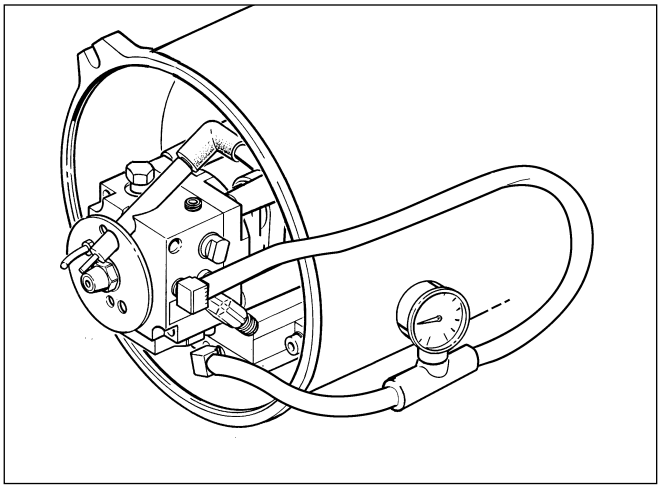
ITEM	PART#	QTY	DESCRIPTION

ITEM	PART#	QTY	DESCRIPTION
	967632		Test lead, Blower, Bravo 80
	967921		Test Lead, Main Harness
			These leads allow the user to: • apply power to components from a remote source • check the internal resistance of components • check component voltages using a multimeter • check components amperage using a multimeter.

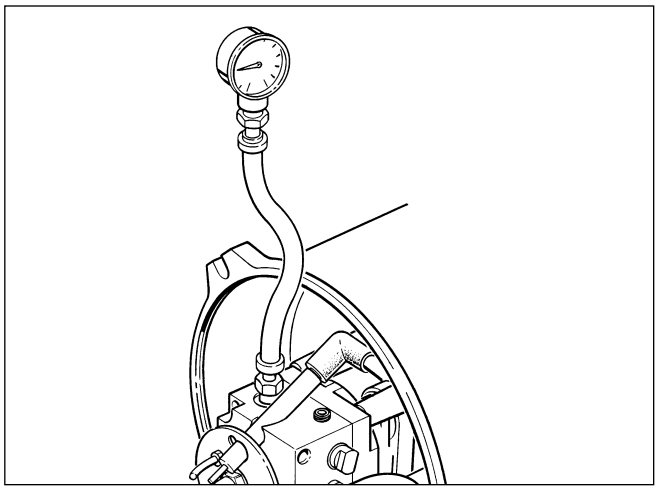


GAUGES

ITEM	PART#	QTY	DESCRIPTION
	PK0060		Air Pressure Test Gauge



ITEM	PART#	QTY	DESCRIPTION
	PK0067		Fuel Pressure Test Gauge



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