



# FUEL SYSTEM

## Section 3B – Direct Fuel Injection

### Table of Contents

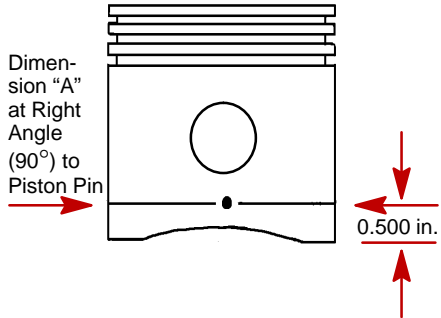
|                                                 |       |                                                 |       |
|-------------------------------------------------|-------|-------------------------------------------------|-------|
| Specifications .....                            | 3B-2  | Air Temperature Sensor Removal .....            | 3B-25 |
| Special Tools .....                             | 3B-3  | Air Temperature Sensor Installation .....       | 3B-26 |
| Notes: .....                                    | 3B-5  | Throttle Plate Assembly Removal .....           | 3B-26 |
| Air Handler .....                               | 3B-6  | Throttle Plate Assembly Installation .....      | 3B-26 |
| Air Handler Components .....                    | 3B-8  | Vapor Separator Disassembly .....               | 3B-26 |
| Vapor Separator Components .....                | 3B-10 | Vapor Separator Reassembly .....                | 3B-28 |
| Fuel Rails/Air Compressor Hose Routing .....    | 3B-12 | Air Plenum Installation .....                   | 3B-29 |
| Fuel Rails .....                                | 3B-14 | Low Pressure Electric Fuel Pump Installation .  | 3B-29 |
| Air Compressor Components .....                 | 3B-16 | Vapor Separator Installation .....              | 3B-31 |
| DFI Operation .....                             | 3B-18 | Fuel Rail Removal .....                         | 3B-33 |
| Air Induction Through Crankcase .....           | 3B-18 | Fuel Rail Disassembly .....                     | 3B-34 |
| Air Compressor System .....                     | 3B-18 | Fuel Pressure Regulator .....                   | 3B-37 |
| Fuel .....                                      | 3B-18 | Air Pressure Regulator .....                    | 3B-39 |
| Oil .....                                       | 3B-19 | Tracker Valve .....                             | 3B-41 |
| Electrical .....                                | 3B-19 | Fuel Rail Cleaning .....                        | 3B-43 |
| Operation .....                                 | 3B-19 | Direct Injector Removal .....                   | 3B-43 |
| Testing Electric Fuel Pump Pressure Output .... | 3B-20 | Fuel Rail and Direct Injector Installation .... | 3B-45 |
| Low Pressure Electric Fuel Pump .....           | 3B-20 | Air Compressor .....                            | 3B-46 |
| High Pressure Electric Fuel Pump .....          | 3B-21 | Air Compressor Disassembly/Reassembly ...       | 3B-49 |
| Fuel Management Assembly Removal .....          | 3B-22 | Air Compressor Flow Diagram .....               | 3B-50 |
| Reed Block Assembly Removal .....               | 3B-25 | Air Compressor Pressure Test .....              | 3B-51 |
| Reed Block Assembly Installation .....          | 3B-25 |                                                 |       |

**3  
B**



# Specifications

| Fuel System Specifications                     |                                 |
|------------------------------------------------|---------------------------------|
| Fuel Pressure                                  | 89 ± 2 psi (613.5 ± 13.8 kPa)   |
| Air Pressure                                   | 79 ± 2 psi (544.0 ± 13.8 kPa)   |
| Fuel/Air Differential                          | 10 psi (68.5 kPa)               |
| High Pressure Electric Fuel Pump Amperage Draw | 6-9 Amps                        |
| Low Pressure Electric Fuel Pump Amperage Draw  | 1-2 Amps                        |
| Low Pressure Electric Fuel Pump Output         | 6-10 psi (41.37 kPa – 68.5 kPa) |
| Fuel Injector Ohm Resistance                   | 1.8 ± 0.1Ω                      |
| Direct Injector Ohm Resistance                 | 1.3 ± 0.3Ω                      |

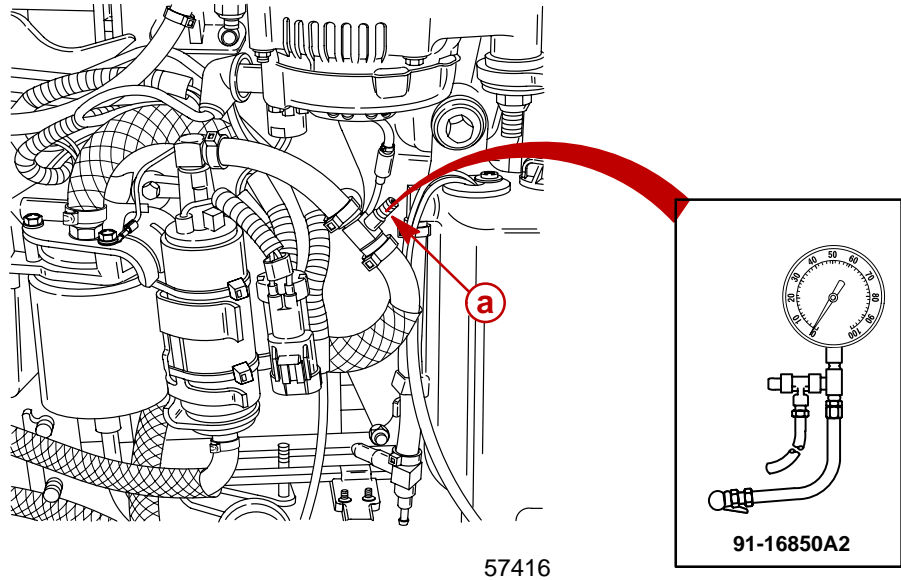
| Air Compressor Specifications |                                                                                                                                              |                                                                                                                              |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Air Compressor                | Type<br>Compressor Output                                                                                                                    | Reciprocating Piston<br>(1 to 1 ratio with engine RPM)<br>@ Idle – 80 psi<br>@ W.O.T. – 110 psi                              |
| Cylinder Block                | Displacement                                                                                                                                 | 7.07 cu. in. (116 cc)                                                                                                        |
| Cylinder Bore                 | Diameter (Standard)<br>Taper/Out-of-Round/Wear Maximum<br>Bore Type                                                                          | 2.5591 in. (65.0 mm)<br>0.001 in. (0.025 mm)<br>Cast Iron                                                                    |
| Stroke                        | Length                                                                                                                                       | 1.374 in. (34.9 mm)                                                                                                          |
| Piston                        | Piston Type                                                                                                                                  | Aluminum                                                                                                                     |
| Piston Diameter               |  <p>Dimension "A" at Right Angle (90°) to Piston Pin</p> | 2.5578 ± .0004 in.<br>(64.97 ± 0.010 mm)                                                                                     |
| Piston Ring                   | End Gap<br>Top Ring<br>Middle Ring<br>Bottom Ring                                                                                            | 0.0059 – 0.0098 in.<br>(0.15 – 0.25 mm)<br>0.0059 – 0.0098 in.<br>(0.15 – 0.25 mm)<br>0.0039 – 0.014 in.<br>(0.10 – 0.35 mm) |
| Reeds                         | Reed Stand Open                                                                                                                              | 0.010 in. (0.25 mm)                                                                                                          |



# Special Tools

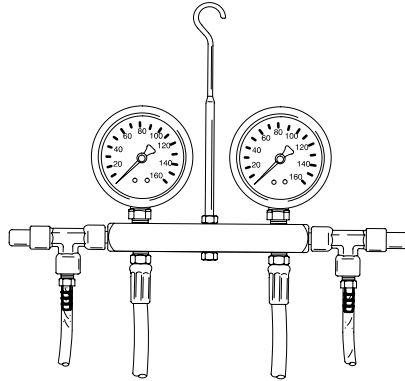
1. Single Fuel/Air Pressure Gauge 160 psi – 91-16850A2

**NOTE:** To convert 100 psi gauge 91-16850A1 to 160 psi gauge, order upgrade 91-16850--1.



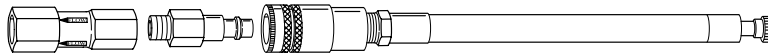
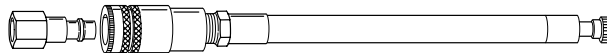
- a** - Schrader Valve (22-84906) – part of Schrader Valve Fuel Pressure Kit (849021A4)

2. Duel Fuel Air/Air Pressure Gauge 160 psi – 91-852087A1 or A2



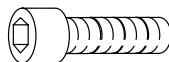
55295

3. Adaptors to convert pressure gauge 91-852078A1 to an A2



57341

4. Screw (5mm x 25mm) (2 each) – 10-40073-25



5. Flat Washer (2 each) – 12-30164.



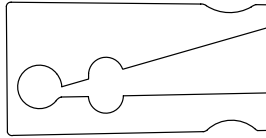


- 6. Seal/Teflon Ring Installation Tool – 91-851980



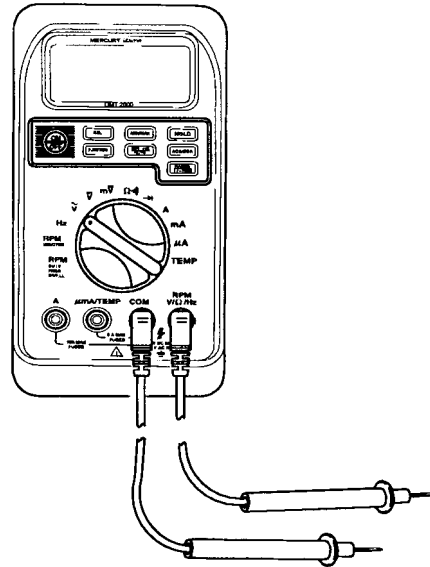
56015

- 7. Seal/Teflon Ring Sizing Tool – 91-851980-1

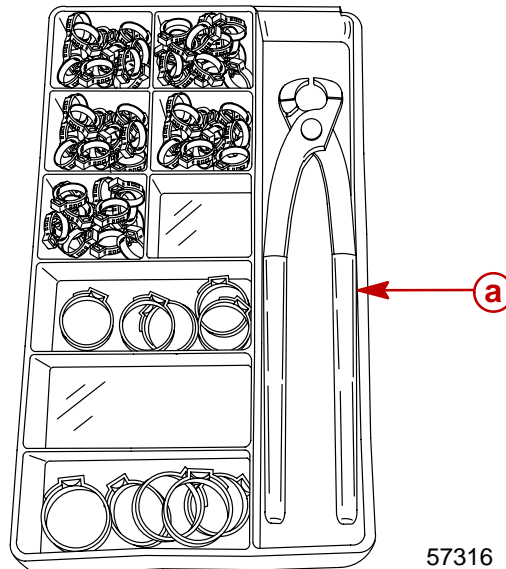


56014

- 8. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



- 9. Clamp Tool Kit 91-803146A2



57316

**a** - Clamp Tool 91-803146T

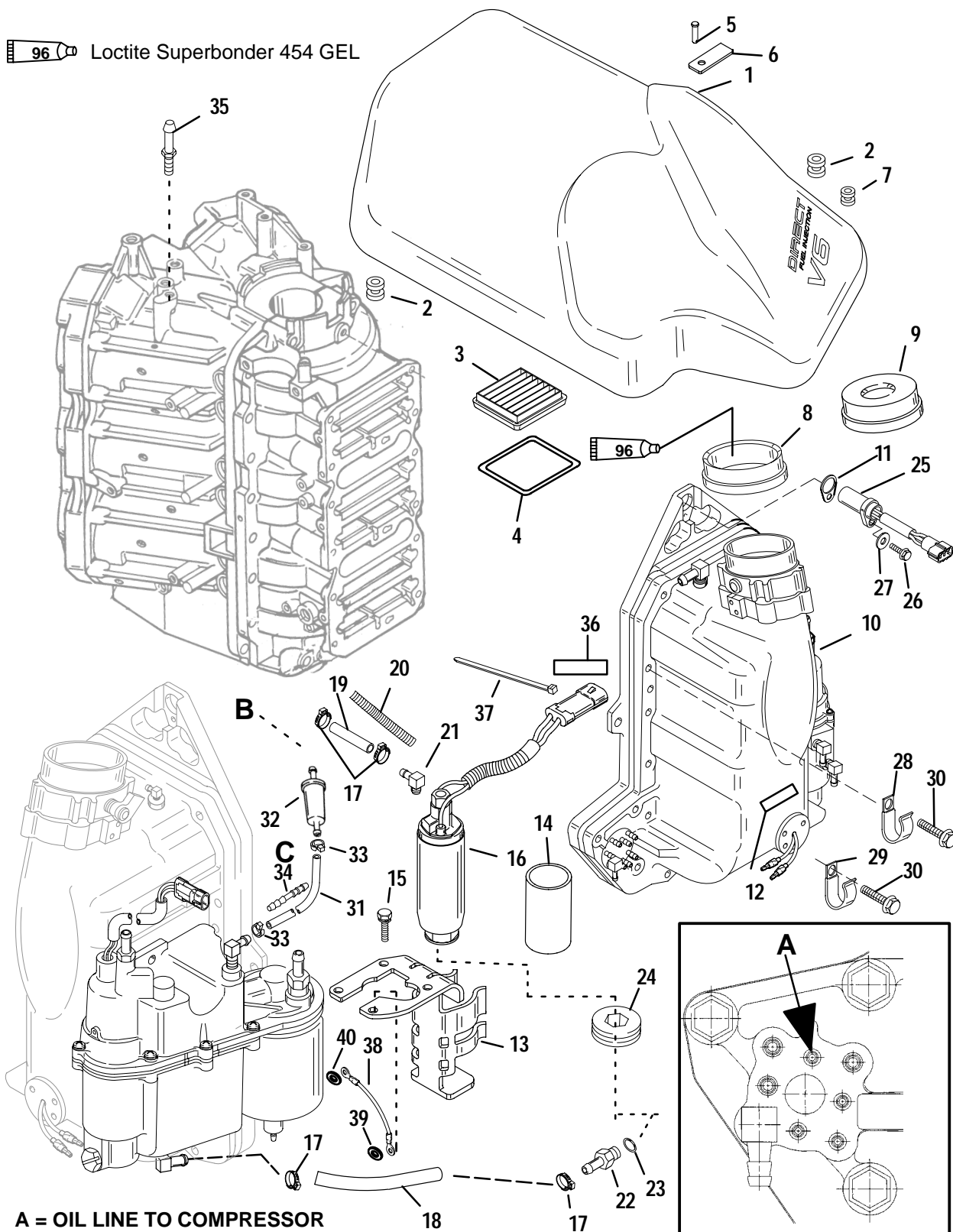


## Notes:



# Air Handler

96 Loctite Superbonder 454 GEL



**A = OIL LINE TO COMPRESSOR**  
**B = TO FITTING IN FLYWHEEL COVER**  
**C = PRESS INTO TUBING**



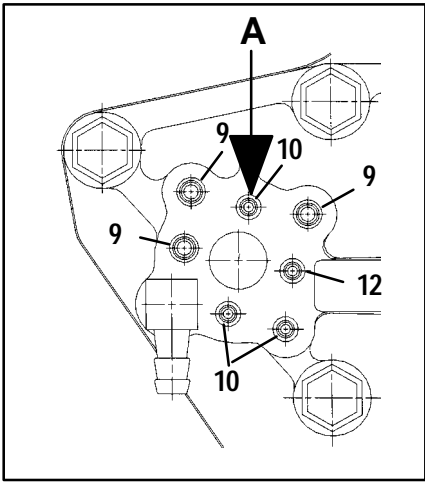
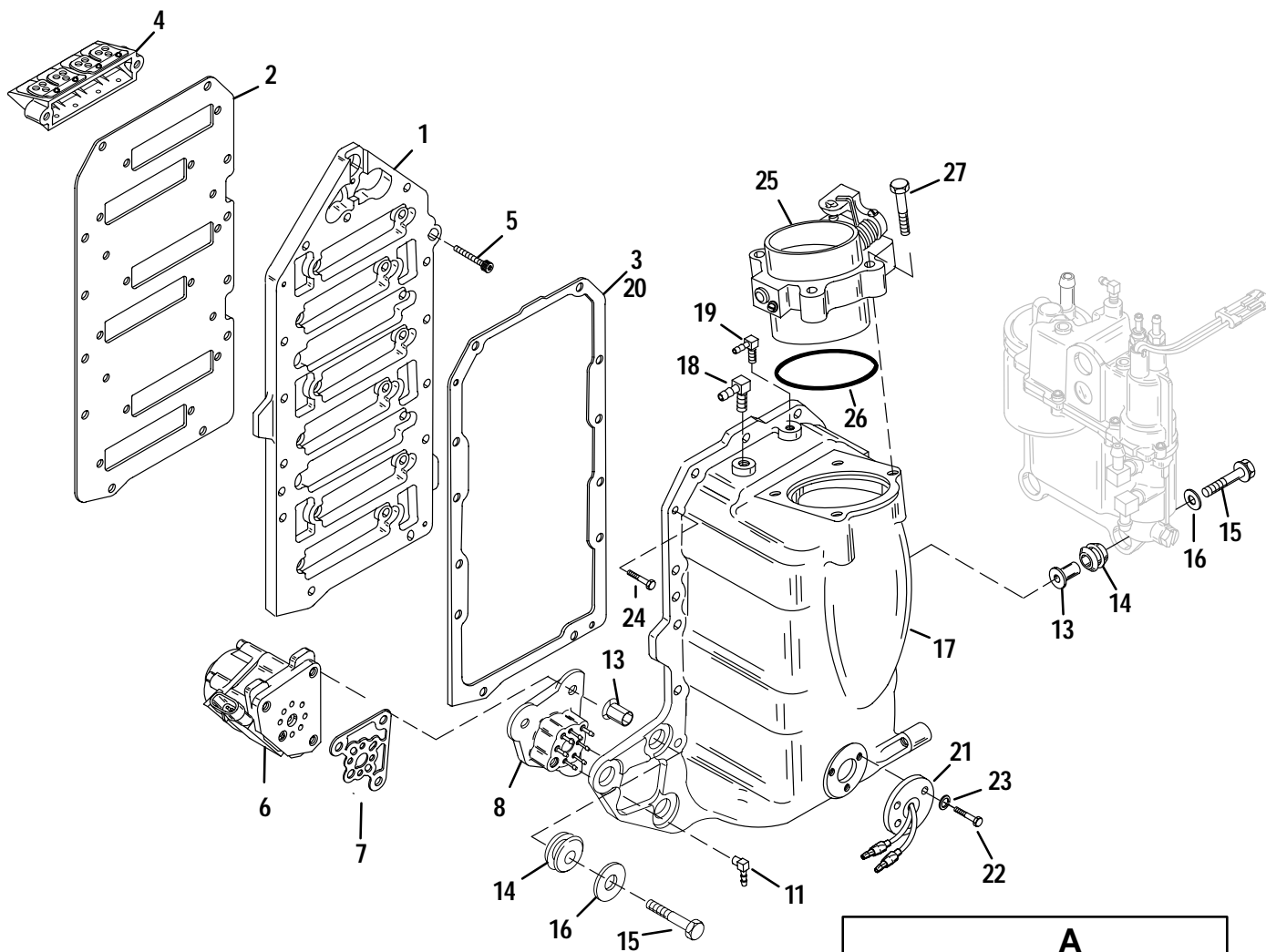
# Air Handler

| REF. NO. | QTY. | DESCRIPTION                                                       | TORQUE      |       |      |
|----------|------|-------------------------------------------------------------------|-------------|-------|------|
|          |      |                                                                   | lb-in       | lb-ft | Nm.  |
| 1        | 1    | COVER ASSEMBLY                                                    |             |       |      |
| 2        | 2    | GROMMET                                                           |             |       |      |
| 3        | 1    | AIR FILTER                                                        |             |       |      |
| 4        | 1    | COVER                                                             |             |       |      |
| 5        | 1    | RIVET                                                             |             |       |      |
| 6        | 1    | RETAINER                                                          |             |       |      |
| 7        | 1    | GROMMET                                                           |             |       |      |
| 8        | 1    | GROMMET <b>(150)</b>                                              |             |       |      |
| 9        | 1    | GROMMET <b>(135)</b>                                              |             |       |      |
| 10       | 1    | AIR HANDLER ASSEMBLY<br>(See Breakdown on Air Handler Components) |             |       |      |
| 11       | 1    | SHIM <b>(.020 THICK)</b>                                          |             |       |      |
|          | 1    | SHIM <b>(.010 THICK)</b>                                          |             |       |      |
| 12       | 1    | DECAL-Caution-Start in Gear                                       |             |       |      |
| 13       | 1    | BRACKET                                                           |             |       |      |
| 14       | 1    | SLEEVE                                                            |             |       |      |
| 15       | 4    | SCREW (M6 x 16)                                                   | 100         |       | 11.5 |
| 16       | 1    | FUEL PUMP                                                         |             |       |      |
| 17       | 4    | CLAMP                                                             |             |       |      |
| 18       | 1    | HOSE                                                              |             |       |      |
| 19       | 1    | TUBING (18 IN.)                                                   |             |       |      |
| 20       | 1    | INSULATING SLEEVE                                                 |             |       |      |
| 21       | 1    | ELBOW                                                             |             |       |      |
| 22       | 1    | FITTING                                                           |             |       |      |
| 23       | 1    | O RING                                                            |             |       |      |
| 24       | 1    | GROMMET                                                           |             |       |      |
| 25       | 1    | ENCODER                                                           |             |       |      |
| 26       | 1    | SCREW (10-24 x 5/8 IN.)                                           | Drive Tight |       |      |
| 27       | 1    | WASHER                                                            |             |       |      |
| 28       | 2    | J CLAMP (Upper Stbd.)                                             |             |       |      |
| 29       | 1    | CLAMP-(Lower)                                                     |             |       |      |
| 30       | 12   | SCREW (1/4-20 x 1-1/2 IN.)                                        | 175         | 15    | 20   |
| 31       | 1    | TUBING (5-3/4 IN.)                                                |             |       |      |
| 32       | 1    | CANISTER-Vent                                                     |             |       |      |
| 33       | 3    | STA STRAP                                                         |             |       |      |
| 34       | 1    | CONNECTOR                                                         |             |       |      |
| 35       | 1    | PIN                                                               |             |       |      |
| 36       | 1    | DECAL EPA LABEL <b>(1999) (SEE NOTE)</b>                          |             |       |      |
| 37       | 1    | CABLE TIE (14 IN.)                                                |             |       |      |
| 38       | 1    | CABLE                                                             |             |       |      |
| 39       | 1    | WASHER                                                            |             |       |      |
| 40       | 1    | WASHER                                                            |             |       |      |

