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# **Service Manual**

**MDKAV, MDKAW**

**MDKAZ, MDKBD**

**MDKBE, MDKBF**

**MDKBG**

**California**

**Proposition 65 Warning**

**Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.**

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# Safety Precautions

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Thoroughly read the **OPERATOR'S MANUAL** before operating the genset. Safe operation and top performance can only be attained when equipment is operated and maintained properly.

The following symbols in this manual alert you to potential hazards to operators, service personnel and equipment.

**⚠ DANGER** *alerts you to an immediate hazard which will result in severe personal injury or death.*

**⚠ WARNING** *alerts you to a hazard or unsafe practice which can result in severe personal injury or death.*

**⚠ CAUTION** *alerts you to a hazard or unsafe practice which can result in personal injury or equipment damage.*

Electricity, fuel, exhaust, hot engine coolant, moving parts and batteries present hazards which can result in severe personal injury or death.

## GENERAL PRECAUTIONS

- Keep children away from the genset.
- Do not step on the genset when entering or leaving the generator room. Parts can bend or break leading to electrical shorts or to fuel, coolant or exhaust leaks.
- To prevent accidental or remote starting while working on the genset, disconnect the negative (-) battery cable at the battery.
- Let the engine cool down before removing the coolant pressure cap or opening the coolant drain. Hot coolant under pressure can spray and cause severe burns.
- Do not use evaporative starting fluids. They are highly explosive.
- Keep the genset, drip pan and compartment clean. Oily rags can catch fire. Gear stowed in the compartment can restrict cooling.

- Make sure all fasteners are secure and properly torqued.
- Do not work on the genset when mentally or physically fatigued or after having consumed alcohol or drugs.
- You must be trained and experienced to make adjustments while the genset is running—hot, moving or electrically live parts can cause severe personal injury or death.
- Used engine oil has been identified by some U. S. state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or contact used oil or its vapors.
- Ethylene glycol, used as engine antifreeze, is toxic to humans and animals. Clean up spills and dispose of used engine coolant in accordance with local environmental regulations.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10)
- Genset installation and operation must comply with all applicable local, state and federal codes and regulations.

## GENERATOR VOLTAGE IS DEADLY

- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- The genset must not be connected to shore power or to any other source of electrical power. Back-feed to shore power can cause electric shock resulting in severe personal injury or death and damage to equipment. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry, stand on a dry wooden platform or rubber insulating mat and use tools with insulated handles.

## ENGINE EXHAUST IS DEADLY

- Never sleep in the boat while the genset is running unless the boat is equipped with properly working carbon monoxide detectors.
- The exhaust system must be installed in accordance with the genset Installation Manual and be free of leaks.
- Make sure the bilge is adequately ventilated with a power exhauster.
- Inspect for exhaust leaks every startup and after every eight hours of operation.
- For more information about carbon monoxide see American Boat and Yacht Council (ABYC) publication TH-22—*Educational Information About Carbon Monoxide*.

## DIESEL FUEL IS COMBUSTIBLE

- Do not smoke or turn electrical switches ON or OFF where fuel fumes are present or in areas sharing ventilation with fuel tanks or equipment. Keep flames, sparks, pilot lights, arc-producing equipment and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.

## BATTERY GAS IS EXPLOSIVE

- Wear safety glasses while servicing batteries and do not smoke.
- To reduce arcing when disconnecting or reconnecting battery cables, always disconnect the negative (-) battery cable first and reconnect it last.

## MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not wear loose clothing or jewelry near moving parts such as PTO shafts, fans, belts and pulleys.
- Keep hands away from moving parts.
- Keep guards in place over fans, belts, pulleys, and other moving parts.

## FLAMMABLE VAPOR ENVIRONMENT

Flammable vapor can cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury or death. ***Do not operate a diesel-powered genset in a flammable vapor environment created by fuel spill, leak, etc.*** The owners and operators of the genset are solely responsible for operating the genset safely.

**POST THESE SUGGESTIONS IN POTENTIAL HAZARD AREAS OF THE BOAT**

# 1. Introduction

## ABOUT THIS MANUAL

This is the service manual for the generator sets (gensets) listed on the front cover. Read and carefully observe all of the instructions and precautions in this manual.

**⚠WARNING** *Improper service or replacement of parts can lead to severe personal injury or death and to damage to equipment and property. Service personnel must be qualified to perform electrical and mechanical service.*

**⚠WARNING** *Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.*

See the Installation Manual (981-0630) for important recommendations concerning the installation and for a list of the installation codes and standards for safety which may be applicable.

See the Engine Workshop Manual (Table 6-1) for major engine service procedures. See *Specifications* in this manual to identify the engine model number for the genset.

See the Parts Manual (981-0268) for part identification numbers and required quantities and for exploded views of the genset subassemblies. Genuine Onan® replacement parts are recommended for best results.

When contacting Onan for parts and product information, be ready to provide the model and serial numbers on the genset nameplate. Figure 1-1 illustrates the nameplate and its location. The numbers in the gray boxes are typical model and serial numbers. Every character in these numbers is significant. (The last character of the model number is the specification letter, which is important for obtaining the right parts.)

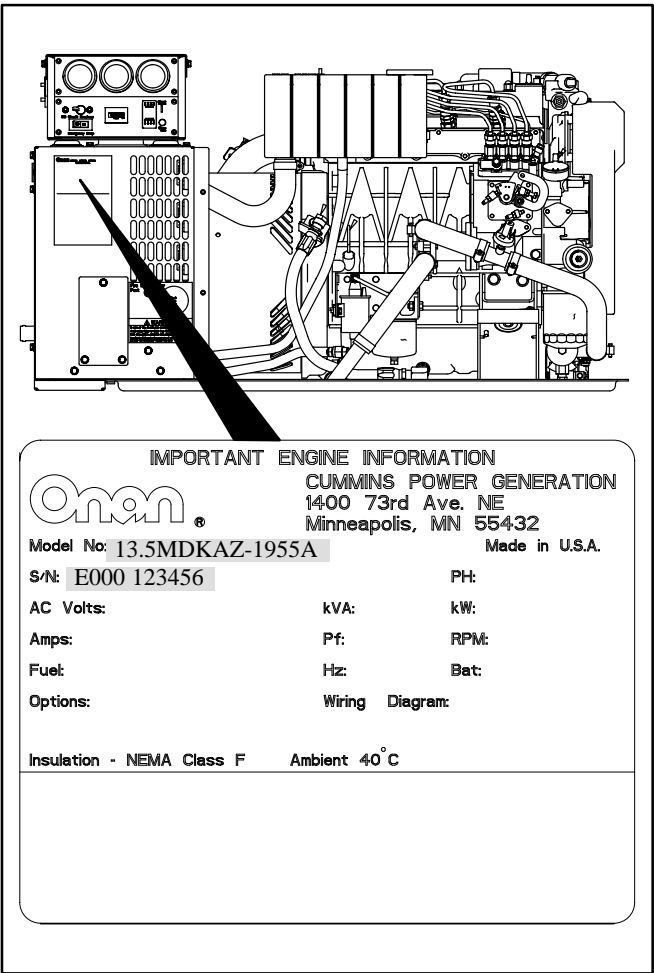


FIGURE 1-1. TYPICAL NAMEPLATE



## FUEL RECOMMENDATIONS

High quality fuel is necessary for good performance and long engine life. Use No. 2 diesel fuel (American Society for Testing and Materials [ASTM] Grade 2-D). The Cetane number should not be less than 45 and sulfur content not more than 0.5 percent (by weight). Where fuel is exposed to cold ambient temperatures, use fuel that has a cloud point (temperature at which wax crystals begin to form) at least 10° F (6° C) degrees below the lowest expected fuel temperature.

**⚠ WARNING** *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.*

## ENGINE OIL RECOMMENDATIONS

Use API (American Petroleum Institute) performance Class **CH-4** engine oil or better. Also look for the SAE (Society of Automotive Engineers) viscosity grade. Referring to Figure 1-2, choose the viscosity grade appropriate for the ambient temperatures expected until the next scheduled oil change. Multi-grade oils such as SAE 15W-40 are recommended for year-round use.

Synthetic motor oil is not recommended.

## STARTING BATTERIES

The genset requires a 12 volt battery to power its control and starting circuits. Reliable genset starting and starter service life depend upon adequate battery system capacity and maintenance. See *Specifications* (Page 1-3) for battery requirements and *Periodic Maintenance* (Page 3-6) for battery care.

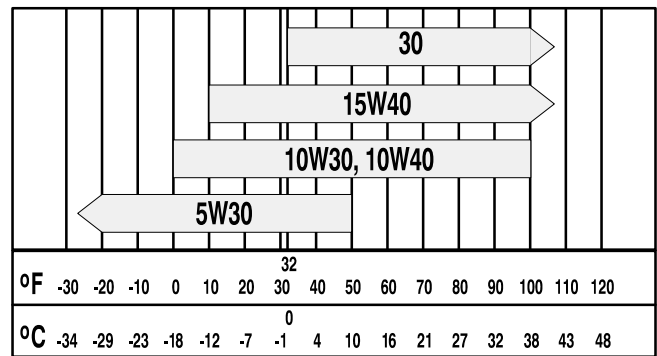


FIGURE 1-2. SAE VISCOSITY GRADE vs. AMBIENT TEMPERATURE

## SPECIFICATIONS

|   | MDKAV  | MDKBG  | MDKAW   | MDKAZ   |
|---|--|--|---|---|
| <b>ALTERNATOR:</b> Single-Bearing, Brushless 4-Pole Rotating Field with Digital Electronic Regulation. See Genset Nameplate for Rating. |  |  |   |   |
| Alternator Cooling Air Flow: 60 Hz<br>50 Hz   | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)             | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min) | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)              | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)              |
| <b>FUEL CONSUMPTION:</b>  |  |  |   |   |
| 60 Hz: Full Load<br>Half Load   | 0.8 gph (3.0 liter/hr)<br>0.5 gph (1.9 liter/hr)                                     | 0.8 gph (3.0 liter/hr)<br>0.5 gph (1.9 liter/hr)                         | 1.0 gph (3.8 liter/hr)<br>0.6 gph (2.3 liter/hr)                                      | 1.2 gph (4.5 liter/hr)<br>0.7 gph (2.7 liter/hr)                                      |
| 50 Hz: Full Load<br>Half Load   | 0.7 gph (2.7 liter/hr)<br>0.4 gph (1.5 liter/hr)                                     | 0.7 gph (2.7 liter/hr)<br>0.4 gph (1.5 liter/hr)                         | 0.8 gph (3.0 liter/hr)<br>0.5 gph (1.9 liter/hr)                                      | 0.9 gph (3.4 liter/hr)<br>0.5 gph (1.9 liter/hr)                                      |
| <b>ENGINE:</b> Kubota 4-Stroke Cycle, Indirect Injection, Water Cooled Diesel with Digital Electronic Governing                         |  |  |   |   |
| Model   | D1105  | D1105  | V1305   | V1505   |
| Number of Cylinders   | 3  | 3  | 4   | 4   |
| Displacement  | 68.58 in <sup>3</sup> (1124 cm <sup>3</sup> )  | 68.58 in <sup>3</sup> (1124 cm <sup>3</sup> )                            | 81.47 in <sup>3</sup> (1335 cm <sup>3</sup> )   | 91.44 in <sup>3</sup> (1499 cm <sup>3</sup> )   |
| Bore  | 3.07 in (78 mm)  | 3.07 in (78 mm)  | 2.99 in (76 mm)   | 3.07 in (78 mm)   |
| Stroke  | 3.09 in (78.4 mm)  | 3.09 in (78.4 mm)  | 2.90 in (73.6 mm)   | 3.09 in (78.4 mm)   |
| Compression Ratio   | 22:1   | 22:1   | 22:1  | 22:1  |
| Firing Order (Clockwise Rotation)   | 1-2-3  | 1-2-3  | 1-2-4-3   | 1-2-4-3   |
| Fuel Injection Timing   | 15.5° - 17.5° BTDC   | 15.5° - 17.5° BTDC   | 15.5° - 17.5° BTDC  | 15.5° - 17.5° BTDC  |
| Valve Lash (cold)   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)                                   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)  | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)  |
| Lube Oil Capacity   | 4.2 quart (4.0 liter)  | 4.2 quart (4.0 liter)  | 4.5 quart (4.3 liter)   | 4.5 quart (4.3 liter)   |
| Lube Oil Drain Connection   | 3/8 NPT  | 3/8 NPT  | 3/8 NPT   | 3/8 NPT   |
| Coolant Capacity  | 4.2 quart (4.0 liter)  | 4.2 quart (4.0 liter)  | 5.3 quart (5.0 liter)   | 5.3 quart (5.0 liter)   |
| Coolant Flow Rate: 60 Hz<br>50 Hz   | 5.0 gpm (18.9 liter/min)<br>4.2 gpm (15.9 liter/min)                                 | 5.0 gpm (18.9 liter/min)<br>4.2 gpm (15.9 liter/min)                     | 5.0 gpm (18.9 liter/min)<br>4.2 gpm (15.9 liter/min)                                  | 5.0 gpm (18.9 liter/min)<br>4.2 gpm (15.9 liter/min)                                  |
| Raw Water Flow Rate: 60 Hz<br>50 Hz   | 6.0 gpm (22.7 liter/min)<br>5.0 gpm (18.9 liter/min)                                 | 6.0 gpm (22.7 liter/min)<br>5.0 gpm (18.9 liter/min)                     | 6.0 gpm (22.7 liter/min)<br>5.0 gpm (18.9 liter/min)                                  | 6.0 gpm (22.7 liter/min)<br>5.0 gpm (18.9 liter/min)                                  |
| Combustion Air Flow: 60 Hz<br>50 Hz   | 30 cfm (0.85 m <sup>3</sup> /min)<br>25 cfm (0.71 m <sup>3</sup> /min)               | 30 cfm (0.85 m <sup>3</sup> /min)<br>25 cfm (0.71 m <sup>3</sup> /min)   | 36 cfm (1.02 m <sup>3</sup> /min)<br>30 cfm (0.85 m <sup>3</sup> /min)                | 41 cfm (1.16 m <sup>3</sup> /min)<br>34 cfm (0.96 m <sup>3</sup> /min)                |
| Heat Rejection to Ambient: 60 Hz<br>50 Hz   | 200 Btu/min (50 kcal/min)<br>179 Btu/min (45 kcal/min)                               | 200 Btu/min (50 kcal/min)<br>179 Btu/min (45 kcal/min)                   | 230 Btu/min (58 kcal/min)<br>190 Btu/min (48 kcal/min)                                | 280 Btu/min (71 kcal/min)<br>210 Btu/min (53 kcal/min)                                |
| <b>CONNECTIONS:</b>   |  |  |   |   |
| Max Fuel Pump Lift  | 4 ft (1.2 m)   | 4 ft (1.2 m)   | 4 ft (1.2 m)  | 4 ft (1.2 m)  |
| Fuel Supply   | 1/4 NPT female   | 1/4 NPT female   | 1/4 NPT female  | 1/4 NPT female  |
| Fuel Return   | 1/4 NPT female   | 1/4 NPT female   | 1/4 NPT female  | 1/4 NPT female  |
| Max Raw Water Pump Lift   | 4 ft (1.22 m)  | 4 ft (1.22 m)  | 4 ft (1.22 m)   | 4 ft (1.22 m)   |
| Raw Water Inlet   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose  | 1 in (25.4 mm) ID Hose  |
| Wet Exhaust Outlet  | 2 in (50.8 mm) ID Hose   | 2 in (50.8 mm) ID Hose   | 2 in (50.8 mm) ID Hose  | 2 in (50.8 mm) ID Hose  |
| Max Exhaust Back Pressure   | 3 in (76 mm) Hg  | 3 in (76 mm) Hg  | 3 in (76 mm) Hg   | 3 in (76 mm) Hg   |
| <b>KEEL COOLING AND DRY EXHAUST:</b>  |  |  |   |   |
| Coolant Inlet & Outlet  | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose  | 1 in (25.4 mm) ID Hose  |
| Max Coolant Friction Head   | 1 psi (6.9 kPa)  | 1 psi (6.9 kPa)  | 1 psi (6.9 kPa)   | 1 psi (6.9 kPa)   |
| Heat Rejection to Coolant: 60 Hz<br>50 Hz   | 950 Btu/min (239 kcal/min)<br>780 Btu/min (197 kcal/min)                             | 950 Btu/min (239 kcal/min)<br>780 Btu/min (197 kcal/min)                 | 1220 Btu/min (307 kcal/min)<br>980 Btu/min (247 kcal/min)                             | 1420 Btu/min (358 kcal/min)<br>1160 Btu/min (292 kcal/min)                            |
| Dry Exhaust Outlet  | 1-1/4 NPT  | 1-1/4 NPT  | 1-1/4 NPT   | 1-1/4 NPT   |
| Max Exhaust Back Pressure   | 3 in (76 mm) Hg  | 3 in (76 mm) Hg  | 3 in (76 mm) Hg   | 3 in (76 mm) Hg   |
| <b>BATTERIES:</b>   |  |  |   |   |
| Nominal Battery Voltage   | 12 volts*  | 12 volts*  | 12 volts*   | 12 volts*   |
| Min CCA Rating - SAE @ 32° F (0° C)   | 360 amps   | 360 amps   | 500 amps  | 500 amps  |
| Battery Charging  | 5 amps   | 5 amps   | 5 amps  | 5 amps  |
| <b>SIZE, WEIGHT, NOISE:</b>   |  |  |   |   |
| Without Enclosure<br>Dry Weight<br>Dimensions: L x W x H  | 555 lbs (252 kg)<br>35.9 x 22.3 x 23.0 in<br>(911 x 566 x 585 mm)                    | 525 lbs (238 kg)<br>32.4 x 18.9 x 22.1 in<br>(479.1 x 822.6 x 560.9 mm)  | 640 lbs (290 kg)<br>40.7 x 22.3 x 23.0 in<br>(1033 x 566 x 585 mm)                    | 640 lbs (290 kg)<br>40.7 x 22.3 x 23.0 in<br>(1033 x 566 x 585 mm)                    |
| With Enclosure<br>Noise<br>Dry Weight<br>Dimensions: L x W x H  | 66 dB(A) @ 60HZ<br>600 lbs (272 kg)<br>35.9 x 22.3 x 23.4 in<br>(911 x 566 x 593 mm) | -  | 66 dB(A) @ 60HZ<br>695 lbs (315 kg)<br>40.7 x 22.3 x 23.4 in<br>(1033 x 566 x 593 mm) | 66 dB(A) @ 60HZ<br>695 lbs (315 kg)<br>40.7 x 22.3 x 23.4 in<br>(1033 x 566 x 593 mm) |
| * - 24 volts optional   |  |  |   |   |

## SPECIFICATIONS

|   | MDKBD  | MDKBE  | MDKBF   |
|---|--|--|---|
| <b>ALTERNATOR:</b> Single-Bearing, Brushless 4-Pole Rotating Field with Digital Electronic Regulation. See Genset Nameplate for Rating. |  |  |   |
| Alternator Cooling Air Flow: 60 Hz<br>50 Hz   | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)                     | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)                     | 275 cfm (0.85 m <sup>3</sup> /min)<br>230 cfm (0.71 m <sup>3</sup> /min)                      |
| <b>FUEL CONSUMPTION:</b>  |  |  |   |
| 60 Hz: Full Load<br>Half Load   | 1.3 gph (4.9 liter/hr)<br>0.8 gph (3.0 liter/hr)   | 1.9 gph (7.2 liter/hr)<br>1.1 gph (4.2 liter/hr)   | 2.5 gph (9.5 liter/hr)<br>1.5 gph (5.7 liter/hr)  |
| 50 Hz: Full Load<br>Half Load   | 1.1 gph (4.2 liter/hr)<br>0.7 gph (2.7 liter/hr)   | 1.6 gph (6.1 liter/hr)<br>0.9 gph (3.4 liter/hr)   | 2.1 gph (8.0 liter/hr)<br>1.3 gph (4.9 liter/hr)  |
| <b>ENGINE:</b> Kubota 4-Stroke Cycle, Indirect Injection, Water Cooled Diesel with Digital Electronic Governing                         |  |  |   |
| Model   | V1903B   | V2203B   | V2803B  |
| Number of Cylinders   | 4  | 4  | 5   |
| Displacement  | 113.37 in <sup>3</sup> (1857 cm <sup>3</sup> )   | 134.07 in <sup>3</sup> (2197cm <sup>3</sup> )  | 167.57 in <sup>3</sup> (2748 cm <sup>3</sup> )  |
| Bore  | 3.15 in (80 mm)  | 3.43 in (87 mm)  | 3.43 in (87 mm)   |
| Stroke  | 3.64 in (92.4 mm)  | 3.64 in (92.4 mm)  | 3.64 in (92.4 mm)   |
| Compression Ratio   | 23:1   | 23:1   | 23:1  |
| Firing Order (Clockwise Rotation)   | 1-3-4-2  | 1-3-4-2  | 1-3-5-4-2   |
| Fuel Injection Timing   | 15.5° - 17.5° BTDC   | 15.5° - 17.5° BTDC   | 15.5° - 17.5° BTDC  |
| Valve Lash (cold)   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)   | 0.0071 - 0.0087 in<br>(0.18 - 0.22 mm)  |
| Lube Oil Capacity   | 8 quart (7.6 liter)  | 8 quart (7.6 liter)  | 12.7 quart (12 liter)   |
| Lube Oil Drain Connection   | 3/8 NPT  | 3/8 NPT  | 3/8 NPT   |
| Coolant Capacity  | 8 quart (7.6 liter)  | 8 quart (7.6 liter)  | 8 quart (7.6 liter)   |
| Coolant Flow Rate: 60 Hz<br>50 Hz   | 14.0 gpm (53.0 liter/min)<br>10.0 gpm (37.9 liter/min)                                       | 14.0 gpm (53.0 liter/min)<br>10.0 gpm (37.9 liter/min))                                      | 14.0 gpm (53.0 liter/min)<br>10.0 gpm (37.9 liter/min)  |
| Raw Water Flow Rate: 60 Hz<br>50 Hz   | 9.0 gpm (34.1 liter/min)<br>7.0 gpm (26.5 liter/min)   | 9.0 gpm (34.1 liter/min)<br>7.0 gpm (26.5 liter/min)   | 9.0 gpm (34.1 liter/min)<br>7.0 gpm (26.5 liter/min)  |
| Combustion Air Flow: 60 Hz<br>50 Hz   | 52 cfm (1.45 m <sup>3</sup> /min)<br>42 cfm (1.21 m <sup>3</sup> /min)                       | 60 cfm (1.72 m <sup>3</sup> /min)<br>50 cfm (1.43 m <sup>3</sup> /min))                      | 41 cfm (1.16 m <sup>3</sup> /min)<br>34 cfm (0.96 m <sup>3</sup> /min)                        |
| Heat Rejection to Ambient: 60 Hz<br>50 Hz   | Btu/min ( kcal/min)<br>Btu/min ( kcal/min)   | Btu/min (kcal/min)<br>Btu/min (kcal/min)   | Btu/min (kcal/min)<br>Btu/min (kcal/min)  |
| <b>CONNECTIONS:</b>   |  |  |   |
| Max Fuel Pump Lift  | 4 ft (1.2 m)   | 4 ft (1.2 m)   | 4 ft (1.2 m)  |
| Fuel Supply   | 1/4 NPT female   | 1/4 NPT female   | 1/4 NPT female  |
| Fuel Return   | 1/4 NPT female   | 1/4 NPT female   | 1/4 NPT female  |
| Max Raw Water Pump Lift   | 4 ft (1.22 m)  | 4 ft (1.22 m)  | 4 ft (1.22 m)   |
| Raw Water Inlet   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose  |
| Wet Exhaust Outlet  | 2 in (50.8 mm) ID Hose   | 2 in (50.8 mm) ID Hose   | 2 in (50.8 mm) ID Hose  |
| Max Exhaust Back Pressure   | 3 in (76 mm) Hg  | 3 in (76 mm) Hg  | 3 in (76 mm) Hg   |
| <b>KEEL COOLING AND DRY EXHAUST:</b>  |  |  |   |
| Coolant Inlet & Outlet  | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose   | 1 in (25.4 mm) ID Hose  |
| Max Coolant Friction Head   | 1 psi (6.9 kPa)  | 1 psi (6.9 kPa)  | 1 psi (6.9 kPa)   |
| Heat Rejection to Coolant: 60 Hz<br>50 Hz   | Btu/min ( kcal/min)<br>Btu/min ( kcal/min)   | Btu/min (kcal/min)<br>Btu/min (kcal/min)   | Btu/min (kcal/min)<br>Btu/min (kcal/min)  |
| Dry Exhaust Outlet  | 1-1/2 NPT  | 1-1/2 NPT  | 1-1/2 NPT   |
| Max Exhaust Back Pressure   | 3 in (76 mm) Hg  | 3 in (76 mm) Hg  | 3 in (76 mm) Hg   |
| <b>BATTERIES:</b>   |  |  |   |
| Nominal Battery Voltage   | 12 volts*  | 12 volts*  | 12 volts*   |
| Min CCA Rating - SAE @ 32° F (0° C)   | 500 amps   | 625 amps   | 625 amps  |
| Battery Charging  | 5 amps   | 5 amps   | 5 amps  |
| <b>SIZE, WEIGHT, NOISE:</b>   |  |  |   |
| Without Enclosure<br>Dry Weight<br>Dimensions: L x W x H  | 830 lbs (377 kg)<br>44.4 x 23.7 x 26.1 in<br>(1127 x 602 x 663 mm)                           | 870 lbs (375 kg)<br>44.4 x 23.7 x 26.1 in<br>(1127 x 602 x 663 mm)                           | 1090 lbs (494 kg)<br>53.5 x 23.7 x 28.8 in<br>(1358 x 602 x 732 mm)                           |
| With Enclosure<br>Noise<br>Dry Weight<br>Dimensions: L x W x H  | 67/64 dB(A) @ 60/50 HZ<br>890 lbs (404 kg)<br>44.4 x 23.7 x 27.5 in<br>(1127 x 602 x 698 mm) | 67/64 dB(A) @ 60/50 HZ<br>930 lbs (422 kg)<br>44.4 x 23.7 x 27.5 in<br>(1127 x 602 x 698 mm) | 67/66 dB(A) @ 60/50 HZ<br>1175 lbs (533 kg)<br>53.5 x 23.7 x 30.0 in<br>(1358 x 602 x 763 mm) |
| * - 24 volts optional   |  |  |   |

## 2. Operation

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### CONTROL PANEL

#### Genset (Local) Control Panel

The control panel is located in the front, upper left hand corner of the genset (Figure 2-1).

