



Service Manual

Cummins **Onan**

Performance you rely on.™



RV Generator Set

HDKAH (Spec A-M)
HDKAJ (Spec A-M)
HDKAK (Spec A-M)
HDKAT (Spec A-M)
HDKAU (Spec A-M)
HDKAV (Spec A-M)

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.



WARNING



**Do not use this genset on a boat
Such use may violate U. S. Coast Guard
regulations and can result in
severe personal injury or death from
fire, electrocution, or
carbon monoxide poisoning**



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SAFETY PRECAUTIONS

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

The following symbols in this manual alert you to potential hazards to the operator, service person and equipment.

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

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

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

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

ENGINE EXHAUST IS DEADLY

- Inspect for exhaust leaks at every startup and after every eight hours of running.
- Learn the symptoms of carbon monoxide poisoning in the Operator's Manual.
- Never sleep in the vehicle while the genset is running unless the vehicle is equipped with a working carbon monoxide detector.
- Do not operate the genset when the vehicle is in a confined space, such as a garage.
- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before storing the vehicle or parking it in a garage or other confined space.
- The exhaust system must be installed in accordance with the genset Installation Manual.

- Engine cooling air must not be used for heating working or living spaces or compartments.

GENERATOR VOLTAGE IS DEADLY

- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before servicing the genset.
- 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 the public utility or any other source of electrical power. Back-feed could lead to electrocution of utility personnel 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.

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.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before servicing the genset.
- Do not wear loose clothing or jewelry near moving parts such as PTO shafts, fans, belts and pulleys.
- Keep hands away from moving parts.

BATTERY GAS IS EXPLOSIVE

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

FLAMMABLE VAPOR CAN CAUSE A DIESEL ENGINE TO OVERSPEED

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

GENERAL PRECAUTIONS

- Keep children away from the genset.
- Do not use evaporative starting fluids. They are highly explosive.
- 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 out and cause severe burns.
- Keep the genset and its compartment clean. Excess oil and oily rags can catch fire. Dirt and gear stowed in the compartment can restrict cooling air.
- Make sure all fasteners are secure and torqued properly.
- Do not work on the genset when mentally or physically fatigued or after consuming 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.
- Keep guards in place over fans, belts, pulleys, and other moving parts.

1. Introduction

ABOUT THIS MANUAL

This is the Service Manual for the generator set (genset) models listed on the front cover. Read and carefully observe all of the instructions and precautions in this manual.

⚠ WARNING *Improper service or parts replacement 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.*

⚠ CAUTION *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 for important recommendations concerning the installation and for a list of the installation codes and standards for safety which may be applicable.

See the Parts Catalog for parts identification numbers and required quantities. Genuine Onan® replacement parts are recommended for best results.

SERVICE PARTS AND INFORMATION

When contacting Onan for parts, service or product information, be ready to provide the model number and the serial number, both of which appear 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.)

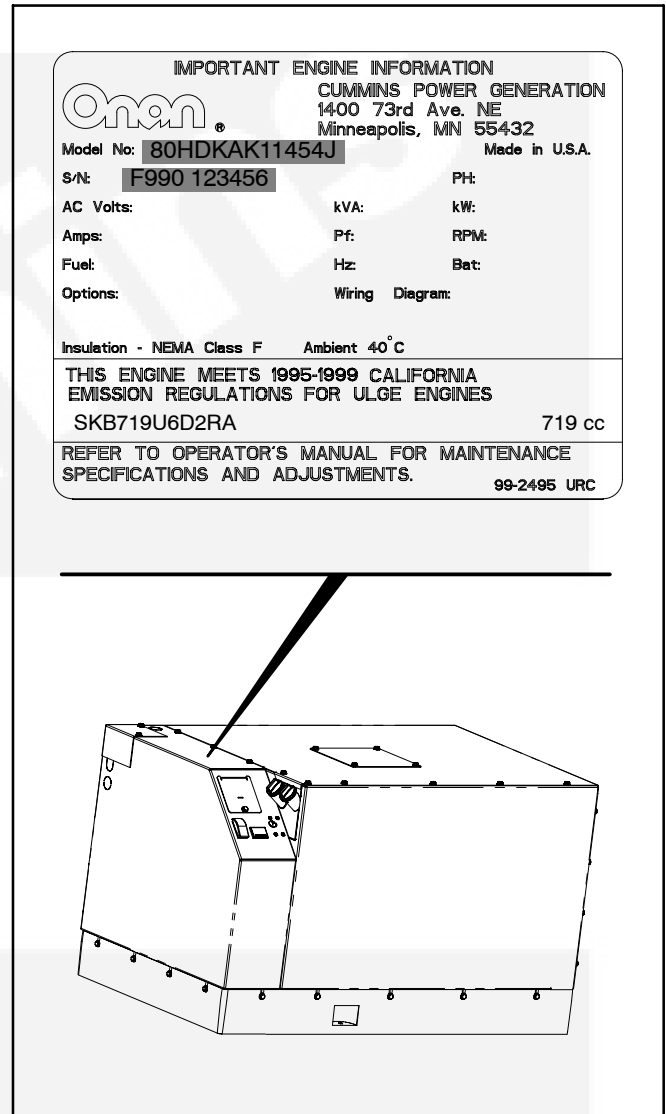


FIGURE 1-1. TYPICAL NAMEPLATE

TYPICAL GENSET

Figure 1-2 illustrates a typical genset.

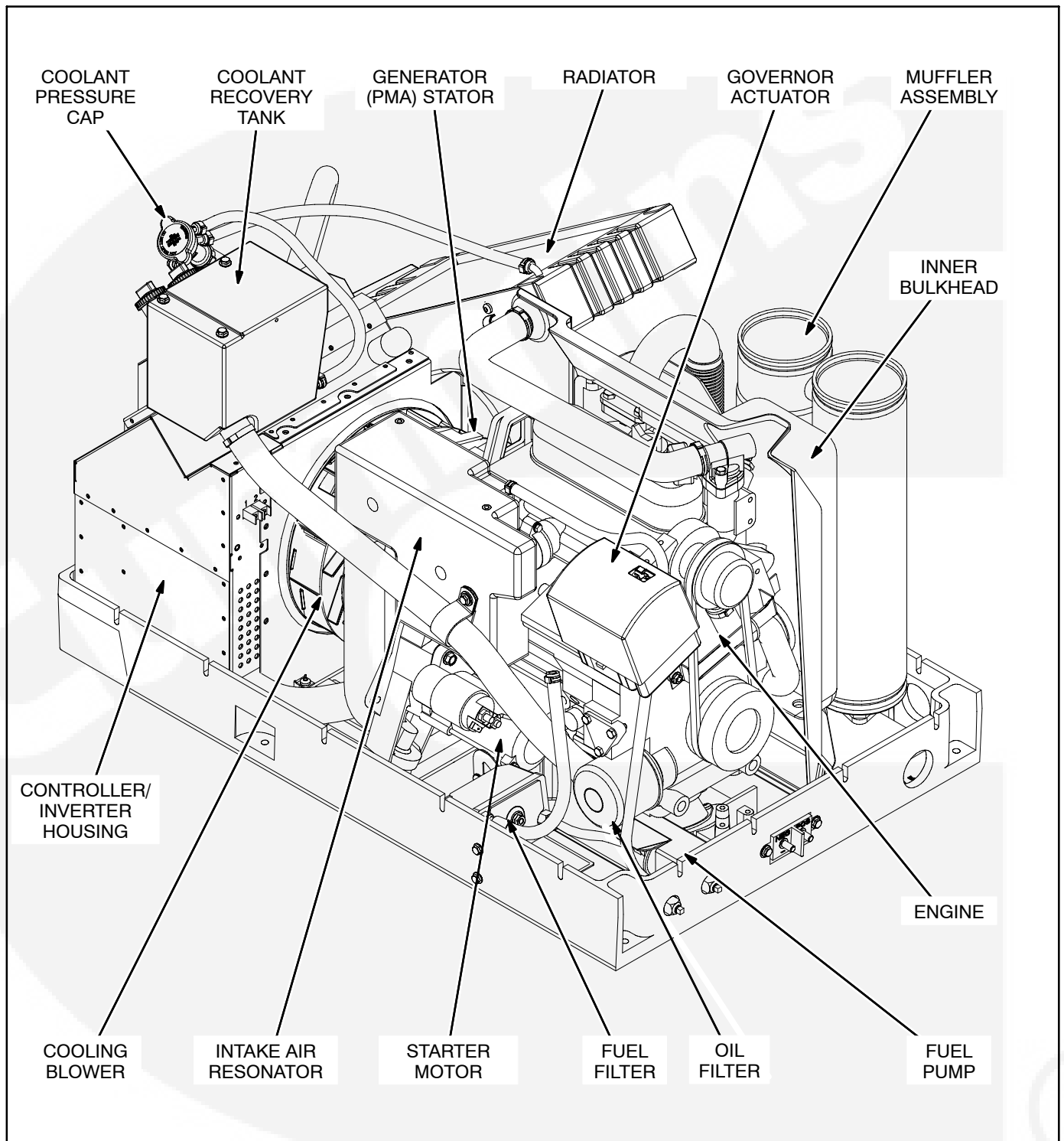


FIGURE 1-2. TYPICAL GENSET WITH HOUSING PANELS REMOVED

2. Specifications

	HDKAH	HDKAJ	HDKAK
GENSET CONTROLLER: Integrated Microprocessor Based Engine and Generator Controller			
GENERATOR: Brushless, Exciterless, Bearingless, Permanent Magnet Alternator			
AC OUTPUT RATINGS:			
Power (@1.0 power factor)	6000 W	7500 W	8000 W
Voltage	120 volts	120 volts	120 volts
Frequency	60 Hz	60 Hz	60 Hz
Number of Phases	1	1	1
Current	50.0 ampere	62.5 ampere	66.7 ampere
Line Circuit Breaker(s)	2-pole, 30 amp	2-pole, 30 or 35 amp	2-pole, 30 or 35 amp
ENGINE: 3-Cylinder In-Line, Water-Cooled, Indirect-Injection, 4-Stroke Cycle Diesel			
Bore	2.64 inch (67 mm)		
Stroke	2.68 inch (68 mm)		
Displacement	44 inch ³ (719 cc)		
Compression Ratio	23 : 1		
Oil Capacity (with filter)*	3 quart (2.6 l)		
Cooling System Capacity**	4.2 quart (4 l)		
Intake and Exhaust Valve Lash (Cold)	0.0065 inch (0.165 mm)		
Lubricating Oil Pressure	14 to 64 psi over speed range		
Cylinder Compression Pressure	414 to 469 psi, 327 psi minimum		
OPERATING SPEED RANGE:	1600 to 2900 RPM	1600 to 3200 RPM	1600 to 3300 RPM
FUEL CONSUMPTION:			
No-load	0.13 gph (.49 l/h)	0.13 gph (.49 l/h)	0.13 gph (.49 l/h)
Half-load (4000 W)	0.49 gph (1.85 l/h)	0.49 gph (1.85 l/h)	0.49 gph (1.85 l/h)
Full-load	0.80 gph (3.03 l/h)	0.96 gph (3.63 l/h)	1.02 gph (3.86 l/h)
DC SYSTEM:			
Nominal Battery Voltage	12 volts		
Minimum Battery Capacity	450 CCA*** down to 0° F (–17° C) 650 CCA*** down to –20° F (–29° C)		
Maximum Regulated-Voltage Battery Charging Current (Optional)	10 ampere		
Fuse F1 (control circuit)	10 ampere mini-bayonet		
Fuse F2 (starter solenoid circuit)	10 ampere mini-bayonet		
Fuse F3 (glow plug circuit)	25 ampere		
WEIGHT AND SIZE:			
Weight (wet)	420 lbs (191 kg)		
Length x Width x Height	36.3 x 23.6 x 22.3 inch (922 x 599 x 566 mm)		
* See oil filling instructions.			
** Includes coolant recovery tank.			
*** Cold Cranking Amps @ 0° F (–17° C)			

	HDKAV	HDKAT	HDKAU
GENSET CONTROLLER: Integrated Microprocessor Based Engine and Generator Controller			
GENERATOR: Brushless, Exciterless, Bearingless, Permanent Magnet Alternator			
AC OUTPUT RATINGS:			
Power (@1.0 power factor)	6000 W	7500 W	8000 W
Voltage	120 volts	120 volts	120 volts
Frequency	60 Hz	60 Hz	60 Hz
Number of Phases	1	1	1
Current	50.0 ampere	62.5 ampere	66.7 ampere
Line Circuit Breaker(s)	2-pole, 30 amp	2-pole, 30 or 35 amp	2-pole, 30 or 35 amp
ENGINE: 3-Cylinder In-Line, Water-Cooled, Indirect-Injection, 4-Stroke Cycle Diesel			
Bore	2.64 inch (67 mm)		
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*** Cold Cranking Amps @ 0° F (–17° C)			

3. Thread Torques

	lbf-ft*	N-m *
Air Cleaner Cover Bolt—Three to four clicks past seating.	–	–
Air Cleaner Housing Mounting Screws	7-9	10-12
Intake Air Hose Clamp Screws	7-9	10-12
Air Intake Resonator Mounting Screws	7-9	10-12
Fuel Pump Mounting Screws	75-80 lbf-inch	8.5-9
Fuel Fitting At Fuel Pump	7-9	10-12
Fuel Fittings at Fuel Filter—One flat passed finger tight.	–	–
Exhaust Assembly Flange Bolts	16-20	22-28
Exhaust Isolator Clamp Screws	7-9	10-12
Housing Panel Screws	11-13	15-18
Component Mounting Screws (threads into skid-base)	7-9	10-12
Vibration Isolator Center Bolt	43-53	58-72
Vibration Isolator Mounting Screws	7-9	10-12
Battery Cable Terminal Block Terminal Nuts	6.7-8.3	9-11
Battery Cable Terminal Block Mounting Screws	7-9	10-12
Starter Solenoid Terminal Nuts	4.4-8.7	5.9-11.8
AC Output Terminal Block Terminal Screws	12-14 lbf-inch	1.4-1.6
AC Output Terminal Block Mounting Screws	20-22 lbf-inch	2.2-2.5
Circuit Breaker Terminal Screws	12-14 lbf-inch	1.4-1.6
Circuit Breaker Mounting Screws	12-14 lbf-inch	1.4-1.6
Flywheel Housing Mounting Bolts	18-22	24-30
Rotor/Flywheel Mounting Bolts	40-43	53.9-58.8
Stator Mounting Bolts	7-9	10-12
Blower Mounting Bolts	7-9	10-12
Starter Mounting Bolts	18-22	24-30
Oil Pan Mounting Bolts	5.8-6.9	7.9-9.3
Coolant Temperature Sender (use thread sealant)	26-32	35-43
Low Oil Pressure Switch (use thread sealant)	10.8-14.5	14.7-19.6
Governor Actuator Bearing Carrier Mounting Screws	21-27 lbf-inch	2.4-3.0
Oil Fill Hose Support Clip Screw	7-9	10-12
M6 Engine Bolts Except When Otherwise Specified	5.8-6.9	7.9-9.3
M8 Engine Bolts Except When Otherwise Specified	13.0-15.2	17.7-20.6
M10 Engine Bolts Except When Otherwise Specified	28.9-33.3	39.2-45.1
M12 Engine Bolts Except When Otherwise Specified	46.3-53.5	62.8-72.6

* – Use engine oil as a lubricant for all threads except when otherwise specified.

4. Operation

FUEL RECOMMENDATIONS

Use clean, fresh No. 2 diesel fuel (ASTM 2-D) in ambients above freezing and No. 1 diesel fuel (ASTM 1-D) in ambients below freezing. The fuel should have a Cetane number of at least 45 for reliable starting.

⚠️WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near diesel fuel tanks or equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and switches and all other sources of ignition well away. Keep a type ABC fire extinguisher in the vehicle.*

ENGINE OIL RECOMMENDATIONS

Use API (American Petroleum Institute) performance Class **CH-4**, **CG-4** or **CF-4D** engine oil, which may be in combination with performance

Class SJ, SH or SG (for example: CH-4/SJ). Also look for the SAE (Society of Automotive Engineers) viscosity grade. Referring to Figure 4-1, choose the viscosity grade appropriate for the ambient temperatures expected until the next scheduled oil change.

STARTING BATTERIES

These gensets have a 12 volt, direct current (DC) starting and control system. See *Specifications* for minimum battery requirements (cold cranking amperes) for genset starting.

Regular, monthly maintenance of batteries may be required. See *Periodic Maintenance*, and any instructions available from the vehicle manufacturer or battery manufacturer. Either the vehicle or the genset will be equipped with a battery charger.

Reliable genset starting and starter service life depend upon adequate battery system capacity and proper maintenance.

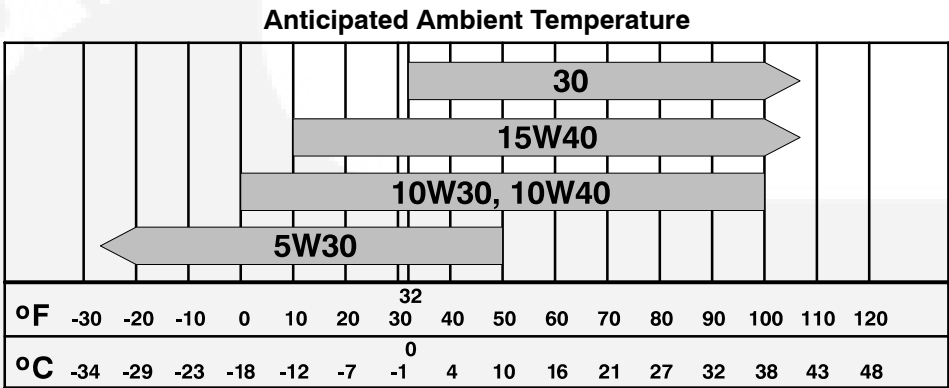


FIGURE 4-1. OIL VISCOSITY VS. TEMPERATURE

OPERATOR'S CONSOLE

The operator's console (Figure 4-2) has the following features:

Control Switch – This switch is used to start and stop the genset, prime the engine fuel system and restore the fault code (blinking status light).

Status Light – This is an LED (light emitting diode) in the control switch which blinks rapidly during pre-heat and cranking. (Preheat is the period of time prior to engine cranking when the glow plugs pre-heat the combustion chambers. The time is automatically varied by the genset controller on the basis of engine temperature.) After the genset starts up, this light stays on continuously, indicating that the genset is running and that the starter has disconnected. Also, if the genset shuts down, this light blinks in a coded fashion to indicate the nature of the shutdown. See *Troubleshooting*.

Line Circuit Breaker(s) – The line circuit breaker(s) protect the AC power leads connected to the genset.

Engine Oil Fill Cap/Dipstick – The oil dipstick is attached to the fill cap and is marked ADD and FULL.

Coolant Recovery Tank Fill Cap – The recovery tank provides for coolant expansion. Replenish the normal loss of coolant by filling here.

Coolant Pressure Cap – The coolant pressure cap is accessible by removing the access plate on the control console. It provides for a pressurized engine cooling system. Fill coolant here when refilling the system.

Fuses F1, F2 and F3 – These fuses are accessible by removing the access plate on the control console. They protect the control circuits of the genset.

REMOTE CONTROL PANEL

The vehicle may be equipped with a remote control panel having a **Control Switch** and **Preheat/Diagnostics Light**. In addition, it may have an hour meter and the following engine gauges:

Oil Pressure Gauge – The oil pressure gauge indicates the presence of engine oil pressure.

Water Temperature Gauge – The water temperature gauge indicates engine coolant temperature.

Voltmeter – The voltmeter indicates battery voltage.

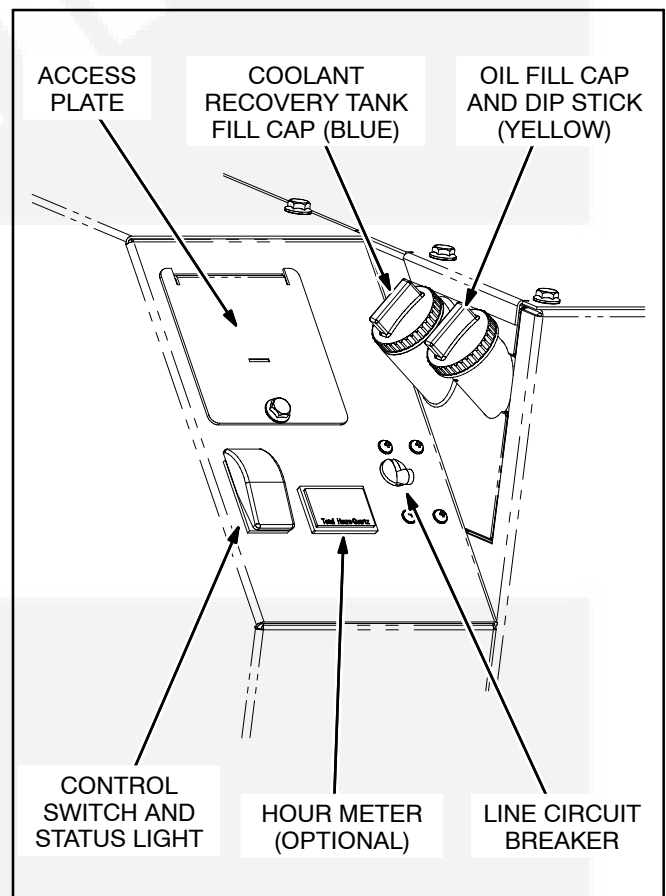


FIGURE 4-2. OPERATOR'S CONSOLE

⚠ WARNING **EXHAUST GAS IS DEADLY!** All engine exhaust contains carbon monoxide, an odorless, colorless, poisonous gas that can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

- Dizziness
- Nausea
- Vomiting
- Headache
- Weakness and Sleepiness
- Inability to Think Coherently

IF YOU EXPERIENCE ANY OF THESE SYMPTOMS, GET INTO FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the genset and do not operate it until it has been inspected and repaired.

Never sleep in the vehicle while the genset is running unless the vehicle has a working carbon monoxide detector. The exhaust system must be installed in accordance with the genset Installation Manual. Make sure there is ample fresh air when operating the genset in a confined area.

PRIMING THE FUEL SYSTEM

The fuel system should be primed after replacing the fuel filter or running the genset out of fuel. To prime the fuel system hold the control switch down in its **Stop** position for at least 1 minute.

STARTING

The genset can be started and stopped from the genset control panel or from a remote control panel inside the vehicle.

1. Review *Powering Equipment, Varying Operating Conditions, Genset Break-In, Exercise and Storage* and the *Maintenance Record* in the Operator's Manual before starting or servicing the genset.
2. Check fuel, oil and coolant levels, prime the fuel system if necessary (by pushing the **Stop** switch), and turn off the air conditioner(s) and other large electrical loads.
3. Push the control switch to its **Start** position and hold it there while the status light blinks rapidly indicating preheat. Let go when the light comes on continuously, indicating that the genset is running and that the starter has been disconnected. (Depending on how cold it is, preheat can take up to 15 seconds, extending the time that the light blinks.)

⚠ CAUTION Excessive cranking can overheat and damage the starter motor. Do not crank for more than 30 seconds at a time. Wait at least 2 minutes before trying again.

4. See *Troubleshooting* if the genset does not start after three tries.
5. Let the genset warm up a few minutes until it is running smoothly before connecting the vehicle electrical loads (appliances).
6. Monitor the engine gauges if the remote panel is so equipped. Normal readings during operation are as follows:

Oil Pressure: Approximately center of scale

Temperature: 160°-220° F (71°-104° C)

DC Voltage: 14-15 volts.

7. Check for fuel, coolant and exhaust leaks. Stop the genset immediately if there is a fuel, coolant or exhaust leak and repair it before continuing operation.

STOPPING

Run the genset at no load for a few minutes to allow the engine to cool down and then push the control switch briefly to its **Stop** position.

5. Periodic Maintenance

PERIODIC MAINTENANCE SCHEDULE

Periodic maintenance is essential for top performance and long genset life. Use Table 5-1 as a

guide for normal periodic maintenance. Under hot or dusty operating conditions some maintenance operations should be performed more frequently, as indicated by the footnotes in the table.x

TABLE 5-1. PERIODIC MAINTENANCE SCHEDULE

MAINTENANCE OPERATION	MAINTENANCE FREQUENCY					
	Every Day	Every Month	Every 150 Hours	Every 500 Hours	Every 1000 Hours	P a g e
General Inspection	x					5-2
Check Engine Oil Level	x					5-3
Check Engine Coolant Level	x					5-8
Clean and Check Battery		x ³				5-3
Change Engine Oil and Filter			x ^{1, 2, 3, 4}			5-3
Clean Spark Arrestor			x ⁴			5-5
Replace Engine Air Filter				x ^{2, 4}		5-6
Replace Fuel Filter				x ⁴		5-7
Check Coolant Anti-freeze Protection				x ⁴		5-8
Flush Coolant System					x ⁵	5-8
Replace Coolant Pressure Cap					x ⁵	5-8
Replace Coolant Hoses and Thermostat					x ^{6, 7}	12-1
Replace Engine V-belt					x ^{6, 7}	12-1
Clean Crankcase Breather					x ^{6, 7}	12-1
Adjust Valve Lash					x ⁷	12-1
1. As a part of engine break-in, change the engine oil and oil filter after the first 50 hours of operation. 2. Perform more often when operating in dusty conditions. 3. Perform more often when operating in hot weather. 4. Perform at least once a year. 5. Perform at least once every two years. 6. Perform at least once every five years. 7. Must be performed by a qualified mechanic (authorized Onan dealer).						

GENERAL INSPECTION

Inspect the genset before the first start of the day.

Oil Level

Check engine oil level (p. 5-3).

Engine Coolant System

Check the coolant level and look for coolant leaks around the bottom of the genset and on the ground below. Minor leaks that can be replenished by daily additions of coolant to the recovery tank should be repaired by a qualified service technician as soon as possible. Larger leaks are cause for shutting down the genset until it can be repaired.

⚠ CAUTION *Operating the genset when the coolant level is low can cause serious engine damage.*

Exhaust System

Look and listen for exhaust system leaks while the genset is running. Shut down the genset if a leak is found and have it repaired before operating the genset.

Look for openings or holes between the genset compartment and vehicle cab or living space if the genset engine sounds louder than usual. Have all such openings or holes closed off and sealed to prevent exhaust gases from entering the vehicle.

Replace dented, bent or severely rusted sections of the tailpipe and make sure the tailpipe extends at least 1 inch (25.4 mm) beyond the perimeter of the vehicle.

Park the vehicle so that the genset exhaust gases can disperse away from the vehicle. Barriers such as walls, snow banks, high grass and brush and other vehicles can cause exhaust gases to accumulate in and around the vehicle.

Do not operate power ventilators or exhaust fans while the vehicle is standing with the genset running. The ventilator or fan can draw exhaust gases into the vehicle.

⚠ WARNING *EXHAUST GAS IS DEADLY! Do not operate the genset if there is an exhaust leak or any danger of exhaust gases entering or being drawn into the vehicle.*

⚠ WARNING *Do not park the vehicle in high grass or brush. Contact with the exhaust system can cause a fire.*

Fuel System

Look for fuel leaks around the bottom of the genset and its fuel supply lines when the genset is running. Do not operate the genset if there is a fuel leak. Have the leaks fixed as soon as possible.

⚠ WARNING *Diesel fuel leaks can lead to fire. Do not operate the genset if operation causes fuel to leak.*

Mechanical

Look for mechanical damage. Start the genset and look, listen and feel 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.

Check the engine gauges from time to time while the genset is running (if so equipped).

Battery Connections

Check the battery terminals for clean, tight connections. See BATTERIES (p. 5-6).

CHECKING ENGINE OIL LEVEL

Shut off the genset before checking the engine oil level.

1. Remove the oil fill cap (yellow) and wipe the stick clean (Figure 5-1).
2. Screw the oil fill cap back on and remove it to check the oil level on the dipstick.
3. Add oil as necessary until the full mark is reached. See ENGINE OIL RECOMMENDATIONS (p. 4-1). DO NOT FILL TO A LEVEL ABOVE THE FULL MARK ON THE DIPSTICK. Drain the excess oil if too much has been added.