**NOTE: THE EPA LABEL HAS IMPORTANT INFORMATION ON EPA EMISSION REGULATIONS. REPLACE ANY MISSING OR UNREADABLE EPA LABEL.**



# Air Handler Components



**A = OIL LINE TO COMPRESSOR**



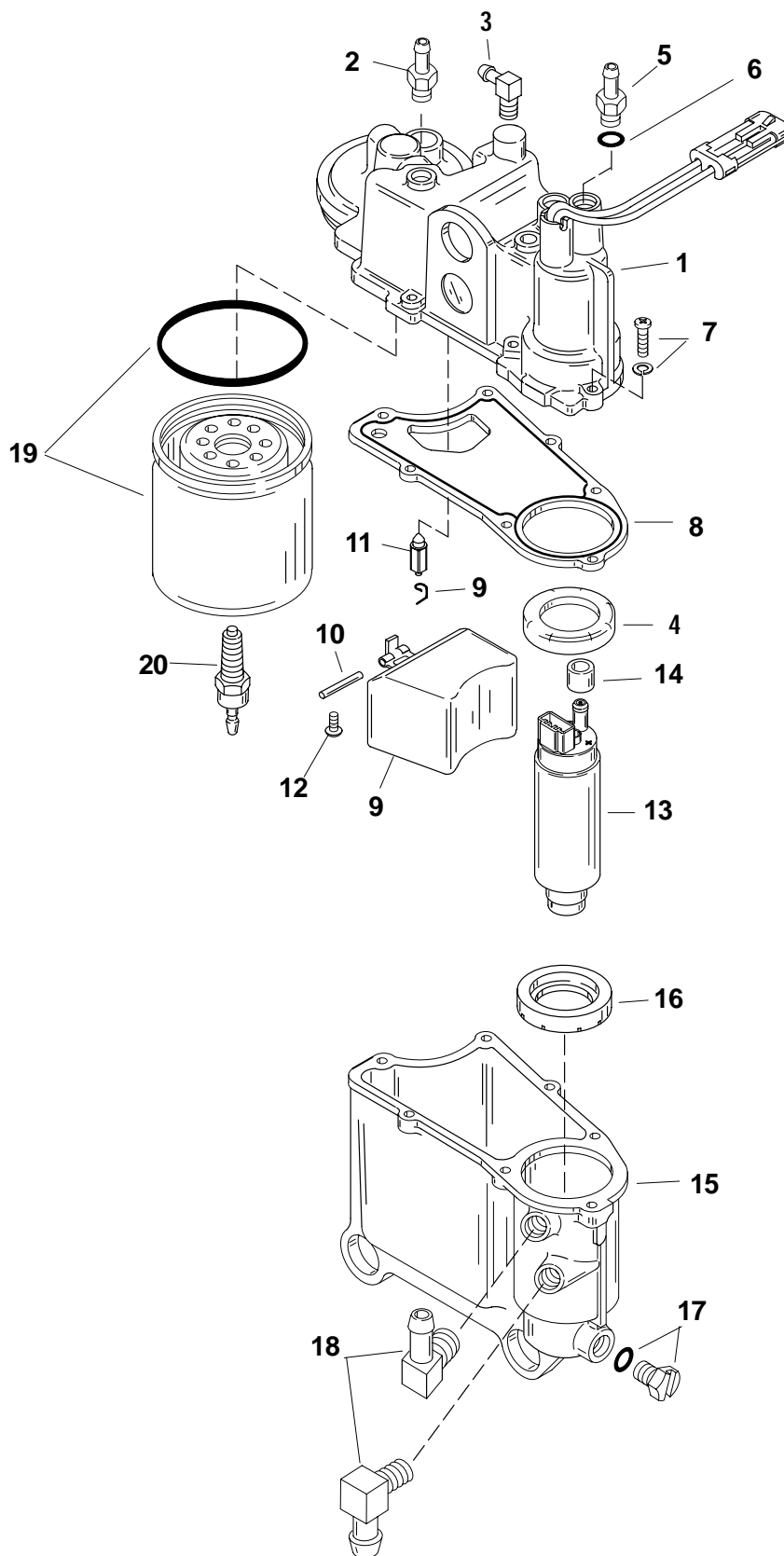


# Air Handler Components

| REF. NO. | QTY. | DESCRIPTION          | TORQUE |       |             |
|----------|------|----------------------|--------|-------|-------------|
|          |      |                      | lb-in  | lb-ft | Nm.         |
| -        | 1    | AIR HANDLER          |        |       |             |
| 1        | 1    | ADAPTOR PLATE KIT    |        |       |             |
| 2        | 1    | GASKET               |        |       |             |
| 3        | 1    | GASKET               |        |       |             |
| 4        | 6    | REED BLOCK           |        |       |             |
| 5        | 12   | SCREW (1/4-20 x .88) | 100    |       | 11.5        |
| 6        | 1    | OIL PUMP             |        |       |             |
| 7        | 1    | GASKET               |        |       |             |
| 8        | 1    | BRACKET              |        |       |             |
| 9        | 3    | FITTING              |        |       |             |
| 10       | 3    | FITTING              |        |       |             |
| 11       | 1    | ELBOW                |        |       |             |
| 12       | 1    | FITTING (STRAIGHT)   |        |       |             |
| 13       | 6    | BUSHING              |        |       |             |
| 14       | 6    | GROMMET              |        |       |             |
| 15       | 6    | SCREW                | 140    | 12    | 16          |
| 16       | 6    | WASHER               |        |       |             |
| 17       | 1    | AIR PLENUM KIT       |        |       |             |
| 18       | 1    | ELBOW                |        |       |             |
| 19       | 1    | ELBOW (.236 O.D.)    |        |       |             |
|          | 1    | ELBOW (.159 O.D.)    |        |       |             |
| 20       | 1    | GASKET               |        |       |             |
| 21       | 1    | TEMPERATURE SENSOR   |        |       |             |
| 22       | 3    | SCREW                |        |       | Drive Tight |
| 23       | 3    | LOCKWASHER           |        |       |             |
| 24       | 12   | SCREW (M4 x 16)      |        |       | Drive Tight |
| 25       | 1    | THROTTLE BODY KIT    |        |       |             |
| 26       | 1    | O RING               |        |       |             |
| 27       | 4    | SCREW                | 100    |       | 11.5        |



# Vapor Separator Components



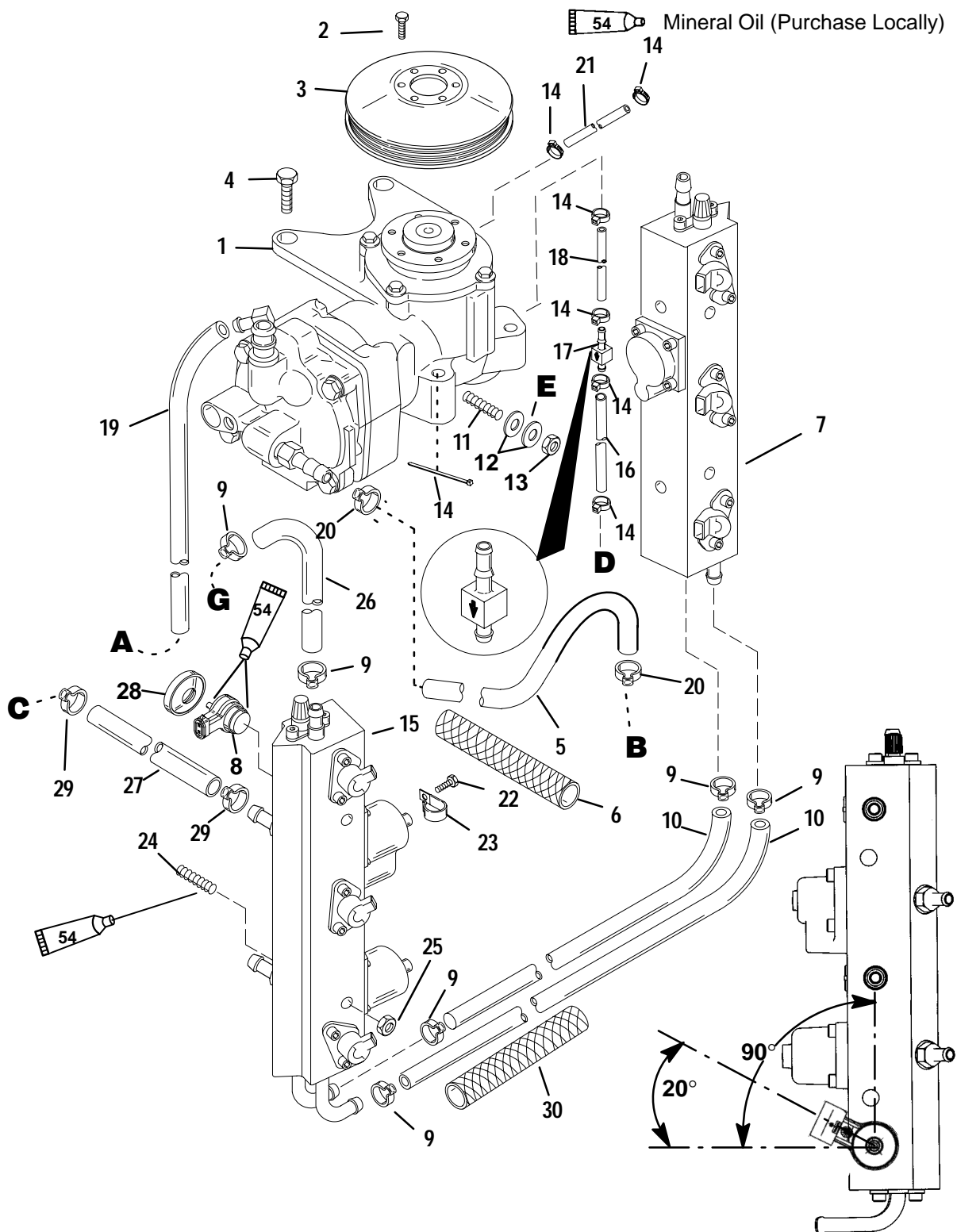


# Vapor Separator Components

| REF. NO. | QTY. | DESCRIPTION             | TORQUE |       |     |
|----------|------|-------------------------|--------|-------|-----|
|          |      |                         | lb-in  | lb-ft | Nm. |
| 1        | 1    | COVER KIT               |        |       |     |
| 2        | 1    | FITTING - Straight      |        |       |     |
| 3        | 1    | ELBOW                   |        |       |     |
| 4        | 1    | SEAL                    |        |       |     |
| 5        | 1    | FITTING KIT-Pump Outlet |        |       |     |
| 6        | 1    | O RING                  |        |       |     |
| 7        | 7    | SCREW                   | 30     |       | 3.5 |
| 8        | 1    | GASKET                  |        |       |     |
| 9        | 1    | FLOAT KIT               |        |       |     |
| 10       | 1    | FLOAT PIN               |        |       |     |
| 11       | 1    | NEEDLE VALVE            |        |       |     |
| 12       | 1    | SCREW                   | 10     |       | 1.0 |
| 13       | 1    | FUEL PUMP KIT           |        |       |     |
| 14       | 1    | SLEEVE                  |        |       |     |
| 15       | 1    | BOWL KIT                |        |       |     |
| 16       | 1    | SEAL                    |        |       |     |
| 17       | 1    | PLUG KIT                |        |       |     |
| 18       | 2    | ELBOW                   |        |       |     |
| 19       | 1    | FUEL FILTER ASSEMBLY    |        |       |     |
| 20       | 1    | PROBE                   |        |       |     |



# Fuel Rails/Air Compressor Hose Routing



**A = TO TELL TALE   B = TO STARBOARD FUEL RAIL   C = TO FUEL COOLER   D = TO TOP OF AIR HANDLER  
E = QTY. OF ONE (1) ON EACH SIDE OF COMPRESSOR FLANGE   G = TO VAPOR SEPARATOR**

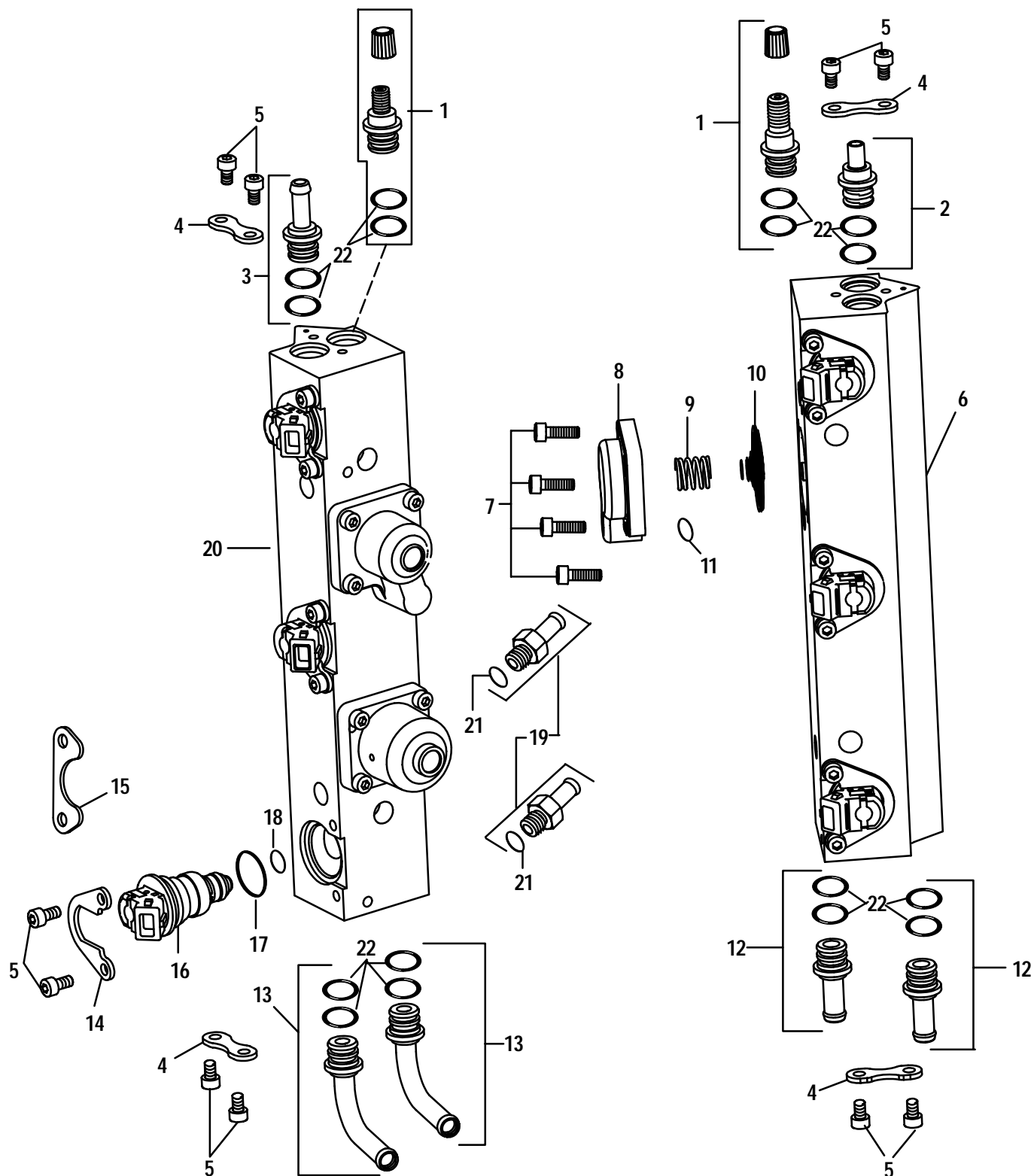


# Fuel Rails/Air Compressor Hose Routing

| REF. NO. | QTY. | DESCRIPTION                                                    | TORQUE |       |      |
|----------|------|----------------------------------------------------------------|--------|-------|------|
|          |      |                                                                | lb-in  | lb-ft | Nm.  |
| 1        | 1    | AIR COMPRESSOR<br>(See breakdown on Air Compressor Components) |        |       |      |
| 2        | 5    | SCREW (M6 x 12)                                                | 100    |       | 11.5 |
| 3        | 1    | PULLEY                                                         |        |       |      |
| 4        | 2    | SCREW                                                          |        | 40    | 54   |
| 5        | 1    | HOSE                                                           |        |       |      |
| 6        | 1    | INSULATOR SLEEVE (16 IN.)                                      |        |       |      |
| 7        | 1    | FUEL RAIL ( <b>STARBOARD</b> )                                 |        |       |      |
| 8        | 6    | INJECTOR                                                       |        |       |      |
| 9        | 4    | CLAMP                                                          |        |       |      |
| 10       | 2    | HOSE (16 IN.)                                                  |        |       |      |
| 11       | 1    | STUD                                                           |        |       |      |
| 12       | 2    | WASHER                                                         |        |       |      |
| 13       | 1    | NUT                                                            |        | 25    | 34   |
| 14       | 8    | STA STRAP                                                      |        |       |      |
| 15       | 1    | FUEL RAIL ( <b>PORT</b> )                                      |        |       |      |
| 16       | 1    | TUBING (22-1/2 IN.)                                            |        |       |      |
| 17       | 1    | CHECK VALVE                                                    |        |       |      |
| 18       | 1    | TUBING (2-1/2 IN.)                                             |        |       |      |
| 19       | 1    | TUBING (28-1/2 IN.)                                            |        |       |      |
| 20       | 2    | CLAMP                                                          |        |       |      |
| 21       | 1    | TUBING (28-1/2 IN.)                                            |        |       |      |
| 22       | 4    | SCREW (M5 x 10)                                                |        |       |      |
| 23       | 4    | CLAMP                                                          |        |       |      |
| 24       | 4    | STUD                                                           |        |       |      |
| 25       | 4    | NUT                                                            |        | 33    | 45   |
| 26       | 1    | HOSE (30 IN.) (W/INSULATING SLEEVE)                            |        |       |      |
| 27       | 1    | HOSE (W/INSULATING SLEEVE)                                     |        |       |      |
| 28       | 6    | CUPPED WASHER                                                  |        |       |      |
| 29       | 4    | CLAMP                                                          |        |       |      |
| 30       | 1    | INSULATOR SLEEVE (18 IN.)                                      |        |       |      |



# Fuel Rails



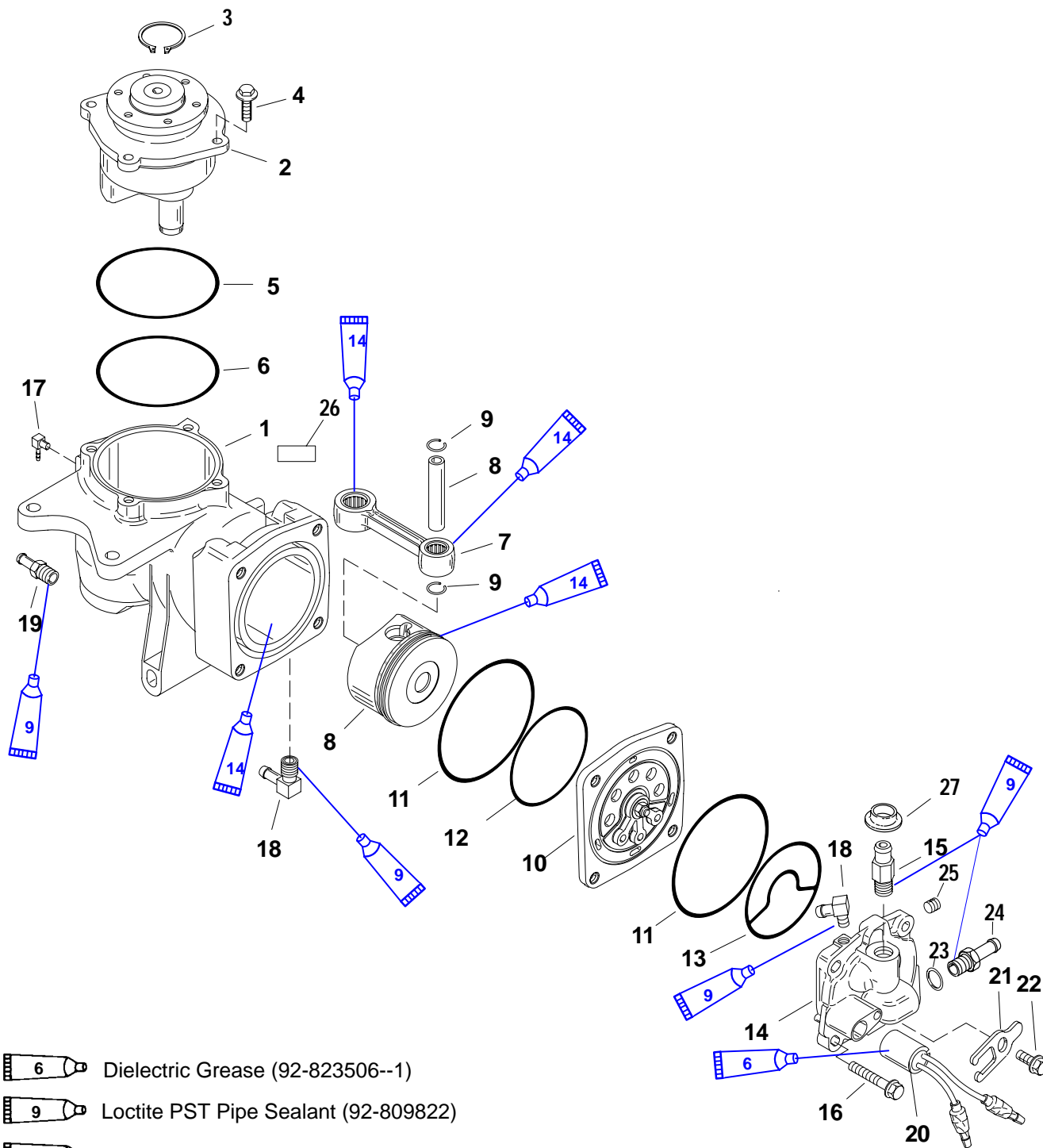


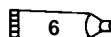
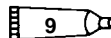
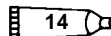
# Fuel Rails

| REF. NO. | QTY. | DESCRIPTION                          | TORQUE |       |     |
|----------|------|--------------------------------------|--------|-------|-----|
|          |      |                                      | lb-in  | lb-ft | Nm. |
| 1        | 2    | SCHRADER VALVE KIT (air and fuel)    |        |       |     |
| 2        | 1    | FITTING (air inlet)                  |        |       |     |
| 3        | 1    | FITTING (fuel inlet)                 |        |       |     |
| 4        | 4    | CLAMP (fitting retainer)             |        |       |     |
| 5        | 10   | SCREW M5X8                           | 70     |       | 8   |
| 6        | 1    | RAIL (starboard) w/out injectors     |        |       |     |
| 7        | 4    | SCREW M5X16                          | 70     |       | 8   |
| 8        | 1    | COVER (tracker valve)                |        |       |     |
| 9        | 1    | SPRING (tracker valve)               |        |       |     |
| 10       | 1    | DIAPHRAGM (tracker valve)            |        |       |     |
| 11       | 1    | O-RING (tracker cover)               |        |       |     |
| 12       | 2    | FITTING (air/fuel) starboard         |        |       |     |
| 13       | 2    | FITTING (air/fuel) port              |        |       |     |
| 14       | 6    | RETAINER (injector) DESIGN II        |        |       |     |
| 15       | 6    | RETAINER (injector) DESIGN I         |        |       |     |
| 16       | 6    | INJECTOR (fuel)                      |        |       |     |
| 17       |      | O-RING KIT (large) 6 per kit         |        |       |     |
| 18       |      | O-RING KIT (small) 6 per kit         |        |       |     |
| 19       | 2    | FITTING                              |        |       |     |
| 20       | 1    | RAIL (port) w/out injectors          |        |       |     |
| 21       |      | O-RING (2 per kit)                   |        |       |     |
| 22       |      | O-RING fitting/schrader (16 per kit) |        |       |     |