**Control Switch** - This switch is used to prime the fuel system, start and stop the genset and display the shutdown codes.

- Hold the switch in its **START** position to pre-heat, crank and start the genset. (Preheat is the period of time prior to engine cranking when the glow plugs preheat the combustion chambers. The time is automatically varied by the genset controller on the basis of engine temperature.)
- Press the switch to its **STOP/PRIME** position to stop the genset.
- Hold the switch in its **STOP/PRIME** position to prime the fuel system (starts in 2 seconds).
- See *Troubleshooting* (Page 7-1) about displaying the shutdown codes.

**Status Indicator Lamps**- There are two LED (light emitting diode) lamps in the control switch. The *amber* status lamp lights during priming, blinks rapidly during pre-heat and cranking and goes out when the engine is up to speed. If the genset shuts down abnormally, this lamp will slowly blink a code to indicate the cause of shutdown. See *Troubleshooting* (Page 7-1). The *green* status lamp lights

after the starter disconnects and the engine is up to speed and stays on while the genset runs.

**Emergency Stop Switch** - In an emergency push **OFF**. Push **ON** after all necessary repairs to genset and connected equipment have been made.

**DC Circuit Breaker** - This circuit breaker protects the DC control circuits of the genset from short circuits. Push the handle left to reset after all necessary repairs have been made to the genset.

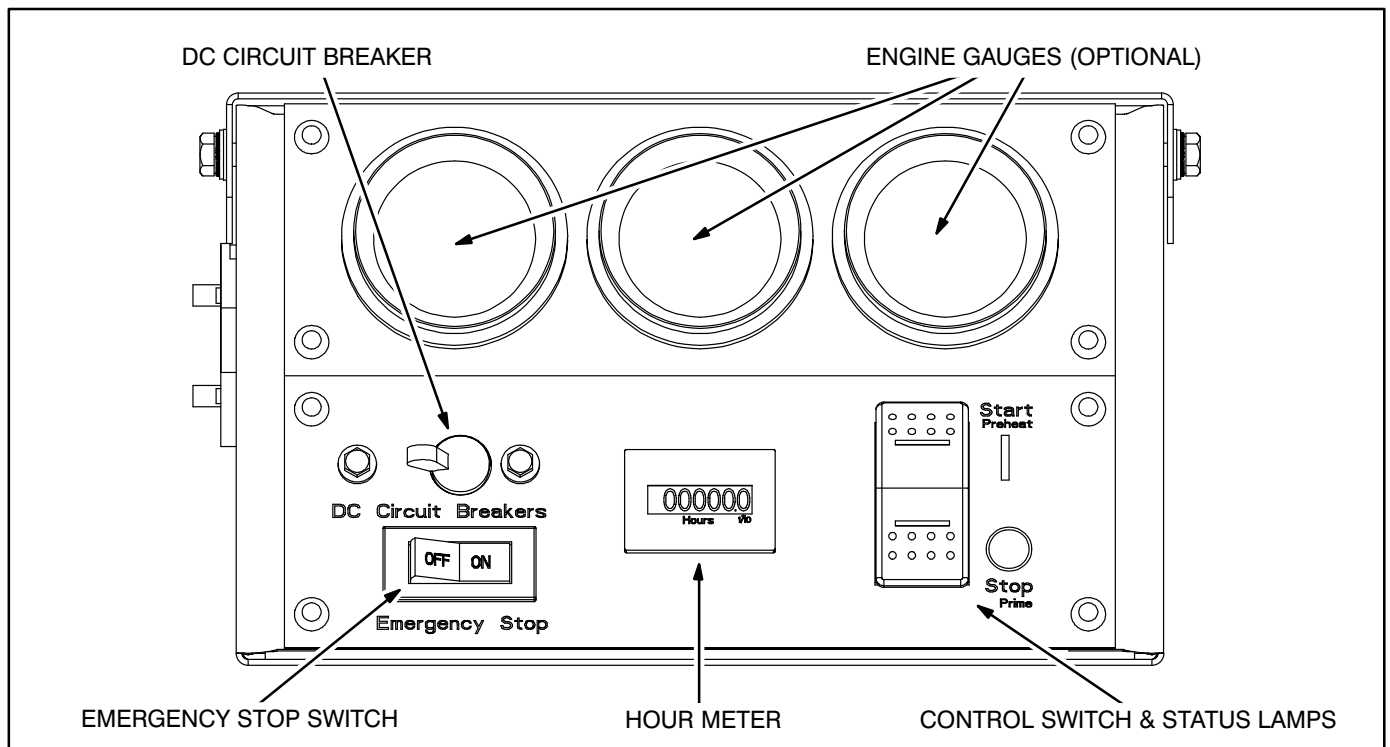
**Hour Meter** - The hour meter records genset operating time in hours. It cannot be reset.

**Engine Gauges (Optional)**- These gauges monitor engine oil pressure, coolant temperature and battery voltage. They have green, yellow and red LEDs. GREEN indicates normal operation. YELLOW and RED warn of abnormal engine conditions requiring maintenance or service. RED is more severe than YELLOW. See *Periodic Maintenance* (Page 3-1).

**Line Circuit Breaker** - The line circuit breaker protects the AC power leads connected to the genset from overloads and equipment short circuits.

#### Remote Control Panel

The boat probably has one or two remote control panels for starting and operating the genset. The gauges on Onan-supplied remote panels are like the ones on the genset.



**FIGURE 2-1. GENSET CONTROL PANEL**

## **⚠WARNING** EXHAUST GAS IS DEADLY!

*Engine exhaust contains carbon monoxide, a poisonous, odorless and colorless gas that can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:*

- Dizziness
- Throbbing in Temples
- Nausea
- Muscular Twitching
- Headache
- Vomiting
- Weakness
- Trouble Thinking Clearly
- Sleepiness

**GET EVERYONE OUT INTO FRESH AIR IMMEDIATELY IF ANYONE EXPERIENCES ANY OF THESE SYMPTOMS. Seek medical attention if symptoms persist. Never sleep in the boat when the genset is running unless the cabin has a working carbon monoxide detector.**

**Look over the entire exhaust system and listen for leaks every time you start up the genset and after every eight hours of operation. Shut down the genset immediately if there is a leak. Do not run the genset until the leak has been repaired. The exhaust system must be installed in accordance with the genset Installation Manual.**

## **STARTING AND STOPPING THE GENSET**

### **Pre-Start Checks**

Conduct general inspections (Page 3-2) before the first start of the day and after every eight hours of operation. Perform periodic maintenance that may be due and maintenance required to return the genset to service if the boat has been in storage (Page 2-5). Before each start:

1. Make sure all CO detectors on board are working properly.
2. Check for swimmers that might be exposed to the engine exhaust.
3. Turn off air conditioners and other large appliances.

### **Priming the Fuel System**

If the genset ran out of fuel, prime the fuel system by holding the control switch at **STOP/PRIME** for 30 seconds. (The *amber* status lamp will light.)

### **Starting the Genset**

1. Push and hold the control switch at **START** until the genset starts. The *amber* status lamp will blink rapidly. The *amber* status lamp will go out and the *green* status lamp will light when the engine is up to speed. (Depending on how cold the engine is, preheat can take up to 15 seconds before cranking starts.)
2. For longer engine life, let the engine warm up for two minutes before turning on air conditioners and other large appliances.

3. Check for water, coolant, fuel and exhaust leaks. Stop the genset immediately if there is a leak. Repair fuel leaks immediately.
4. Monitor the engine gauges if so equipped. Perform maintenance or service as necessary if a gauge indicates an abnormal engine condition. See *Periodic Maintenance* (Page 3-1).
5. **If the genset fails to start**, cranking will discontinue in 20 to 60 seconds, depending on how cold the engine is, and the *amber* status lamp will blink Shutdown Code No. 4 (Page 7-5). See *Troubleshooting* (Page 7-1) if the genset does not start after two or three tries.

**⚠CAUTION** *Do not continue cranking and risk burning out the starter or flooding the engine (exhaust flow during cranking is too low to expel water from the exhaust system). Find out why the genset does not start and make necessary repairs.*

6. **If the genset shuts down**, the *amber* status lamp will blink one of the shutdown codes. See *Troubleshooting* (Page 7-1).

### **Stopping the Genset**

Turn off air conditioners and other large appliances and let the genset run for two minutes to cool down. Then touch the Control Switch to **STOP(Prime)**.

### **Emergency Stop**

Push the **EMERGENCY STOP SWITCH** to **STOP** (Page 2-2). After all necessary repairs have been made, push the switch to **ON** so that the genset can be operated.

## OPERATION

### Resetting Circuit Breakers

If a circuit breaker in the main power distribution panel of the boat or on the genset (Figure 2-2) trips, either a circuit shorted or too many appliances were running. Note that the genset may continue to run after a circuit breaker trips.

If a circuit breaker trips, disconnect or turn off all connected loads and reset the circuit breaker. (Push the circuit breaker to **OFF** to reset it and then to **ON** to reconnect the circuit.) If the circuit breaker trips right away, either the electrical distribution system has a short circuit or the circuit breaker is faulty. Call a qualified electrician.

If the circuit breaker does not trip, reconnect or turn on appliances one by one up to a total load that does not exceed genset or circuit breaker rating. If a circuit breaker trips right away when an appliance is connected, that appliance probably has a short.

### Connecting Shore Power

If the boat has provisions for connecting shore power, it must also have an approved device to keep the genset and shore power from being interconnected.

**⚠ WARNING** *Backfeed to shore power can cause electric shock resulting in severe personal injury or death and damage to equipment. The boat must have an approved device to prevent the genset from being interconnected with shore power.*

### New or Re-Built Engine Care

Change the oil and oil filter after the first 50 hours of operation with a new or re-built engine (Page 3-3).

### No-Load Operation

**Keep no-load operation to a minimum.** During no-load operation cylinder temperatures drop to the point where fuel does not burn completely, causing fuel wetting and white smoke. It is best to run the genset at 1/4 to 3/4 load.

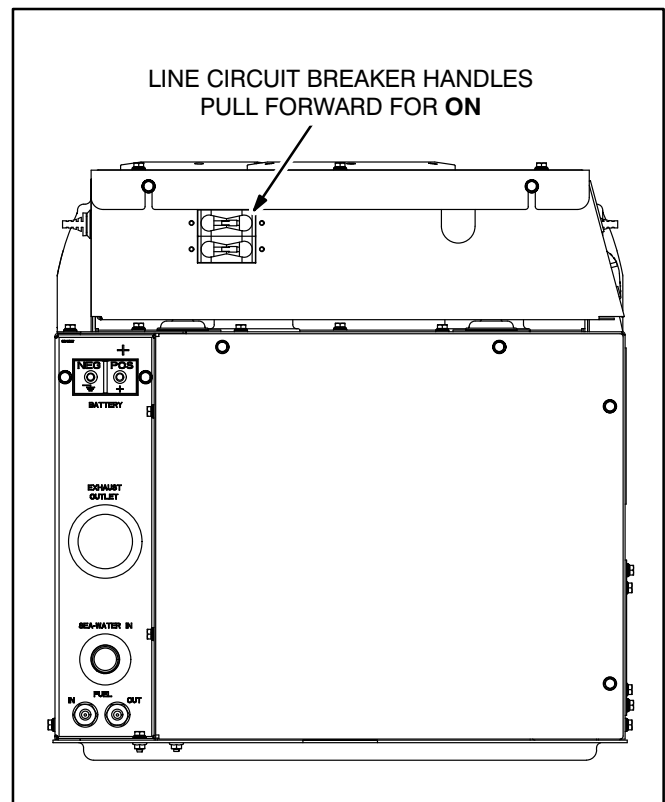


FIGURE 2-2. LINE CIRCUIT BREAKER

## Exercising the Genset

Exercise the genset at least 1 hour every month if use is infrequent. Run the genset at 1/4 to 3/4 load. A single exercise period is better than several shorter periods. Exercising a genset drives off moisture, re-lubricates the engine, uses up fuel before it becomes stale and removes oxides from electrical contacts and generator slip rings. The result is better starting, more reliable operation and longer engine life.

## Cold Temperature Operation

Do not let raw water freeze in the heat exchanger (Page 3-8) during cold weather when the genset is not operating. Freezing water can damage the raw water tubes in the heat exchanger. Engine coolant, but not raw water, is protected from freezing. Drain the heat exchanger if there is a danger of freezing.

## Storing the Genset

**Storing the Genset:** Proper storage is essential for preserving top genset performance and reliability when the genset will be idle for more than 120 days.

1. Change the engine oil (Page 3-3) and attach a tag indicating viscosity grade (Page 1-2).
2. Disconnect the battery cables (negative [-] first) from the battery (Page 3-6). Follow the

manufacturer's recommendations when storing the battery.

**⚠WARNING** *Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.*

3. Check coolant level and add as necessary (Page 3-7). Test the coolant mixture if freezing temperatures are possible and change if necessary.
4. If freezing temperatures are expected, drain the heat exchanger (Page 3-8), hoses and muffler to prevent damage from freezing water.
5. Clean and lightly oil parts that can rust.

## Returning the Genset to Service:

1. Check the oil tag on the genset and change the oil (Page 3-3) if the viscosity is not appropriate for the temperatures expected (Page 1-2).
2. Reconnect the battery cables (negative [-] last) (Page 3-6).
3. Replace the raw water pump impeller if it was installed more than a year ago (Page 3-12).
4. Perform the maintenance required (Page 3-1), conduct the pre-start checks (Page 2-3) and prime the fuel system (Page 2-3).
5. Start and run the genset (Page 2-3).



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# 3. Periodic Maintenance

Periodic maintenance is essential for good performance and long genset life. Use Table 3-1 as a guide for normal periodic maintenance.

Maintenance, replacement or repair of emission control devices and systems may be performed by any engine repair establishment or individual. How-

ever, warranty work must be completed by an authorized Onan dealer.

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent starting while working on the genset.*

**TABLE 3-1. PERIODIC MAINTENANCE SCHEDULE**

| PROCEDURE   | FREQUENCY          |                  |                      |                     |                     |                |               |                         |         |
|---|--------------------|------------------|----------------------|---------------------|---------------------|----------------|---------------|-------------------------|---------|
|   | After first 50 Hrs | Every Day/ 8 Hrs | Every Month/ 100 Hrs | Every Year/ 200 Hrs | Every Year/ 500 Hrs | Every 800 Hrs  | Every 2 years | Every 5 years/ 2000 Hrs | P a g e |
| General Inspection <sup>1</sup>   |                    | x                |                      |                     |                     |                |               |                         | 3-2     |
| Check Engine Oil Level  |                    | x                |                      |                     |                     |                |               |                         | 3-3     |
| Check Battery   |                    |                  | x <sup>2</sup>       |                     |                     |                |               |                         | 3-6     |
| Check V-Belt Tension  |                    |                  | x <sup>3</sup>       |                     |                     |                |               |                         | 3-11    |
| Drain Water in Fuel   |                    |                  | x                    |                     |                     |                |               |                         | 3-5     |
| Check Siphon Break  |                    |                  | x                    |                     |                     |                |               |                         | 3-10    |
| Change Oil & Oil Filter   | x                  |                  |                      | x                   |                     |                |               |                         | 3-3     |
| Change Fuel Filter  |                    |                  |                      |                     | x                   |                |               |                         | 3-5     |
| Replace Raw Water Impeller  |                    |                  |                      |                     | x                   |                |               |                         | 3-12    |
| Replace Zinc Anode  |                    |                  |                      |                     | x                   |                |               |                         | 3-12    |
| Adjust Valve Lash   |                    |                  |                      |                     |                     | x <sup>4</sup> |               |                         | -       |
| Change Coolant, Pressure Cap & Thermostat   |                    |                  |                      |                     |                     |                | x             |                         | 3-7     |
| Check Generator Bearing   |                    |                  |                      |                     |                     |                |               | x <sup>4</sup>          | -       |
| 1 - Includes Oil Level, Coolant Level, Fuel System, Exhaust System and Battery Checks.<br>2 - See battery manufacturer's recommendations.<br>3 - Check for slippage, cracking and wear.<br>4 - Must be performed by a trained and experienced mechanic (authorized Onan dealer) in accordance with the engine and genset Service Manuals. |                    |                  |                      |                     |                     |                |               |                         |         |

## GENERAL INSPECTION

Inspect the genset before the first start of the day and after every eight hours of operation.

### Oil Level

Check engine oil level (Page 3-3).

### Exhaust System

Inspect the exhaust system for leaks and loose hose clamps at the exhaust manifold, exhaust elbow, muffler, water separator and hull fittings. Replace damaged sections of exhaust hose.

Check that all CO monitors are working properly.

**⚠WARNING** ***EXHAUST GAS IS DEADLY! Do not operate the genset until all exhaust leaks have been repaired.***

### Fuel System

Check for leaks at hose, tube and pipe fittings in the fuel supply and return systems while the genset is running and while it is stopped. Check flexible fuel hose for cuts, cracks, abrasions and loose hose clamps. Make sure fuel lines do not rub against other parts. Replace worn or damaged fuel line parts before leaks occur. Replace hose with USCG TYPE A1 or ISO 7840-A1 fuel hose.

**⚠WARNING** ***Fuel leaks can lead to fire. Repair leaks immediately. Do not run the genset if it causes fuel to leak.***

Prime the fuel system (Page 2-3) if the genset ran out of fuel.

### Coolant Level Check

Keep the level of coolant in the recovery tank between COLD and HOT. The recovery tank is de-

signed to maintain coolant level; not to fill the system. If the tank is empty, check for and repair any coolant leaks and refill the system through the fill neck on the engine. Then refill the recovery tank up to the COLD mark. Use the recommended mixture of antifreeze.

### Raw Water System

Clean out the sea water strainer if necessary and make sure the sea cock is open for genset operation. Also, when a water/exhaust separator is provided (see Installation Manual), open the sea cock for the water drain hose.

Check for and replace hoses that leak or are damaged.

### Battery Connections

Check the battery terminals and keep them clean and tight (Page 3-6). Loose or corroded terminals have high electrical resistance, which can cause hard starting and short starter life.

### Mechanical

Look for mechanical damage. Start the genset and look and listen for any unusual noises and vibrations.

Check the genset mounting bolts to make sure they are secure.

Check to see that the genset air inlet and outlet openings are not clogged with debris or blocked. Keep the genset and generator compartment clean.

Monitor the engine gauges, if so equipped, whenever the genset is running.

## CHECKING ENGINE OIL LEVEL

**⚠WARNING** *Crankcase pressure can blow hot engine oil out the fill opening causing severe burns. Always stop the genset before removing the oil fill plug.*

Shut off the genset before checking engine oil level and remove the access door if the genset has an enclosure.

1. Remove, wipe off and reinsert the oil level dipstick (Figure 3-1 or 3-2). Remove the dipstick again and check the oil level.
2. Add or drain oil as necessary. See ENGINE OIL RECOMMENDATIONS (Page 1-2). Keep the oil level between the high and low marks on the end of the dipstick. It is not necessary to add oil between oil changes if the oil has not dropped more than 1/3 of the way between the high and low marks. A full quart (0.9 liter) can be added if the oil level is at the lower mark.

**⚠CAUTION** *Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the high and low beads on the dipstick.*

3. Secure the maintenance access door if the genset has an enclosure.

## CHANGING ENGINE OIL AND FILTER

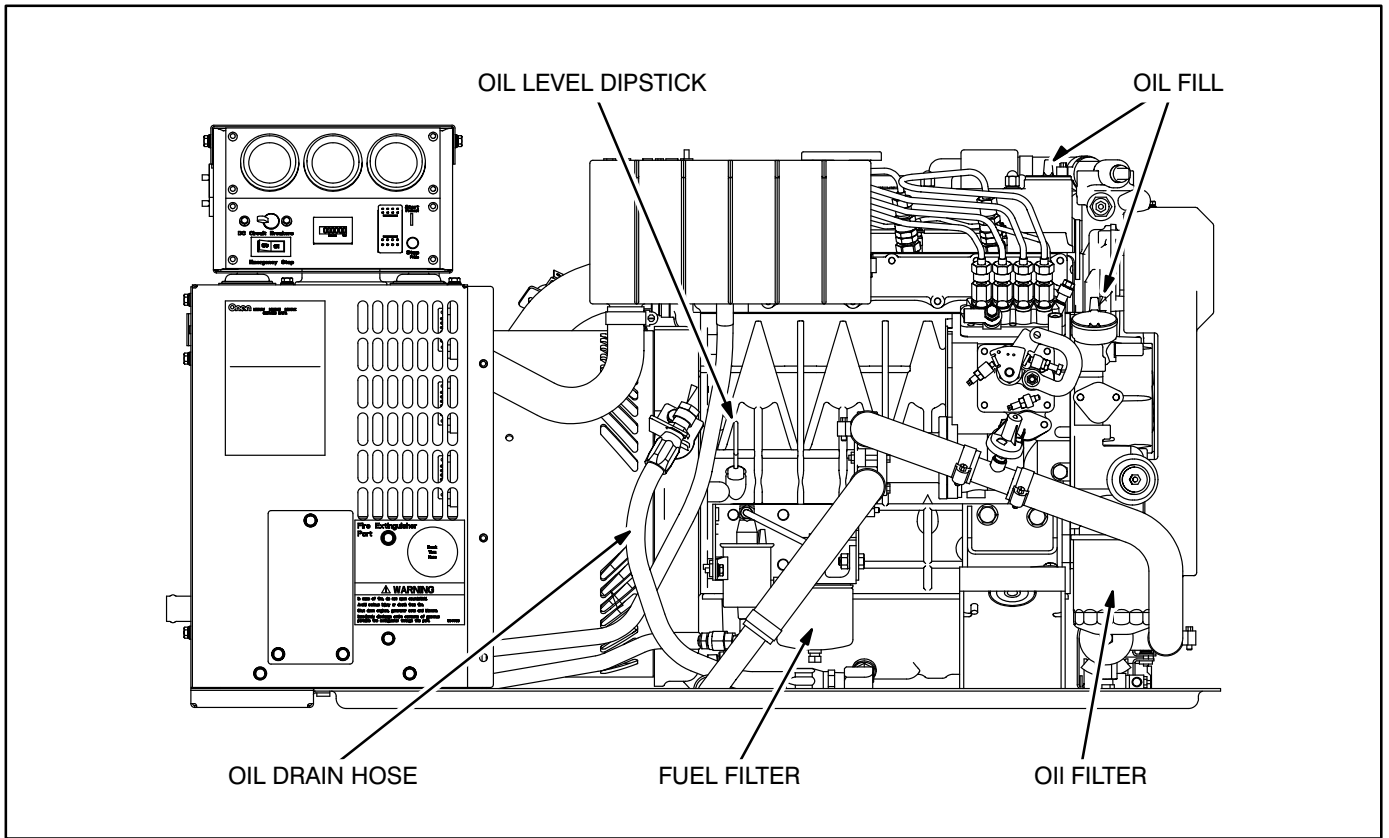
**⚠WARNING** *U. S. state and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Avoid skin contact and breathing of vapors. Use rubber gloves and wash exposed skin.*

See Table 3-1 for scheduled oil change.