⚠ CAUTION *Too much oil can cause high oil consumption, high operating temperatures and oil foaming. Too little oil can cause severe engine damage. Keep the oil level between the Full and Add marks on the dipstick.*

4. Screw the oil fill cap on securely to prevent oil leakage.

CHANGING ENGINE OIL AND OIL FILTER

Refer to Table 5-1 for scheduled engine oil change. In hot weather and dusty conditions the oil should be changed more often.

⚠ WARNING *State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. Take care to limit skin contact and breathing of vapors as much as possible. Use rubber gloves and wash exposed skin.*

1. Place a pan under the oil drain plug. Run the engine until it is warm and shut it off.
2. Remove the oil fill cap (Figure 5-1).
3. Unscrew the oil drain plug (Figure 5-2) and allow all of the oil to drain from the engine.
4. Reinstall the oil drain plug and tighten it securely to prevent oil leakage.

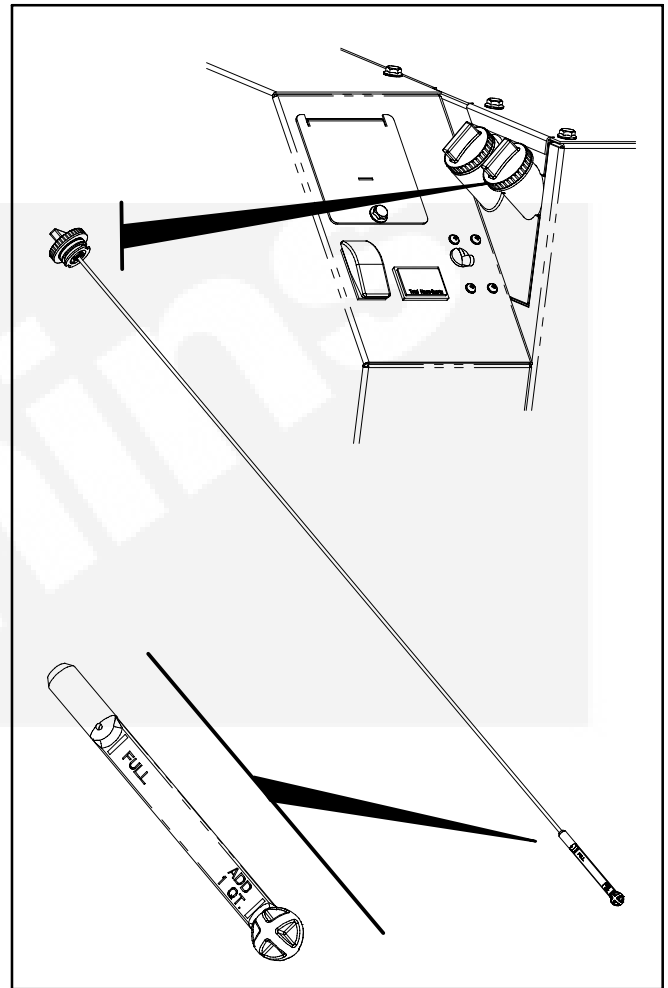


FIGURE 5-1. OIL DIPSTICK

5. Squeeze the access door latches together and let the door swing down (Figure 5-2). Spin off the oil filter canister, drain it of oil and discard it according to local regulations.
6. Thoroughly wipe off the filter mounting surface. Remove the old gasket if it does not come off with the filter canister.
7. Make sure the new gasket is in place on the new filter canister and apply a thin film of oil to the gasket. (The replacement filter canister has a larger diameter than the original filter canister, but will fit.)
8. Spin on the new filter canister by hand until the gasket just touches the mounting pad and then turn it an additional 1/2 to 3/4 turn. Do not over-tighten. Close the access door, making sure it latches securely.
9. Refill and check the oil level. See *Specifications* for oil capacity.
10. Dispose of the used oil properly.

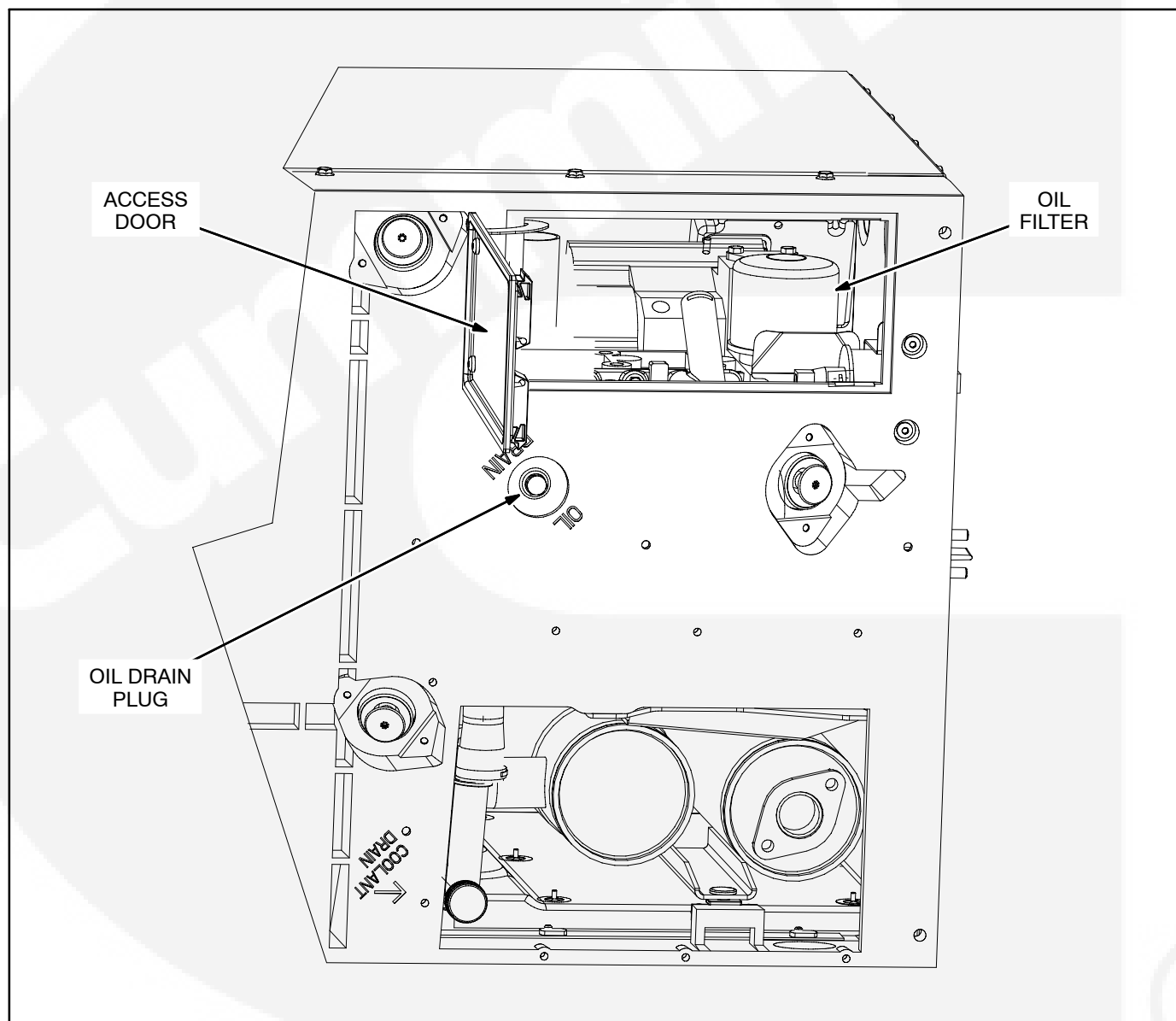


FIGURE 5-2. OIL DRAIN PLUG AND OIL FILTER

SPARK ARRESTOR

Refer to Table 5-1 for scheduled cleaning of the spark arrestor muffler (which meets U.S. Forest Service requirements). Cleaning is required for maximum genset performance.

⚠WARNING *A hot muffler can cause severe burns. Let the muffler cool down before removing or installing the cleanout plug.*

The muffler is mounted inside the genset housing. The cleanout plug is located on the side of the muf-

fler, accessible through the air outlet opening in the bottom of the genset. Clean out the spark arrestor muffler as follows:

1. Remove the cleanout plug from the muffler (Figure 5-3).
2. Restart the genset and load it nearly to full power. Let the genset run for about five minutes to expel the soot in the muffler.
3. Stop the genset, allow the muffler to cool down and then reinstall the plug.

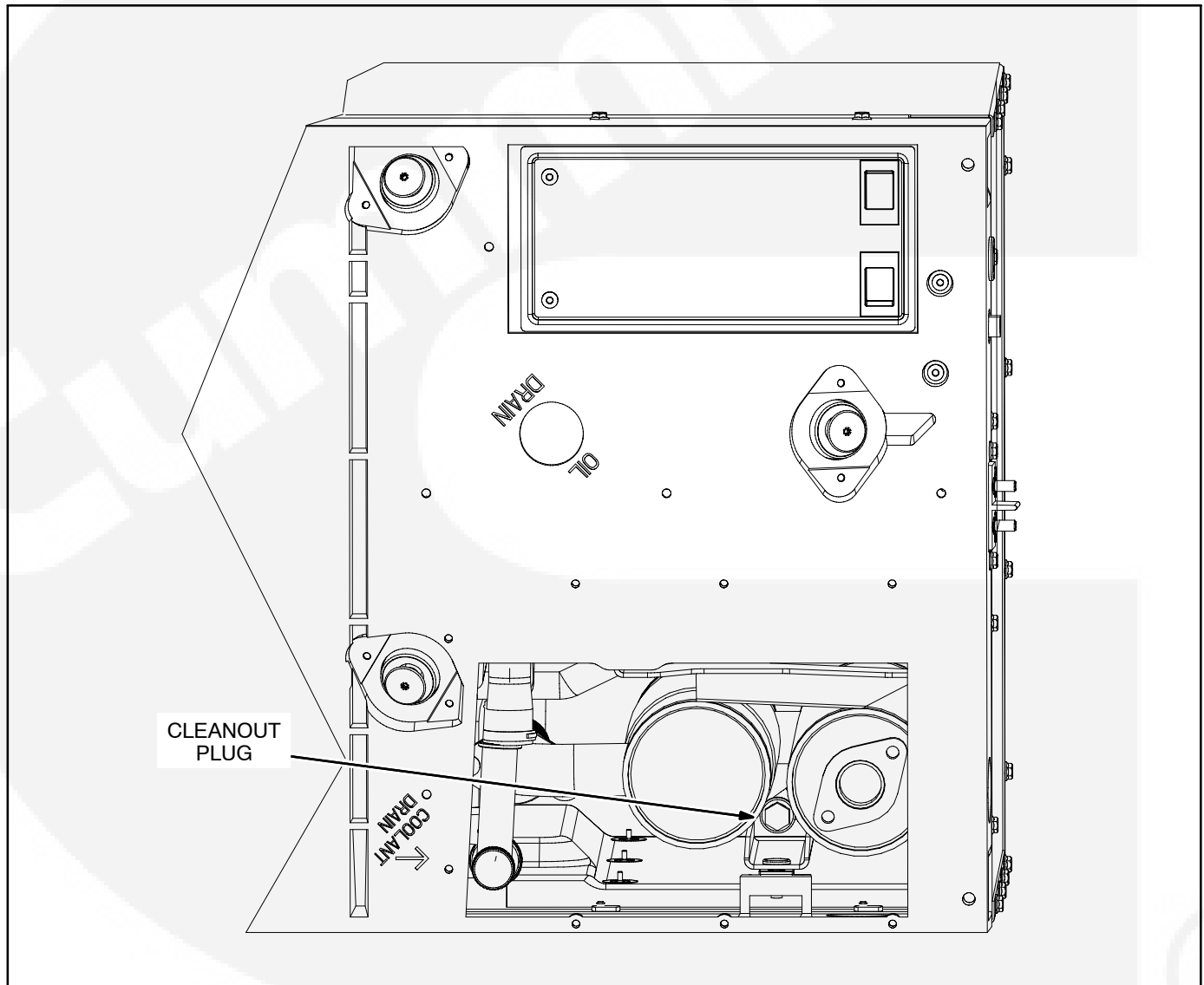


FIGURE 5-3. SPARK ARRESTOR CLEANOUT PLUG

BATTERIES

⚠WARNING *Arcing at battery terminals, light switch or other equipment, flame, and sparks can ignite battery gas causing severe personal injury.*

Ventilate battery area before working on or near battery—Wear safety glasses—Do not smoke—Switch trouble light ON or OFF away from battery—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

Refer to Table 5-1 for scheduled battery maintenance, and 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 and terminals clean and dry and the terminals tight.

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 removing the negative (–) cable first and reconnecting it last to reduce arcing.

AIR FILTER

Refer to Table 5-1 for scheduled air filter replacement. In dusty conditions the air filter element should be inspected and changed more frequently for best operation. To change the air filter element, remove the outer and inner covers (Figure 5-4) and reassemble with a new air filter element. Turn the inner cover wingnut three to four clicks past seating. Make sure the outer cover is seated before tightening its wingnut. ***Check for noise when the genset is running, and retighten if necessary.***

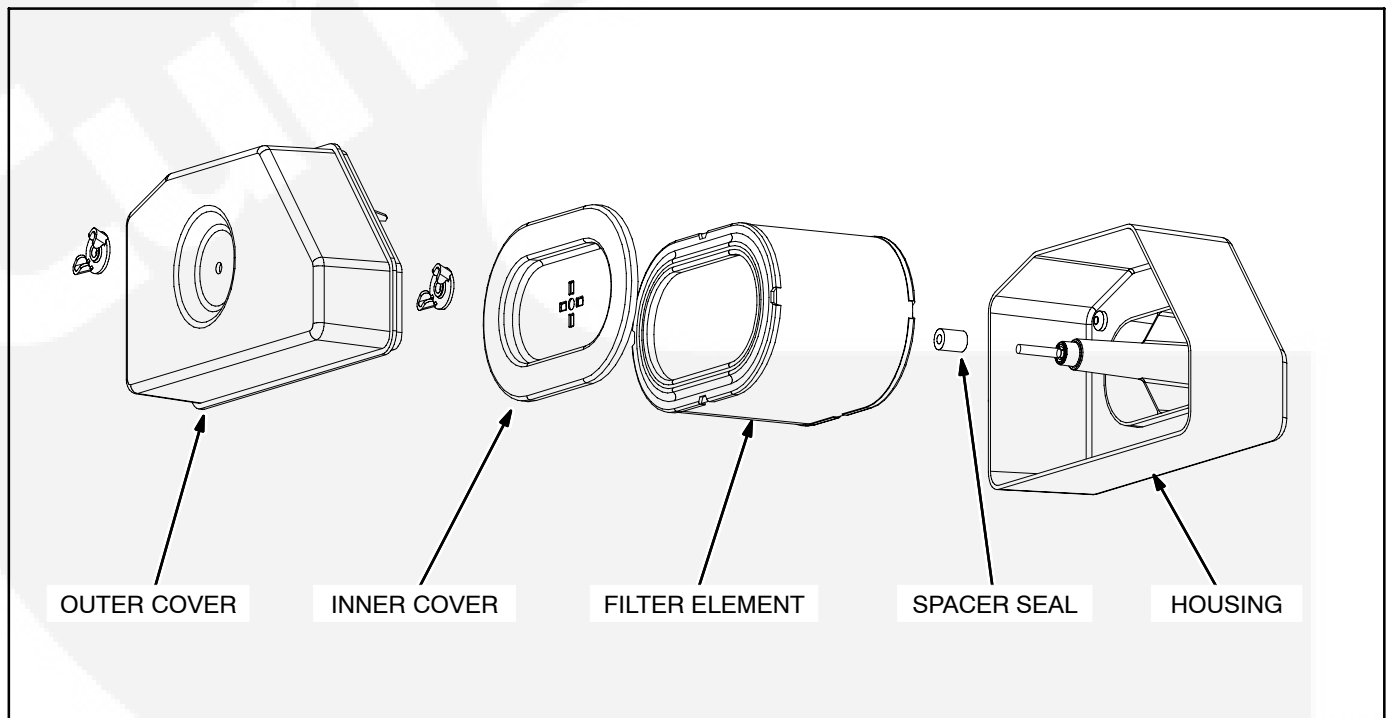


FIGURE 5-4. AIR FILTER ELEMENT

FUEL FILTER

Refer to Table 5-1 for scheduled replacement of the fuel filter (Figure 5-5). A dirty fuel filter may be the cause if the engine fails to start. The fuel filter is accessible through the maintenance access door in the skid-base. Squeeze the latches together to open the door.

⚠ CAUTION *Wipe the dirt off the fuel fittings before disconnecting them to keep dirt from entering the fuel system.*

⚠ WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away. Keep a type ABC fire extinguisher handy.*

Removing the Fuel Filter: To remove the filter, disconnect the two fittings at the filter and remove the mounting nut. Apply a wrench on the filter fitting as well as on the flare nut so as not to stress the fitting. Flare nut wrenches should be used on the flare nuts so as not to round the corners on the nuts. Dispose of the fuel filter according to local regulations.

Installing the Fuel Filter: Rotate the filter half a turn around its mounting stud if the fittings interfere with the bracket. It only fits properly one way.

Connect the fuel fittings before tightening the filter mounting nut. Take care not to crosstread the fuel fittings. Thread them in by hand and tighten one flat past seating.

Close the access door and prime the fuel system by holding the control switch down in its **Stop** position for at least 1 minute. Priming is necessary to displace the air in the new filter with fuel.

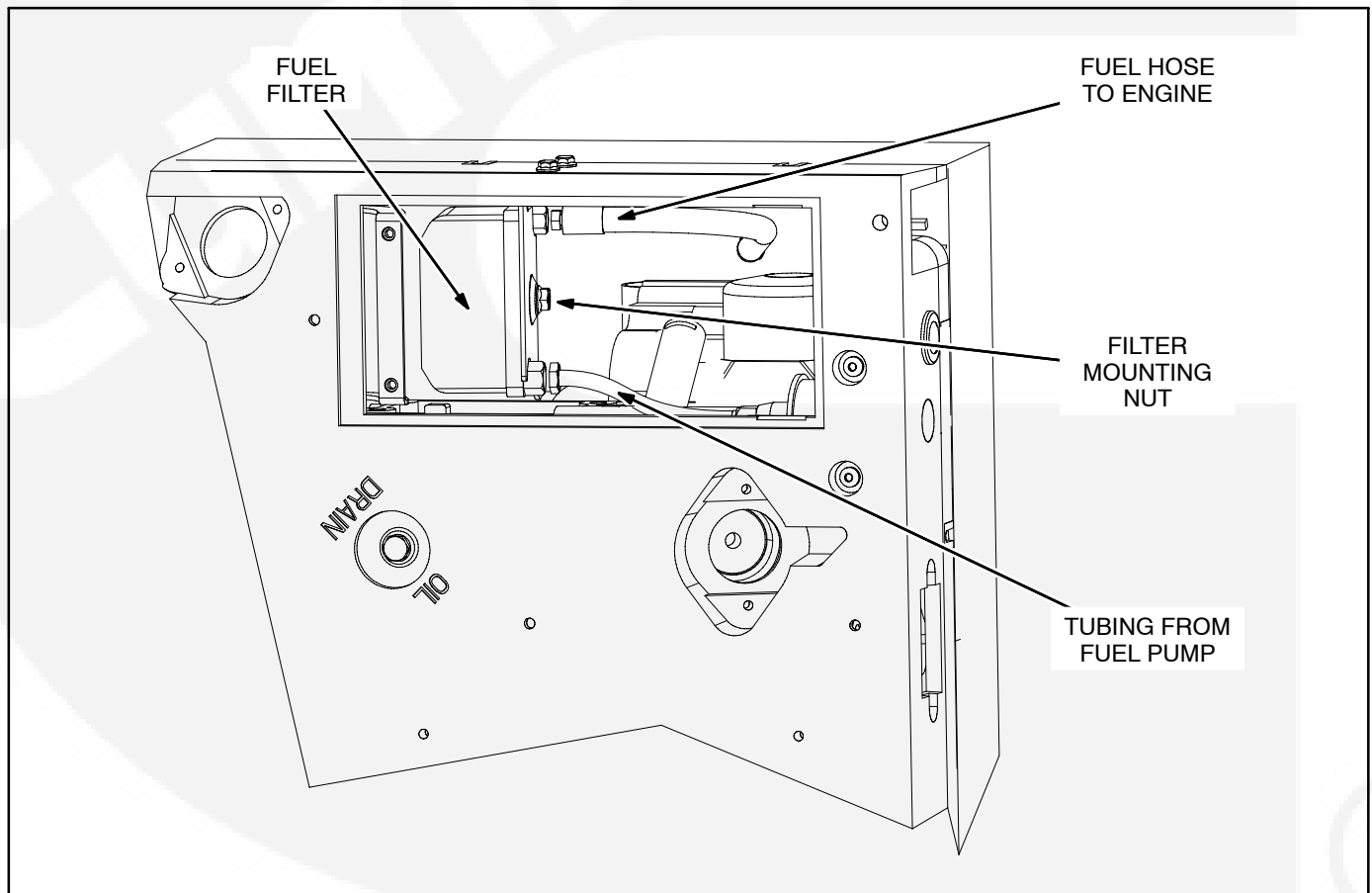


FIGURE 5-5. FUEL FILTER

CHANGING COOLANT

Refer to Table 5-1 for scheduled maintenance. The engine cooling system is filled with a 50/50 mixture of ethylene glycol anti-freeze and water when the genset leaves the factory, which is suitable for temperatures down to -34° F (-37° C).

Replace the coolant every two years. Use ethylene or propylene glycol anti-freeze solution that contains a rust and corrosion inhibitor. **The anti-freeze must not contain a stop-leak additive.**

The water used for engine coolant must be clean, low in minerals, and free of corrosive chemicals. Use distilled water if available.

See *Specifications* for cooling system capacity.

Pressure Cap

Replace the pressure cap every two years because its seals can deteriorate and begin to leak. Proper cooling system pressure is essential for optimal engine cooling and minimal coolant loss.

Draining the Cooling System

⚠WARNING *Hot coolant spray can cause severe burns. Let the engine cool before releasing the pressure cap or removing the drain cap.*

Allow the engine to cool before removing the pressure cap. Then relieve any remaining pressure by turning the pressure cap slowly, without pushing down on it, until it catches. When the pressure has been relieved, remove the pressure cap by pushing

down and turning it until it can be withdrawn. Then get a suitable container and drain the coolant by removing the system drain cap (Figure 5-6).

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

It is recommended that the system be cleaned and flushed before refilling. Radiator cleaning chemicals are available at local auto parts stores. Follow the instructions for cleaning and flushing that come with the cleaning solution.

Refilling the Cooling System

Fill the recovery tank with coolant mixture to the COLD mark.

Secure the system drain cap. Fill the cooling system with coolant mixture through the pressure cap/fill opening. Pull the hose connected to the pressure cap assembly out as far as it will go. When coolant fills up to the fill opening, start and operate the genset for a few minutes and shut it down. (It is recommended that the air conditioners or other large loads be turned on so that the genset will operate under load, causing the engine to run faster and expel trapped air.) Add more coolant if necessary and secure the pressure cap.

Coolant Level Check

Check coolant level in the recovery tank before the first startup of each day and fill to the COLD mark if necessary.

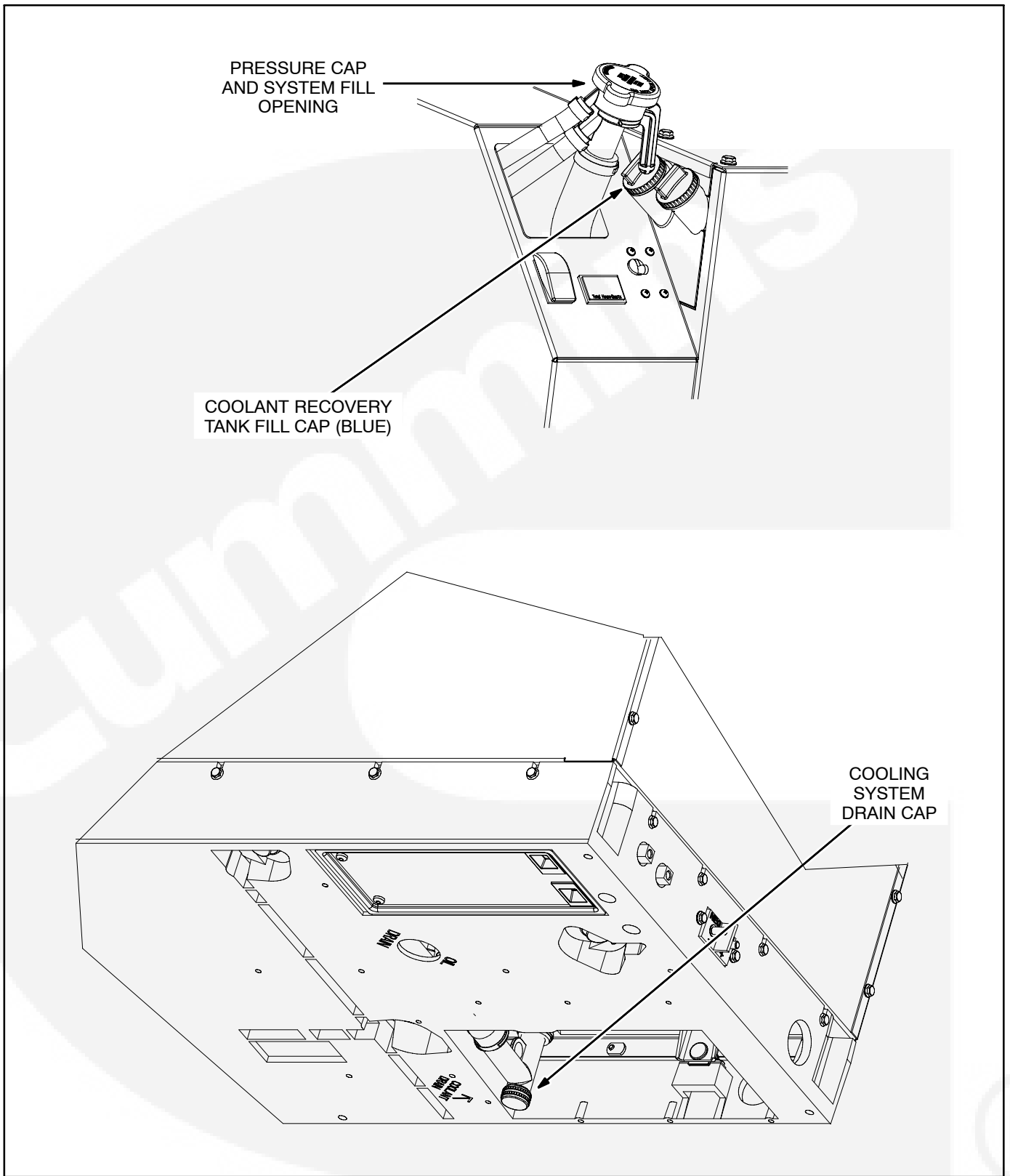


FIGURE 5-6. ENGINE COOLING SYSTEM FILL AND DRAIN CAPS

COOLANT TEMPERATURE INPUT

Resistance measurements should be taken between the sensor lead and the battery ground post (rather than the engine chassis) for most accurate reading with the harness disconnected at the sensor.

This sensor is not a precise temperature measurement. Differences between the table values and values displayed on the LCD or tool are possible. See sensor print for details. For example, if the sensor is placed in an ice bath, the control may read 32°F +/- few degrees, depending on the actual resistance of the sensor being tested (sensor spec is +/-10% resistance for a given temperature.)