# Air Compressor Components



-  Dielectric Grease (92-823506--1)
-  Loctite PST Pipe Sealant (92-809822)
-  2 Cycle Outboard Oil (92-826666A24)





# Air Compressor Components

| REF. NO. | DESCRIPTION         | TORQUE |       |      |
|----------|---------------------|--------|-------|------|
|          |                     | lb-in  | lb-ft | Nm.  |
| 1        | AIR COMPRESSOR      |        |       |      |
| 2        | END CAP             |        |       |      |
| 3        | RETAINING RING      |        |       |      |
| 4        | SCREW (M6 x 20)     | 100    |       | 11.5 |
| 5        | O RING              |        |       |      |
| 6        | O RING              |        |       |      |
| 7        | CONNECTING ROD      |        |       |      |
| 8        | PISTON ASSEMBLY     |        |       |      |
| 9        | LOCK RING           |        |       |      |
| 10       | REED PLATE ASSEMBLY |        |       |      |
| 11       | O RING              |        |       |      |
| 12       | O RING              |        |       |      |
| 13       | SEAL                |        |       |      |
| 14       | COMPRESSOR HEAD     |        |       |      |
| 15       | FITTING-Straight    |        |       |      |
| 16       | SCREW (M8 x 35)     | 240    | 20    | 27   |
| 17       | ELBOW               |        |       |      |
| 18       | ELBOW               |        |       |      |
| 19       | FITTING-Straight    |        |       |      |
| 20       | TEMPERATURE SENSOR  |        |       |      |
| 21       | RETAINER            |        |       |      |
| 22       | SCREW (M8 x 12)     | 240    | 20    | 27   |
| 23       | O RING              |        |       |      |
| 24       | FITTING             |        |       |      |
| 25       | PIPE PLUG           |        |       |      |
| 26       | DECAL-Important     |        |       |      |
| 27       | GROMMET             |        |       |      |
| -        | <b>O RING KIT</b>   |        |       |      |



## DFI Operation

### Air Induction Through Crankcase

Combustion air enters the cowl through holes located in the top aft end of the cowl. The cowl liner directs this air to the bottom of the powerhead. This limits the exposure of salt air to the components inside the engine cowl.

Once inside the cowl the air enters the plenum through the throttle shutter which are located in the plenum assembly. The air then continues through the reed valves and into the crankcase. The throttle shutter are actuated by the throttle shaft. Mounted onto a separate shaft are two throttle position sensors (TPS). These sensors tell the engine control unit (ECM) the position of the throttle.

2 TPS's are installed on the DFI engine for safety redundancy. If one TPS should fail, the dash mounted CHECK ENGINE light will flash and the warning horn will sound. engine speed will be reduced to 3000 RPM. If both TPS's should fail, engine speed will be reduced to idle. DFI engines require large amounts of air into the cylinders at idle speed. To accomplish this, the throttle shutters are partially open at low engine speeds. The dual TPS system reads the shaft movement in both directions, one reads movement up (increasing resistance), while the other reads the same movement as down (decreasing resistance). The ECM reads both and calculates the throttle shutter position.

### Air Compressor System

Air from inside the engine cowl is drawn into the compressor through the flywheel cover. This cover acts like a muffler to quiet compressor noise and contains a filter to prevent the ingestion of debris into the compressor. The compressor is driven by a serpentine belt from a pulley mounted on the crankshaft, and is automatically self adjusted using a single idler pulley. This air compressor is a single cylinder unit containing a connecting rod, piston, rings, bearings, reed valves, and a crankshaft. The compressor is water cooled to lower the temperature of the air charge and is lubricated by oil from the engine oil pump assembly. As the compressor piston moves downward inside the cylinder, air is pulled through the filter, reed valves and into the cylinder. After the compressor piston changes direction, the intake reeds close and the exhaust reeds open allowing compressed air into the hose leading to the air/fuel rails.

The air/fuel rails contain two passages; one for fuel, the second is the air passage. The air passage is common between all the cylinders included in the rail. A hose connects the starboard rail air passage to the air compressor. Another hose connects the starboard air rail passage to the port air rail passage. An air pressure regulator will limit the amount of pressure developed inside the air passages to approximately 10 psi below the pressure of the fuel inside the fuel passages (i.e. 80 psi air vs 90 psi fuel). Air exiting the pressure regulator is returned into the exhaust adaptor and exits thru the propeller.

### Fuel

Fuel for the engine is stored in a typical fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A crankcase mounted pulse driven diaphragm fuel pump draws fuel through the fuel line, primer bulb, fuel pump assembly and then pushes the fuel thru a water separating fuel filter. This filter removes any contaminants and water before the fuel reaches the vapor separator. Fuel vapors are bled through a vent cannister into the air compressor inlet in the front of the flywheel cover. The electric fuel pump is different than the fuel pump that is utilized on the standard EFI engine (non DFI), and is capable of developing fuel pressures in excess of 90 psi. Fuel inside the rail must remain pressurized at exactly 10 psi over the air rail pressure or the ECM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the top of one fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the



rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 50 p.s.i. of air pressure on the air rail side of the diaphragm, 60 p.s.i. of fuel pressure will be required to open the regulator. The return fuel line to the vapor separator is water cooled.

To equalize the pulses developed by the pumps (both air and fuel) a tracker diaphragm (3) is installed in the starboard rail. The tracker diaphragm is positioned between the fuel and air passages. The tracker diaphragm is a rubber diaphragm which expands and retracts depending upon which side of the diaphragm senses the pressure increase (pulse).

## Oil

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside a standard remote oil reservoir. Crankcase pressure will force oil from the remote oil reservoir into the oil storage reservoir on the side of the powerhead. Oil will flow from the oil storage tank into the oil pump. The oil pump is a solenoid design. It is activated by the ECM and includes 7 pistons with corresponding discharge ports. The oil pump is mounted directly onto the powerhead. Each cylinder is lubricated by one of the discharge ports. The oil is discharged into the crankcase. The seventh passage connects to the hose that leads to the air compressor for lubrication. Excess oil from the compressor returns into the plenum and is ingested through the crankcase.

The ECM will change the discharge rate of the oil pump, depending upon engine demand. The ECM will also pulse the pump on initial start up to fill the oil passages eliminating the need to bleed the oil system. The ECM provides additional oil for break in, as determined by its internal clock. The oil ratio varies with engine rpm and load.

## Electrical

The electrical system consists of the ECM, crank position sensor (flywheel speed & crankshaft position), throttle position sensor (TPS), MAP sensor, engine temperature sensor, ignition coils and injectors (fuel & direct). The engine requires a battery to start (i.e. the ignition and injection will not occur if the battery is dead). The system will run off of the alternator.

## Operation

The operation of the system happens in milliseconds (ms); exact timing is critical for engine performance. As the crankshaft rotates, air is drawn into the crankcase through the throttle shutters, into the plenum, and through the reed valves. As the piston nears bottom-dead-center, air from the crankcase is forced through the transfer system into the cylinder. As the crankshaft continues to rotate the exhaust and intake ports close. With these ports closed, fuel can be injected into the cylinder. The ECM will receive a signal from the throttle position sensor (TPS), engine temperature sensor (TS) and the crank position sensor (flywheel speed and position sensor). With this information the ECM refers to the fuel calibration (maps) to determine when to activate (open and close) the injectors and fire the ignition coils. With the piston in the correct position, the ECM opens the fuel injector, 90 psi fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge. Next the direct injector will open, discharging the air/fuel mixture into the combustion chamber. The direct injector directs the mixture at the bowl located in top of the piston. The piston's bowl directs the air/fuel mixture into the center of the combustion chamber. This air fuel mixture is then ignited by the spark plug.



**Compressor Notes:** To aid in starting when the air rail pressure is low and before the compressor has time to build pressure, the direct injector is held open by the ECM. This allows the compression from inside the cylinders to pressurize the air rail faster (1 or 2 strokes, or 60° of crankshaft rotation).

**Idle Notes:** Idle quality is controlled by fuel volume and fuel timing. The throttle shutters will be open at idle speeds. The shift cut-out switch will interrupt the fuel to 3 of the cylinders to assist in shifting.

The TPS signals the ECM to change the fuel and spark without movement of the throttle shutters. The throttle cam is manufactured to allow the TPS sensor shaft to move before opening the throttle shutters.

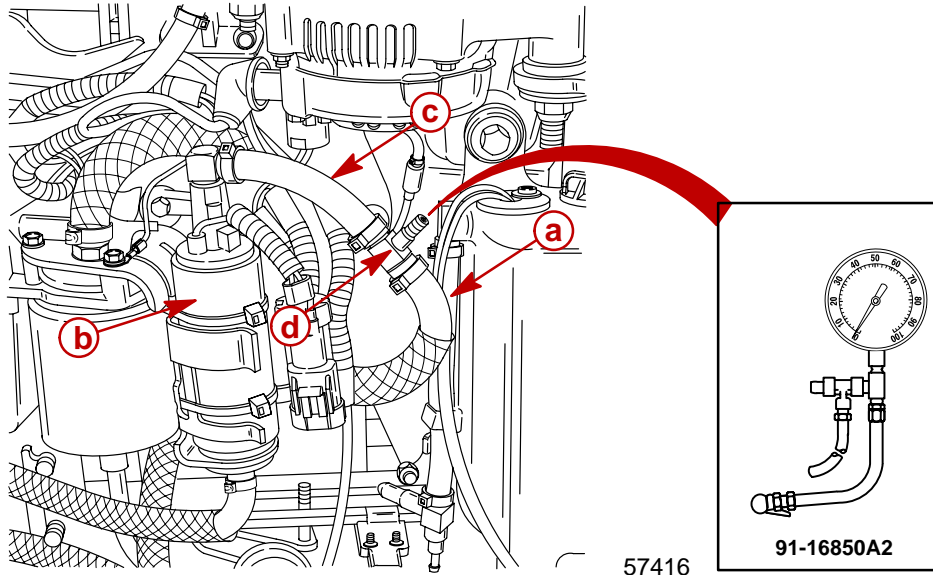
The crankshaft position sensor is different from the standard 3.0 liter sensor. The crank position sensor serves two functions (flywheel speed and position).

## Testing Electric Fuel Pump Pressure Output

### Low Pressure Electric Fuel Pump

**IMPORTANT:** After completing fuel pressure tests, reconnect and secure fuel outlet hose to fuel pump with full circle stainless clamps in Clamp Tool Kit 91-803146T.

1. Remove outlet fuel hose from low pressure pump. Install a short piece of hose (obtain locally) onto pump outlet fitting. Install Schrader Valve t-fitting (22-849606) from Schrader Valve Fuel Pressure Kit (849021A4) between outlet fuel hose (removed from pump) and new fuel hose (installed on pump). Secure hose connections with straps. Connect Fuel/Air Pressure Gauge (91-16850A2) to Schrader Valve. Gauge should indicate 6-9 psi (41.37 – 62.04 kPa).



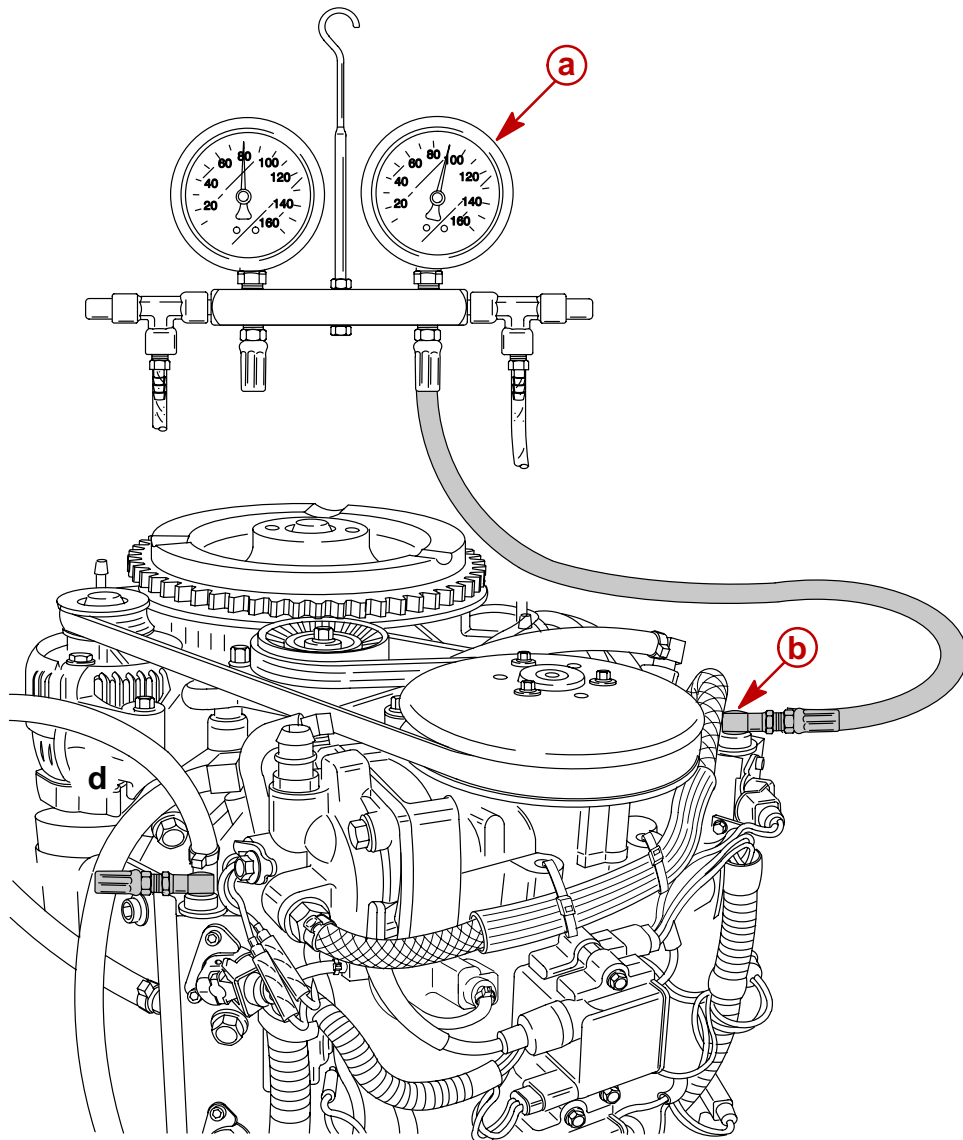
- a** - Outlet Fuel Hose
- b** - Low Pressure Electric Fuel Pump
- c** - Fuel Hose (obtain locally)
- d** - Schrader Valve (22-849606)



## High Pressure Electric Fuel Pump

1. Install Pressure Gauge Assembly 91-852087A1/A2 to starboard fuel rail pressure test valve.

**NOTE:** After 15 seconds of cranking engine with starter motor, fuel pressure gauge should indicate  $89 \pm 2$  psi ( $613.5 \pm 13.8$  kPa).



56146

- a** - Fuel Pressure Gauge (Should Indicate  $89 \pm 2$  psi ( $613.5 \pm 13.8$  kPa))
- b** - Fuel Pressure Test Valve



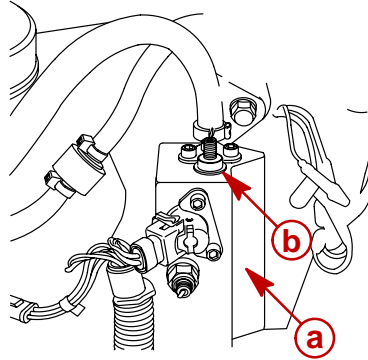
# Fuel Management Assembly Removal

## ⚠ CAUTION

Fuel system must be bled off prior to removal of fuel system components.

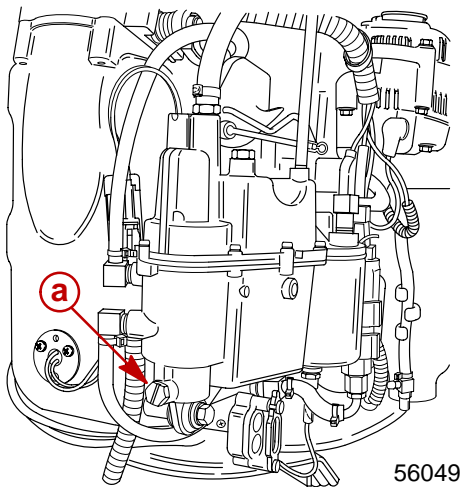
**NOTE:** Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2 to de-pressurize air hose first and then fuel hose.

1. De-pressurize fuel system.

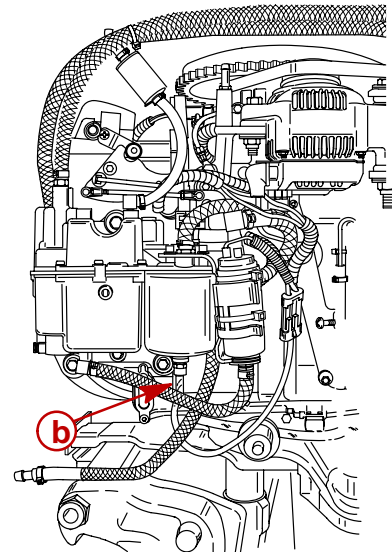


**a** - Starboard Fuel Rail  
**b** - Fuel Pressure Port

2. Place suitable container underneath vapor separator drain plug and remove plug.
3. Disconnect electric fuel pump harness connector.



**a** - Drain Plug  
**b** - Sensor Lead

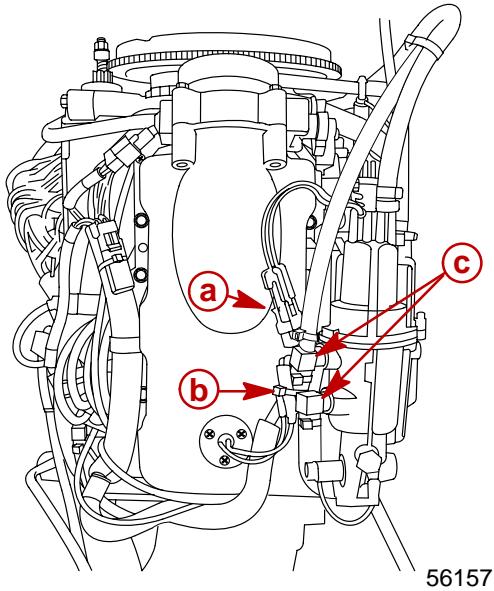




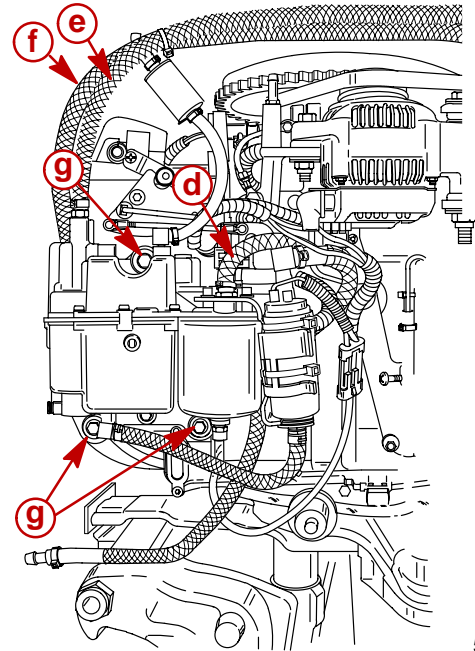
4. Remove sta-strap securing air temperature sensor harness to fuel hose.
5. Remove vapor separator vent hose to air plenum.

**NOTE:** Upper fuel hose goes to fuel cooler. Lower fuel hose goes to electric pump beside fuel/water separator.

6. Remove the fuel inlet hose from the pulse fuel pump.
7. Remove the fuel outlet hose and fuel return hose from the vapor separator.
8. Remove 3 mounting bolts and remove separator.