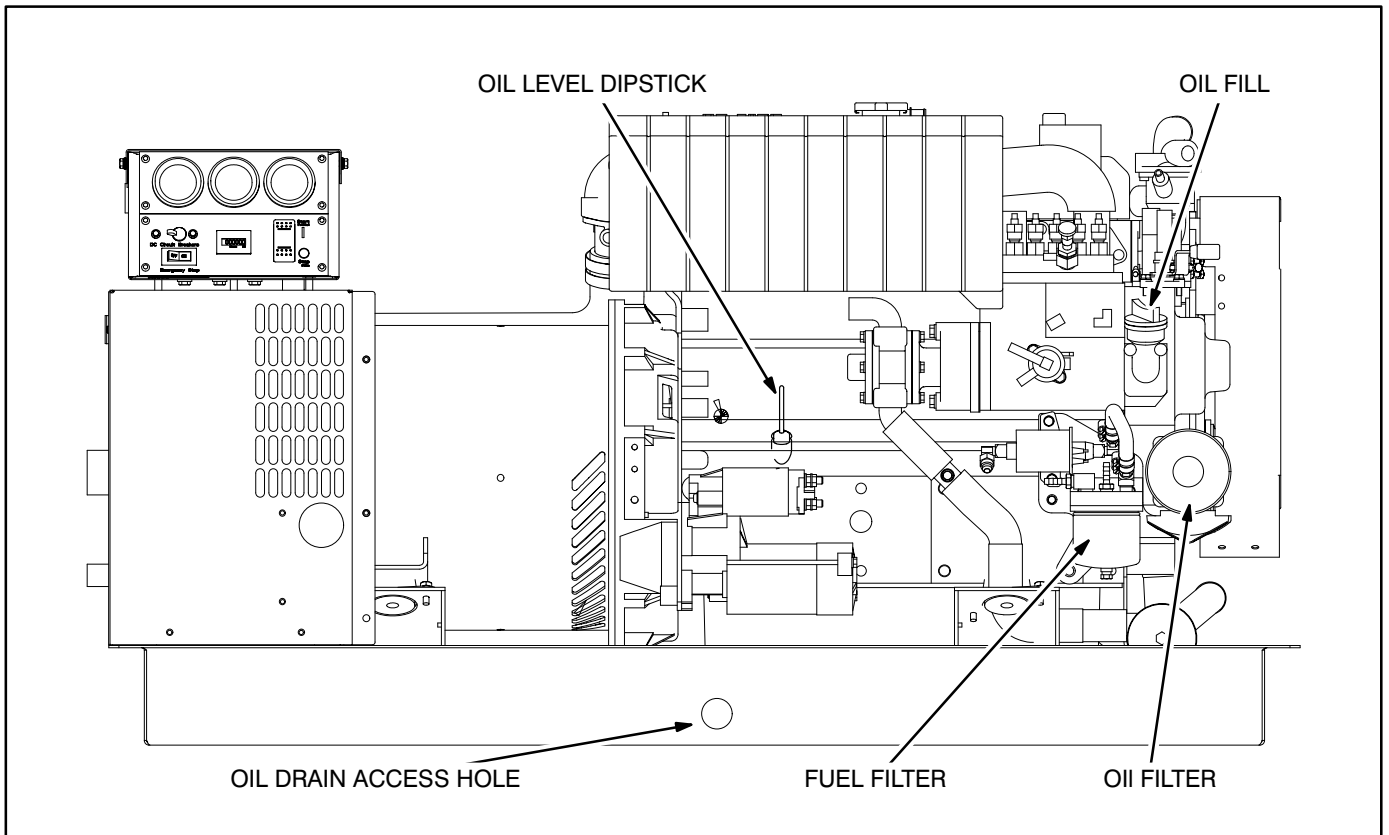
1. Run the genset under load until it is up to operating temperature, stop it and disconnect the negative (-) battery cable at the battery.

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.*

2. Remove the access door if the genset has an enclosure. Unscrew the plug on the end of the drain hose (Figure 3-1 or 3-2) and drain the oil into a suitable container. (Two wrenches are necessary to keep from twisting the hose when loosening and tightening the plug.) If an oil pump-out system is installed, follow the instructions provided.
3. Secure the oil drain plug in the end of the hose and secure the hose in its hanger.
4. Spin off the old oil filter (Figure 3-1 or 3-2) and wipe off the filter mounting surface. (A filter wrench is available from Onan.) Remove the old gasket if it does not come off with the filter.
5. Apply a film of oil to the filter gasket and partly fill the filter with oil so that it reaches engine parts sooner at startup. Spin the new filter on by hand until the gasket just touches the mounting pad and tighten 3/4 turn.
6. Refill with the proper type (Page 1-2) and amount (Page 1-2) of engine oil and check the level (see CHECKING ENGINE OIL LEVEL).
7. Secure the access door if the genset has an enclosure.
8. Dispose of the used oil and oil filter in accordance with local environmental regulations.



**FIGURE 3-1. OIL AND FUEL SERVICE POINTS—MDKAV, MDKBG, MDKAW, MDKAZ**



**FIGURE 3-2. OIL AND FUEL SERVICE POINTS—MDKBD, MDKBE, MDKBF**

## DRAINING / CHANGING FUEL FILTER

**⚠WARNING** *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.*

**Fuel Handling Precautions:** Keep dirt, water and other contaminants from entering the fuel system and corroding or clogging fuel injection components. The genset has a water separator type of fuel filter (Figure 3-1 or 3-2). The fuel supply system should also have a water separator and filter.

Humid air condenses on the walls of fuel tanks and is the primary source of water in fuel. Water clogs fuel passages by freezing and causes corrosion by forming sulfuric acid with the sulfur in the fuel. Keeping fuel tanks full reduces condensation by reducing the area on which condensation can take place.

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.*

**Draining Water and Sediment:** Drain water and sediment more often than scheduled (Table 3-1) if fuel quality is poor or condensation cannot be avoided.

1. Disconnect the negative (-) cable at the battery to prevent the engine from starting and close

the fuel supply valve, if provided, to prevent loss of prime.

2. Remove the maintenance access door if the genset has an enclosure. Drain the filter (about 1/2 cup [120 ml]) into a suitable container by removing the drain plug (bottom of filter).
3. *Re-install the drain plug* and dispose of the drain-off in accordance with local environmental regulations.
4. Secure the maintenance access door if the genset has an enclosure.

**Changing Fuel Filter:** See Table 3-1 for scheduled change. Change the filter if the engine lacks power.

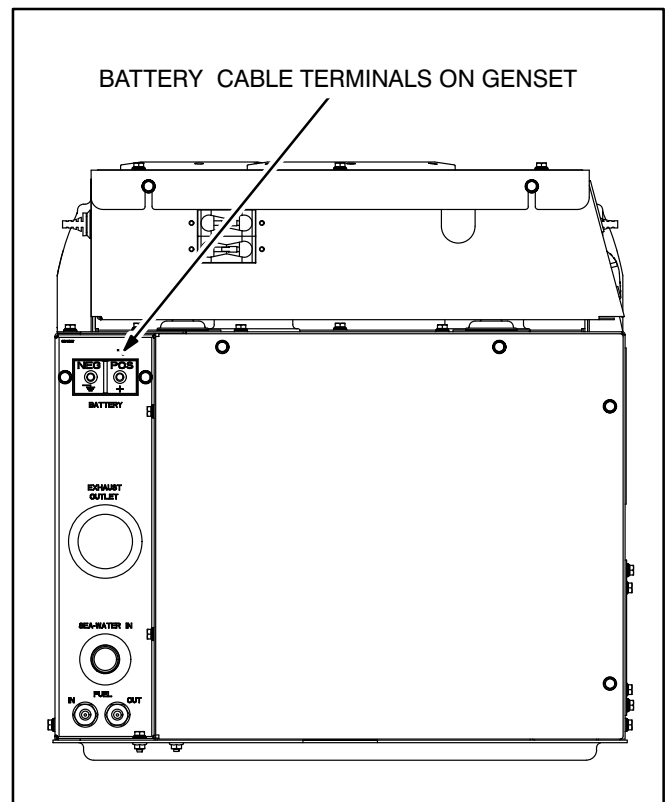
1. Disconnect the negative (-) cable at the battery to prevent the engine from starting and close the fuel supply valve, if provided, to prevent loss of prime.
2. Remove the maintenance access door if the genset has an enclosure. Spin off the old filter and dispose of it in accordance with local environmental regulations.
3. Clean the contact surface on the filter base, lubricate the new filter gasket and spin the new filter on hand tight.
4. Prime the engine for at least 30 seconds (Page 2-3) to fill the new filter. Run the genset and check for leaks. Tighten the filter by hand, if necessary.
5. Secure the maintenance access door if the genset has an enclosure.

## MAINTAINING BATTERY AND BATTERY CONNECTIONS

**⚠ WARNING** *Flames, sparks or arcing at battery terminals, light switches or other equipment can ignite battery gas causing severe personal injury — Ventilate the battery area before working on or near the battery — Wear safety glasses — Do not smoke — Switch a work lamp ON and OFF away from the battery — Do not disconnect the battery cables while the genset is running or a battery charger is on — Always disconnect the negative (-) cable first and reconnect it last.*

See Table 3-1 for scheduled maintenance. Follow the battery manufacturer's instructions. Have the battery charging system serviced if DC system voltage is consistently low or high. Always:

1. Keep the battery case, terminals and cables clean and dry and the terminals tight at the battery and at the genset (Figure 3-3).
2. Remove battery cables with a battery terminal puller.
3. Make sure which terminal is positive (+) and which is negative (-) before making battery connections. Always remove the negative (-) cable first and reconnecting it last to reduce arcing.
4. Follow the manufacturer's recommendations when storing the battery. Disconnect the battery so that it does not discharge through the genset control during storage.



**FIGURE 3-3. BATTERY CABLE TERMINALS**

## ENGINE COOLING SYSTEM

### Cooling System Overview

The engine is cooled by a pressurized, closed-loop liquid cooling system (Figure 3-4 or 3-5). Coolant is pumped through passages in the engine block, head and exhaust manifold by a belt-driven pump and is cooled in a heat exchanger mounted on the base pan or in a keel cooler. The exhaust manifold also serves as the engine coolant reservoir.

If the genset has a heat exchanger and/or exhaust-water mixer, the engine is equipped with a gear-driven raw water pump. The raw water cools the heat exchanger and/or exhaust gases and exits the boat through the exhaust system.

### Recommended Coolant Mixture

Use the best quality ethylene glycol antifreeze solution available. It should be fully formulated with rust inhibitors and coolant stabilizers. Use fresh water that is low in minerals and corrosive chemicals. Distilled water is best. Unless prohibited by shipping regulations, the genset is shipped with the recommended 50/50 mixture of water and ethylene glycol, which is good for -34° F (-37° C). See *Specifications* regarding coolant capacity.

**⚠ WARNING** *Ethylene glycol antifreeze is considered toxic. Dispose of it according to local regulations for hazardous substances.*

### Replenishing Normal Coolant Loss

Keep the level of coolant in the coolant recovery tank between COLD and HOT. The recovery tank is designed to maintain coolant level; not to fill the system. If the tank is empty, check for and repair any coolant leaks and refill the system through the fill neck on the engine. Then refill the recovery tank up to the COLD mark. Use the recommended coolant mixture.

### Changing Coolant

See Table 3-1 for scheduled change of coolant.

**Draining the System:** Have towels and containers ready to wipe up, collect and properly dispose of the coolant.

1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and remove the front and back access doors if the genset has an enclosure.

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable from the battery to prevent the engine from starting.*

**⚠ WARNING** *Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.*

2. Remove the coolant pressure cap.
3. Open the block and heat exchanger drain cocks (Figure 3-4) and collect the used coolant in containers for proper disposal. See the manufacturer's instructions regarding how to drain a keel cooler.

**Coolant Hoses:** Inspect and replace hoses that leak or are damaged.

**Pressure Cap:** See Table 3-1 for scheduled replacement. The pressure cap is necessary for optimal engine cooling and reduced coolant loss.

**Cleaning and Flushing the System:** Use radiator cleaning chemicals to clean and flush the cooling system before refilling with fresh coolant. Follow the cleaner manufacturer's instructions.

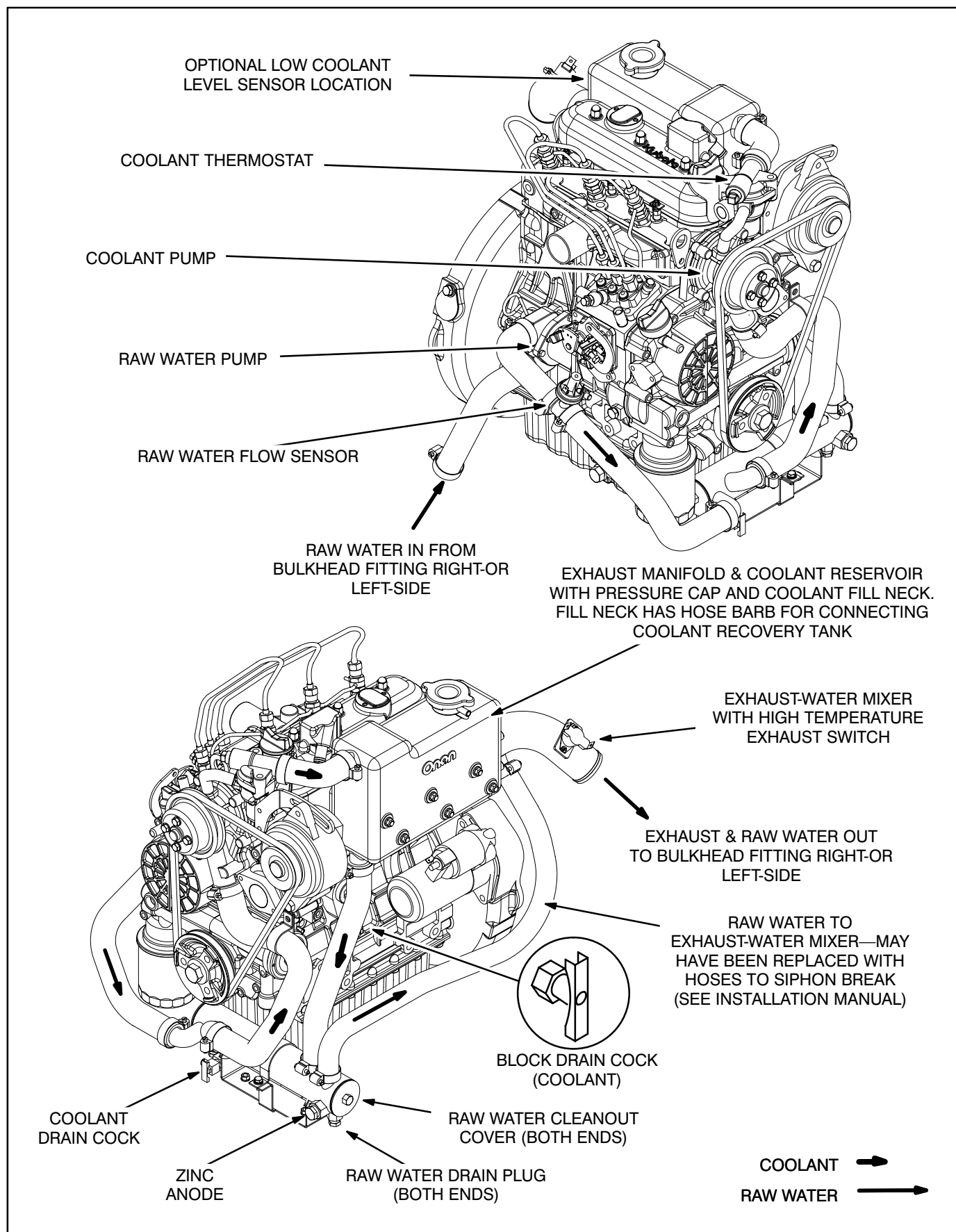
**⚠ CAUTION** *Filling a hot engine with cold water can cause cracks in the manifold, head and block. Follow the manufacturer's instructions for cleaning and flushing.*

**Filling the System:** Close the block and heat exchanger drain cocks and fill the system through the engine fill neck. The system will fill only as fast as the air can escape. Fill to the bottom of the fill neck. Start and run the engine for a couple of minutes to dislodge air pockets and shut it down. Add as much coolant as necessary and secure the pressure cap. Then refill the recovery tank up to the COLD mark.

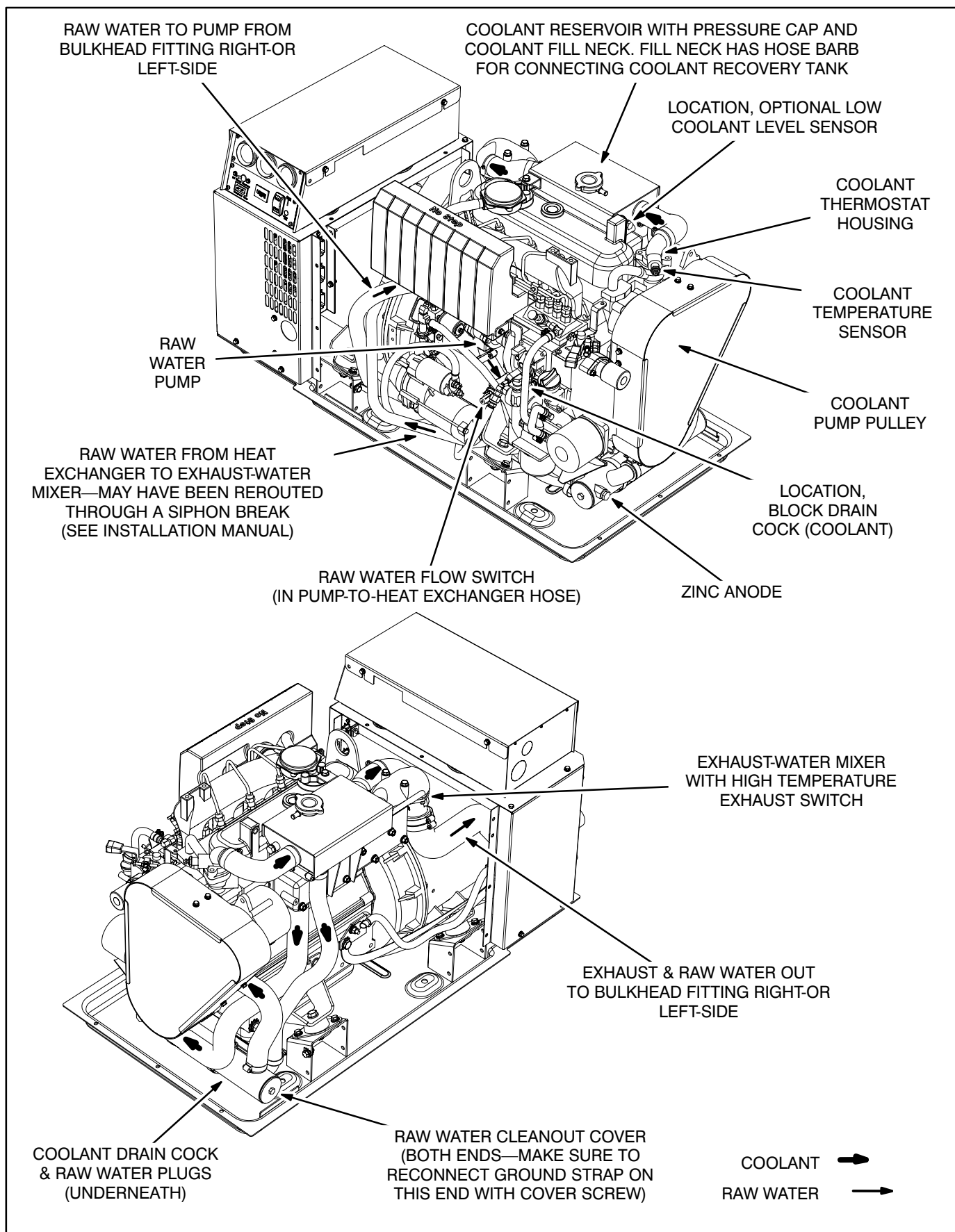
**⚠ CAUTION** *Low coolant level can cause severe engine damage. Make sure the system is full.*

Secure the access door if the genset has an enclosure.





**FIGURE 3-4. ENGINE COOLING SYSTEM—MDKAV, MDKBG, MDKAW, MDKAZ**



**FIGURE 3-5. ENGINE COOLING SYSTEM—MDKBD, MDKBE, MDKBF**

## Siphon Break

**⚠WARNING** *Bypassing a siphon break or failing to maintain it can lead to engine flooding and damage to the engine not covered under Warranty.*

See Table 3-1 for scheduled maintenance. A siphon break is installed when the exhaust-water mixer is below the water line. If of a spring-loaded valve design, check for free movement of the plunger. Replace the device if the plunger does not move freely or the body is encrusted with deposits from leakage past the valve seat. If of the bleed-vent type, check that the vent hose is properly connected on both ends. If the vent is connected to a through-hull fitting, check for normal water flow whenever the engine is running. See the Installation Manual for more information regarding siphon breaks.

## Replacing the Thermostat

See Table 3-1 for scheduled replacement. Referring to Figure 3-6, replace the thermostat as follows:

1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and remove the front and back access doors if the genset has an enclosure.

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable from the battery to prevent the engine from starting.*

**⚠WARNING** *Hot coolant is under pressure and can cause severe burns when loosening the pressure cap. Let the engine cool before loosening the pressure cap.*

2. Remove the coolant pressure cap.
3. Remove the two thermostat housing bolts and pull off the housing, thermostat and gasket. The hose does not need to come off.
4. Clean off the gasket area and install the new thermostat and gasket. Apply Three Bond 1215 liquid sealant or equivalent to the top side of the gasket.
5. Replenish any lost coolant, secure the pressure cap and any doors and panels removed and reconnect the battery cables (negative [-] last).