TABLE 5-2. COOLANT TEMPERATURE INPUT

DIG °C	DEG °F	Sensor (OHMS)	V to A/D	Genset A/D Count
-20	-4	2100	4.27	218
-10	14	1700	4.13	211
-5	23	1500	4.04	206
0	32	1300	3.92	200
5	41	1150	3.82	195
10	50	1000	3.68	188
20	68	750	3.39	173
30	86	600	3.13	160
40	104	450	2.79	142
50	122	320	2.36	121
60	140	210	1.85	94
65	149	175	1.64	84
70	158	145	1.44	74
75	167	128	1.32	67
80	176	110	1.18	60
85	185	90	1.01	51
90	194	70	0.82	42
100	212	57	0.69	35
110	230	43	0.54	27
120	248	33	0.42	22
130	266	25	0.33	17
140	284	20	0.27	14
150	302	15	0.20	10

6. Preparations for Service

SPECIAL TOOLS

The following tools are necessary for servicing the genset:

- Torque wrench: 0-75 lbs-ft (0-100 N-m)
- Tachometer
- Digital multi-meter: AC and DC Voltage, Ohms
- Load test panel and leads

SAFETY

There are hazards in servicing gensets. Study *Safety Precautions* and become familiar with the hazards listed in Table 6-1. Note the following safeguards and ways of avoiding hazards:

- **Use personal protection:** Wear appropriate protective safety equipment, such as safety shoes and safety glasses. Do not wear rings or jewelry and do not wear loose or damp clothing that might get caught in equipment or conduct electricity.
- **Reduce the hazard:** A safe, orderly workshop area and well-maintained equipment reduce the hazard potential. Keep guards and shields in place on machinery and maintain equipment in good working condition. Store flammable liquids in approved containers; away from fire, flame, spark, pilot light, switches, arc-producing equipment and other ignition sources. Keep the workshop clean and well-lighted and provide adequate ventilation.
- **Develop safe work habits:** Unsafe actions cause accidents with tools and machines. Be familiar with the equipment and know how to use it safely. Use the correct tool for the job and check its condition before starting. Comply with the warnings in this manual and take special precautions when working around electrical

equipment. Do not work alone if possible and take no risks.

- **Be prepared for an accident:** Keep fire extinguishers and safety equipment nearby. Agencies such as the Red Cross and public safety departments offer courses in first aid, CPR and fire control. Take advantage of this information to be ready to respond to an accident. Learn to be safety-conscious and make safety procedures part of the work routine.

TABLE 6-1. HAZARDS AND THEIR SOURCES

Fire and Explosion	<ul style="list-style-type: none">• Leaking or spilled fuel• Hydrogen gas from battery• Oily rags improperly stored• Flammable liquids improperly stored
Burns	<ul style="list-style-type: none">• Hot exhaust pipes• Hot engine and generator surfaces• Electrical shorts
Poisonous Gas	<ul style="list-style-type: none">• Operating genset where exhaust gases can accumulate
Electrical Shock (AC)	<ul style="list-style-type: none">• Improper generator connections• Faulty wiring• Working in damp conditions• Jewelry touching electrical components
Rotating Machinery	<ul style="list-style-type: none">• Fan guards not in place
Slippery Surfaces	<ul style="list-style-type: none">• Leaking or spilled oil
Heavy Objects	<ul style="list-style-type: none">• Removing genset from vehicle

REMOVING GENSET FROM VEHICLE

See *Troubleshooting* to determine the probable cause of the problem before removing the genset for service. The genset is normally mounted in a special compartment on the floor of the vehicle or on a supporting frame. Contact the vehicle manufacturer or installer if the best way to remove the genset is not obvious.

Disconnections

1. Disconnect the negative (-) battery cable *from the battery* and then disconnect the battery cables from the genset.

⚠WARNING *Sparks and high current could cause fire and other damage to the battery, battery cables and vehicle if the loose ends of cables connected to the battery touch. Always disconnect the negative (-) battery cable from the battery before disconnecting the battery cables from the genset.*

2. Disconnect the remote control wiring harness connector at the genset.
3. Disconnect the AC output leads at the genset terminals.
4. Disconnect the exhaust tailpipe from the muffler flange.
5. Disconnect the supply and return fuel lines from the genset.

⚠WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke if you are near fuel tanks or fuel-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away.*

Removal from the Vehicle

⚠WARNING *Gensets are heavy and can cause severe personal injury if dropped during removal. Use adequate lifting devices. Keep hands and feet clear while lifting.*

Make sure that the genset is firmly supported before loosening any mounting bolts. There are four bolt holes in the skid-base for securing the genset to the floor or supporting frame. A lifting eye is accessible through the access opening in the top panel of the genset (Figure 6-2).

TEST STAND

⚠WARNING *EXHAUST GAS IS DEADLY! Engine exhaust must be vented outside if the genset is operated inside a building.*

⚠CAUTION *Restricting the air inlet and outlet openings could lead to damage to the genset due to overheating.*

When testing and servicing the genset on a workbench or test stand make sure the openings in the skid-base shown in Figure 6-1 (shaded areas) are free and clear. Also, make sure there is ample fresh air when operating the genset.

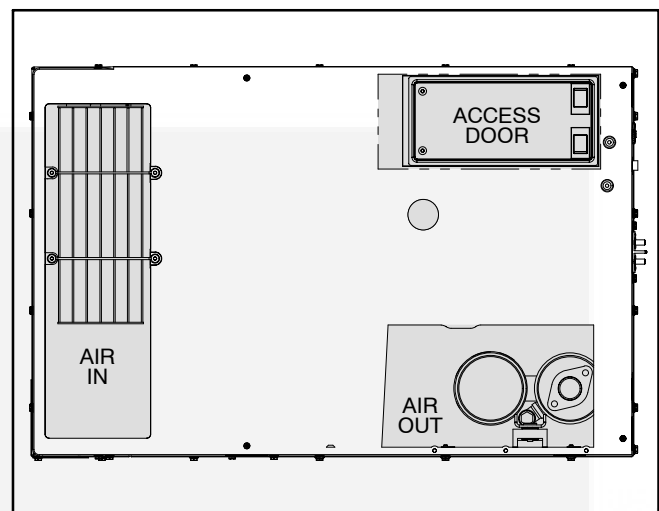


FIGURE 6-1. BOTTOM VIEW OF SKID-BASE

REMOVING HOUSING PANELS

⚠ WARNING *Do not operate the genset without the housing panels secure in place. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death. The housing is also required for proper genset cooling.*

See Figure 6-2. The housing consists of five removable panels. The front (service) panel may also include a removable service door secured by latches. *Note that the screws which secure the panels to the skid-base are slightly longer than the screws between panels.* Keep the screws separated to make reassembly easier.

Removing the Front and Top Panels

It may be necessary to remove only the front (service) or front and top panels for access to the parts which need service (Figure 1-2). To do so, remove all the screws around the perimeter of each panel and pull the panel away. Note that the three screws in the top panel which are circled also support the coolant recovery tank.

⚠ CAUTION *Screws that are too long will damage the coolant recovery tank and may cause it to break away. Make sure the shorter panel screws are used for the recovery tank.*

Removing the Back Panel

Remove the top panel, all the screws around the perimeter of the back panel and the two screws into the

radiator frame. Because of overlapping edge flanges, loosen the screws along the bottom edge of the left end panel so that it can be tilted out of the way while lifting out the back panel.

Removing the Right End Panel

Remove the top panel and all the screws around the perimeter of the right end panel and lift it out.

Removing the Left End Panel

1. Remove the front, top and back panels.
2. Remove the AC terminal block mounting screws so that it will be unnecessary to loosen the wire binding screws.
3. Remove the line circuit breaker mounting screws (on the operator's console).
4. Disconnect the engine harness from the control switch and hour meter (if provided).
5. Remove the screws along the bottom edge, tilt the panel out, disconnect the leads to the control switch and hour meter (if so equipped) and cut the wire ties which secure the wiring harness to the panel.

INSTALLING HOUSING PANELS

Installation is the reverse of removal. Use wire ties to secure the engine and AC harnesses (p. A-1 and A-2) to the left end panel when reassembling the genset. Tighten the panel screws according to *Thread Torques*.

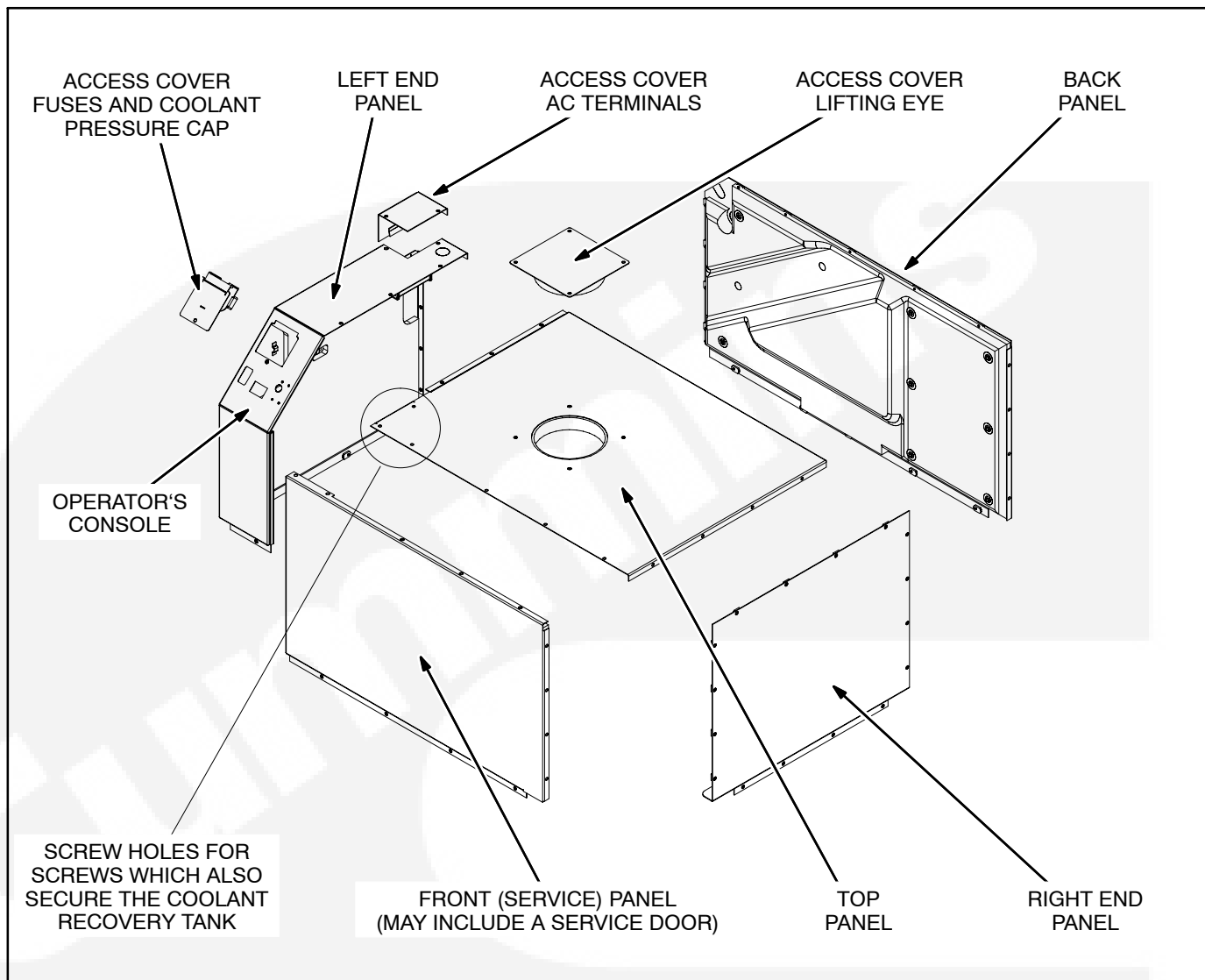


FIGURE 6-2. THE GENSET HOUSING PANELS

7. Engine Air Intake

COMPONENT LAYOUT

Figure 7-1 illustrates the series of parts connected to the engine air intake manifold. The arrows indicate the flow of air.

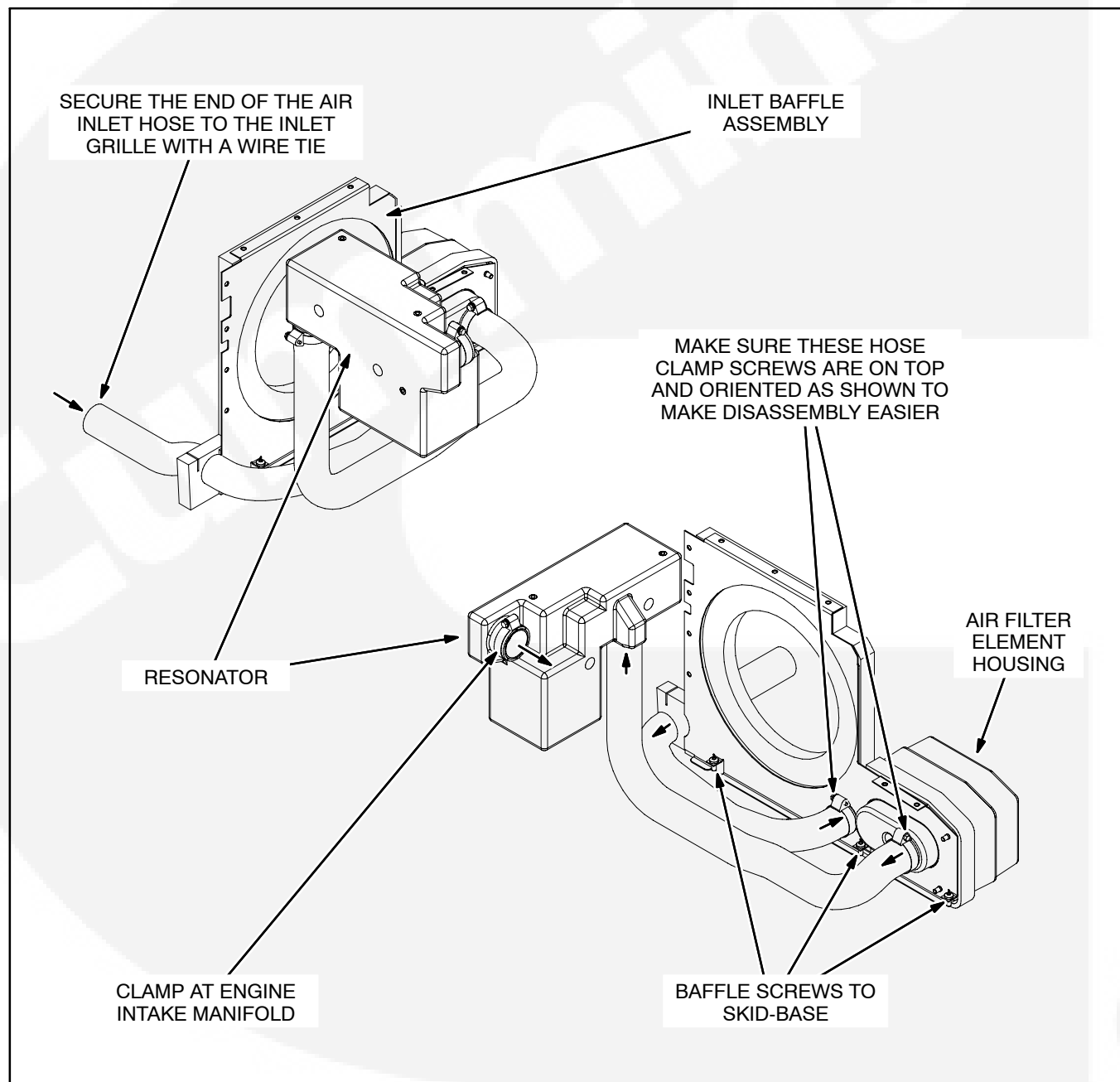


FIGURE 7-1. ENGINE AIR INTAKE ASSEMBLY

8. Muffler

REMOVAL

The muffler assembly is mounted inside the genset housing. See Figure 8-1. To remove the muffler:

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting and remove the top and back genset housing panels (p. 6-3).
2. Disconnect the tailpipe.
3. Remove the flange bolts on both ends of the flexible connector and remove it carefully.
4. Remove the outboard bearing clamp and slide the assembly to the right (while facing the genset from the back) until the pins in the two inboard bearings are free.

INSTALLATION

Installation is the reverse of removal. Always use new flange gaskets on both ends of the flexible con-

necter when installing the muffler. Tighten all bolts and screws according to *Thread Torques*.

⚠ CAUTION *The flexible connector is fragile when removed from the assembly and must not be bent or twisted. Make sure the muffler is securely in place and properly aligned before connecting the flexible connector.*

Important safety warnings and instructions regarding the routing and termination of the tailpipe (not supplied by Onan) are included in the Installation Manual. Always use a new flange gasket when connecting the tail pipe.

⚠ WARNING *Exhaust gas is deadly. The exhaust system must not leak. Liability for injury, death, damage and warranty expense due to the use of an unapproved muffler or due to modifications becomes the responsibility of the person installing the unapproved muffler or performing the modifications. Use Onan approved exhaust system parts.*

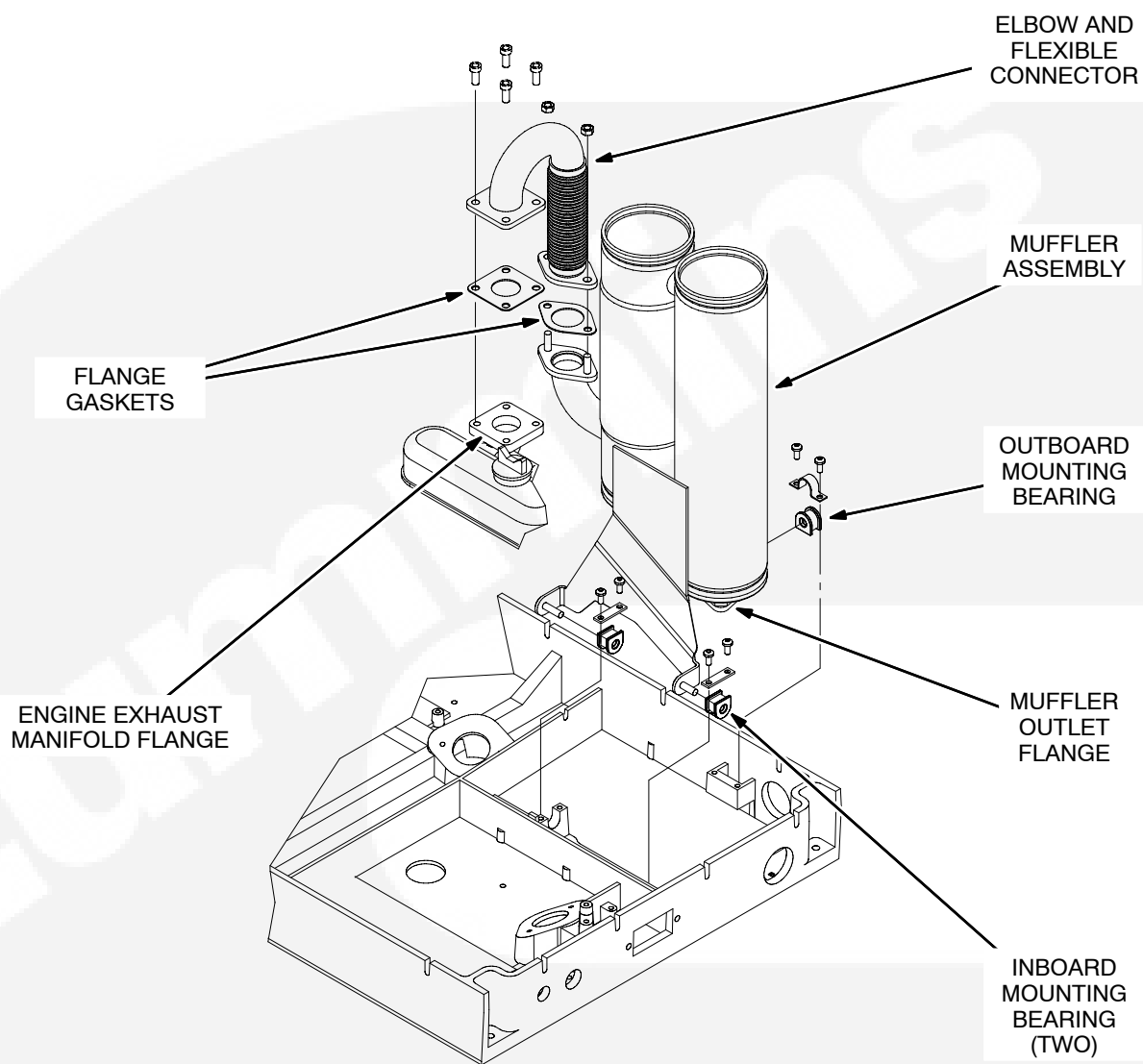


FIGURE 8-1. MUFFLER ASSEMBLY

9. Engine Cooling System

GENERAL

The genset has a liquid cooled engine. A centrifugal blower (Figure 11-2) is mounted on the end of the generator (PMA) rotor to move air for cooling the genset and radiator. The blower pulls air in from an opening in the bottom of the genset to pressurize the engine compartment. Air flows through the radiator from the top side into the muffler compartment and then out the bottom. See Figures 9-1 and 9-2.

See *Periodic Maintenance* for cooling system maintenance.

See Page 12-1 for instructions on how to replace the coolant pump drive belt.

See the engine service manual for thermostat and pump service.

RADIATOR REMOVAL

Removal Procedure

1. Remove the top and back housing panels of the genset (p. 6-3).
2. Drain the system.

⚠WARNING *Hot coolant spray can cause severe burns. Let the engine cool before releasing the pressure cap or removing the drain cap.*

3. Disconnect all four hoses.

4. Remove the two screws which secure the radiator to the inner bulkhead and pull it away.

Alternative Removal Procedure

1. Perform Steps 1 and 2.
2. Remove the muffler (p. 8-1).
3. Disconnect the upper and lower hoses from the engine and loosen the hose bracket at the front of the engine.
4. Remove the screw which secures the system drain "T" (Figure 9-2).
5. Remove the two screws in the horizontal portion of the bulkhead that projects under the radiator.
6. Pull the radiator, coolant recovery tank and inner bulkhead away as an assembly with all the hoses connected.

RADIATOR INSTALLATION

Installation is the reverse of removal. If the inner bulkhead was removed, make sure the end of the crankcase breather hose (Figure 9-2) is pushed back through the exit hole in the bulkhead (Figure 9-1).

Make sure to reinstall the hose bracket at the front of the engine to keep the belt from rubbing on the hose. (The bracket squeezes the hose slightly.)

Tighten all screws according to *Thread Torques*.

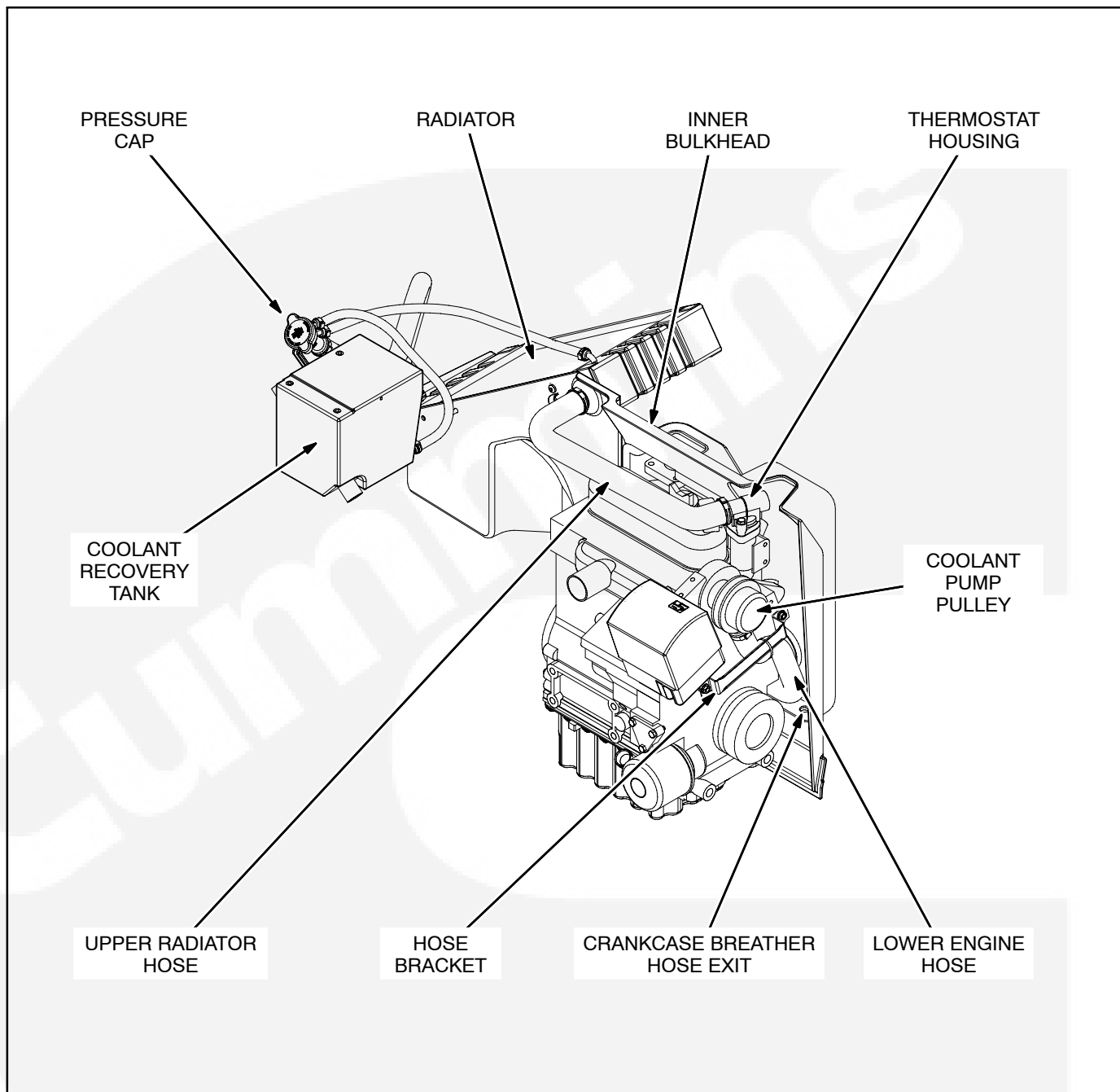


FIGURE 9-1. ENGINE COOLING SYSTEM (I OF 2)

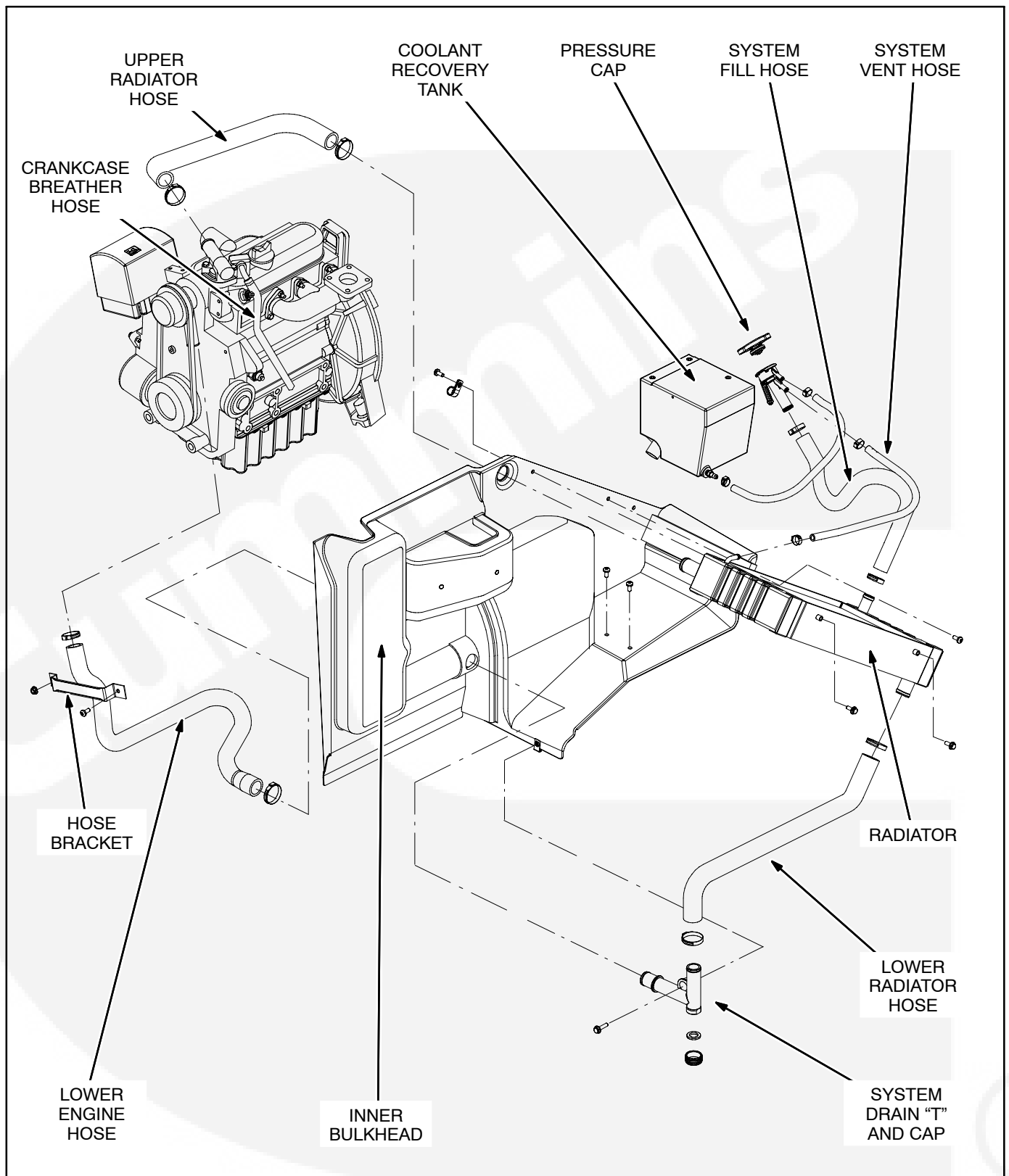


FIGURE 9-2. ENGINE COOLING SYSTEM (2 OF 2)

10. Controller-Inverter

GENERAL

Figure 10-1 shows two views of the controller-inverter housing. Also shown are all of the wiring leads, connectors and terminals on the housing, and the heat sink for the electronic components inside.