- a - Harness Connector
- b - Sta-strap
- c - Fuel Hoses

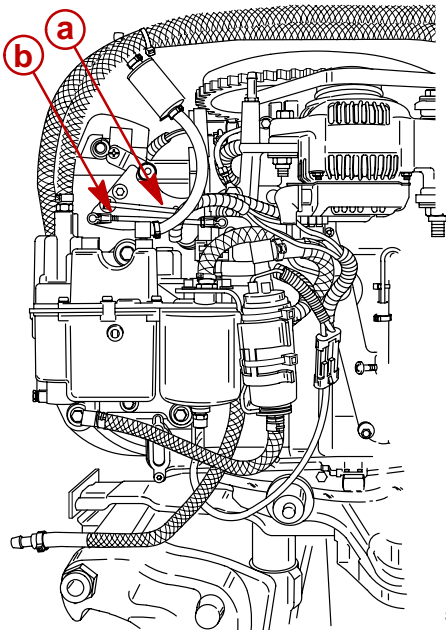


- d - Fuel Inlet Hose
- e - Fuel Outlet Hose
- f - Fuel Return Hose
- g - Mounting Bolts

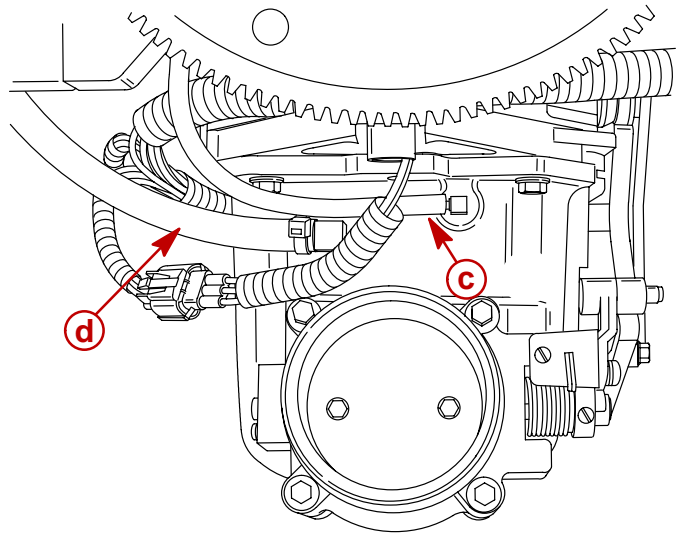




9. Disconnect throttle cam link rod and the Throttle Position Sensor link rod.
10. Disconnect MAP Sensor hose and compressor oil return hose from air management assembly.



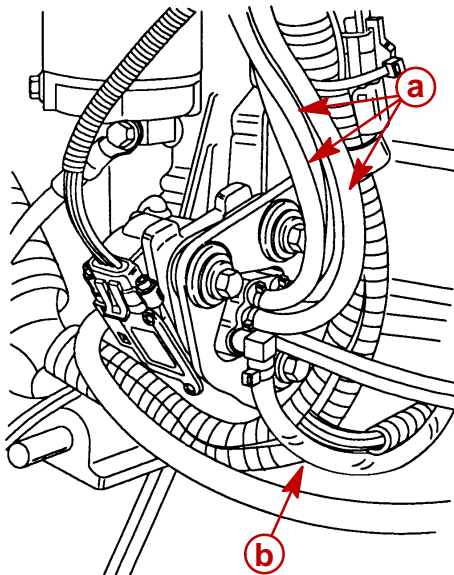
57317



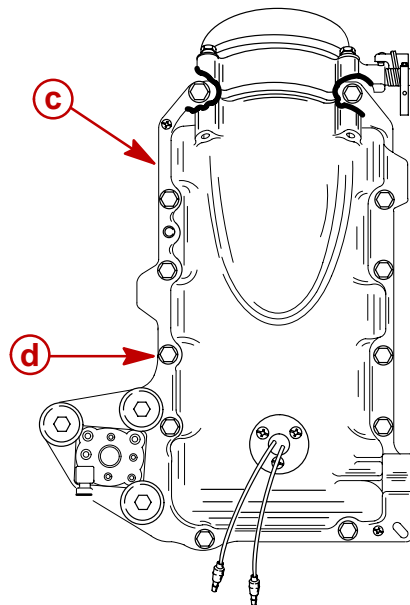
56068

- a** - Throttle Link Rod
- b** - Throttle Position Sensor Link Rod
- c** - MAP Sensor Hose
- d** - Oil Return Hose

11. Disconnect oil hoses from oil pump.
12. Remove and plug oil inlet hose to oil pump.
13. Remove 12 bolts securing air management assembly to crankcase and remove assembly.



56140



56144

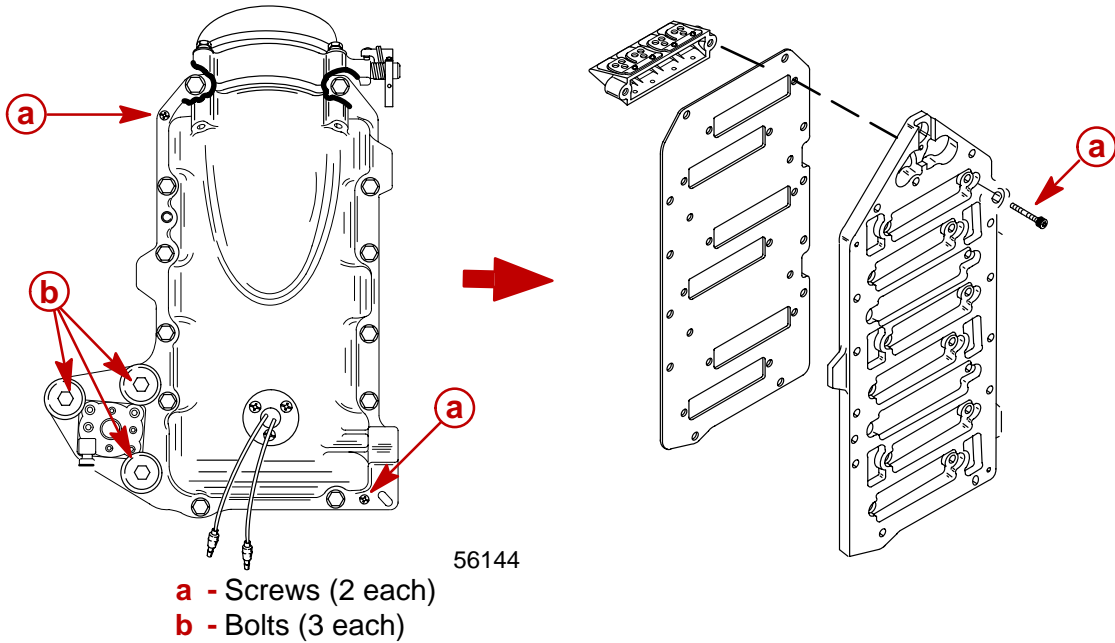
- a** - Oil Hoses
- b** - Oil Inlet Hose
- c** - Air Management
- d** - Bolts (12 each)





## Reed Block Assembly Removal

1. Remove 2 screws securing air plenum to reed plate assembly.
2. Remove 3 bolts securing oil pump adaptor plate to air plenum assembly.

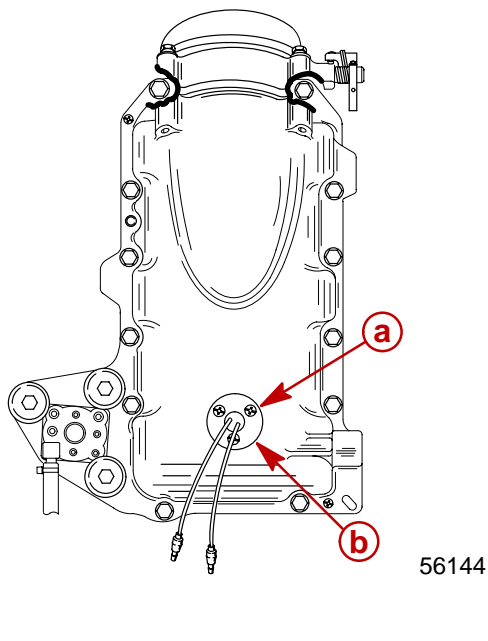


## Reed Block Assembly Installation

1. Secure oil pump adaptor plate to air plenum with 3 bolts. Torque bolts to 16 lb. ft. (22.0 Nm).
2. Secure air plenum to reed plate with 2 screws. Drive screws tight.

## Air Temperature Sensor Removal

Remove 3 screws securing sensor and remove sensor.





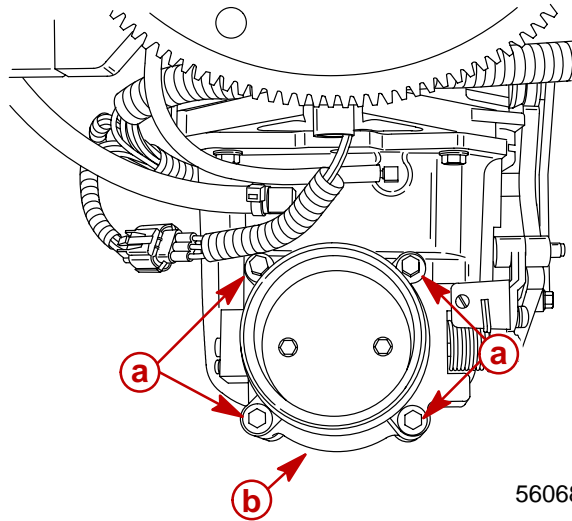
## Air Temperature Sensor Installation

Secure sensor in air plenum with 3 screws. Drive screws tight.

## Throttle Plate Assembly Removal

**NOTE:** The throttle plate assembly is calibrated and preset for proper running characteristics and emissions at the factory. Other than complete assembly removal from the air plenum, no further disassembly should be made.

Remove 4 bolts securing throttle plate assembly to air plenum and remove assembly.



56068

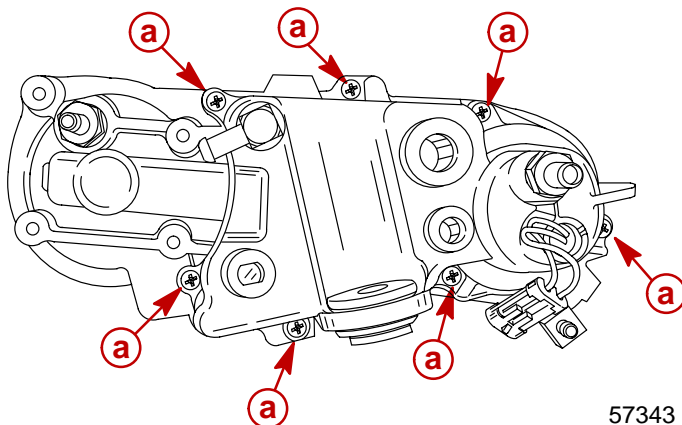
- a - Bolts
- b - Throttle Plate Assembly

## Throttle Plate Assembly Installation

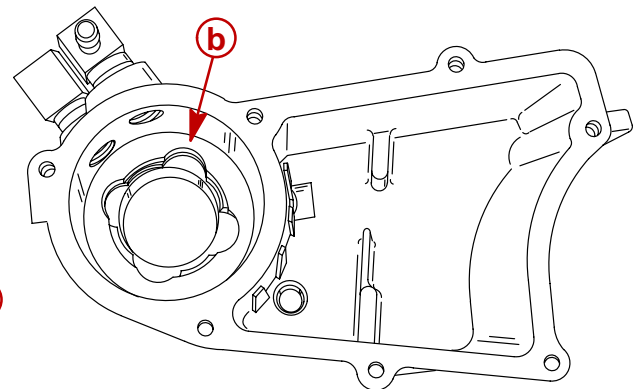
Secure throttle plate assembly to air plenum with 4 bolts. Torque bolts to 100 lb. in. (11.5 Nm).

## Vapor Separator Disassembly

1. Remove 7 screws securing separator cover and remove cover.
2. Inspect seal in fuel pump chamber of separator tank for cuts and abrasions. Replace seal if necessary. If seal is serviceable, apply 2-4-C w/Teflon Marine Lubricant (92-825407A12) to seal lips.



57343



57342

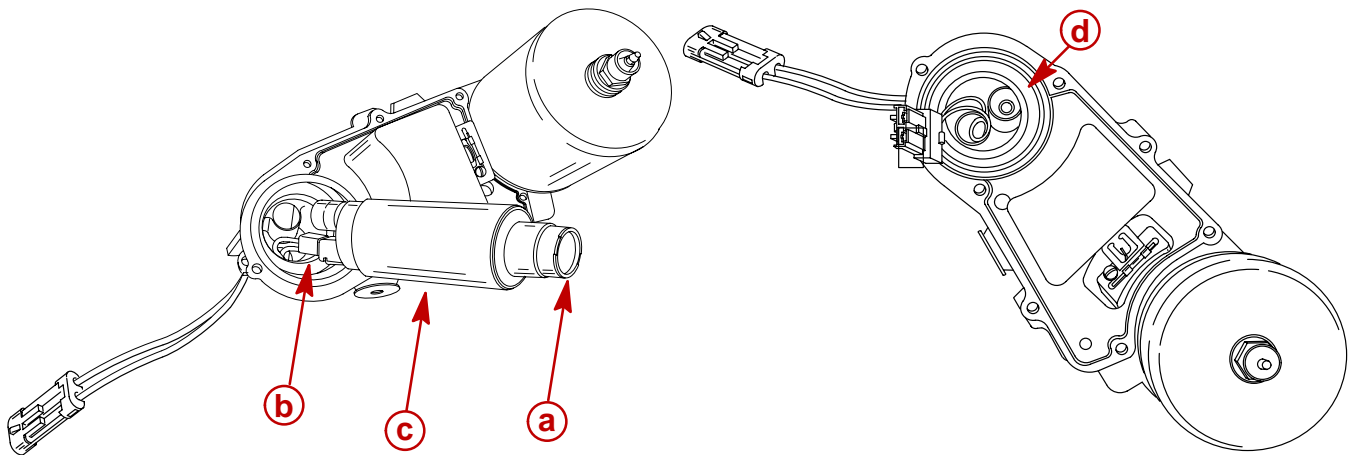
- a - Screws (7 each)
- b - Seal



- Fuel pump may be removed from cover by wiggling slightly while pulling outward.

**IMPORTANT: DO NOT twist pump during removal as wire harness may be damaged.**

- Disconnect harness from pump to separate pump from cover. Inspect filter screen for debris. Screen may be pried out of pump and cleaned as required.
- Inspect seal above fuel pump for cuts or abrasions. Replace seal if necessary. Apply 2-4-C w/Teflon to seal lips.

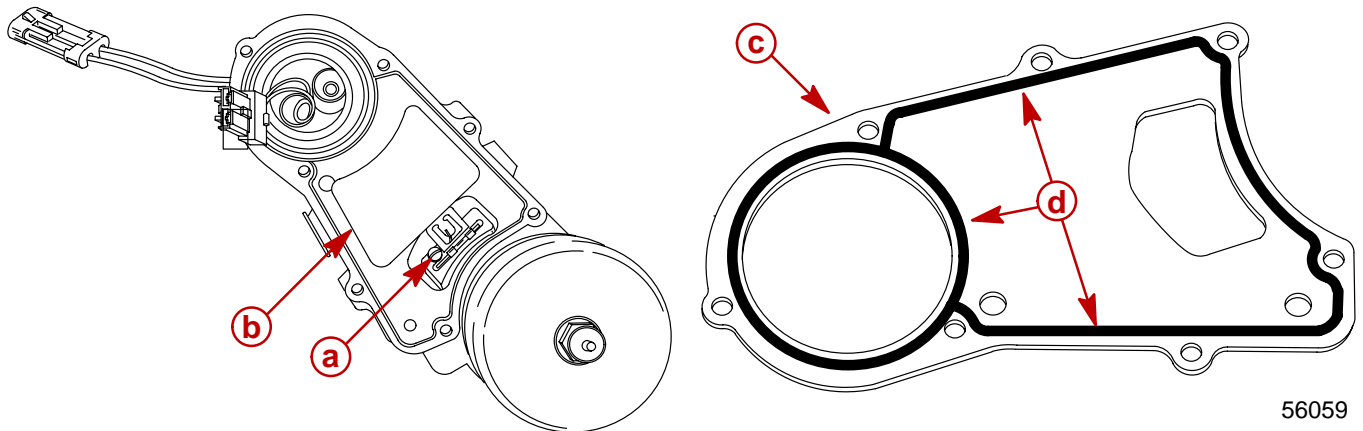


56057

56058

- a** - Filter Screen
- b** - Harness Connector
- c** - Pump
- d** - Seal (Seal shoulder faces OUT)

- Loosen screw securing float assembly and remove float. Inspect float for deterioration or fuel retention. Replace float as required.
- Remove phenolic sealing plate and inspect imbedded neoprene seal on both sides of plate for cuts or abrasions. Replace plate/seal assembly as required.



56058

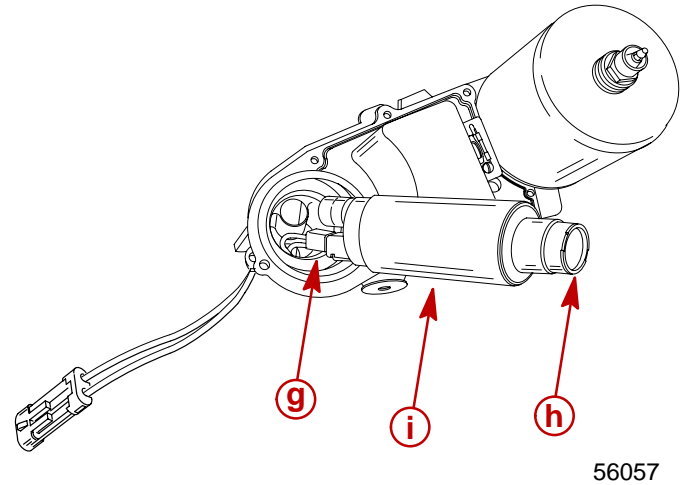
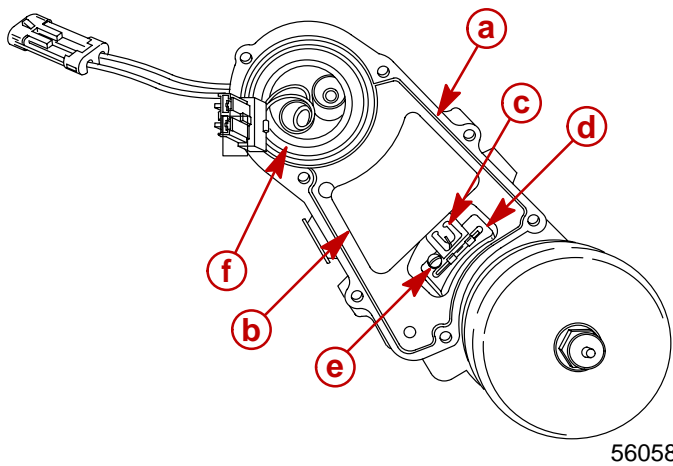
56059

- a** - Screw
- b** - Float
- c** - Plate
- d** - Seal



## Vapor Separator Reassembly

1. Reinstall phenolic sealing plate onto vapor separator cover.
2. Secure float, needle and pivot pin assembly to separator cover with screw. Torque screw to 10 lb. in. (1.0 Nm)
3. Apply 2-4-C w/Teflon to lips of seal in separator cover.
4. Connect electrical harness to fuel pump. Inspect fuel pump filter screen for debris. Remove screen and clean as required.
5. Seat fuel pump and harness into separator cover being careful not to pinch harness.



**a** - Sealing Plate

**b** - Float

**c** - Needle

**d** - Pivot Pin

**e** - Screw [Torque to 10 lb. in. (1.0 N-m)]

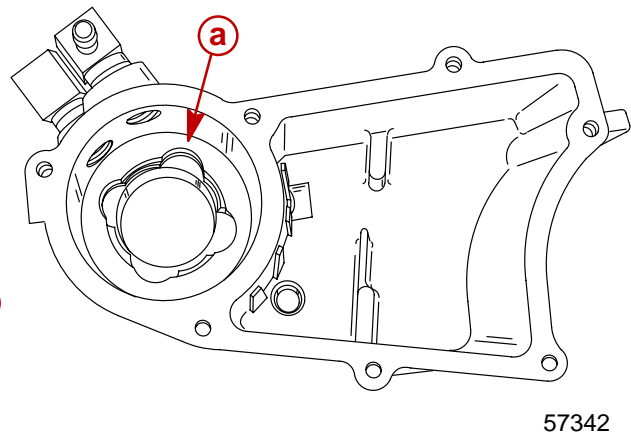
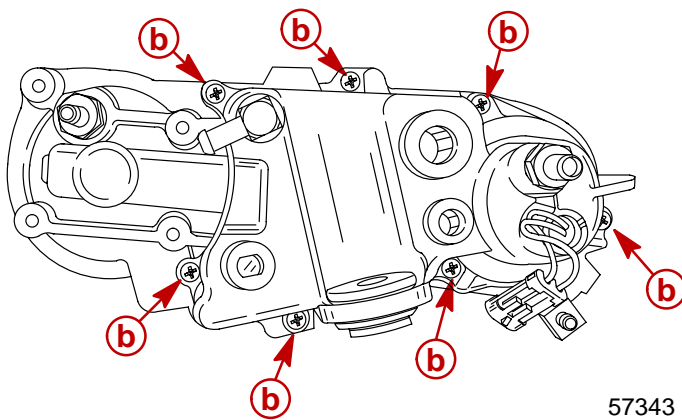
**f** - Seal (Seal shoulder faces OUT)

**g** - Harness

**h** - Filter

**i** - Fuel Pump

6. Apply 2-4-C w/Teflon to lips of seal in separator tank.
7. Install separator cover with pump onto separator tank.
8. Secure cover to tank with 7 screws. Torque screws to 30 lb. in. (3.5 Nm).