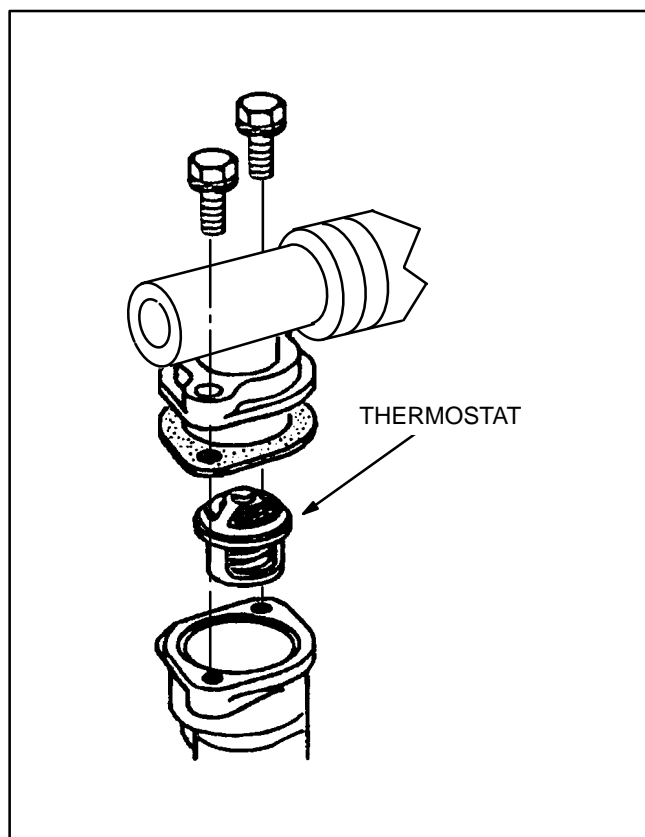


FIGURE 3-6. THERMOSTAT

## Adjusting V-Belt Tension

Referring to Figure 3-7, readjust belt tension as follows:

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.*

1. Disconnect the negative (-) cable at the battery to prevent the engine from starting.
2. Remove the belt guard or the access doors and top panel if the genset has an enclosure.
3. Loosen the alternator pivot bolt first and then the adjusting bracket bolt on top.
4. Pivot the alternator out to tighten belt tension. Hold tension by tightening the tension adjusting bolt and check it by applying 20 pounds (10 kg) to the middle of the pulley span. Belt tension is correct when deflection is 0.4 inch (10 mm). Tighten the alternator bolts when tension is correct.
5. Tighten the bolts, secure the belt guard or panels and doors and reconnect the battery cables (negative [-] last).

## Replacing the V-Belt When PTO Equipped

A special belt replacement kit must be used when the genset is equipped with a PTO. The kit includes a tool to keep the flexible coupling from twisting during assembly/disassembly. The coupling has to be disassembled so that the belt can be looped around the crank pulley. Follow the instructions in the kit.

## Heat Exchanger and Zinc Anode

Both ends of the heat exchanger (Figure 3-4) have raw water drain plugs and cleanout covers. Clean the raw water tubes if the engine keeps shutting down (Code No.1) or the engine gauge indicates abnormally high engine temperatures. Drain the heat exchanger if there is a danger of freezing when the genset is not running or is in storage. (Freezing water can damage the raw water tubes in the heat exchanger. Engine coolant, but not raw water, is protected from freezing.)

Replace the zinc anode as recommended (Table 3-1). Use thread sealant on the zinc plug and drain plugs and replace the clean out cover gaskets if the old ones are torn or otherwise damaged.

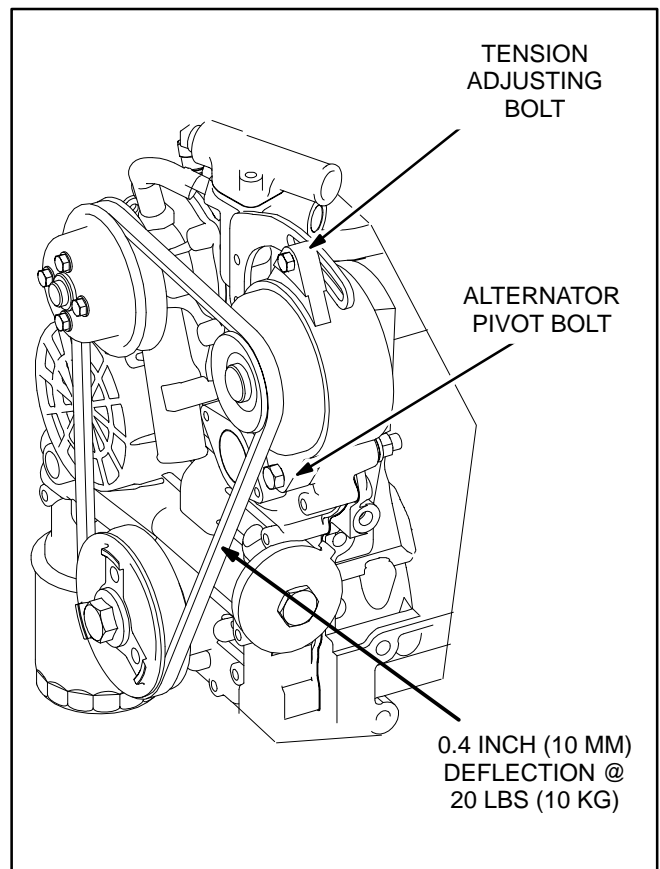


FIGURE 3-7. ADJUSTING V-BELT TENSION

## Replacing the Raw Water Pump Impeller

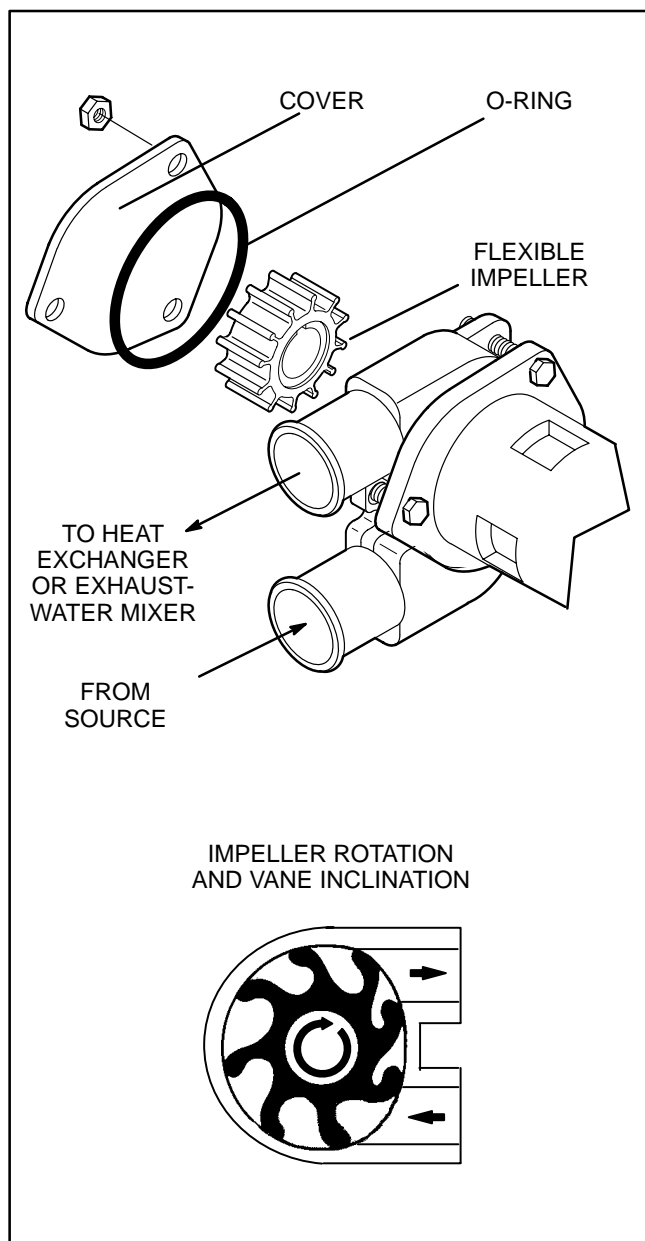
See Table 3-1 for scheduled replacement. Have towels and containers ready and avoid spilling raw water on the electrical components below the pump. Referring to Figure 3-8 replace the impeller as follows:

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Disconnect the negative (-) cable at the battery to prevent the engine from starting.*

1. Disconnect the negative (-) cable at the battery to prevent the engine from starting, let the engine cool and *close the sea cock*.
2. Remove the access door if the genset has an enclosure.
3. Remove the impeller cover and O-ring.
4. Use two pliers to grip vanes on opposite sides if the impeller is difficult to remove. *It will be necessary to check for and cleanout pieces of the impeller from the heat exchanger if vanes have broken off.*
5. Install the new impeller. It helps to twist the impeller clockwise (the way it turns) while squeezing it into the housing.
6. To provide initial lubrication and better pump suction before water reaches the pump, wet the inside of the pump and impeller with water, soap solution or a silicone lubricant and secure the O-ring and cover.

**⚠ CAUTION** *Do not lubricate with petroleum products like grease and oil which chemically attack impeller materials.*

7. If the sea water strainer is above the water line, fill it for faster prime and secure its cover.
8. Open the sea cock, reconnect the battery cables (negative [-] last) and start the genset. The genset will shut down within 16 seconds if there is no raw water flow and the *amber* status lamp will blink shutdown Code No. 7 (Page 7-6). If it shuts down, find out why, remove any blockage and restart the genset.
9. Secure the access door if the genset has an enclosure.



**FIGURE 3-8. REPLACING THE IMPELLER**

## 4. Control System

### CONTROLLER A1

Controller A1 is an integrated microcontroller-based engine and generator control. It provides all the control, monitoring and diagnostic functions required to operate the genset. It is located behind the air inlet screen on the front of the genset (Figure 4-1).

All connections to the controller are through connectors P1 (black), P2 (grey) and P3 (green). Refer to the wiring diagrams and wiring harness drawings on Pages A-1 and A-2. When removing a connector from the controller, squeeze the locking tabs on the sides while pulling it out. When reinstalling a plug, make sure the seal is in place and that the locking tabs snap into position.

### Controller Removal / Replacement

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

**All Models Except MDKBG:** Disassemble the controller as follows:

1. If the genset has an enclosure, remove the front access door and panel to the left.
2. Remove the panel on the left end of the genset.
3. Remove the screw securing the bond strap to the left side of the controller.
4. Remove the three connectors and two mounting screws on the right side of the controller and withdraw the controller out to the left.

When reassembling the controller, make sure to reconnect the electrostatic discharge bond strap.

**Model MDKBG:** Remove the four (4) screws that secure the controller enclosure to the side of the genset and pull the enclosure and controller away as an assembly. If it is necessary to remove the controller, remove the four (4) screws that secure the controller to the enclosure and disconnect the three connectors, which come out the bottom.

When reassembling the controller, make sure to reconnect the electrostatic discharge bond strap.

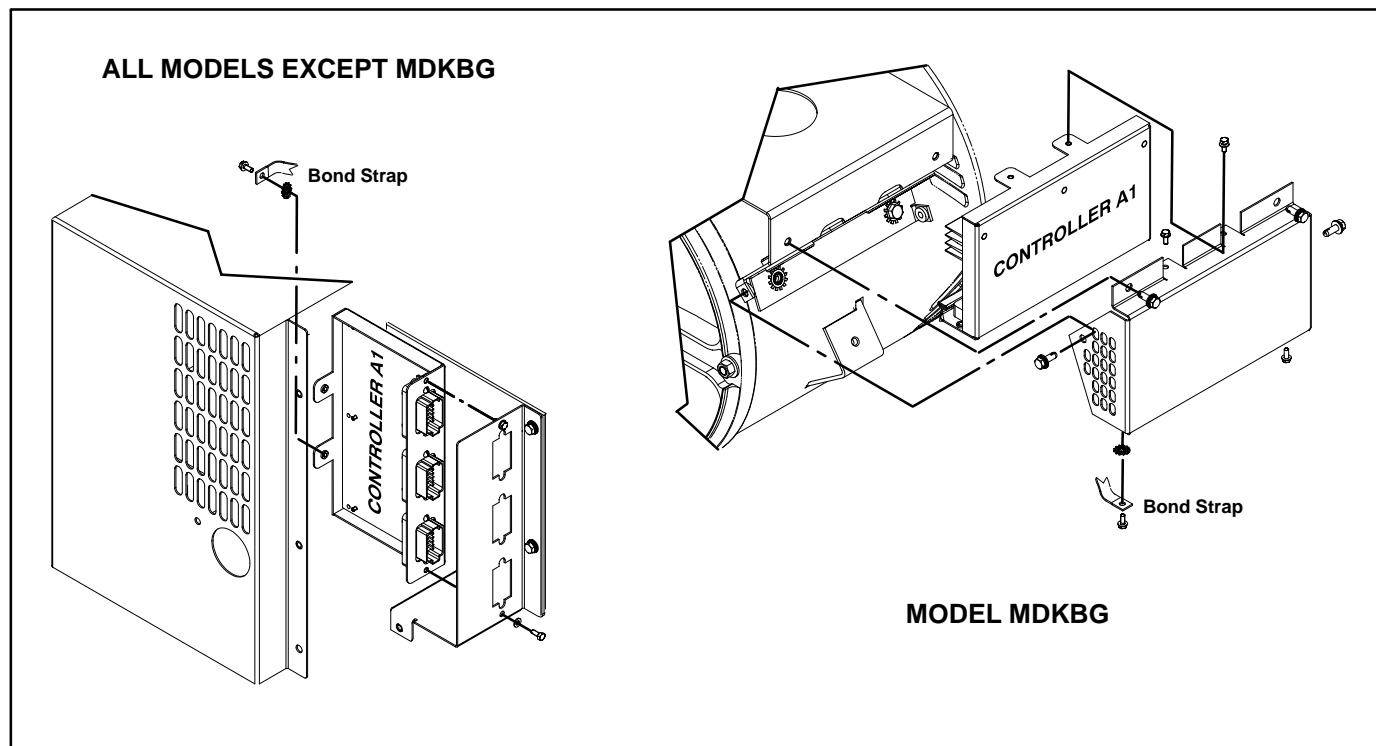


FIGURE 4-1. CONTROLLER A1 AND ITS MOUNTING

## Major Functions of Controller A1

Figure 4-2 is a block diagram of controller functions.

**Initialization:** Control initialization consists of checking memory (RAM, ROM, EEPROM) and genset configuration.

**Fuel Prime:** Press and hold the control switch at **STOP (Prime)** for more than 3 seconds to cause fuel pump E5 to prime the fuel system.

**Startup:** Press and hold the control switch at **START (Preheat)** until the genset starts. The controller:

1. Energizes fuel lift pump E5.
2. Energizes the glow plugs during pre-heat and cranking. The duration of pre-heat prior to cranking is engine temperature dependent, but does not exceed 15 seconds.
3. Enables the *amber* status lamp to blink rapidly.
4. Enables some fault detection.
5. Enables cranking. The maximum allowed duration of cranking is engine temperature dependent and varies between 20 and 60 seconds.
6. Enables field flash if no frequency pulses are present (F1-F2).
7. Energizes governor actuator A12 (full rack).
8. Disconnects the starter (B1) at 800 rpm.
9. When operating speed is reached:
  - A. Enables output voltage.
  - B. Turns off field flash.
  - C. Turns off *amber* status lamp.
  - D. Turns on *green* run lamp.

E. Enables Switched B+ (J7).

F. Enables complete fault detection.

**Stop:** Touch the control switch to **STOP (Prime)**. The controller:

1. Disables output voltage.
2. Deenergizes the fuel lift pump and governor actuator.
3. Turns off the *green* run lamp.
4. Writes session data (number of cranks, minutes of operation, last fault, etc.) to non-volatile memory (NVM).
5. Removes processor power when idle 5 minutes.

**Note:** Stop takes precedence over Start if both present due to a faulty switch or other cause.

**Voltage Control:** The controller maintains nominal AC output voltage during steady state operation by varying field current as load varies. In response to transient loads it lowers the voltage setpoint to allow engine recovery.

**Voltage Adjustments:** See ADJUSTING VOLTAGE (Page 5-8).

**Fuel Control:** The controller maintains nominal frequency as load varies by modulating the pulse width of the current energizing governor actuator A12 (Page 4-7), which moves the fuel rack.

**Frequency Adjustments:** See ADJUSTING FREQUENCY (Page 5-8).

**Fault Monitoring, Shutdown and Diagnostics:** See *Troubleshooting* (Page 7-1).

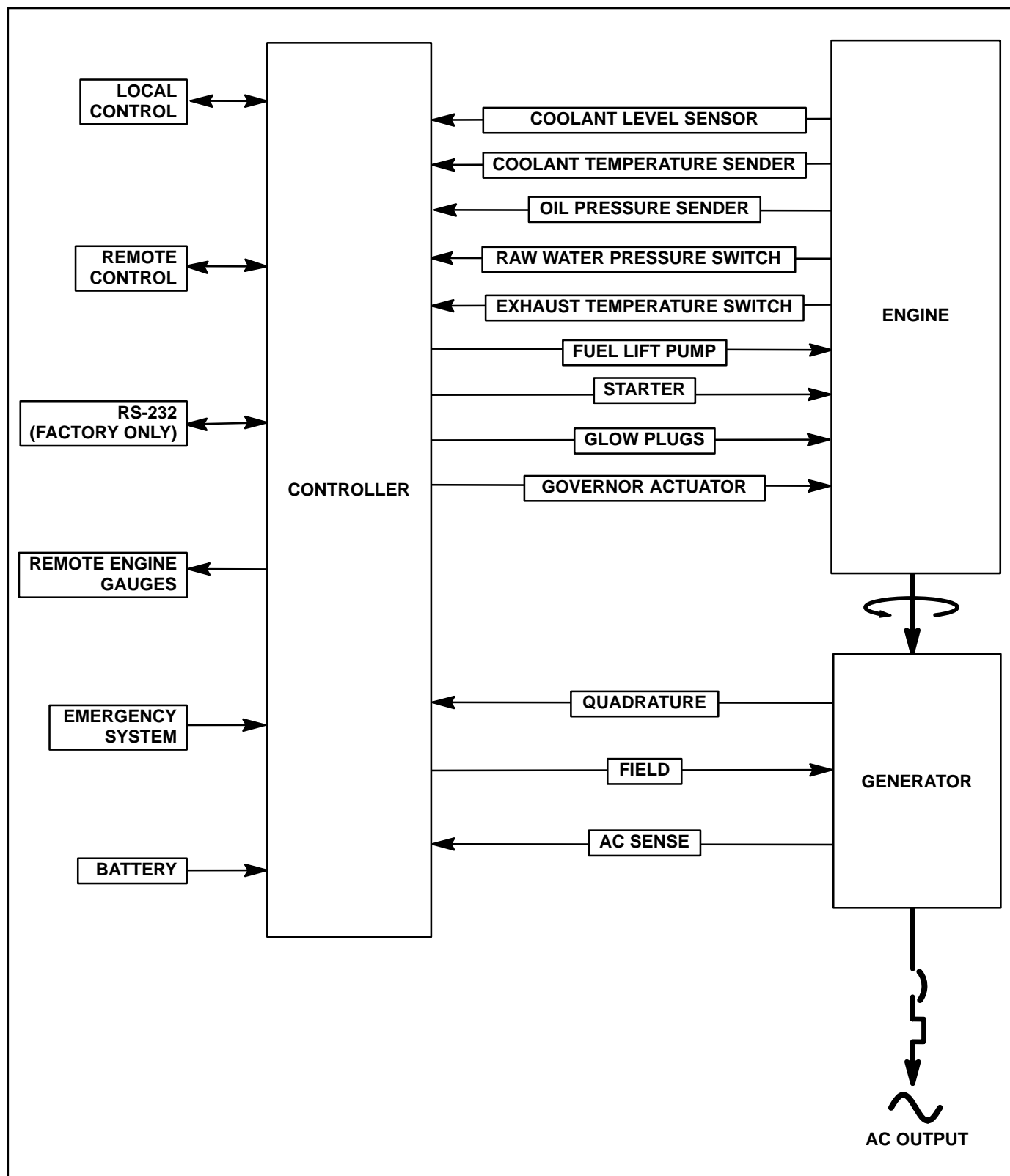


FIGURE 4-2. CONTROLLER A1 BLOCK DIAGRAM



## CONTROL SWITCH S4

The switch is mounted on the control panel (Figure 2-1). Unsnap the connector for access to its terminals. Replace the switch if **Start** does not close terminals 2 and 3, **Stop** does not close terminals 1 and 2, *Green* does not light when 12 VDC is applied across terminals 7 (-) and 8 (+), or *Amber* when 12 VDC is applied to terminals 7 (-) and 6 (+).

### EMERGENCY STOP SWITCH CB1

The switch/circuit breaker is mounted on the control panel (Figure 2-1). Disconnect the leads and check electrical continuity across the two terminals. Replace the circuit breaker if it does not reset or turn ON and OFF. For easier access to the switch terminals, push out the four plastic buttons that secure the panel and pull the panel and switch forward.

### DC CIRCUIT BREAKER CB2

The switch/circuit breaker is mounted on the control panel (Figure 2-1). Disconnect the leads and check electrical continuity across the two terminals. Replace the circuit breaker if it does not reset or turn ON and OFF. For easier access to the switch terminals, push out the four plastic buttons that secure the panel and pull the panel and switch forward.

### HOUR METER M11

The hour meter is mounted on the control panel (Figure 2-1).

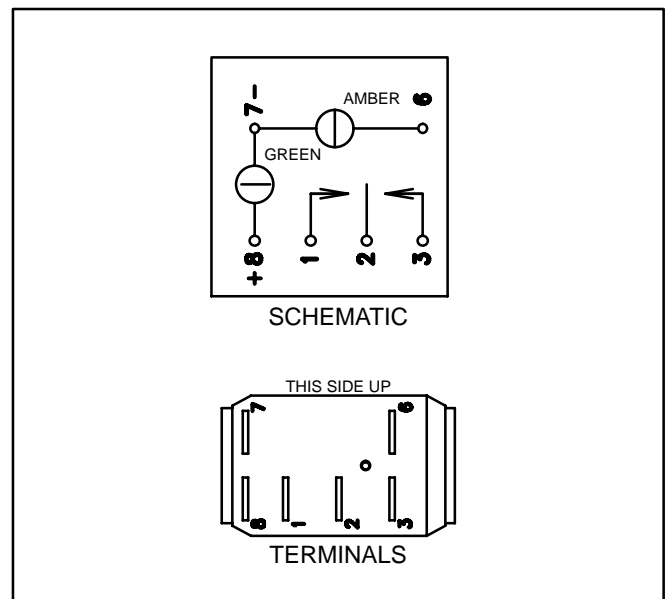


FIGURE 4-3. CONTROL SWITCH S4

## ENGINE OIL PRESSURE SENDER E1

The oil pressure sender is threaded into the side of the block (Figure 4-4) or to a manifold (Figure 4-5). Use thread sealant and engage at least two full threads when installing. In isolated-ground applications the sender has two terminals.

Replace the sender if resistance is not between 227 and 257 ohms when the engine is idle (0 psi), or is not reasonably steady between 50 and 200 ohms when the engine is running and known to have normal oil pressure.

## ENGINE COOLANT TEMPERATURE SENDER E2

The engine coolant temperature sender is threaded into the thermostat housing (Figure 4-4 or 4-5). Use thread sealant and engage at least two full threads when installing. In isolated-ground applications the sender has two terminals.

Replace the sender if resistance is not approximately 800 ohms at room temperature or does not decrease rapidly when immersed in boiling water.

## RAW WATER FLOW SWITCH S6

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

The raw water flow switch is threaded into a hose “T” (Figure 4-4 or 4-5). Use thread sealant and engage at least two full threads when installing.

Check continuity across the switch terminals while blowing into it (1 psi). Replace the switch if it does not open and close.