There are no field replaceable parts inside the controller/inverter housing. See *Troubleshooting* to determine when it may be necessary to replace the assembly.

Note: Tests with an ohmmeter or diode checker across the leads, terminals and connector pins on the controller/inverter housing itself have not been prescribed, as they would not lead to useful service information.

Note also that attempting to operate the genset with any of the wiring disconnected from the controller/inverter assembly results only in shutdown and a Fault Code being displayed.

REMOVAL

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting

and remove the genset housing panels (p. 6-3).

2. Disconnect all external wiring connections and the grounding strap from the housing.
3. Remove the screw securing the housing to the radiator frame and inner bulkhead.
4. Remove the 6 screws securing the housing to the inlet baffle assembly (Figure 7-1).
5. Remove the 5 screws along the lower back of the housing and lift out the housing.

INSTALLATION

Installation is the reverse of removal.

1. Make sure to reconnect the grounding eyelet in the AC harness (p. A-2) and the grounding strap from the skid-base.
2. Tighten all screws according to *Thread Torques*.

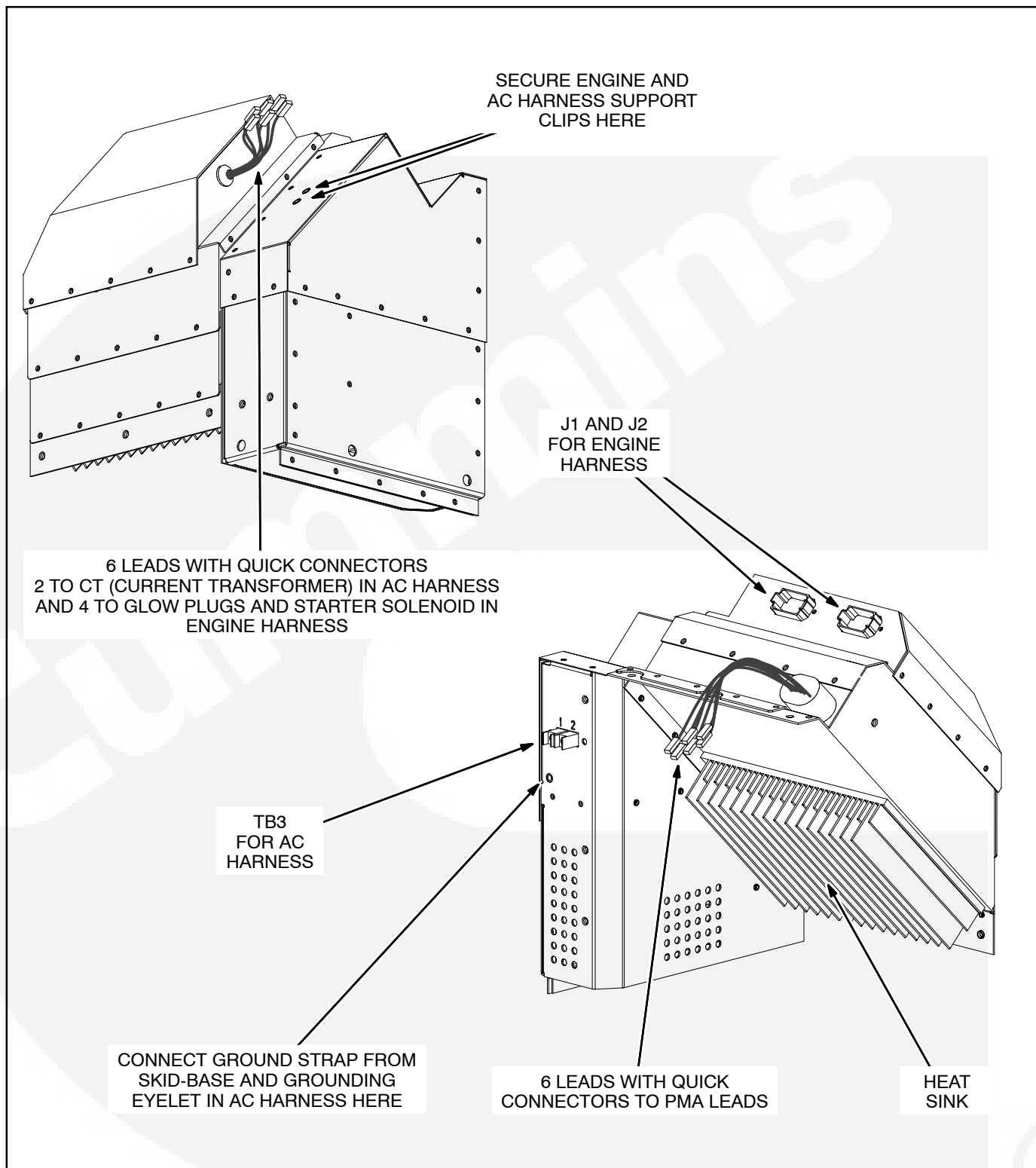


FIGURE 10-1. CONTROLLER-INVERTER HOUSING

CONTROLLER-INVERTER FUNCTIONS

The controller-inverter is an integrated microprocessor-based engine and generator control. See the block diagram in Figure 10-2. It provides all the control, monitoring and diagnostics functions required to operate the genset. Major functions include:

Initialization

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

Starting

When the control switch is pressed and held in the Start position until start disconnect, the startup sequence of the Controller:

1. Energizes the fuel pump.
2. Flashes the status indicator to indicate preheat and crank.
3. Energizes the glow plugs for temperature-dependent durations (Tables 10-1 and 10-2).
4. Energizes the governor actuator (moves toward full rack).
5. Energizes the starter when preheat has been completed.
6. Deenergizes the starter at 800 rpm.
7. Turns on the status indicator to indicate start disconnect.
8. Turns on Switched B+ (remote connector pin J8-F).
9. Enables the inverter (output voltage).

TABLE 10-1. PREHEAT TIMINGS

Coolant Temp > 120 °F	0 sec
Coolant Temp 50 °F	5 sec
Coolant Temp 23 °F	10 sec
Coolant Temp < -4 °F	15 sec

TABLE 10-2. POSTHEAT TIMINGS*

Coolant Temp > 70 °F	0 sec
Coolant Temp < 70 °F	5 sec

* – Following start disconnect

Note: Beginning Spec F, Start must be released and reapplied for subsequent start attempts.

Stopping

When the control switch is touched to the Stop position, the Controller disables output voltage, deenergizes the fuel pump and governor actuator, turns off the status indicator, writes session data (number of cranks, minutes of operation, last fault, etc.) to non-volatile memory (NVM) and removes processor power when idle 5 minutes (battery saver function).

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

Priming

When the control switch is pressed and held in the Stop position for more than 2 seconds, the Controller energizes the fuel pump and turns on the status indicator for as long as Stop is held.

Note: Beginning Spec F, Stop must be released if stopping the genset and reapplied to prime.

Speed Control

The Controller maintains the speed range for which the genset is configured (*Specifications*). For RV configurations (HDKAH, HDKAJ and HDKAK) a speed of approximately 2300 rpm is commanded during the first minute, 1950 rpm during the second minute and 1600 rpm (idle) thereafter. Speed will be increased at any time as loading requires (variable speed control).

Voltage Control

The Inverter converts the 3-phase AC output of the engine-driven PMA (permanent magnet alternator) into 1-phase AC output at the voltage and frequency for which the genset is configured (follow the heavy arrows in Figure 10-2). The Controller maintains nominal AC voltage output during steady state operation. In response to transient loads the Controller adjusts the voltage setpoint to allow engine recovery.

Fault Shutdown and Diagnostics

See *Troubleshooting*.

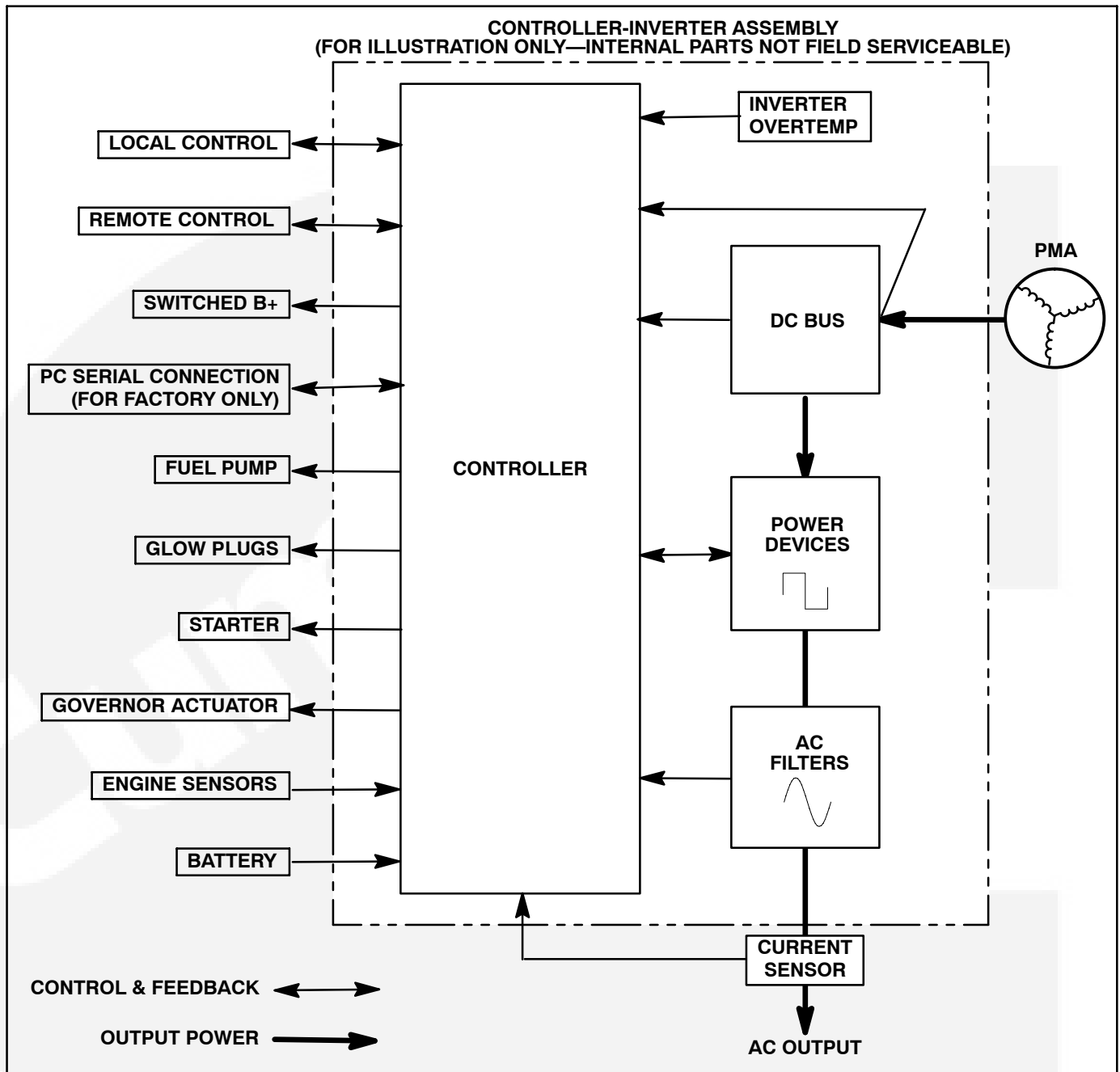


FIGURE 10-2. CONTROLLER-INVERTER BLOCK DIAGRAM

11. PMA (Generator)

GENERAL

The genset has an 8-pole permanent magnet alternator (PMA) type of generator with a 3-phase stator (Figure 11-1). The magnets are bonded to the rotor with adhesive. The rotor is a one piece casting with the flywheel. A bearing is not used to support the end of the rotor and there are no slip rings, brushes or exciters. See Figure 11-2.

STATOR TESTS

Winding Insulation Resistance Test

Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting and remove the top panel of the housing (p. 6-3).

⚠WARNING *Do not operate the genset without the housing panels secured in place. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death.*

Disconnect the six PMA winding leads from the controller/inverter assembly leads (p. 10-2).

Testing with a Megger: A 500 VDC megger is recommended for testing winding insulation resistance. Apply the test voltage between a lead from each winding group (T1-1 and T1-2) and ground (stator laminations) for 10 minutes and record resistance values at one minute and at 10 minutes.

Resistance values of at least 5 megohms should be obtained for a new stator with dry windings. The polarization index (the ratio of the resistance reading at 10 minutes to the reading at one minute) should also be at least 2. For a genset that has been in service, the resistance reading should not be less than 1 megohm nor the polarization index less than 2.

If the readings are low, or the genset has been in storage for a long time in a high-humidity environ-

ment, the test should be repeated after the windings have been dried. The most effective way of drying the stator windings, if the genset is operable, is to run it under full load for at least one hour.

Testing with a Digital Ohmmeter: A digital ohmmeter can be used (highest scale) as a preliminary check. It should read infinite resistance.

Winding Resistance

Testing with a Digital Ohmmeter: A digital ohmmeter can be used (lowest scale) as a preliminary check for an open winding. It should read approximately 1 ohm.

Testing with a Wheatstone Bridge: Use a Wheatstone bridge having at least a 0.001 ohm precision to measure the resistance across each winding lead pair: T1-1—T2-1, T3-1—T2-1, T1-1—T3-1, T1-2—T2-2, T3-2—T2-2, T1-2—T3-2. The resistance should be 0.997-1.219 ohms at 70° F (21° C).

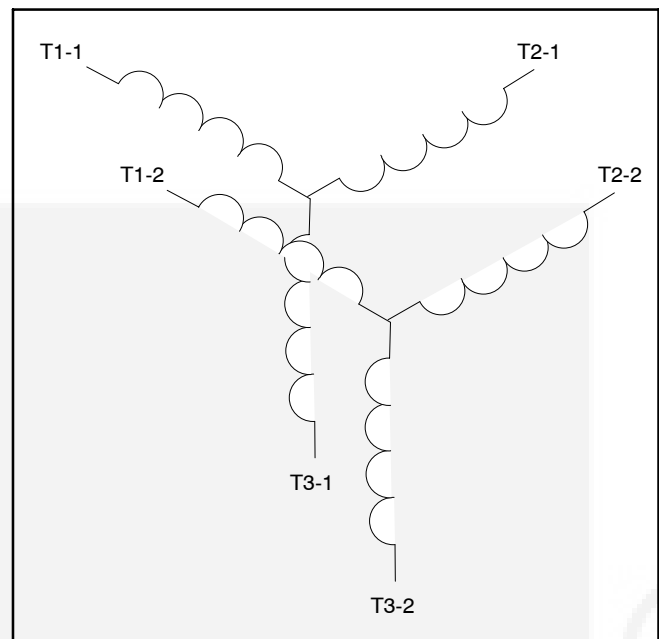


FIGURE 11-1. STATOR WINDING GROUPS

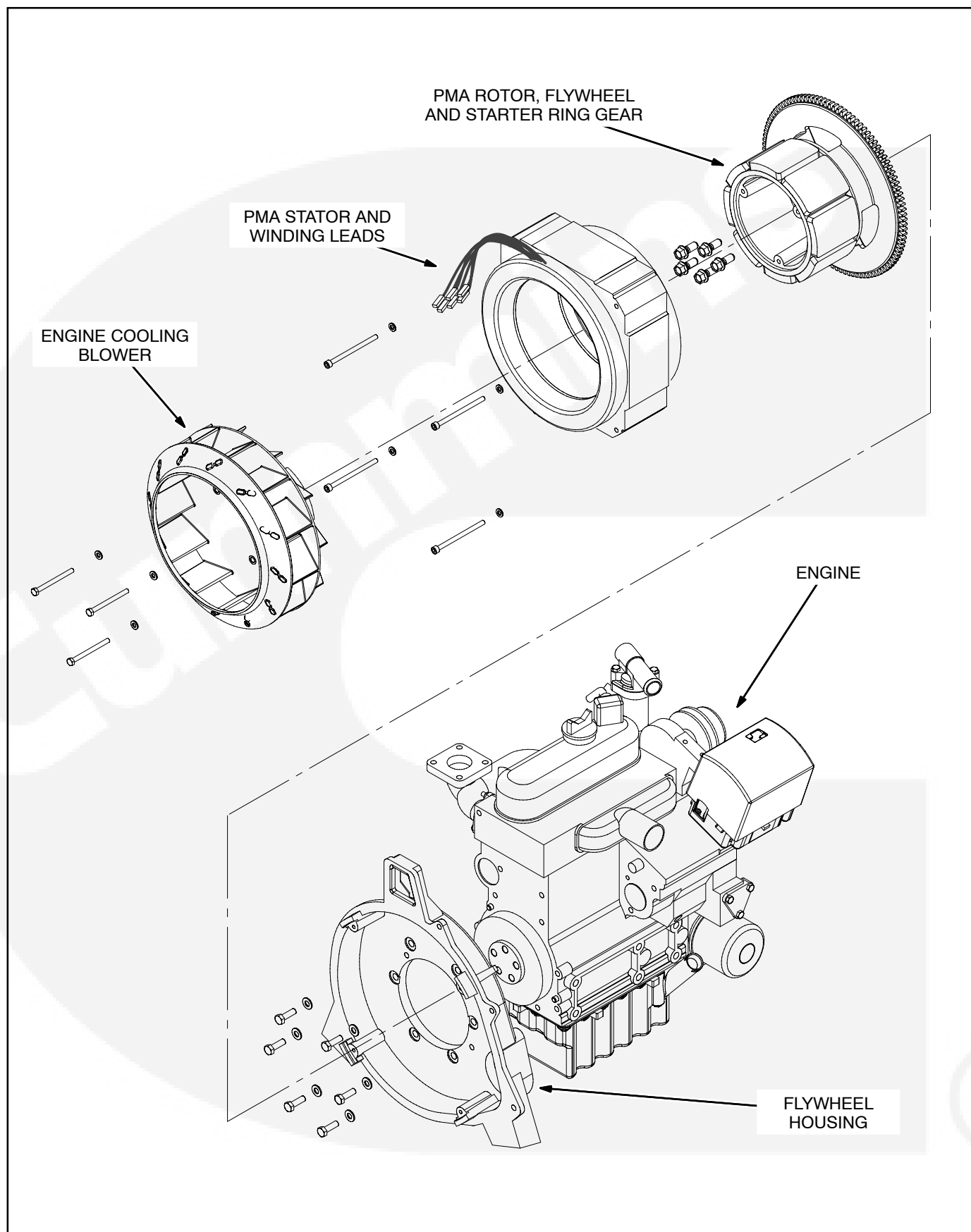


FIGURE 11-2. PMA ASSEMBLY

STATOR REMOVAL

See Page 12-2 if the stator and engine are to be removed as an assembly. If the engine and rotor are to remain in place, remove the stator as follows:

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting and remove the housing (p. 6-3).
2. Disconnect the stator winding leads.
3. Remove the controller/inverter assembly (p. 10-1).
4. Remove the blower (Figure 11-2).
5. Remove the air filter cover and element.
6. Remove the three screws which secure the inlet baffle assembly (Figure 7-1) to the base and the two screws which secure it to the inner bulk-head and tilt it out.
7. Remove the 4 stator mounting bolts and pull the stator straight back. (The rotor magnets will resist the motion.)

STATOR INSTALLATION

Installation is the reverse of removal. The stator leads must be oriented as shown (Figure 11-2). The stator must sit square within the four guide ears in the flywheel housing. Tighten all bolts and screws according to *Thread Torques*.

⚠ CAUTION *The rotor magnets can be chipped by rough handling, especially along the edges. Guide the stator on and off carefully to avoid chipping the edges of the magnets.*

To prevent loss of magnetism due to shock, protect the rotor from being dropped or struck while the stator is off, and keep metal chips away from the rotor.

ROTOR REMOVAL

The rotor can be unbolted from the engine after the stator has been removed.

ROTOR INSTALLATION

Note when installing the rotor that the five rotor-to-crankshaft bolts are not equally spaced, though they look as if they are. To register the rotor and crankshaft bolt holes properly before bolting:

1. Bar the engine until the counterweight on the front engine pulley is straight down.
2. Mate the rotor to the crankshaft such that the middle line on the back of the flywheel lines up with the pointer in the window in the flywheel housing. See Figure 11-3.
3. Tighten all bolts according to *Thread Torques*.

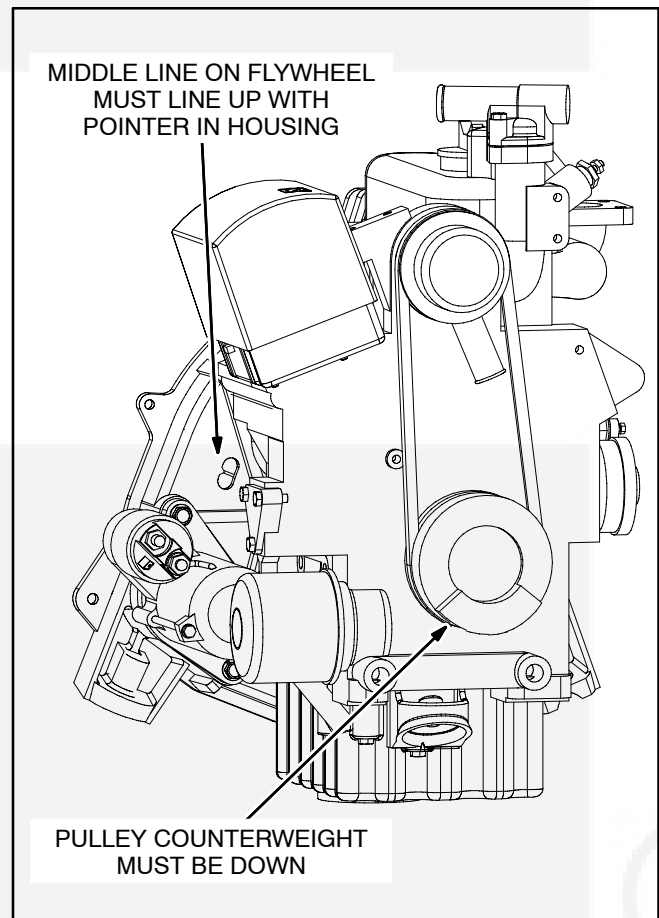


FIGURE 11-3. ROTOR-CRANKSHAFT ALIGNMENT

12. Engine

ENGINE SERVICE

See Engine Workshop Manual 981–0514 for servicing the engine proper and for adjusting valve clearance (lash), replacing the glow plugs, cleaning the crankcase breather assembly, replacing the coolant thermostat and pump and servicing the fuel injection system. See Page 16-1 for starter motor removal. See *Periodic Maintenance* regarding regular maintenance.

Use the flywheel timing mark shown in Figure 12-1 when adjusting valve lash and fuel injector pump timing. The center line is 20° BTDC. The reference marks on either side are 4° degrees from the timing mark.

REPLACING COOLANT PUMP BELT

See *Periodic Maintenance* for the belt replacement interval. Since there is no means to adjust belt tension, it is critical that the correct replacement belt be used. (Belt tension increases slightly as the engine runs and is sufficient for the relatively light pump load.)

⚠ CAUTION *Using the wrong coolant pump drive belt can lead to engine overheating.*

To remove the belt, remove the negative (–) battery cable from the battery to prevent accidental starting of the set during replacement. Remove the 4 bolts which secure the pump pulley to its hub and pull the pulley and belt off.

To install a new belt, run the belt over both pulleys and pull the pump pulley up to its hub and push it on. Secure the pulley with the 4 bolts and tighten the bolts according to *Thread Torques*.

Re-attach negative (–) battery cable to the battery.

ENGINE SENSORS

The engine is equipped with a coolant temperature sensor and low oil pressure cutout switch (Figure 12-2). The associated fault codes are as follows:

- **No. 2**—Low Oil Pressure
- **No. 23**—Oil Pressure Switch Fault
- **No. 24**—Temperature Sender Fault
- **No. 33**—High Engine Temperature Fault

See *Troubleshooting*.

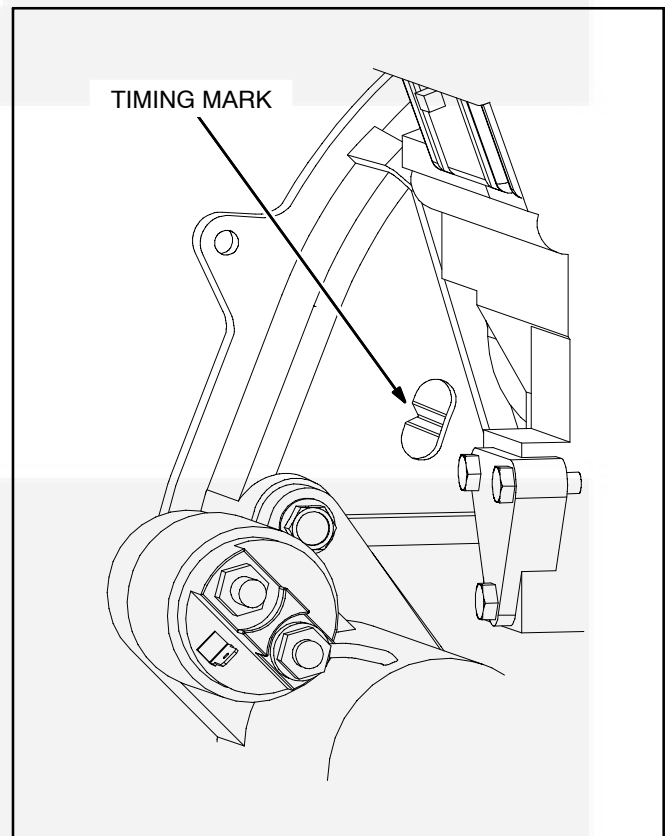


FIGURE 12-1. ENGINE TIMING MARKS

ENGINE REMOVAL

The engine is mounted on 3 vibration isolator mounts secured to the skid-base (Figure 12-2). To remove the engine:

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting. Remove the front, top, back and right end housing panels (p. 6-3).
2. Remove the muffler (p. 8-1).
3. Remove the oil dipstick and disconnect the oil fill tube from the coolant recovery tank. (If the oil fill tube is to be removed from the oil pan, drain the oil first to avoid spillage.)
4. Drain the coolant system, disconnect the hoses at the engine and remove the radiator and inner bulkhead (p. 9-1).
5. Disconnect the air inlet hose at the resonator (Figure 7-1).
6. Disconnect the PMA stator leads (Figure 11-2).
7. Disconnect the engine harness from the controller/inverter assembly and fuel pump.
8. Disconnect the skid-base ground strap from the flywheel housing.
9. Disconnect the battery harness from the engine.