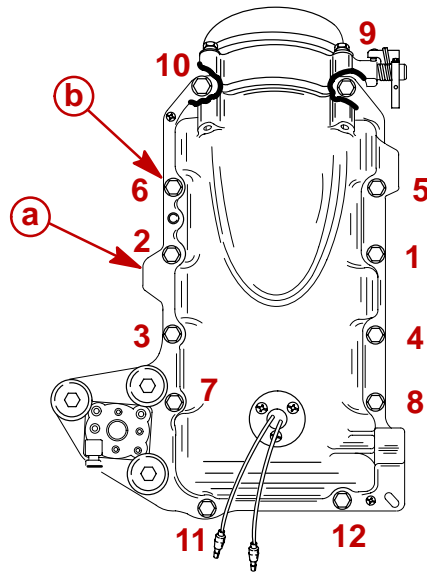
**a** - Seal

**b** - Screws [Torque to 30 lb. in. (3.5 Nm)]



## Air Plenum Installation

Secure plenum to crankcase with 12 bolts. Torque bolts to 100 lb. in. (11.5 Nm), in sequence shown



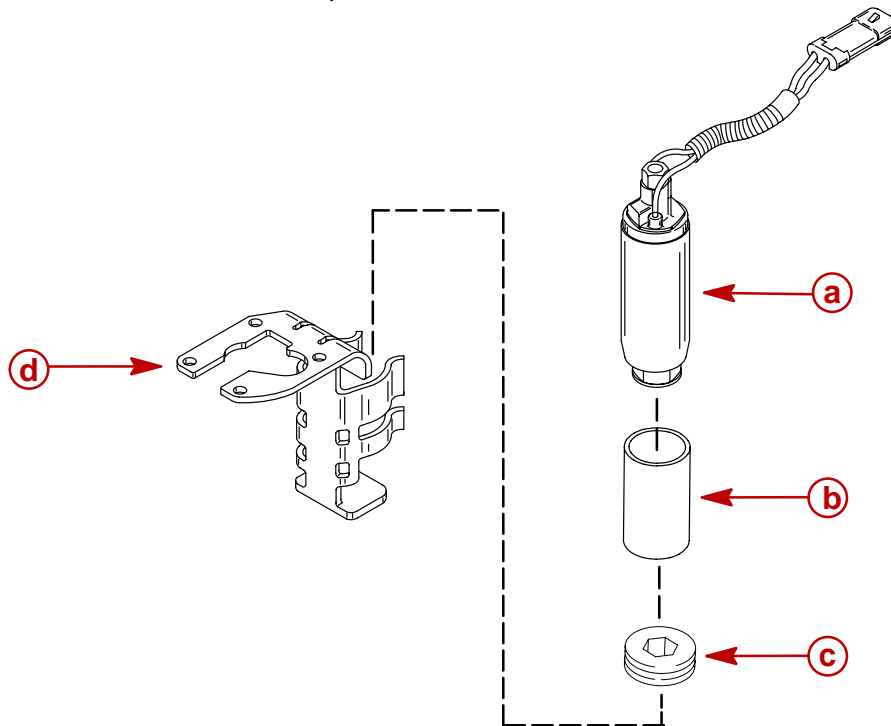
56144

- a - Air Plenum
- b - Bolts [Torque to 100 lb. in. (11.5 Nm)]

## Low Pressure Electric Fuel Pump Installation

**NOTE:** If pump does not have a sleeve or grommet, refer to Service Bulletin 98-8.

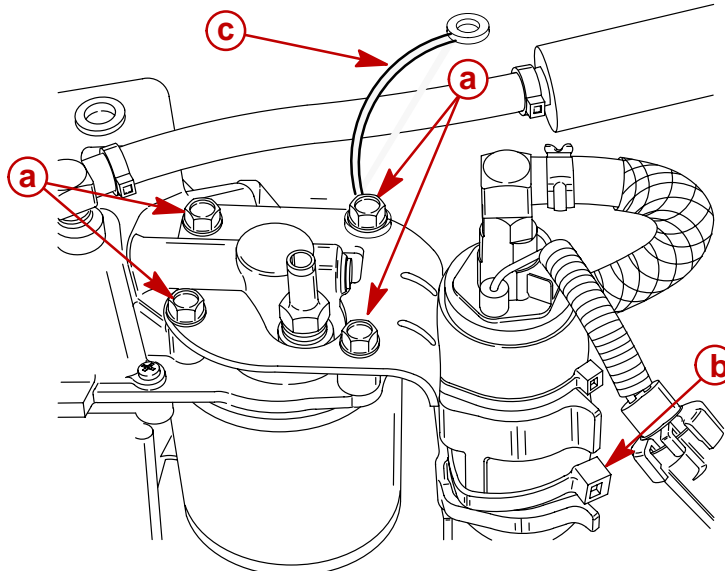
1. Seat electric fuel pump w/sleeve against grommet in pump bracket. Secure pump to bracket with sta-strap.



- a - Low Pressure Electric Fuel Pump
- b - Sleeve
- c - Grommet
- d - Bracket

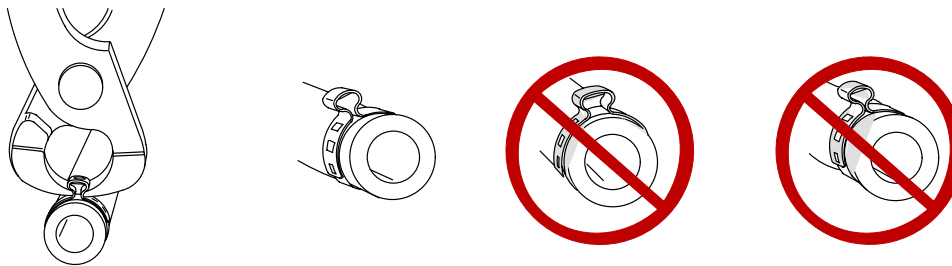


- Secure bracket assembly to vapor separator with 4 screws. Torque screws to 100 lb. in. (11.5 Nm).

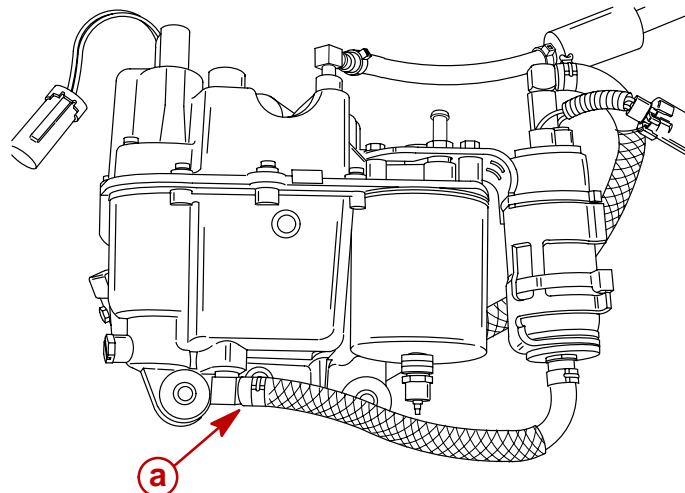


- a** - Screws – Torque to 100 lb. in. (11.5 Nm)
- b** - Sta-strap securing pump to bracket
- c** - Ground lead – attach to air plenum

**IMPORTANT:** Only use tool 91-803146T (or Snap-On equivalent YA3080) to crimp full circle clamps. Using a different tool could result in a crimp that is too loose, or too tight. Do not use screw type metal hose clamp as it may damage hose.



- Connect fuel hose from bottom of low pressure fuel pump to 90° elbow in bottom of vapor separator. Secure hose with 16.2 mm full circle clamp (54-855697) using crimping tool 91-803146T.

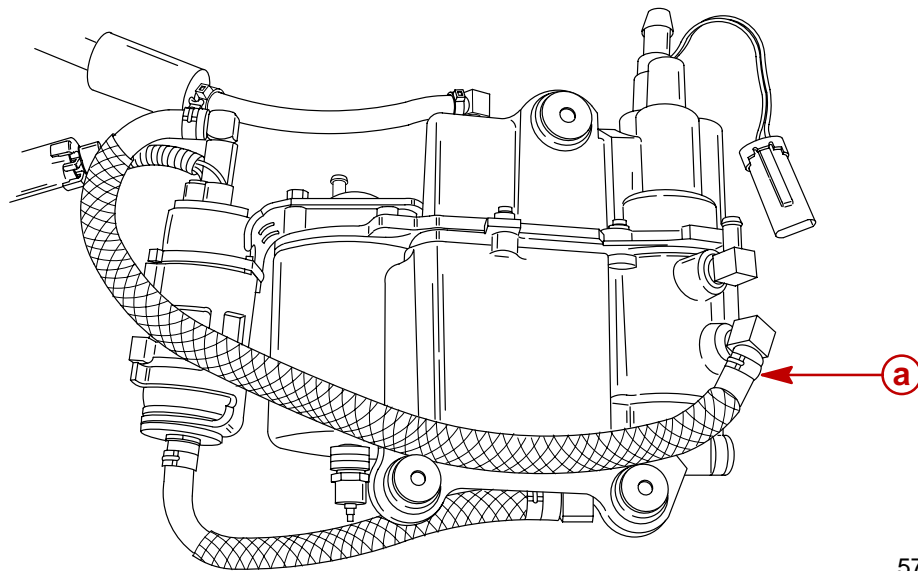


- a** - Secure Fuel Hose with 16.2 mm Full Circle Clamp (54-855697)

27291



4. Connect fuel hose from top of low pressure fuel pump to 90° elbow on back side of vapor separator. Secure hose with 15.3 mm full circle clamp (54-856880) using crimping tool 91-803146T. (Back view of vapor separator shown below)

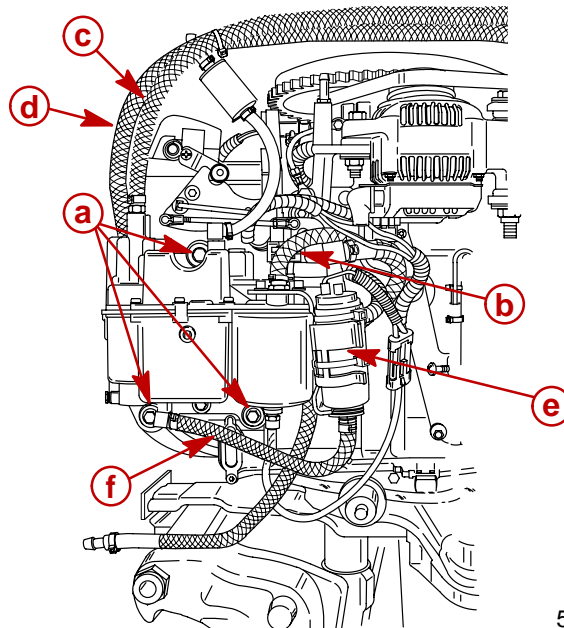


57293

**a** - Secure Fuel Hose with 15.3 mm Full Circle Clamp (54-856880)

## Vapor Separator Installation

1. Secure vapor separator to air plenum with 3 bolts. Torque bolts to 45 lb. in. (5.0 Nm).
2. Connect fuel inlet hose from pulse pump.
3. Connect fuel outlet hose and fuel return hose to vapor separator.



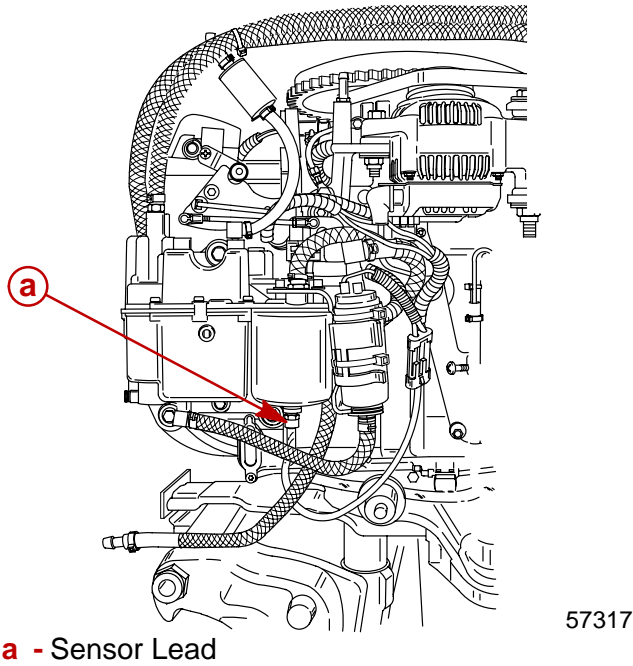
57317

**a** - Mounting Bolts [Torque to 45 lb. in. (5.0 Nm)]  
**b** - Fuel Inlet Hose  
**c** - Fuel Outlet Hose  
**d** - Fuel Return Hose  
**e** - Low Pressure Electric Fuel Pump (6 - 9 psi)  
**f** - Inlet Fuel Hose to Low Pressure Pump



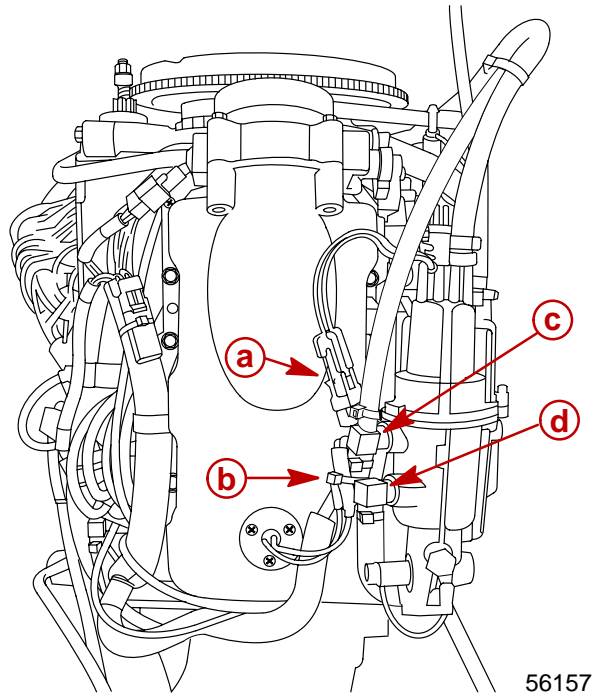


4. Connect water separator sensor lead to water separator.



**a** - Sensor Lead

5. Connect electric fuel pump harness.
6. Connect vapor separator vent hose to air plenum.
7. Secure air temperature sensor leads to fuel hose with sta-strap.



**a** - Electric Fuel Pump Harness Connector  
**b** - Sta-Strap  
**c** - Top Fuel Hose (Fuel return from fuel cooler)  
**d** - Bottom Fuel Hose (Inlet from low pressure pump)





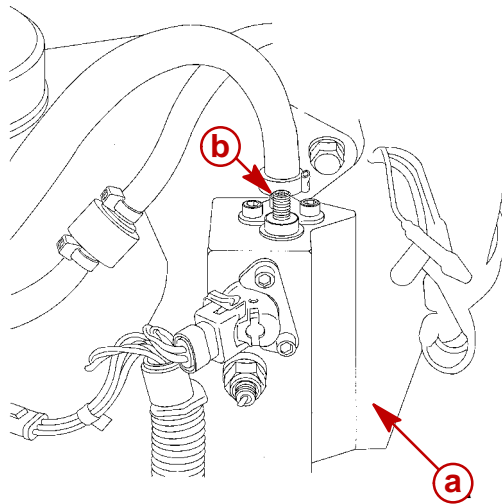
## Fuel Rail Removal

### CAUTION

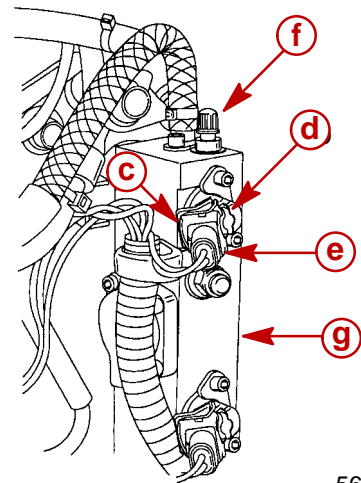
Fuel system must be bled off prior to removal of fuel system components.

**NOTE:** Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2 to de-pressurize air hose first and then fuel hose.

1. De-pressurize fuel system.
2. Remove fuel injector harness from each injector by compressing spring clip with flat tip screw driver while pulling on connector.



- a - Port Fuel Rail
- b - Air Pressure Port
- c - Spring Clip
- d - Fuel Injector

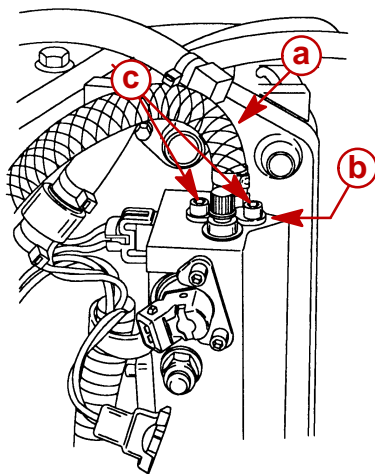


- e - Harness Connector
- f - Fuel Pressure Port
- g - Starboard Fuel Rail

56118

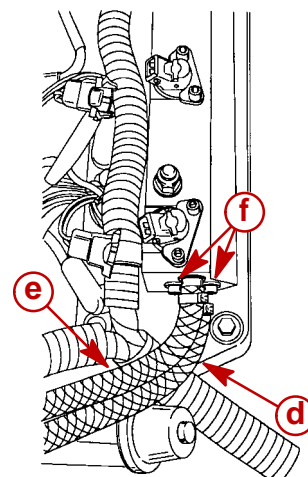
**NOTE:** Always remove fuel/air hose and fitting together by removing fitting retainer rather than cutting clamps.

3. Remove fuel inlet hose, fuel outlet hose and air hose from fuel rail.



#### Top Fuel Rail Connections

- a - Air Hose
- b - Retainer
- c - Allen Screws (remove)



#### Bottom Fuel Rail Connections

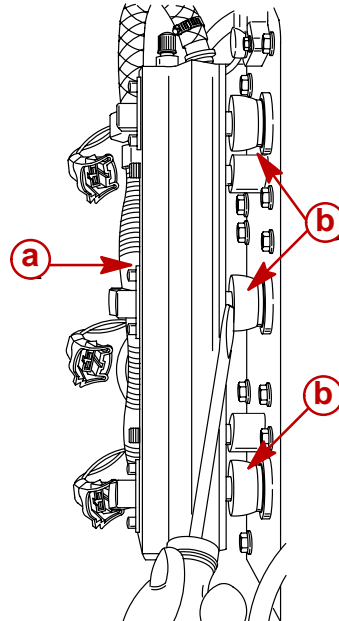
- d - Air Hose
- e - Fuel Hose
- f - Allen Screws

56140



**NOTE:** It is recommended that direct injectors remain in the cylinder head (if they are not to be replaced) while removing the fuel rail. The direct injectors have a teflon seal which may expand if the injector is removed from the head. This expansion may cause reinstallation difficulty or require the replacement of the seal.

4. Remove 2 nuts securing fuel rail.
5. As fuel rail is removed, use a flat tip screw driver to hold direct injectors in cylinder head.



56121

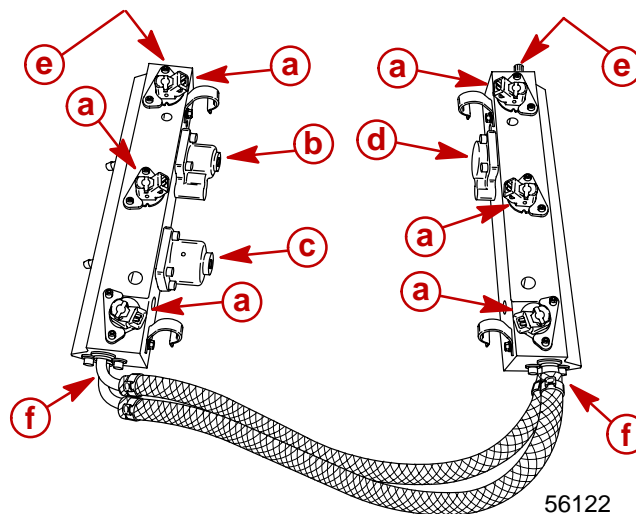
- a - Fuel Rail
- b - Direct Injectors

### Fuel Rail Disassembly

The starboard fuel rail contains 3 fuel injectors and a tracker valve.

The port fuel rail contains 3 fuel injectors, 1 fuel regulator and 1 air regulator.

**NOTE:** Each fuel/air inlet or outlet hose adaptor has 2 O-ring seals. These O-rings should be inspected for cuts or abrasions and replaced as required when fuel rail is disassembled for cleaning.



56122

- a - Fuel Injector
- b - Fuel Regulator
- c - Air Regulator
- d - Tracker Valve
- e - Fuel/Air Inlet (hidden)
- f - Fuel/Air Outlet

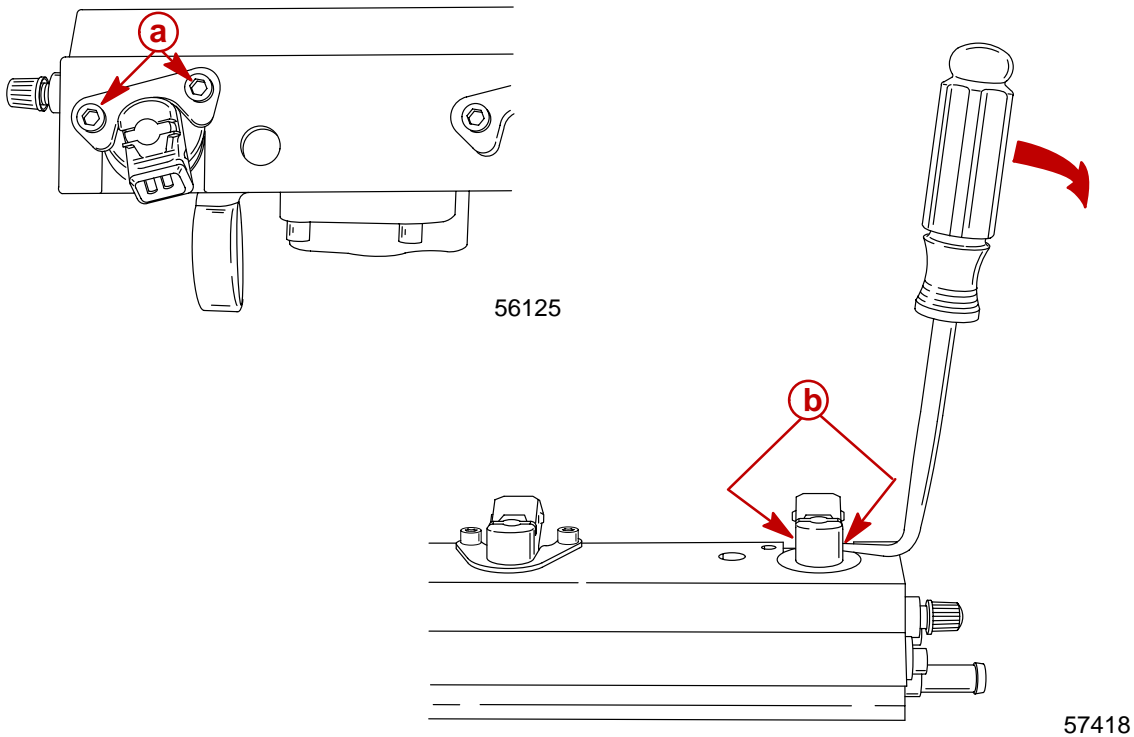


## FUEL INJECTOR REMOVAL

1. Remove 2 screws securing injector.

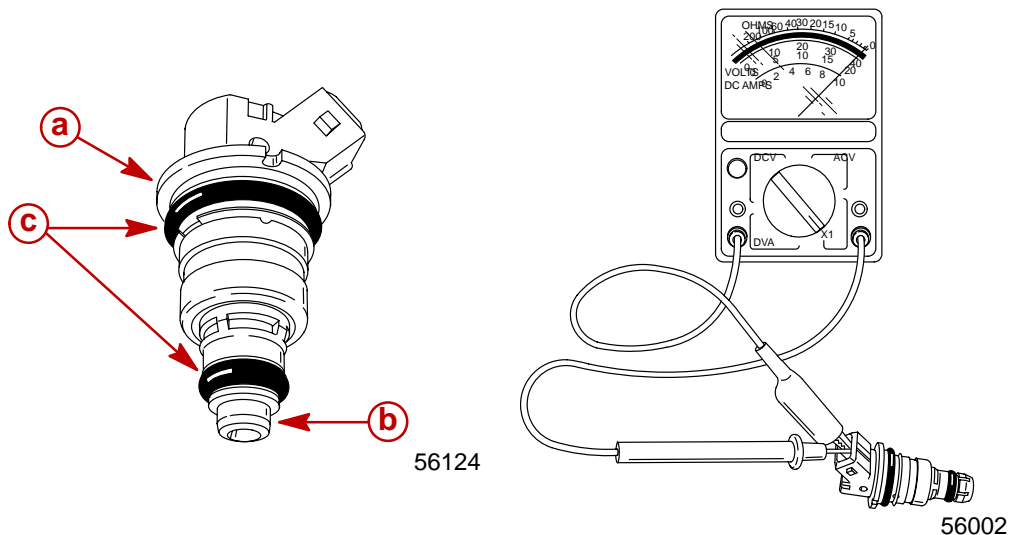
**NOTE:** Use a cotter pin extractor tool in pry holes to remove injectors.