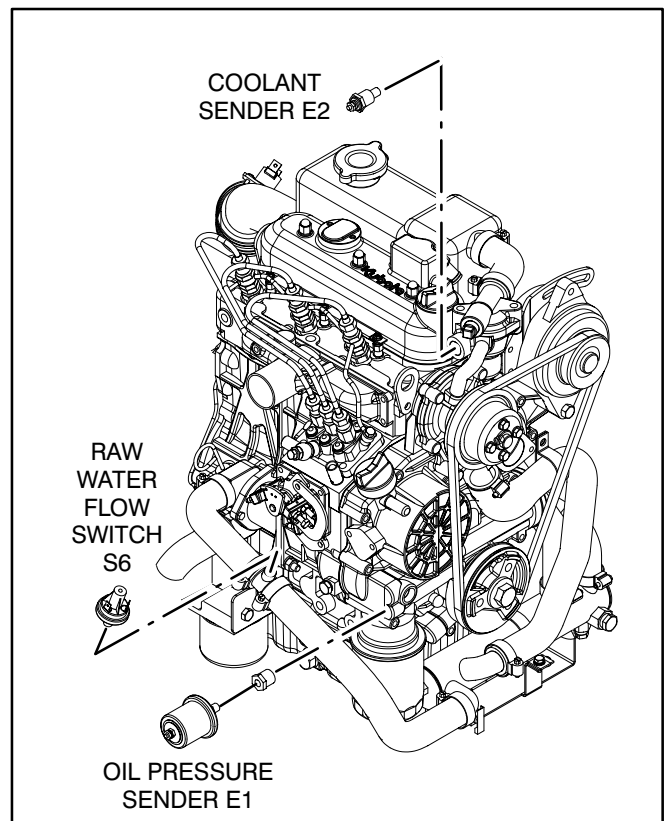


FIGURE 4-4. ENGINE SENSORS—MDKAV, MDKBG, MDKAW, MDKAZ

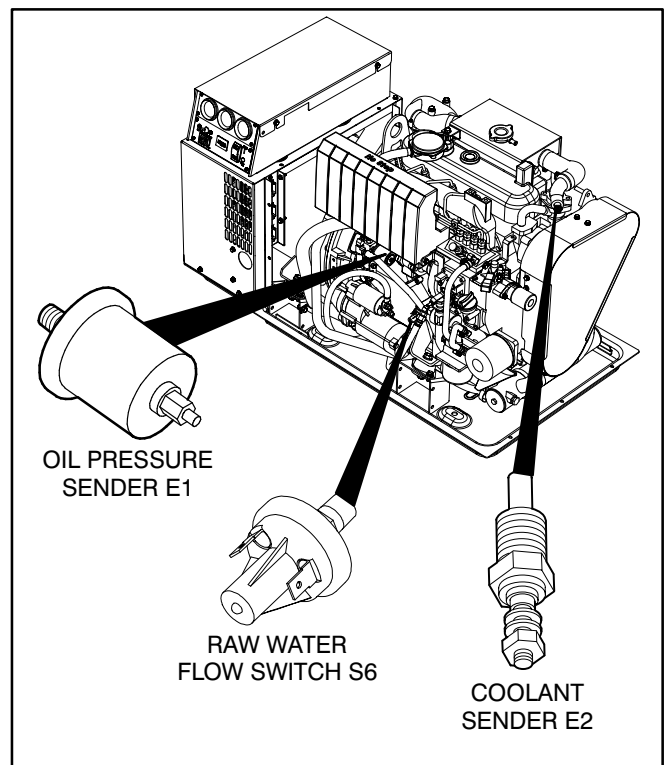


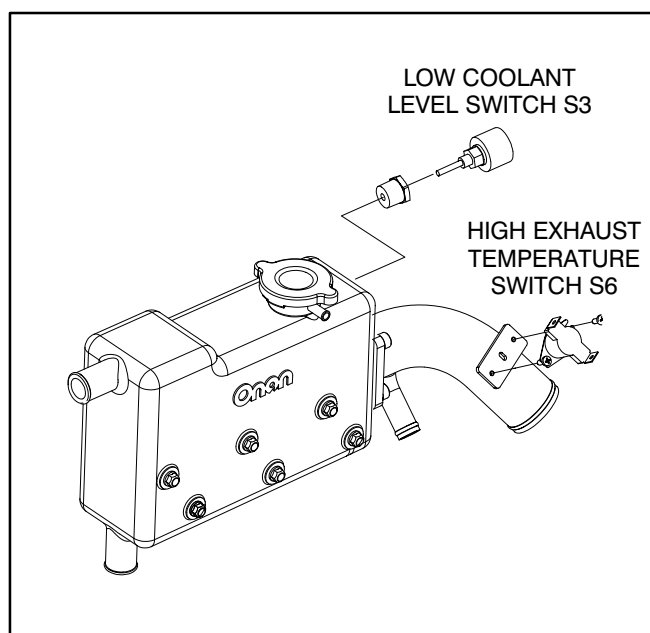
FIGURE 4-5. ENGINE SENSORS—MDKAV, MDKBG, MDKAW, MDKAZ

## HIGH EXHAUST TEMPERATURE SWITCH S5

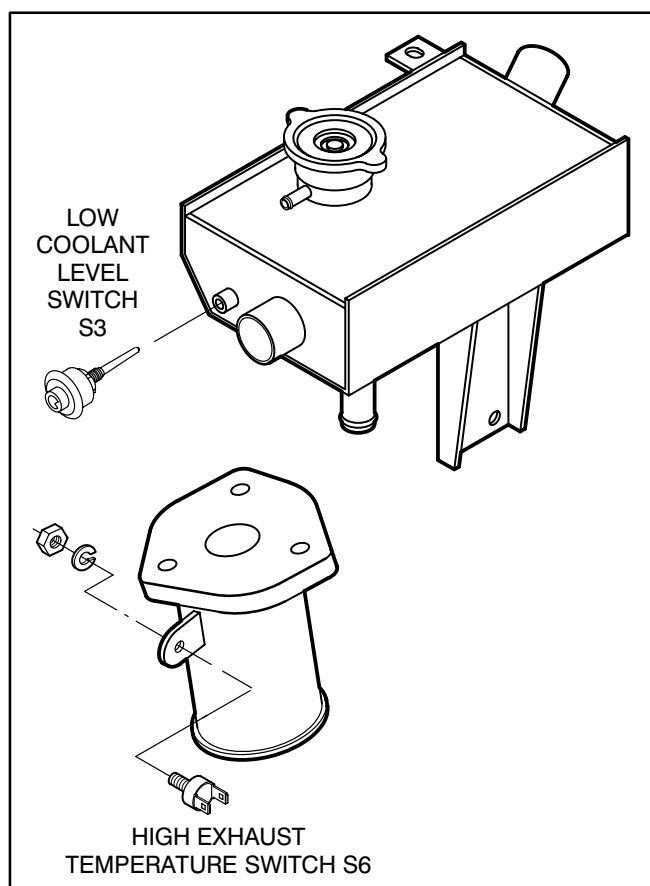
The high exhaust temperature switch is secured to the side of the water/exhaust mixer (Figure 4-6 or 4-7).

## LOW COOLANT LEVEL SWITCH S3 (OPTIONAL)

When provided, this switch is threaded into the coolant reservoir (Figure 4-6 or 4-7). Use thread sealant when remounting the switch.



**FIGURE 4-6. LOW COOLANT LEVEL & HIGH EXHAUST TEMPERATURE SWITCHES—MDKAV, MDKBG, MDKAW, MDKAZ**



**FIGURE 4-7. LOW COOLANT LEVEL & HIGH EXHAUST TEMPERATURE SWITCHES—MDKBD, MDKBE, MDKBF**

## GOVERNOR ACTUATOR A12

Controller A1 modulates the pulse width of the current it sends to governor actuator A12 (Figure 4-8 or 4-9), which positions the engine fuel rack accordingly.

If troubleshooting indicates that the actuator might be malfunctioning, disconnect its two leads and remove the actuator. Replace the actuator if the plunger does not move smoothly when pushed in or the internal spring does not return it smoothly. If the plunger moves smoothly without binding, apply battery voltage (12 or 24 volts, depending on the genset) and observe the plunger. Replace the actuator if the plunger does not pull in all the way and stay in while power is applied.

Reinstall the actuator with a new flange gasket. Torque the two mounting screws to 7-9 lb-ft (9.5-12.2 N-m).

### GLow PLUG RELAY K3

The glow plug relay is mounted on its wiring socket inside the genset control box. Pull the relay out to test it. Apply 12 VDC across terminals 85-86. Replace the relay if the contacts across terminals 30-87 (NO) do not open and close.

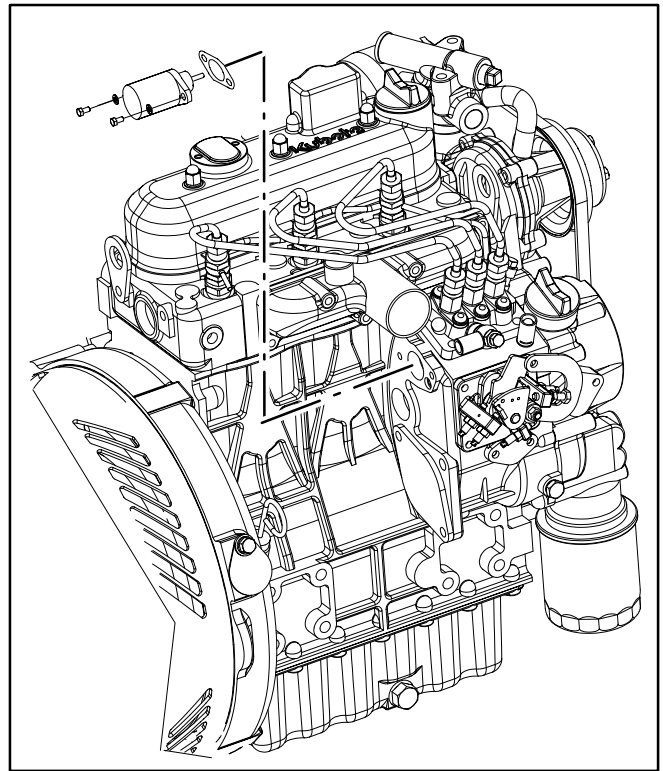
**Note:** A 12 volt relay is used for 12 or 24 volt gensets.

### STARTER RELAY K4

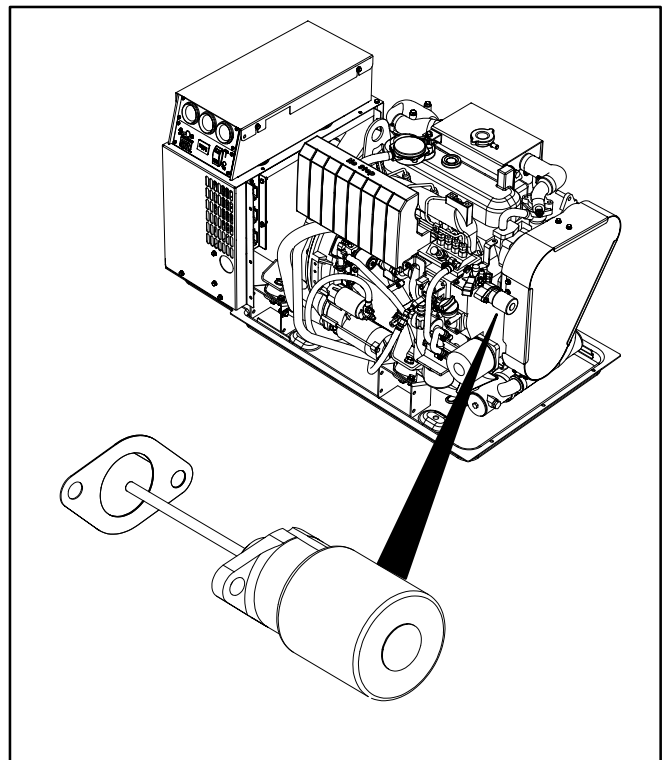
The starter relay is mounted on its wiring socket inside the genset control box. Pull the relay out to test it. Apply 12 VDC across terminals 85-86. Replace the relay if the contacts across terminals 30-87 (NO) do not open and close.

### GROUND ISOLATION RELAY K9

See GROUND ISOLATION RELAY K9 (Page 6-5).



**FIGURE 4-8. ACTUATOR A12—MDKAV, MDKBG, MDKAW, MDKAZ**



**FIGURE 4-9. ACTUATOR A12—MDKBD, MDKBE, MDKBF**

## BONDING FOR ELECTROSTATIC DISCHARGE CONTROL

To prevent electrostatic discharge from interfering with genset control, controller A1, the generator,

and the surrounding panels are bonded with braided wire straps or panel screws with toothed washers (Figure 4-10). Make sure all bond straps and toothed washers are in place when reassembling components.

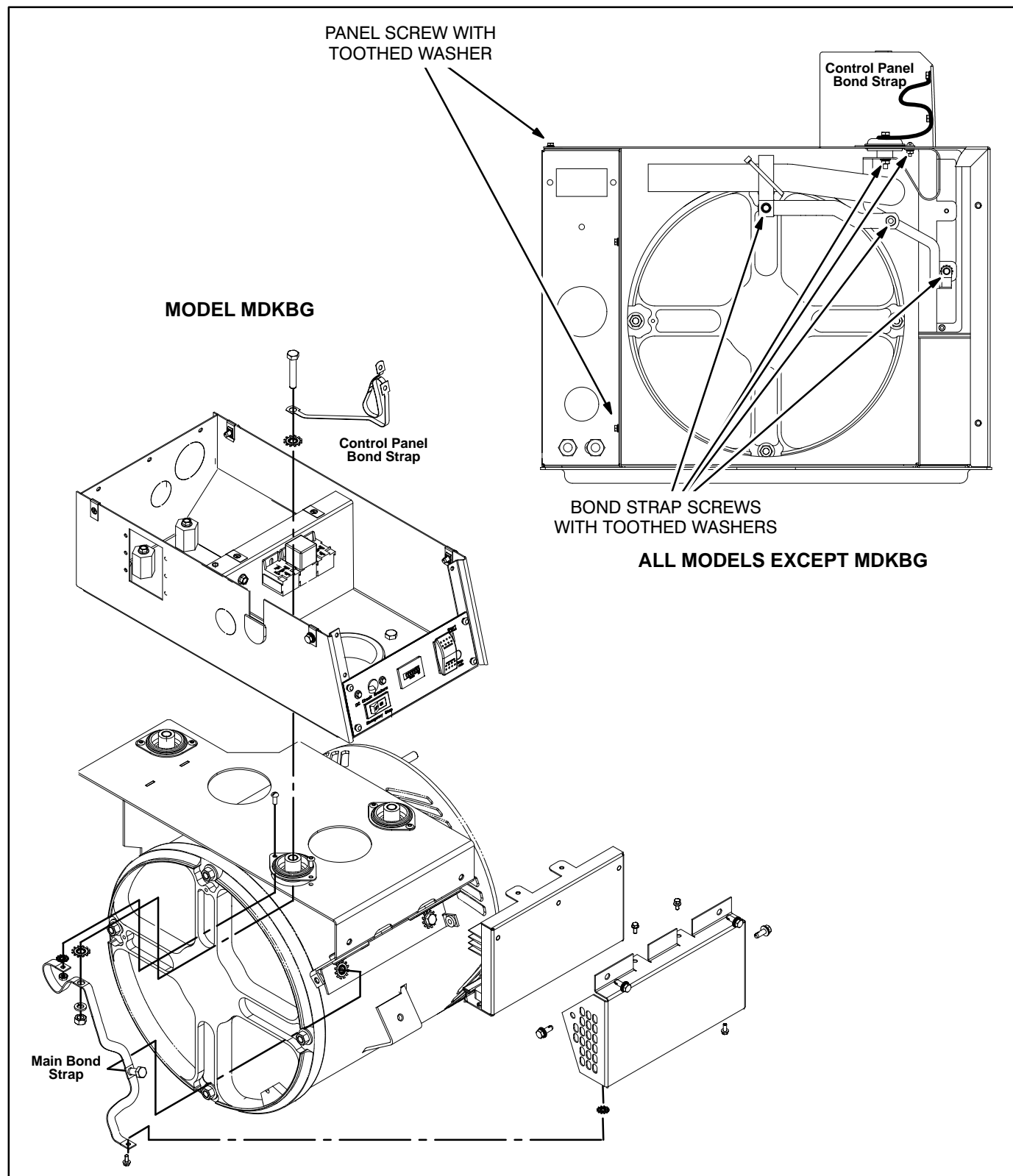


FIGURE 4-10. BONDING FOR ELECTROSTATIC DISCHARGE CONTROL

# 5. Generator

## OVERVIEW

These are 4-pole, rotating-field, brushless, single-bearing generators (Figure 5-1). Operation is as follows:

1. The engine rotates the generator field (main rotor) to induce output current (AC) in the main stator windings.
2. Generator output is proportional to the main rotor (field) current supplied by the exciter rotor through its full-wave rectifier bridge (rotating rectifiers).
3. Controller A1 (Page 4-1) rectifies and modulates quadrature winding output (**Q1**, **Q2**) to supply the exciter stator (**F1**, **F2**). By comparing generator output voltage with a reference value, controller A1 regulates field current to maintain nominal output voltage under varying loads. Also, in response to transient loads, it lowers the voltage setpoint to allow for engine recovery.
4. Residual field magnetism and a permanent magnet in one of the exciter stator poles initiates "self-excitation" during startups.

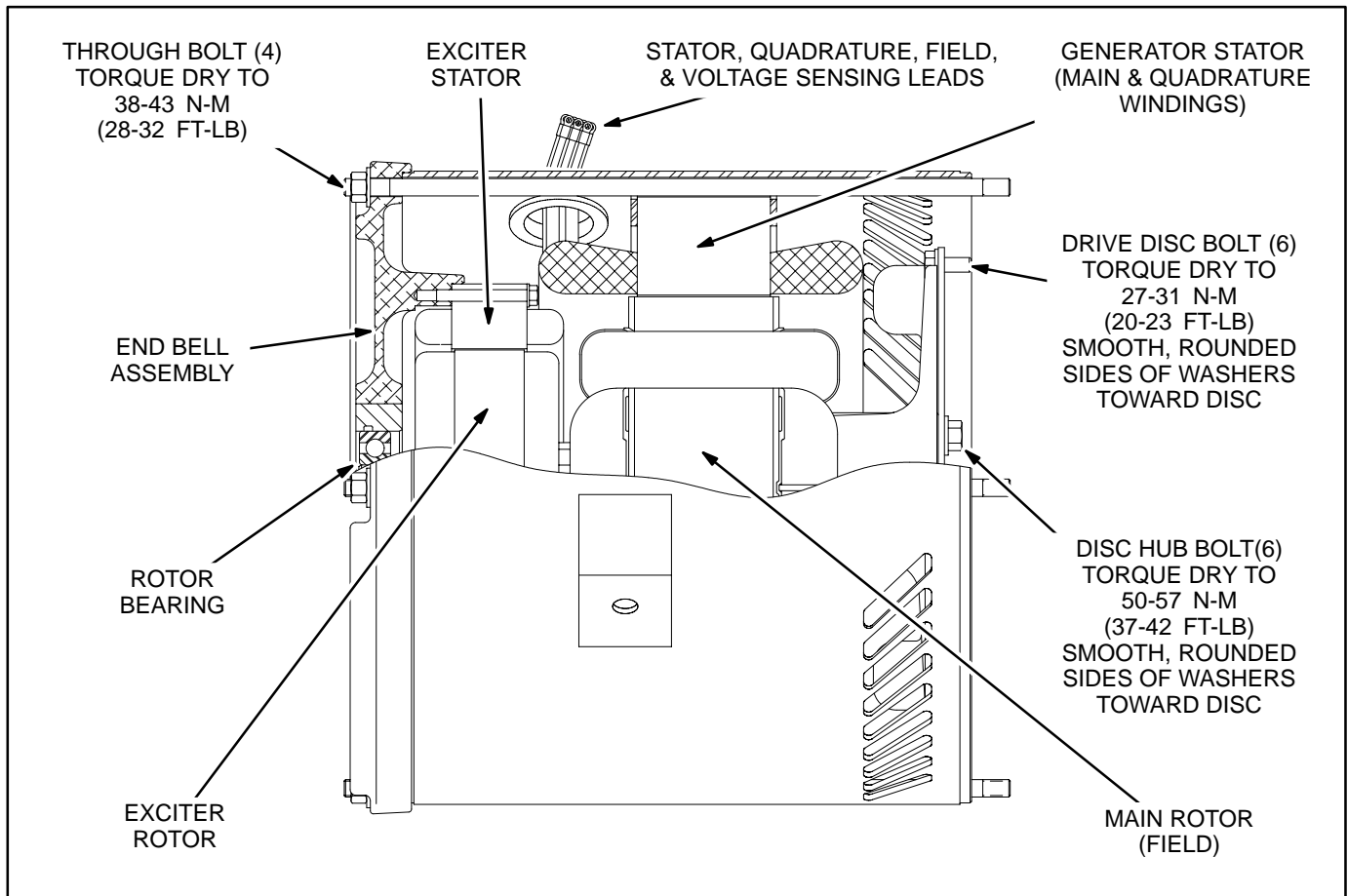


FIGURE 5-1. GENERATOR

## TESTING

### Testing Winding Insulation Resistance

A 500 VAC megger is recommended for the winding insulation resistance tests prescribed below. A test consists of applying the test potential between the winding and ground (winding laminations) for a period of 10 minutes and recording resistance at 1 minute and again at 10 minutes.

Resistance values of at least 5 megohms should be obtained for a new generator with dry windings. The polarization index should also be at least 2 (the ratio of the resistance reading at ten minutes to the reading at one minute). For a set that has been in service, the resistance reading should not be less than 1 megohm nor the polarization index less than 2.

Dry the windings if low readings are obtained or the set has been in standby for a long time in high humidity conditions and repeat the test.

### Testing Winding Resistance

Use a digital ohmmeter or Wheatstone bridge to measure winding resistance. The device should have a precision of at least 0.01 ohm.

### Exciter Stator

**Winding Insulation Resistance:** Disconnect controller A1 connector **P3**. Connect pin **P3-7** or **P3-8** to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

**Winding Resistance:** Measure winding resistance between pins **P3-7** and **P3-8**. Replace the exciter stator if the resistance is not as specified in Table 5-1.

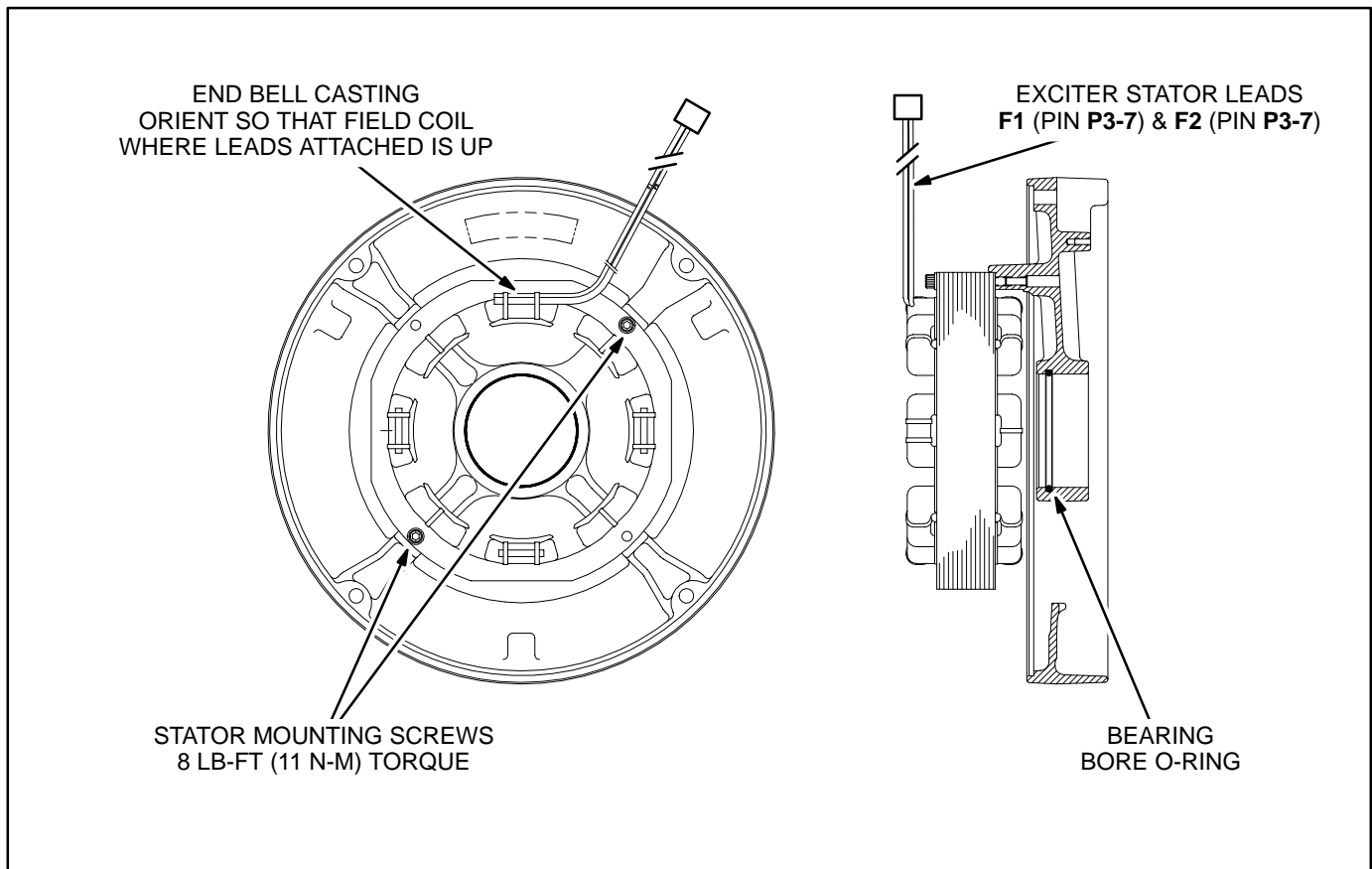


FIGURE 5-2. EXCITER STATOR AND END BELL

## Exciter Rotor

**Winding Insulation Resistance:** Disconnect all six exciter rotor leads from diode terminals **CR1** through **CR6** and isolate them from ground. Connect any lead to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

**Winding Resistance:** Measure electrical resistance across each pair of rotor windings: **T11-T12**, **T21-T22**, **T12-T13**, **T22-T23**, **T13-T11** and **T23-T21**. See the connection schematic. Replace the exciter rotor if the resistance of any winding is not as specified in Table 5-1.

## Rotating Rectifiers

The rotating rectifier assembly is mounted on the back face of the exciter rotor. It consists of one positive (+) and one negative (-) diode assembly. Each assembly carries three diodes in an epoxy potting. Each diode has a terminal for connecting the appro-

priate lead from the exciter rotor (**CR1-CR6**). Each assembly has a field terminal (**F1+** or **F2-**) for connecting the leads from the main rotor (generator field).

**Diode Resistance:** Measure electrical resistance between diode terminals **CR1**, **CR2** and **CR3** and field terminal **F1+** on the positive diode assembly and between diode terminals **CR4**, **CR5** and **CR6** and field terminal **F2-** on the negative diode assembly. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the whole diode assembly.

**Replacing Diode Assembly:** Make sure the replacement diode assembly is of the correct polarity, positive (+) or negative (-). Then disconnect all leads from the defective diode assembly and remove the two mounting screws. Mount the new diode assembly, reconnect all leads and torque the terminal screws to 24 lb-in (2.6 N-m).

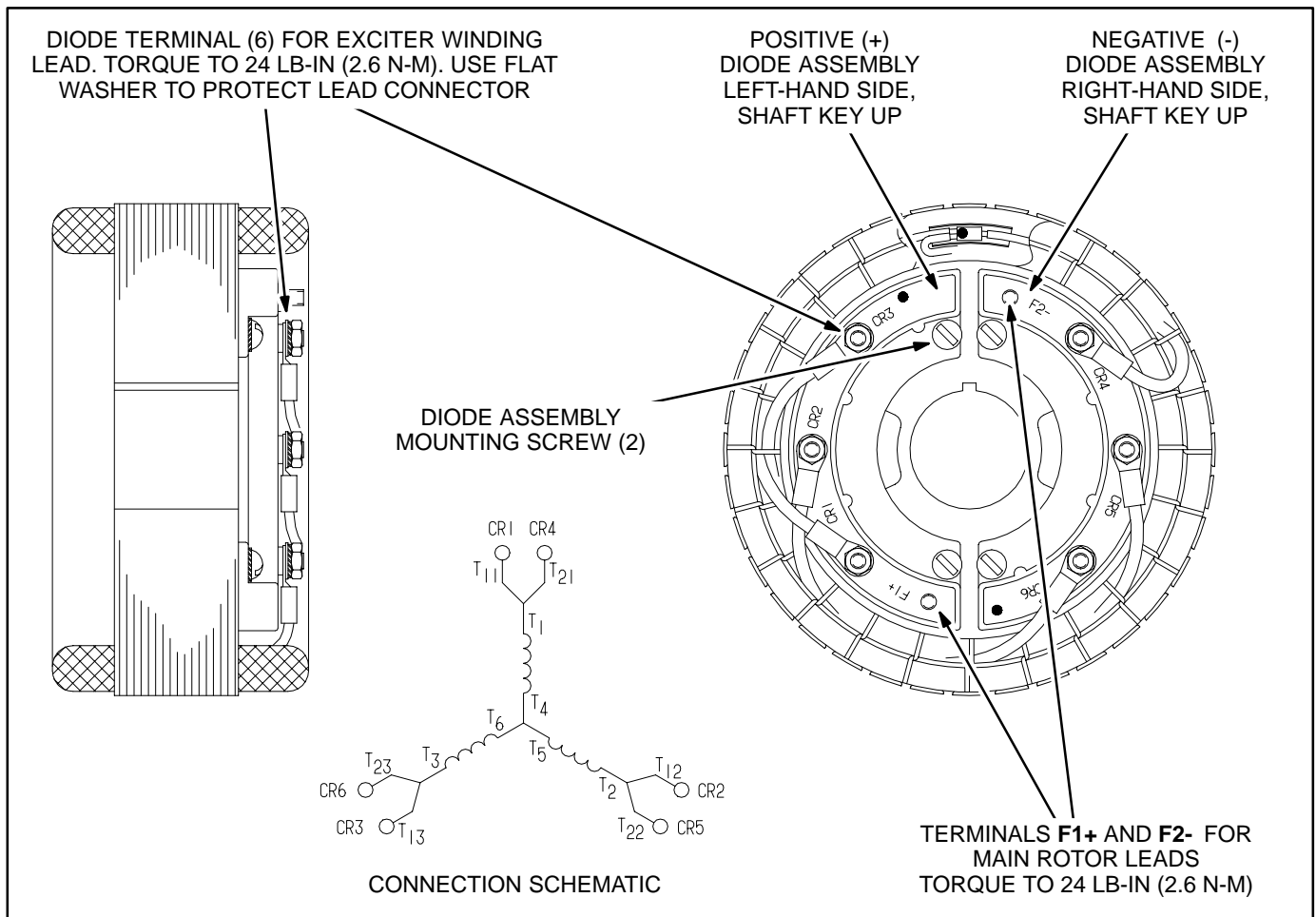


FIGURE 5-3. ROTATING RECTIFIER ASSEMBLY



## Main Rotor

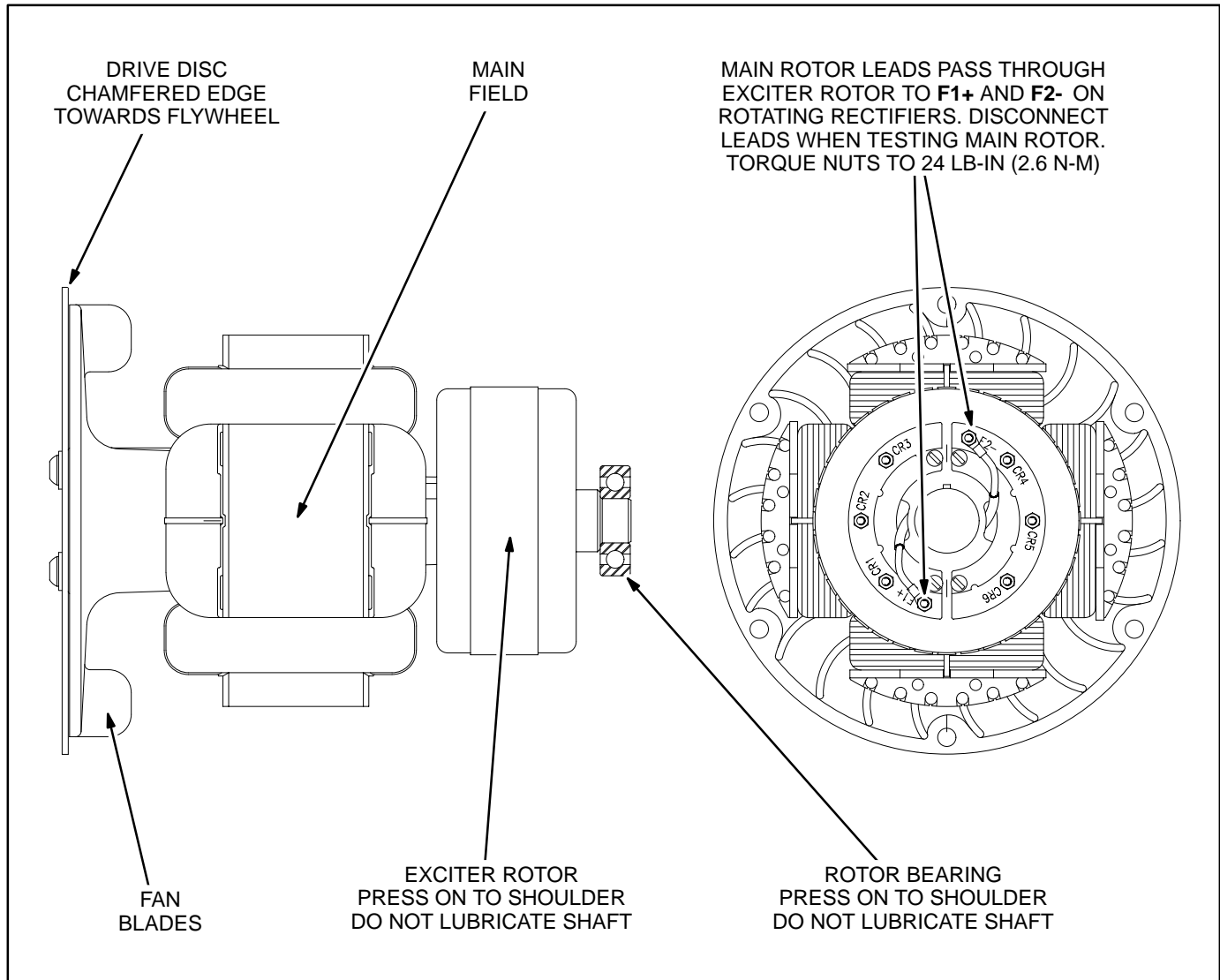
**Winding Insulation Resistance:** Disconnect the main rotor leads from terminals **F1+** and **F2+** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2+**).

**⚠ CAUTION** *Because of the opposing residual magnetism of the rotor, it might be difficult to reestablish self excitation if the polarity of the main rotor leads is reversed upon reassembly.*

Connect either or both leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

**Winding Resistance:** Disconnect the main rotor leads from terminals **F1+** and **F2+** on the rotating rectifier assemblies and measure electrical resistance between them. Replace the rotor if the resistance is not as specified in Table 5-1.

Reconnect the rotor leads and torque the terminals to 24 lb-in (2.7 N-m) when reassembling.



**FIGURE 5-4. ROTOR ASSEMBLY**

## Main Stator

**Quadrature Winding Insulation Resistance:** Disconnect controller A1 connector **P3**. Connect pin **P3-4** or **P3-5** to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

**Quadrature Winding Resistance:** Measure winding resistance between pins **P3-4** and **P3-5** with a Wheatstone bridge. Replace the stator assembly if the resistance is not as specified in Table 5-1.

**Main Winding Insulation Resistance:** Test each winding separately. Disconnect the winding lead from its grounded neutral connection and isolate it. Leave the other windings grounded. Connect either

or both winding leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

**Main Winding Resistance:** Disconnect all main stator leads from the terminals to which they are connected and measure resistance across the following lead pairs:

4-Lead Generators:

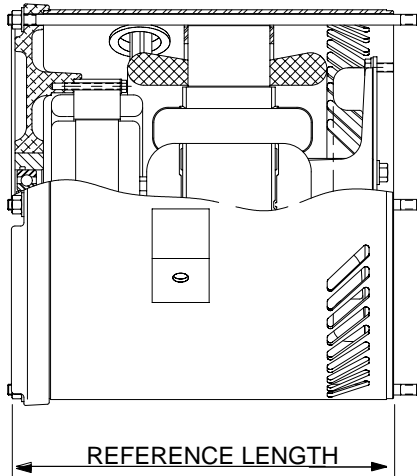
**T1-T2, T3-T4**

12-Lead Generators:

**T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, T9-T12**

Replace the stator assembly if the resistance of any winding is not as specified in Table 5-1.

**TABLE 5-1. GENERATOR STATOR AND ROTOR WINDING RESISTANCES**

| REFERENCE LENGTH<br>MILLIMETERS<br>(INCHES) <sup>1</sup>   | MAIN WINDING<br>RESISTANCE<br>OHMS <sup>2, 3</sup> | QUADRATURE<br>WINDING<br>RESISTANCE<br>OHMS <sup>2</sup> | MAIN ROTOR<br>WINDING<br>RESISTANCE<br>OHMS <sup>2</sup> | EXCITER ROTOR<br>WINDING<br>RESISTANCE<br>OHMS <sup>2</sup> | EXCITER STATOR<br>WINDING<br>RESISTANCE<br>OHMS <sup>2</sup> |
|--|--|--|--|---|--|
| 4-Lead Generators (Single-Phase)   |  |  |  |   |  |
| 341 (13.4)   | 0.179-0.197  | 1.716-1.864  | 2.54-3.10  | 0.58-0.71   | 13-16  |
| 378 (14.9)   | 0.097-0.108  | 1.010-1.110  | 2.17-2.65  | 0.58-0.71   | 13-16  |
| 376 (14.8)   | 0.078-0.086  | 0.807-0.897  | 2.12-2.59  | 0.58-0.71   | 13-16  |
| 412 (16.2)   | TBD  | 0.658-0.728  | 1.89-2.32  | 0.58-0.71   | 13-16  |
| 485 (19.1)   | TBD  | 0.506-0.560  | 2.20-2.68  | 0.58-0.71   | 13-16  |
| 12-Lead Generators (Three-Phase)   |  |  |  |   |  |
| 341 (13.4)   | 0.36-0.44  | 2.961-3.219  | 2.54-3.10  | 0.58-0.71   | 13-16  |
| 378 (14.9)   | 0.15-0.19  | 2.356-2.593  | 2.17-2.65  | 0.58-0.71   | 13-16  |
| 412 (16.2)   | 0.105-0.117  | 1.852-2.047  | 1.89-2.32  | 0.58-0.71   | 13-16  |
| 485 (19.1)   | 0.056-0.062  | 1.605-1.774  | 2.20-2.68  | 0.58-0.71   | 13-16  |
|   |  |  |  |   |  |
| <ol style="list-style-type: none"> <li>1. Measure this length to identify the generator.</li> <li>2. If high, recheck winding resistance after the windings have cooled to room temperature.</li> <li>3. The main windings are probably good if some of the resistances fall outside the range but are all within 10 percent of each other.</li> </ol> |  |  |  |   |  |

## DISASSEMBLY

The generator is heavy. You will need an assistant and hoist of sufficient capacity.

**⚠WARNING** *Accidentally dropping the generator can damage it and cause severe personal injury or death. Use a hoist and straps of sufficient capacity and attach them so that the load cannot shift.*

Disconnect the negative (-) cable(s) at the battery(ies) to prevent the genset from starting.

**⚠WARNING** *Accidental starting can cause severe personal injury or death. Disconnect the negative (-) cable(s) at the battery(ies) to prevent the genset from starting.*

1. Disconnect all power output and remote control connections and conduit at the generator. For easier reconnections later, make sure each lead is clearly marked.
2. Disconnect all engine harness connections and grounding straps in the control box, all generator leads from connections in the output box, and Connectors P1, P2 and P3 from controller A1. Disassemble the pins for generator leads Q1, Q2, F1, F2, S1, S2 from connector P3. Remove the control box, output box and saddle as an assembly.
3. Hook the genset lifting eye with a hoist, remove the throughbolts in the two generator mounts, tip the generator end up slightly with the hoist and block the flywheel housing to support the engine while the generator is being serviced.
4. Cinch a strap around the middle of the generator stator and take up slack with the hoist.
5. Scribe lines before separating the end bell from the stator and the stator from the flywheel housing to register the parts for reassembly.
6. Remove the four nuts on the throughbolts and tap the end bell free of the stator.
7. Tap the stator free of the flywheel housing, carefully draw the stator straight back until it clears the ends of the throughbolts and remove the throughbolts.
8. Cinch a strap around the rotor and remove the six disc-to-flywheel bolts (Figure 5-2). When removed, cradle the rotor horizontally in wooden blocks to prevent damage to windings, laminations and drive disc.
9. Use a gear puller to remove the rotor bearing or exciter rotor (Figure 5-4).

## REASSEMBLY

Reassembly is the reverse of disassembly. Note the following when reassembling the generator:

1. Press a new exciter rotor or rotor shaft bearing on up to its locating shoulder on the shaft. Do not lubricate the shaft (Figure 5-4).
2. Torque the six disc-to-hub bolts (Figure 5-1) to 50-57 N-m (37-42 lb-ft). Make sure that:
  - A. The chamfered edge on the drive disc perimeter faces out to make assembly with the flywheel easier.
  - B. The rounded edges of the washers are on the disc side.
3. Torque the six disc-to-flywheel bolts (Figure 5-1) to 27-31 N-m (20-23 lb-ft). Make sure the rounded edges of the washers are on the disc side.
4. Use the four throughbolts to help guide the stator on. Thread the ends with less thread into the flywheel housing and make sure the threads bottom.
5. Make sure the scribed stator-flywheel index lines (Step 5, Disassembly) register.
6. Torque the two exciter stator screws (Figure 5-2) to 11 N-m (8 lb-ft). The pole to which the leads are tied must be up.
7. Wipe the bearing bore in the end bell lightly with molybdenum disulfide grease and make sure the rubber O-ring (Figure 5-2) is in place.

8. Assemble the end bell to the stator, making sure the scribed index lines (Step 5, Disassembly) register and the rotor bearing seats fully in the bore. Pull the field leads out the same opening as the stator leads. Torque the nuts on the generator throughbolts to 38-43 N-m (28-32 lb-ft).
9. Secure the end bell cover plate and torque the four screws to 3.8 N-m (8 lb-in).
10. Reassemble all the remaining components. Make sure to resecure the ring terminals of grounding straps and leads with two star washers, one on each side, for good electrical continuity. Torque the vibration isolator through bolts to 27-33 lb-ft (37-44.7 N-m).

## RECONNECTING THE GENERATOR

Reconnect the generator properly for the application. See Page A-4.

## LINE CIRCUIT BREAKERS

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

The line circuit breakers are mounted in the AC output box. Disconnect all leads and check electrical continuity across each pole. Replace a circuit breaker if either pole does not reset or turn ON and OFF. Reconnect the generator and load wires properly (Page A-4).

## ADJUSTING FREQUENCY

If it is necessary to change the output frequency for the application, remove the access cover on the left end of the genset. Find the leads marked **J8 HZ**, **60 HZ** and **50 HZ** in the wiring harness (Page A-2 or A-3). Connect **60 HZ** or **50 HZ** to **J8 HZ**, as appropriate, and secure the access cover (4 screws).

## ADJUSTING VOLTAGE

Output voltage may need to be readjusted for the application, especially if it was necessary to change the frequency and/or reconnect the generator

(Page A-4). Recheck generator reconnections and reconsider whether frequency needs to be changed before attempting voltage adjustments.

Voltage is adjusted by means of the control switch. Rapidly pressing the switch to **START** 6 times *during the first minute after startup* puts the genset controller into *voltage set mode*. The *amber* status indicator lamp will begin blinking once every second to confirm voltage set mode. The *green* status indicator lamp will remain on. The controller resumes normal operating mode 20 seconds after the last adjustment.

**Note:** If a fault shutdown occurs or the control switch is pressed to **STOP** during voltage set mode, voltage adjustments will not be stored in controller memory.

To adjust voltage:

1. Disconnect all generator loads and connect accurate meters to measure AC volts and frequency.

**⚠ WARNING** **HAZARDOUS VOLTAGE!** *Touching uninsulated live parts inside the genset or connected equipment can result in severe personal injury or death. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands and use tools with insulated handles.*

2. Start the genset and let voltage and frequency stabilize for 5 to 10 seconds.
3. Rapidly press the control switch to **START** 6 times within 10 seconds.
4. **To adjust voltage up**, press the control switch to **START** and release quickly. Each time the switch is released, voltage will rise approximately 0.6 volt.
5. **To adjust voltage down**, press the control switch to **START** and release in approximately 2 seconds. Each time the switch is released, voltage will drop approximately 0.6 volt.
6. Normal operation will resume in 20 seconds after the last adjustment. The last adjustment will be retained by the controller.

# 6. Engine

## MAJOR ENGINE SERVICE

See the Engine Workshop Manual (Table 6-1) for major engine service procedures. See *Specifications* in this manual to identify the engine model number for the genset.

TABLE 6-1 ENGINE WORKSHOP MANUAL

| Genset                     | Manual   |
|----------------------------|----------|
| MDKAV, MDKBG, MDKAW, MDKAZ | 981-0528 |
| MDKBD, MDKBE, MDKBF        | 981-0521 |

When remounting the engine torque the vibration isolator through bolts to 27-33 lb-ft (37-44.7 N-m).

## ENGINE SENSORS

See *Control System* (Pages 4-5 and 4-6).

## GOVERNOR ACTUATOR

See *Control System* (Page 4-7).

## EXHAUST MANIFOLD

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

**MDKAV, MDKBG, MDKAW, MDKAZ:** (Figure 6-1) Use new manifold and mixer gaskets when re-assembling. Torque the manifold nuts (2 per port) to 9.5-12.2 lb-ft (12.9-16.6 N-m) and the mixer flange bolts (4) to 15-19 lb-ft (20-25.7 N-m).

**MDKBD, MDKBE, MDKBF:** (Figure 6-2) Use new manifold and mixer gaskets when reassembling. Torque the manifold nuts (2 per port) and mixer or dry exhaust flange bolts (4) to 16-23 lb-ft (21-32 N-m). Torque the wet exhaust hose adapter flange bolts (3) to 6.4-9.6 lb-ft (8.7-13.0 N-m).

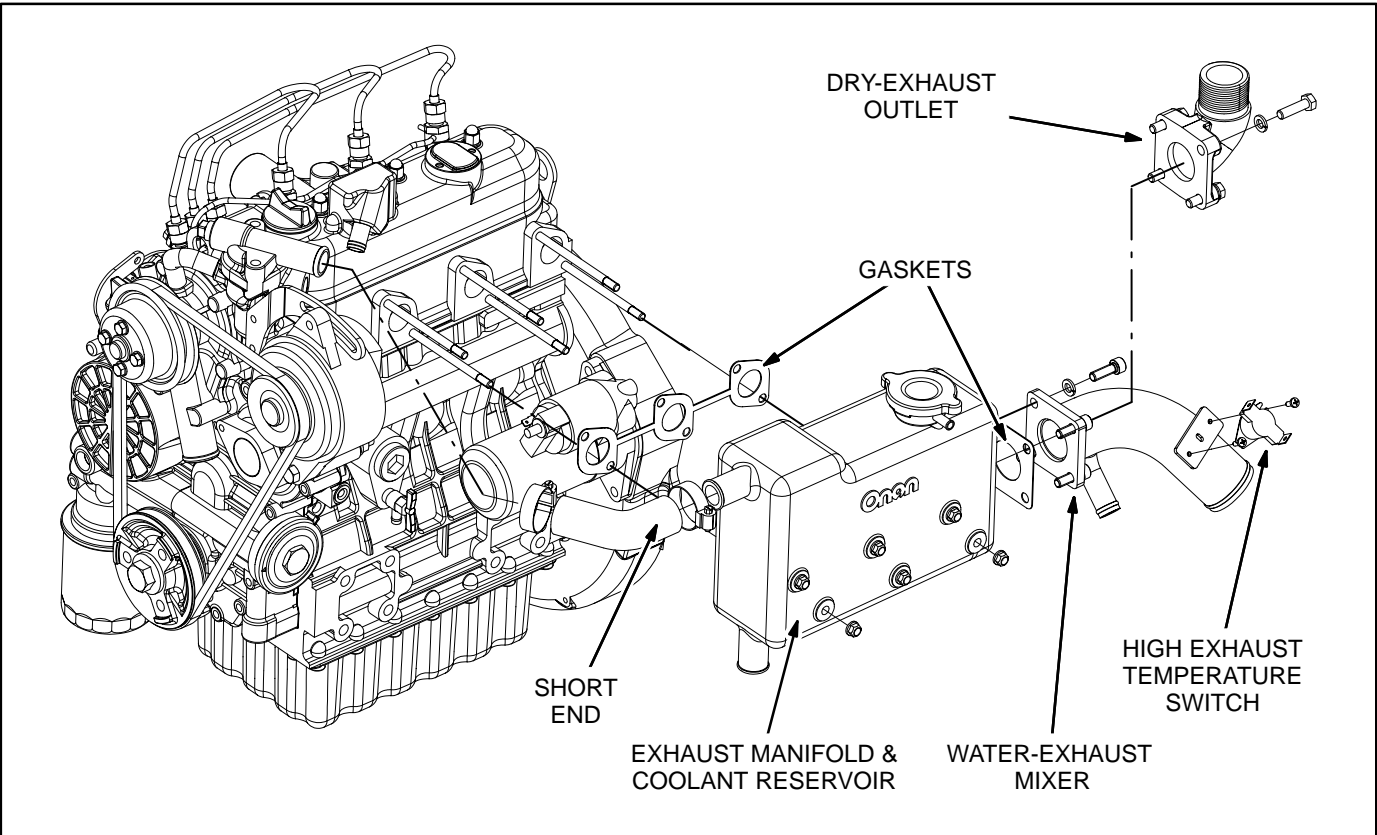
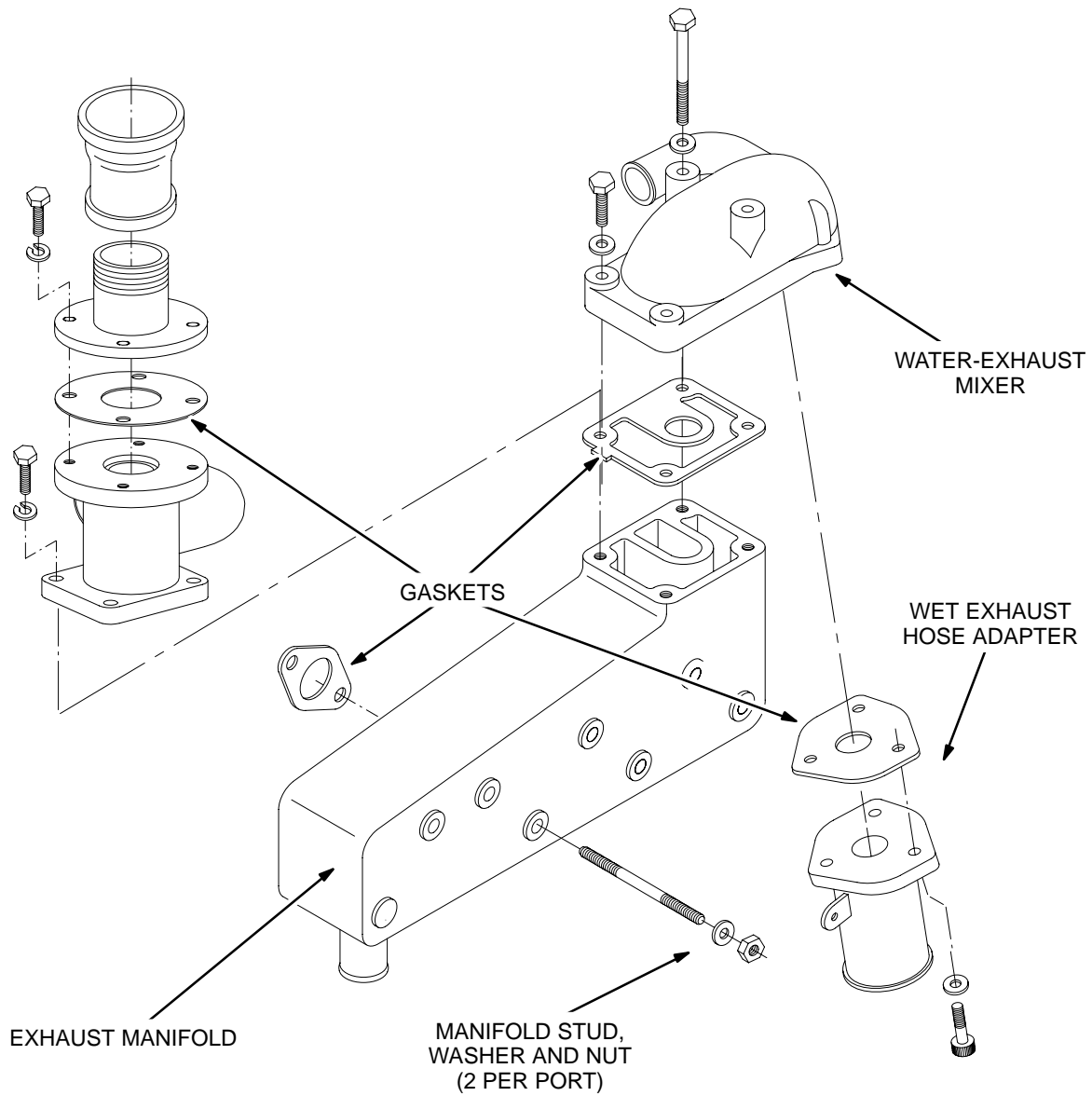


FIGURE 6-1. TYPICAL EXHAUST MANIFOLD / COOLANT RESERVOIR—MDKAV, MDKBG, MDKAW, MDKAZ

**DRY-EXHAUST ASSEMBLY**

**WET-EXHAUST ASSEMBLY**



**FIGURE 6-2. TYPICAL EXHAUST MANIFOLD—MDKBD, MDKBE, MDKBF**

## FUEL SYSTEM

**⚠ WARNING** *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a multi-class ABC fire extinguisher handy.*

Figure 6-3 illustrates how the fuel system is assembled for delivering fuel to and from the fuel injection system. See the engine Workshop Manual for fuel injection system service.

**⚠ WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

**Fuel Filter:** See DRAINING / CHANGING FUEL FILTER (Page 3-5) regarding fuel filter maintenance.

**Fuel Pump Test:** First service all of the fuel filters in the system and repair any restrictions to fuel flow. If fuel delivery still appears to be weak, test for pump delivery as follows:

1. Disconnect the fuel return hose from the line to the supply tank and point the end into a container of known volume, such as a 1 or 2 liter (quart) bottle.

2. Prime the genset by pushing the Start/Stop switch to **STOP(Prime)** and holding it there for the duration of the test. It should not take longer than 1-1/2 minutes to fill a 1 liter container (2/3 liter per minute).

3. Replace the pump if flow is less than specified.

**Fuel Fittings:** The genset has bulkhead fittings on either end. For these fittings use *liquid-type* pipe thread sealant Listed as suitable for diesel fuel. Apply the sealant sparingly to the male threads only.

**⚠ CAUTION** *Excess liquid-type pipe thread sealant or pieces of Teflon-type pipe thread sealant can plug the engine fuel system. Apply liquid-type pipe thread sealant sparingly to the male threads only. Do not use Teflon tape.*

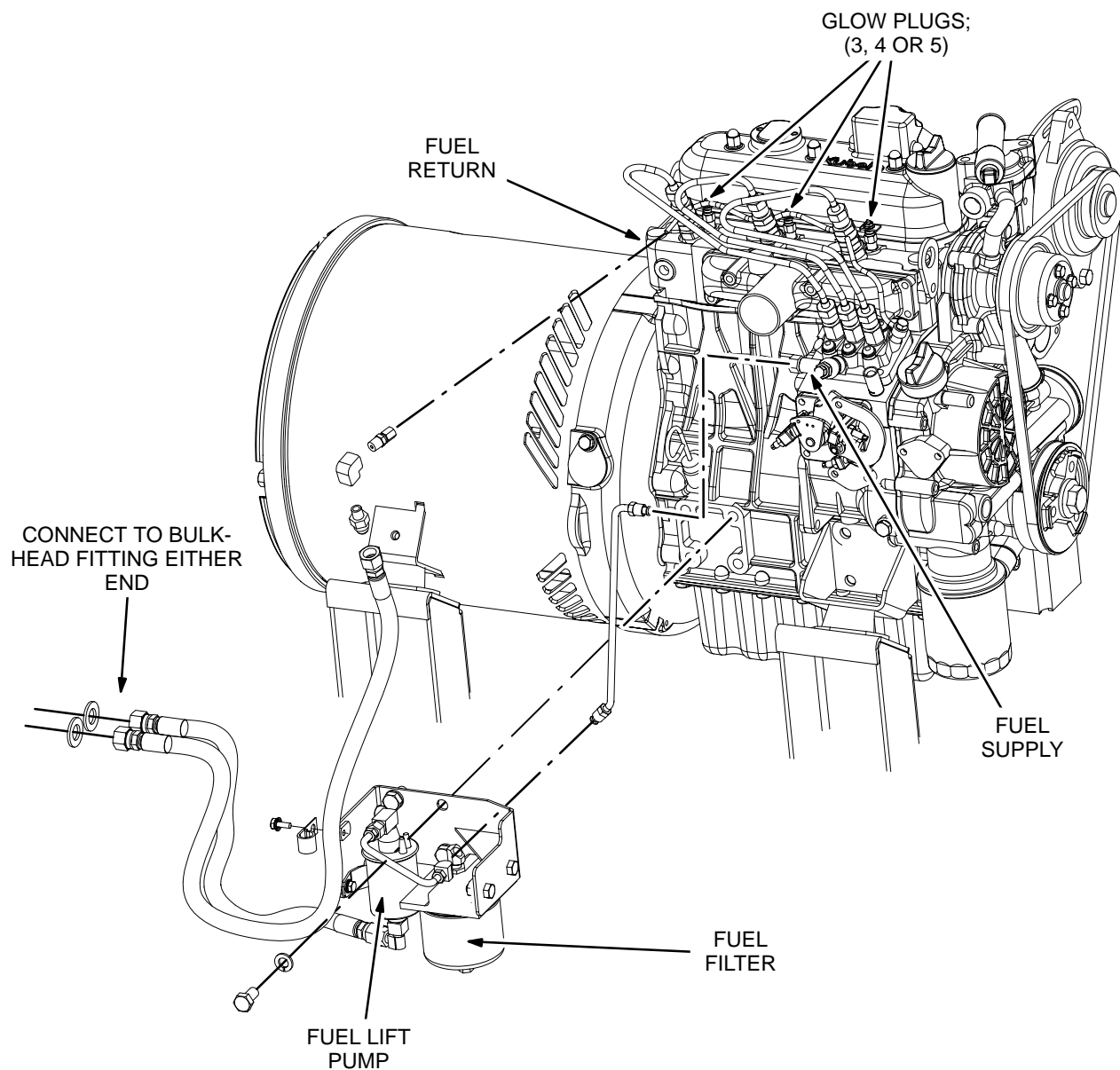
**Fuel Hose:** Replace worn or damaged fuel hose with USCG TYPE A1 or ISO 7840-A1 fuel hose. The hoses must be long enough not to rub on the engine oil pan.

## GLOW PLUGS

Refer to the Engine Workshop Manual when replacing the glow plugs (Figure 6-3).

**Note:** If a glow plug does not come out after unscrewing it, or the end has broken off, it will be necessary to remove the engine head. Glow plugs can swell if preheat voltage is greater than the nominal 12 or 24 volts, such as when a battery booster is used for starting.





**FIGURE 6-3. TYPICAL FUEL SYSTEM AND GLOW PLUGS**

## STARTER

**⚠WARNING** *Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable at the battery to prevent the engine from starting.*

The starter motor is on the back side of the engine (Figure 6-4). Parts are available for rebuilding the

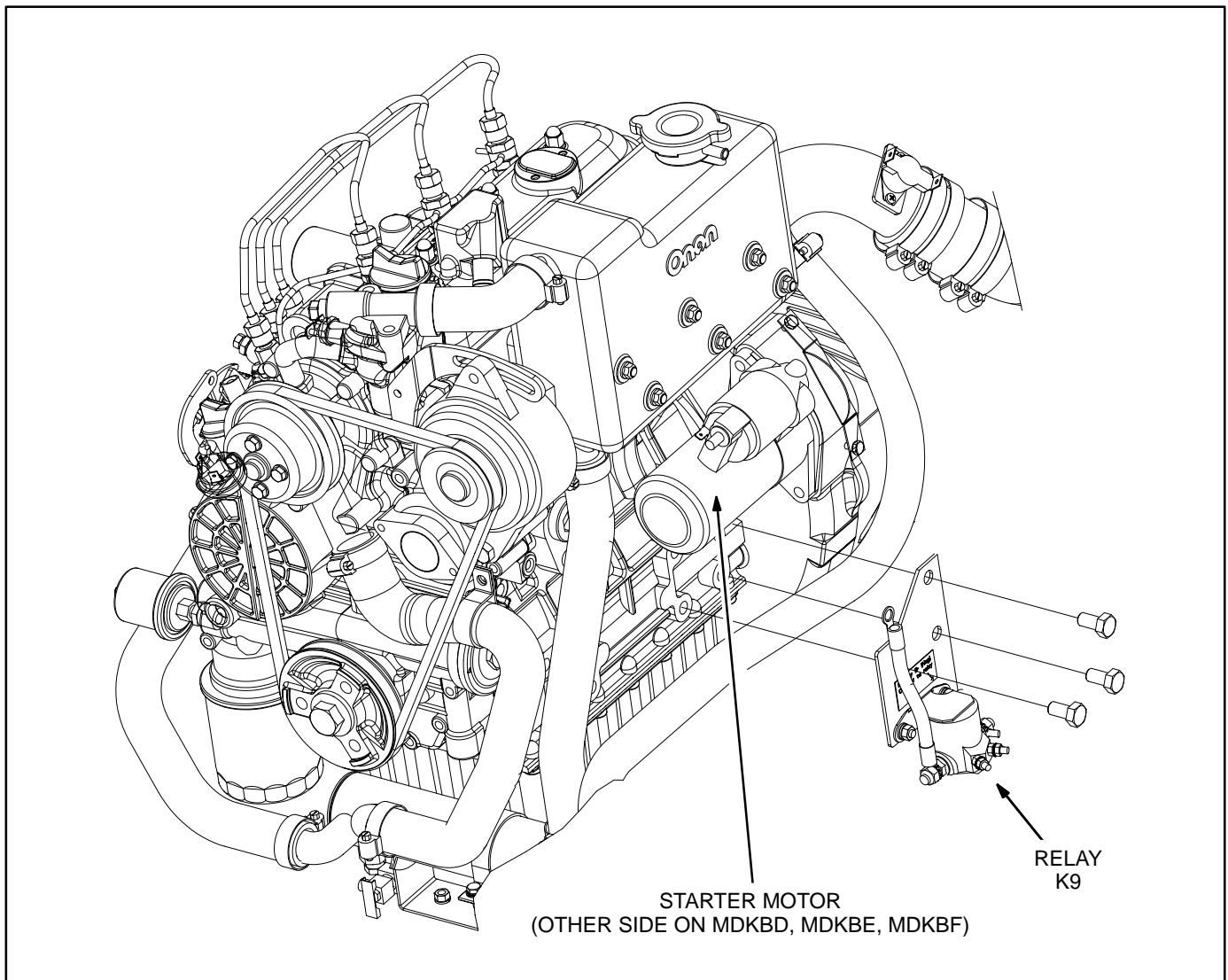
starter. Torque the mounting bolts to 29 lb-ft (39 N-m).

## GROUND ISOLATION RELAY K9

When required, the genset is equipped with isolation relay K9 (Figure 6-4) to isolate the negative (-) battery terminal from the vessel grounding system. Replace the relay if its contacts do not close when battery voltage is applied to the coil terminals.

## RAW WATER PUMP

Kits are available for servicing the raw water pump. Follow the instructions in the kit.



**FIGURE 6-4. TYPICAL STARTER MOTOR AND B- ISOLATING RELAY K9**

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# 7. Troubleshooting

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TABLE 7-1 lists the shutdown codes in numerical order along with step-by-step corrective actions. First note the following:

- Maintaining engine oil and coolant levels, cleaning the sea water strainer, keeping battery connections clean and tight, watching the fuel gauge and not overloading the genset will prevent most shutdowns.
- When the genset and propulsion engines share a common fuel tank, the fuel dip tubes are usually arranged so that the genset will run out of fuel first. Marking the genset empty point on the fuel gauge will make it easier to tell when to stop the genset before running it out of fuel.

## SHUTDOWN CODES

The genset controller provides extensive diagnostics by causing the *amber* status lamp on the control switch to blink. Following a shutdown, the indicator lamp will blink 1, 2, 3, 4 or 7 times, pause, and then repeat the blinking. ***The number of blinks is the shutdown code.***

- **One blink** indicates shutdown due to high engine temperature.
- **Two blinks** indicate shutdown due to low oil pressure.

- **Three blinks** indicate shutdown due to a condition normally requiring service by a trained and experienced person. To access the second-level, two-digit shutdown code, press **STOP** once. The two-digit code consists of 1 to 6 blinks, a brief pause, and then 1 to 9 blinks. The first set of blinks represents the tens digit and the second set of blinks the units digit of the shutdown code number. For example, **Shutdown Code No. 23** blinks as follows:

blink-blink—*pause*—blink-blink-blink—*long pause*—repeat

- **Four blinks** indicate shutdown due to a failure to start within the time allowed for cranking.
- **Seven blinks** indicate shutdown due to a loss of raw water flow for engine and exhaust cooling.

Blinking of the shutdown code continues for five minutes and stops. Pressing **STOP** three times restores blinking. (If you press **STOP** again, blinking stops entirely and you have to start over by pressing **STOP** three times.)

**Note:** The last shutdown logged will blink, even though the condition that caused shutdown has been serviced.

TABLE 7-1 . TROUBLESHOOTING

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### **NO POWER—GENSET RUNNING, RUN LAMP ON**

(Line circuit breaker OFF, tripped or malfunctioning)

#### **Corrective Action:**

1. Turn on, reset, repair or replace the genset line circuit breaker (Page 2-4).
2. Turn on, reset, repair or replace the line circuit breakers on the main distribution panel in the boat.
3. Reconnect the generator as required (Page A-4).

### **STARTER ENGAGES-DISENGAGES**

(Battery voltage dips below 6 volts while cranking—low battery charge, poor connections, long cables)

#### **Corrective Action:**

1. Clean and tighten the positive (+) and negative (-) battery cable connections at the battery and genset (Page 3-6).
2. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
3. Increase battery cable size or run parallel cables.

### **RUN-DOWN STARTING BATTERY**

(Marginal battery, connections or charging system, or parasitic loads)

#### **Corrective Action:**

1. Clean and tighten the positive (+) and negative (-) battery cable connections at the battery and genset (Page 3-6).
2. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
3. Service the engine battery charging alternator (Engine Workshop Manual 981-0528) and/or boat battery charging system.

### **ENGINE CRANKS, STARTS, ACCELERATES, BUT STOPS WHEN SWITCH LET GO**

(Open field or open or grounded quadrature circuit)

**Corrective Action:** Check for an open exciter stator circuit (Page 5-2) or open or grounded quadrature circuit (Page 5-6) and service as necessary.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### NO LIGHTS, NO RESPONSE

(Poor connections, faulty wiring or dead battery)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. At the genset control panel, push emergency stop switch CB1 and DC circuit breaker CB2 to ON.
2. Try the local genset control switch (S4) if the remote control switch does not work, and vice versa. If neither works, go to Step 3. If only local switch S4 works, go to Step 10. If only the remote switch works, go to Step 11.
3. Clean and tighten the positive (+) and negative (-) battery cable terminals at the battery and genset (Page 3-6).
4. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
5. Check wiring to and from and functioning of emergency stop switch CB1 and DC circuit breaker CB2 (Page 4-4). Rewire and replace components as necessary.
6. Disconnect connector P1 (black) from controller A1 (Page 4-1) and check for B+ at Pin 6. If there is no B+, check for a missing, bent or corroded pin and faulty wiring and repair as necessary.
7. Disconnect connector P2 (grey) from controller A1 (Page 4-1) and check for continuity between Pin 1 and B- (ground). If open, check for a missing, bent or corroded pin and faulty wiring and repair as necessary.
8. While P1 and P2 are disconnected, disconnect the connector on control switch S4. Check continuity between the following points: P1-7 and S4-2, P2-3 and S4-1, P2-2 and S4-3, P2-4 and S4-6, and P2-5 and S4-8. If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
9. Replace controller A1 (Page 4-1).
10. Disconnect remote connector P4 and check remote wiring and switch function and repair or replace as necessary.
11. Disconnect control switch S4, check switch function (Page 4-4) and replace if faulty.

### HIGH ENGINE TEMPERATURE—CODE NO. 1

(First-level shutdown—Engine coolant temperature exceed design limit)

**Corrective Action:**

1. Add coolant as necessary and repair leaks (Page 3-7).
2. Replace the engine thermostat, which might not be opening fully (Page 3-10).
3. Clean the raw water tubes in the heat exchanger, which might be clogged with scale (Page 3-11).
4. Flush the coolant system to remove coolant passage fouling (Page 3-7).
5. Test coolant sender E2 (Page 4-5) and replace if necessary.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### LOW OIL PRESSURE—CODE NO. 2

(First-level shutdown—Low oil pressure)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Add engine oil or drain excess oil, as necessary (Page 3-3).
2. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 10 and B- (ground). If resistance is greater than 257 Ohms, check for a missing, bent or corroded pin or faulty wiring or loose ring terminal on sender E1 (Page 4-5). Repair as necessary.
3. Replace the sender with a gauge, ground the sender wire (to keep engine running) and start the engine. *Shut down the engine immediately if there is no oil pressure.*
  - A. If engine oil pressure is less than 14 psi (98 kPa), service the oil lubricating system (Engine Workshop Manual 981-0528).
  - B. If engine oil pressure is at least 14 psi (98 kPa), test oil pressure sender E1 (Page 4-5) and replace if necessary. Replace controller A1 (Page 4-1) if sender E1 is in working order.

### SERVICE CHECK—CODE NO. 3

(First-level shutdown—Indicates presence of second-level shutdown)

**Corrective Action:** Check the second-level shutdown code by pressing **STOP** once. The second-level shutdown code will have two-digits. The shutdowns are listed below in numerical order.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

#### OVERCRANK—CODE NO. 4

(First-level shutdown—Cranking exceeded 20 to 60 seconds [temperature dependent] without start)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
2. Open any closed fuel valves.
3. Remove any blockage in the combustion air inlet (front grille) or exhaust system.
4. Tighten loose fuel line fittings so that air cannot be drawn in by genset lift pump suction.
5. Drain and/or replace the fuel filter (Page 3-5) and prime the fuel system (Page 2-3).
6. Drain and/or replace fuel supply system filters and prime the fuel system (Page 2-3).
7. Conduct a fuel pump flow test and service as necessary (Page 6-3).
8. Inspect and service the glow plugs (Page 6-3) as follows:
  - A. If loose, tighten the glow plug terminals.
  - B. Check for B+ at the glow plug terminals during cranking. If there is no B+, remove glow plug relay K3 from its socket in the control box, test for proper operation (Page 4-7) and replace if necessary. Also check for B+ at relay socket terminal 30, for continuity between terminal 87 and the glow plugs and for continuity between terminal 86 and B- (ground). Clean and tighten connections and replace wiring as necessary.
  - C. Check for B+ at relay socket terminal 85 while cranking. If there is no B+, disconnect connector P3 (green) from controller A1 (Page 4-1) and check for a missing, bent or corroded pin (P3-6) and faulty wire and repair as necessary. If the wire and connections are good, replace controller A1.
  - D. Remove the glow plug bus bar and check for electrical continuity between each glow plug terminal and B- (ground). Replace any open glow plug (Page 6-3).
9. Remove the governor actuator and replace it if malfunctioning (Page 4-8).
10. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 5 and A12+ and between Pin 12 and A12-. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.
11. Replace controller A1 (Page 4-1).
12. Service the engine (Engine Workshop Manual 981-0528).



TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### LOSS OF RAW WATER FLOW—CODE NO. 7

(First-level shutdown—Low raw water pressure in heat exchanger)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Open the sea cock.
2. Close the sea cock and clean the sea water strainer. If the strainer is above the water line, fill it with water to assist priming. Secure the strainer cover and reopen the sea cock.
3. Reconnect or replace any disconnected or leaking raw water hoses (Page 3-7).
4. Remove any blockage from the strainer on the through-hull fitting on the bottom side of the hull.
5. Replace the raw water impeller (Page 3-12).
6. If loose, reconnect the two leads to flow switch S5 (Page 4-6).
7. Check for continuity between S5-2 and B- (ground). If open, clean and tighten connections and replace wiring as necessary.
8. Disconnect connector P1 (black) from controller A1 (Page 4-1) and check for continuity between Pin 4 and S5-1. If open, check for a missing, bent or corroded pin and faulty wiring and repair as necessary.
9. Test flow switch S5 (Page 4-6) and replace if necessary.
10. Remove any blockage from the strainer on the through-hull fitting on the bottom side of the hull.

### OVERVOLTAGE—CODE NO. 12

(Controller unable to maintain rated voltage)

**Corrective Action:**

1. Push line circuit breaker (Page 2-2) to OFF, start the genset and measure output voltage.  
*If output voltage is normal*, the problem is not the genset.  
*If output voltage is high*, test and service the generator (Page 5-2) as necessary.
2. Replace controller A1 (Page 4-1).

### UNDERVOLTAGE—CODE NO. 13

(Controller unable to maintain rated voltage)

**Corrective Action:**

1. Push line circuit breaker (Page 2-2) to OFF, start the genset and measure output voltage.  
*If output voltage is normal*, reduce the number of connected appliances, especially when air conditioners and battery chargers are running.  
*If output voltage is low*, test and service the generator (Page 5-2) as necessary.
2. Replace controller A1 (Page 4-1).

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### OVERFREQUENCY—CODE NO. 14

(Engine governor unable to maintain rated frequency)

#### Corrective Action:

1. If the line circuit breaker or any other circuit breaker has tripped, start the genset before resetting the breaker. (Frequency can overshoot when a circuit breaker trips under load.) *If the genset continues to run*, turn off or disconnect all loads, reset the breaker and bring the loads on one at a time without overloading the genset.
2. Tighten loose fuel line fittings so that air cannot be drawn in by genset lift pump suction.
3. Prime the fuel system to remove air in the fuel lines (Page 2-3).
4. Remove the governor actuator and replace it if malfunctioning (Page 4-8).
5. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 5 and A12+ and between Pin 12 and A12-. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.
6. Replace controller A1 (Page 4-1).

### UNDERFREQUENCY—CODE NO. 15

(Engine governor unable to maintain rated frequency)

#### Corrective Action:

1. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove any blockage in the combustion air inlet (front grille) or exhaust system.
4. Tighten loose fuel line fittings so that air cannot be drawn in by genset lift pump suction.
5. Drain and/or replace the fuel filter (Page 3-5) and prime the fuel system (Page 2-3).
6. Drain and/or replace fuel supply system filters and prime the fuel system (Page 2-3).
7. Conduct a fuel pump flow test and service as necessary (Page 6-3).
8. Remove the governor actuator and replace it if malfunctioning (Page 4-8).
9. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 5 and A12+ and between Pin 12 and A12-. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.
10. Service the fuel injectors and injection pump as necessary (Engine Workshop Manual 981-0528).
11. Check fuel injection timing (Engine Workshop Manual 981-0528).
12. Replace controller A1 (Page 4-1).

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### OVER-PRIME—CODE NO. 17

(Prime mode exceed 5 minutes)

#### Corrective Action:

1. Check for and remove any object that may be holding either control switch (remote or local) in the prime position.
2. Disconnect remote connector P4 and check for continuity between Pins 4 and 2 when the remote switch is *not* held at STOP. If there is continuity, repair or reconnect the remote wiring as necessary.
3. Disconnect control switch S4 and check for continuity between terminals 1 and 2 when the switch is *not* held at STOP (Page 4-4). If there is continuity, replace switch S4.

### GOVERNOR OVERLOAD—CODE NO. 22

(Maximum allowable time at full-duty cycle was exceeded)

#### Corrective Action:

1. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Remove any blockage in the combustion air inlet (front grille) or exhaust system.
4. Tighten loose fuel line fittings so that air cannot be drawn in by genset lift pump suction.
5. Drain and/or replace the fuel filter (Page 3-5) and prime the fuel system (Page 2-3).
6. Drain and/or replace fuel supply system filters and prime the fuel system (Page 2-3).
7. Conduct a fuel pump flow test and service as necessary (Page 6-3).
8. Remove the governor actuator and replace it if malfunctioning (Page 4-8).
9. Service the fuel injectors and injection pump as necessary (Engine Workshop Manual 981-0528).
10. Check fuel injection timing (Engine Workshop Manual 981-0528).
11. Replace controller A1 (Page 4-1).

### FAULTY OIL PRESSURE SENDER—CODE NO. 23

(Controller sensed grounded sender)

#### Corrective Action: (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 10 and B- (ground). If there is a short to ground, repair the wiring or test and replace sender E1 (Page 4-5), as necessary.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### **FAULTY TEMPERATURE SENDER—CODE NO. 24**

(Controller sensed open sender)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Tighten the ring terminal on sender E2 (Page 4-5) if loose. (For isolated-ground applications only, connect flag terminal E2-2 if loose. Also check continuity between E2-2 and B- [ground] and repair wire as necessary.)
2. Measure resistance across sender E2 (Page 4-5) and replace it if open.
3. Disconnect connector P1 (black) from controller A1 (Page 4-1) and check continuity between Pin 9 and ring terminal E2-1. Repair the wiring as necessary if open.

### **LOSS OF VOLTAGE SENSE—CODE NO. 27**

(Controller unable to sense output voltage)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Disconnect connector P3 (green) from controller A1 (Page 4-1) and check continuity between Pin 11 and S1 and between Pin 12 and S2. If open, check for missing, bent or corroded pins and faulty wiring and repair as necessary.
2. Test and service the generator (Page 5-2) as necessary.
3. Replace controller A1 (Page 4-1).

### **HIGH BATTERY VOLTAGE—CODE NO. 29**

(Battery system at more than 19.2 volts if 12 VDC system, or 38.4 volts if 24 volt system)

**Corrective Action:**

1. Check battery bank connections and reconnect if necessary to supply 12 volts or 24 volts, as appropriate.
2. Select a lower external battery boost charge rate.

### **CONTROL CARD FAILURE—CODE NO. 35**

(Microprocessor EEPROM error during self-test)

**Corrective Action:** Replace controller A1 (Page 4-1).

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### ENGINE STOPPED—CODE NO. 36

(Engine stopped without command by controller)

#### Corrective Action:

1. Open any closed fuel supply valves.
2. Check the fuel tank and fill as necessary. (Note: The arrangement of pickup tubes in the fuel supply tank probably is such that the genset will run out of fuel before the propulsion engines.)
3. Check for mechanical damage and service as necessary.
4. Remove any blockage in the combustion air inlet (front grille) or exhaust system.
5. Tighten loose fuel line fittings so that air cannot be drawn in by genset lift pump suction.
6. Drain and/or replace the fuel filter (Page 3-5) and prime the fuel system (Page 2-3).
7. Drain and/or replace fuel supply system filters and prime the fuel system (Page 2-3).
8. Conduct a fuel pump flow test and service as necessary (Page 6-3).
9. Remove the governor actuator and replace it if malfunctioning (Page 4-8).
10. Disconnect connector P1 (black) from controller A1 (Page 4-1) and measure resistance between Pin 5 and A12+ and between Pin 12 and A12-. If either lead is open, check for a missing, bent or corroded pin or faulty wiring and repair as necessary.
11. Replace controller A1 (Page 4-1).
12. Check for a malfunctioning exciter (Page 5-2) or rotor (Page 5-3, 5-4) or open or grounded quadrature circuit (Page ) and service as necessary.
13. Service the engine (Engine Workshop Manual 981-0528).

### INVALID GENSET CONFIGURATION—CODE NO. 37

(Controller cannot determine genset operating parameters)

#### Corrective Action:

1. Disconnect connector P2 (grey) from controller A1 (Page 4-1) and check continuity between Pin 9 and B- (ground). *Pin 9 should not be grounded.* Repair the wiring as necessary.
2. Replace controller A1 (Page 4-1).

### FIELD OVERLOAD—CODE NO. 38

(High field voltage induced by high rotor temperature or low power factor loads)

#### Corrective Action:

1. Remove blockages to generator air flow at the front inlet grill and right side, if enclosed.
2. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners.
3. Have air conditioners and other appliances checked for proper operation. (A locked compressor rotor can cause very low power factor.)
4. Test and service the generator (Page 5-2) as necessary.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

### GROUNDING ROTOR—CODE NO. 41

(F+ grounded)

**Corrective Action:** (Refer to Page A-1 and to Page A-2 or A-3, as appropriate.)

1. Disconnect connector P3 (green) from controller A1 (Page 4-1) and check for continuity between Pin 7 (F+) and B- (ground). **Pin 7 should not be grounded.** Repair or replace wiring and/or the exciter stator (Page 5-2), as necessary.
2. Replace controller A1 (Page 4-1).

### PROCESSOR FAILURE—CODE NO. 42

(Microprocessor ROM error during self-test)

**Corrective Action:** Replace controller A1 (Page 4-1).

### PROCESSOR FAILURE—CODE NO. 43

(Microprocessor RAM error during self-test)

**Corrective Action:** Replace controller A1 (Page 4-1).

### PROCESSOR FAILURE—CODE NO. 48

(Controller unable to sense field voltage)

**Corrective Action:** Replace controller A1 (Page 4-1).

### HIGH EXHAUST TEMPERATURE—CODE NO. 58

(Exhaust temperature exceeded design limits)

**Corrective Action:**

1. Check for and reconnect or replace any disconnected or leaking raw water hoses (Page 3-7).
2. Check for and replace a worn raw water impeller (Page 3-12).
3. Disconnect connector P1 (black) from controller A1 (Page 4-1) and check continuity between Pin 11 and B- (ground). If open, check for a missing, bent or corroded pin, faulty wiring or open exhaust temperature switch S6 (Page 4-6). Repair as necessary.

TABLE 7-1 . TROUBLESHOOTING (CONT.)

**⚠ WARNING** *Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.*

*Accidental or remote starting can cause severe personal injury or death. Before removing an access door or belt guard, disconnect the negative (-) cable from the battery to prevent the engine from starting.*

**LOW COOLANT LEVEL—CODE NO. 59**

(Exhaust temperature exceeded design limits)

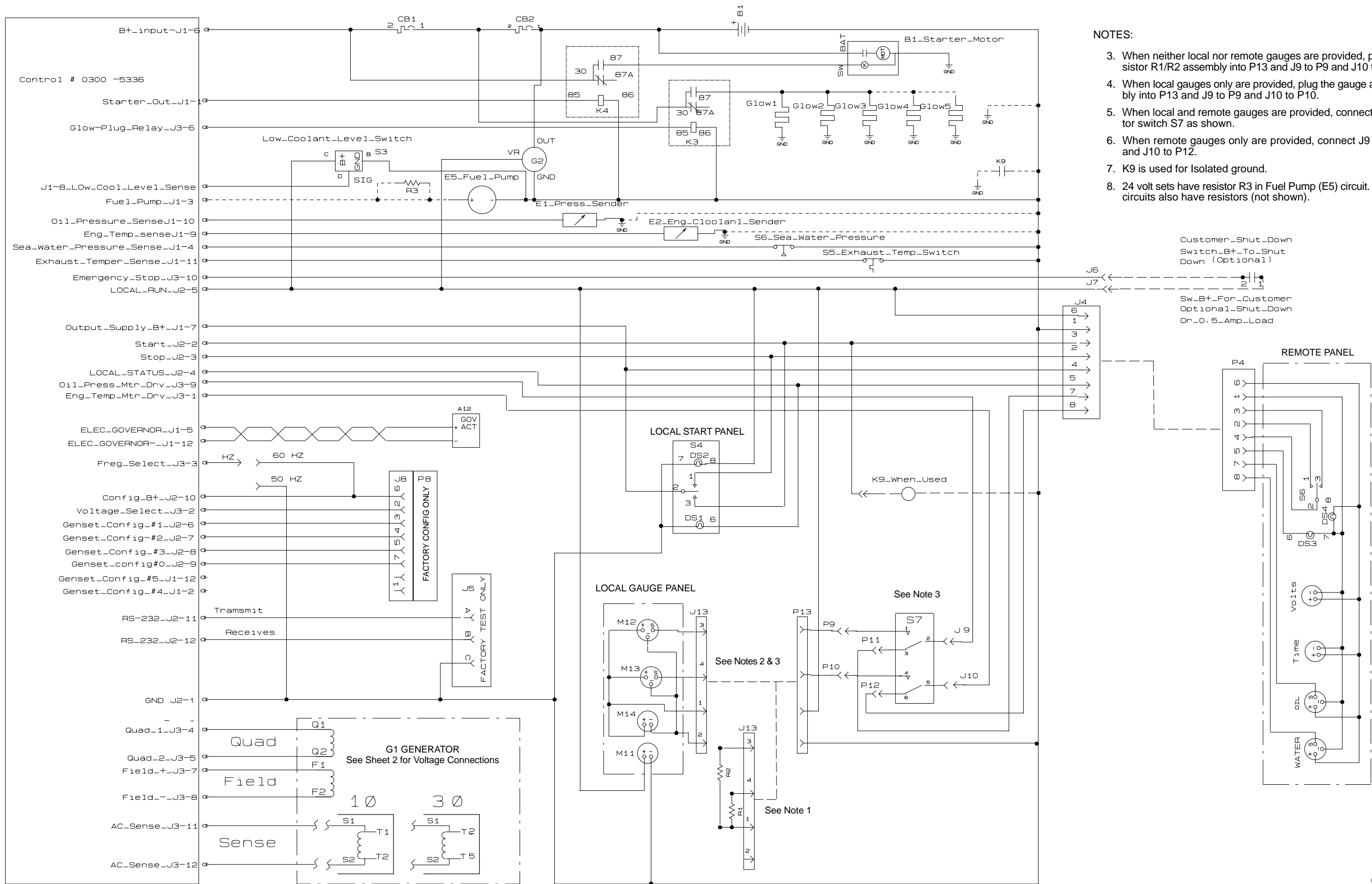
**Corrective Action:** Add coolant as necessary and repair leaks (Page 3-7).

**EMERGENCY SHUTDOWN—CODE NO. 61**

(Genset was shut down by a fire suppression system or other external control)

**Corrective Action:**

1. Make all necessary repairs to the genset and connected equipment and reset the external control which shut down the genset.
2. Disconnect the external wiring connected at connector J6 and check for B+. If there is B+, find out why and reconnect or repair the external control circuit.

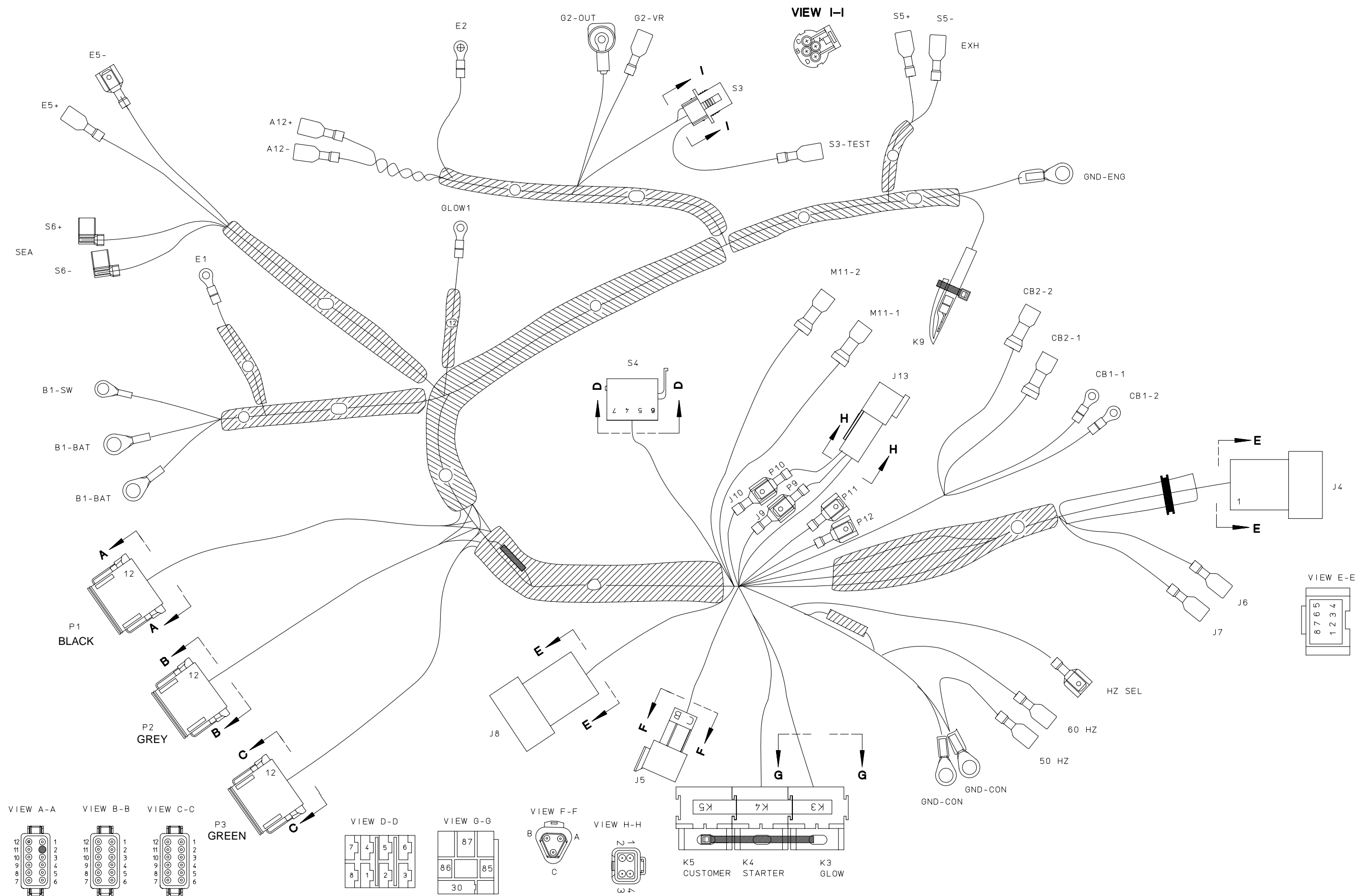


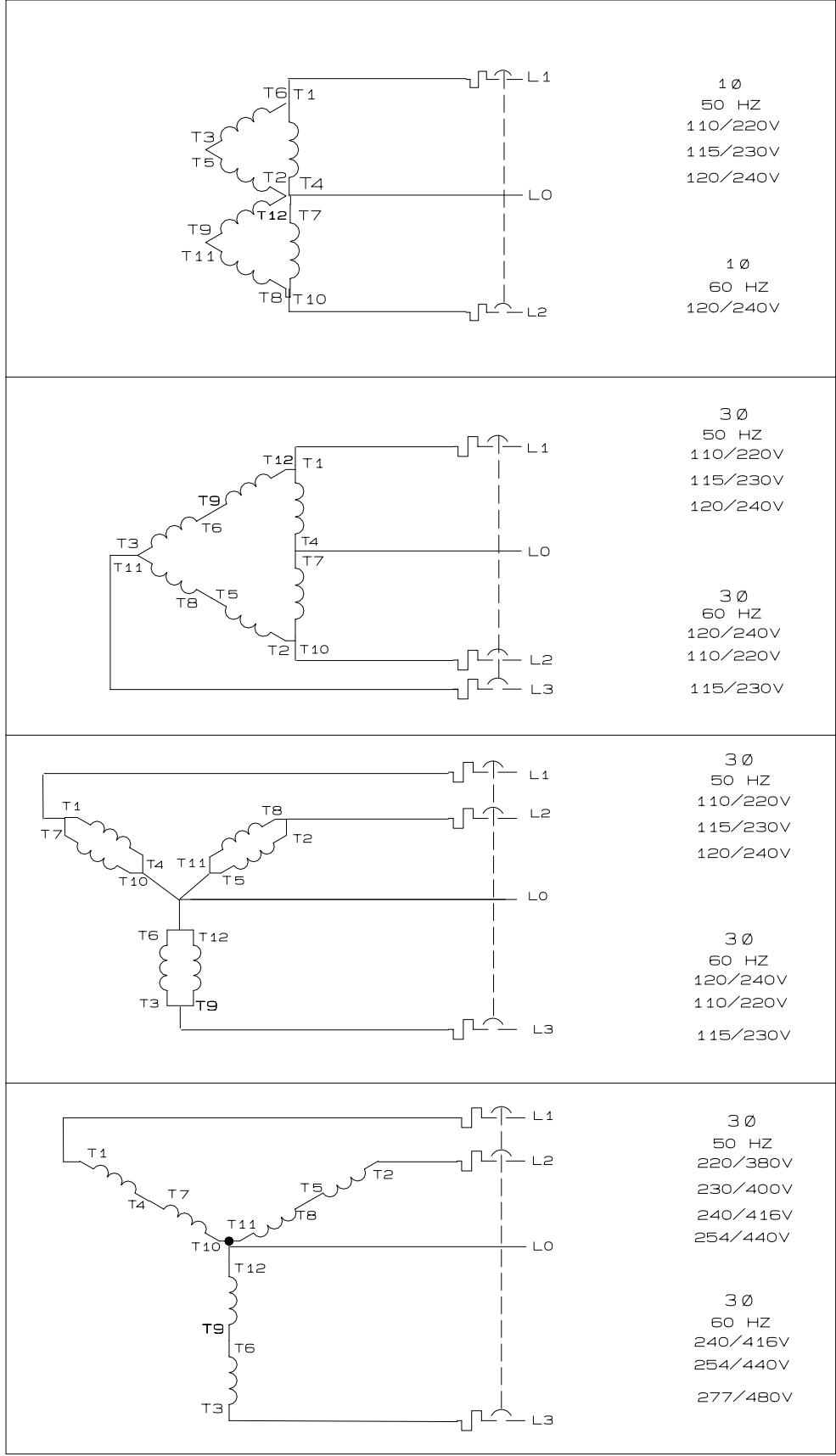
- NOTES:
- When neither local nor remote gauges are provided, plug resistor R1/R2 assembly into P13 and J9 to P9 and J10 to P10.
  - When local gauges only are provided, plug the gauge assembly into P13 and J9 to P9 and J10 to P10.
  - When local and remote gauges are provided, connect selector switch S7 as shown.
  - When remote gauges only are provided, connect J9 to P11 and J10 to P12.
  - K9 is used for Isolated ground.
  - 24 volt sets have resistor R3 in Fuel Pump (E5) circuit. Gauge circuits also have resistors (not shown).

WIRING DIAGRAM









3 Ø Generator Reconnection

| VOLTAGE   | A          | B          | C                  | HZ |
|-----------|------------|------------|--------------------|----|
|           | 100<br>120 | 200<br>240 | 100/200<br>120/240 | 60 |
| SCHEMATIC | 110<br>115 | 220<br>230 | 110/220<br>115/230 | 50 |
|           |            |            |                    |    |
| DIAGRAM   |            |            |                    |    |
|           |            |            |                    |    |

1 Ø Generator Reconnection



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