⚠ CAUTION *Using only one lifting eye will cause the unit to rotate and drop, causing severe equipment damage and possible personal injury.*

10. Attach a hoist at *both* the flywheel housing lifting eye and the front engine lifting eye.
11. Remove the three isolator-mount center bolts and lift the engine/PMA assembly away.
12. Remove the cooling blower, PMA stator, rotor and flywheel housing from the engine (Figure 11-2).

ENGINE INSTALLATION

Installation is the reverse of removal.

1. Make sure the air seal ring is in place around the oil drain hole in the skid-base to seal against leakage of cooling air and noise.
2. Tighten all screws and bolts according to *Thread Torques*.
3. Make sure the engine crankcase breather hose is pushed back through the hole in the inner bulkhead (p. 9-3).

REPLACING LOW OIL PRESSURE CUTOFF SWITCH

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting and remove the front, top, back and right end housing panels (p. 6-3).
2. Remove the muffler (p. 8-1).
3. Disconnect the the PMA stator leads (Figure 11-2) to prevent strain when the inner bulkhead is tilted.
4. Remove the screw that secures the coolant drain "T" (p. 9-3), the two screws in the horizontal portion of the bulkhead that projects under the radiator and the screw that secures the radiator to the controller/inverter assembly.
5. Lift and tilt the inner bulkhead until the switch is accessible.
6. Disconnect the lead and remove the switch.

Reassembly is the reverse of removal. Use thread sealant and tighten according to *Thread Torques*. Make sure the engine crankcase breather hose is pushed back through the hole in the inner bulkhead (p. 9-3).

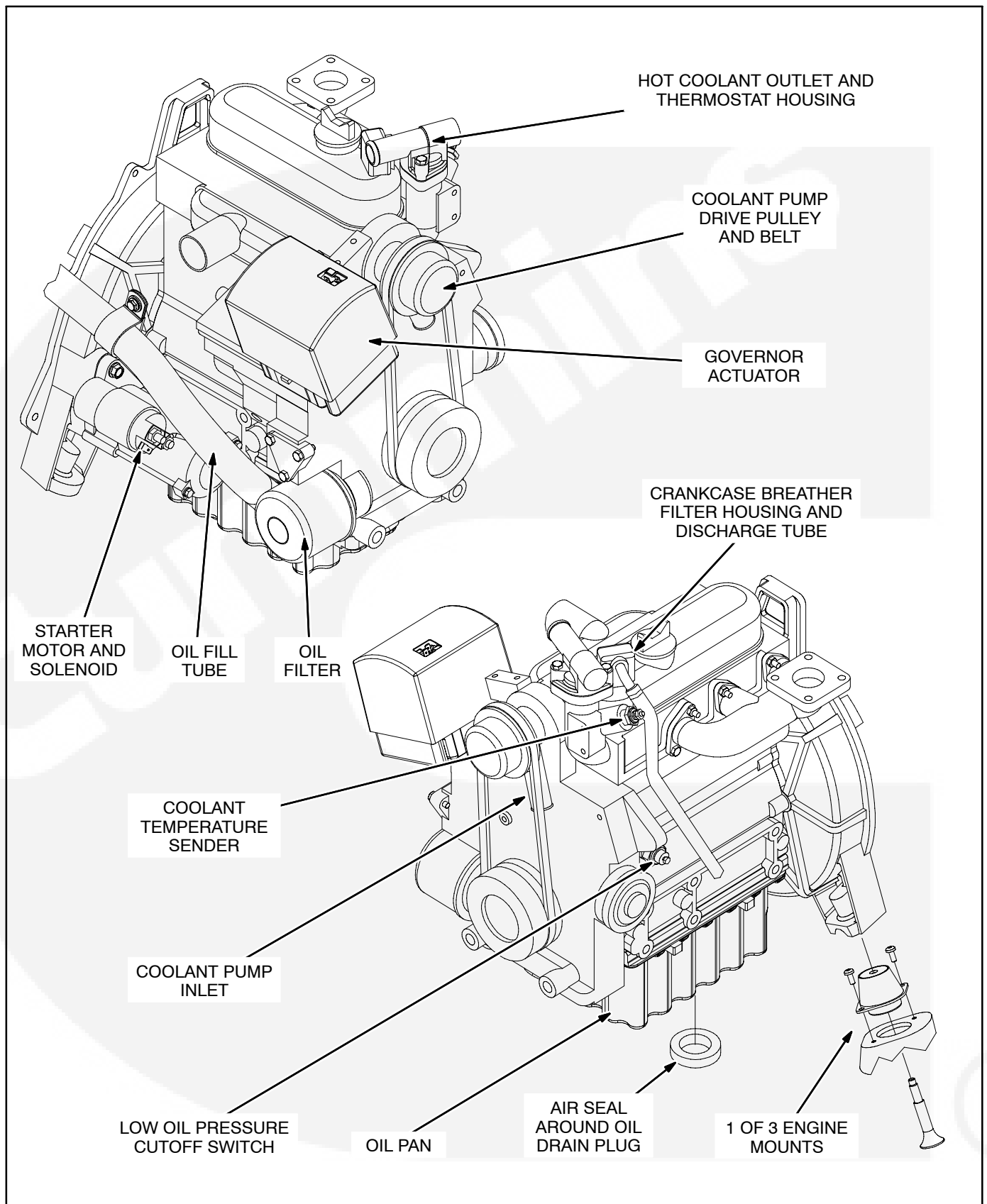


FIGURE 12-2. ENGINE AND ACCESSORIES

13. Governor Actuator

GENERAL

The governor actuator (Figure 13-1) is powered by the genset controller to position the fuel rack (Figure 13-2) according to load demand.

Note: The engine governor used with these gensets has 4 steel balls (Figure 13-2) instead of the 8 shown in the engine Workshop Manual.

ACTUATOR REMOVAL

1. Disconnect the negative (-) battery cable from the battery to prevent the genset from starting and remove the front housing panel (p. 6-3).
2. Disconnect the two leads from the engine harness and remove the cover.

⚠ WARNING *Uncontrolled release of spring tension can cause eye damage. Wear safety glasses with side shields when removing spring.*

3. Use a screwdriver to pry the leg of the fuel rack return spring out of its slot in the bearing carrier. Be prepared to catch the spring from flying off.
4. Remove the four stator screws and lift off the bearing carrier and stator.
5. Pry the rotor off the shaft.
6. Remove the four screws that secure the base to the top of the engine gear cover. Note that there are copper washers under the two in-board screw heads. These washers seal against oil seepage since these screw holes run through into the gear case.
7. Unhook the governor spring from the actuator high-idle speed control lever (top lever) while lifting the actuator assembly away.

ACTUATOR INSTALLATION

Note: The actuator base assembly used for gensets beginning Spec B is the replacement part also for Spec A gensets.

Installation is the reverse of removal. Note the following:

1. Use a long-nose pliers to rehook the governor spring to the actuator high-idle speed control lever.
2. Apply a liquid-type gasket (Three Bond 1215 or equivalent) to both sides of the new gasket between the engine gear cover and actuator base.
3. Tighten the four base mounting screws according to *Thread Torques*.
4. Adjust the actuator speed control lever stop (beginning Spec B) before installing the rotor (p. 13-4).
5. Install the rotor using a new retainer ring. Note that the ring is concave (dished). Push the dished side down against the rotor to keep it in place on the shaft.
6. Install the stator and bearing carrier. Tighten the four mounting screws according to *Thread Torques*.

⚠ CAUTION *The genset may not stop reliably on command if the fuel rack return spring is not assembled properly.*

7. Check the fuel rack return spring for wear and replace it if worn. This spring returns the fuel rack to the no-fuel position. Push the spring on over the flat on the shaft and then pry the leg into its slot in the bearing carrier (Figure 13-1). The extension below the knee must catch under the bearing carrier. Finally, push the spring down as far as it will go on the shaft.
8. Readjust high-idle speed (p. 13-5).
9. Snap the cover onto the actuator **and then secure a wire tie around the actuator and cover to make sure the cover stays in place.**
10. Reconnect the two leads from the engine harness.

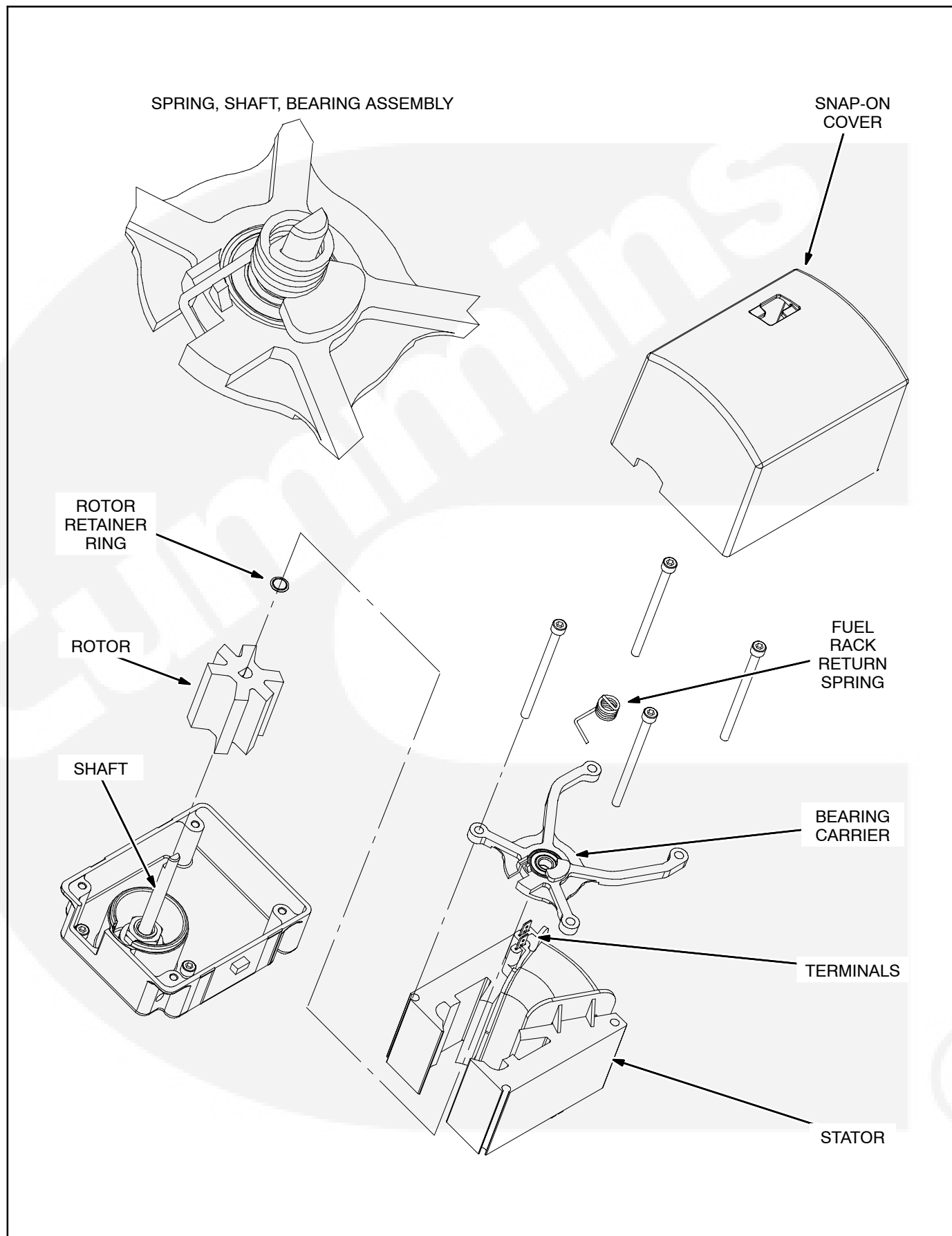


FIGURE 13-1. GOVERNOR ACTUATOR

ACTUATOR HIGH-IDLE
SPEED CONTROL
LEVER

FUEL INJECTION
PUMP ASSEMBLY

FUEL RACK
CONTROL ROD

GOVERNOR
SPRING

ACTUATOR SPEED
CONTROL LEVER

4-BALL
GOVERNOR

HIGH-IDLE
STOP SCREW

FIGURE 13-2. INTERNAL GOVERNOR PARTS

ACTUATOR SPEED CONTROL LEVER STOP (BEGINNING SPEC B)

The actuator speed control lever stop (Figure 13-3) must be adjusted whenever a different actuator base assembly is installed. The stop screw, rather than the fuel rack control lever, must stop the speed control linkage when the fuel rack is driven to the no-fuel position (to the right, as shown in Figure 13-2).

Actuator Rotor Not In Place

1. Assemble the actuator stator and bearing carrier to the base so that the shaft will be supported in its bearing.
2. Loosen the stop screw locknut and back the screw out a few turns. (Top one in the group of three.)
3. Turn the stop screw in until it just makes contact. Turn the screw one more full turn in and set the locknut.
4. Remove the bearing carrier and stator and complete reassembly with the rotor in place.

Actuator Rotor In Place

1. Loosen the stop screw locknut and back the screw out a few turns. (Top one in the group of three.)
2. Turn the stop screw in until it just makes contact and set the locknut.

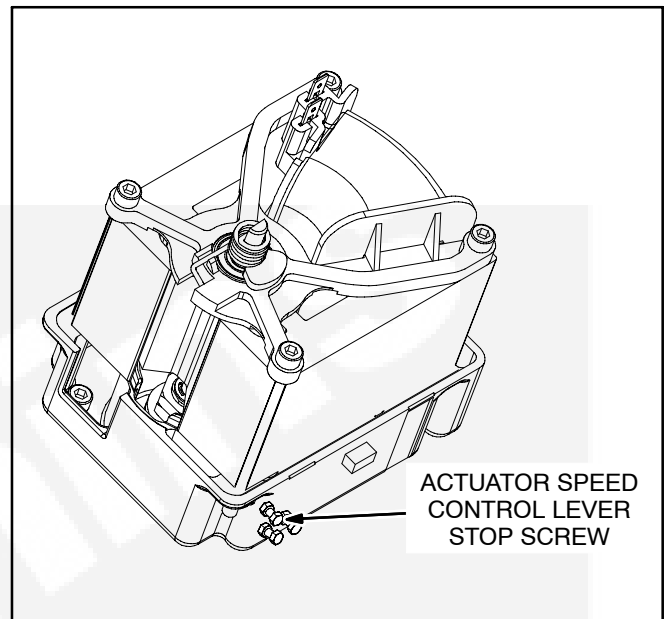


FIGURE 13-3. ACTUATOR SPEED CONTROL LEVER STOP (BEGINNING SPEC B)

HIGH-IDLE SPEED

High-idle speed must be readjusted each time the governor actuator base or the fuel injector pump is installed.

⚠WARNING *This adjustment involves operating the genset without a housing panel in place. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death. Keep your hands, clothing, and jewelry away from the engine pulleys, blower blades and electrical terminal block TB3 on the controller/inverter housing (Figure 10-1).*

Note: *The genset will only run a few minutes before shutting down because the controller has shut down the fuel pump.*

1. Remove the front housing panel (p. 6-3).
2. Set up a tachometer to indicate engine speed. (If the tachometer has to be held or adjusted while taking a reading, it will take two people to make this adjustment.)
3. Remove the actuator cover and reconnect the leads.
4. Start the genset and push the actuator rotor clockwise by hand as far as it will go (about 1/2 inch [12 mm]) and hold it there. (It may be easier to use a wrench on the flat at the top of the shaft to hold the rotor position.) Make sure the fuel rack return spring is in place on the rotor shaft to shut down the genset if you lose hold.

⚠CAUTION *Do not let engine speed exceed 3600 rpm. PMA voltages caused by higher speeds can damage the controller/inverter.*

5. Adjust high-idle speed to 3500-3600 rpm:
6. **Spec A:** (Figure 13-4)
 - A. If the genset hunts under full load, see HIGH IDLE STOP SCREW ADJUSTMENT (p. 13-6).
 - B. Adjust high-idle speed by turning the adjusting screw (2.5 mm allen head).
7. **Beginning Spec B:** (Figure 13-5).
 - A. Loosen the lock nuts on the two screws in the bottom row and remove the clamping screw.

B. Adjust high-idle speed by turning the adjusting screw and set its lock nut.

C. Run the clamping screw back in by hand until snug, back it out 1-1/2 turns and set its lock nut.

8. Let the rotor go. The genset should stop and display a fault code. Restart the genset and re-check high idle speed. Readjust if necessary.

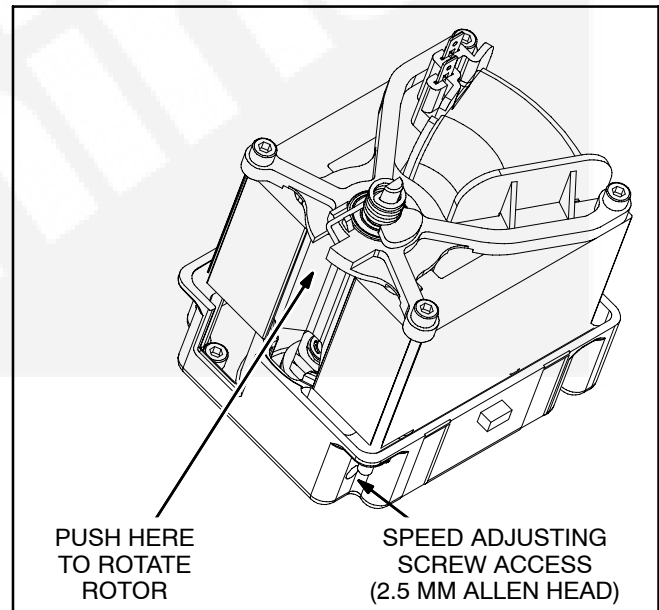


FIGURE 13-4. HIGH-IDLE SPEED ADJUSTMENT (SPEC A)

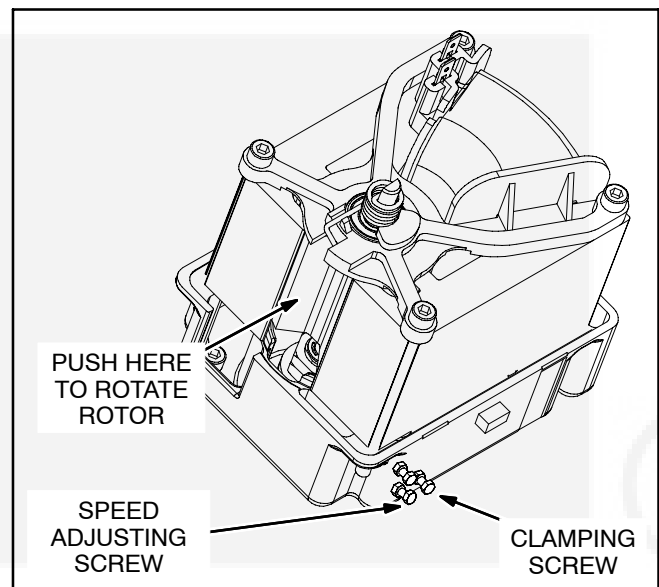


FIGURE 13-5. HIGH-IDLE SPEED ADJUSTMENT (BEGINNING SPEC B)

HIGH-IDLE STOP SCREW

On Spec A engines prior to 1997 adjust the high-idle stop screw (Figure 13-6) if the genset hunts under full load.

1. Back off high-idle speed in accordance with Steps 4 and 5 of the HIGH-IDLE SPEED adjustment procedure (p. 13-5) to less than 3300 rpm.
2. Adjust the high-idle stop screw in the front of the engine to obtain a speed of 3550 to 3590 rpm, while holding the actuator fully clockwise, and set the jam nuts.
3. Readjust high-idle speed according to Step 5 of the HIGH-IDLE SPEED adjustment procedure (p. 13-5).

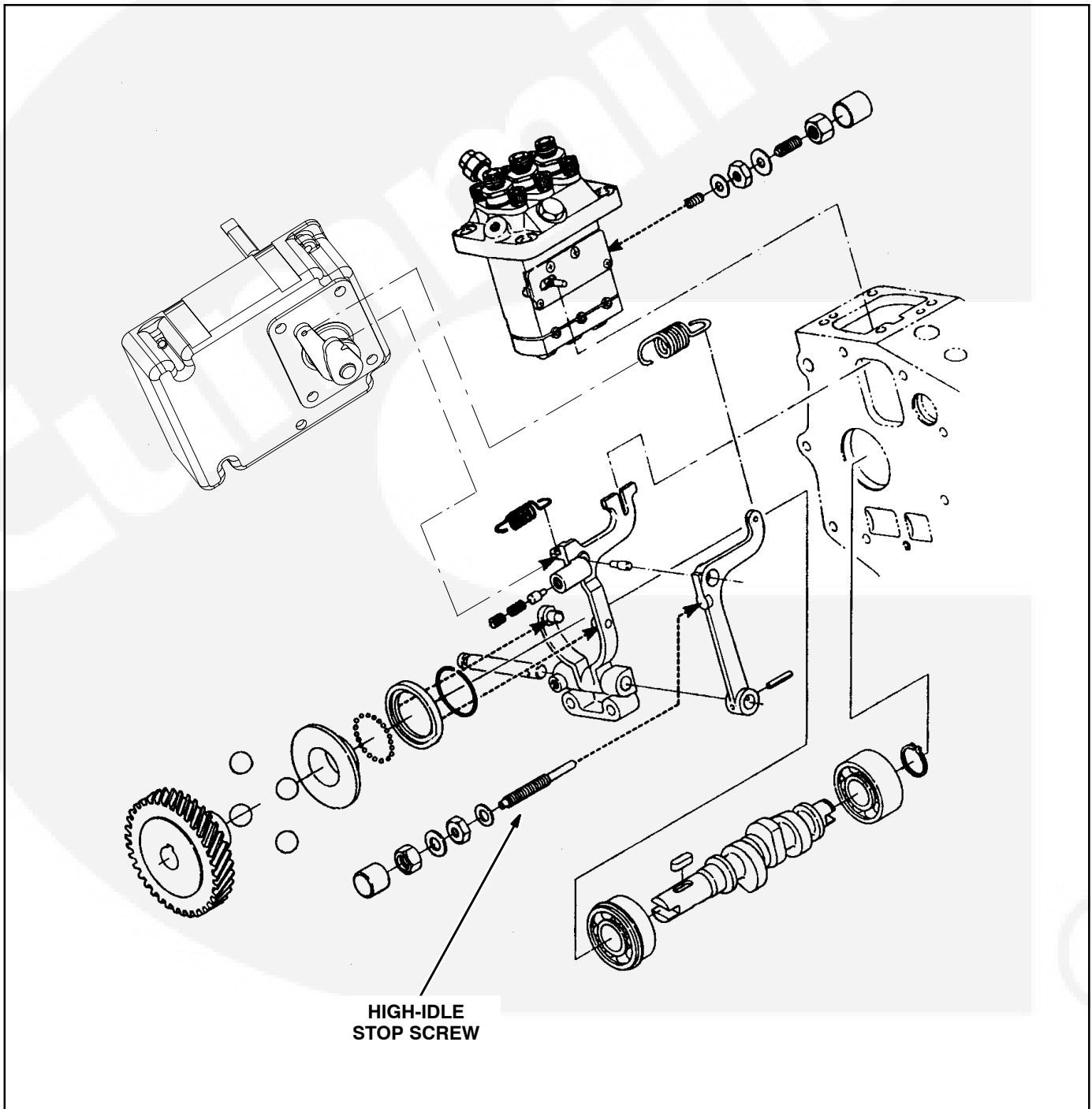


FIGURE 13-6. HIGH-IDLE STOP SCREW (SPEC A PRIOR TO 1997)

14. Fuel System

GENERAL

Figure 14-1 shows two views of the fuel filter, pump and hoses for delivering fuel to and from the fuel injection 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 are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and other sources of ignition well away. Keep a type ABC fire extinguisher handy.*

⚠ CAUTION *Always wipe dirt off fuel fittings before disconnecting them to keep dirt from entering the fuel system.*

FUEL PUMP

Fuel Flow Test

1. Disconnect the fuel return hose from the line to the supply tank and point the end into a quart (1 liter) or larger container that has volume graduations.
2. Prime the genset by pushing the Start/Stop switch to **STOP** and holding it there for the duration of the test. Flow should not be less than 200 ml (0.4 pints) per minute.
3. If flow is less than specified:
 - A. Replace the fuel filter.
 - B. Check for other restrictions in the fuel lines.
 - C. Check for air bubbles in the fuel. Tighten fittings and replace fuel lines as necessary. Replace a cracked fuel filter body.
 - D. Replace the fuel pump.

Removal and Installation

The fuel pump mounting screws are accessible from below the skid-base and the fuel pump is removeable through the maintenance access door. Unless provision has been made to provide access to these screws, the genset will have to be tilted up or removed from the vehicle.

When installing a fuel pump make sure the air seal is placed around the fuel inlet fitting to seal against leakage of cooling air and noise. Tighten all screws according to *Thread Torques*.

Thread Sealant and Fuel Line Fittings

The fuel line between the fuel pump and fuel filter has flare fittings. **Do not use any type of thread sealant on flare fittings.**

The connections for fuel supply and return that extend through the side of the base are pipe thread fittings. 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 FILTER

The fuel filter is mounted on a bracket just above the maintenance access door in the skid-base. See *Periodic Maintenance* for the filter replacement interval.

FUEL INJECTION SYSTEM

See the Engine Workshop Manual for fuel injection system service.

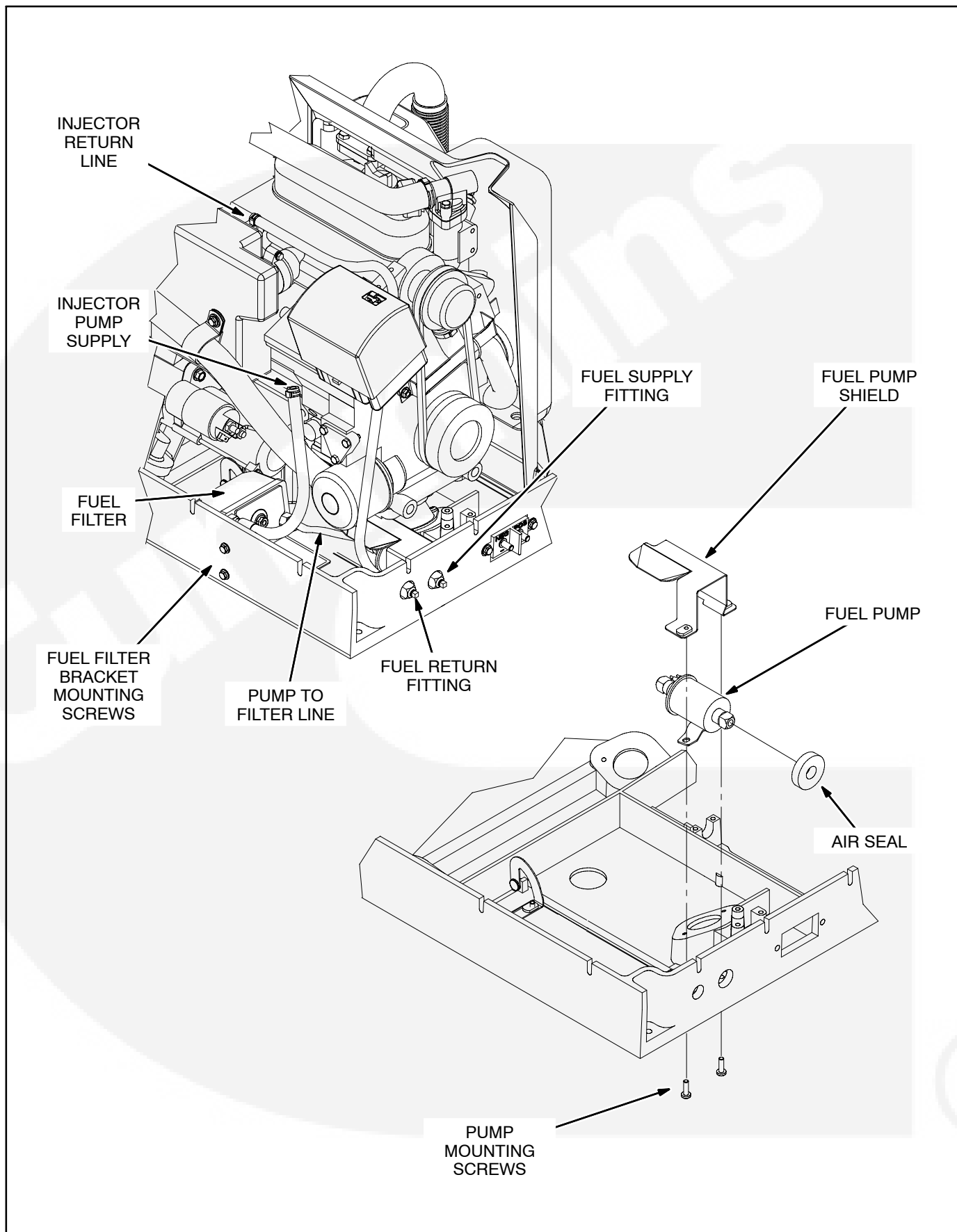


FIGURE 14-1. FUEL DELIVERY SYSTEM

15. Battery Charger

REMOVAL

The battery charger is optional. The charger and its transformer are mounted on the skid-base as shown in Figure 15-1.

Battery Charger Removal

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting and remove the front housing panel (p. 6-3).
2. Disconnect the quick-connectors in the two leads to the transformer and disconnect the third lead at the starter solenoid.
3. Remove the mounting screw.

Transformer Removal

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting

and remove the front, top and left end housing panels (p. 6-3).

2. Remove the battery charger.
3. Remove the controller/inverter assembly (Figure 10-1), the cooling blower (Figure 11-2) and the air intake hoses from the back of the air filter housing (Figure 7-1).
4. Disconnect the quick connectors in the two remaining leads (four leads altogether).
5. Remove the two mounting screws.

INSTALLATION

Installation of the battery charger and transformer is the reverse of removal. Tighten all screws according to *Thread Torques*.

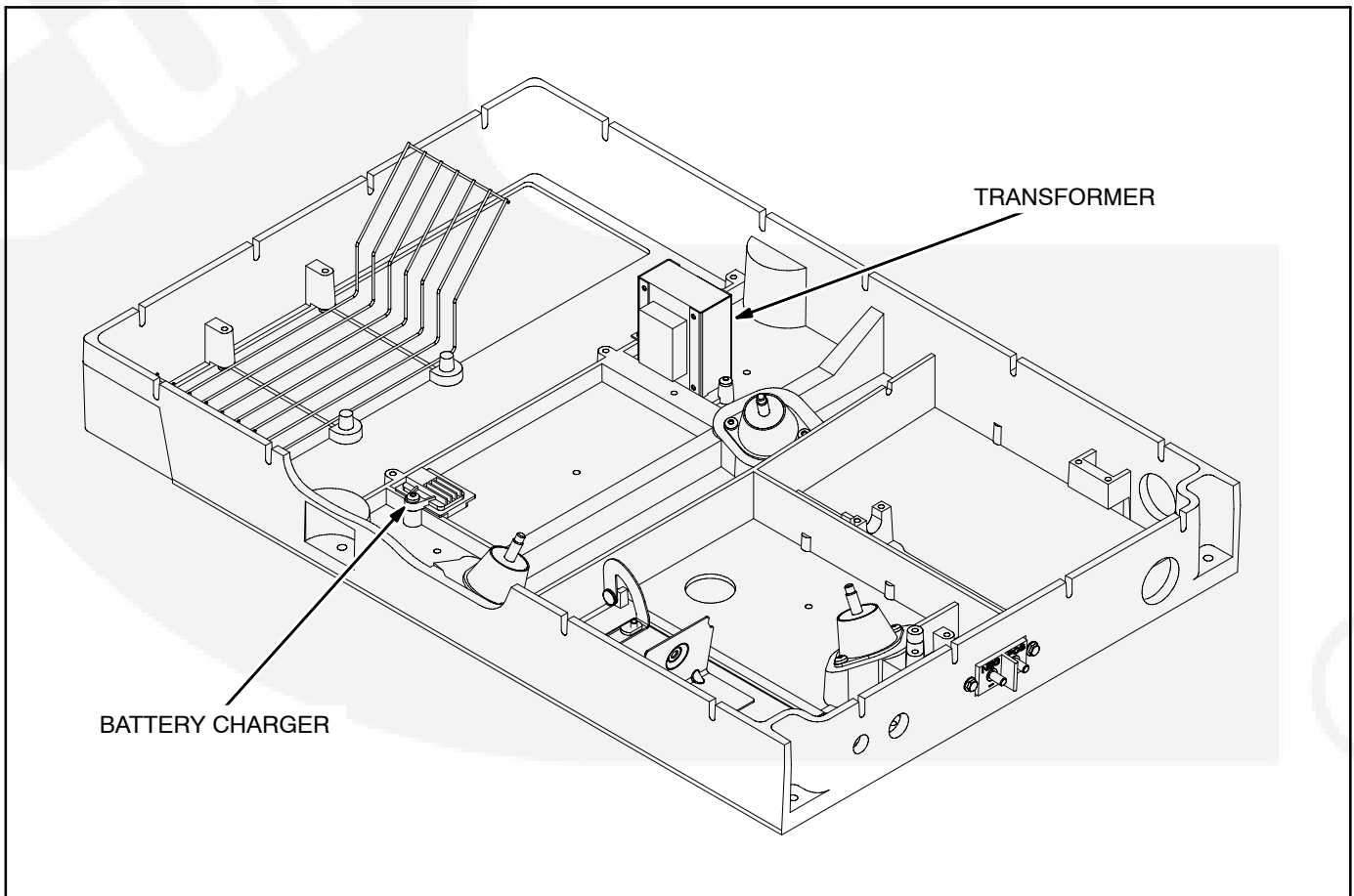


FIGURE 15-1. BATTERY CHARGER AND TRANSFORMER

16. Starter Motor

REMOVAL

See Figure 16-1. To remove the starter motor assembly from the genset:

1. Disconnect the negative (-) battery cable *from the battery* to prevent the genset from starting.
2. *If the genset is installed in the vehicle and does not have an access door in the front panel*, open the maintenance access door in the skid-base and remove the fuel filter and its mounting bracket (Figure 14-1).

⚠WARNING *Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away. Keep a type ABC fire extinguisher handy.*

3. *If the genset has been removed from the vehicle*, remove the front housing panel (p. 6-3). (If the genset has an access door in the front panel, remove the access door instead.)
4. Disconnect all wires and cables from the motor terminals.
5. Remove the two starter mounting bolts and remove the starter.

INSTALLATION

Installation is the reverse of removal. Tighten bolts and terminals according to *Thread Torques*.

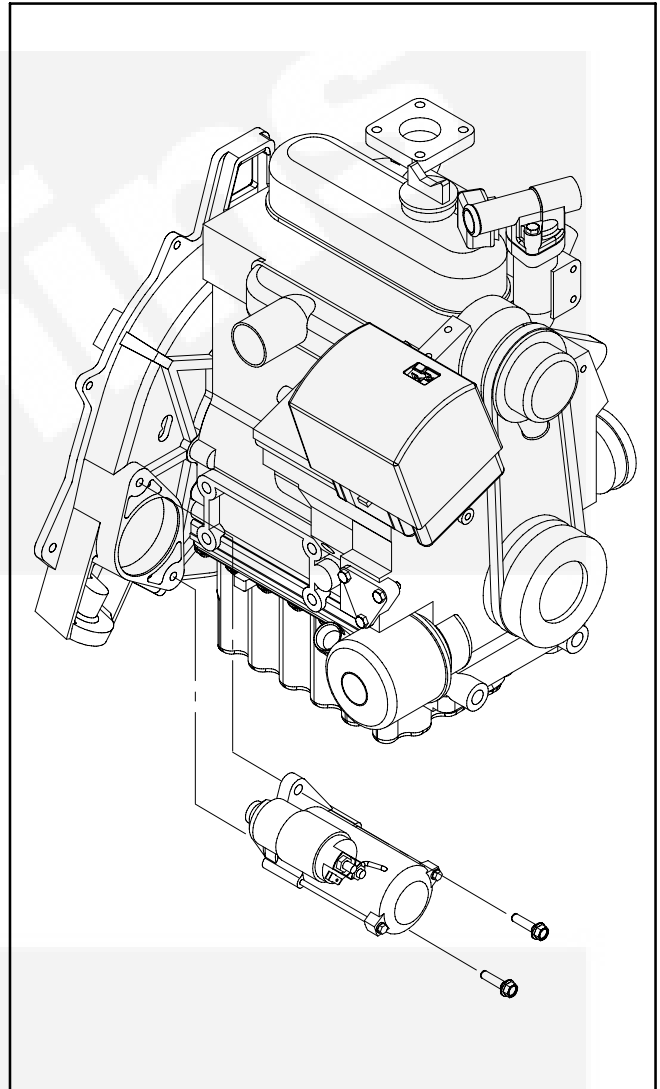


FIGURE 16-1. STARTER MOTOR AND SOLENOID

STARTER SOLENOID REPLACEMENT

⚠WARNING *This test involves high electrical currents, strong arcing and moving parts that can cause severe personal injury. Do not conduct this test near fuel tanks or when flammable vapors are present. Wear safety glasses. Keep fingers away from the pinion gear.*

The starter solenoid is separately replaceable. To determine whether the problem is in the solenoid or in the motor:

1. Secure the motor assembly in a vice after it has been removed from the genset.
2. Using a heavy jumper cable, because of the large currents involved, connect the motor terminal on the solenoid (the one closest to the motor) to the positive (+) terminal on a 12 volt battery.

3. Using a heavy cable from the negative (-) terminal on the battery, briefly touch the mounting flange on the motor.

- A. *If the motor does not spin up quickly and smoothly*, replace the motor/solenoid assembly.
- B. *If the motor does spin up quickly and smoothly*, the motor is probably okay: replace the solenoid.
- C. The solenoid is removeable by disconnecting the motor lead from the solenoid terminal and removing the two solenoid mounting nuts. When installing a new solenoid, make sure the solenoid plunger engages the shift fork.

17. Service Checklist

GENERAL

After servicing, inspect and test the installation to confirm that the genset will operate as intended. Check each of the areas described below before putting the genset into service.

HOUSING

Check to see that all housing panels and access covers are in place and secure (p. 6-3).

MOUNTING

Examine all mounting bolts and supporting members to verify that the genset is properly mounted. All fasteners should be tightened securely to prevent them from working loose when subjected to vibration.

LUBRICATION

If the engine oil was drained, refill as instructed in *Periodic Maintenance*.

COOLING SYSTEM

If the engine coolant was drained, refill as instructed in *Periodic Maintenance*.

WIRING

Verify that all wiring connections are tight and installed properly. Check each of these connections:

- Load wires
- Control wires
- Ground straps
- Battery cables

OUTPUT CHECK

Apply a full load to make sure the genset can produce its full rated output. Use a load test panel to apply a progressively greater load until full load is reached.

EXHAUST SYSTEM

While the genset is running inspect the entire exhaust system. Look and listen for leaks at all connections, welds, gaskets and joints. Also make sure the exhaust pipe is not overheating adjacent materials or equipment. Do not run the genset until all exhaust leaks have been repaired.

⚠️WARNING *Exhaust gas is deadly. The exhaust system must not leak and must discharge all exhaust away from the vehicle. Do not run the genset until the exhaust leaks have been repaired.*

The exhaust tailpipe must be supported by a hanger near the vehicle perimeter and terminate at least 1 inch outside the perimeter and at least 1 foot from doors and windows.

FUEL SYSTEM

While the genset is running, inspect the fuel supply and return lines, filter and fittings for leaks. Check flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause leakage. Repair all fuel leaks immediately.

⚠️WARNING *Diesel fuel is combustible. Leaking fuel could lead to fire and to severe personal injury or death. Repair fuel leaks immediately.*

CONTROL

Stop and start the genset several times at the control panel on the genset and at the remote control board (if provided) to verify that they work properly.

MECHANICAL

Stop the genset and inspect it for leaking gaskets, loose fasteners, damaged components and interference with other equipment. Repair as necessary. Inspect the generator compartment and verify that there are no breaks or openings in the vapor-proof wall that separates the compartment from the vehicle interior. Seal openings as necessary. Make sure that all soundproofing material is in place.

18. Troubleshooting

TROUBLESHOOTING WITH TABLE 18-1

To aid troubleshooting the genset controller causes the status indicator light to blink the numeric code assigned to the fault that caused shutdown. For a brief description of the fault and step-by-step corrective action, refer to TABLE 18-1. TROUBLESHOOTING, which lists the fault codes in numerical order.

Many genset shutdowns can be avoided by performing periodic maintenance on schedule (TABLE 5-1. PERIODIC MAINTENANCE SCHEDULE) and by *not* running the genset out of fuel. Note that when the genset and propulsion engine draw from the same fuel tank, the fuel dip tubes are usually arranged so that the genset will run out of fuel first. By marking the genset empty point on the fuel gauge, it will be easier to tell when the genset may run out of fuel.

FAULT CODE BLINKING

At fault shutdown, the status indicator light will repeatedly blink sets of 1, 2 or 3 blinks.

- **One blink** indicates shutdown due to high engine coolant temperature.
- **Two blinks** indicate shutdown due to a loss of engine oil pressure.
- Three blinks is code for shutdown due to some other abnormal condition.

For a 1-blink or 3-blink fault code, one touch to Stop brings up a second-level fault code. This code consists of 1, 2, 3 or 4 or 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 fault code number in Table 18-1. For example, Fault Code **No. 23** would be:

blink-blink—pause—blink-blink-blink—...

NOTE: Consciously avoid mistaking Fault Codes 11, 22 and 33 for Fault Codes 1, 2 and 3. The pauses between repetitions of the fault code are longer than the pauses between the tens and units digits of the the code. For example, Fault Code 33 would be:

blink-blink-blink—pause—blink-blink-blink
—longer pause—
blink-blink-blink—pause—blink-blink-blink—...

RESTORING FAULT CODE BLINKING

The fault code stops blinking after five minutes. **Prior to Spec F**, one touch to Stop restores fault code blinking. **Beginning Spec F**, 3 touches to Stop are required (also earlier Spec gensets with newer replacement controller-inverter assemblies).

NOTE: The last fault logged will blink even though the condition that caused the shutdown may have been corrected.

BYPASSABLE FAULTS: PRIOR TO SPEC F

When a fault condition persists, the genset shuts down when an attempt is made to restart. Prior to Spec F, (unless the controller assembly has been replaced) there are four faults the genset controller will bypass on a *second* attempt at restart:

- **No. 17**—fuel pump fault
- **No. 18**—glow plug fault
- **No. 23**—oil pressure switch fault
- **No. 24**—temperature sender fault.

Before making the second attempt at starting the genset, however, consider the following:

- As long as the ambient temperature is greater than 77° F (25° C), a glow plug fault (**No. 18**) will not affect starting or operation. As the ambient temperature keeps dropping, however, the genset will eventually fail to start.
- Bypassing an oil pressure switch fault (**No. 23**) or temperature sender fault (**No. 24**) could lead to serious engine damage if the oil pressure fails or the engine overheats.

⚠ CAUTION *Operating the genset under oil pressure switch or temperature sender fault conditions can lead to serious engine damage. Read the Warranty regarding possible exclusions when operating the genset under such conditions.*

TABLE 18-1. 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.*

GENSET WON'T STOP RUNNING—STATUS INDICATOR LIGHT ON

(Faulty Stop Switch or grounded wiring)

⚠WARNING *Removing genset panels or disconnecting fuel lines to stop a genset that won't stop can lead to severe personal injury or death from electrocution, contact with moving parts or fire.*

- *Try the genset Stop Switch if the remote Stop Switch does not work and vice versa.*
- *If possible, pinch flexible fuel hoses until the genset stops.*
- *Otherwise, let the genset run out of fuel before attempting service.*

Corrective Action:

1. Try the genset Stop Switch if the remote Stop Switch does not work, and vice versa. If only the genset Stop Switch works, go to Step 2. If neither switch works, or only the remote Stop Switch, go to Step 3.
2. Disconnect the remote control panel connector (J8/P8). While pressing the Remote Stop Switch, check for electrical continuity between remote control connector pins J8-A and J8-E. Replace a switch that does not close when pressed to Stop and repair or reconnect wiring as necessary.
3. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4). Reconnect the remote control panel (J8/P8) and while pressing the respective Stop Switch, check for electrical continuity between:
 - A. Pin P2-3 (remote stop) and pin P2-2 (remote ground).
 - B. Pin P2-10 (local stop) and pin P2-11 (local ground).
 - C. Replace a switch that does not close when pressed to Stop, check for missing, bent or corroded terminals and connector pins and repair or reconnect wiring as necessary.
4. Replace the controller assembly (p. 10-1).

GENSET WON'T STOP RUNNING—STATUS INDICATOR LIGHT OFF

(Binding governor mechanism, misadjusted speed stop)

⚠WARNING *Removing genset panels or disconnecting fuel lines to stop a genset that won't stop can lead to severe personal injury or death from electrocution, contact with moving parts or fire.*

- *Try the genset Stop Switch if the remote Stop Switch does not work and vice versa.*
- *If possible, pinch flexible fuel hoses until the genset stops.*
- *Otherwise, let the genset run out of fuel before attempting service.*

Corrective Action:

1. Remove the front and top housing panels (p. 6-3) and check the fuel rack return spring and replace it if worn or broken (Figure 13-1). Make sure it is reassembled correctly.
2. Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring. It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (Figure 13-2) as necessary.
3. Readjust the actuator speed control lever stop so that the fuel rack can go to no-fuel (p. 13-4).

TABLE 18-1. 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.*

STATUS INDICATOR LIGHT STAYS ON

(Reversed battery connections)

Corrective Action: Reconnect the battery correctly.

ENGINE CRANKS WHEN BATTERY CONNECTED

(Faulty Start Switch or grounded wiring)

Corrective Action:

1. Disconnect the remote control panel connector (J8/P8). Check for electrical continuity between remote control connector pins J8-A and J8-C. Replace a switch that does not open when released and repair or reconnect wiring as necessary.
2. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4). Reconnect the remote control panel (J8/P8) and check for electrical continuity between:
 - A. Pin P2-1 (remote start) and pin P2-2 (remote ground).
 - B. Pin P2-12 (local start) and pin P2-11 (local ground).
 - C. Replace a switch that does not open when released and repair or reconnect wiring as necessary.
3. Replace the controller assembly (p. 10-1).

ENGINE WON'T CRANK—FUEL PUMP WON'T STOP

(Faulty Stop Switch or grounded wiring)

Corrective Action:

1. Disconnect the remote control panel connector. Check for electrical continuity between remote control connector pins J8-A and J8-E. Replace a switch that does not open when released and repair or reconnect wiring as necessary.
2. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4). Reconnect the remote control panel (J8/P8) and check for electrical continuity between:
 - A. Pin P2-3 (remote stop) and pin P2-2 (remote ground).
 - B. Pin P2-10 (local stop) and pin P2-11 (local ground).
 - C. Replace a switch that does not open when released and repair or reconnect wiring as necessary.
3. Replace the controller assembly (p. 10-1).

TABLE 18-1. 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.*

STATUS INDICATOR LIGHT DEAD

(Faulty connections, no battery voltage)

Corrective Action:

1. Try the genset Start Switch if the remote Start Switch does not work, and vice versa. Disconnect the remote control panel (J8/P8) and try the genset Start Switch again. If nothing works, go to Step 2. If only the genset start switch works, go to Step 9. If only the remote start switch works, go to Step 12.
2. Replace **Fuse F1** (B+) if blown.
3. Clean and tighten the positive (+) and negative (–) battery cable connections at the battery, vehicle frame and genset.
4. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
5. Remove the front and top housing panels (p. 6-3). Check that all engine and battery harness wires (p. A-1, A-3) are properly connected to the grounding bolt on the flywheel housing, to the B+ terminal on the starter solenoid and to the battery terminal block (p. A-3). Clean and tighten connections and replace wiring as necessary.
6. Disconnect engine harness connector P1 from the controller (Figure 10-1, p. A-1, A-4). Check for B+ (12 VDC) at pin P1-8 and for continuity to ground at pin P1-7. Check for missing, bent or corroded connector pins and faulty wiring and repair as necessary.
7. Disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4) and reconnect the remote control panel (J8/P8). Press the switch and check for electrical continuity between:
 - A. Pin P2-1 (remote start) and pin P2-2 (remote ground).
 - B. Pin P2-3 (remote stop) and pin P2-2 (remote ground).
 - C. Pin P2-12 (local start) and pin P2-11 (local ground).
 - D. Pin P2-10 (local stop) and pin P2-11 (local ground).
 - E. Replace switches that do not close when pressed, check for missing, bent or corroded terminals and connector pins and faulty wiring and repair as necessary.
8. Replace the controller assembly (p. 10-1).
9. Disconnect the remote control panel (J8/P8). Check for electrical continuity between remote control connector pins J8-A and J8-C. Replace a switch that does not close when pressed and repair or reconnect wiring as necessary.
10. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4) and reconnect the remote control panel (J8/P8). Press the switch, check and for electrical continuity between:
 - A. Pin P2-1 (remote start) and pin P2-2 (remote ground).
 - B. Pin P2-3 (remote stop) and pin P2-2 (remote ground).
 - C. Replace a switch that does not close when pressed, check for missing, bent or corroded terminals and connector pins and faulty wiring and repair as necessary.
11. Replace the controller assembly (p.10-1).
12. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P2 from the controller (Figure 10-1, p. A-1, A-4). Press the switch and check for electrical continuity between:
 - A. Pin P2-12 (local start) and pin P2-11 (local ground).
 - B. Pin P2-10 (local stop) and pin P2-11 (local ground).
 - C. Replace a switch that does not close when pressed, check for missing, bent or corroded terminals and connector pins and faulty wiring and repair as necessary.
13. Replace the controller assembly (p.10-1).

TABLE 18-1. 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.*

STARTING BATTERIES RUN DOWN

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

Corrective Action:

1. Clean and tighten the positive (+) and negative (-) battery cable connections at the battery, vehicle frame and genset.
2. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
3. Install or service a battery charging system in the vehicle if the genset is not so equipped.
4. If the genset is equipped with a battery charging system, check performance by measuring voltage across the battery terminals while running the genset. Watch the meter while turning the genset circuit breaker (operator's console) on and off several times. The battery charger is probably okay if voltage jumps to more than 12 VDC each time the breaker is turned on. Check for parasitic loads external to the genset and/or replace the battery.
5. If the battery charger does not seem to be working, remove the front housing panel (p. 6-3). If loose, reconnect battery charger transformer input connectors J12 and J13 to the AC harness (p. A-2, A-4), output connectors J14 and J15 to the battery charger (p. A-4) and the battery charger output lead to the B+ terminal on the starter solenoid.
6. Disconnect transformer connectors J12 through J15 and check winding continuity across J12-J13 and across J14-J15. Replace the transformer if a winding is open (p. 15-1).
7. Reconnect J12 and J13 and run the genset. Replace the battery charger if transformer output across J14-J15 is approximately 16.3 VAC. If not, go to Step 8.
8. Disconnect J12 and J13 and measure voltage. Replace the transformer if there is approximately 120 VAC across J12-J13. If not, go to Step 9.
9. Replace or repair wiring in the AC harness if there is no voltage.

⚠WARNING *This test involves operating the genset with housing panels removed. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death. Keep your hands away from the engine pulleys, blower blades and electrical terminal block TB3 on the controller housing (Figure 10-1).*

TABLE 18-1. 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.*

ENGINE CRANKS BUT DOES NOT START

(Fuel delivery, glow plugs or engine are marginal)

Corrective Action:

1. Check fuel level. (Note: The genset fuel pickup is probably higher than the vehicle engine pickup.)
2. Prime the engine fuel system.
3. Check the engine air filter and remove any blockage.
4. Replace **Fuse F3** (glow plugs) if blown. If it blows again, go to Step 8.
5. Check for fuel and air leaks at each fitting in the fuel supply line. (Note: White smoke indicates air in the fuel.)
6. Conduct a fuel flow test and service as necessary (p. 14-1).
7. Remove the top housing panel (p. 6-3) and observe the governor actuator rotor (Figure 13-1) while cranking. (Remember to reattach the leads after removing the cover.) The rotor should rotate smoothly through about 1/2 inch (12 mm). If it does not, check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring. It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it, or service the internal engine governor mechanism (Figure 13-2), as necessary.
8. Remove the front and top housing panels (p. 6-3) and check out the glow plug system as follows:
 - A. If the glow plugs are not working, it can be the result of a failed temperature sensor which results in a no start.
 - B. If loose, reconnect spade connector HR-1 to the glow plug bus bar at the front of the engine, engine harness connectors A1-J7 and A1-J8 to the leads from the controller assembly (Figure 10-1, p. A-1, A-4), and the engine harness ground connections to the flywheel housing.
 - C. Disconnect HR-1 from the glow plug bus bar and A1-J8 from the controller assembly (p. 10-1). Check for continuity (ground short) between either connector and ground. Replace wiring as necessary.
 - D. Remove the glow plug bus bar along side the engine valve cover and check for electrical continuity between each glow plug terminal and ground. Replace any open glow plug (p. 12-1).
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 14 volts, such as when a battery booster is used for starting.
 - E. Check for B+ on the glow plug bus bar while pressing Start. Replace the controller assembly if B+ is not available for preheat in accordance with Table 10-1.
9. Service the engine (p. 12-1).

TABLE 18-1. 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.*

STARTER ENGAGES-DISENGAGES

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

Corrective Action:

1. Have the vehicle propulsion engine running while trying to start the genset—the battery charging alternator may be able to maintain starting voltage high enough to get the genset started.
2. Clean and tighten the positive (+) and negative (–) battery cable connections at the battery, vehicle frame and genset.
3. Recharge or replace the battery. Refer to the battery manufacturer's recommendations.
4. Increase battery cable size or run parallel cables.
5. Remove the front and top housing panels (p. 6-3) Check that all engine and battery harness wires (p. A-1, A-3) are properly connected to the grounding bolt on the flywheel housing, to the B+ terminal on the starter solenoid and to the battery terminal block (p. A-3). Clean and tighten connections and replace wiring as necessary.
6. Disconnect engine harness connector P1 from the controller (Figure 10-1, p. A-1, A-4). Check for B+ (12 VDC) at pin P1-8 and for continuity to ground at pin P1-7. Check for missing, bent or corroded connector pins and faulty wiring and repair as necessary.

NO POWER—GENSET RUNNING, RUN LIGHT ON

(Line circuit breaker OFF or tripped or faulty wiring)

Corrective Action:

1. Reset or turn “On” the line circuit breaker on the genset operator's console.
2. Reset or turn “On” the line circuit breakers on the main distribution panel in the vehicle.
3. Check the voltage at genset AC output terminal block TB2. If there is approximately 120 VAC across TB2-1 and TB2-3 and across TB2-2 and TB2-4, repair or reconnect the wiring between the genset and the vehicle. If there is no voltage, go to Step 4.
4. Remove the front and top housing panels (p. 6-3) and check for proper AC harness connections at TB3, TB2 and the line circuit breakers (Figure 10-1, p. A-2, A-4). Reconnect wiring as necessary and tighten all terminal screws and nuts.
5. Check for electrical continuity across the terminals of each breaker (p. A-2). Replace a circuit breaker which lacks electrical continuity when “On”.
6. Run the genset and measure voltages. If there is approximately 120 VAC across TB3-1 and TB3-2, replace the AC wiring harness. If there is no voltage, replace the controller assembly (p. 10-1).

⚠ WARNING *This test involves operating the genset with housing panels removed. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death. Keep your hands, clothing, jewelry, and hair away from the engine pulleys, blower blades and electrical terminal block TB3 on the controller housing (Figure 10-1).*

TABLE 18-1. 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.*

GENSET HUNTS UNDER FULL LOAD

(Fuel delivery marginal, governor misadjusted)

Corrective Action:

1. Prime the engine fuel system by holding the control switch down in its **Stop** position for at least 1 minute.
2. Check for fuel and air leaks at each fitting in the fuel supply line.
3. Conduct a fuel flow test and service as necessary (p. 14-1).
4. Connect a source of known fuel quality, prime the fuel system, and run the genset. If performance improves, replace the bad fuel in the supply tank.
5. Readjust high-idle speed (p. 13-5).

HIGH TEMPERATURE—FAULT CODE NO. 1

(Engine coolant or inverter heat sink temperature exceeded design limit)

Corrective Action: Check the second-level fault code by touching Stop. The second-level fault will be either No. 33 or No. 34.

LOW OIL PRESSURE—FAULT CODE NO. 2

(Low oil pressure cutoff switch did not open)

Corrective Action:

1. Check engine oil level and add oil as necessary.
2. Drain excess oil (above dipstick Full mark).
3. Remove the top housing panel (p. 6-3). Reconnect engine harness spade connector S2 to the low oil pressure cutout switch (Figure 12-2) if it is loose (short to ground will cause shutdown).
4. Disconnect engine harness connector P2 (p. A-1) from the controller assembly (Figure 10-1) and the pressure switch. Check both ends for electrical continuity to ground. Replace wiring as necessary if the lead is shorted to ground.
5. Install an oil pressure gauge in place of the pressure switch and observe oil pressure after the engine has run a few minutes (let RV models step down to low idle speed). Replace the low oil pressure cutoff switch if engine oil pressure is 14 psi (98 kPa) or greater. Service the engine if engine oil pressure is less than 14 psi (98 kPa). (Simulate normal switch operation to keep the genset running during the test by starting with connector S2 grounded and removing it from ground when the engine starts.)

⚠WARNING *This test involves operating the genset with housing panels removed. The panels guard against rotating parts and bare live electrical parts that can cause severe personal injury or death. Keep your hands, clothing, jewelry, and hair away from the engine pulleys, blower blades and electrical terminal block TB3 on the controller housing (Figure 10-1).*

TABLE 18-1. 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.*

SERVICE CHECK FAULT—CODE NO. 3

(A second-level fault occurred)

Corrective Action: Check the second-level fault code by touching Stop. The second-level fault will be one of the following in this table. See Page 18-1 for a description of how the fault code blinks.

SERVICE CHECK FAULT—CODE NO. 4

(Begin Spec K)

Corrective Action: Set has been commanded to crank, and cranks for a total of 35 seconds continuous, without the set starting (speed exceeding – 1200 RPM) Typical troubleshooting should be related to an out of fuel condition (see FC36) – check fuel flow and return, actuator operation, wiring, etc.

OVERLOAD—CODE NO. 8

(Models HDKAH & HDKAV only: Load exceeded 110 percent of genset rating for 2 minutes)

Corrective Action: Reduce load and restart

TABLE 18-1. 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.*

OVERCURRENT FAULT—CODE NO. 11

(AC output short)

Logic: If inverter is enabled and inverter short circuit is indicated for > 3 counts.

Corrective Action:

1. Turn-off the genset line circuit-breaker. If the genset no longer shuts down, the genset is probably okay – check for and repair a short-circuit in the vehicle, wiring or shorted battery-charger transformer.
 - Short Circuit Test:
 - Check resistance across inverter output terminals (with and without breaker).
 - Meter should read 'Open' if there are no shorts.
 - If meter reads a low resistance value, it indicates a short either in wiring and/or loads.
2. Remove battery charger loads and transfer switch/es connected directly to the inverter output. Also remove any motor starting loads such as Air conditioners, Vacuum cleaners etc.

Note: If this step resolves the issue, check to see if there are any issues with specific loads.

3. Check whether the vehicle engine and genset share the same starting battery, if so and this fault occurs when cranking the vehicle engine, low battery voltage maybe causing this shutdown. Increase battery capacity or connect to house battery or install a separate battery and battery charging system for the genset. If the genset still shuts down and has spec # "11296" in the Model Number, go to step 4. if not, go to step 5.
4. Remove the front and top housing panels (p. 6-3) and disconnect the AC harness (p. A-2) from TB3 on the controller assembly (Figure 10-1). Reconnect the short grounding lead in the harness to TB3-2 so that the genset will run. If the genset no longer shuts down, find and repair the short in the AC harness, reconnecting the line circuit breaker, output terminal block (TB2) and battery-charger as necessary.
5. Perform PMA stator test (p. 11-1). If all values are within spec, go to step 6.
6. Replace the controller assembly.

Document all details of the troubleshooting steps including load type and conditions.

INVERTER OVERVOLTAGE FAULT—CODE NO. 12

(Controller not able to regulate to rated voltage)

Corrective Action:

1. Check whether the vehicle engine and genset share the same starting battery. If so, and this fault occurs when cranking the vehicle engine, low battery voltage may be causing this shutdown. Increase battery capacity or install a separate battery and battery charging system for the genset.
2. Replace the controller assembly (p. 10-1).

TABLE 18-1. 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.*

INVERTER UNDERVOLTAGE FAULT—CODE NO. 13

(Controller not able to regulate to rated voltage)

Corrective Action:

1. Check whether the vehicle engine and genset share the same starting battery. If so, and this fault occurs when cranking the vehicle engine, low battery voltage may be causing this shutdown. Increase battery capacity or install a separate battery and battery charging system for the genset.
2. Remove the front and top housing panels (p. 6-3).
 - A. If loose, reconnect the leads of current transformer (p. A-2, A-4) to controller leads J9 and J10. If that does not work, check resistance. If electrical resistance is not 15 to 25 ohms, replace the current transformer.
 - B. Check for proper connections between the generator (PMA) and the controller assembly and reconnect as necessary.
 - C. Check for a shorted generator stator winding (p. 11-1). If a winding is shorted, replace the stator.
3. Replace the controller assembly (p. 10-1).

INVERTER OVERFREQUENCY FAULT—CODE NO. 14

(Controller not able to regulate to rated frequency)

Logic: With inverter enabled, set is running at rpm > 800 and inverter frequency > 102.5% rated for 5 samples (125ms).

Corrective Action:

1. Reduce the number of connected appliances, especially when air conditioners and on board battery-charger are running.
2. Replace the controller assembly.

Document all details of the troubleshooting steps.

INVERTER UNDERFREQUENCY FAULT—CODE NO. 15

(Controller not able to regulate to rated frequency)

Logic: With inverter enabled, set is running with rpm > 800 and inverter frequency < 97.5% rated for 5 samples (125ms).

Corrective Action:

1. Reduce the number of connected appliances, especially when air conditioners and battery charger are running.
2. Verify that air-conditioners are working properly.
3. Remove the top housing panel (p. 6-3) and check for correct connections at terminal TB3-1 and TB3-2 (Figure 10-1).
4. Check PMA connections for continuity. Reconnect PMA leads and retest.
5. Check high idle adjustments.
6. If problem is not resolved, replace the controller assembly.

Document all details of the troubleshooting steps.

TABLE 18-1. 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.*

FUEL PUMP FAULT—CODE NO. 17*

(Controller sensed open circuit)

Corrective Action:

1. Try priming the fuel system by holding the control switch at Stop. If the fuel pump functions, the fault was improperly declared and will probably not recur.
2. If loose, reconnect the two fuel pump leads (p. A-1, A-4). They are accessible through the access door in the skid-base, and also through an access door in the front panel on some models.
3. Disconnect the fuel pump leads from the engine wiring harness and connect the white fuel pump lead to the positive (+) terminal of a 12 volt battery and the black lead to the negative (–) terminal. Replace the pump if there is no audible sound or vibration.
4. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connector P1 (Figure 10-1, p. A-1, A-4) from the controller assembly. Check for electrical continuity between pin P1-2 and connector E2-1 and between E2-2 and ground and repair as necessary. Also check for missing, bent or corroded terminals and connector pins and repair or reconnect as necessary.

* – This is a bypassable fault discontinued beginning Spec F.

GLOW PLUG CIRCUIT PROTECTION FAULT—CODE NO. 18*

(Controller sensed short circuit)

Corrective Action:

1. Remove the top housing panel (p. 6-3) and, if loose, reconnect engine harness spade connector HR-1 (p. A-1, A-4) to the glow plug bus bar at the front of the engine (short to ground will cause shut-down).
2. Disconnect engine harness connector HR-1 at the glow plug bus bar and A1-J8 at the controller assembly. Check for continuity between either connector and ground (ground short). Replace the engine harness if it is shorted to ground.
3. Replace the controller assembly (p. 10-1).

* – This is a bypassable fault discontinued beginning Spec F.

GOVERNOR ACTUATOR FAULT—CODE NO. 19

(Controller sensed open or short circuit)

Corrective Action:

1. Remove the front housing panel (p. 6-3) and reconnect the engine wiring harness connectors E1-1 and E1-2 to the governor actuator if they are loose. Polarity does not matter.
2. Measure actuator coil resistance with a digital ohmmeter. Replace the actuator stator assembly if coil resistance is not 1.7 to 2.8 ohms.
3. Disconnect engine harness connector P1 from the controller assembly (Figure 10-1, p. A-1, A-4). Check for electrical continuity between pin P1-1 and quick connector E1-1 and between E1-2 and ground. Replace the engine harness if either leg lacks electrical continuity. Also check for missing, bent or corroded terminals and connector pins and repair or reconnect as necessary.

TABLE 18-1. 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.*

STARTER SOLENOID CIRCUIT PROTECTION FAULT—CODE NO. 21*

(Controller sensed short circuit)

Corrective Action:

1. Open the maintenance access door and reconnect engine harness quick connector K-1 to the starter motor solenoid if it is loose (p. A-1, A-4).
2. Disconnect engine harness connector K-1 from the starter solenoid and connect battery positive (+) by means of a switch and jumper to energize the solenoid. If the starter does not crank the engine when the solenoid is energized, remove the starter motor assembly. Replace the starter motor assembly or solenoid, as necessary (p. 16-1).
3. Remove the top housing panel (p. 6-3) and reconnect engine harness connector A1-J6 to the lead from the controller/inverter assembly if it is loose (Figure 10-1).
4. Disconnect engine harness connector A1-J6 at the controller/inverter assembly and connector K1 at the starter solenoid and check for continuity to ground from either connector (ground short). Replace the engine harness if it is shorted to ground.
5. Replace the controller assembly (p. 10-1).

* – Discontinued beginning Spec F.

GOVERNOR ACTUATOR OVERLOAD FAULT—CODE NO. 22

(Duration of operation at or near full-duty cycle beyond design limit)

Corrective Action:

1. Reduce the number of connected appliances, especially when air conditioners and battery chargers are running.
2. Check for fuel and air leaks at each fitting in the fuel supply line.
3. Conduct a fuel flow test and service as necessary (p. 14-1).
4. Replace the engine air filter (p. 5-6) and clean the spark-arrest muffler (p. 5-5).
5. Remove the front and top housing panels (p. 6-3). Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring. It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (p. 13-2) as necessary.
6. Check for an open or shorted PMG stator winding (p. 11-1). (The controller will drive the actuator harder to compensate for loss of output.)
7. Readjust high-idle speed (p. 13-4).
8. Service the fuel injectors and injection pump as necessary (p. 12-1).
9. Check fuel injection timing (p. 12-1).
10. Service a worn engine (p. 12-1).

TABLE 18-1. 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.*

LOW OIL PRESSURE CUTOFF SWITCH FAULT—CODE NO. 23*

(Controller sensed switch still open during start—not a running fault**)

Corrective Action:

1. Remove the top housing panel (p. 6-3). If loose, reconnect engine harness spade connector S2 to the low oil pressure cutoff switch (Figure 12-2).
2. Disconnect engine harness connector P2 from the controller assembly (Figure 10-1, p. A-1, A-4). Check for electrical continuity between pin P2-9 and connector S2 and for missing, bent or corroded connector pins and repair as necessary.
3. Check for loose or corroded ground connections between the engine and the base and the base and controller assembly and repair as necessary.
4. Replace the low oil pressure cutoff switch.

* – This is a bypassable fault prior to Spec F.

** – Beginning Spec F, this fault is enabled 20 seconds after the genset stops and is declared during start.

COOLANT TEMPERATURE SENDER FAULT—CODE NO. 24*

(Controller did not sense temperature change during first 5 minutes of operation)

Corrective Action:

1. Remove the top housing panel (p. 6-3). If loose, reconnect engine harness spade connector E3-1 to the coolant temperature sender (Figure 10-1, p. A-1, A-4).
2. Disconnect engine harness connector P1 from the controller assembly. Check for electrical continuity between pin P1-12 and connector E3-1 and for missing, bent or corroded connector pins and repair as necessary.
3. Replace the coolant temperature sender.

* – This is a bypassable fault prior to Spec F. Note also that an open circuit is sensed as cold temperature, resulting in maximum pre-heat and post-heat times.

ENGINE ABOVE SPEED TARGET FAULT—CODE NO. 25

(Governor unable to regulate to target speed)

Corrective Action:

1. Remove the front and top housing panels (p. 6-3). Check the fuel rack return spring and replace it if it is worn or broken (Figure 13-1). Make sure it is reassembled correctly.
2. Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring. It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (Figure 13-2) as necessary.
3. Readjust high-idle speed (p. 13-5).

TABLE 18-1. 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.*

ENGINE BELOW SPEED TARGET FAULT—CODE NO. 26

(Governor unable to regulate to target speed)

Corrective Action:

1. Reduce the number of connected appliances, especially when air conditioners and battery chargers are running.
2. Prime the engine fuel system.
3. Check for fuel and air leaks at each fitting in the fuel supply line.
4. Conduct a fuel flow test and service as necessary (p. 14-1).
5. Replace the engine air filter (p. 5-6) and clean the spark-arrest muffler (p. 5-5).
6. Connect a source of known fuel quality, prime the fuel system and run the genset. If performance improves, replace the bad fuel in the supply tank.
7. Remove the front and top housing panels (p. 6-3). Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring (Figure 13-1). It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (Figure 13-2) as necessary.
8. Readjust high-idle speed (p. 13-4).
9. Service the fuel injectors and injection pump, as necessary (p. 12-1).
10. Check fuel injection timing (p. 12-1).
11. Service a worn engine (p. 12-1).

TABLE 18-1. 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.*

PMA SENSE LOST FAULT—CODE NO. 27

(Controller unable to sense PMA frequency)

Logic: If between cranking and run_down, rpm = 0 and dc bus voltage present for > 2 seconds.

Corrective Action:

1. Check for proper connections between the generator (PMA) stator (Figure 11-2) and the controller assembly (Figure 10-1) and reconnect as necessary.
2. Disconnect the PMA leads from the control. Using InPower, turn on the control starter relay in controller assembly (Refer to Step 7).

⚠ WARNING Do Not crank for more than 30 seconds.

3. Connect Digital Multi Meter (DMM) to the PMA leads. While the engine is cranking, measure the voltage between PMA leads T1–T2, T2–T3 and T3–T1 using DMM. Set DMM to AC and range. Do not crank the engine for more than 30 seconds.
 - A. If all of the leads measure > 20Vrms, replace controller–assembly.
 - B. If any of the leads measure < 20Vrms, troubleshoot PMA (Refer Step 6).

TIP:

- If values of all leads (T1–T2, T2–T3 and T3–T1) is < 20Vrms, problem is with the rotor.
 - If value of one/more leads is < 20Vrms, problem lies with the stator.
4. After measuring the PMA leads, turn–off control starter relay in controller assembly (Refer Step 7E) using InPower.
 5. Run the set again and check if fault is cleared.

6. PMA Troubleshooting Steps:

- A. Check for PMA to Ground shorts.
 - Use a digital multimeter to measure resistance between each PMA lead to Ground.
 - Meter will read 'Open' if there are no shorts.
 - If meter reads a finite resistance, it indicates a short.
- B. Check for an open generator stator winding (p. 11-1). If winding is open, replace the stator.

⚠ CAUTION *Ensure actuator is at zero and/or fuel is Off.*

- C. Remove top housing panel (p. 6-3), check PMA rotor and integrity of the magnets. Attempt to bar the engine by hand to check for jammed magnets. Replace the rotor if damaged.

Note: If the rotor is damaged, Do Not replace the controller–assembly. Replace the rotor first and check to verify if that solves the problem.

7. Steps for turning on the control starter relay in controller assembly using Inpower:

- A. Enable the parameter "Starter Override Request".
- B. Turn on the parameter "Startes Override Command".
- C. To verify, check to see if "Starter Override Status" = on.
- D. To switch off starter relay, turn off the parameter "Starter Override Command".
- E. To verify, check to see if "Starter Override Status" = off.

TABLE 18-1. 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.*

DC SENSE LOST FAULT—CODE NO. 28

(Controller unable to sense DC bus voltage)

Corrective Action:

1. Open the circuit breaker. If the fault does not persist, check for and disconnect excessive loads from the genset before starting.
2. Check for proper connections between the generator (PMA) stator (Figure 11-2) and the controller assembly (Figure 10-1) and reconnect as necessary.
3. Replace the controller assembly (p. 10-1).

HIGH BATTERY VOLTAGE FAULT—CODE NO. 29

(Voltage across battery system greater than 17.5 volts)

Corrective Action:

1. Check battery bank connections and reconnect if necessary so that the 12 volt batteries serving the genset are connected in parallel (12 volt) rather than in series (24 volt).
2. Select a lower battery booster charge rate.

OVERSPEED FAULT—CODE NO. 31

(Engine speed greater than 3600 rpm)

Corrective Action:

1. Remove the front and top housing panels (p. 6-3). Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring (Figure 13-1). It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (Figure 13-2) as necessary.
2. Readjust high-idle speed (p. 13-4).
3. Replace the controller assembly (p. 10-1).

TABLE 18-1. 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.*

LOW CRANKING SPEED FAULT—CODE NO. 32

(Cranking speed less than 180 rpm for more than 2 seconds)

Logic: If CRANK and generator frequency < 3Hz for > 2 seconds.

Corrective Action:

Troubleshooting for Fault Code 32 is divided into 2 failure modes:

1. The engine does not crank.
2. The engine cranks.

If The Engine Does Not Crank

1. Inspect fuse F2. If blown, inspect wiring connections for shorts to chassis or other shorts. Replace fuse and repeat test.
2. Check battery voltage at the genset terminal – should be $11 \pm 0.2V$ or above. Replace/recharge battery as necessary.
3. Inspect battery connections at the terminals. Check DC system and cables.
4. Follow the steps below to troubleshoot and verify control starter relay (in controller assembly) and starter motor assembly. In the steps below the numbers in parenthesis refer to the wiring diagram on page A-5.
 - A. Using InPower, turn ON the control starter relay (in controller assembly) (Refer Step 5).
 - B. Measure voltage at A1–J6–K1 **(1)** at starter assembly. If measured voltage is > 10V, replace starter assembly.
 - C. If measured voltage is < 10V, unplug A1–J6–K1 at the Starter Assembly **(2)**.
 - D. Measure voltage at A1–J6–K1 **(2)** at the harness. It should measure approximately Battery voltage.
 - If it measures approximately battery voltage, replace starter motor
 - If it does not measure approximately battery voltage or measures less than 10V, unplug J6 **(4)** from A1–J6 **(3)** at controller assembly and measure voltage at J6 **(4)** on controller assembly.
 - If measured voltage at **(4)** < 10V, then disconnect A1–J5 **(5)** from J5 **(6)** and measure voltage at A1–J5 **(5)**. If value is > 10V at A1–J5 **(5)**, then replace controller assembly.
 - If measured voltage at **(5)** < 10V, verify wiring.
5. Steps for turning on the control starter relay in controller assembly using Inpower:
 - A. Enable the parameter "Starter Override Request".
 - B. Turn on the parameter "Starter Override Command".
 - C. To verify, check to see if "Starter Override Status" = on.
 - D. To switch off starter relay, turn off the parameter "Starter Override Command".
 - E. To verify, check to see if "Starter Override Status" = off.

TABLE 18-1. 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.*

LOW CRANKING SPEED FAULT—CODE NO. 32 (CONT.)

(Cranking speed less than 180 rpm for more than 2 seconds)

If The Engine Cranks

While the start button is pressed, Monitor the parameters "waveform period", "Inverter dc voltage" using Inpower and refer to table below:

Note: Waveform period <80000 indicates Normal cranking speed. Waveform period >80000 indicates unit is cranking too slow.

Condition No.	Waveform Period	Symptom	Troubleshooting
1	80000–140000	Engine cranking slow	See step 1
2	30000000 for > 4s	Engine cranks normal but control does not sense PMA output	See step 2

Step 1: Engine cranking slow

1. Verify engine setup for ambient conditions.
2. Low/weak batteries cause starting issues. Monitor battery voltage during crank. It must be > 8V. Ideally it should be greater than 9V.
 - A. If the battery voltage is \leq 8V, inspect battery connections at the terminals.

Step 2: Engine cranks normal but control does not sense PMA output

1. Check for proper connections between the generator (PMA) stator (Figure 11-2) and the controller assembly (Figure 10-1) and reconnect as necessary.
2. Disconnect the PMA leads from the control. Using InPower, turn on the control starter relay in controller assembly (Refer Step 7).

⚠WARNING Do Not crank for more than 30 seconds.

3. While the engine is cranking, use a digital multimeter (DMM) set to AC and range to measure the voltage between PMA leads T1–T2, T2–T3 and T3–T1. Do Not crank for more than 30 seconds.
 - A. If any of the leads measure > 20Vrms, replace controller–assembly.
 - B. If any of the leads measure < 20Vrms, troubleshoot PMA. (Refer Step 6.)

TIP:

- If values of all leads (T1–T2, T2–T3 and T3–T1) is > 20Vrms, problem is with the magnetic field.
 - If value of one/more leads is < 20Vrms, problem lies with the stator.
4. Turn–off control starter relay in the inverter (Refer Step 7D) using InPower after measuring the leads
 5. Run the set again and check if fault is cleared.

TABLE 18-1. 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.*

LOW CRANKING SPEED FAULT—CODE NO. 32 (CONT.)

(Cranking speed less than 180 rpm for more than 2 seconds)

6. PMA Troubleshooting Steps:

- A. Check for PMA to Ground shorts.
 - 1). Use a digital multimeter to measure resistance between each PMA lead to Ground.
 - a). Meter will read 'Open' if there are no shorts.
 - b). If meter reads a finite resistance, it indicates a short.
- B. Check for an open generator stator winding (p. 11-1). If winding is open, replace the stator.

⚠ CAUTION *Ensure actuator is at zero and/or fuel is Off.*

- C. Remove top housing panel (p. 6-3), check PMA rotor and integrity of the magnets. Attempt to bar the engine by hand to check for jammed magnets. Replace the rotor if damaged.

Note: If the rotor is damaged, Do Not replace the controller—assembly. Replace the rotor first and check to verify if that solves the problem.

7. Steps for turning on the control starter relay in controller assembly using Inpower:

- A. Enable the parameter "Starter Override Request".
- B. Turn on the parameter "Starter Override Command".
- C. To verify, check to see if "Starter Override Status" = on.
- D. To switch off starter relay, turn off the parameter "Starter Override Command".
- E. To verify, check to see if "Starter Override Status" = off.

HIGH ENGINE COOLANT TEMPERATURE FAULT—CODE NO. 33

(Engine coolant temperature exceeded design limit)

Corrective Action:

1. Check the engine coolant level and add coolant and repair leaks as necessary.
2. Check for and remove any objects blocking the air inlet or outlet openings in the bottom of the genset.
3. Reduce the number of appliances connected at the same time. (Note that high altitude and high ambient temperature decrease engine cooling capacity.)
4. Look for a broken or worn coolant pump drive belt (Figure 12-2) and replace as necessary. (Visible through the maintenance access door in the skid-base.)
5. Remove the air intake grille in the skid-base and check to see that the cooling blower (Figure 11-2) is secure and that the blades are not fouled.
6. Check for air leaks in the housing—missing or loose housing panels and access covers, including the access covers for the fuses and AC terminals.
7. Clean and flush the cooling system to remove coolant passage fouling.
8. Remove the top housing panel (p. 6-3). If loose, reconnect engine harness spade terminal connector E3-1 to the coolant temperature sender (Figure 12-2) (If the lead is loose and touching ground, the controller will sense a high engine temperature.)
9. While the top housing panel is off (Step 6-3), check for fouling of the radiator air passages and clear out dust and debris with compressed air directed from below (reverse of normal air flow).
10. Replace the coolant thermostat (Figure 12-2).
11. If the genset overheats only underway, see the coach manufacture regarding air baffles or other means to direct cooling air into the genset.

TABLE 18-1. 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.*

HIGH INVERTER TEMPERATURE FAULT—CODE NO. 34

(Inverter heat sink temperature exceeded design limit*)

Corrective Action:

1. Check for and remove any objects blocking the air inlet or outlet openings in the bottom of the genset.
2. Remove the air intake grille in the skid-base and clean the heat sink fins (Figure 10-1) if they are fouled. Also check to see that the cooling blower (Figure 11-2) is secure and that the blades are not fouled.
3. Reduce the number of appliances connected at the same time. (Note that high altitude and high ambient temperature decrease cooling capacity.)
4. Replace the controller assembly (p. 10-1) if the genset cannot carry rated load.

*— Prior to Spec F, use compressed air to cool off the fins of the heat sink if it is necessary to get the genset started right away. Beginning Spec F, the genset will run for 2 minutes after being restarted, which is enough time to cool down the heat sink if the connected load is less than 2 kW.

CONTROL CARD FAILURE FAULT—CODE NO. 35

(Microprocessor EEPROM error during self-test)

Corrective Action: Report this failure to the Factory and replace the controller assembly (p.10-1). This fault occurs when using obsolete software.

ENGINE STOPPED FAULT—CODE NO. 36

(Engine stopped without command by controller)

Corrective Action:

1. Check fuel level. (Note: The genset fuel pickup is probably higher than the vehicle engine pickup.)
2. Prime the engine fuel system if the genset ran out of fuel.
3. Check for fuel and air leaks at each fitting in the fuel supply line. (Note: White smoke indicates air in the fuel.)
4. Check the engine air filter and remove any blockage.
5. Check for mechanical damage.
6. Check auxiliary fuel pump (if equipped).
7. Conduct a fuel flow test and service as necessary (p. 14-1).
8. Remove the front and top housing panels (p. 6-3) and disconnect engine harness connectors P1 and P2 from the controller (Figure 10-2, p. A-1, A-4,). Check for missing, bent or corroded connector pins and faulty wiring and repair as necessary.
9. Service the engine (p. 12-1).

INVALID GENSET CONFIGURATION FAULT—CODE NO. 37

(Genset configuration is preprogrammed at the factory)

Corrective Action: Replace the controller assembly (p. 10-1). The controller assembly must be configured at the factory.

TABLE 18-1. 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.*

OVERCURRENT FAULT—CODE NO. 38

(Too many loads connected)

Corrective Action:

1. Reduce the number of appliances running at the same time, especially those with high motor starting loads such as air conditioners. Start up with no load and let the genset run for five minutes to cool down the inverter.
2. If the appliance and air conditioner loading patterns have remained the same but genset performance has deteriorated:
 - A. Check for fuel and air leaks at each fitting in the fuel supply line. (Note: White smoke indicates air in the fuel.)
 - B. Conduct a fuel flow test and service as necessary (p. 14-1).
 - C. Remove the front and top housing panels (p. 6-3). Check for binding in the governor mechanism by pushing the actuator rotor clockwise by hand—against the action of the fuel rack return spring (Figure 13-1). It should rotate smoothly about 1/2 inch (12 mm) and return smoothly. If it binds or catches, remove the governor actuator base assembly and replace it or service the internal engine governor mechanism (Figure 13-2) as necessary.
 - D. Readjust high-idle speed (p. 13-4).
 - E. Service the fuel injectors and injection pump as necessary (p. 12-1).
 - F. Service a worn engine (p. 12-1).

LOW BATTERY VOLTAGE FAULT—CODE NO. 39*

(Battery voltage dropped below 9 volts while genset running)

Logic: If power supply shutdown is indicated and battery voltage < 9.5V during wakeup state

Corrective Action:

1. Inspect connections at battery and genset.
2. Avoid running the genset while cranking the propulsion engine, specially in installations where genset batteries are used to supplement vehicle engine batteries
3. Check battery voltage at the genset terminal –typical should be 11V \pm 0.3V or above. If not, replace/recharge battery.
Note: Due to the long battery cables, battery voltage at the genset terminal may be lower than at battery terminals.
4. Check Battery Voltage at the genset terminal "while cranking engine". If battery Voltage drops < 9V \pm 0.2V, replace/recharge the battery.
Note: Battery voltage dipping below 9V during crank indicates a potentially weak battery. Battery needs to be replaced.

* – Fault Code Active for Specs A–E and beginning M
Fault Inactive for Specs F–L

TABLE 18-1. 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.*

PROCESSOR FAULT—CODE NO. 42*

(Microprocessor ROM error during self-test)

Corrective Action: Replace the controller assembly (p. 10-1).

* – Beginning Spec F and replacement controller assemblies

PROCESSOR FAULT—CODE NO. 43*

(Microprocessor RAM error during self-test)

Corrective Action: Replace the controller assembly (p. 10-1).

* – Beginning Spec F and replacement controller assemblies

INVERTER POWER SUPPLY FAULT—CODE NO. 46*

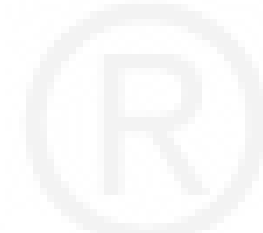
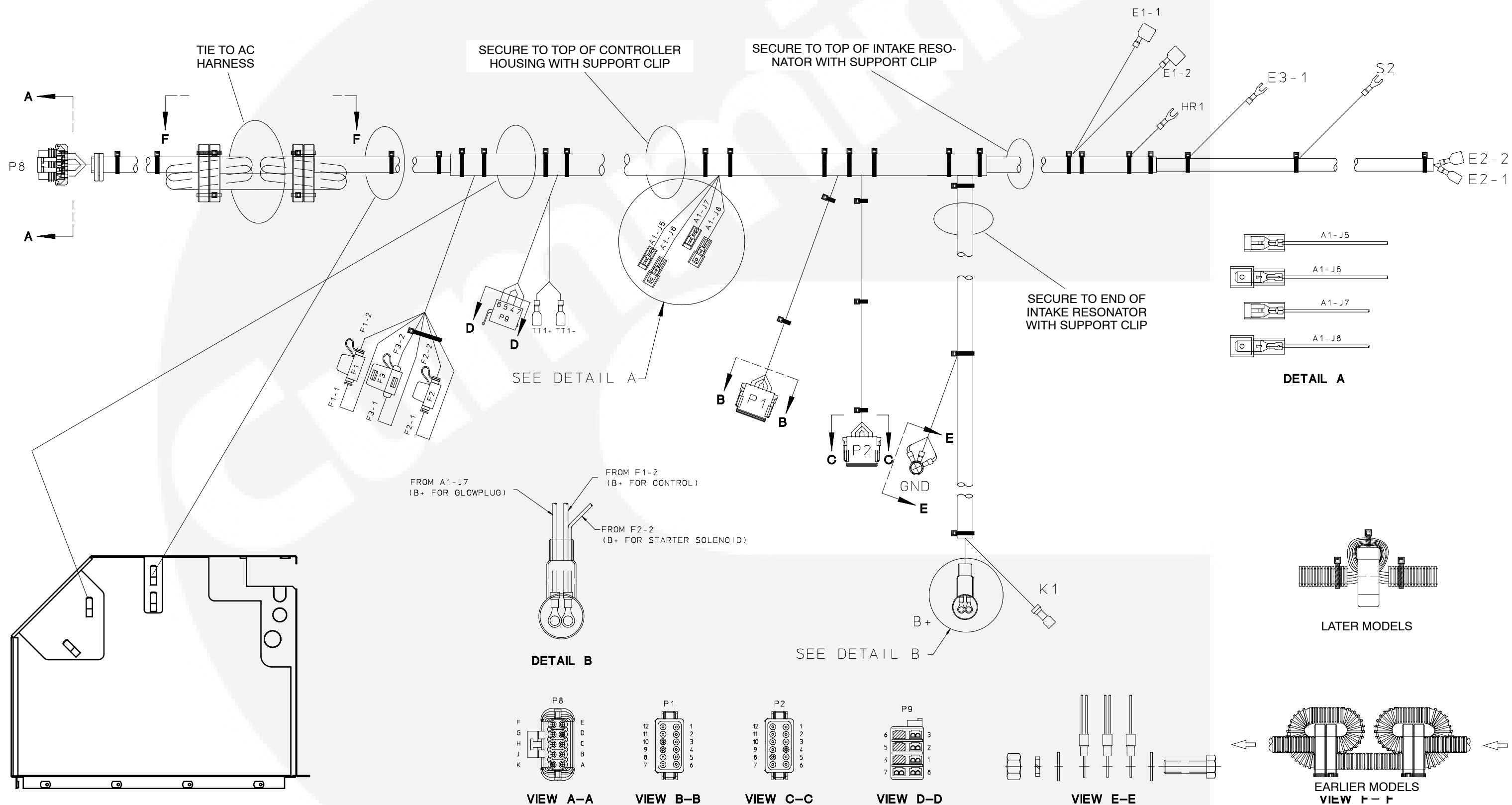
(Low battery voltage or power supply device failure)

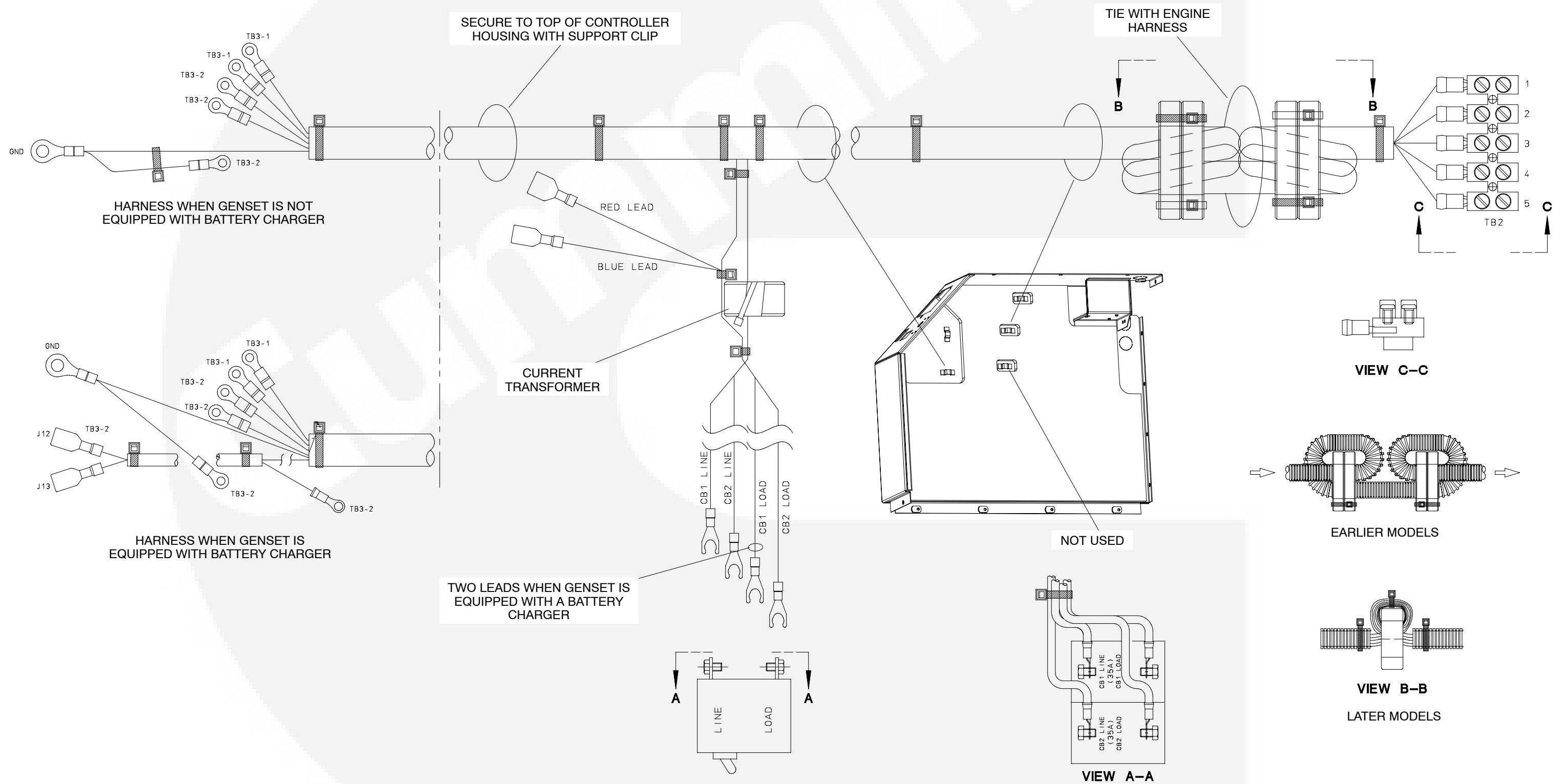
Logic: If input indicates power supply shutdown for 3 samples at 32ms rate.

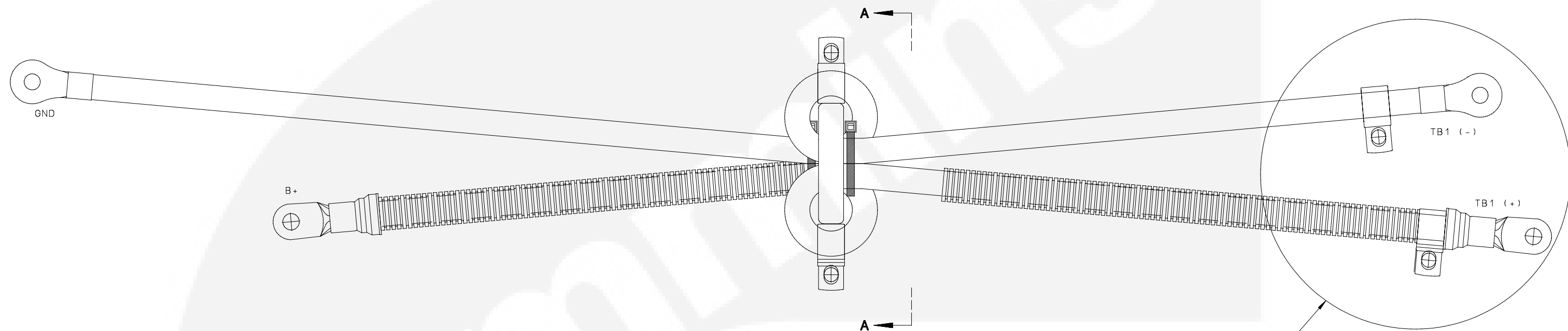
Corrective Action:

1. Avoid running the genset while cranking the propulsion engine, specially in installations where genset batteries are used to supplement vehicle engine batteries.
2. Inspect battery cable connections at the battery, vehicle frame, and genset.
3. Check battery voltage at the genset terminal –typical voltage should be $11V \pm 0.3V$ or above. If not, replace/recharge battery.
Note: Due to the long battery cables, battery voltage at the genset terminal may be lower than at battery terminals.
4. Check battery voltage at the genset terminal "while cranking engine". If battery Voltage drops to $< 9V \pm 0.2V$, replace/recharge the battery.
Note: Battery voltage dipping below 9V during crank indicates a potentially weak battery. Battery needs to be replaced.
5. Remove battery charger or unplug the battery charger from its AC source, before cranking.
6. Replace the controller assembly (p 10-1).

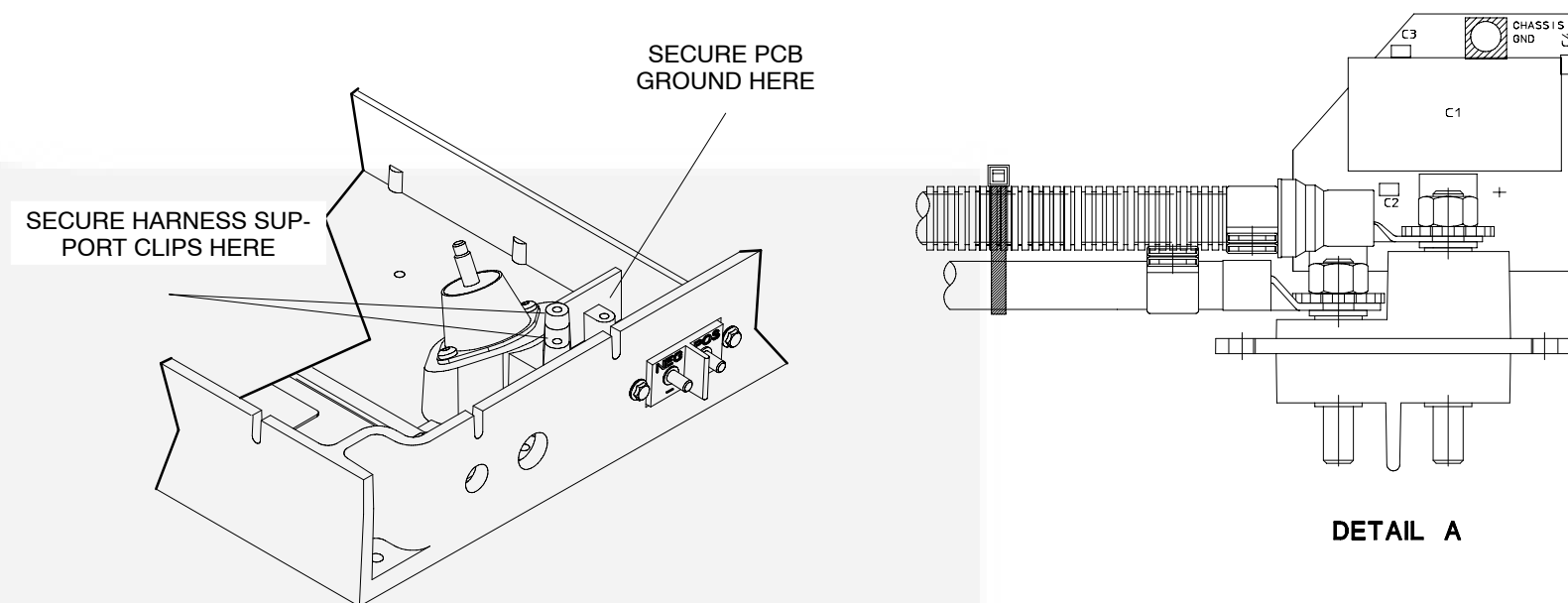
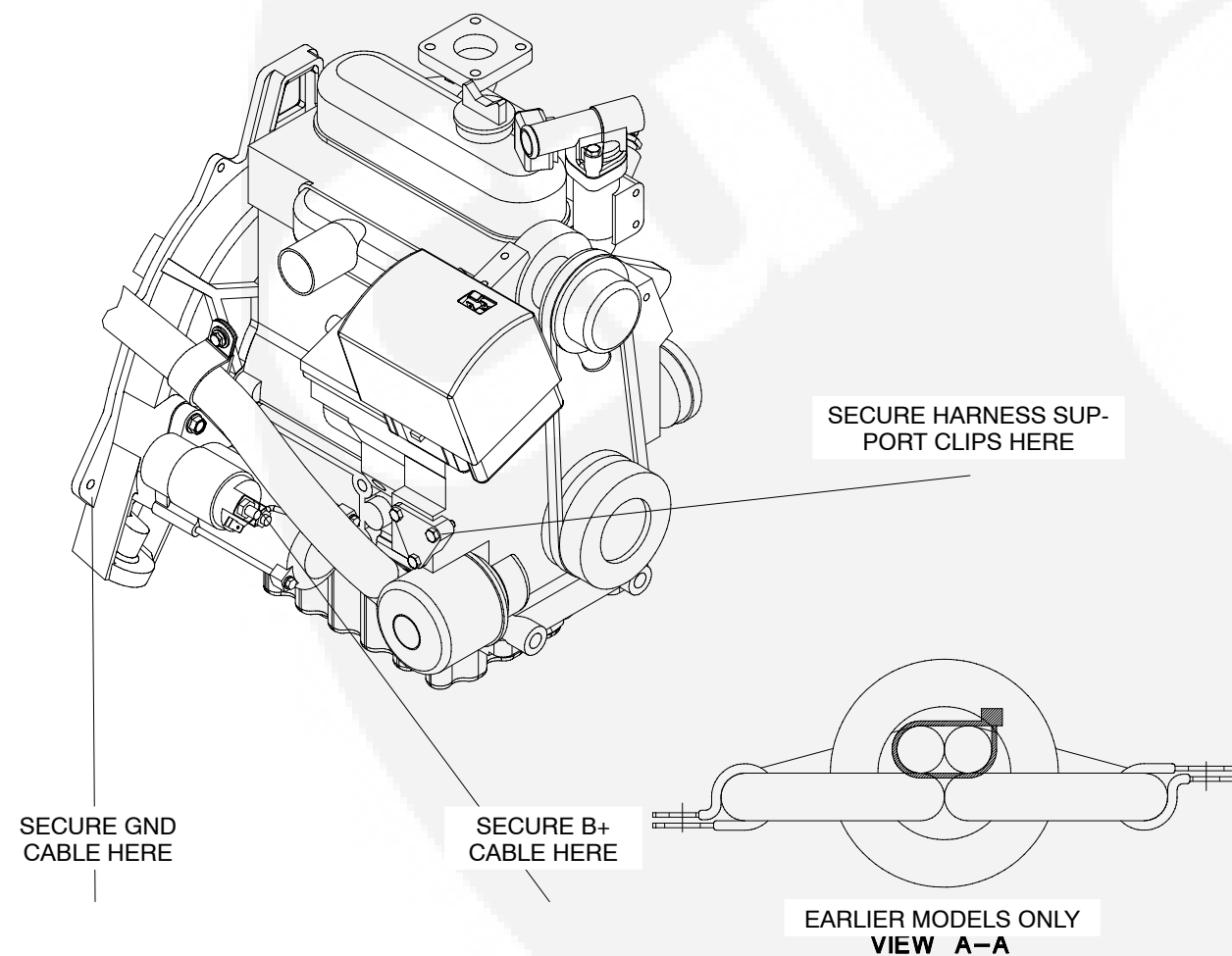
* – Beginning Spec F and replacement controller assemblies







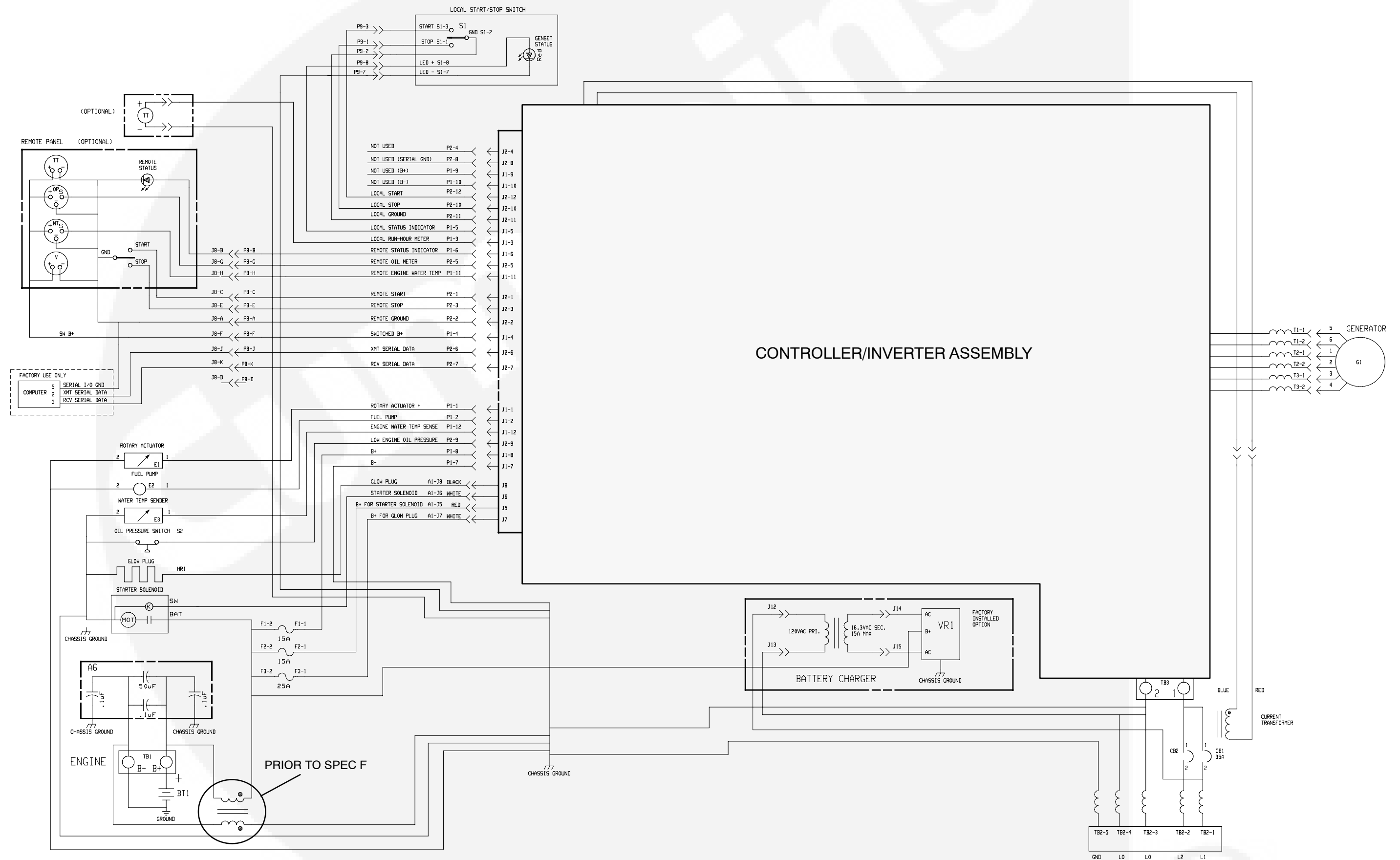
SEE DETAIL A
FOR PCB AND TERMINAL
BLOCK CONNECTIONS.



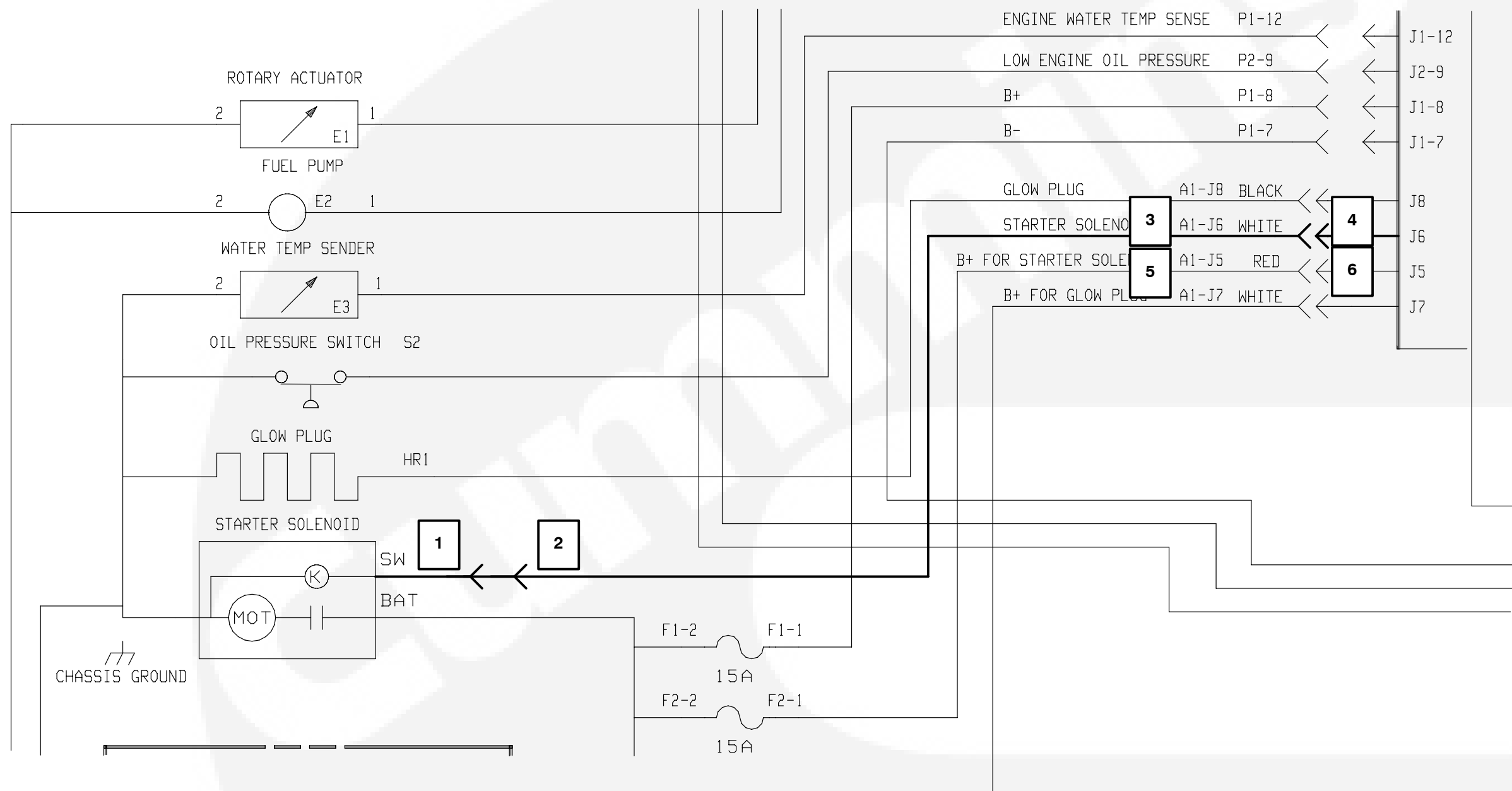
NOTES:

1. DO NOT TORQUE NUTS. LEAVE LOOSE
ENOUGH SO WIRES CAN BE ROUTED
PROPERLY DURING ASSEMBLY.

BATTERY WIRING HARNESS



WIRING DIAGRAM



CONTROLLER/INVERTER ASSEMBLY

- | Ref # | Description |
|-------|--|
| 1. | INPUT TERNINAL AT STARTER SOLENOID. |
| 2. | A1-J6-K1 HARNESS CONNECTION AT STARTER SOLENOID. |
| 3. | A1-J6-K1 HARNESS CONNECTION AT CONTROL ASSEMBLY. |
| 4. | J6 TERMINAL AT CONTROL ASSEMBLY. |
| 5. | A1-J5-K1 HARNESS CONNECTION AT CONTROL ASSEMBLY. |
| 6. | J5 TERMINAL AT CONTROL ASSEMBLY. |

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