2. Gently pry up on injector to loosen O-ring adhesion and remove injector.



- a - Screws
- b - Pry Holes

3. Inspect fuel injector orifices for foreign debris; O-rings for cuts or abrasions and plastic components for heat damage. Replace components as required.
4. An ohm test of the fuel injector may be made by connecting test leads to injector terminals. Ohm reading should be  $1.8 \pm 0.1$  ohm.



- a - Fuel Injector
- b - Fuel Nozzle
- c - O-Rings

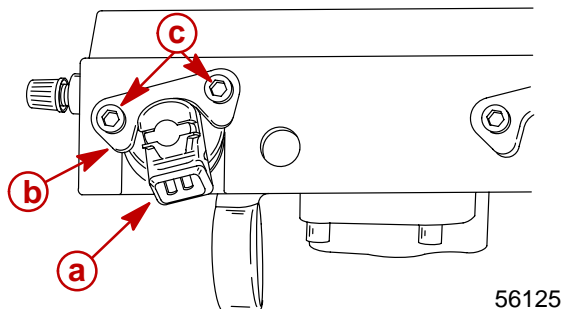


## FUEL INJECTOR INSTALLATION

**NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to fuel injector attaching screw threads.

1. Insert fuel injector into fuel rail with connector pins facing (inwards) towards center of engine.

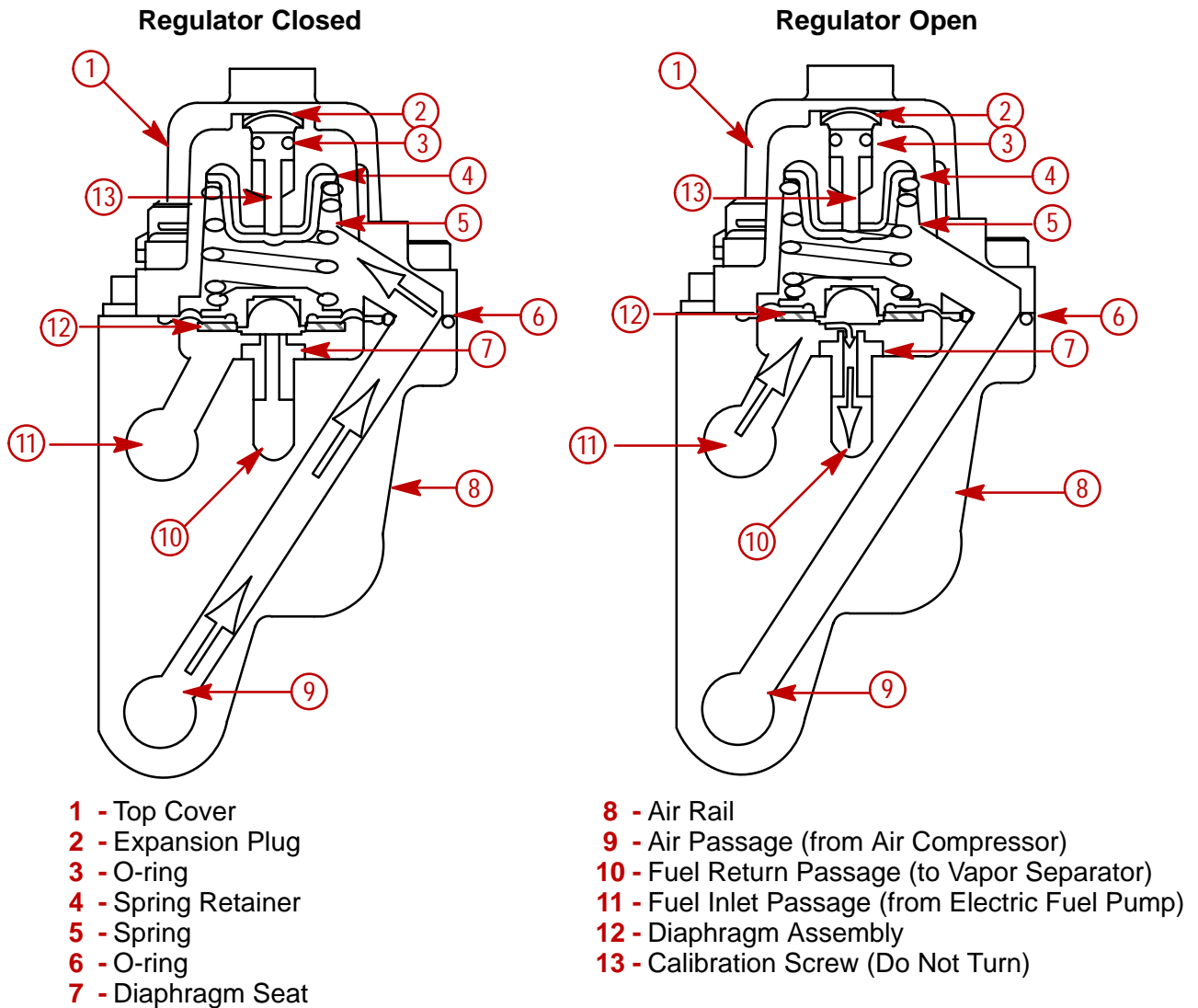
**NOTE:** Turn injector back-and-forth slightly to seat injector O-rings in fuel rail while securing injector with retainer and 2 screws. Torque screws to 70 lb. in. (8.0 Nm).



- a** - Injector
- b** - Retainer
- c** - Screws [Torque to 70 lb. in. (8.0 Nm)]



## Fuel Pressure Regulator



The fuel pump is capable of delivering more fuel than the engine can consume. Excess fuel flows through the fuel pressure regulator, interconnecting passages/hoses, fuel cooler, and back to the vapor separator tank. This constant flow of fuel means that the fuel system is always supplied with cool fuel, thereby preventing the formation of fuel vapor bubbles and minimizing the chances of vapor lock.

The fuel pressure regulator is calibrated to raise the fuel pressure to 10 psi above the air pressure.

The fuel regulator is mounted on the port fuel rail, near the top. This regulator relies on both air and spring pressure to control the fuel pressure. Inside the regulator assembly is a 10 lb. spring, this spring holds the diaphragm against the diaphragm seat. The contact between the diaphragm and diaphragm seat closes the passage between the incoming fuel (from the electric fuel pump) and the fuel return passage.

When the engine is not running (no air pressure on the spring side of the diaphragm) the fuel pressure required to move the diaphragm is 10 psi.

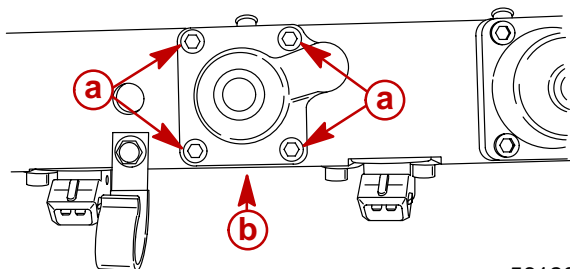
When the engine is running, air pressure from the air compressor (80 psi) is routed through the air passages, to the spring side of the fuel pressure regulator diaphragm.

The air pressure (80 psi) and spring pressure (10 psi) combine to regulate system fuel pressure to 90 psi - or 10 psi higher than the air pressure in the DFI system fuel/air rails.

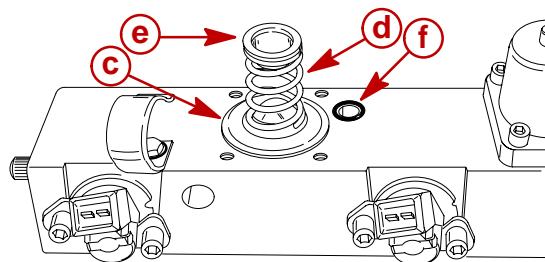


### FUEL REGULATOR REMOVAL

1. Remove 4 screws securing regulator and remove regulator.
2. Inspect regulator diaphragm for cuts or tears.
3. Inspect regulator housing O-ring for cuts and abrasions. Replace components as required.



56126



56127

- a - Screws
- b - Fuel Regulator
- c - Diaphragm
- d - Spring
- e - Cup
- f - O-Ring

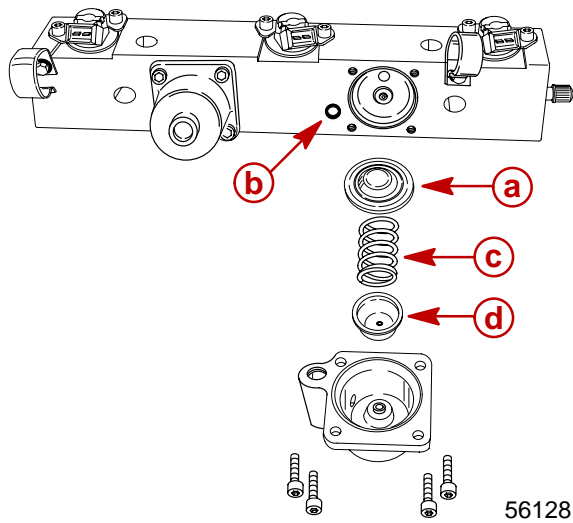
### FUEL REGULATOR INSTALLATION

**NOTE:** Apply a light coat of 2-4-C w/Teflon to diaphragm surface and O-ring to aid in the retention of diaphragm and O-ring on fuel rail during reassembly.

1. Position diaphragm on fuel rail.
2. Position O-ring on fuel rail.
3. Position spring and cup onto diaphragm.

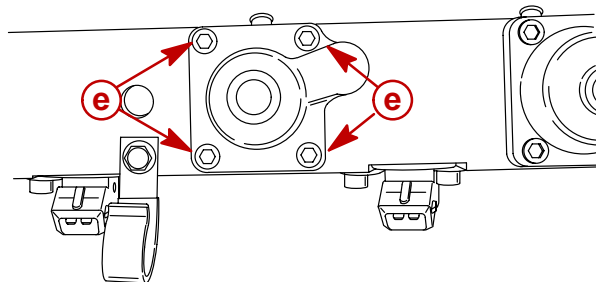
**NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to regulator attaching screw threads.

4. Place cover over spring/cup/diaphragm assembly and secure with 4 screws. Torque screws to 70 lb. in. (8.0 Nm).



56128

- a - Diaphragm
- b - O-Ring
- c - Spring
- d - Cup
- e - Screws [Torque to 70 lb. in. (8.0 Nm)]

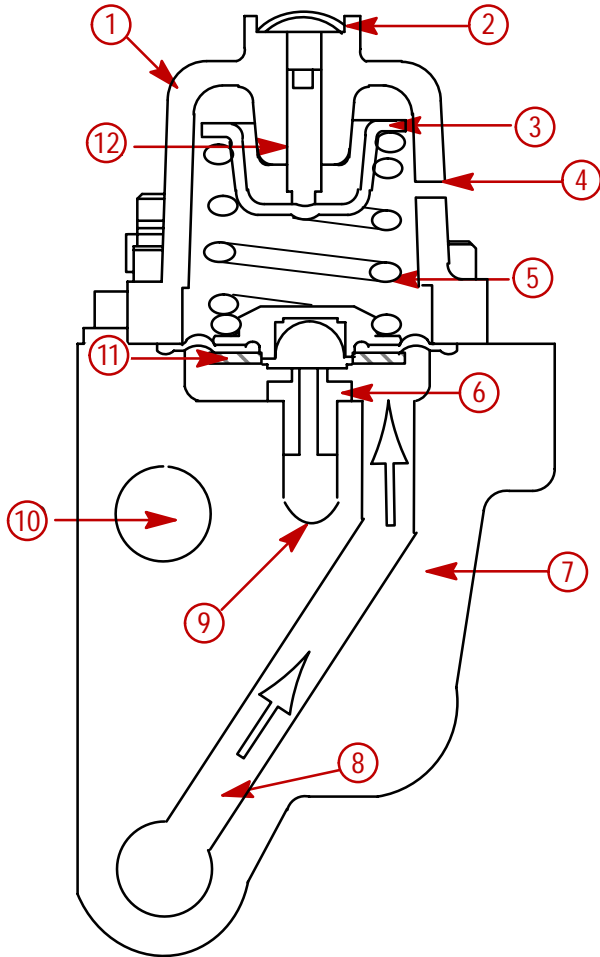


56126



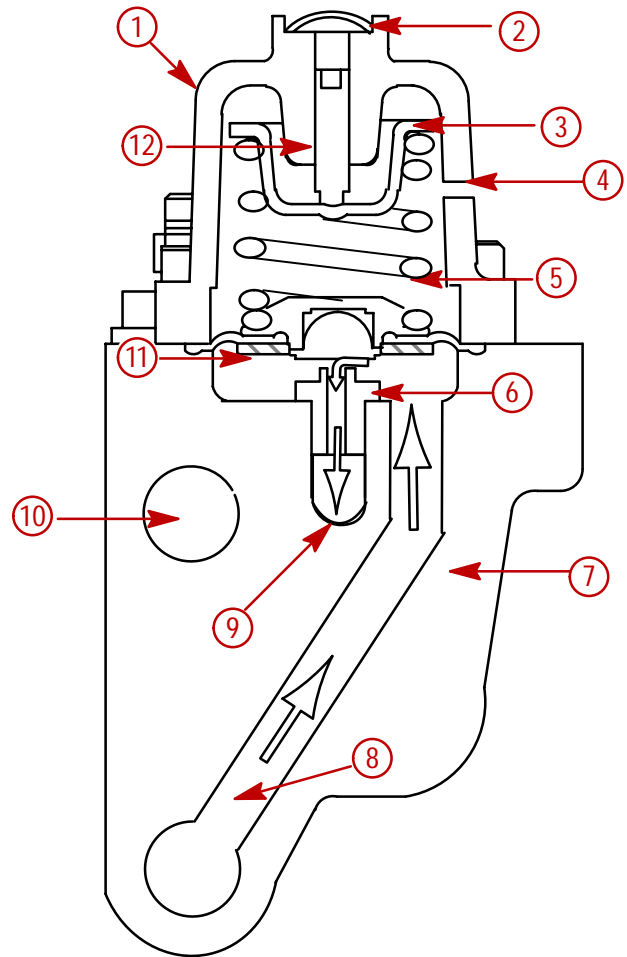
## Air Pressure Regulator

### Regulator Closed



- 1 - Top Cover
- 2 - Expansion Plug
- 3 - Spring Retainer
- 4 - Vent
- 5 - Spring
- 6 - Diaphragm Seat

### Regulator Open



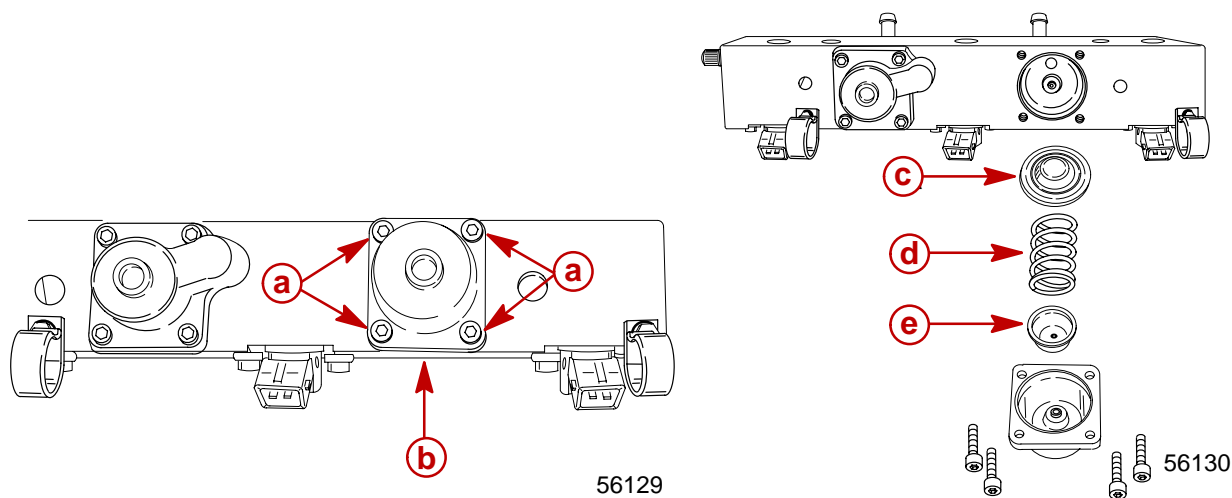
- 7 - Air Rail
- 8 - Air Passage (from Air Compressor)
- 9 - Excess Air Passage (to Exhaust Adaptor)
- 10 - Fuel Inlet Passage (from Electric Fuel Pump)
- 11 - Diaphragm Assembly
- 12 - Calibration Screw (Do Not Turn)

The air pressure regulator is designed to limit the air pressure inside the rails to approximately 80 psi.

The air regulator uses a spring (pressure) to control the air pressure. This spring (80 psi) holds the diaphragm against the diaphragm seat. The contact area blocks (closes) the air inlet passage from the excess air, return passage. As the air pressure rises (below the diaphragm), it must reach a pressure equal to or greater than the spring pressure holding the diaphragm closed. Once this pressure is achieved, the spring compresses, allowing the diaphragm to move. The diaphragm moves away from the diaphragm seat, allowing air to exit through the diaphragm seat, into the excess air passage leading to the exhaust adaptor plate.

**AIR REGULATOR REMOVAL**

1. Remove 4 screws securing regulator and remove regulator.
2. Inspect regulator diaphragm for cuts or tears. Replace as required.



- a** - Screws
- b** - Air Regulator
- c** - Diaphragm
- d** - Spring
- e** - Cup

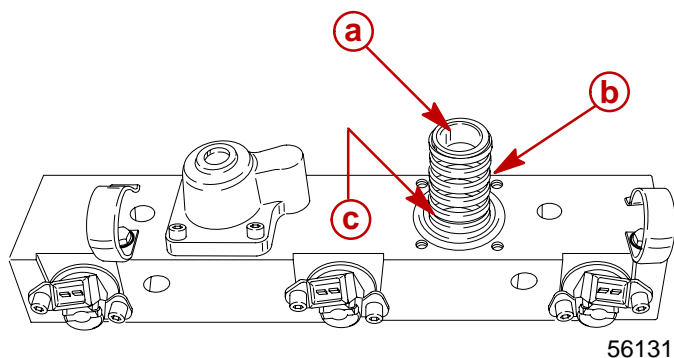
**AIR REGULATOR INSTALLATION**

**NOTE:** Apply a light coat of 2-4-C w/Teflon to diaphragm surface to aid in the retention of diaphragm on fuel rail during reassembly.

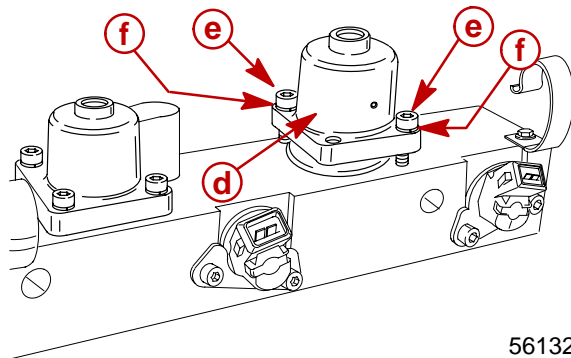
1. Position diaphragm, spring and cup onto fuel rail with fuel rail in horizontal position.

**NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to regulator attaching screw threads.

**NOTE:** Due to the stiffness of the regulator spring, it is recommended that 2 longer screws (5mm x 25mm long) (10-40073 25) and 2 flat washers (12-30164) be installed through cover first to begin compression. This will allow 2 shorter screws (5mm x 15mm long) to be installed. Remove 2 long screws w/flat washers and install remaining 2 short screws (5mm x 15mm). Torque screws to 70 lb. in. (8.0 Nm).



- a** - Cup
- b** - Spring
- c** - Diaphragm
- d** - Cover
- e** - Screws (5mm x 25mm) (10-40073 25)
- f** - Flat Washers (12-30164)

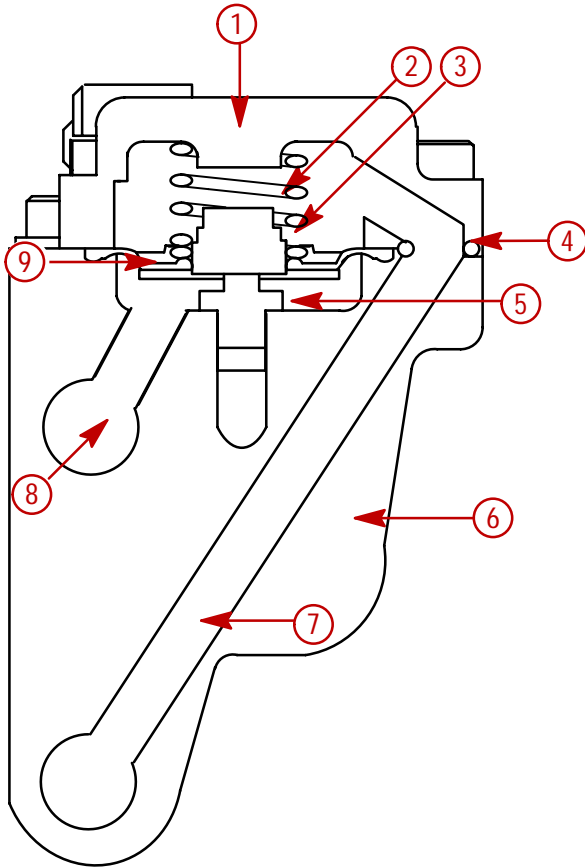




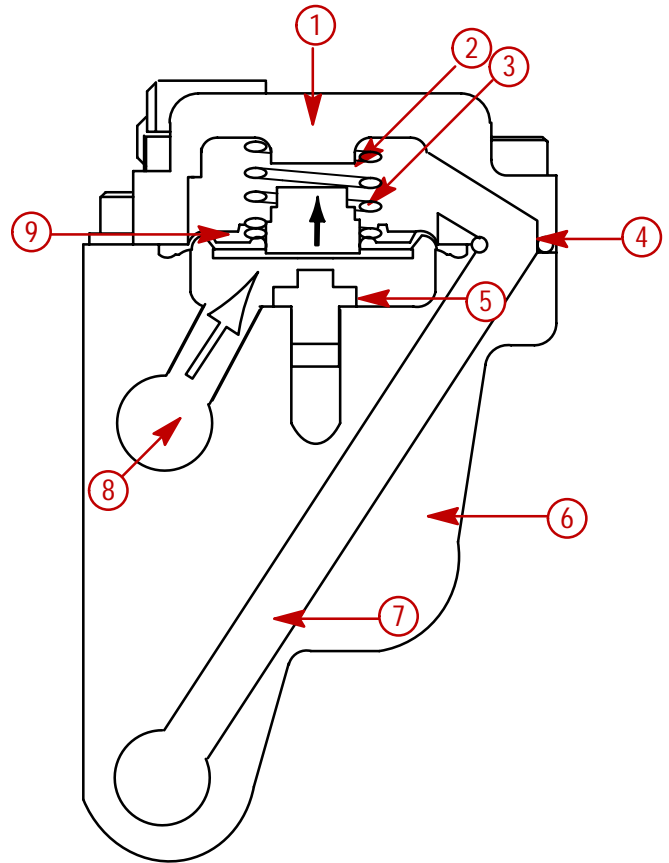


## Tracker Valve

### Engine Off (No Pressure)



### Engine at Operating Pressures



- 1 - Top Cover
- 2 - Spring Retainer (not shown)
- 3 - Spring
- 4 - O-ring
- 5 - Diaphragm (at rest) Seat

- 6 - Air Rail
- 7 - Air Passage (from Air Compressor)
- 8 - Fuel Inlet Passage (from Electric Fuel Pump)
- 9 - Diaphragm Assembly

The tracker is located on the starboard fuel/air rail assembly. The DFI system must maintain a constant 10 psi pressure difference between the fuel pressure and air pressure in the rails, at all times. The tracker is designed to maintain the 10 psi differential when the air or fuel pressure suddenly raises (i.e. pulses generated by the compressor's piston or by the fuel injectors opening and closing). The tracker contains a spring on the air side of the diaphragm. This spring positions the diaphragm against the diaphragm's seat (when the engine is not running).

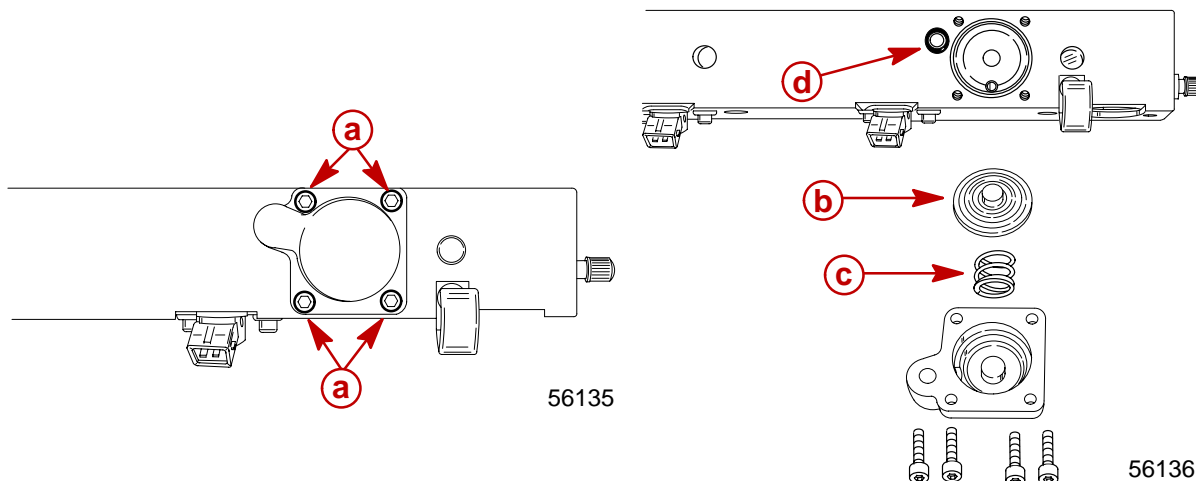
After the engine starts, and the fuel and air pressure reach normal operating range, the fuel pressure will compress the spring and the diaphragm will move slightly away from the seat (to a neutral position). At this point the pressure on both sides of the tracker diaphragm is equal (10 psi spring pressure + 80 psi air pressure = 90 psi fuel pressure).

Any air or fuel pressure "spikes" on one side of the diaphragm will transfer this pressure rise to the other system (air or fuel) on the other side of the diaphragm. Both systems will have a momentary increase in pressure so that the 10 psi difference between air and fuel system pressures can be maintained.

**NOTE:** To prevent excessive wear in the seat, the tracker is calibrated to allow the diaphragm to be slightly away from the seat during normal operation.

**TRACKER VALVE REMOVAL**

1. Remove 4 screws securing tracker valve and remove tracker assembly.
2. Inspect tracker diaphragm for cuts and tears.
3. Inspect tracker cover O-ring for cuts and abrasions. Replace components as required.



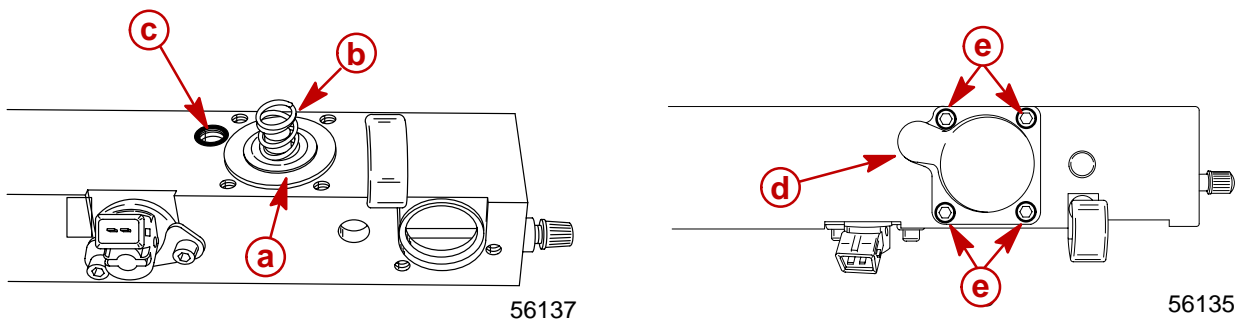
- a** - Screws
- b** - Diaphragm
- c** - Spring
- d** - O-ring

**TRACKER VALVE INSTALLATION**

**NOTE:** Apply a light coat of 2-4-C w/Teflon to tracker diaphragm and cover O-ring to aid in their retention on fuel rail while reinstalling tracker valve to fuel rail.

**NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to tracker valve attaching screw threads.

1. Position diaphragm, spring and O-ring onto fuel rail.
2. Place cover over diaphragm/spring/O-ring assembly and secure with 4 screws. Torque screws to 70 lb. in. (8.0 Nm).

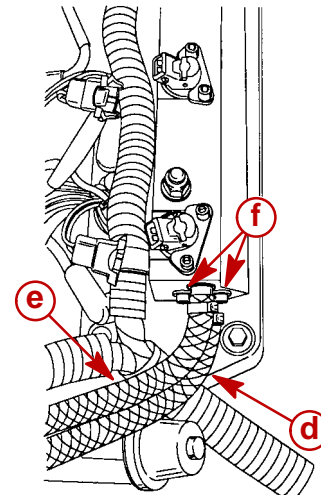
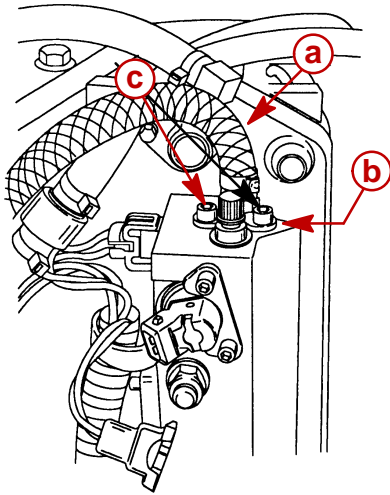


- a** - Diaphragm
- b** - Spring
- c** - O-ring
- d** - Cover
- e** - Screws [Torque to 70 lb. in. (8.0 Nm)]



## Fuel Rail Cleaning

After all fuel injectors, air regulator, tracker valve, fuel regulator, inlet hoses and outlet hoses have been removed, the fuel rails may be flushed out with a suitable parts cleaning solvent. Use compressed air to remove any remaining solvent.



56140

### Top Fuel Rail Connections

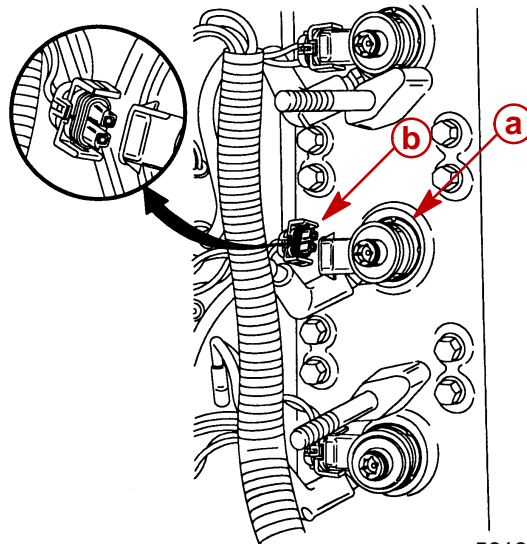
- a** - Air Hose
- b** - Retainer
- c** - Allen Screws (remove)

### Bottom Fuel Rail Connections

- d** - Air Hose
- e** - Fuel Hose
- f** - Allen Screws

## Direct Injector Removal

1. Remove harness connectors from direct injectors.
2. Remove direct injector from cylinder head



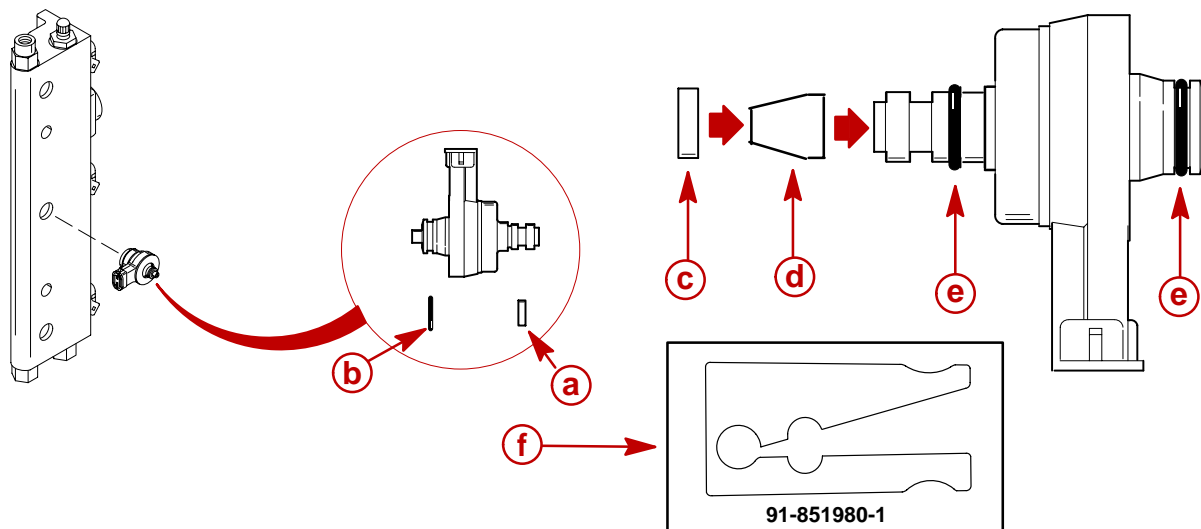
56138

- a** - Direct Injector (3 each cylinder head)
- b** - Harness Connector

3. Inspect injector teflon sealing ring (white) for signs of combustion blowby (teflon ring will be streaked brownish black). If blowby is present, replace teflon sealing ring. If blowby is not present, sealing ring may be reused.
4. Inspect O-rings and cork gasket for cuts or abrasions. Replace components as required.



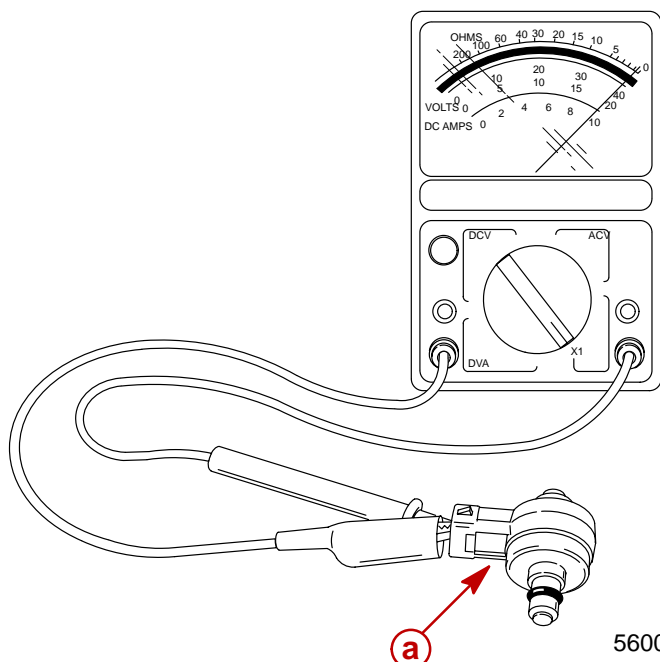
- If teflon seal requires replacement, use teflon ring installation tool 91-851980 to slide new seal onto injector. Following installation of teflon ring, the teflon ring sizing tool (91-851980-1) can be used to compress the teflon seal to aid in the installation of the injector into the cylinder head.



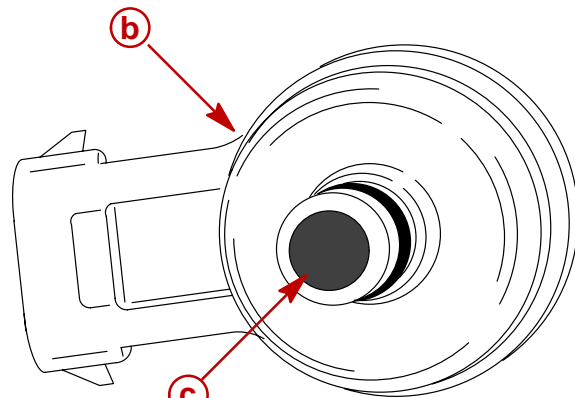
- a** - Teflon Sealing Ring
- b** - O-ring
- c** - Teflon Seal

- d** - Seal Installation Tool (91-851980)
- e** - O-ring
- f** - Teflon Ring Sizing Tool (91-851980-1)

- An ohm test of the direct injector may be made by connecting test leads to injector terminals. Ohm reading should be  $1.3 \pm 0.3$  ohm.
- Carbon buildup on tip of direct injector may be removed by use of a brass wire hand brush.



- a** - Direct Injector
- b** - Direct Injector
- c** - Tip

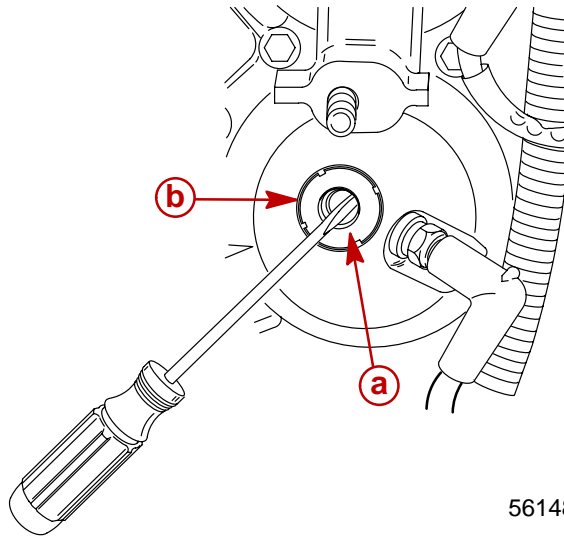


56017

56003



**NOTE:** If cylinder head is going to be replaced, remove cup washers from each direct injector port by prying out with a flat tip screwdriver. Reinstall washers with retainers into new cylinder head. Washers provide tension between direct injectors, cylinder head and fuel rails.



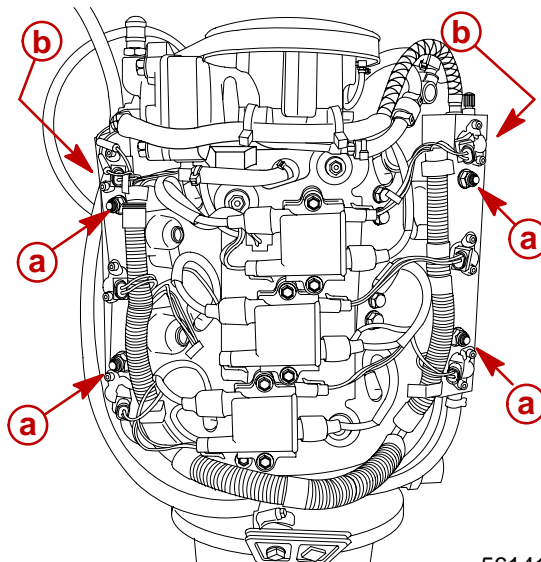
- a** - Cup Washer  
**b** - Retainer

## Fuel Rail and Direct Injector Installation

1. Use Teflon Ring Sizing Tool (91-851980-1) to compress new teflon sealing rings prior to installation of injector into cylinder head.
2. Carefully slide fuel rail over mounting studs and onto direct injectors.

**IMPORTANT: ALL fuel and air hoses attached to the fuel rails MUST be secured with stainless steel hose clamps.**

3. Secure each fuel rail with 2 nuts. Torque nuts to 33 lb. ft. (44 Nm).
4. Reinstall direct injector harness connectors.

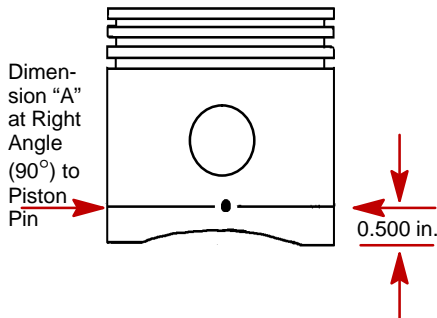


- a** - Nuts [Torque to 33 lb.ft. (44 Nm)]  
**b** - Direct Injector Harness Connectors



## Air Compressor

Air compressor is a single cylinder, water cooled and lubricated by the outboard oil pump.

| Air Compressor Specifications |                                                                                                                                             |                                                                                                                              |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>Air Compressor</b>         | Type<br>Compressor Output                                                                                                                   | Reciprocating Piston<br>(1 to 1 ratio with engine RPM)<br>@ Idle – 80 psi<br>@ W.O.T. – 110 psi                              |
| <b>Cylinder Block</b>         | Displacement                                                                                                                                | 7.07 cu. in. (116 cc)                                                                                                        |
| <b>Cylinder Bore</b>          | Diameter (Standard)<br>Taper/Out-of-Round/Wear Maximum<br>Bore Type                                                                         | 2.5591 in. (65.0 mm)<br>0.001 in. (0.025 mm)<br>Cast Iron                                                                    |
| <b>Stroke</b>                 | Length                                                                                                                                      | 1.374 in. (34.9 mm)                                                                                                          |
| <b>Piston</b>                 | Piston Type                                                                                                                                 | Aluminum                                                                                                                     |
| <b>Piston Diameter</b>        |  <p>Dimension "A" at Right Angle (90°) to Piston Pin</p> | 2.5578 ± .0004 in.<br>(64.97 ± 0.010 mm)                                                                                     |
| <b>Piston Ring</b>            | End Gap<br>Top Ring<br>Middle Ring<br>Bottom Ring                                                                                           | 0.0059 – 0.0098 in.<br>(0.15 – 0.25 mm)<br>0.0059 – 0.0098 in.<br>(0.15 – 0.25 mm)<br>0.0039 – 0.014 in.<br>(0.10 – 0.35 mm) |
| <b>Reeds</b>                  | Reed Stand Open                                                                                                                             | 0.010 in. (0.25 mm)                                                                                                          |

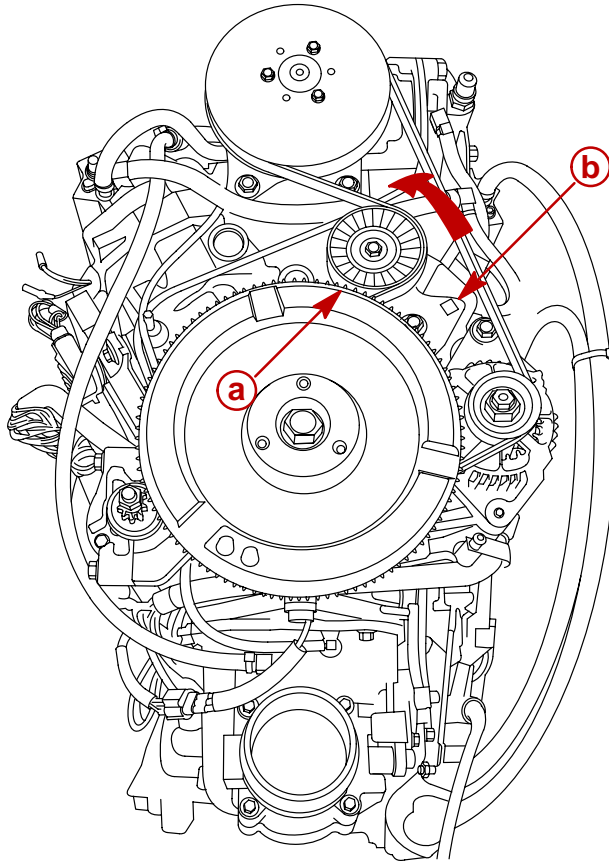


## COMPRESSOR REMOVAL

1. Disconnect battery cables from battery terminals.
2. Remove top cowling.

**IMPORTANT: Prior to removing flywheel cover, remove vent hose from fitting on flywheel cover.**

3. Remove flywheel cover.
4. Use 3/8 inch (9.5 mm) drive on belt tensioner arm to relieve belt tension. Remove belt.



56142

- a** - Belt Tensioner  
**b** - 3/8 in. (9.5 mm) drive

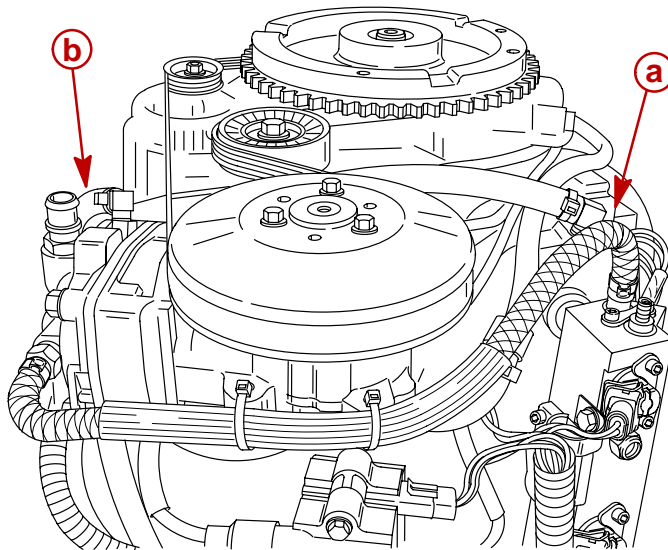
### **CAUTION**

**If engine has been recently run, air pressure outlet hose fittings may be extremely hot. Allow components to cool off before beginning disassembly.**

5. Disconnect air pressure outlet hose.



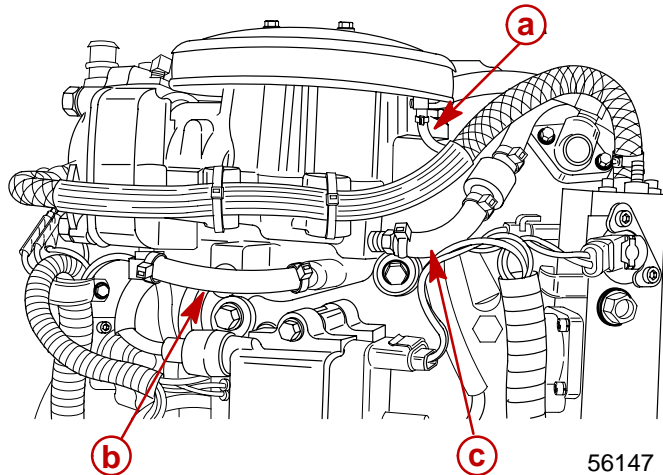
6. Disconnect water outlet hose (tell-tale).



56149

- a** - Air Pressure Outlet Hose
- b** - Water outlet Hose (tell-tale)

7. Disconnect air compressor oil inlet hose.
8. Disconnect water inlet hose.
9. Disconnect excess oil return hose.



56147

- a** - Air Compressor Oil Inlet Hose
- b** - Water Inlet Hose
- c** - Excess Oil Return Hose

10. Remove 4 bolts securing air compressor to outboard and remove compressor.

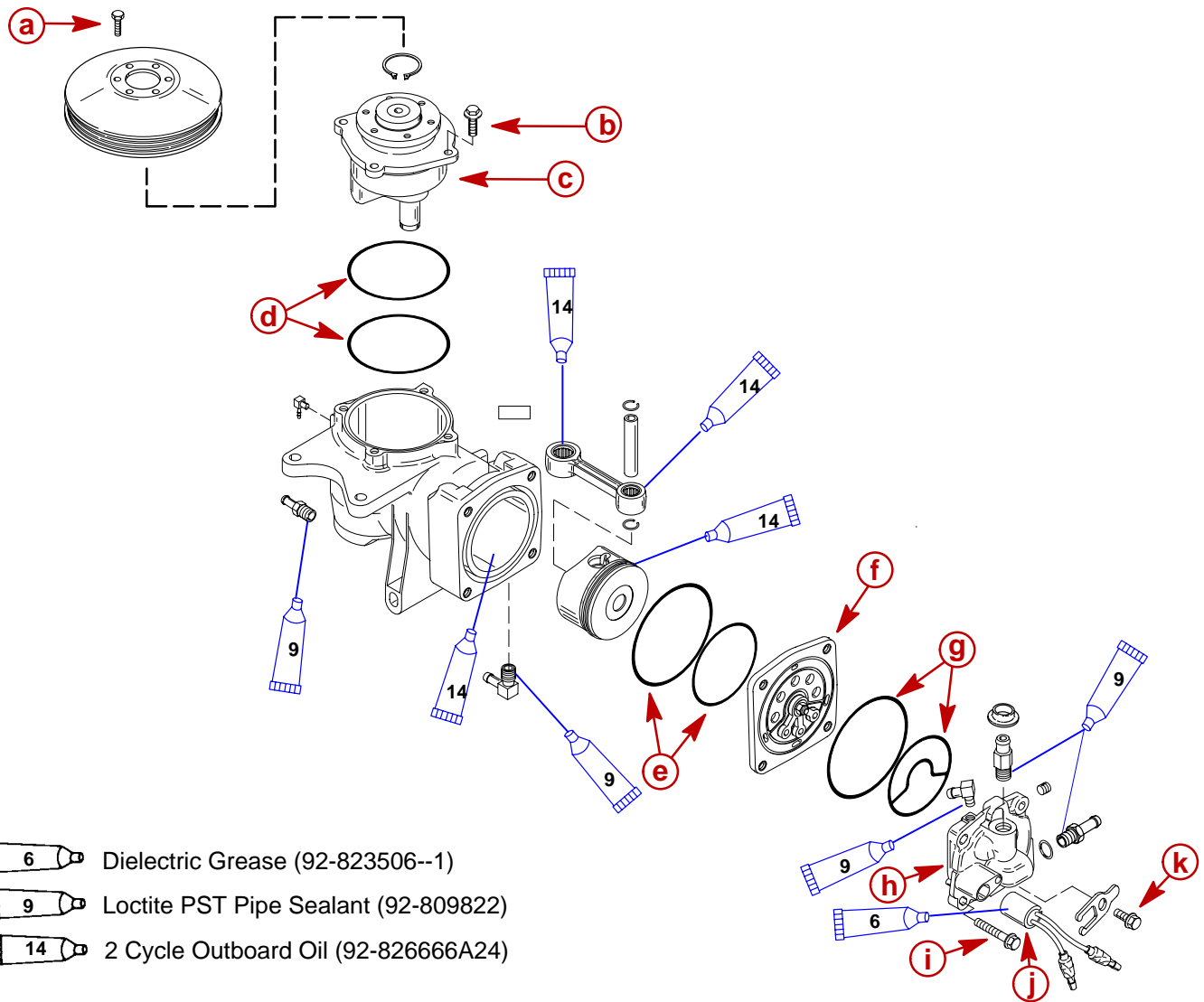


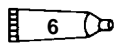
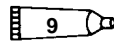
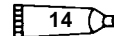


## Air Compressor Disassembly/Reassembly

**NOTE:** If cylinder bore is scored, air compressor must be replaced as an assembly.

**NOTE:** The piston and rings are not sold separately. They must be replaced as an assembly. The connecting rod and bearings are not sold separately. They must be replaced as an assembly.



-  6 Dielectric Grease (92-823506--1)
-  9 Loctite PST Pipe Sealant (92-809822)
-  14 2 Cycle Outboard Oil (92-826666A24)

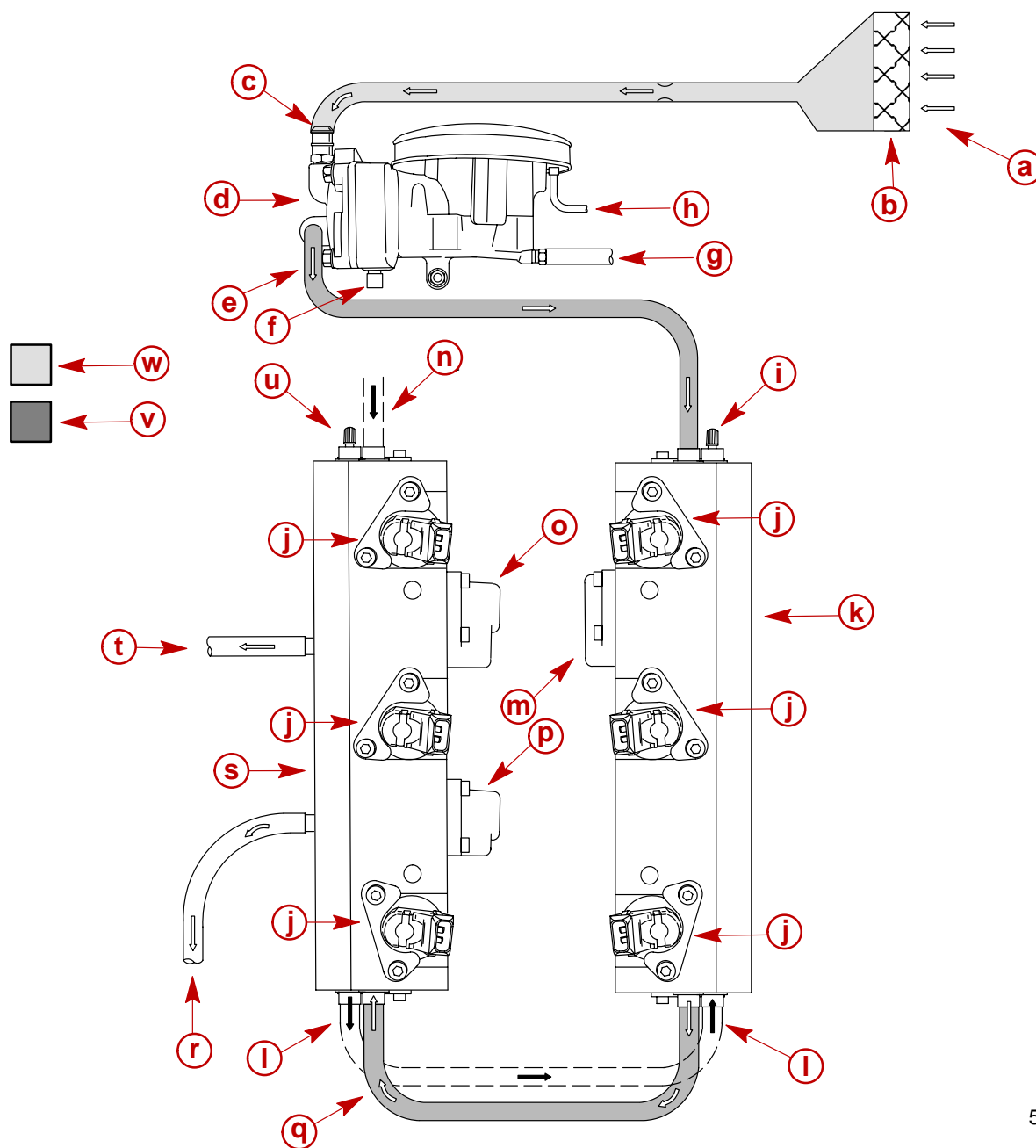
**NOTE:** End cap bearing and seal are not sold separately. End cap must be replaced as an assembly

**NOTE:** Piston Installation – use a metal hose clamp for piston ring compressor. Stagger piston ring openings.

- |                                                                                                                  |                                                    |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>a</b> - Bolt [Torque to 100 lb. in. (11.5 Nm)]                                                                | <b>g</b> - O-rings (Inspect for cuts or abrasions) |
| <b>b</b> - Bolt (4 each) [Torque to 100 lb. in. (11.5 Nm)]                                                       | <b>h</b> - Cylinder Head                           |
| <b>c</b> - End Cap Assembly (Inspect bearing for roughness)                                                      | <b>i</b> - Bolt [Torque to 20 lb. ft. (27 Nm)]     |
| <b>d</b> - O-rings (Inspect for cuts or abrasions)                                                               | <b>j</b> - Temperature Sensor                      |
| <b>e</b> - O-rings (Inspect for cuts or abrasions)                                                               | <b>k</b> - Bolt [Torque to 20 lb. ft. (27 Nm)]     |
| <b>f</b> - Reed Plate (Inspect for broken or chipped reeds/stops) Maximum Reed Stand-Open – 0.010 in. (0.254 mm) |                                                    |



# Air Compressor Flow Diagram



56150

- a** - Air Inlet
- b** - Air Filter
- c** - Compressor Air Inlet w/Inlet Restrictor
- d** - Air Compressor
- e** - Compressor Air Outlet
- f** - Compressor Water Inlet
- g** - Excess Oil Return
- h** - Compressor Oil Inlet
- i** - Fuel System Pressure Test Valve
- j** - Fuel Injector
- k** - Starboard Fuel Rail
- l** - High Pressure Fuel [89 ± 2 psi (613.5 ± 13.8 kPa)]

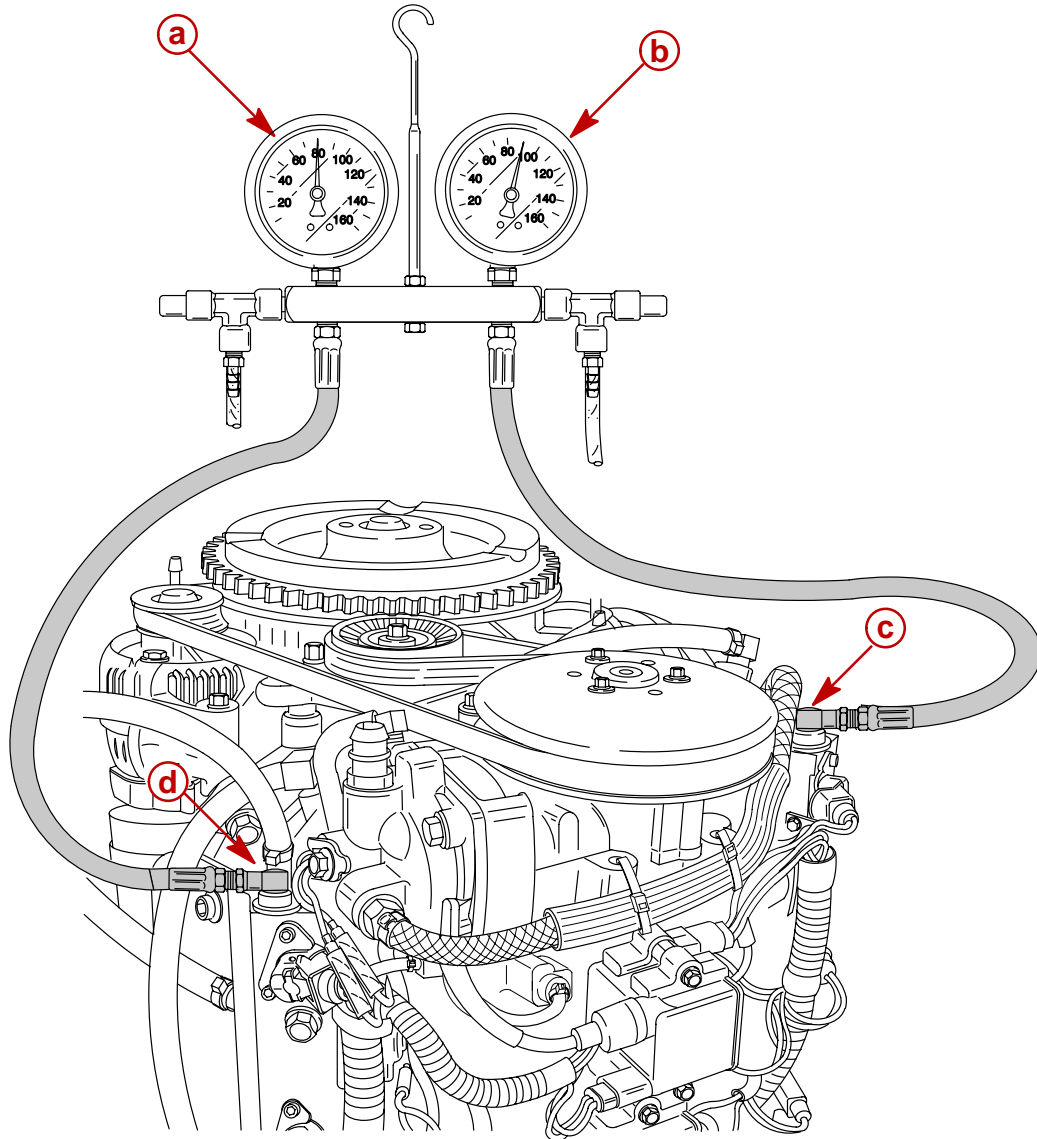
- m** - Tracker Valve
- n** - Fuel Inlet
- o** - Fuel Regulator [89 ± 2 psi (613.5 ± 13.8 kPa)]
- p** - Air Regulator [79 ± 2 psi (544.0 ± 13.8 kPa)]
- q** - Air [79 ± 2 psi (544.0 ± 13.8 kPa)]
- r** - Excess Air Return to Exhaust Adaptor Plate
- s** - Port Fuel Rail
- t** - Excess Fuel Return to Fuel Cooler
- u** - Air Pressure Test Valve
- v** - High Pressure
- w** - Low Pressure



## Air Compressor Pressure Test

Install Pressure Gauge Assembly 91-852087A1/A2 to fuel rail pressure test valves. Starboard rail has fuel pressure test valve. Port fuel rail has air pressure test valve.

**NOTE:** After 15 seconds of cranking engine with starter motor, air pressure gauge should indicate  $79 \pm 2$  psi ( $544.0 \pm 13.8$  kPa) and fuel pressure gauge should indicate  $89 \pm 2$  psi ( $613.5 \pm 13.8$  kPa).



56146

- a** - Air Pressure Gauge (Should Indicate  $79 \pm 2$  psi ( $544.0 \pm 13.8$  kPa))
- b** - Fuel Pressure Gauge (Should Indicate  $89 \pm 2$  psi ( $613.5 \pm 13.8$  kPa))
- c** - Fuel Pressure Test Valve
- d** - Air Pressure Test Valve



## FUEL PRESSURE AND AIR PRESSURE TROUBLESHOOTING CHART

| PROBLEM                                                                              | CORRECTIVE ACTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fuel Pressure and Air Pressure are Both Low                                          | <ol style="list-style-type: none"> <li>1. Inspect air compressor air intake (air filter in fly-wheel cover) for blockage.</li> <li>2. Remove air compressor cylinder head and inspect for scuffing of cylinder wall. Inspect for broken reeds and/or reed stops.</li> <li>3. Tracker Valve – Remove and inspect diaphragm for cuts or tears and seat damage on diaphragm and rail.</li> <li>4. Air Regulator – Remove and inspect diaphragm for cuts or tears on diaphragm and rail.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Fuel Pressure Low or Fuel Pressure Drops while Running (Air Pressure Remains Normal) | <ol style="list-style-type: none"> <li>1. Each time key is turned to the RUN position, both electric pumps should operate for 2 seconds. If it they do not run, check 20 ampere fuse and wire connections.</li> <li>2. If pumps run but have no fuel output, check vapor separator (remove drain plug) for fuel.</li> <li>3. If no fuel present in vapor separator, check fuel/water separator for debris. Check crankcase mounted fuel pump for output.</li> <li>4. Check high pressure pump amperage draw. Normal draw is 6 - 9 amperes; if draw is below 2 amperes, check fuel pump filter (base of pump) for debris. If filter is clean, replace pump. If amperage is above 9 amperes, pump is defective – replace pump.<br/>Check low pressure output – 6-9 psi.<br/>Check low pressure electric fuel pump amperage draw. Normal draw is 1 - 2 amperes; if draw is below 1 ampere, check for blockage between pump inlet fitting and vapor separator tank. If ampere draw is above 2 amperes, replace pump.</li> <li>5. Fuel Regulator – Remove and inspect diaphragm for cuts or tears.</li> </ol> |
| Fuel Pressure High and Air Pressure is Normal                                        | <ol style="list-style-type: none"> <li>1. Stuck check valve in fuel return hose.</li> <li>2. Debris blocking fuel regulator hole.</li> <li>3. Faulty pressure gauge</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Fuel and Air Pressure Higher than Normal                                             | <ol style="list-style-type: none"> <li>1. Debris blocking air regulator passage.</li> <li>2. Air dump hose (rail to driveshaft housing) blocked/plugged.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |