



Service Manual

Onan Generator Set for RV

HGJBB (Spec A-B)

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1 SAFETY PRECAUTIONS

Thoroughly read the OPERATOR'S MANUAL before operating the generator set. Safe operation and top performance can be obtained only 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 which will result in severe personal injury or death.

WARNING

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

CAUTION

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

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

1.1 General Precautions

WARNING

The generator set emits exhaust fumes, may be hot, and utilizes moving parts - all of which may cause personal injury or death. Keep children away from the generator set at all times.

WARNING

Evaporative starting fluids are highly explosive. Do not use evaporative starting fluids.

WARNING

The generator set may accidentally or remotely start during service. Before servicing the generator set, disconnect the negative (-) battery cable at the battery to make sure the generator set does not accidentally or remotely start.

WARNING

Mental or physical fatigue and the consumption of alcohol and drugs can severely impair an operator, installer or servicing personnel, which can lead to personal injury or death. Never operate, install or service the generator set while impaired.

WARNING

Unsafe or improper installation and operation of the generator set can lead to equipment damage, severe personal injury or death. Make sure the generator set installation and operation comply with all applicable local, state, and federal codes and regulations.

NOTICE

A running generator set utilizes hot, moving, or electrically live parts, which can cause severe injury or death. Only trained and experienced personnel may make adjustments to a running generator set.

⚠ CAUTION

A cluttered generator set compartment can restrict air flow and start a fire. Keep the generator set compartment free of any clutter (Examples include, but are not limited to: excess oil and oily rags, dirt and gear).

⚠ CAUTION

Fasteners can come loose during generator set operation, presenting the possibility of equipment damage or personal injury. Make sure all fasteners are secure and torqued properly.

1.2 Generator Voltage is Deadly

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

1.3 Engine Exhaust is Deadly

- Learn the symptoms of carbon monoxide poisoning in this manual and never occupy the vehicle while the generator set is running unless the vehicle is equipped with a working carbon monoxide detector.
- The exhaust system must be installed in accordance with the generator set Installation Manual. Engine cooling air must not be used for heating the working or living space or compartment.
- Inspect for exhaust leaks at every startup and after every eight hours of running.
- Make sure there is ample fresh air when operating the generator set in a confined area.

1.4 Fuel is Flammable and Explosive

- 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 flame, sparks, pilot lights, arc-producing equipment and switches and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.

- Leaks can lead to explosive accumulations of gas. Natural gas rises when released and can accumulate under hoods and inside housings and buildings. LPG sinks when released and can accumulate inside housings and basements and other below-grade spaces. Prevent leaks and the accumulation of gas.

1.5 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.

1.6 Moving Parts Can Cause Severe Personal Injury or Death

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

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2 Introduction

This is the service manual for the generator set model series listed on the front cover. Read and carefully observe all of the instructions and precautions in this manual.

WARNING

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

WARNING

This generator set is not a life support system. It can stop without warning. Children, persons with physical or mental limitations, and pets could suffer severe personal injury or death. A personal attendant, redundant power or an alarm system must be used if generator set operation is critical.

CAUTION

Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law.

See the Operator's Manual for instructions concerning operation, maintenance and storage and for recommendations concerning engine lubricating oil and fuel.

See the Installation Manual for important recommendations concerning the installation and for a list of the installation codes and standards for safety that may be applicable.

See the Parts Manual for parts identification numbers and required quantities and for exploded views of the generator set subassemblies. Genuine Cummins Inc. replacement parts are recommended for best results.

When contacting Cummins Inc. for parts and product information, be ready to provide the model and serial numbers on the generator set nameplate ([Figure 1](#)). 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.)

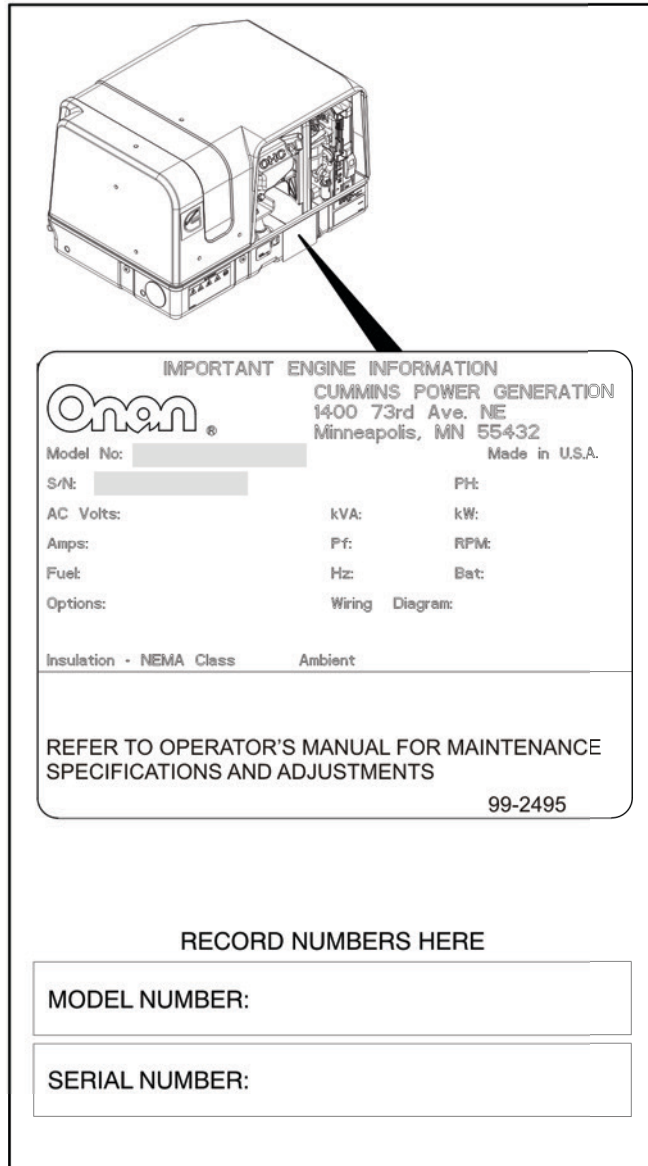


FIGURE 1. TYPICAL NAMEPLATE

2.1 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with the warnings and operating procedures.

⚠ CAUTION

A generator set must be operated and maintained properly if you are to expect safe and reliable operation. The Operator manual includes a maintenance schedule and a troubleshooting guide. The Health and Safety manual must be read in conjunction with this manual for the safe operation of the generator set:

- Health and Safety Manual (0908-0110)

The relevant manuals appropriate to your generator set are also available, the documents below are in English:

- Operator Manual for RV Generator Set HGJBB (Spec A-B) (A031C171)
- Installation Manual for RV Generator Set HGJBB (Spec A-B) (A031C172)
- Generator Set Service Manual for RV Generator Set HGJBB (Spec A) (A031C173)
- Recommended Spares List (RSL) for RV Generator Set HGJBB (Spec A) (A043W890)
- Parts Manual for RV Generator Set HGJBB (Spec A-B) (A035B506)
- Standard Repair Times - CY Family (A031C174)
- Service Tool Manual (A043D529)
- Failure Code Manual (F1115C)
- Warranty Administration Manual (4021290)
- Global Commercial Warranty Statement (A028U870)

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3 Specifications Table

	GASOLINE MODELS			LPG MODELS	
	2.8HGJBB	2.3HGJBB	2.8HGJBB	2.5HGJBB	2.3HGJBB
GENERATOR: 2-Pole Revolving Field, Self-Excited, Electronically Regulated, 1-Phase, Direct Drive					
Power (W)	2800	2300	2800	2500	2300
Frequency (Hz)	60*	50	60*	60*	50
Voltage (Volts)	120	230	100	120	230
Current (Amps)	23.3	10	28	20.8	10
Breaker (Amps)	25	10	30	21	10
Speed (RPM)	3600	3000	3600	3600	3000
ENGINE: 1-Cylinder, 4-Cyle, Spark Ignited, OHC, Air-Cooled					
Bore mm (in)	67 (2.64)				
Stroke mm (in)	60 (2.36)				
Displacement ml (cubic in)	211 (12.87)				
Compression Ratio	8.5:1				
Lube Oil Cap L (qt)	0.6 (0.63)				
Int Valve Clearance-Cold mm (in)	0.12-0.15 (0.0047-0.0059)				
Exh Valve Clearance-Cold mm (in)	0.12-0.15 (0.0047-0.0059)				
Spark Plug Gap mm (in)	0.6-0.7 (0.024-0.028)				
Ignition Timing	BTDC 23°				
Ignition Coil Gap mm (in)	0.3-0.7 (0.012-0.020)				
Compression kPa (psi)	382.46 (55.47) @ 500 rpm				
DC SYSTEM: 12 volts, 360 amps minimum CCA battery					
LPG Vapor Supply Pressure (Range)	n/a			9 to 13 inch (229 to 330 mm) W.C. (water column)	
Fuel Consumption-No Load	0.78L/h (0.2 gal/h)	0.69L/h (0.18 gal/h)	0.78L/h (0.2 gal/h)	0.53kg/h (1.17 lb/h) 0.29 gal/h	0.49kg/h (1.08 lb/h) 0.27 gal/h
Fuel Consumption-50% Load	1.32L/h (0.35 gal/h)	1.18L/h (0.31 gal/h)	1.32L/h (0.35 gal/h)	0.76kg/h (1.66 lb/h) 0.42 gal/h	0.69kg/h (1.53 lb/h) 0.38 gal/h
Fuel Consumption-Full Load	1.75L/h (0.46 gal/h)	1.56L/h (0.41 gal/h)	1.75L/h (0.46 gal/h)	1.02kg/h (2.25 lb/h) 0.56 gal/h	0.94kg/h (2.07 lb/h) 0.52 gal/h

	GASOLINE MODELS			LPG MODELS	
	2.8HGJBB	2.3HGJBB	2.8HGJBB	2.5HGJBB	2.3HGJBB
Sound Level (dBA @ 3m half load)	70				
Weight - dry kg (lb)	57 (125)				
Length mm (in)	560 (22.0)				
Width mm (in)	415 (16.3)				
Height mm (in)	325 (12.8)				
* 60 Hz models are listed by CSA and the US Testing Company					

3.1 Engine Specifications

The Robin-Subaru EX21 series engine is an air-cooled, 4-cycle, slant single-cylinder, horizontal P.T.O shaft, OHC gasoline engine.

TABLE 1. ENGINE SPECIFICATIONS

Description	Specification
Bore and stroke	67 x 60 mm (2.64 x 2.36 inches)
Piston displacement	211 ml (12.87 cubic inches)
Compression ratio	8.5
Direction of rotation	Counterclockwise as viewed from the P.T.O shaft side
Valve arrangement	Overhead cam system
Cooling system	Forced air cooling system
Lubrication system	Splash lubrication system
Lubricant	Automobile engine oil; Grade SE or higher (SG, SH or SJ is recommended) SAE 10W-30 - Under ordinary atmospheric temperatures SAE 5W-30 - In cold areas
Capacity of lubricant	06. L
Carburetor	Horizontal draft, float type
Fuel	Automobile unleaded gasoline
Ignition system	Transistorized magneto
Spark plug	NGK BR-6HS (CHAMPION RL86C)
Charging capacity (option)	12-1A, 3A, 16.7A
Starting system	Electric starter
Governor system	Centrifugal flyweight system
Dry weight	16 kg (35.28 lb)

Description	Specification
Dimensions (L x W x H)	311 x 366 x 335 mm (12.2 x 14.4 x 13.2 inches)
Number of oval steel links on timing chain	92

TABLE 2. ENGINE TORQUES

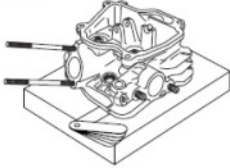



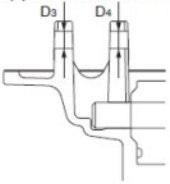
Item		Tightening Torque			
		N • m	kgf • cm	ft • lb	
Cylinder head bolts	M8 x 68 flange bolt	Re-use	25-27	250-270	18.1-19.5
		When replace to new cylinder head and flange bolts	28-30	280-300	20.3-21.7
	M8 x 35 flange bolt	17-19	170-190	12.3-13.7	
Connecting rod cap bolts	EX13, 17, 21	13-15	130-150	9.4-10.8	
Flywheel nut		59-64	590-640	42.7-46.3	
Main bearing cover bolts		22-24	220-240	16.2-17.7	
Spark Plug	New	12-15	120-150	8.7-10.8	
	Re-tightening	23-27	230-270	16.6-19.5	
Muffler nut		18-22	180-220	13.0-15.9	
Ignition coil		7-9	70-90	5.1-6.5	

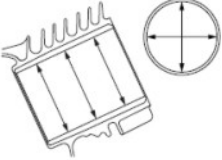
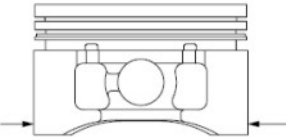
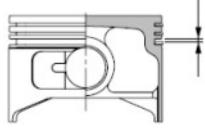
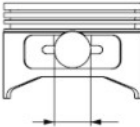
3.2 Generator Set Torques

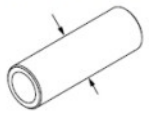
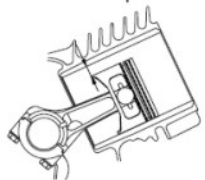
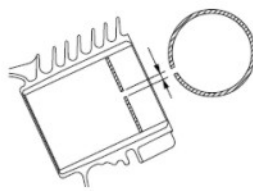
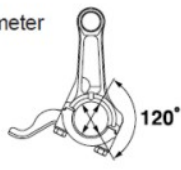
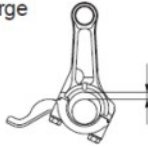


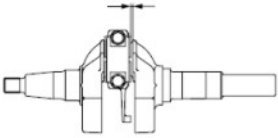
TABLE 3. GENERATOR SET TORQUES

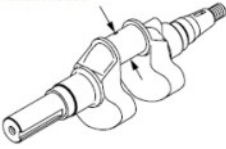
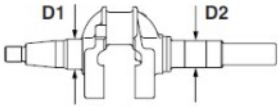
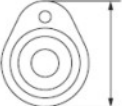
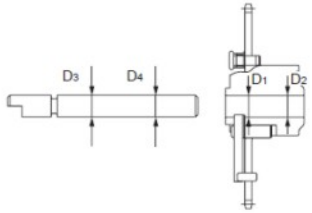
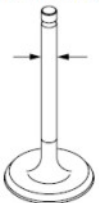
Item	Tightening Torque		
	N • m	kgf • cm	ft • lb
Generator	25.2-30.8	256.97-314	18.6-22.7
Generator Adapter	22-24	224.34-244.73	16.23-17.7


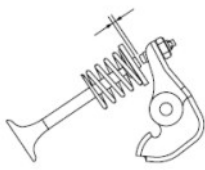
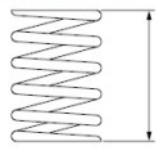
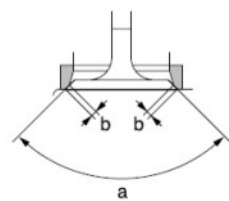
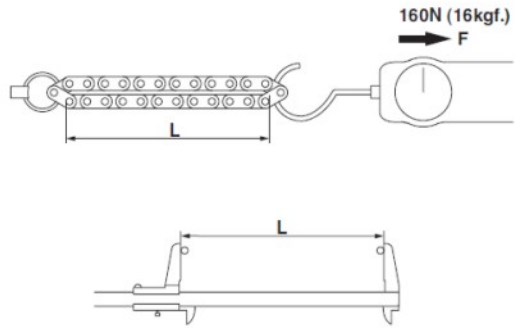
3.3 Standard Dimensions and Limits of Use

Item		STD mm (in.)	Limit mm (in.)
CYLINDER HEAD * Flatness 		0.05 (0.002)	0.1 (0.004)
* Intake/exhaust valve seat contact width 	Intake Exhaust	0.7 - 1.0 (0.0276 - 0.0394)	-
* Intake/exhaust valve guide inner diameter 	Intake Exhaust	5.500 - 5.518 (0.2165 - 0.2172)	-
* Rocker arm pin outer diameter 	Pin outer diameter D_1, D_2	5.970 - 5.980 (0.235 - 0.235)	5.9 (0.232)
* Rocker arm pin support inner diameter 	Support inner diameter D_3, D_4	6.00 - 6.018 (0.236 - 0.237)	6.05 (0.238)

Item	STD mm (in.)	Limit mm (in.)	
<p>CYLINDER * Inner diameter</p>  <p>* Roundness after reboring</p> <p>* Cylindricity after reboring</p>	Standard	67.000 - 67.019 (2.6378 - 2.6385)	To be rebored when the difference between max. and min. of diameter reached to 0.1 (0.004).
	First reboring	67.250 - 67.269 (2.6476 - 2.6484)	To be rebored when the difference between max. and min. of diameter reached to 0.1 (0.004).
	Second reboring	67.500 - 67.519 (2.6575 - 2.6582)	To be rebored when the difference between max. and min. of diameter reached to 0.1 (0.004).
		Less than 0.01 (0.0004)	
		Less than 0.015 (0.0006)	
<p>PISTON * Outer diameter at skirt in thrust direction</p> 	Standard		66.88 (2.6331)
	Oversize +0.25		67.13 (2.6429)
	Oversize +0.50		67.38 (2.6528)
<p>PISTON * Ring groove side clearance</p> 	Top second	0.035 - 0.080 (0.0014 - 0.0031)	0.15 (0.0059)
	Oil ring Coil exp	0.01 - 0.065 (0.0004 - 0.0026)	0.15 (0.0059)
	Oil ring (three-piece)	0.0300 - 0.185 (0.0012 - 0.0073)	-
<p>* Piston pin hole</p> 		15.991 - 16.009 (0.6296 - 0.6303)	16.035 (0.6313)

Item		STD mm (in.)	Limit mm (in.)
* Piston pin outer diameter 		15.992 - 16.000 (0.6296 - 0.6299)	15.960 (0.6283)
* Clearance between piston and cylinder at skirt 		0.050 - 0.089 (0.0020 - 0.0035)	0.25 (0.010)
* Piston ring end gap 	Top	0.15 - 0.3 (0.0059 - 0.0118)	1.5 (0.0591)
	Second	0.2 - 0.4 (0.0078 - 0.0157)	1.5 (0.0591)
	Oil (Coil exp)	0.05 - 0.25 (0.0020 - 0.0098)	1.5 (0.0591)
CONNECTING ROD * Large end inner diameter 		30.000 - 30.016 (1.1811 - 1.1817)	30.1 (1.1850)
* Clearance between large end and crank pin 		0.020 - 0.049 (0.0008 - 0.0019)	0.2 (0.0078)
* Small end inner diameter 		16.010 - 16.021 (0.6303 - 0.6307)	16.08 (0.6331)
* Clearance between small end and piston pin 		0.010 - 0.029 (0.0004 - 0.0011)	0.12 (0.0047)
* Large end side clearance 		0.100 - 0.780 (0.0040 - 0.307)	1.0 (0.0394)

Item		STD mm (in.)	Limit mm (in.)
CRANKSHAFT * Crank pin outer diameter 		29.967 - 29.980 (1.1798 - 1.1803)	29.85 (1.1752)
* Journal outer diameter 	D1	27.988 - 27.997 (1.1019 - 1.1022)	
	D2	24.988 - 24.997 (0.9838 - 0.9841)	
CAMSHAFT * Cam peak height (intake and exhaust) 	Cam peak height	29.028 - 29.128 (1.1428 - 1.1468)	28.98 (1.1409)
	Cam inner diameter D ₁ , D ₂	9.0 - 9.036 (0.3543 - 0.3557)	9.05 (0.3563)
* Cam sprocket inner diameter * Pin (cam sprocket) outer diameter 	Pin outer diameter D ₃ , D ₄	8.953 - 8.975 (0.3525 - 0.3533)	8.95 (0.3524)
INTAKE/EXHAUST VALVES * Valve stem outer diameter 	Intake	5.440 - 5.455 (0.2142 - 0.2148)	5.35 (0.2106)
	Exhaust	5.426 - 5.444 (0.2136 - 0.2143)	5.35 (0.2106)

Item		STD mm (in.)	Limit mm (in.)
<p>* Clearance between valve stem and valve guide</p> 	Intake	0.045 - 0.078 (0.0018 - 0.0031)	0.3 (0.0118)
	Exhaust	0.056 - 0.092 (0.0022 - 0.0036)	0.3 (0.0118)
<p>* Valve clearance (in cold state)</p> 	Intake	0.12 - .015 (0.0047 - 0.0059)	
	Exhaust	0.12 - .015 (0.0047 - 0.0059)	
<p>VALVE SPRING FREE LENGTH</p> 		27.4 (1.0787)	
<p>VALVE SEAT ANGLE (INTAKE AND EXHAUST) * Valve cutter angle (a) * Valve contact width (b)</p> 	Intake Exhaust	a: 90° b: 0.7 - 1.0 (0.0276 - 0.0394)	2.0 (0.0787)
<p>CHAIN LENGTH</p> 		281.7 (11.0906)	284.9 (11.2165)

4 Preparing for Service

4.1 Troubleshooting

Refer to before starting work on the generator set. Note that some problems have several possible causes.

4.2 Safety

There are hazards in servicing generator sets. Study [Chapter 1](#) and become familiar with the hazards listed in the table below. Note the following safeguards and ways of avoiding hazards:

- **Use personal protection:** Wear 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 do not take risks.
- **Be prepared:** 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 4. 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 generator set 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 generator set from boat • Removing heavy components
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4.3 Special Tools

The following special tools are required to service the generator set. See the Onan Tool Catalog (0900-0019).

4.3.1 Engine Tools

Torque wrench (0-75 lbs-ft or 0-100 N-m)

Inline spark tester

InPower harness (541-1374)

Feeler gauge

Leak down tester

Spark plug gap gauge

Cylinder compression tester

Flywheel puller

Snap ring pliers

Cylinder ridge reamer

Piston ring compressor

Piston ring spreader

Cylinder hone

Valve seat cutter

Valve spring compressor

Piston groove cleaner

Outside micrometer set (1-4 in.)

Telescoping gauge set (0.500-4.000 in.)

Hole gauge (0.300-0.400 in.)

Plasti-Gage bearing clearance guide

4.3.2 Alternator Tools

Lead or dead-blow hammer

Steel rod

DVOM Multi-tester

Frequency Meter

Load test panel and leads

Rotor Removal Toolkit

4.4 Removing Generator Set

Some service procedures will require removing the generator set from the coach. While there are many variations, generator set installations are generally classified as either conventional compartment mount or under-the-floor mount.

In a compartment mount installation, a special compartment is built into the coach to house the generator set ([Figure 2](#)). The compartment is constructed with a vapor-tight barrier that seals off the generator set from the coach interior. The generator set is usually mounted to the floor of the compartment. Access to the compartment is through a door located in the exterior of the coach.

The under-floor-mount installation uses special brackets to suspend the generator set under the floor of the coach. The mounting brackets bolt to support members that are built into the vehicle framework ([Figure 3](#)). The generator set is mounted near the exterior of the vehicle. Access is provided through a door located in the exterior of the coach.

Due to the wide variety of coach designs, it is not possible to specify the exact removal procedures for each type of installation. If, after examining the following sections, a satisfactory method for removing the set cannot be determined, contact the coach manufacturer or set installer to obtain their recommendations before attempting set removal.

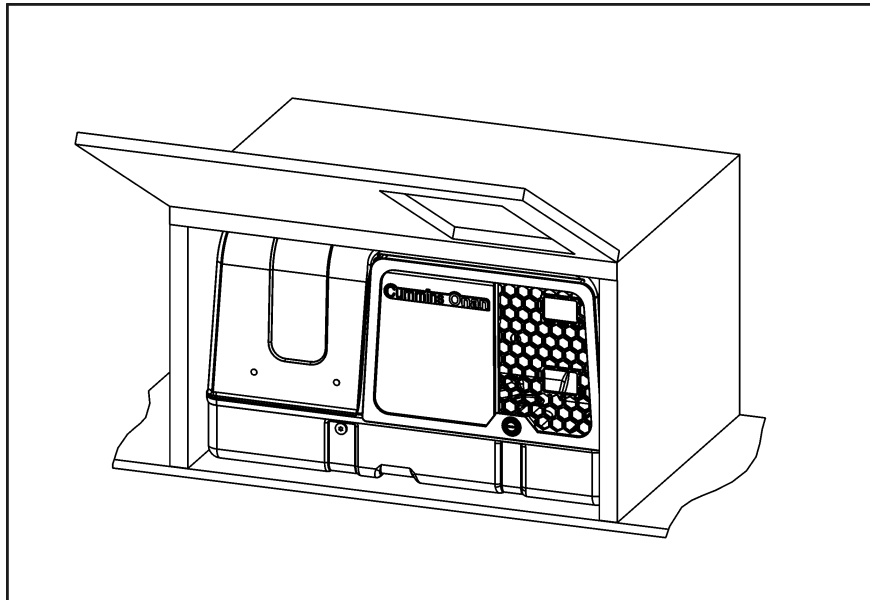


FIGURE 2. TYPICAL COMPARTMENT MOUNT INSTALLATION

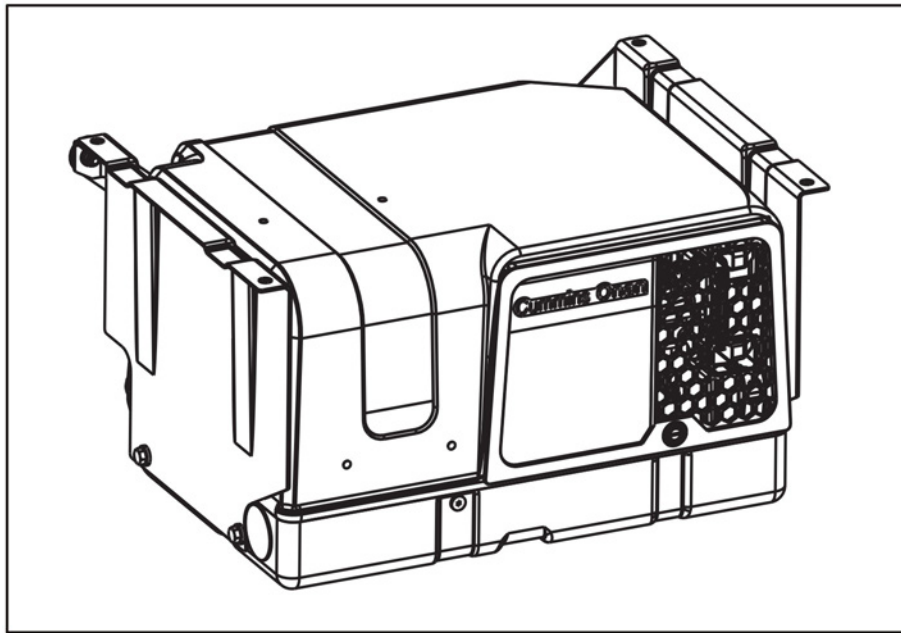


FIGURE 3. TYPICAL UNDER-FLOOR MOUNT

4.4.1 Disconnecting Set from Vehicle Systems

Disconnect the following items from the generator set. Refer to [Section 4.4](#) for component locations in typical generator set installations.

Some installations may require partial removal of the set to gain access to the battery cable, fuel line and other connections. Read this section before starting set removal.

1. Disconnect the vehicle negative (-) battery cable at the battery terminal.

⚠ WARNING

Arcing at battery terminals or in a light switch or other equipment, flames and sparks can ignite battery gas causing severe personal injury. Ventilate the battery compartment before connecting or disconnecting battery cables—Disconnect the negative (-) cable first and reconnect it last—Wear safety glasses—Do not smoke—Switch lights ON and Off away from the battery.

2. Remove the generator set negative (-) battery cable from the ground connection on the generator set.
3. Disconnect the generator set positive (+) battery cable from the B+ connection on the generator set.
4. Disconnect the remote control wire connector from the left side of the generator set housing.
5. Disconnect the generator load wires from the vehicle. Tag the wires for identification when reconnecting.
6. Loosen the conduit connector elbow, and pull the load wires and flexible conduit free of the generator set.
7. Disconnect the exhaust tail pipe from the generator set. Disconnect any exhaust support brackets or hangers that restrict removal of the generator set.

8. Disconnect the fuel line from the generator set. Follow the applicable instructions depending on the fuel.
 - a. **Gasoline-fueled Generator Sets:** Disconnect the fuel line from the generator set and securely plug the end of the fuel line to prevent leakage or an accumulation of explosive gasoline vapor.
9. **LPG-fueled Generator Sets:** Close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from below-grade spaces where LPG could accumulate. To purge most of the LPG from the fuel line and generator set, run the generator set (if it starts) until it runs out of fuel (LPG container valve closed). Disconnect the fuel line from the generator set and plug the end of the hose to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s) at the LPG container(s).

⚠ WARNING

Gasoline and LPG (liquefied petroleum gas) are flammable and explosive and can cause severe personal injury or death. Do not smoke. Keep flames, sparks, pilot lights, arc-producing and switching equipment, and all other sources of ignition away from fuel tank and system, and areas sharing ventilation. Have an ABC fire extinguisher handy.

⚠ WARNING

LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures. LPG "sinks" and can accumulate in explosive concentrations. Before disconnecting the LPG fuel line, close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from pits, basements, and other below-grade spaces where LPG could accumulate.

4.4.2 Set Removal

After the generator set is disconnected from electrical, exhaust and fuel systems, examine the set mounting and support system. Locate all mounting bolts and support members for the set. In most installations the generator housing will be mounted to the coach framework. Depending on the installation, the set may be removable from the side, back or bottom.

Verify that the generator set is adequately supported before loosening any of the mounting bolts or support members. Use a forklift to lift or move the set.

⚠ WARNING

Generator sets are heavy and can cause severe personal injury if dropped. Use adequate lifting devices and keep hands and feet clear while lifting.

Park the vehicle on a level surface which can support the forklift. Move the transmission to PARK, lock the brakes and remove the ignition key. Do not move the vehicle during this procedure.

Compartment Mount:

1. Use an appropriate lifting device to support and move the generator set.
2. Make sure that the generator set is adequately supported before removing any of the mounting bolts.
3. Remove all mounting bolts then slide the generator set out of the compartment and onto the forklift. Slowly lower the generator set before moving it to the service area.

Under-Floor Mount:

1. Use an appropriate lifting device to support the generator set at the points shown.

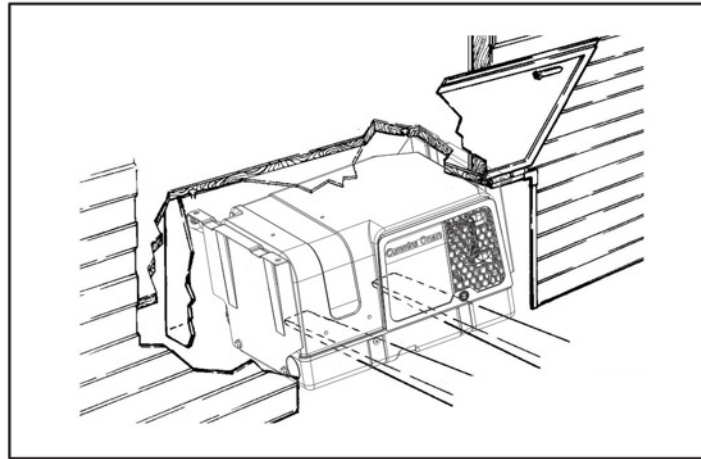


FIGURE 4. COMPLETE GENERATOR SET REMOVAL

2. Raise the lift so it contacts the bottom of the generator set housing, then place slight upward pressure on the generator set. Make certain that the generator set is fully supported by the lift before continuing.
3. Loosen bolts between generator set base pan and side mounting panels (loosen bolts about six turns).
4. Loosen bolts securing the side panels to the rear panel (note slotted holes) or braces and pull side panels away from generator set. Retighten side panels to back panel bolts.
5. Remove side and rear panel to generator set base mounting bolts. Slowly lower the generator set until it clears all obstructions and can be safely moved out from under the vehicle.

When reinstalling the generator set, be sure that all bolts, brackets, and electrical, exhaust, and fuel system components are connected exactly as they were before removal.

4.4.3 Reinstalling Generator Set

Generally reinstallation is the reverse of removal. Perform the service checklist before placing the generator set back into service (see [Chapter 7](#)).

5 Component Based Service Procedures

5.1 Control

5.1.1 Controller

The controller is an integrated microcontroller-based engine and generator control. It provides all the control, monitoring and diagnostic functions required to operate the generator set. All connections to the controller are through connector J1 on the side of the controller. Refer to the appropriate wiring diagrams and wiring harness drawings.

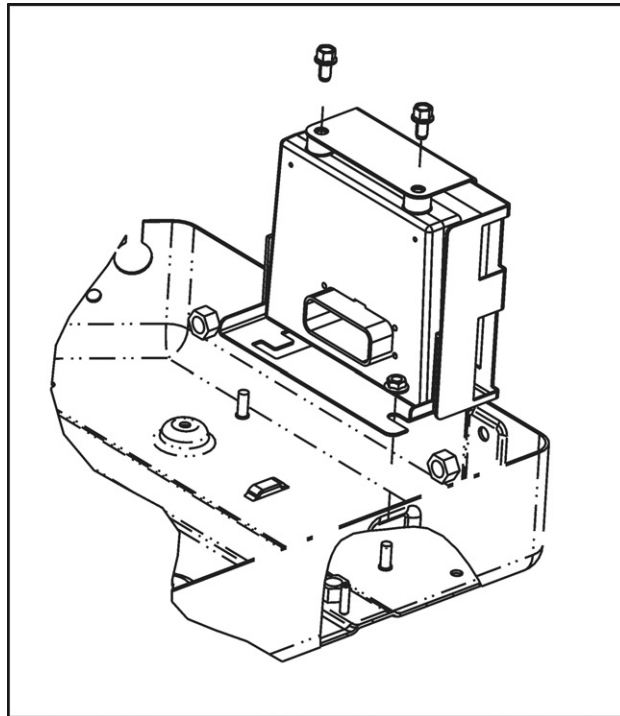


FIGURE 5. CONTROLLER

5.1.1.1 Major Functions of Controller

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

Fuel Prime (Gasoline Generator Sets): Press and hold the stop switch for more than 3 seconds to cause the fuel pump to prime the fuel system.

Startup: Press and hold the start switch until the generator set starts. The controller:

1. Enables cranking.
2. Energizes the fuel pump E2 (gasoline models only).
3. Depending on model:
 - a. Energizes the gasoline carburetor fuel cutoff solenoid and choke heater (if equipped).
 - b. Energizes LPG fuel cutoff solenoid.
4. Flashes the field (F1-F2).

5. Flashes the status indicator light during cranking.
6. Disconnects the starter when engine speed is greater than 1300 rpm and turns the status indicator light on solid.
7. Turns on Switched B+ (remote pin J8-F).
8. Enables output voltage two seconds after operating speed is reached.
9. Turns off field flash.

Stop: Press the stop switch momentarily. The controller:

1. Disables output voltage.
2. Deenergizes the fuel pump or fuel cutoff solenoid.
3. Enables ignition kill.
4. Turns off the status indicator light.
5. Writes session data (number of cranks, minutes of operation, last fault, etc.) to non-volatile memory (NVM).

Fuel Control: See GASOLINE FUEL SYSTEM.

Voltage Control: The controller maintains nominal AC output voltage during steady state operation by varying field current as load varies. In response to transient loads it lowers the voltage setpoint to allow engine recovery. Field power (DC) is supplied by the quadrature windings (AC) through the controller.

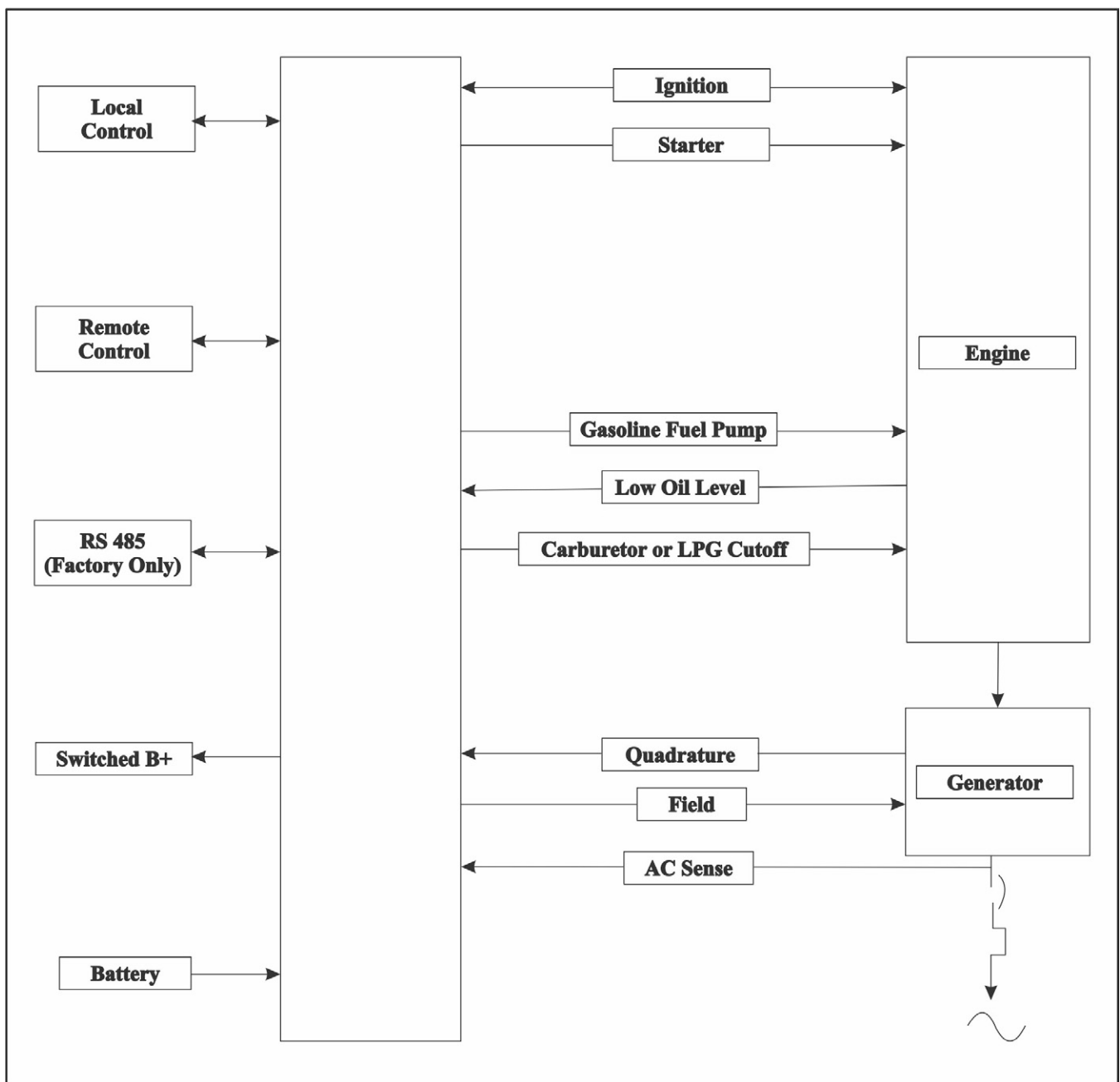


FIGURE 6. CONTROLLER BLOCK DIAGRAM

5.1.1.2 Controller Removal

1. Remove the enclosure.
2. Loosen the controller bracket and slide it out.
3. Use a small flat-bladed screwdriver to lever out the catch on connector P1/J1 and pull the connector apart.

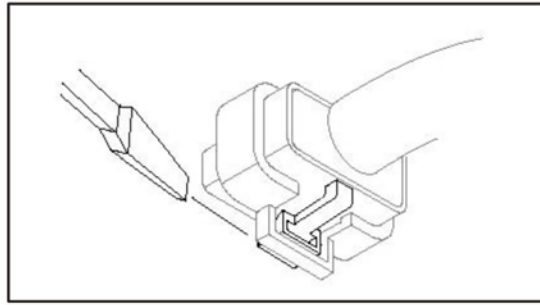


FIGURE 7. DISCONNECTING P1/J1

4. Remove the bolts (2) that are securing the controller to the bracket.

5.1.2 Other Control Components

5.1.2.1 Control Switch S1

The control switch is located as shown. Unsnap connector P9 from the back of the switch for access to its terminals. Replace the switch if it does not: close across terminals 2 and 3 when the switch is held in the Start position, close across terminals 1 and 2 when held in the Stop position, or the status indicator light does not light when 12 VDC is connected across terminals 7 (-) and 8 (+).

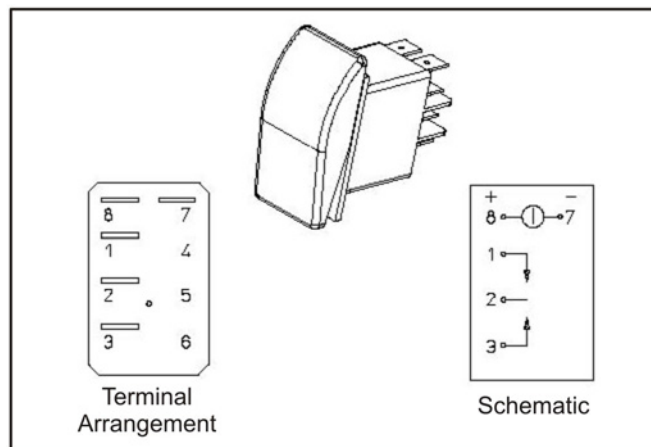


FIGURE 8. CONTROL SWITCH S1

5.1.2.2 Line Circuit Breakers CB1

The line circuit breaker is located as shown.

1. Disconnect all wiring.
2. Check electrical resistance across the terminals of the circuit breaker.
3. Replace a circuit breaker that does not:
 - Reset, or
 - Close or open as the handle is turned ON and OFF.

5.1.2.3 Hour Meter

When the generator set is so equipped, the hour meter is located on the remote panel.

5.1.2.4 Generator DC Grounds

Secure the three GND wiring harness eyelets to the base on a stud with a nut.

5.1.2.5 Remote Control Connector P2/J2

The following image illustrates the sealed 8-pin connector for remote control.

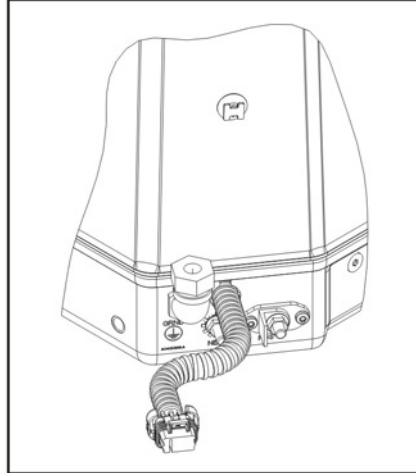


FIGURE 9. 8-PIN CONNECTOR

5.1.2.6 Batteries

The generator set has a 12 VDC, negative-ground engine control and cranking system. See [Chapter 3](#) for the requirements for cranking batteries.

5.1.2.7 Battery Cables

If battery cables need to be replaced, size them appropriately. The current path between the generator set and the negative (-) battery terminal must be able to carry full cranking current without causing excessive voltage drop. The path may be a full-length cable or the vehicle frame. Note also that a generator set grounding conductor, if provided, was probably required by code and must be reconnected to the grounding terminal.

The generator set mounting bolts are not considered adequate means for bonding the generator set to the vehicle frame, either for the purpose of carrying cranking currents or for complying with requirements for generator set/system grounding.

When replacing battery cables route them away from fuel lines and hot engine exhaust components. Battery cables should be accessible for inspection and replacement, protected from damage and secured to prevent chafing due to vibration.

⚠ WARNING

Routing battery cables with fuel lines can lead to fire and severe personal injury or death. Keep battery cables away from fuel lines.

TABLE 5. BATTERY CABLE SIZES FOR TEMPERATURES DOWN TO $-20\text{ }^{\circ}\text{F}$ ($-29\text{ }^{\circ}\text{C}$)

0 to 45 (0 to 13.7)	2**
46 to 60 (14 to 18.3)	0

61 to 80 (18.6 to 24.4)	00
<p>* - Battery cable lengths are total lengths from battery to the generator back to the battery and when using a total of 1000CCA (Cold Cranking Amps).</p> <p>** - A total length of up to 20 feet (6 meters) may be used in warmer climates or when battery capacity totals at least 1000 CCA (Cold Cranking Amps).</p>	

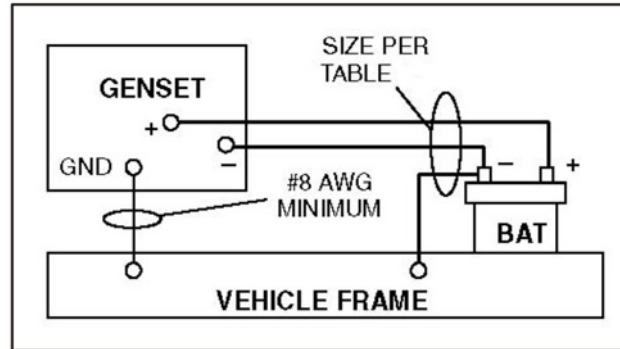


FIGURE 10. FULL-LENGTH CABLE FROM BATTERY NEGATIVE (-) TERMINAL

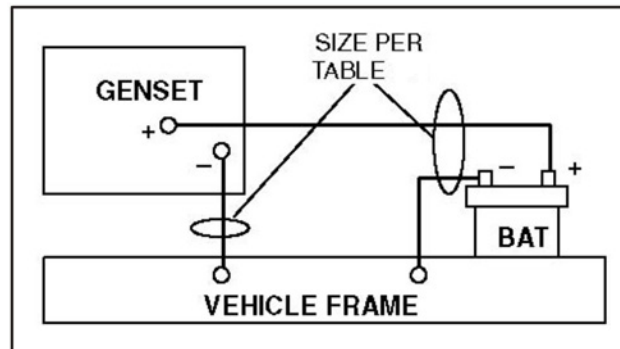


FIGURE 11. VEHICLE FRAME AS PATH FROM BATTERY NEGATIVE (-) TERMINAL

5.1.2.8 Battery Cable Connections at Generator Set

Terminate the battery cables with ring terminals sized for 5/16-inch screws and connect them to the generator set.

Torque the positive (+) and the negative (-) cable terminals to 7.5 lb-ft (10 Nm).

5.1.2.9 Generator Set (Equipment) Grounding Screw

When required, connect the generator set grounding screw to the vehicle frame with a No. 8 AWG or larger stranded cable having a ring terminal sized for a 3/8 inch screw. Torque grounding screw to 8 lb-ft (11 Nm).

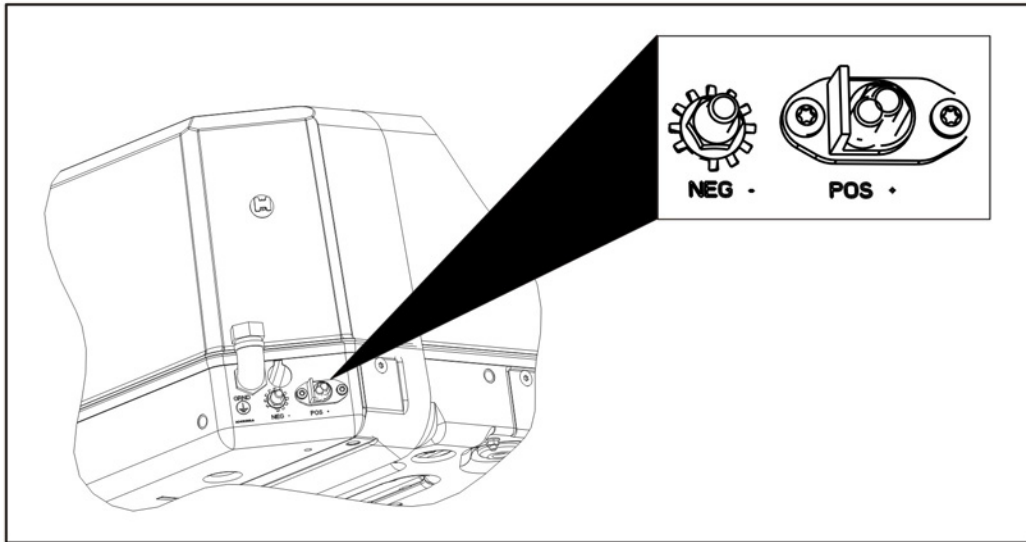


FIGURE 12. BATTERY CABLE CONNECTIONS

5.2 Alternator

5.2.1 Alternator Description

These are 2-pole, revolving field alternators with brushes and slip rings. Output voltage is regulated by microprocessor-based generator set controller A1.

5.2.1.1 Stator

The stator consists of steel laminations with two or three sets of windings wound into slots in the laminations. The main winding set (T1-T2, T3-T4) is for powering the connected loads. The quadrature winding (Q1-Q2) is for field excitation.

5.2.1.2 Rotor

The rotor consists of steel laminations on the rotor shaft. The field windings wrap around the rotor laminations. The rotor shaft also carries the molded slip ring assembly and pressed-on bearing. The rotor shaft is secured to the tapered engine crankshaft by means of a through bolt. The rotor bearing supports the other end in the generator endbell.

5.2.1.3 Alternator Cooling Fan

The alternator cooling fan is mounted on the end of the alternator rotor shaft. The alternator fan draws air from the main air intake to cool the rotor and stator windings.

5.2.1.4 Brush Block

The brush block is a one-piece molded assembly mounted on the endbell. It carries two spring-loaded carbon brushes that make contact with the slip rings on the rotor. The field current passes through the brushes and slip rings.

5.2.1.5 Voltage Regulator

Generator set controller A1 maintains constant output voltage under varying load conditions by varying field current. Field excitation power is supplied by the quadrature winding (Q1-Q2).

5.2.1.6 Principle of Operation

Refer to the schematic that corresponds to your generator set. During startup the controller connects the field winding to the battery to provide magnetism for voltage buildup. As the engine starts and speed increases, the rotating field induces an AC voltage in the stator windings. AC voltage from quadrature winding Q1-Q2 is fed to the controller where it is rectified into DC voltage and fed to the rotor through the brushes and slip rings to cause further voltage buildup. This process continues as the engine picks up speed.

During operation the controller continually monitors output voltage (T1-T2). When additional load is applied to the generator, the output voltage starts to decrease. The controller senses this decrease and increases the field current until the reference voltage and the output voltage match. Similarly, when the load is decreased the output voltage begins to increase and the controller senses this increase. In this case, the controller decreases the amount of current to the field until the output voltage again matches the reference voltage. By continually measuring the output voltage and compensating for load changes, the controller keeps the voltage of the generator constant under varying load conditions.

5.2.2 Alternator Service

Raising the alternator and engine assembly above the base assembly is necessary to disassemble the alternator. A lifting hoist will be required for this step.

NOTICE

There is a consumer alternator service strategy change starting with Spec B alternators/serialized alternator. See below for more information.

Beginning with HGJBB spec B, the rotor (A) and stator (B) will no longer be orderable as individual service parts. Going forward there will be one part number for the complete alternator assembly (C). See [Table 6](#).

TABLE 6. SUMMARY OF SERVICE STRATEGY CHANGE

	Before - Spec A, Alternators	After - Starting With Spec B, Alternators
Rotor Failure	Replace with A	Replace with C (Alternator Assembly)
Stator Failure	Replace with B	

The new spec B may have slightly different characteristics, but the overall form, fit, function, and performance will be the same as that of existing alternators. New spec alternators will be backwards compatible with old spec generator set models. However, the new spec and old spec alternator parts are not interchangeable. If a rotor or stator fails in the existing alternator, the entire alternator must be replaced with the new spec B alternator assembly.

Wiring connections and labels will remain the same as the old spec alternators.

Each new spec alternator is serialized. The serial number sticker will be located on the stator and rotor.

New spec alternators may have different cold resistive (R) values depending on model (see [Section 5.2.4](#)).

Bearings and slip rings will not be individually replaceable on the new spec alternators.

5.2.2.1 Alternator Disassembly

1. Remove the enclosure.
2. Remove the air guide housing.
3. Disconnect the two stator harnesses and the fuel pump/solenoid leads.

4. Remove the bolt securing the alternator fan, then the fan itself.
5. Remove the muffler assembly.
6. Remove the brush block. The brushes cannot be on the slip rings during disassembly as they may be damaged.
7. While supporting the bottom of the stator cover, remove the four bolts securing the stator cover to the engine case, then remove the two bolts securing the stator cover to the isolator bracket.
8. Pull outward on the rotor shaft to remove it. If the rotor does not come loose from the tapered engine crankshaft, use the Rotor Service Tool Kit (A043U423). Insert the 8mm threaded stud (A043U413) into the rotor through the hole and thread into the crankshaft. Thread the 10mm bolt (800-2095) into the end of the rotor shaft and slowly tighten it until the rotor comes loose.
9. Lift the stator and rotor out together.

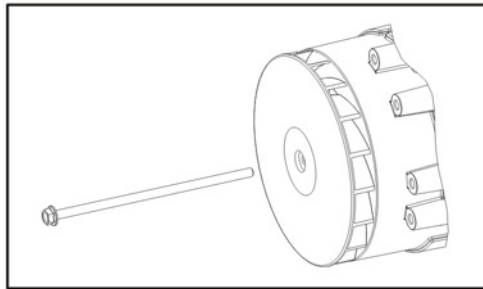


FIGURE 13. ALTERNATOR BOLT

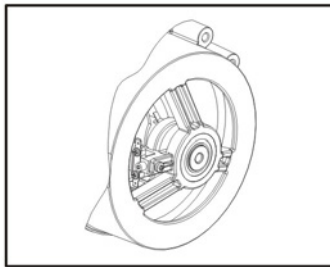


FIGURE 14. BRUSH BLOCK

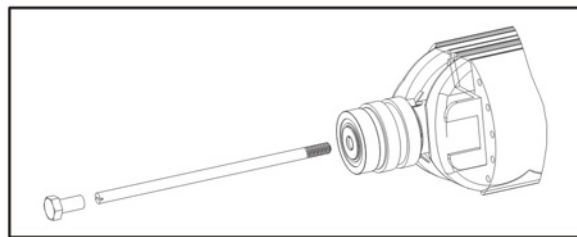


FIGURE 15. ROTOR REMOVAL

5.2.2.2 Alternator Assembly

Use the following procedures to assemble the generator:

1. Wipe any contamination from the crankshaft and install the rotor.
2. Prepare the endbell for installation. Lubricate the O-ring on the bearing.
3. Install the stator housing.
4. Center the brush block on the slip rings and tighten the mounting screw.

5. Install the alternator fan and rotor bolt.
6. Reconnect the two stator harness connectors.
7. Install the air guide housing (cowling).
8. Install the muffler using the new gaskets and torque the hardware to specification.
9. Remove the wooden block from under the stator housing and slowly lower the generator set.
10. Install the generator/engine-to-base mounting blots (use anti-seize lubricant on bolt threads). Tighten the bolts to specified torque.
11. Reconnect the ground wires, battery terminals, fuel line to the carburetor, controller start/stop switch, AC breaker and leads to the fuel solenoid.
12. Inspect the assembly, check all electrical and mechanical connections for correct fit and location. Place the enclosure cover on the generator set and secure with the side mounting screws.
13. Install the generator set, securely fastening all mounting screws and hardware. Reconnect the fuel, exhaust, and electrical systems in reverse order of disassembly (see [Chapter 4](#)).
14. Fill the crankcase with oil (see the Operator's Manual).

5.2.3 Brushes and Slip Rings

5.2.3.1 Brush Replacement

Use the following procedure to inspect the brushes and brush block:

1. Remove the alternator fan.
2. Inspect the brushes and brush block for burn marks or other damage.
 - a. If the brushes appear to be in good condition, check for excessive brush wear (minimum brush length is 0.31 inches [8 mm]).
 - i. Remove and measure the brushes.
 - ii. Replace the brush assembly if less than 0.31 inches (8 mm) in length.
3. Clean carbon deposits from brushes and slip rings.

Use the following procedure to replace the brushes:

1. Remove the brush block mounting screw and lift out the brush block.
2. Reinstall the new brush block assembly.
3. Reassemble the generator.

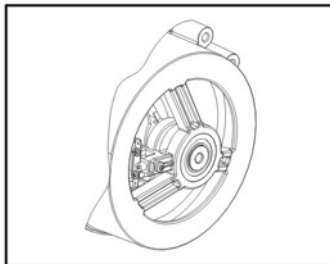


FIGURE 16. BRUSH BLOCK

5.2.3.2 Slip Ring Service

NOTICE

Starting with spec B/serialized alternators, the slip rings are not individually replaceable.

Remove the fan. Inspect the slip rings for grooves, pits, or other damage. A Scotch Brite pad can be used to remove light wear and for surface finishing. If the slip rings are rough, pitted, or out of round by more than 0.002 inches, recondition them in a lathe with a commutator stone. Use the following procedure to service:

1. Remove the stator housing and rotor.
2. Replace the rotor in the machine lathe and center. Turn the rotor and use a commutator stone against the rotating slip rings to clean and true the slip rings. Turn the rotor until all grooves or roughness are smoothed out. Run-out must be less than 0.001 inch, and surface finish must be less than 32 micro inch.

⚠ CAUTION

Careless handling of rotor can damage the insulation on the windings. Place rotor on protected surface when setting down.

3. Clean and reinstall the rotor.

5.2.4 Alternator Testing

This section covers test procedures for the rotor and stator windings. Check all wire harness connectors and leads for continuity prior to alternator testing.

5.2.4.1 Rotor Test

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Remove the fan to gain access to the slip rings. Unplug the generator connections (2).

Grounded Rotor Test: (See [Figure 17](#).) Set the ohmmeter to the highest resistance scale or use a megger. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings. A reading of infinity should be measured. A reading of less than one megohm (one million ohms) indicates the rotor is grounded. Replace a grounded rotor.

Winding Resistance Test: (See [Figure 18](#).) Use an ohmmeter to measure winding resistance. Place the test prods on the slip rings. Replace the rotor if winding resistance is not as specified in the table below.

NOTICE

Starting with generator set spec B, alternators are serialized. These alternators will also be backwards compatible with previous spec generator sets. Verify whether the alternator is serialized or not before taking resistance measurements. A serial number sticker can be found on both the stator and rotor.

TABLE 7. ROTOR WINDING RESISTANCES

RESISTANCE MEASUREMENTS (Ω) @ 25 °C (77 °F)		
Generator Set Spec	60 HZ	50 HZ
Spec A	12.8 ± 0.64	12.8 ± 0.64
Spec B/Serialized Alternators	13.0 ± 0.5	13.0 ± 0.5

Note: Even though winding resistance may be within the tolerances of this Table, replace the Alternator if winding-to-winding or winding-to-ground resistance (winding insulation resistance) is less than 1 megaohm. (An ohmmeter must indicate an open circuit or infinite resistance between windings or between any winding and ground)

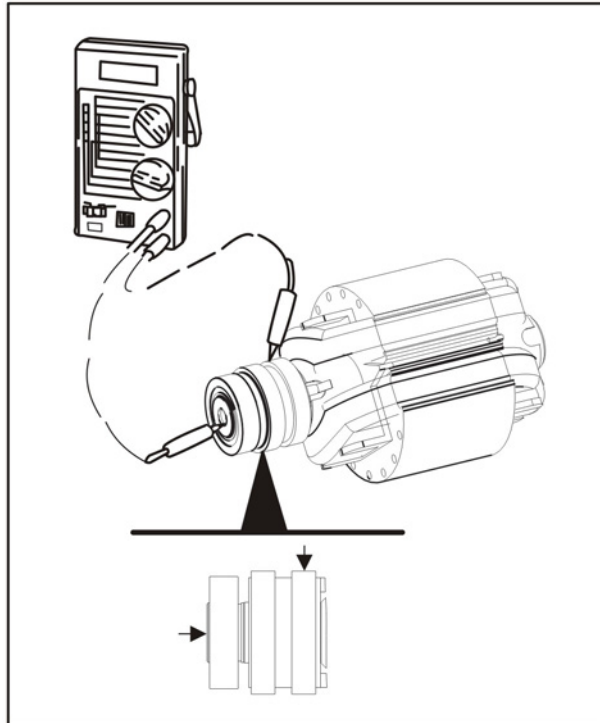


FIGURE 17. GROUNDED ROTOR TEST

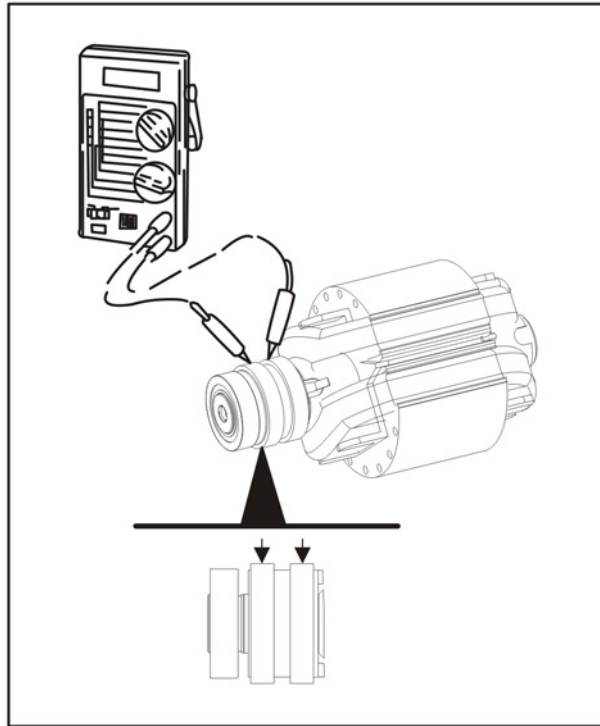


FIGURE 18. WINDING RESISTANCE TEST

5.2.4.2 Stator Tests

The stator can be tested for grounded or open windings using an ohmmeter. Testing for shorted windings requires a digital type ohmmeter that can read to within 0.01 ohms. To perform the stator tests, remove both connector plugs from the stator.

Ground Test: Set the ohmmeter for the highest resistance scale and then connect one test prod to the generator housing. Touch the other test prod to each terminal on the stator connector. A reading of less than one megohm indicates a ground. Replace a grounded stator with a new stator.

Winding Resistance: To test for open windings, set the ohmmeter for the highest resistance scale and then connect the test prods to the specified terminals. The ohmmeter should indicate continuity between terminals. A high resistance reading indicates an open winding. If an open circuit is measured replace the stator.

To test for shorted windings, use a digital type ohmmeter that reads to within 0.001 ohms. Connect the test prods to the specified terminals. A reading of less than the value shown in the following table indicates a shorted winding. If stator tests indicate a shorted winding, replace the stator. If stator tests good, check stator connectors and leads for continuity, and for good electrical connection with the stator terminals.

NOTICE

Starting with generator spec B, alternators are serialized. These alternators will also be backwards compatible with previous spec generator sets. Verify whether the alternator is serialized or not before taking resistance measurements. A serial number tag can be found on both the stator and rotor.

TABLE 8. STATOR WINDING RESISTANCES

RESISTANCE MEASUREMENTS (Ω) @ 25 °C (77°F)				
Generator Set Spec	Terminal Connections	60 HZ, 120V	60 HZ, 100V	50 HZ
Spec A	Main Winding T1-T2	0.51 \pm 10%	0.51 \pm 10%	X
	Main Winding T3-T4	0.51 \pm 10%	0.51 \pm 10%	X
	Main Winding T1-T4	X	X	1.42 \pm 10%
	Quad Winding Z1-Z2	3.07 \pm 10%	3.07 \pm 10%	3.48 \pm 10%
Spec B/Serialized Alternators	Main Winding T1-T2	0.58 \pm 10%	N/A	X
	Main Winding T3-T4	0.58 \pm 10%	N/A	X
	Main Winding T1-T4	X	N/A	1.50 \pm 10%
	Quad Winding Z1-Z2	3.00 \pm 10%	N/A	3.80 \pm 10%

Note: Even though winding resistance may be within the tolerances of this Table, replace the Alternator if winding-to-winding or winding-to-ground resistance (winding insulation resistance) is less than 1 megaohm. (An ohmmeter must indicate an open circuit or infinite resistance between windings or between any winding and ground)

5.2.5 Rotor Bearing Replacement

NOTICE

Starting with spec B/serialized alternators, the rotor bearing is not replaceable.

The rotor bearing is pressed onto the rotor shaft. This bearing must be replaced very carefully to avoid damaging the collector ring assembly and the rotor shaft. Use the following procedures to replace the rotor bearing.

1. Use a small puller with grips that will fit between the bearing and the collector ring assembly or use an arbor press to remove the bearing. Cover the end of the rotor shaft with a steel plate to prevent deformation of the shaft during removal.

NOTICE

Inspect the rotor shaft for dirt or corrosion. If necessary, clean with emery cloth before installing new bearing.

2. Place the rotor, engine end down, in an arbor press. Protect the end of the rotor shaft taper by placing it on a flat steel plate.
3. Press the bearing onto the rotor shaft (**press on inner race only**) until it contacts the snap ring stop. Check the bearing seal for damage after installation.

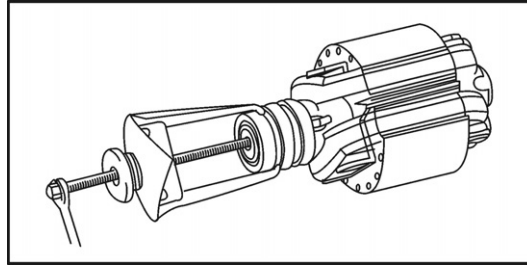


FIGURE 19. ROTOR BEARING REMOVAL

5.3 Primary Engine Systems

5.3.1 Introduction

Some of the primary engine systems can be serviced without removing the generator set from the vehicle. Poor engine performance is often caused by a dirty carburetor. Make certain that the carburetor is clean before troubleshooting for performance problems.

Primary engine systems include:

- Cooling system
- Exhaust system
- Ignition system
- Crankcase ventilation system
- Governor
- Fuel system
- Electric starter

5.3.2 Cooling System

The engine requires constant airflow to cool the engine and generator during operation.

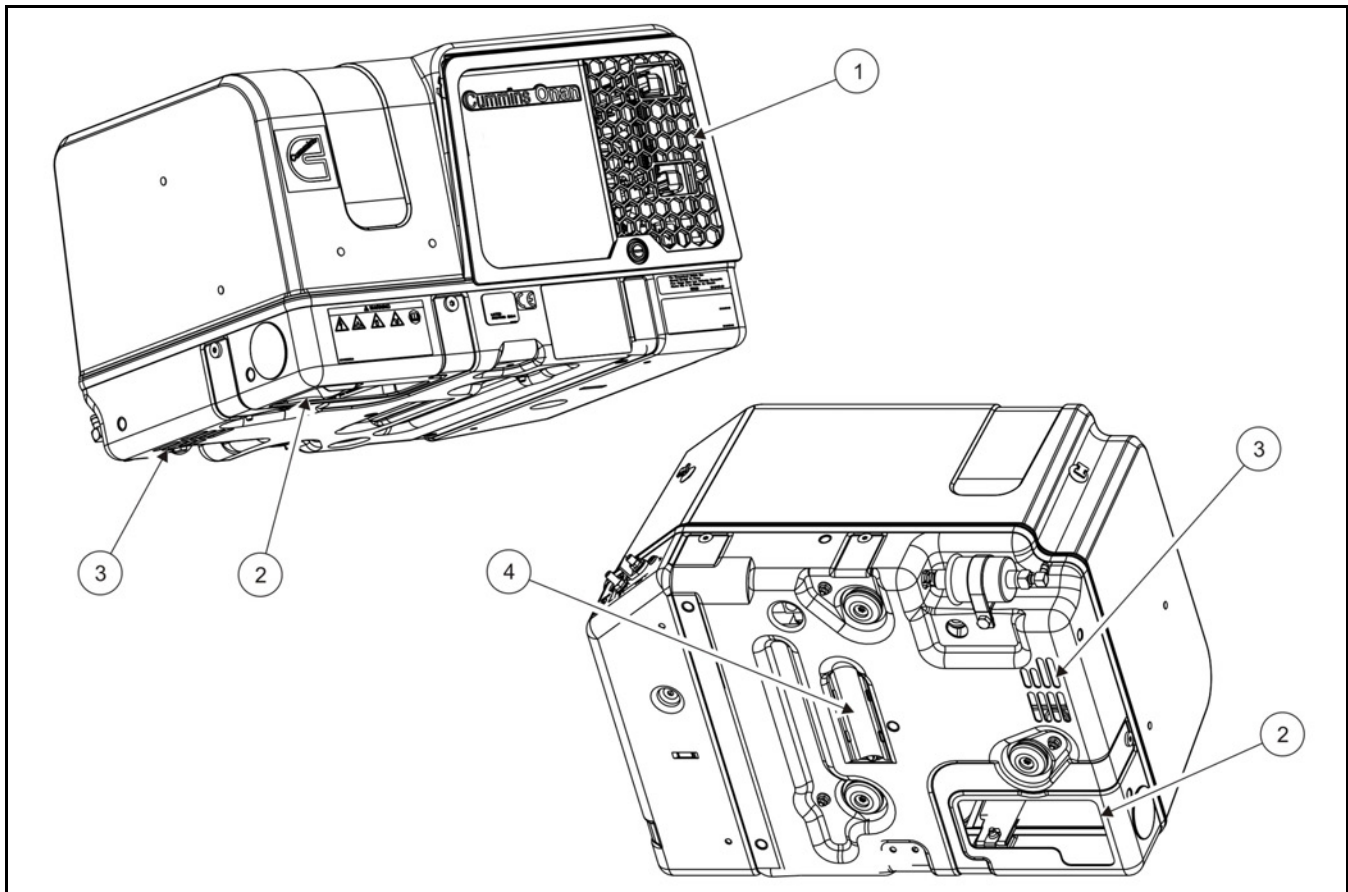
⚠ WARNING

Cooling air can contain poisonous exhaust gases that can result in severe personal injury or death. Never use discharged cooling air to heat the living space.

The engine fan forces air across the cooling fins and exits through the air outlet.

The alternator fan draws air through the duct and through the gap between the alternator rotor and stator and exits through the air outlet.

The air inlet is sized to allow the required flow of cooling air. The air inlet opening and the air discharge openings must be kept free of any obstructions to avoid restricting airflow. Dirt, dust, or other debris that clogs the air openings should be removed during periodic maintenance. Dirt might also become lodged between the cooling fins on the engine block and cylinder head. If this happens, heat transfer is greatly reduced and overheating can occur. The cooling system consists of the generator set housing and base assembly enclosure, fan shroud assembly, engine fan, alternator duct and alternator fan.

TABLE 9. GENERATOR SET COOLING AIR INLET AND OUTLET

No.	Description	No.	Description
1	Air inlet	3	Air outlet vent
2	Air outlet	4	LP vent

5.3.2.1 Inspection

Inspect the air inlet and outlet passages. Remove the access panel and inspect the engine and control area. If the engine is clean and the air inlet area is clean, disassembly for engine cleaning will not be necessary.

5.3.2.2 Disassembly

1. Remove the air box, governor rod and spring, carburetor, air guide housing, and the bolts (4) securing the fan housing.
2. To remove the fan on the alternator, remove the bolt securing it.
3. Use a brush or low pressure compressed air to clean the engine cooling fans. Replace fans if fan blades are damaged.

5.3.2.3 Assembly

Assemble cooling system in reverse order of disassembly.

⚠ CAUTION

Overheating can result in engine damage. To avoid overheating, never operate the generator set with any of the cooling system components removed.

5.3.3 Exhaust System

⚠ WARNING

EXHAUST GAS IS DEADLY! Modifying the exhaust system may let poisonous exhaust gases enter the living space. Use only Cummins Inc. replacement parts to service the exhaust system. Unauthorized modifications will void the Cummins Inc. warranty. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the modification.

The exhaust system consists of the muffler and tail pipe with the clamps and hangers needed for installation of the tail pipe.

The condition of the exhaust system is extremely critical on generator sets because of the possibility of exhaust gases entering the living space. The exhaust system must not have any leaks and it must be well supported. See the Installation Manual for important considerations concerning the installation of an exhaust system.

Do not run the generator set if inspection reveals leaking exhaust connections, loose fasteners, or broken or damaged components. Always replace worn components with new original equipment replacement parts that meet factory specifications. Do not repair a broken exhaust pipe or manifold by welding.

5.3.3.1 Muffler

The muffler is a spark arrester type muffler that is US Forest Service Approved and meets code requirements. Failure to provide and maintain a spark arrester muffler can be in violation of the law. Contact a Cummins Inc. distributor for approved replacement exhaust parts.

⚠ 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.

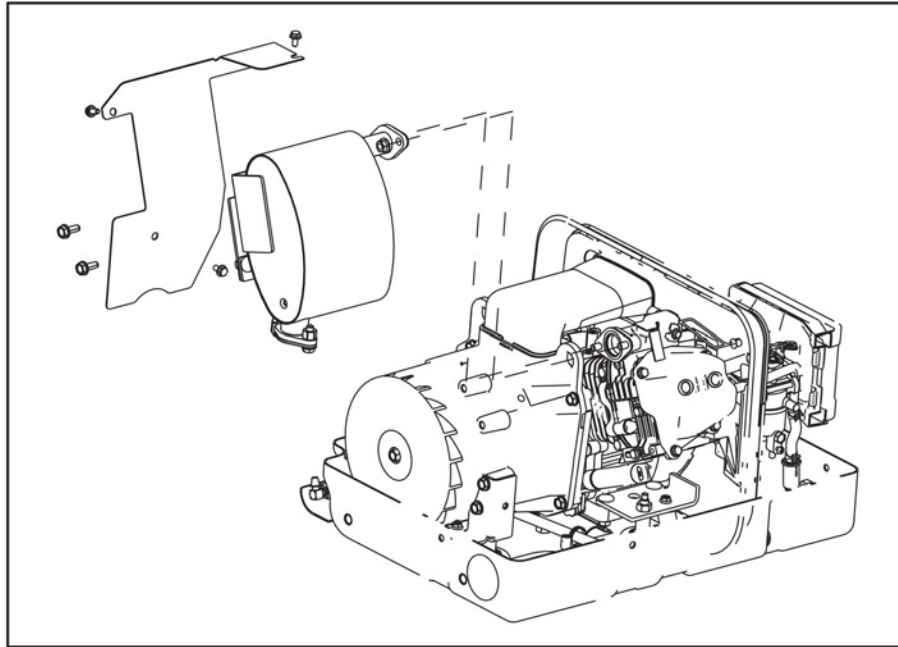


FIGURE 20. MUFFLER

Muffler Disassembly:

1. Remove the bolts (4) securing heat shields.
2. Loosen the nut securing the muffler to the generator bracket.
3. Remove the nuts (2) securing the muffler to the manifold.
4. Slide the muffler out.

Muffler Assembly: Install the muffler in reverse order of removal. Use a new exhaust flange gasket and torque to specifications. Run the generator set and look and listen for leaks. Repair leaks before placing the generator set in service.

5.3.3.2 Cleaning the Spark Arrestor

Refer to the Operator Manual for scheduled cleaning of the spark arrestor muffler (which meets U.S. Forest Service requirements). Cleaning is required for maximum generator set performance.

⚠ WARNING

A hot muffler can cause severe burns. Let the muffler cool down before removing the spark arrestor screen.

The spark arrestor screen is mounted inside the muffler outlet. Clean as follows:

1. Remove the 2 bolts that secure the tailpipe to the muffler (inside the generator set housing) and move the tailpipe aside.
2. Turn the spark arrestor tube flange slightly clockwise and pull to remove from the muffler.
3. Inspect the screen inside for damage and clogging. Replace if damaged.
4. Lightly tap the spark arrestor and remove any remaining deposits with a wire brush. Use a commercial solvent to loosen hard deposits. (Carefully follow the solvent manufacturer's instructions and safety precautions.)
5. Reinstall the spark arrestor and tailpipe, making sure that the two gaskets are installed correctly.

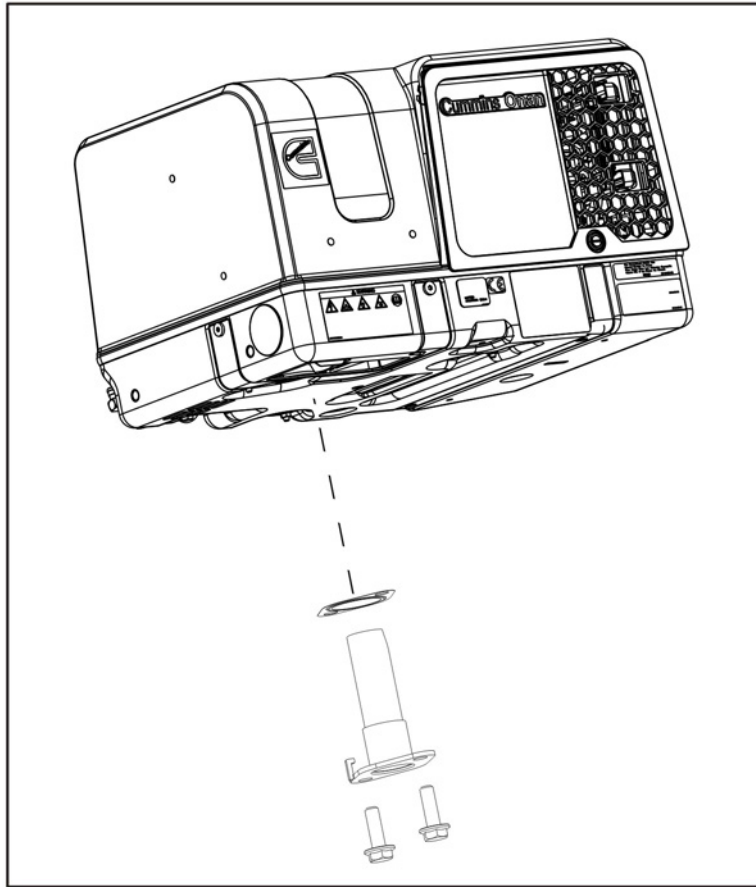


FIGURE 21. SPARK ARRESTOR

5.3.4 Ignition System

The ignition system consists of the flywheel magnet, ignition coil assembly and one spark plug. If the engine does not start, first check to see that the spark plug cable boot is secure on the spark plug. Then proceed in the following order of inspections if an ignition problem is still suspected.

5.3.4.1 Spark Plug Inspection

Remove the spark plug and inspect the electrode. If the spark plug has carbon deposits, use a wire brush to clean it. Replace a badly fouled or burned spark plug. Reset the spark plug gap. Diagnose engine problems by examining the spark plug as follows:

- Carbon Fouled—Check for a poor high tension lead connection, faulty choke operation, rich fuel mixture or dirty air filter.
- Oil Fouled—Check for low compression, plugged crankcase breather, and inspect valve guides and seats.
- Burned or Overheated—Check for leaking intake manifold gasket, lean fuel mixture or incorrect spark plug type.
- Splash Fouled—Check for accumulated combustion chamber deposits.
- Light Tan or Gray Deposits—Normal plug color.
- Spark plug gap—0.6-0.7mm (0.024 - 0.028 inches)

5.3.4.2 Spark Check

⚠ WARNING

Gasoline is flammable and explosive and can cause severe personal injury or death. Make certain that no gasoline or other flammable fumes are present and that the area is well ventilated. Leave the generator set compartment door open for several minutes before performing this test.

1. Use an inline spark tester to verify spark condition
2. Do not touch the spark plug or cable during testing. Crank the engine and look for the spark. If the spark is strong and consistent, the ignition system is good. If spark is absent or weak, see [Section 5.3.4.3](#).

5.3.4.3 Disassembly

1. Remove the generator set from the installation and remove the outer housing. See [Chapter 4](#).
2. Loosen the six mounting isolators so that the generator end can be tipped up high enough to remove the fan housing.
3. Loosen the controller bracket and pull it out.
4. Remove the governor springs and rod.
5. Tip the assembly up and remove the fan housing.
6. Loosen the two ignition coil mounting screws, if the ignition coil is to be removed.
7. Check that the ignition kill lead in the wiring harness is connected to the ignition-coil assembly. Repair as necessary.
8. Replace the assembly if cable or ignition coil insulation is defective or there are signs of electrical leakage, such as carbon tracks, corrosion or other damage.

5.3.4.4 Reassembly

Reassembly is the reverse of assembly. Check the ignition coil to flywheel magnet air gap and reset it, if necessary.

5.3.4.5 Resetting Air Gap

To reset the air gap, hold the ignition coil assembly tight up against the magnet on the flywheel, with a feeler gauge of proper thickness in between, while tightening the two mounting screws.

Air gap should be 0.3–0.5mm (0.019–0.0197 in).

NOTICE

Be sure to install the ignition coil with kill terminal and high tension lead facing downward.

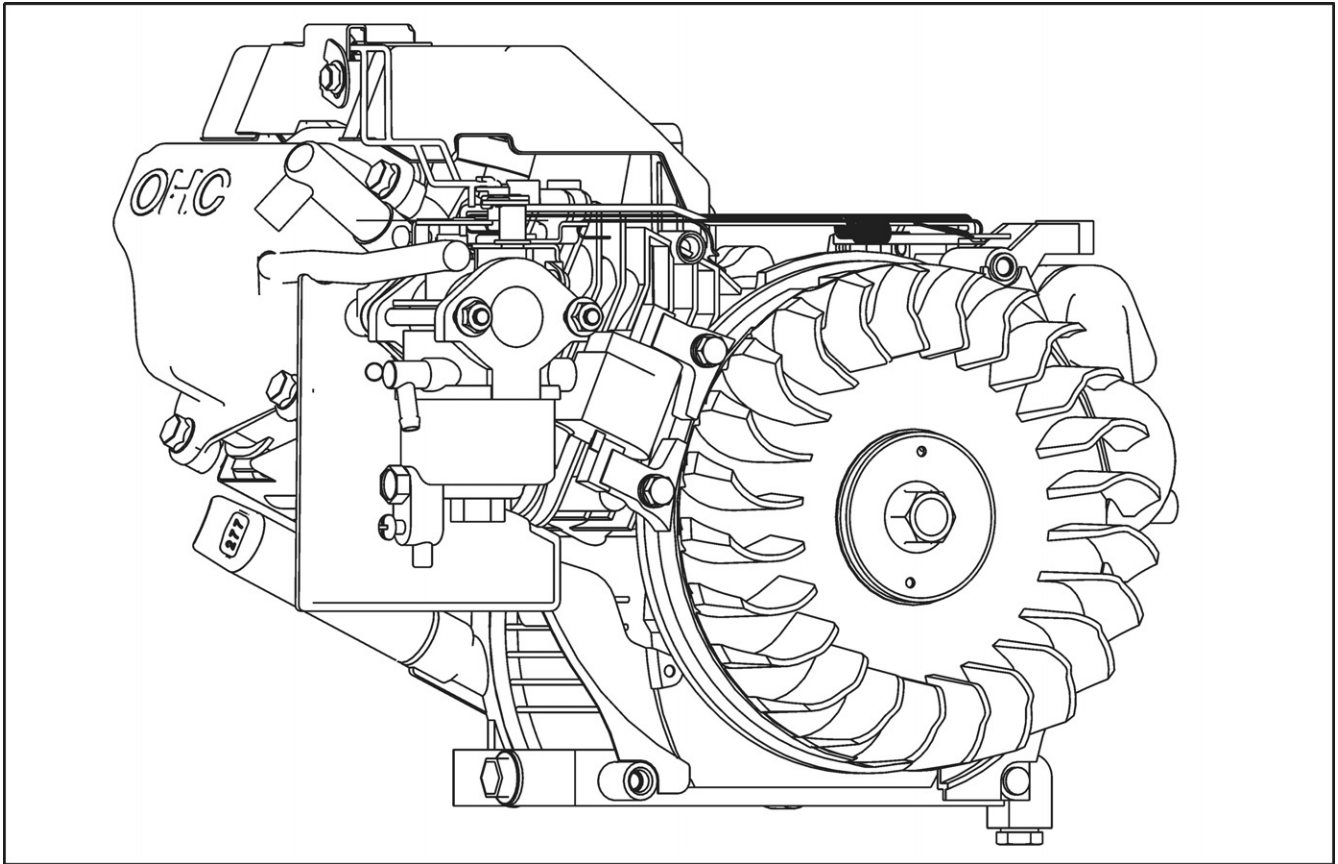


FIGURE 22. IGNITION SYSTEM

5.3.4.6 Ignition Coil Resistance Test

If spark is weak or inconsistent across the spark plug, check ignition coil resistance between a good ground on the engine and each spark plug cable terminal. Replace the ignition coil assembly if its electrical resistance is not within $\pm 40\%$ of the nominal values in the table on the next page.

		Positive Probe		
		Stop Wire Terminal	GND (Core)	Spark Plug Wire
Negative Probe	Stop Wire Terminal	0	10.2k Ω	18.5k Ω
	GND (core)	10.2k Ω	0	8.3k Ω
	Spark Plug Wire	18.5k Ω	8.3k Ω	0

Notes:

1. Recommend tester: Fluke Digital Multi Meter 73111 (range 1k Ω).
2. Ambient temperature: 68 °F (20 °C).
3. The value on flat terminal for stop wire varies according to tester range.
4. This test may not always determine failure.
5. A failed ignition coil may indicate poor ground connected to engine block (ground strap).
6. This is measured with the spark plug boot removed. (If spark plug boot is used when measuring, add 10k Ω to readings.)

5.3.5 Crankcase Ventilation System

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture, gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with the incoming air and burned in the combustion chamber. A stuck or damaged breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, and a rapid formation of sludge and varnish within the engine.

5.3.5.1 Crankcase Breather Service

Oil leaks at the seals may indicate that the crankcase is pressurized. Use the following procedure to eliminate this condition.

1. Remove the breather tube from the valve cover.
2. Remove the valve cover.
3. Inspect the reed valve in the valve cover. If the valve is sticking open or closed, replace the valve cover.
4. Check the breather tube and air passages for clogging and clean as required.

⚠ WARNING

Most parts cleaning solvents are flammable and can result in severe personal injury if used improperly. Follow the solvent manufacturer's recommendations when cleaning parts.

5.3.6 Governor

The governor controls engine speed (frequency) within specified limits of "droop" between no-load and full-load. Too large a droop will result in objectionable voltage and frequency drops. Too small a droop will result in hunting.

⚠ CAUTION

Voltage or frequency-sensitive equipment such as VCRs, televisions, computers, etc. may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet even if the device is not in actual operation. For this reason, disconnect all devices which are voltage or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.

5.3.6.1 Governor Adjustments

Before making governor adjustments, check out other conditions that could also be causing hunting or droop, such as binding in the governor linkage, a fouled spark plug or dirty fuel filter.

⚠ CAUTION

An accurate voltmeter, frequency meter and a load bank capable of providing a load of 3000 watts are needed to properly set the governor adjustments.

A small speed drop, not noticeable without instruments, can cause an objectionable voltage drop. Accurate governor adjustments require:

- Digital multimeter
- Variable load bank with 3 kW capacity

Adjust the governor in the following sequence of steps.

1. Run the generator set at least 10 minutes at 3/4- rated load. Check that the choke is completely open. If the governor is completely out of adjustment, make a preliminary adjustment at no-load to attain a safe voltage and speed operating range. Note the initial governor spring hole.
2. Check the governor linkage for binding or excessive looseness. Check the motion spring for bending or damage and straighten or replace as needed.
3. With the generator set operating at no-load, turn the speed adjustment screw on the governor linkage to obtain 61.5-63.5 Hz for a 60 Hz generator set or 51-53 Hz for a 50 Hz generator set. Turn the screw clockwise to increase speed and counterclockwise to decrease speed.
4. Check frequency and voltage first with load applied and then with no load applied. Frequency and voltage should stay within the limits shown in the following table.
5. ***Output voltage adjustment (50 Hz and 100V - 60 Hz generator sets only).***
 - a. Start the generator set and allow the set to run at no load for 5 to 10 seconds.
 - b. Rapidly press the controls switch to START 6 times within 1 minute of starting.
 - c. Adjust the voltage +/- 1 volt of rated voltage.
 - To adjust the voltage up, press the control switch to START and release quickly. Each time the switch is released, the voltage will rise approximately 0.6 volt.
 - To adjust the voltage down, press the controls switch to START and release after a few seconds. Each time the switch is released, the voltage will decrease approximately 0.6 volt.
6. Normal operation will resume 20 seconds after the last adjustment. The last adjustment will be the voltage set point until changed again.
7. Recheck the speed setting made in Step 3 and readjust if necessary.

8. Set the carburetor throttle stop screw to 45 +/- 5 Hz.

- At no load, pull the governor linkage gently towards the front of the generator set so that the throttle lever rests light against the idle stop screw.
- If the adjustment takes longer than 30 seconds, the control will shut down on underfrequency (fault 15). If this happens, restart and continue the adjustment.

If governor action is erratic after these adjustments, loosen the governor arm mounting bolt and rotate the shaft fully clockwise and then retighten the bolt. Reset the governor adjustments and recheck speed. Springs tend to lose their calibrated tension through fatigue after long usage. It may be necessary to put the stationary end of the spring in a different hole to change the tension, or replace the spring altogether. If this does not improve operation, the problem may be within the governor mechanism (See [Section 5.4](#)).

The governor unit is a centrifugal flyweight type and is installed on the governor gear.

Since it automatically adjusts the throttle valve of the carburetor by means of a link mechanism, it is possible to maintain a constant engine speed, even with load variations.

1. Turn the speed control lever to the full speed position, making sure that the carburetor throttle valve is fully open.
2. Hold the top of the governor shaft with the pliers and turning it clockwise as far as it will go. Tighten the bolt on the governor lever.

NOTICE

Tightening torque: 8.0-10.0 Nm (80 -100 kgf cm) (5.8 - 7.2 ft lb).

TABLE 10. VOLTAGE / FREQUENCY

Rated Voltage	Voltage		Frequency	
	Max No Load	Min Full Load	No Load	Droop
60 HERTZ GENERATOR SETS				
100	108	93	61.5-63.5	0-4
120	125	112	61.5-63.5	0-4
50 HERTZ GENERATOR SETS				
230	249	215	51/53	0-4

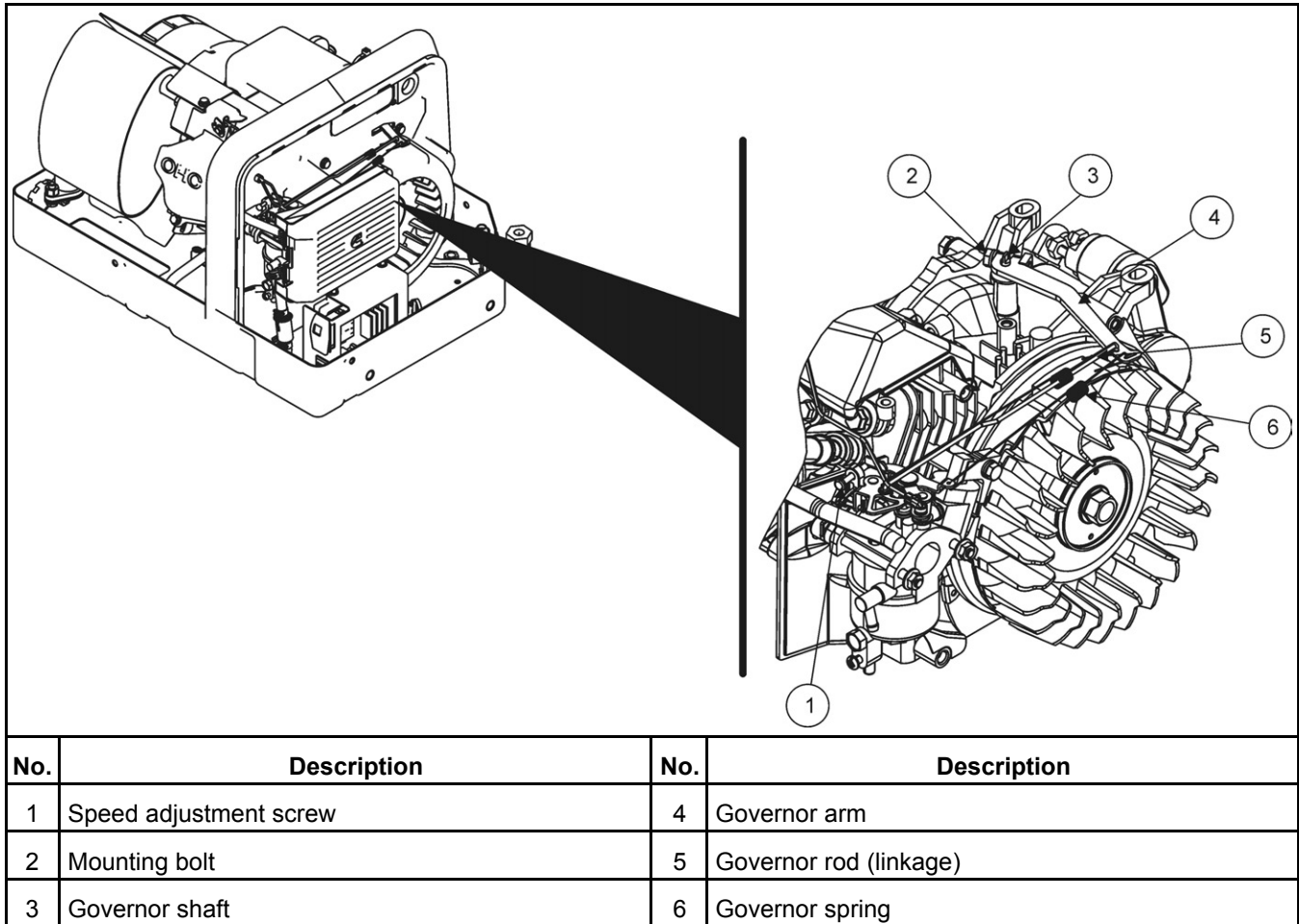


FIGURE 23. GOVERNOR ADJUSTMENTS

5.3.7 Gasoline Fuel System

⚠ WARNING

Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.

The fuel system must be in good condition for efficient generator set operation. The main components of the fuel system include:

- Air filter
- Choke
- Carburetor
- Intake manifold
- Fuel filter
- Fuel pump

5.3.7.1 Air Filter Assembly

This assembly consists of the air filter housing and air filter.

The air filter can be serviced without removing the generator set. Remove the service access cover and the air filter housing/cover. Remove the air filter. If the air filter is dirty, replace it.

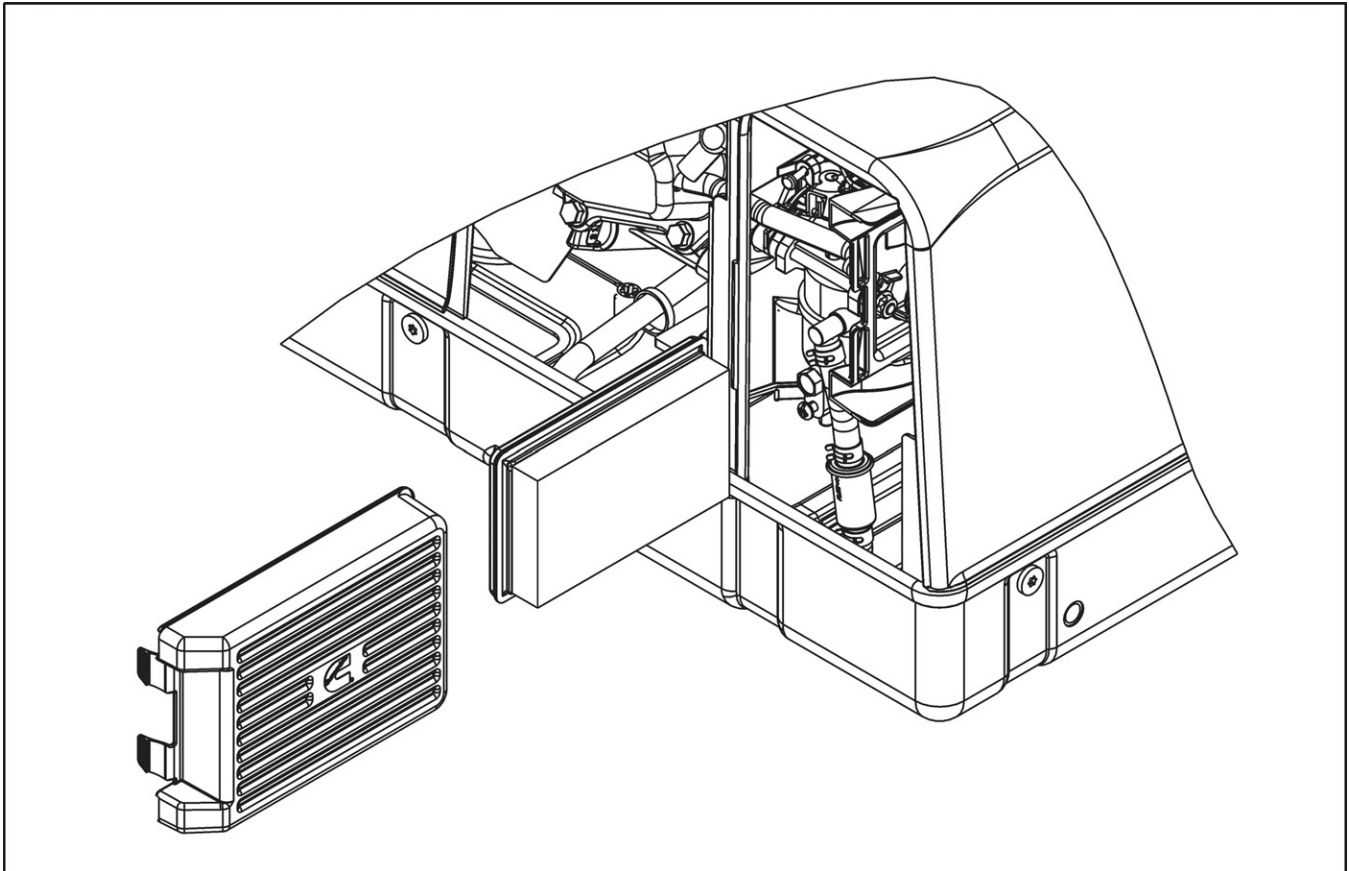


FIGURE 24. AIR FILTER ASSEMBLY

5.3.7.2 Carburetor and Intake Manifold Assembly

This assembly consists of the carburetor and the intake manifold assembly. It is easier to disconnect the carburetor linkages if the generator set housing is removed.

Disassembly: Use the following procedures to remove the carburetor and intake manifold assembly.

1. Disconnect the fuel line from the carburetor and plug it to prevent fuel spill and fuel vapor accumulation. Also disconnect the fuel solenoid leads.
2. Remove the air filter assembly.
3. Plug the intake port with a rag to prevent loose parts from accidentally entering the port.

Assembly: Perform the assembly steps in reverse order of disassembly. Use new gaskets between the intake manifold and the engine, between the intake manifold and the carburetor, and between the carburetor and the air cleaner adapter. Do not use sealer on the gaskets. Tighten the intake manifold capscrews to the specified torque.

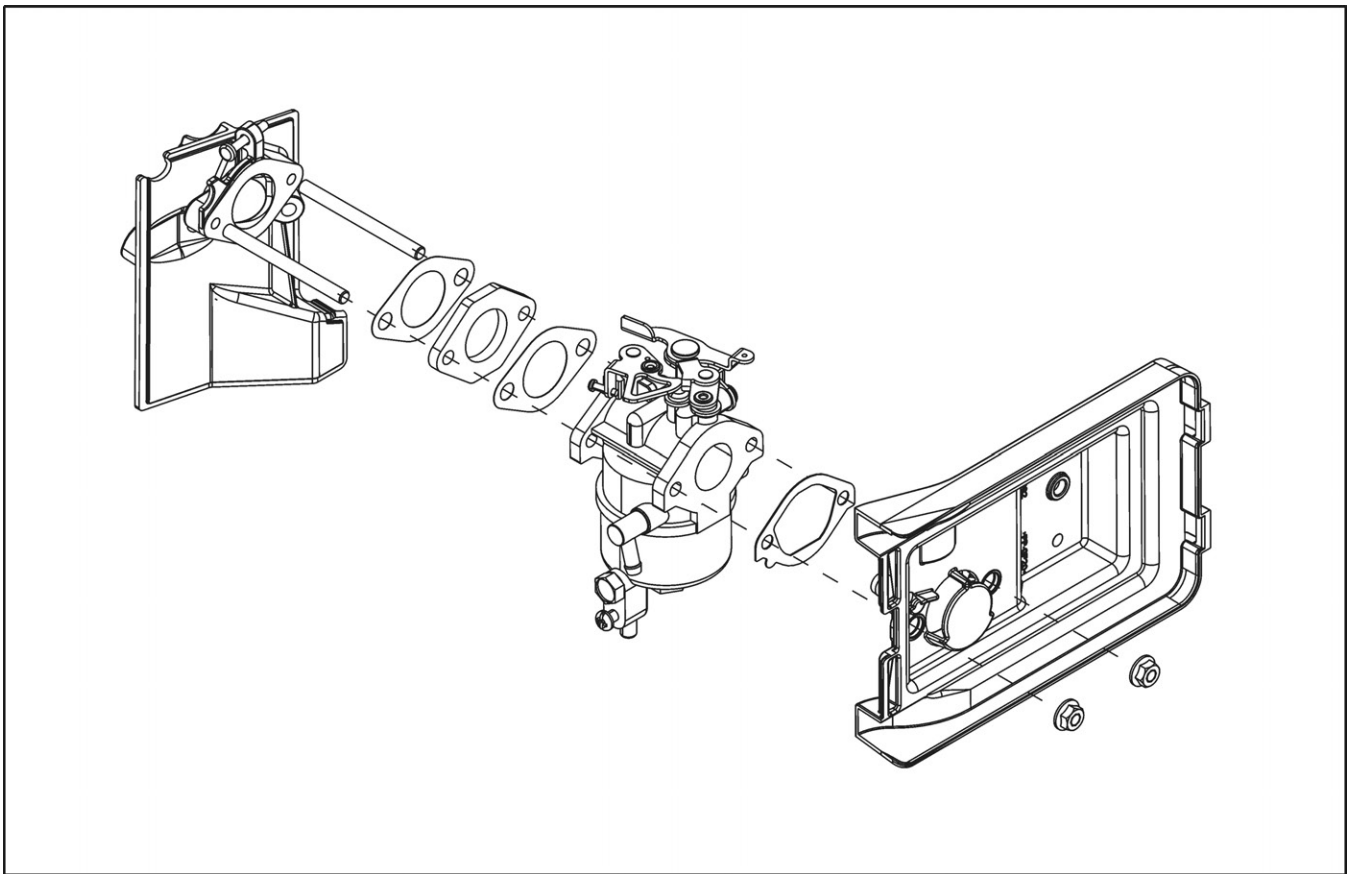


FIGURE 25. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY

5.3.7.3 Operating at a High Altitude

When operating a gasoline generator set at altitudes greater than 7500 ft, it is recommended to install a high altitude kit (A042V579) to avoid performance degradation. Liquid Propane generator sets are self-compensating and do not require adjustment.

5.3.7.4 Gasoline Choke Assembly

The generator set has an automatic choke assembly that consists of a bimetal choke coil, coil housing, heater tube (from the exhaust tube), and choke linkage. The choke linkage connects to the choke shaft lever on the carburetor.

When the engine is cold, the choke coil position causes the linkage to hold the choke nearly closed. When the engine starts, hot air from the exhaust manifold enters the coil housing. The choke coil expands pulling the linkage to partially open the choke. As the engine warms up, the coil continues to expand and gradually opens the choke and holds it open while the engine is operating.

If the engine starts but runs rough and exhausts black smoke after a minute or two of operation, the choke setting is too rich. If the engine starts but sputters or stops before it warms up, the choke setting is too lean.

Choke Adjustment: Check the choke linkage to make sure it is not bent or rubbing. Rotate the choke lever on the carburetor. The choke shaft should move freely and it should return to its original position when released.

⚠ WARNING

The choke housing becomes hot during operation and can cause severe burns if touched. Allow the generator set to cool down before handling the choke assembly.

1. Allow the generator set to cool down. The temperature inside the housing must be the same as the ambient temperature.
2. Loosen the adjustment screw holding the adjustment plate.
 - If ambient temperature is different than 68 °F (20 °C), rotate the adjustment plate according to the following table:

TABLE 11. CHOKE ADJUSTMENTS

Ambient Temp (°C)	8	14	20	26	32	38
Rotation of adjustment plate (notch)	1	0.5	0	0.5	1	1.5
Plate rotation	CW	CW	-	CCW	CCW	CCW

3. Rotate the choke link plate on the carburetor until it is parallel to the carburetor flange.
4. Keeping that choke lever position, remove any tension of bimetal (tapping the adjustment plate or bimetal box lightly).
5. Tighten the adjustment bolt at that position. Release the choke lever and it should rotate back some by return spring.

NOTICE

This is the position the choke lever should be in when the ambient temperature is 68 °F (20 °C).

6. Move the choke lever back and forth to check for free movement. Verify that the choke does not bind or stick.

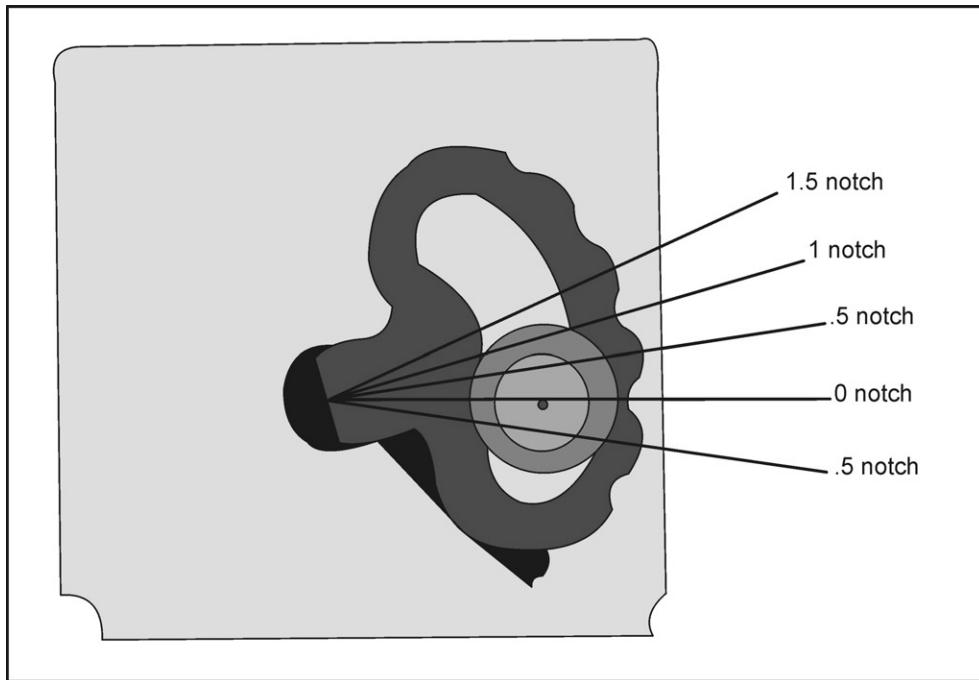


FIGURE 26. CHOKE ADJUST

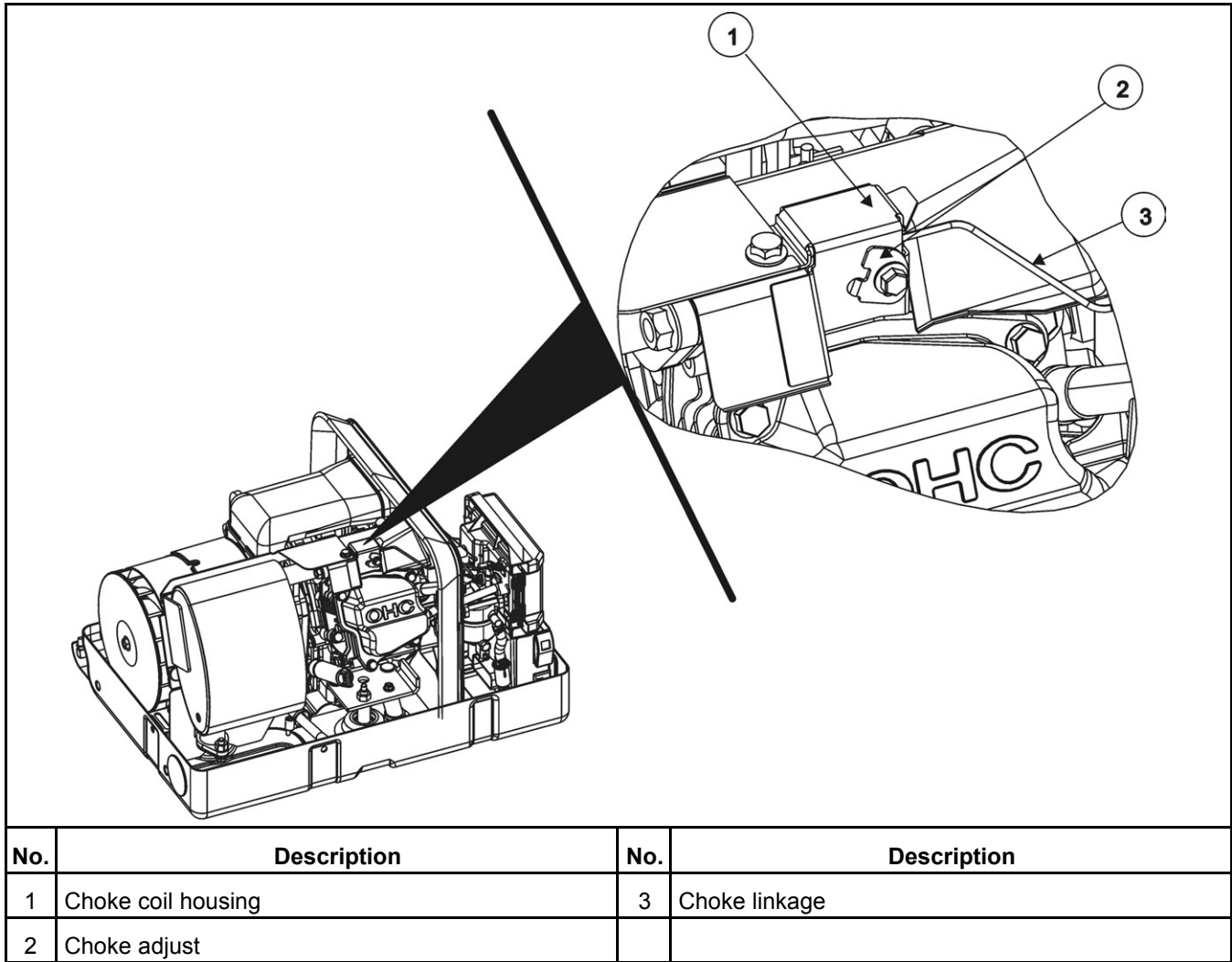


FIGURE 27. CHOKE ASSEMBLY

Bimetal Coil Replacement: After making the choke adjustment, start the generator set and observe engine operation. If the choke does not open properly, replace the bimetal coil in the choke housing as follows.

1. Remove the adjustment screw and washer from the choke coil housing.
2. Remove the housing. Straighten the tab from the adjustment plate to release the bimetal coil.
3. Remove choke linkage from the bimetal coil and install linkage on the new coil.
4. Assemble the new coil to the adjustment plate and bend the tab on the adjustment plate to secure coil.
5. Install choke coil housing and secure with screw and washer. Perform the choke adjustment procedure.

5.3.7.5 Fuel Filter

⚠ WARNING

Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.

Change the fuel filter at the interval recommended in the Operator's Manual, or if performance problems occur and bad fuel is suspected.

1. Remove the fuel line from the fuel filter. Plug the end of the fuel line to prevent fuel leakage and vapor accumulation.
2. Replace the in-line fuel filter near the carburetor. Install carefully so as to prevent fuel leakage.
3. Connect the fuel line to the new filter. Start the generator set and check for fuel leaks. Repair any leaks immediately.

⚠ CAUTION

Incorrect replacement of service parts can result in damage to equipment. Use a genuine Cummins Inc. replacement fuel filter only.

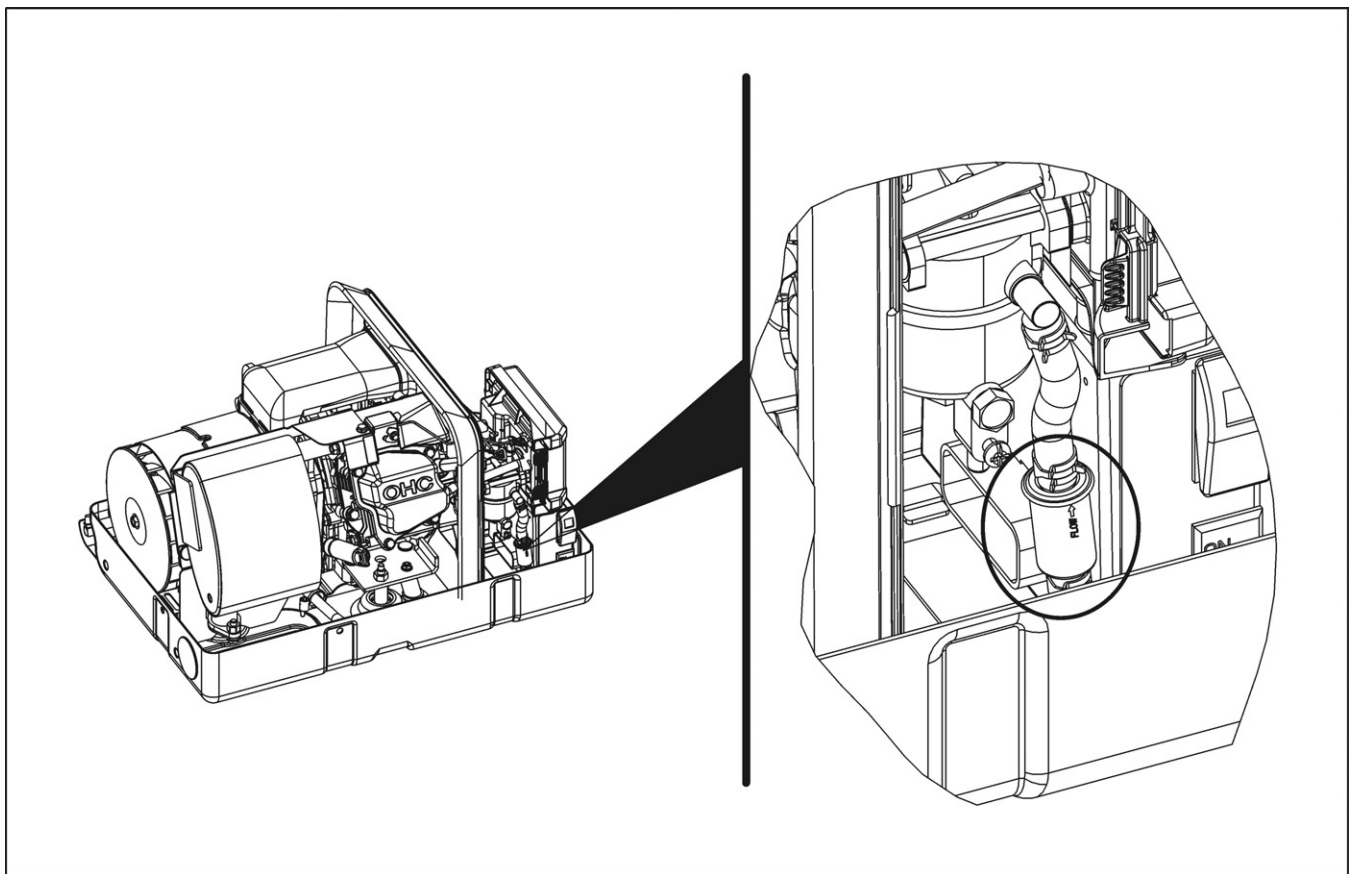


FIGURE 28. FUEL FILTER REPLACEMENT

5.3.7.6 Fuel Pump

⚠ WARNING

Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.

An electric fuel pump is used to supply fuel to the carburetor. If the pump malfunctions or if insufficient fuel delivery is suspected, use the following procedures to test the fuel pump.

⚠ WARNING

Do not substitute an automotive electric fuel pump for the Cummins-supplied fuel pump. The output pressure from an automotive pump is much higher and can cause carburetor flooding or fuel leakage, creating a fire hazard.

Fuel Pump Test: Test the fuel pump by checking the fuel pump outlet pressure as follows:

1. Make sure the fuel tank has sufficient fuel to supply the generator set. The generator set fuel pick-up tube ends well above the bottom of the vehicle fuel tank. The generator set can be out of fuel even when the tank is partly full.
2. Check the generator set starting battery voltage when cranking and running the generator set. Measure battery voltage between the brown lead and ground. The pump will not work properly if the cranking or running voltage is less than 6 VDC. If the battery voltage is low, charge the battery and retest.
3. Remove the fuel line from the carburetor inlet and install a pressure gauge.
4. Press the stop switch and hold it for several seconds until the pressure stabilizes.
5. The pressure reading should be 2.5-4 psi (17-27 kPa). The pressure should hold constant or drop off very slowly.

If the pressure reading is below 2.5 psi (17 kPa), tap the pump body with a screw driver handle to free the piston from fuel deposits. If the pump still does not work and the battery voltage is adequate, replace fuel pump with a Cummins-supplied pump.

If the pressure is higher than 4 psi (27.5 kPa), fuel can overcome the needle and float assembly and cause flooding. A negative fuel supply line pressure (more than minus 1.3 psi or three feet of lift) will prevent the pump from delivering enough fuel. Measure the pressure at the pump inlet. Inlet pump pressure must be between a minus 1.3 psi and a positive 1.5 psi (minus 8.3 kPa and positive 10.3 kPa). If an abnormally high or low inlet pressure is measured the fuel line installation is improper. Refer to *Fuel System* in the Installation Manual.

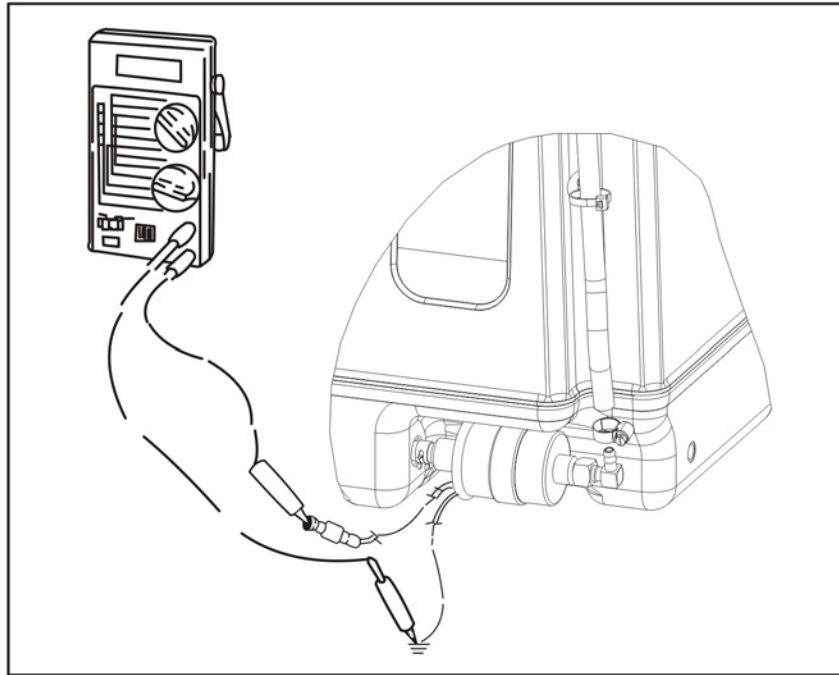


FIGURE 29. FUEL PUMP TEST

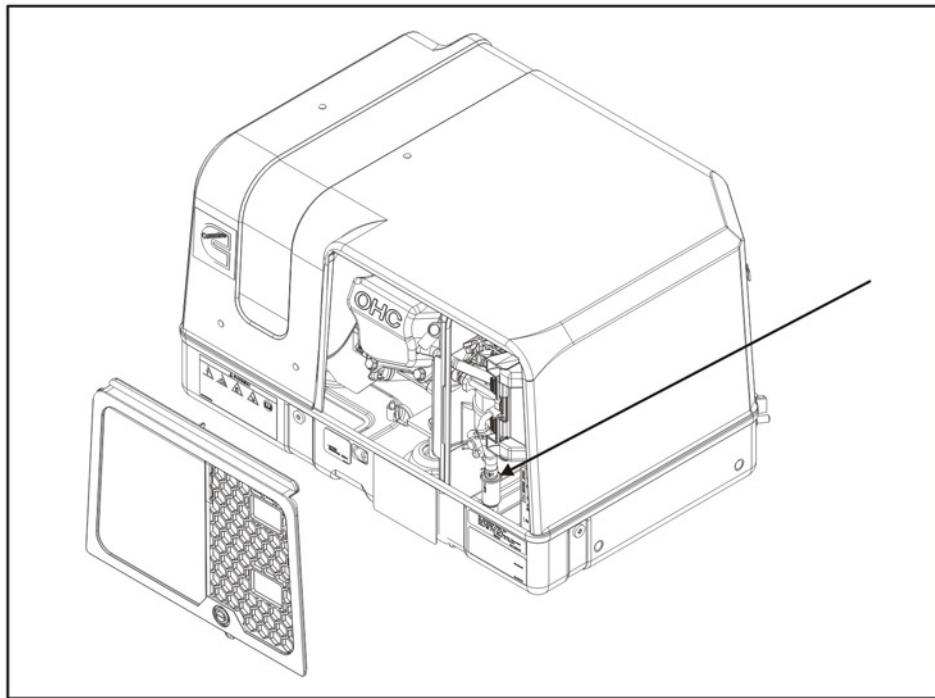


FIGURE 30. PRESSURE GAUGE CONNECTION LOCATION

5.3.8 LPG Fuel System

⚠ WARNING

LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.

⚠ WARNING

Do not smoke if you smell gas or are near LPG containers or LPG-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs, arc-producing equipment, electrical switches and all other sources of ignition well away. Have an ABC fire extinguisher handy.

LPG models are designed for a low-pressure vapor-withdrawal type of LPG supply system. *LPG supply pressure at the inlet to the demand regulator must be 9 to 13 inches (229 to 330 mm) water column (WC) when the generator set is running under full load.*

The components of the generator set LPG system include:

- A fuel-shutoff solenoid valve
- An LPG demand regulator
- An LPG carburetor or mixer

Before servicing the LPG fuel system, check to see that the LPG container(s) is at least half full. The problem may be that there is not enough LPG to provide the rate of vaporization necessary to meet generator set demand, especially on cold days and/or when the generator set is under full load.

⚠ WARNING

LPG "sinks" and can accumulate in explosive concentrations. Before disconnecting the LPG fuel line, close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from pits or basements or other below-grade spaces where LPG could accumulate.

5.3.8.1 Isolating Fuel System Problem

To isolate the problem to the generator set or to the fuel supply system, perform the following test:

1. Close the vehicle gas supply tank valve and disconnect the gas hose at the carburetor (fuel-air mixer).
2. Connect a shop tank (at least 30 lb) through a primary regulator and demand regulator adjusted for 11 inches WC.
3. If the generator set can be started and runs properly, the problem is in the gas supply system up to the connection at the carburetor.
4. If the generator set cannot be started or does not run properly, the problem is in the generator set, starting at the connection to the carburetor.

5.3.8.2 Demand Regulator

The demand regulator assembly supplies fuel to the carburetor. It is usually not the cause of fuel system problems. All other possible causes should be checked out before adjusting or replacing the demand regulator assembly.

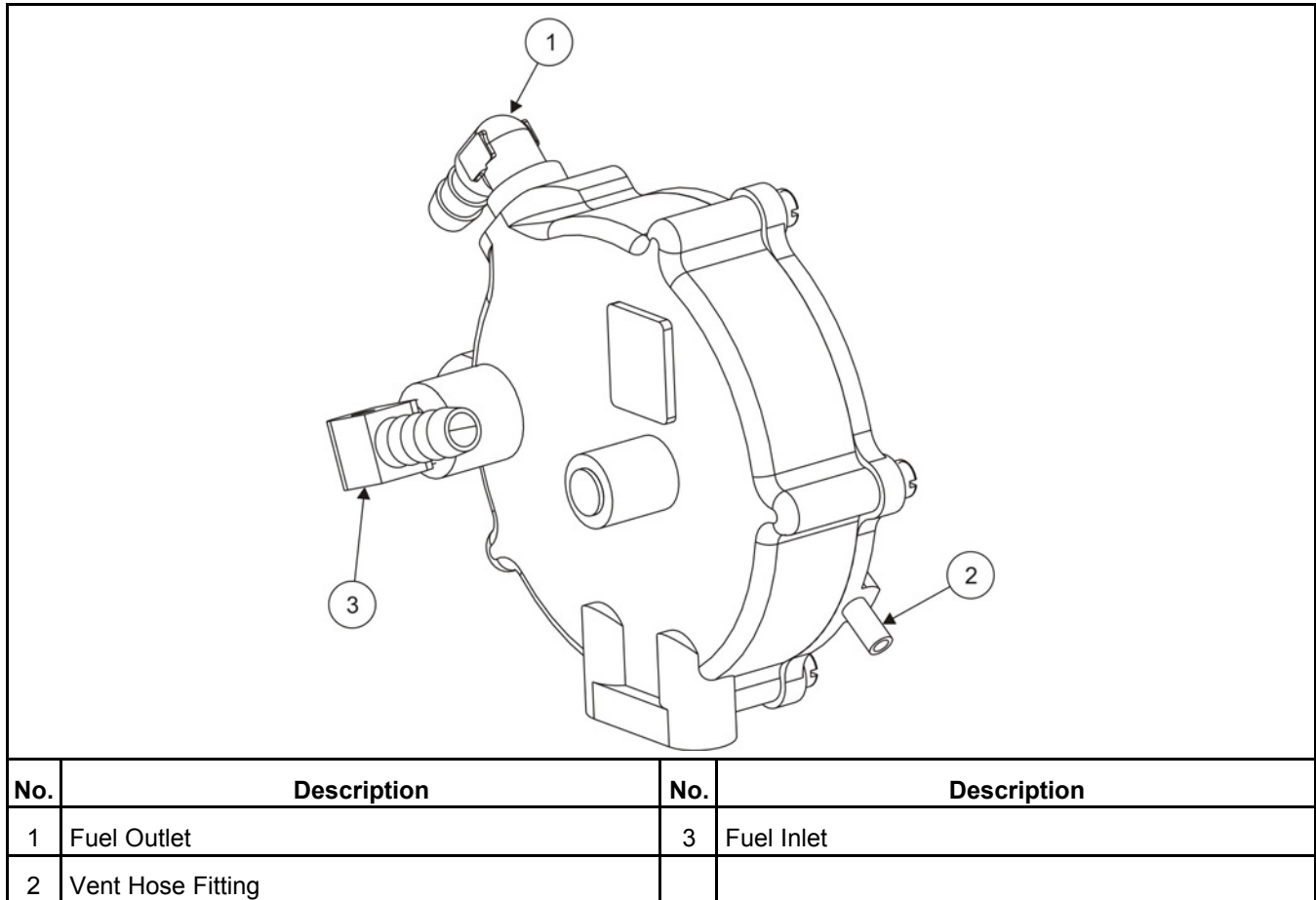


FIGURE 31. DEMAND REGULATOR

Checking Regulator Lock-off Pressure: Lock-off pressure is determined as follows by pressurizing the back (vent) side of the regulator diaphragm to simulate carburetor venturi vacuum:

1. Connect the regulator inlet to a source of air pressure regulated to 11 inches WC (Water Column).
2. Disconnect from the carburetor the LPG supply hose, which comes from the regulator.
3. "T" in two hoses to the end of the hose connected to the regulator vent fitting (3/8 inch I. D.). Use one hose to measure pressure by connecting it to an inclined manometer that reads 0 to 2 inches WC and the other to provide the test pressure.
4. Attach a soap bubble to the end of the LPG supply hose which was disconnected from the carburetor. While reading the pressure indicated by the manometer and watching the soap bubble, blow lightly into the hose being used to pressurize the regulator. Regulator lock-off pressure is the minimum pressure that will cause air to flow through the regulator, as indicated by the expanding soap bubble. (At first the soap bubble may expand due to diaphragm movement but will stop expanding if air is not flowing through the regulator.)

⚠ CAUTION

If this is a bench test of the regulator, make sure the diaphragm is in a vertical plane (as in the generator set), otherwise the weight of the diaphragm will cause erroneous readings of lock-off pressure.

5.3.8.3 Fuel-Shutoff Solenoid Valve

Leak Test: If there is a smell of gas when the generator set is not running, or any other reason to suspect that the valve is leaking, connect the inlet of the valve to a source of air pressure regulated to not more than 14 inches WC (356 mm WC) and disconnect the outlet hose. Replace the solenoid if it leaks, as checked by a soap bubble.

Operation Test: If the generator set cranks, but does not start (first see [Chapter 6](#)), determine whether or not the valve is opening. With the source of air still connected, energize the valve by connecting battery positive (+) to the top terminal and battery negative (-) to the grounded terminal. Replace the solenoid valve if it does not open when it is energized.

5.3.8.4 LPG Choke Assembly

When the generator set is off, the LPG choke should be almost fully closed (choke shaft counter clockwise). When started, the vacuum pulloff will fully open the choke (choke shaft clockwise).

The delay valve slows the opening of the choke. Replace any parts that are not operating correctly.

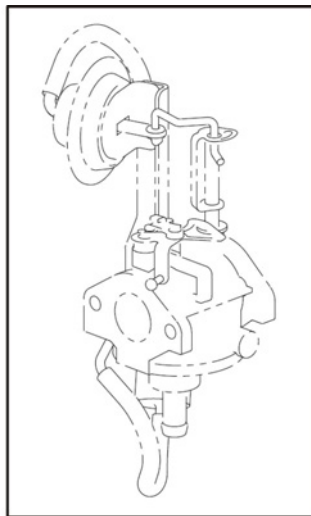


FIGURE 32. LPG CHOKE ASSEMBLY

5.3.8.5 LPG Carburetor

An LPG carburetor is not likely to cause problems and should be replaced only after all other causes have been eliminated (see [Chapter 6](#)). It is not necessary to adjust fuel mixture. These carburetors are calibrated at the factory and the adjustments are sealed.

A throttle stop screw is provided for adjusting the “closed” position of the throttle plate to obtain proper governor response when loads are being disconnected. To adjust the throttle stop screw:

1. Connect a frequency meter and start and run the generator set for 10 minutes at 3/4-rated load until it has warmed up and is stable.
2. Disconnect all loads. Pull the governor linkage gently towards the front of the generator set so that the tang on the throttle lever bears against the throttle (idle) stop screw. Adjust the stop screw to obtain a frequency of 44-46 Hz for 60 Hz generator sets (29-31 Hz for 50 Hz generator sets). (If the adjustment takes longer than 30 seconds the controller may shut down the generator set and display Fault Code No. 15. Simply restart the generator set and resume adjustments.)

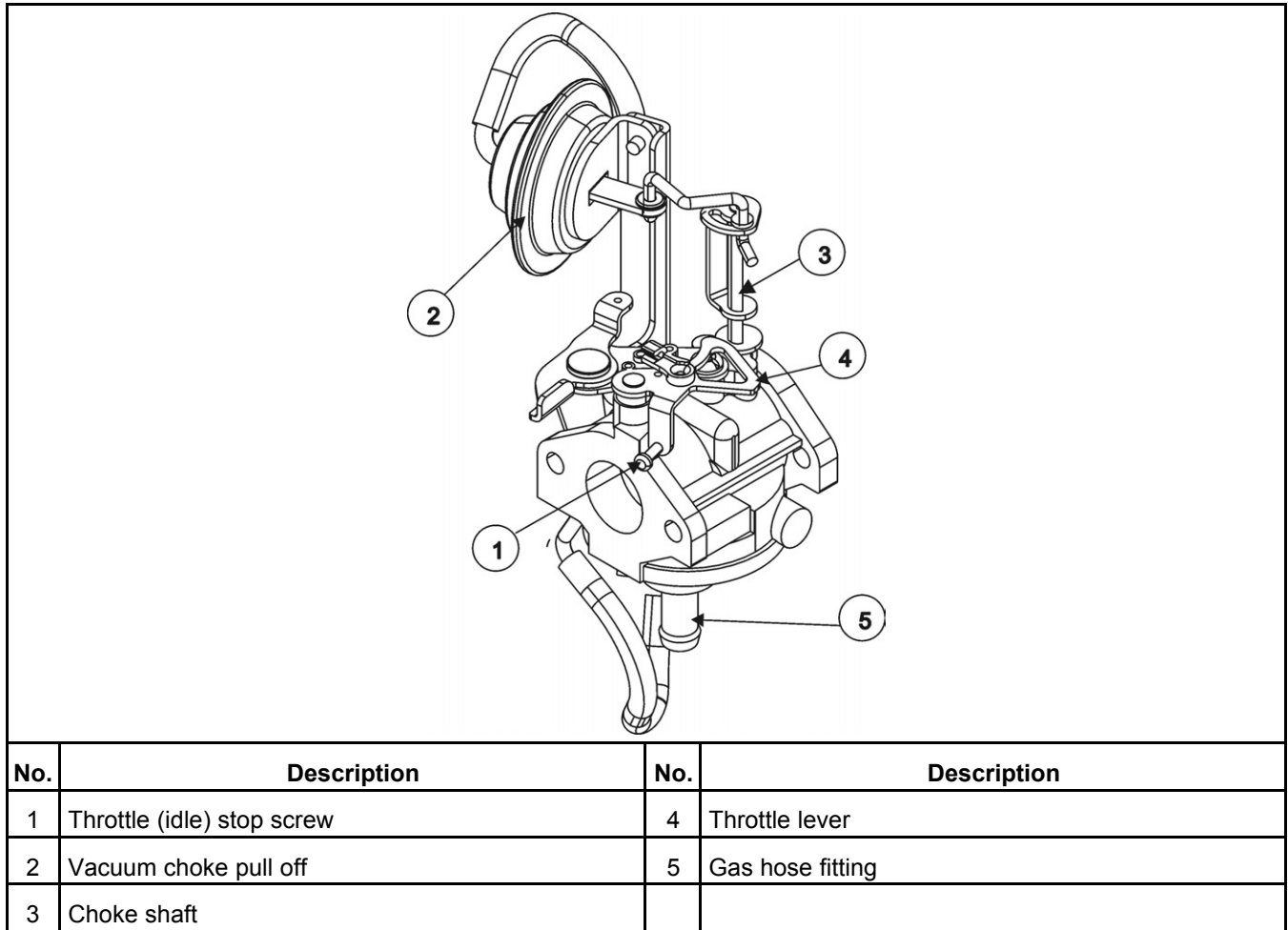


FIGURE 33. LPG CARBURETOR

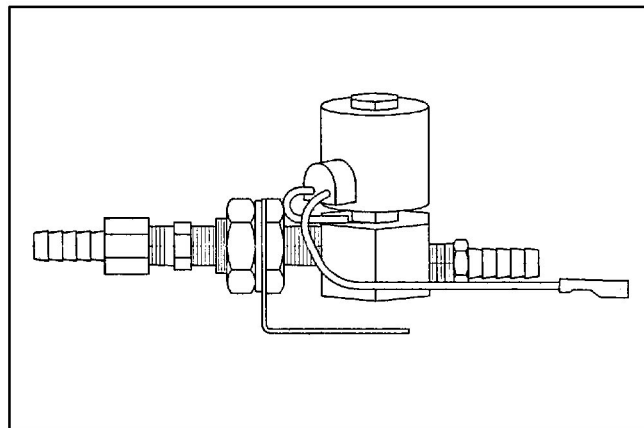


FIGURE 34. FUEL SOLENOID VALVE

5.3.9 Electric Starter

A 12-volt electric starter with a negative ground is used for cranking the engine. The starter has an inertial engagement system.

5.3.9.1 Starter Voltage Check

Before removing the starter for service, perform the following starter check to make sure the starter is getting voltage from the control circuit.

1. Connect a voltmeter between the output terminal on the start relay (opposite the BAT terminal with the starter motor lead connected) and ground.
2. Press the start switch. If there is approximately 12 VDC but the starter does not crank, the starter is defective or the engine is binding. Go to Starter Disassembly. If there is no voltage, check battery, start solenoid and control wiring.

5.3.9.2 Starter Disassembly

1. Disconnect the grounding cable from the battery.
2. Disconnect the wire leading from the key switch "ST" terminal to the magnetic switch.
3. Disconnect the wire that connects the positive terminal of the battery to the magnetic switch.
4. Remove the air cleaner.
5. Remove the carburetor/mixer.
6. Remove the air duct/shroud.
7. Remove the engine flywheel/fan.
8. Remove the electric starter.

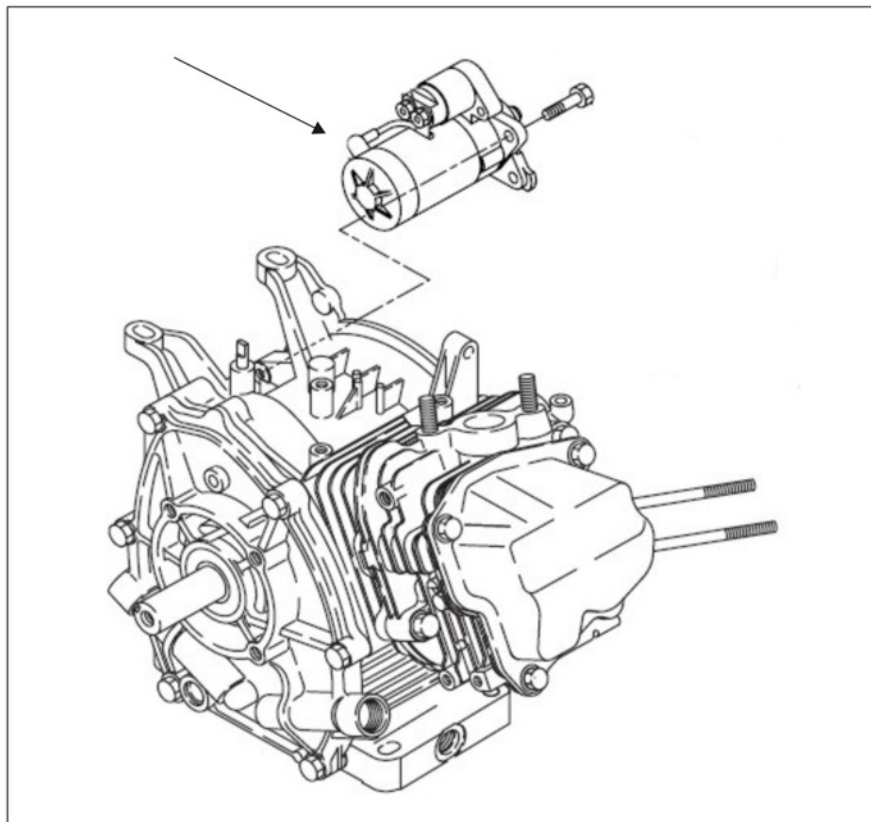


FIGURE 35. ELECTRIC STARTER

5.3.9.3 Starter Reassembly

1. Assemble the electric starter by performing disassembly steps in reverse order.

2. Torque to 2.9 lb-ft (4.0 Nm)

5.4 Engine Block Assembly

5.4.1 Introduction

This section covers service procedures for the engine block assembly. A leak down test can be performed to determine the condition of the engine.

Performing any major service will require generator set removal from the vehicle. See [Chapter 4](#). To gain access to the engine block assembly, the generator and primary engine systems must be removed. Refer to the previous sections for the disassembly procedures.

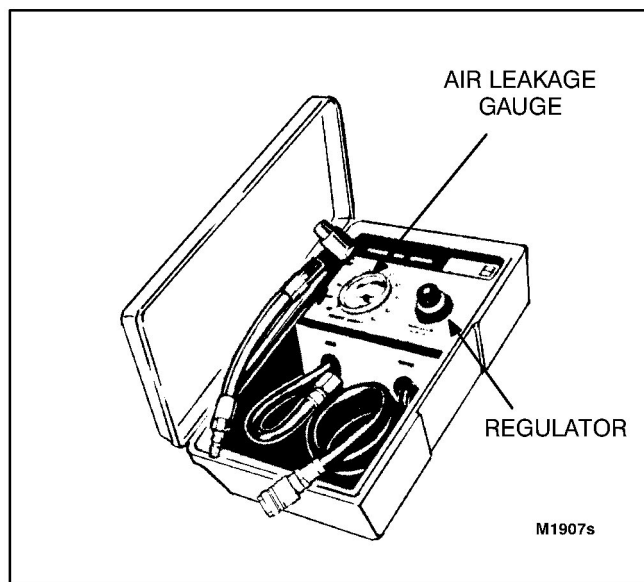
5.4.2 Leak Down Test

Perform the leak down test if performance problems or high oil consumption occur and poor compression is suspected. Follow each of these steps and refer to the test equipment manufacturer's instructions. A typical tester is shown in [Figure 36](#).

1. Start the engine and allow it to warm up for ten minutes. If the engine will not start, continue to the next step.
2. Disconnect the battery negative (-) cable to prevent accidental starting and remove the spark plug.
3. Manually rotate the engine in the direction of normal operation by turning the fan hub assembly. Stop turning the engine when it reaches top dead center (TDC) on the compression stroke. TDC can be determined by:
 - a. Removing the head cover and observing the valve overlap on the compression stroke.
 - b. Feeling compression air escaping the spark plug hole.
 - c. Using a tester with a TDC indicator feature.
4. Connect the tester to shop air and set calibration. Perform the leak down test according to the manufacturer's instructions. Secure the fan wheel to prevent the piston from moving during this test.
5. Screw the air fitting into the spark plug hole. Attach plug fitting to tester.
6. The tester needle indicates the percentage of cylinder leakdown. The following describes the general condition of the engine:
 - 0-10 Percent leak down—Excellent
 - 10-20 Percent leak down—Normal
 - 20-30 Percent leak down—Service limit
7. If leakage is greater than 30 percent, the engine could need major service work. With the tester still connected, listen for air leakage at the points listed in [Table 12](#) and note probable cause of the engine problem.

TABLE 12. LEAK DOWN CHECK POINTS

AIR LEAKAGE AT:	PROBABLE CAUSE
Dipstick hole or Breather valve	<ol style="list-style-type: none"> 1. Broken Ring 2. Worn cylinder bore/rings
Carburetor throat	<ol style="list-style-type: none"> 1. Intake valve stuck 2. Broken intake valve 3. Damaged intake valve seat
Muffler/Exhaust pipe outlet	<ol style="list-style-type: none"> 1. Exhaust valve stuck open 2. Damaged exhaust valve 3. Damaged exhaust valve seat

**FIGURE 36. TYPICAL LEAK DOWN TESTER**

5.4.3 Ignition Coil

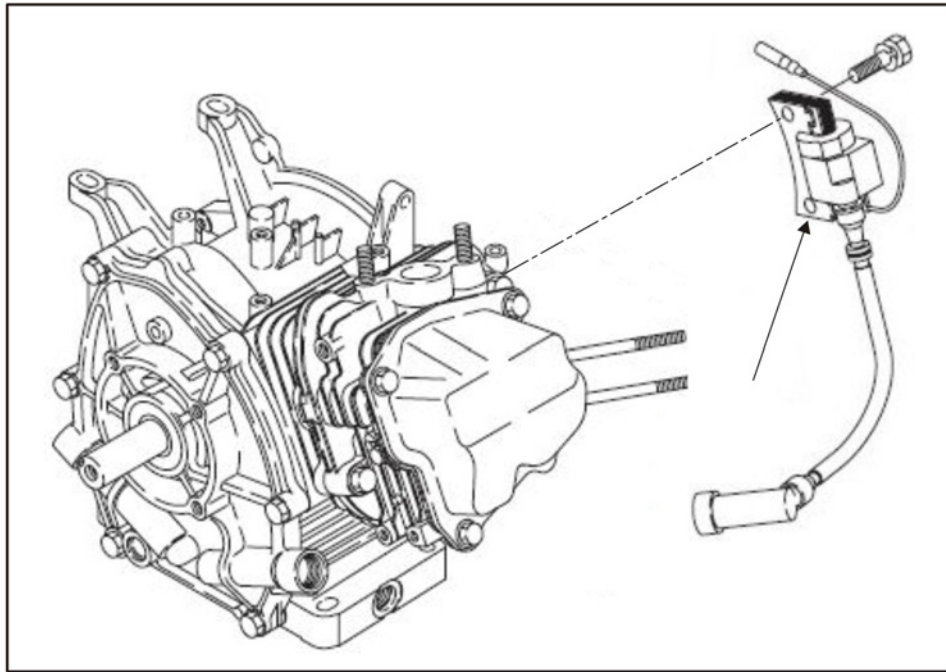


FIGURE 37. IGNITION COIL

5.4.3.1 Disassembly

Remove the spark plug cap from the spark plug and remove the ignition coil from the crankcase.

5.4.3.2 Assembly

1. Insert a thickness gauge between the ignition coil and the flywheel to check the air gap. Air gap should be 0.3–0.5mm (0.019–0.0197 in).
2. Tighten to 7.0–9.0 Nm (5.1–6.5 ft-lb).

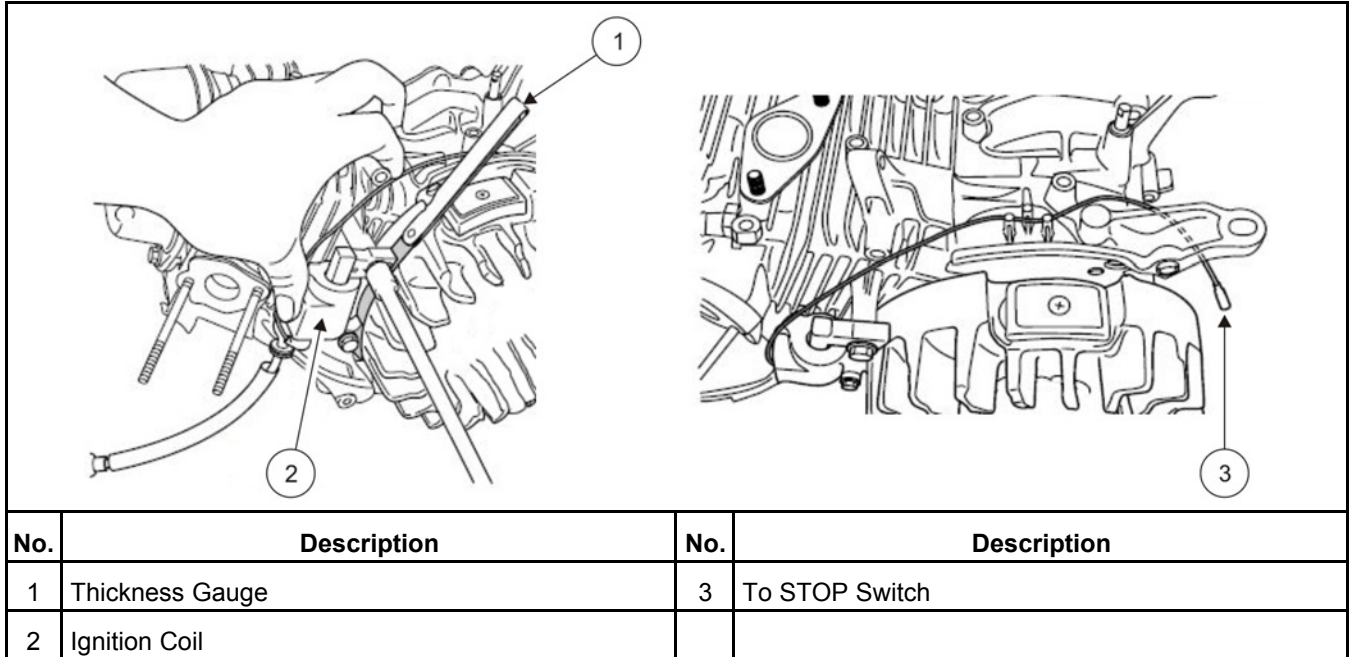


FIGURE 38. IGNITION COIL ASSEMBLY

5.4.4 Flywheel

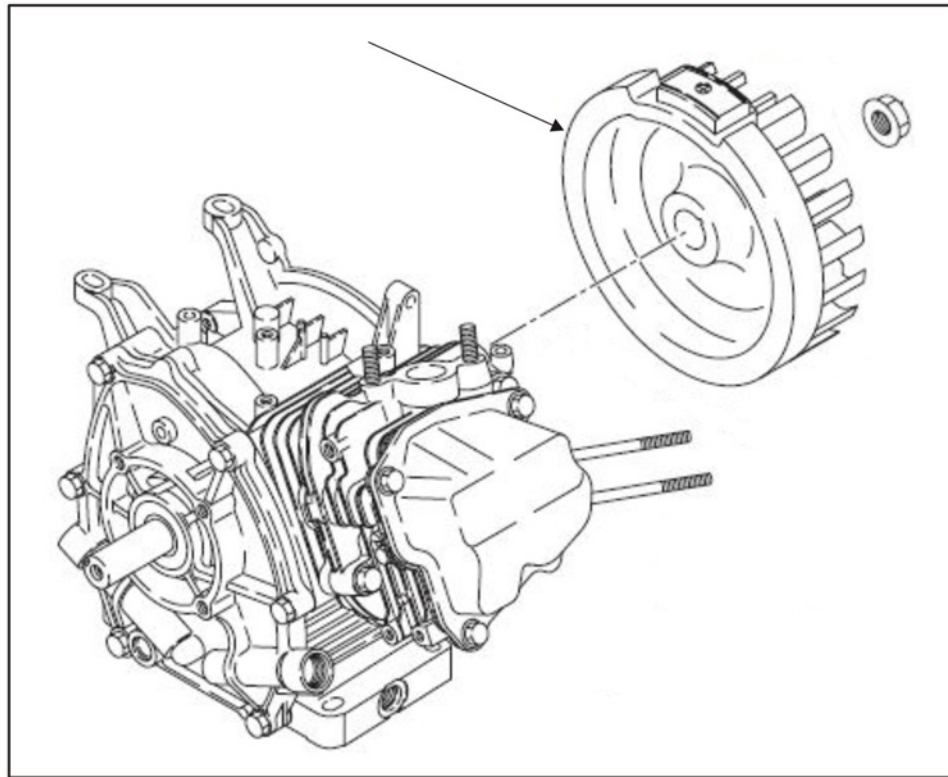
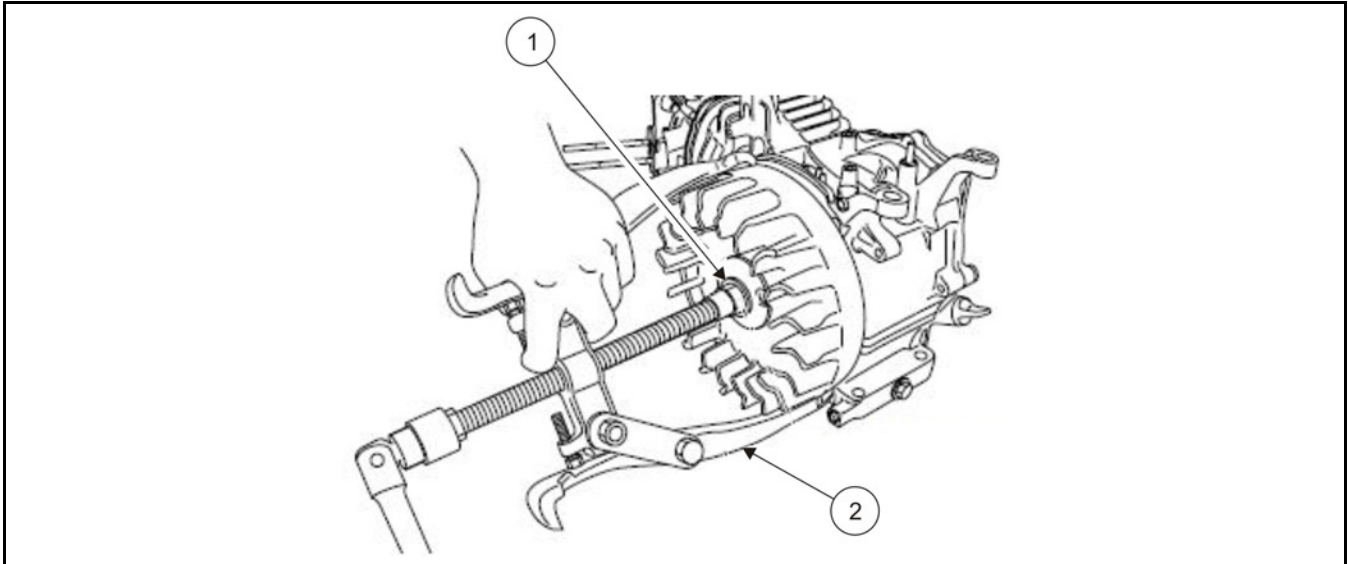


FIGURE 39. FLYWHEEL

5.4.4.1 Disassembly

Fit a box wrench or a socket wrench on the flywheel nut and loosen the nut by knocking the wrench sharply with a hammer in a counter clockwise direction.



No.	Description	No.	Description
1	Attach Nut Temporarily	2	Flywheel Puller

FIGURE 40. FLYWHEEL REMOVAL

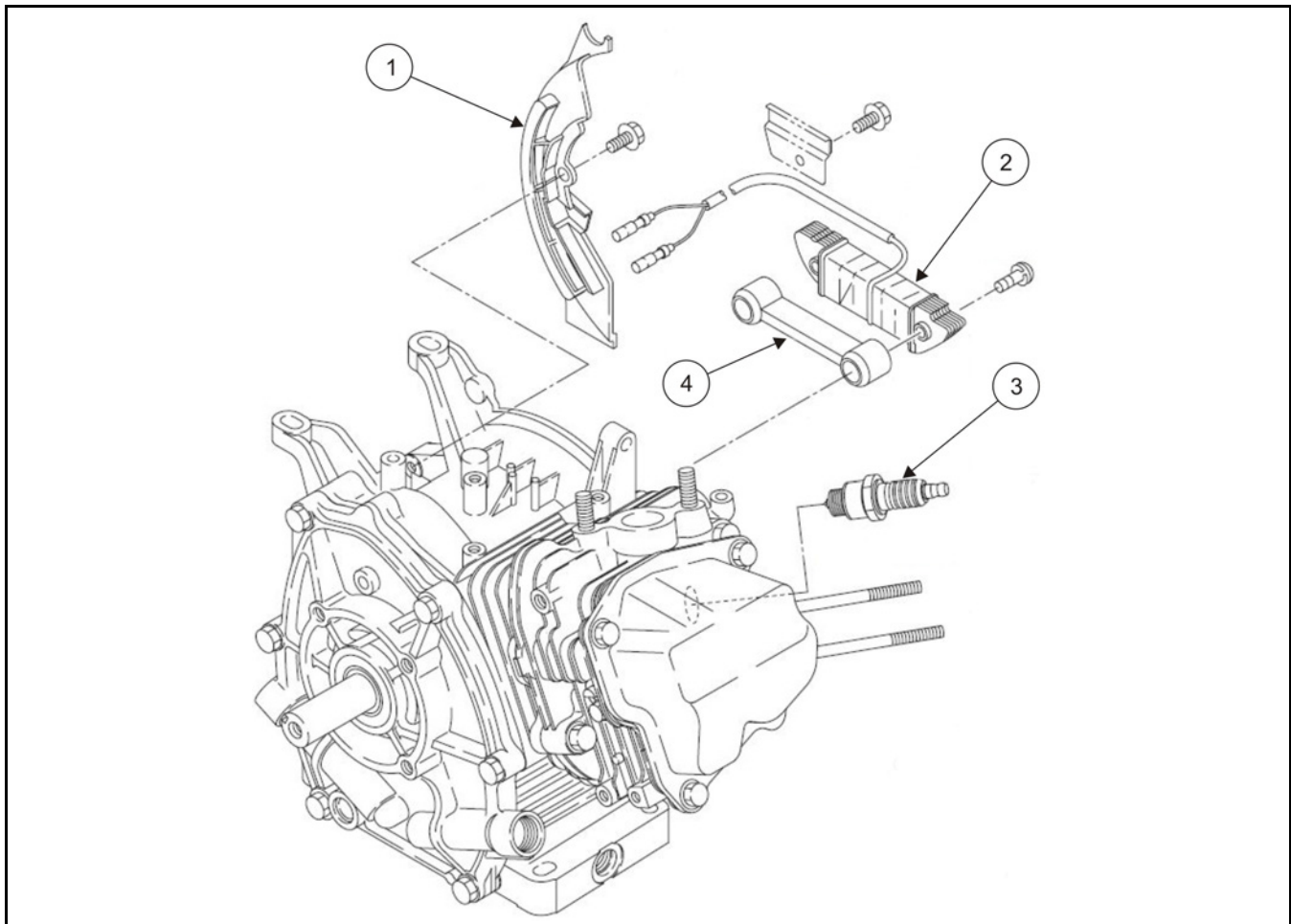
5.4.4.2 Assembly

1. Mount the flywheel on the crankshaft.

NOTICE
When mounting the flywheel, be sure to wipe off any oil on the tapered portion of the crankshaft and flywheel.

2. Tighten the flywheel to 59–64 Nm (42.7–46.3 ft-lb).

5.4.5 Spark Plug, Charge Coil, and Baffle 1 (Case)



No.	Description	No.	Description
1	Baffle 1 (Case)	3	Spark Plug
2	Charge Coil (if equipped)	4	Spacer (if equipped)

FIGURE 41. SPARK PLUG, CHARGE COIL, AND BAFFLE 1 (CASE)

5.4.5.1 Disassembly

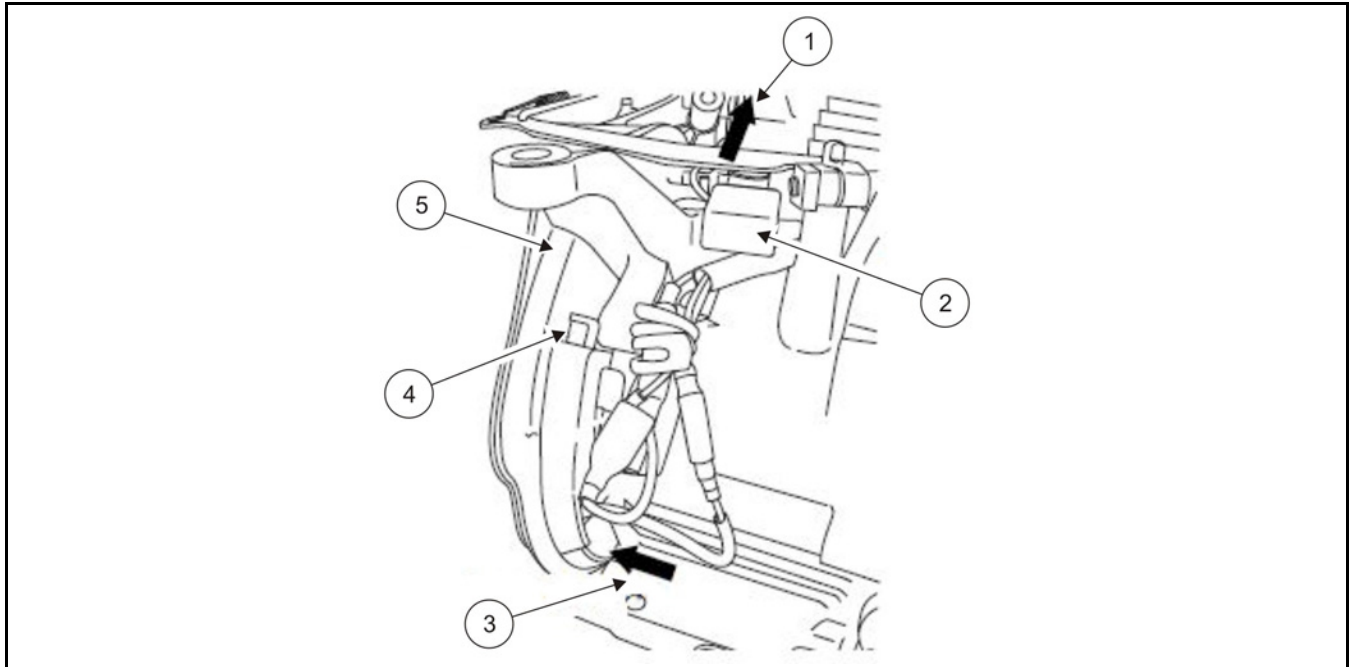
1. Remove the baffle 1 (case).
2. Remove the charge coil (if equipped).
3. Remove the spark plug from the cylinder head.

5.4.5.2 Assembly

1. Remove any carbon deposits from the spark plug and inspect the electrode for damage before mounting and replace if necessary. Electrode gap should be 0.6mm–0.7mm (0.024–0.028 in).
2. Tighten to:

New Spark Plug	Retighten Existing Spark Plug
12–15 Nm (8.7–10.8 ft-lb)	23–27 Nm (16.6–19.5 ft-lb)

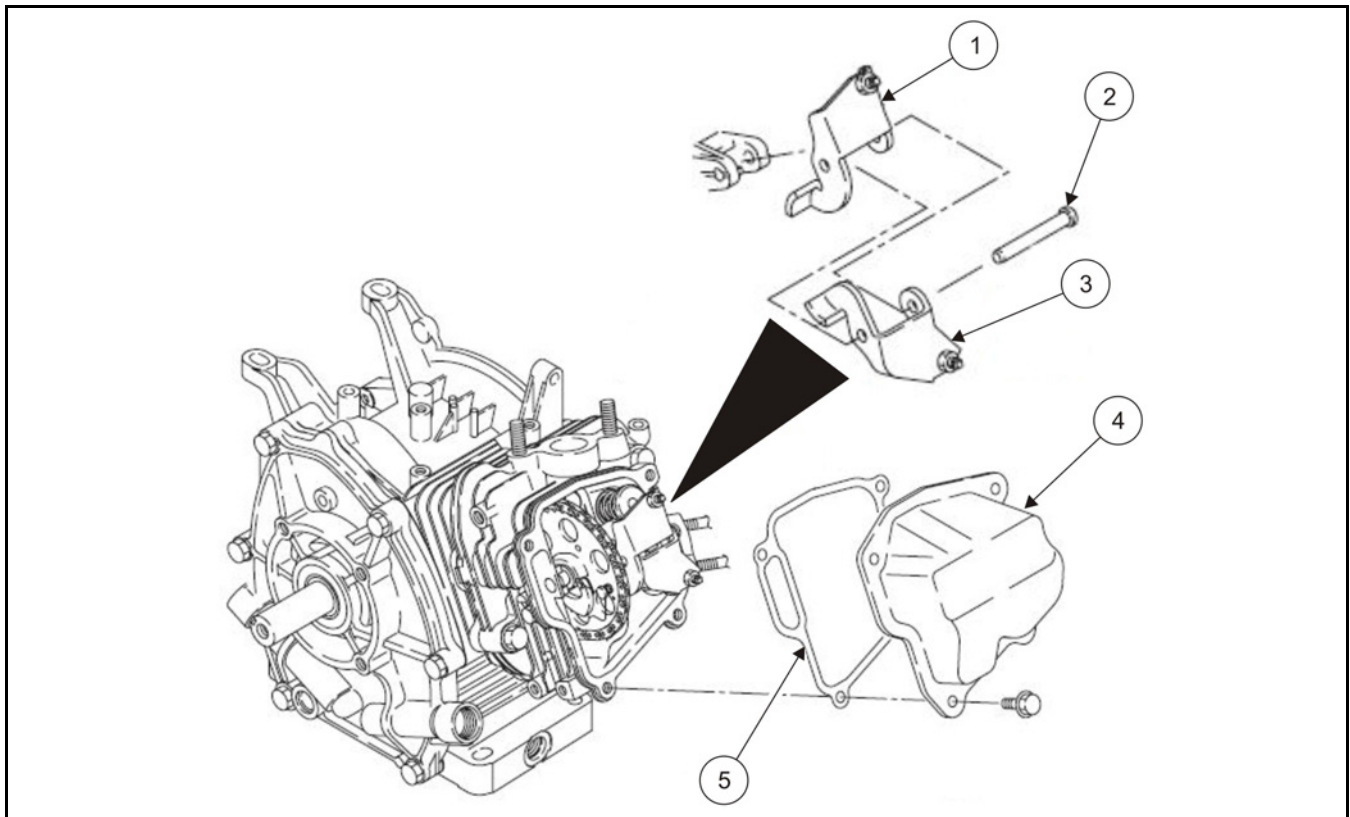
3. Replace charge coil.
4. Align the top and bottom of the baffle 1 (case) with the crankcase and mount it with the bolts. Tighten to 4 Nm (2.9 ft-lb).



No.	Description	No.	Description
1	To Ignition Coil	4	Hook
2	Oil Sensor Unit	5	Baffle 1 (Case)
3	To Oil Sensor		

FIGURE 42. BAFFLE 1 (CASE) ALIGNMENT

5.4.6 Rocker Cover and Rocker Arm



No.	Description	No.	Description
1	Rocker Arm (Exhaust Valve Side)	4	Rocker Cover
2	Rocker Arm Pin	5	Rocker Cover Gasket
3	Rocker Arm (Intake Valve Side)		

FIGURE 43. ROCKER COVER AND ROCKER ARM

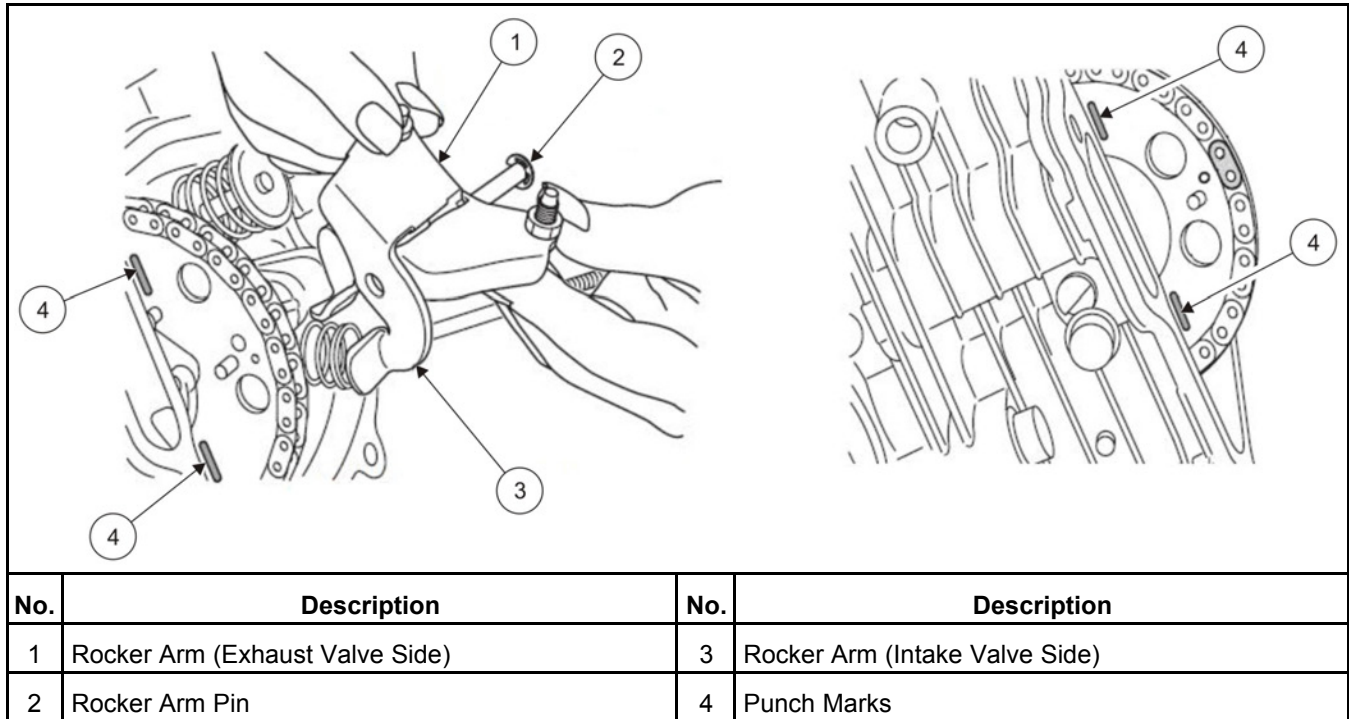


FIGURE 44. POSITION OF COMPRESSION TOP DEAD CENTER

5.4.6.1 Rocker Cover Disassembly and Assembly

To disassembly the rocker cover:

1. Remove the rocker cover from the cylinder head.
2. Remove the rocker cover gasket.

To assembly the rocker cover, replace the gasket with a new one and mount the rocker cover. Tighten to 5–7 Nm (–5.1 ft-lb).

5.4.6.2 Valve Clearance Adjustment

1. Temporarily fit the flywheel.
2. Rotate the crankshaft up to the compression top dead center and insert the thickness gauge between the valve and the adjusting screw of the rocker arm to measure the clearance.

Intake Valve Side Clearance	Exhaust Valve Side Clearance
0.12 ^{+0.03} mm (0.0047 ^{+0.0012} in)	0.12 ^{+0.03} mm (0.0047 ^{+0.0012} in)

3. Loosen the nut on the adjustment screw and turn the screw to adjust the valve clearance.
4. When the valve clearance is correct, tighten the nut to 5–7 Nm (3.6–5.1 ft-lb).

NOTICE

After adjusting the valve clearances, rotate the crankshaft and check again that the intake and exhaust valve clearances are correct.

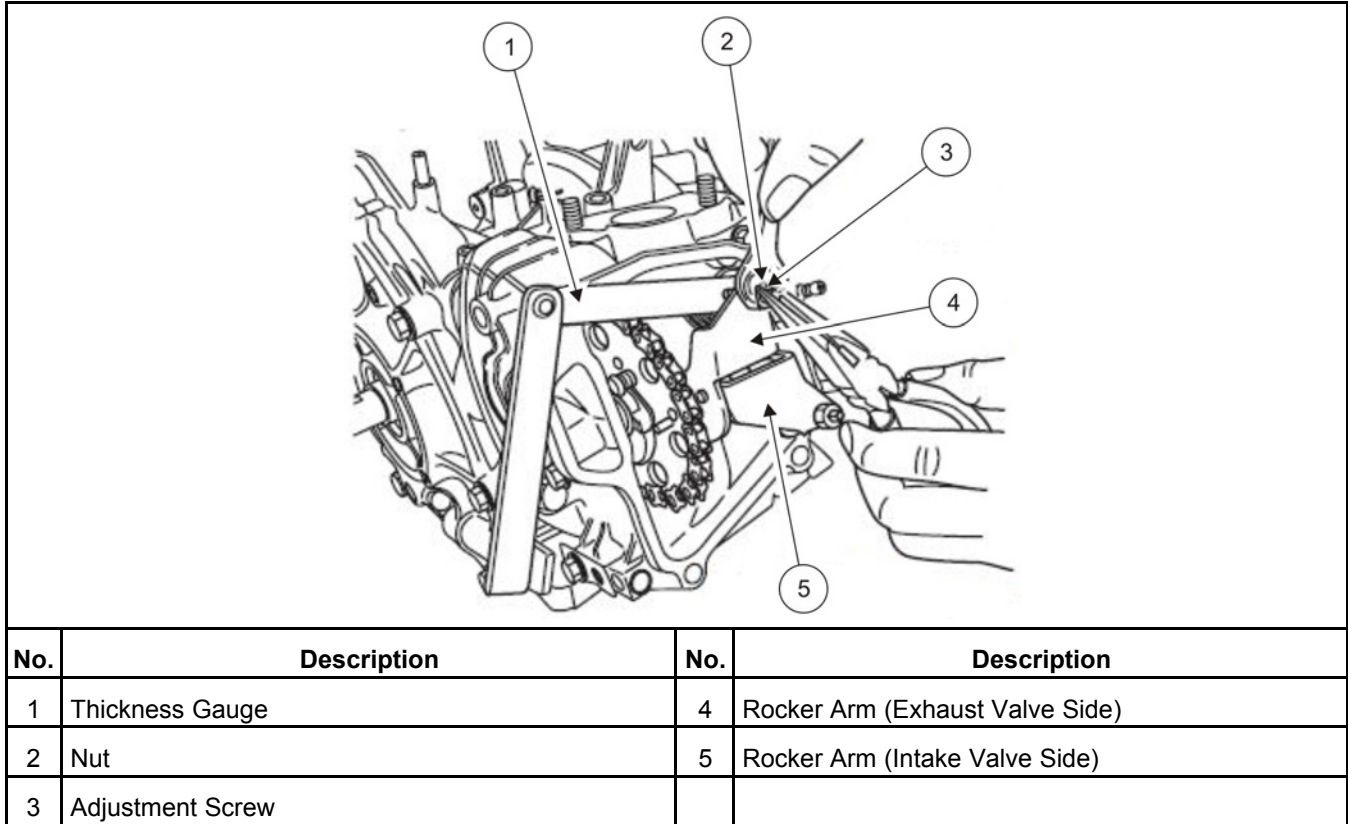


FIGURE 45. VALVE CLEARANCE ADJUSTMENT

5.4.6.3 Rocker Arm Assembly

At the compression top dead center, pass the rocker arm pin through the rocker arm and mount them on the cylinder head.

NOTICE
<p>The position of two punch marks on the cam sprocket is in parallel with the cylinder head surface at the time. Make sure that the piston is at the compression top dead center by checking mutual position between the flywheel and the ignition coil or by checking that the key way is at the top.</p>

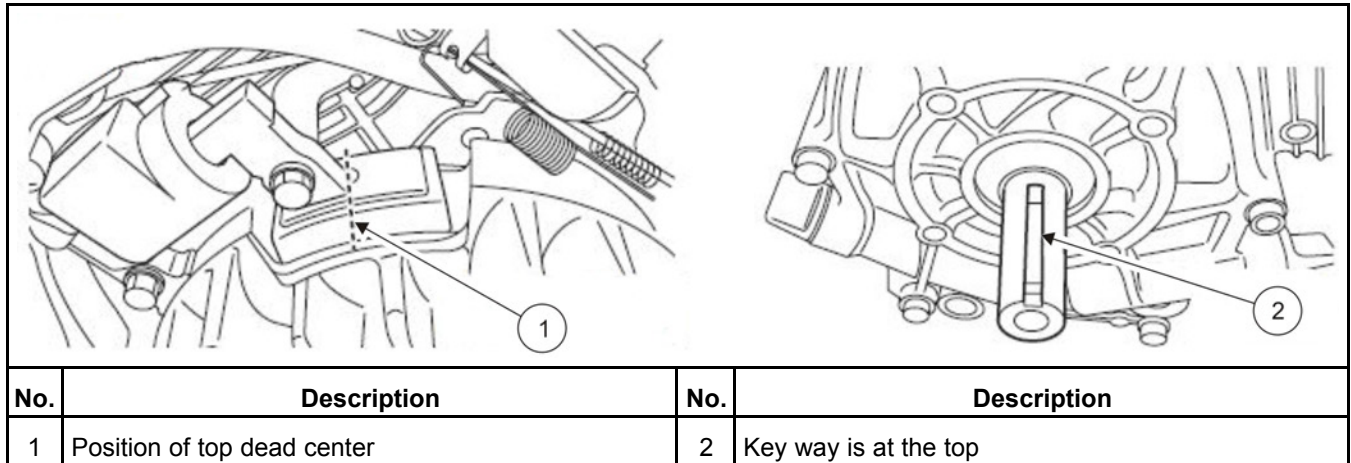


FIGURE 46. ROCKER ARM ASSEMBLY

5.4.7 Main Bearing Cover

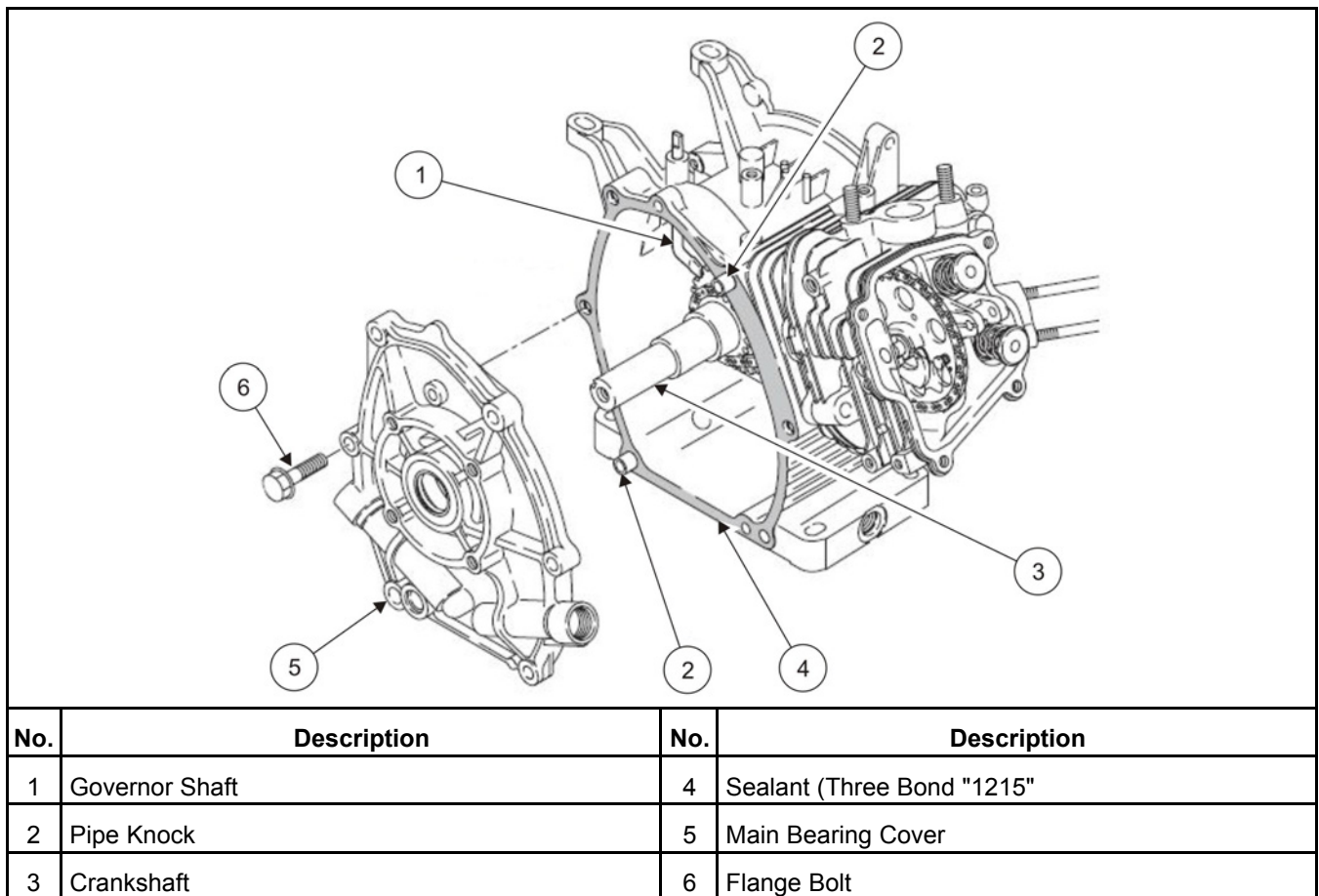


FIGURE 47. MAIN BEARING COVER

5.4.7.1 Disassembly

1. Remove the flange bolts of the main bearing cover from the crankcase.

2. Remove the main bearing cover while tapping gently around the cover using a plastic hammer or similar tool.

NOTICE

Be careful not to damage the oil gauge or oil seal, and not to lose the pipe knocks.

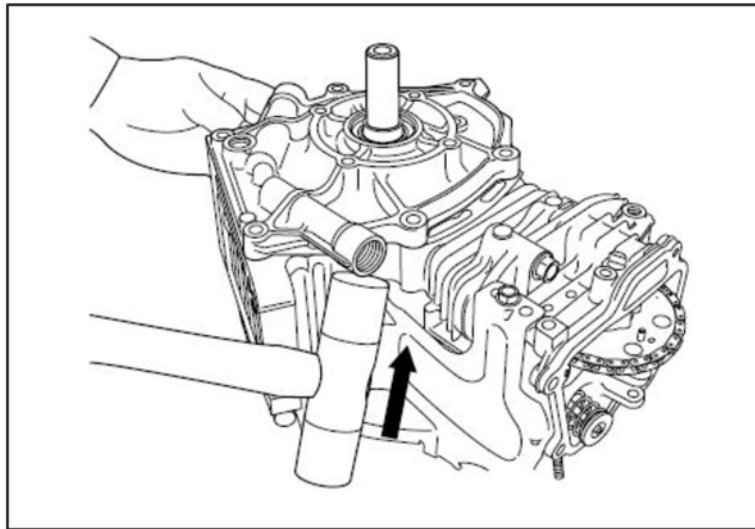


FIGURE 48. MAIN BEARING COVER REMOVAL

5.4.7.2 Assembly

1. Apply oil to the bearing and the oil seal lip before mounting the main bearing cover.
2. Apply sealant (Three Bond "1215") to the surface of the crankcase.
3. Wrap the crankshaft key-way portion with polyvinyl tape before mounting the main bearing cover.

NOTICE

Be careful that the lever portion of the governor shaft does not face the main bearing cover.

4. Tighten the flange bolts to 22–24 Nm (16.2–17.7 ft-lb).

5.4.8 Camshaft and Tensioner

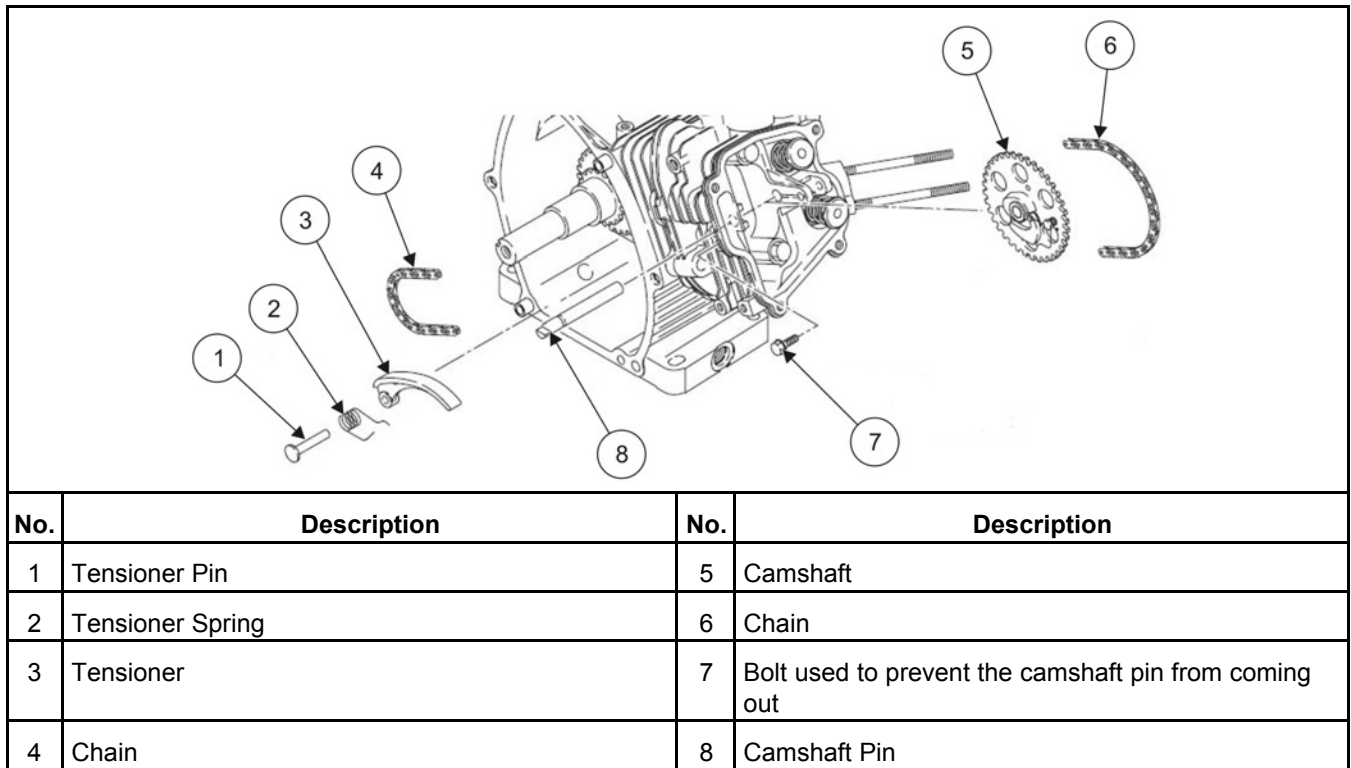


FIGURE 49. CAMSHAFT AND TENSIONER

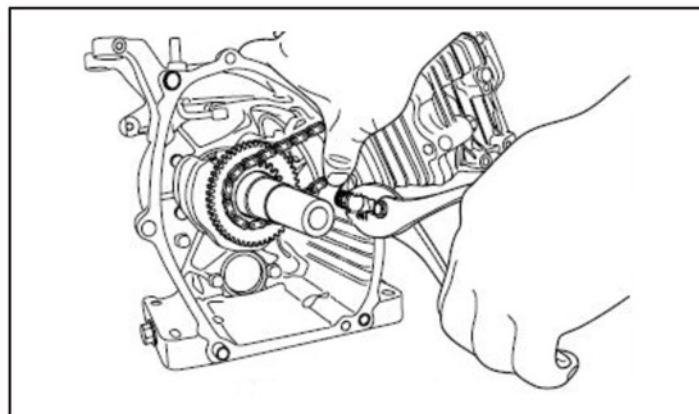


FIGURE 50. TENSIONER PIN

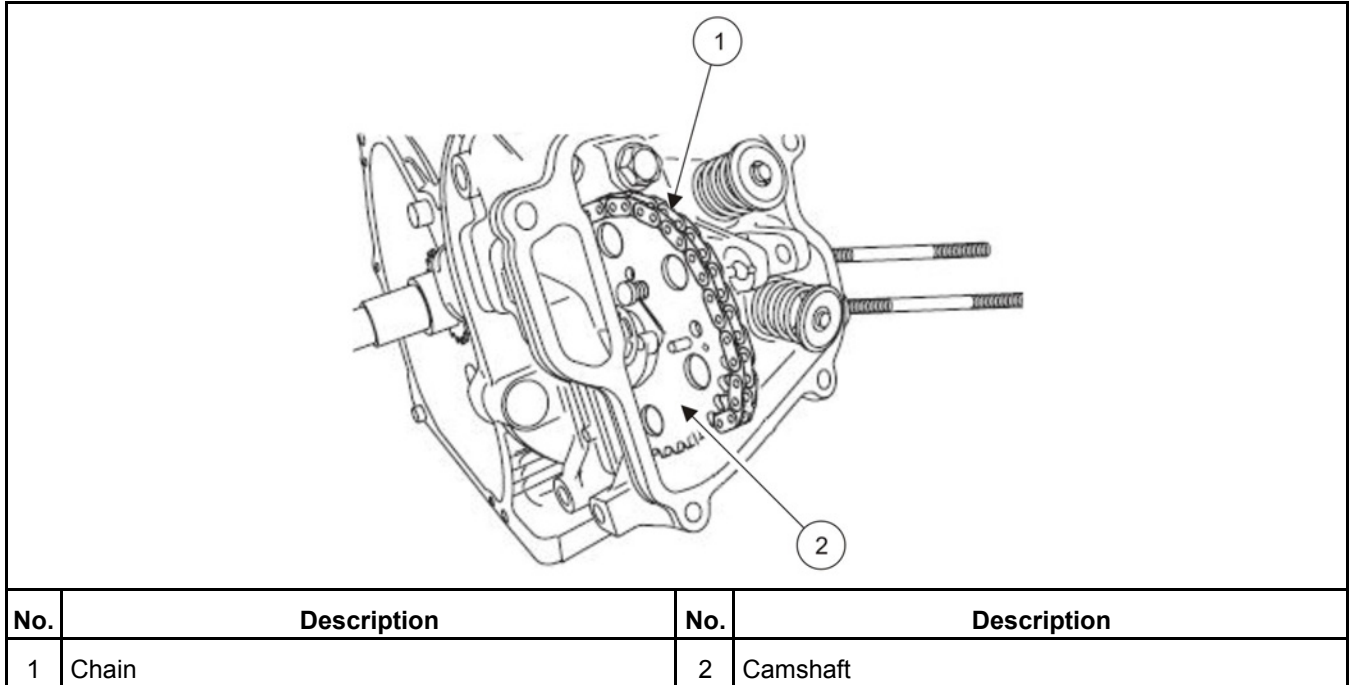


FIGURE 51. CAMSHAFT AND TENSIONER

5.4.8.1 Disassembly

1. Remove the tensioner.

NOTICE
Do not lose the tensioner pin.

2. Remove the retaining bolt of the camshaft pin from the cylinder head.

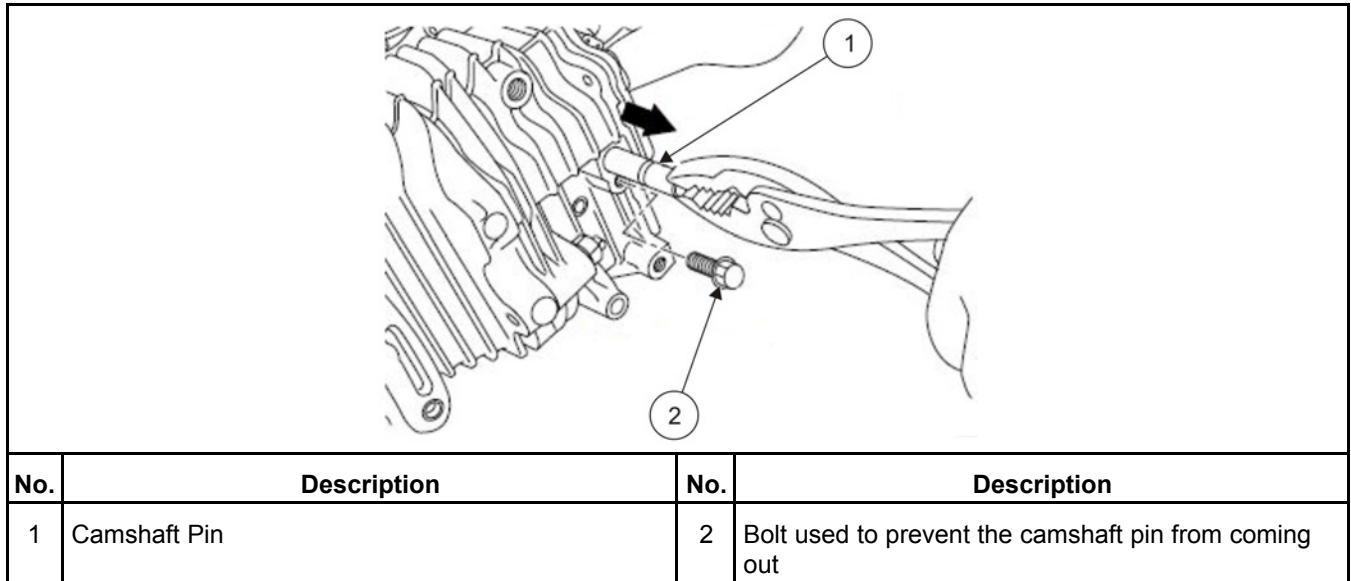


FIGURE 52. CAMSHAFT PIN REMOVAL

3. Remove the camshaft pin, taking care not to scratch the o-ring.
4. Remove the chain from the camshaft sprocket and remove the camshaft.
5. Remove the chain from the crankshaft.

5.4.8.2 Assembly

1. Mount the camshaft on the cylinder head by inserting the camshaft pin through the head.
2. Fix the bolt to prevent the camshaft pin from coming out.

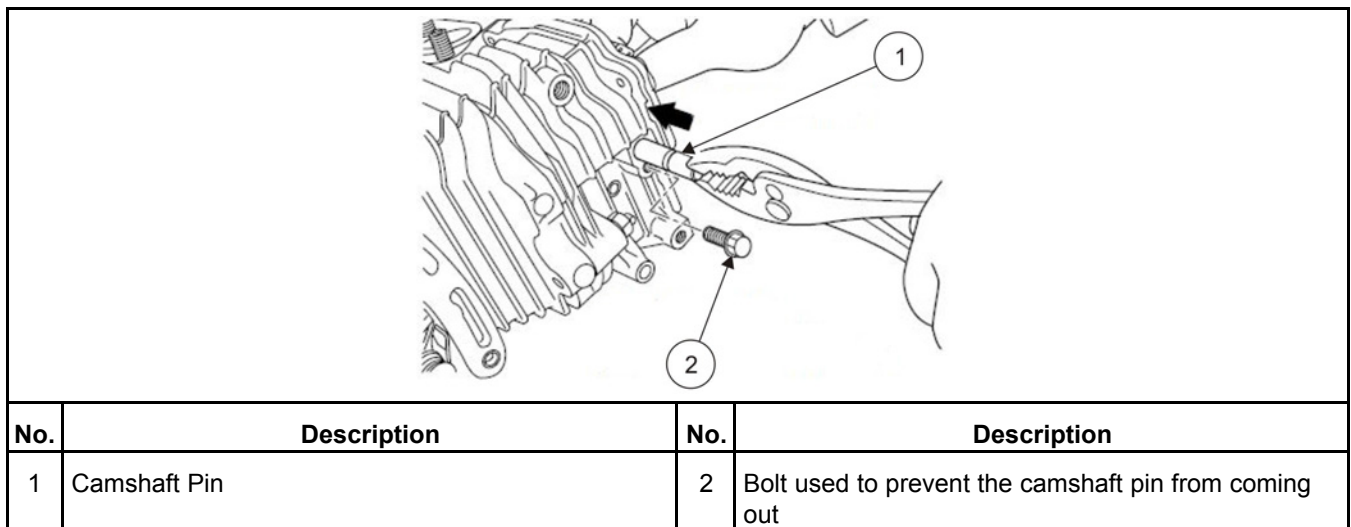


FIGURE 53. CAMSHAFT PIN ASSEMBLY

3. Mount the tensioner.

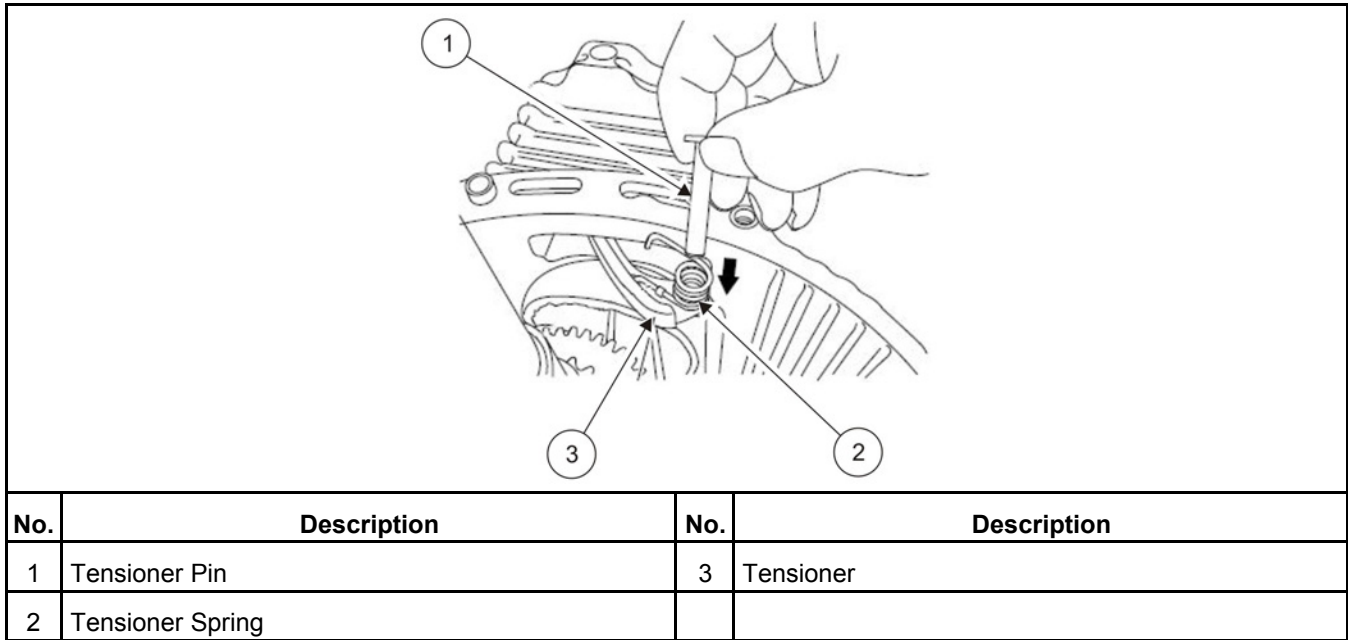


FIGURE 54. CAMSHAFT PIN ASSEMBLY

5.4.9 Cylinder Head and Chain Guide

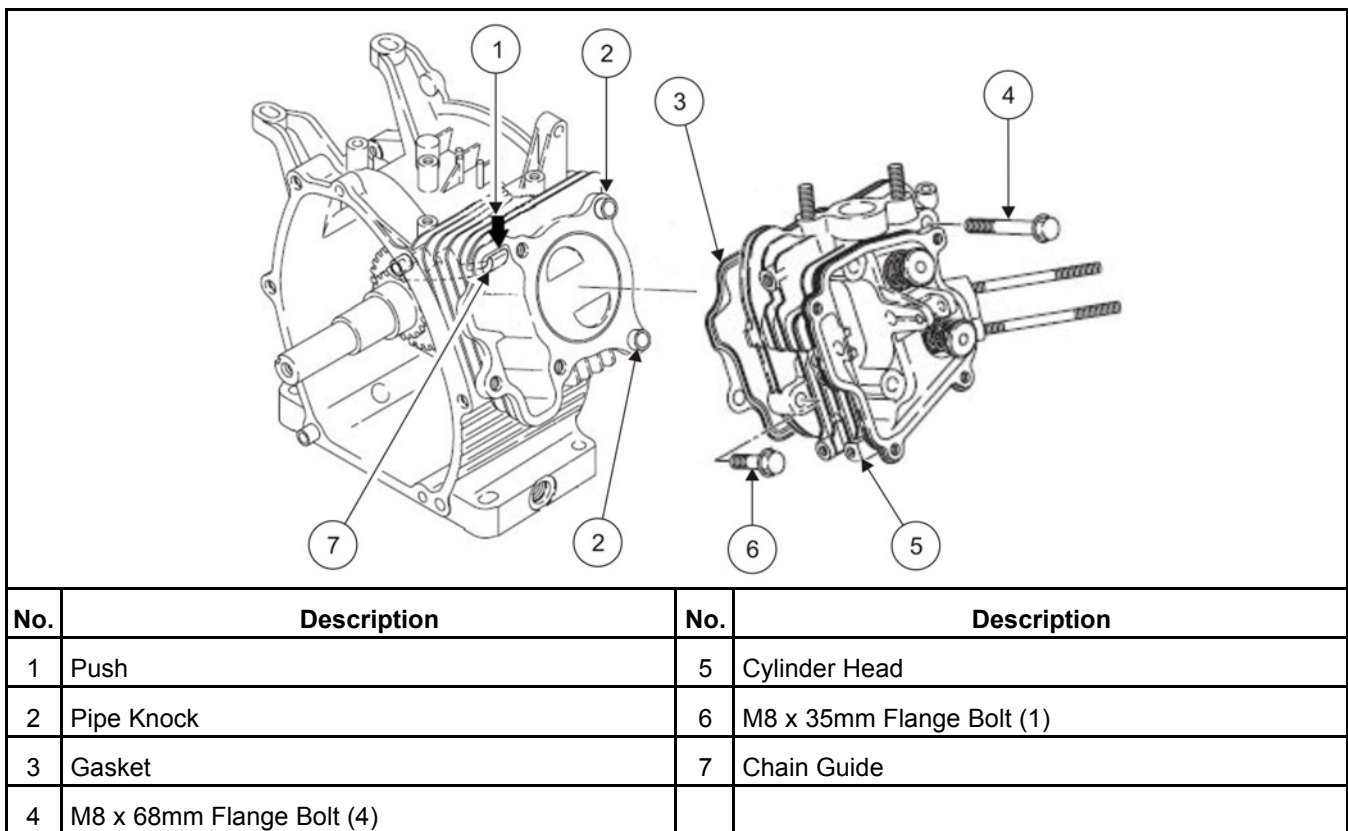


FIGURE 55. CYLINDER HEAD AND CHAIN GUIDE

5.4.9.1 Disassembly

1. Remove the cylinder head from the crankcase.
2. Remove the cylinder head gasket from the cylinder head.

NOTICE

Take care not to lose the pipe knocks.

3. Remove the chain guide from the top side of the crankcase.

NOTICE

Removing the chain guide from the inner side of the crankcase may cause damage.

5.4.9.2 Assembly

1. Mount the chain guide to the crankcase.

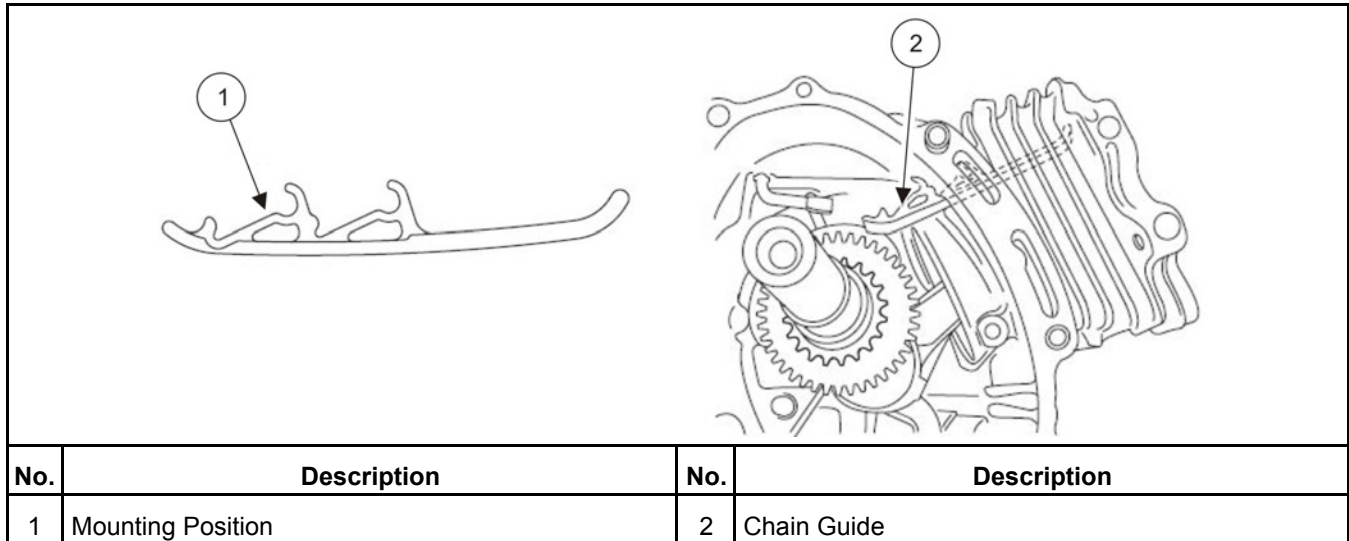
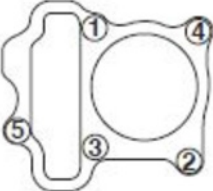


FIGURE 56. CHAIN GUIDE ASSEMBLY

2. Inspect and repair any scratches on the cylinder head mounting surface and replace head gasket with a new one before installing.
3. Install cylinder head.
4. Oil the screw threads and tighten the cylinder head bolts in order as shown. Tighten all bolts to original torque and further tighten the longer bolts (1–4).

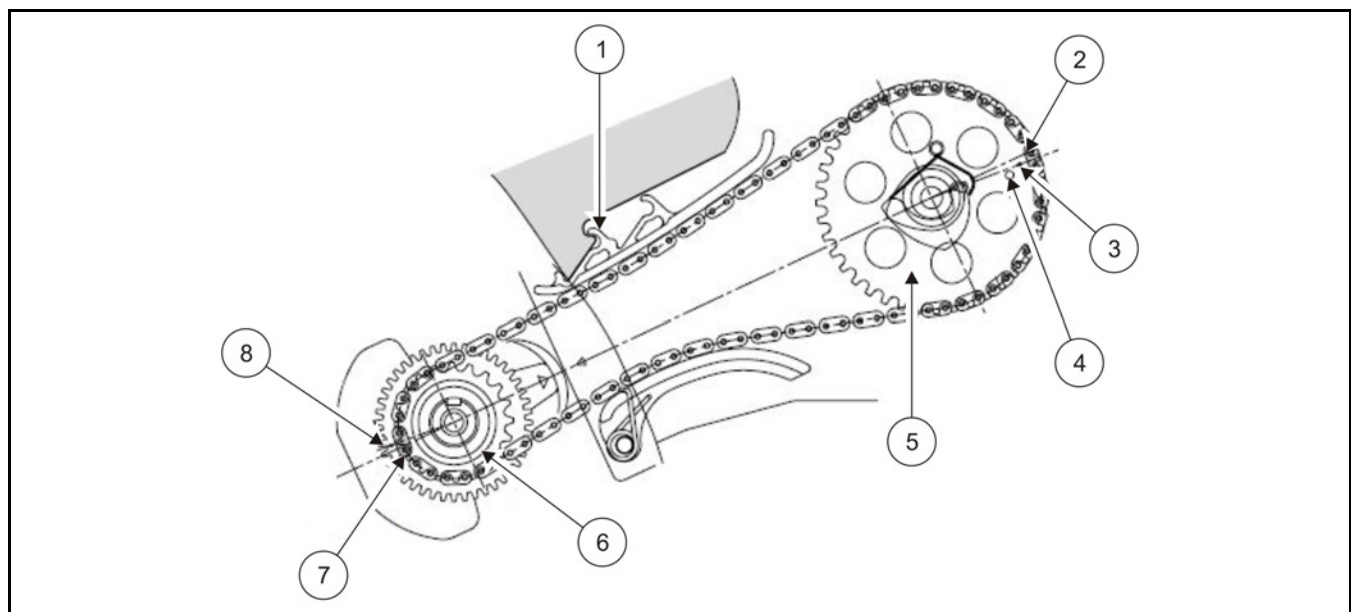
Tightening Order	Original Torque (All)	Bolts 1–4 Torque (Reused)	Bolts 1–4 Torque (New)
	17–19 Nm (12.3–13.7 ft-lb)	25–27 Nm (18.1–19.5 ft-lb)	28–30 Nm (20.3–21.7 ft-lb)

5.4.9.3 Setting the Timing Chain

1. Align the timing mark on the crankshaft sprocket with the mark plate of the timing chain.
2. Align the timing mark on the crankshaft sprocket with the mark plate of the opposite end of the timing chain.

NOTICE

There are 92 oval steel links.



No.	Description	No.	Description
1	Chain Guide Fitting Position	5	Camshaft Sprocket
2	Mark Plate (Does not have a camshaft or crankshaft sprocket side)	6	Crankshaft Sprocket
3	Timing Mark	7	Mark Plate
4	Roll Pin	8	Timing Mark

FIGURE 57. TIMING CHAIN

5.4.10 Intake and Exhaust Valves

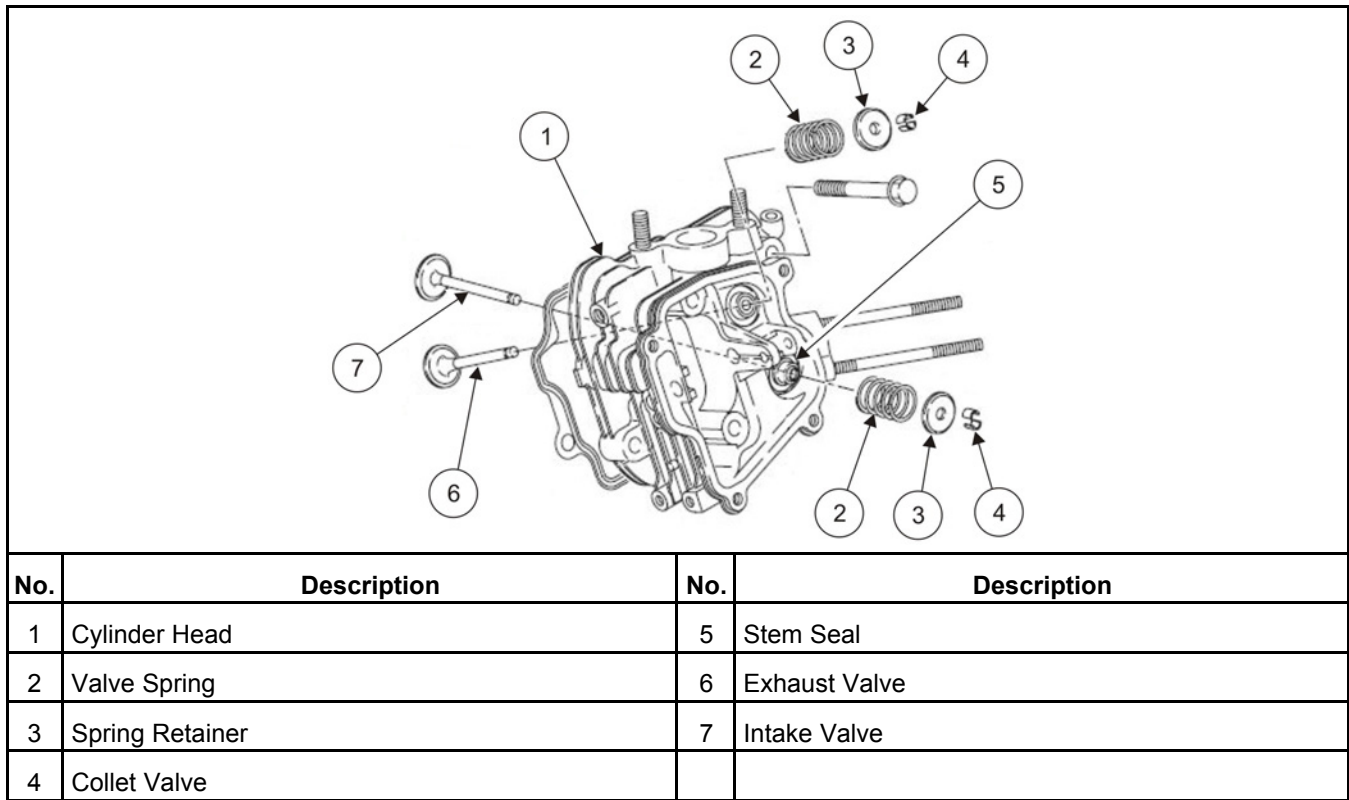


FIGURE 58. INTAKE AND EXHAUST VALVES

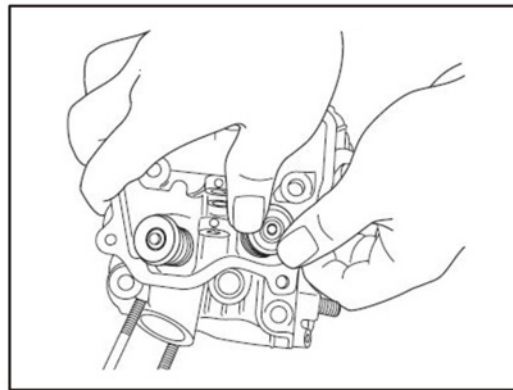


FIGURE 59. COLLET VALVE

5.4.10.1 Disassembly

1. Remove the collet valve from the spring retainer.
2. Remove the intake valve and the exhaust valve.

5.4.10.2 Assembly

1. Replace the valve with a new one if it shows signs of wear (refer to [Section 3.3 on page 12](#)).
2. Carefully scrape off any carbon deposits on the combustion chamber.

3. Apply oil to the valve stems.
4. Insert the valves in the cylinder head and place it on a level workbench.
5. Mount the valve springs, the spring retainers, and collet valves. (Mount the stem seal on the intake valve guide.)

5.4.11 Piston, Piston Rings, and Connecting Rod

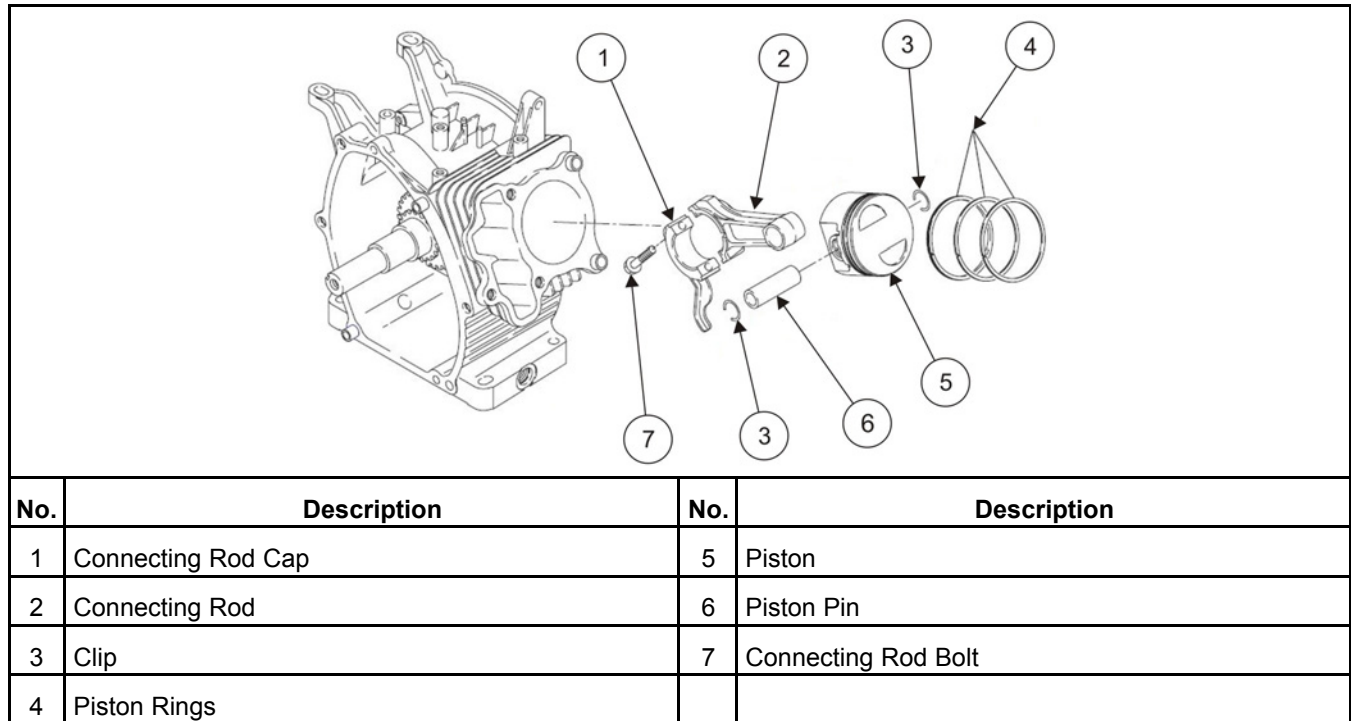


FIGURE 60. PISTON, PISTON RINGS, AND CONNECTING ROD

5.4.11.1 Disassembly

1. Scrape off any carbon from the cylinder and the piston head and remove the connecting rod bolt.
2. Remove the connecting rod cap.
3. Rotate the crankshaft until the piston comes to its top position. Push the connecting rod and remove the piston from the upper part of the cylinder.
4. Remove the piston clips (2).
5. Take out the piston pin and remove the piston from the connecting rod small end, taking care not to damage the connecting rod small end.
6. Remove the piston rings from the piston by spreading them at the gap. Take special care not to damage the rings.

5.4.11.2 Assembly

1. Install each piston ring in the correct groove (oil ring first, followed by second ring, and then top ring) of the piston by widening it enough to slide it over the piston. When installing the second ring, make sure that the 'N' mark is face up.

NOTICE

Be careful not to twist the rings too much to avoid damaging them.

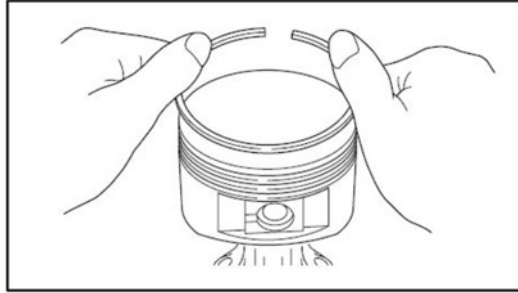


FIGURE 61. PISTON RING ASSEMBLY

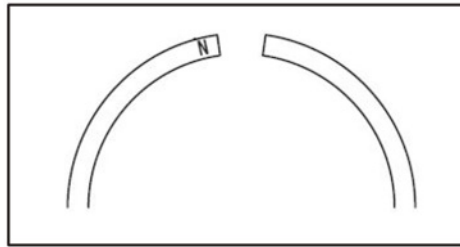


FIGURE 62. PISTON SECOND RING ASSEMBLY

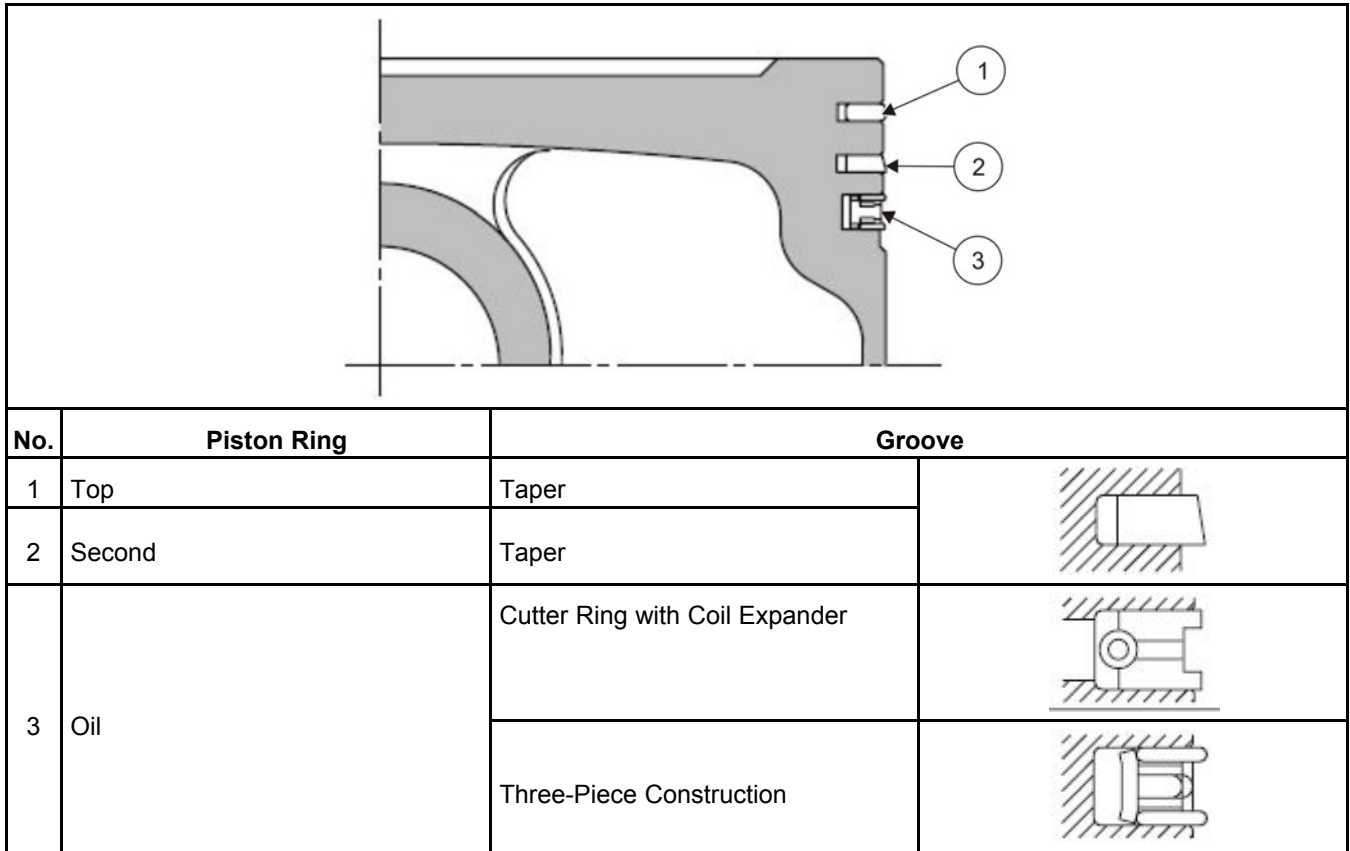


FIGURE 63. PISTON RING GROOVES

2. Apply oil to the small end of the connecting rod.
3. Insert the connecting rod into the piston, making sure to align the mark on the piston head with the 'MAG' mark on the connecting rod.

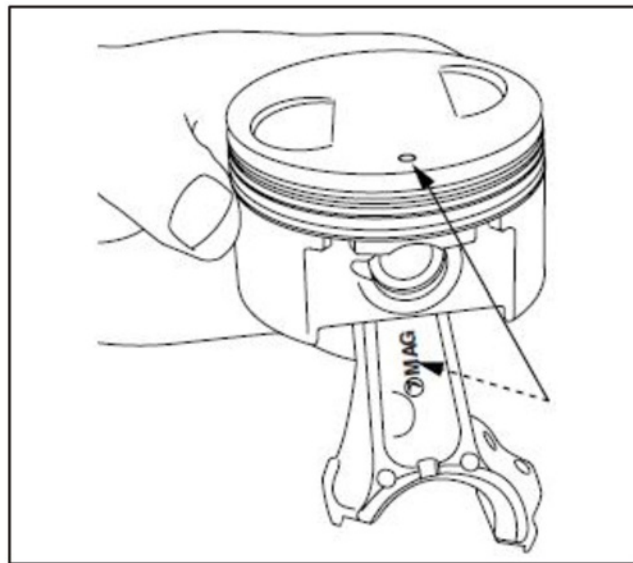


FIGURE 64. PISTON AND CONNECTING ROD ASSEMBLY

4. Insert the piston pin and place clips on each end. Check the clips for any play.

5. Apply oil to the piston rings, the large end of the connecting rod, and cylinder.
6. Install the piston and connecting rod assembly into the cylinder by holding the piston rings with a ring guide, with the 'MAG' mark on the connecting rod on the flywheel side.

NOTICE

If a ring guide is not available, hold the piston rings with the fingers and tap the upper part of the piston with a piece of wood.

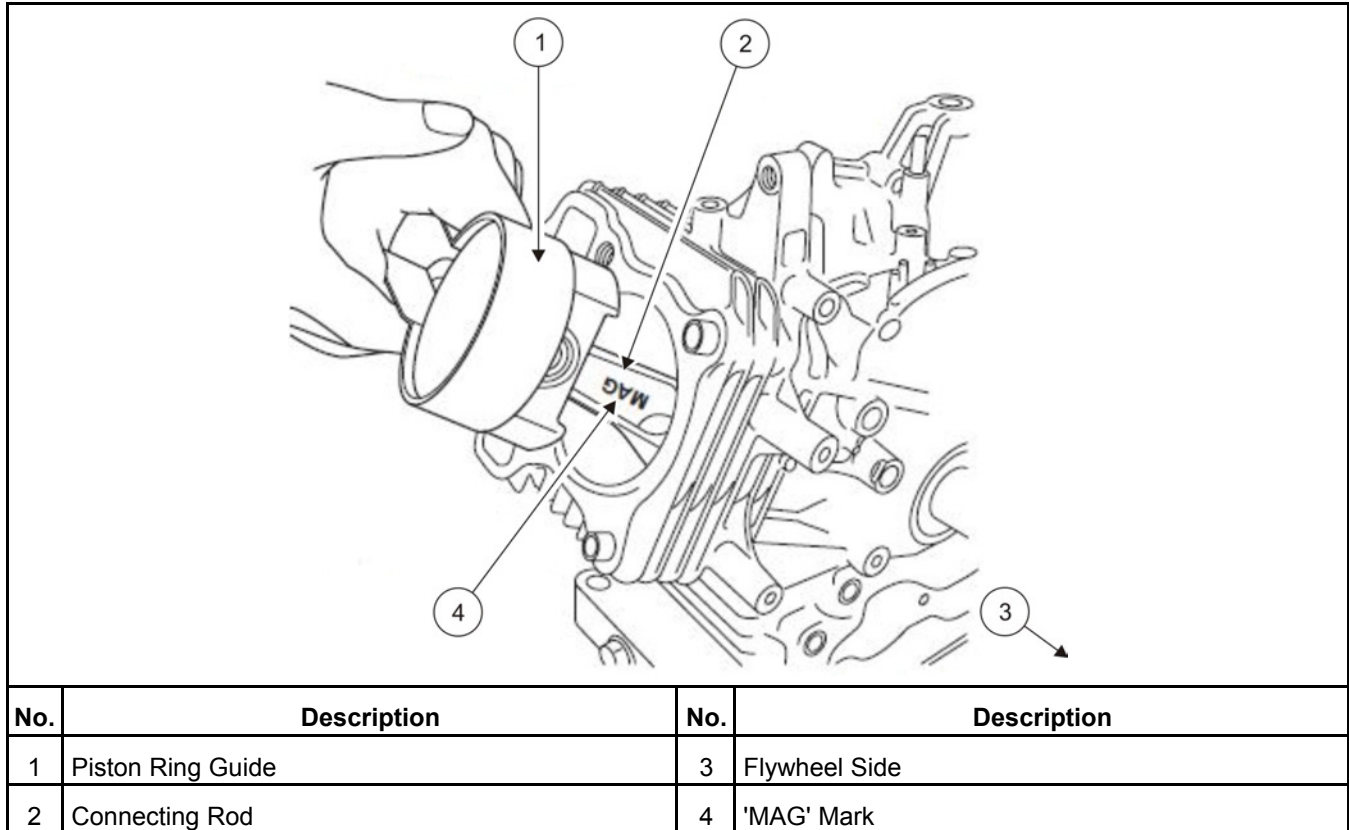


FIGURE 65. CONNECTING ROD ASSEMBLY

NOTICE

The piston ring gaps should be positioned around the piston at 90-degree intervals.

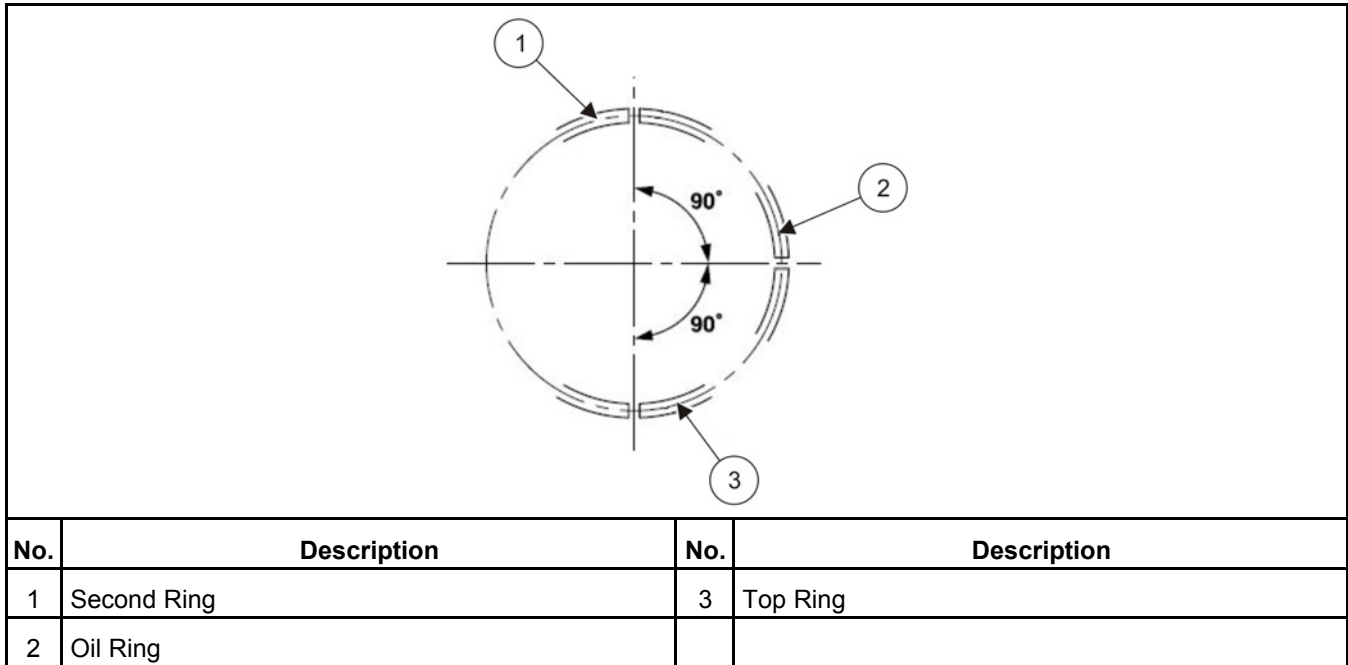


FIGURE 66. PISTON RING GAPS

7. Rotate the crankshaft down to the bottom dead center and lightly tap the piston head until the large end of the connecting rod touches the crank pin.
8. Line up the matching marks and fit the clinch portions firmly together.

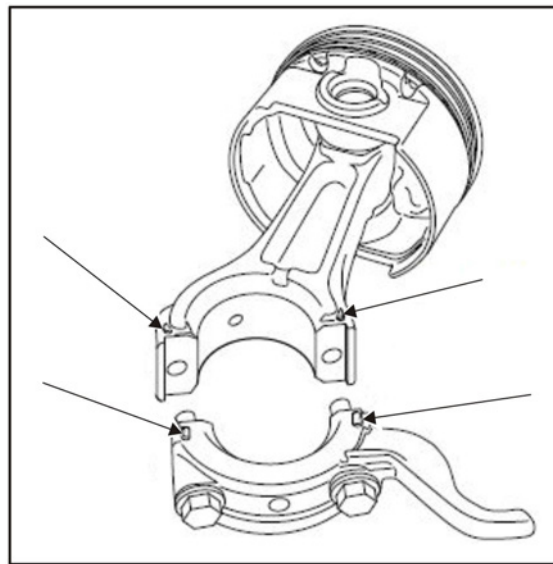


FIGURE 67. CONNECTING ROD ALIGNMENT MARKS

9. Mount the connecting rod and tighten to 13–15 Nm (9.4–10.8 ft-lb).
10. Check for free movement of the connecting rod by turning the crankshaft slowly.

5.4.12 Crankshaft

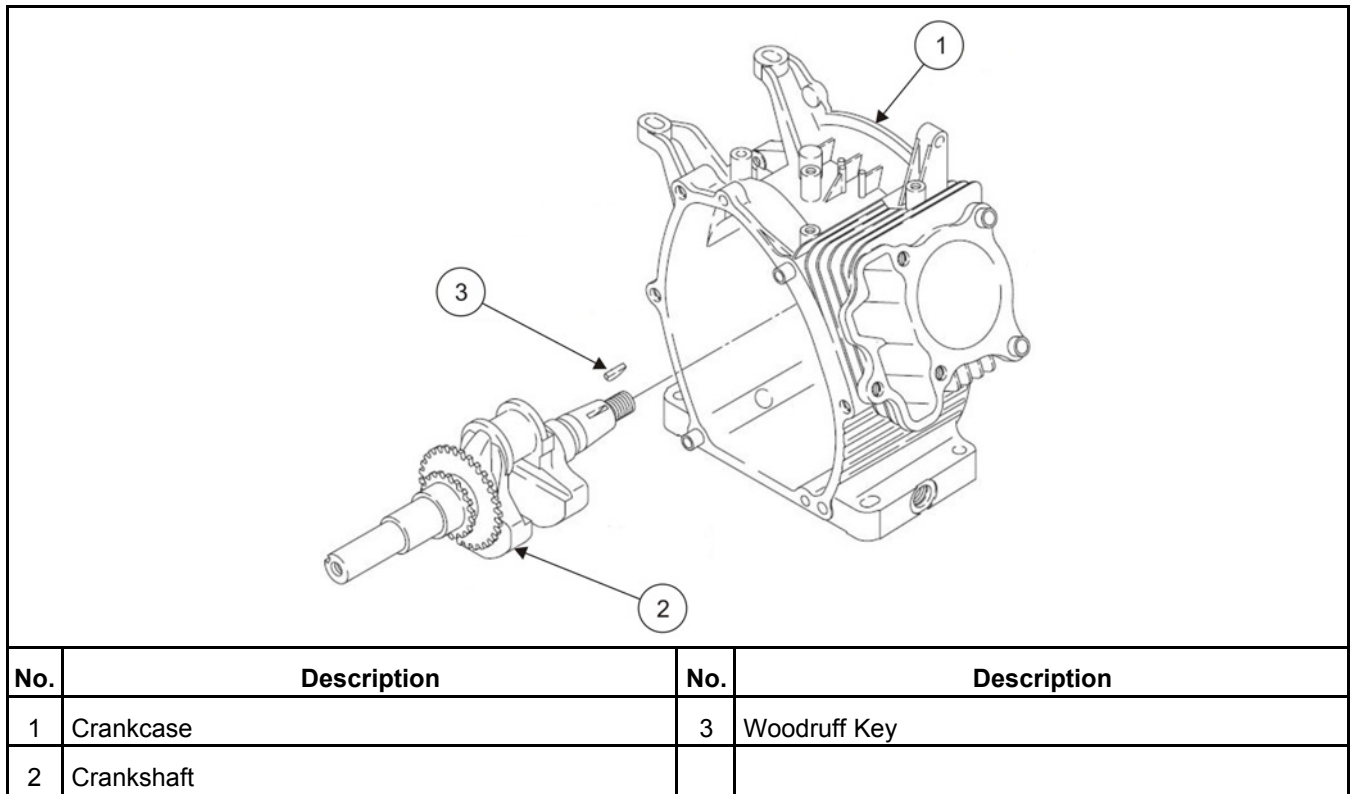


FIGURE 68. CRANKSHAFT

5.4.12.1 Disassembly

1. Remove the woodruff key (for the flywheel magneto).
2. Remove the crankshaft from the crankcase by tapping its magneto side end with a plastic hammer, taking care not to damage the oil seal.

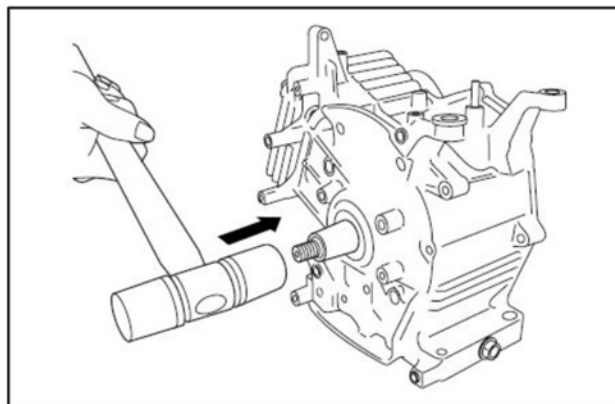


FIGURE 69. CRANKSHAFT REMOVAL

5.4.12.2 Assembly

1. Wrap the key-way portion of the crankshaft with polyvinyl tape and insert the crankshaft into the crankcase, taking care not to damage the oil seal lip.

2. Insert the woodruff key (for the flywheel magneto).

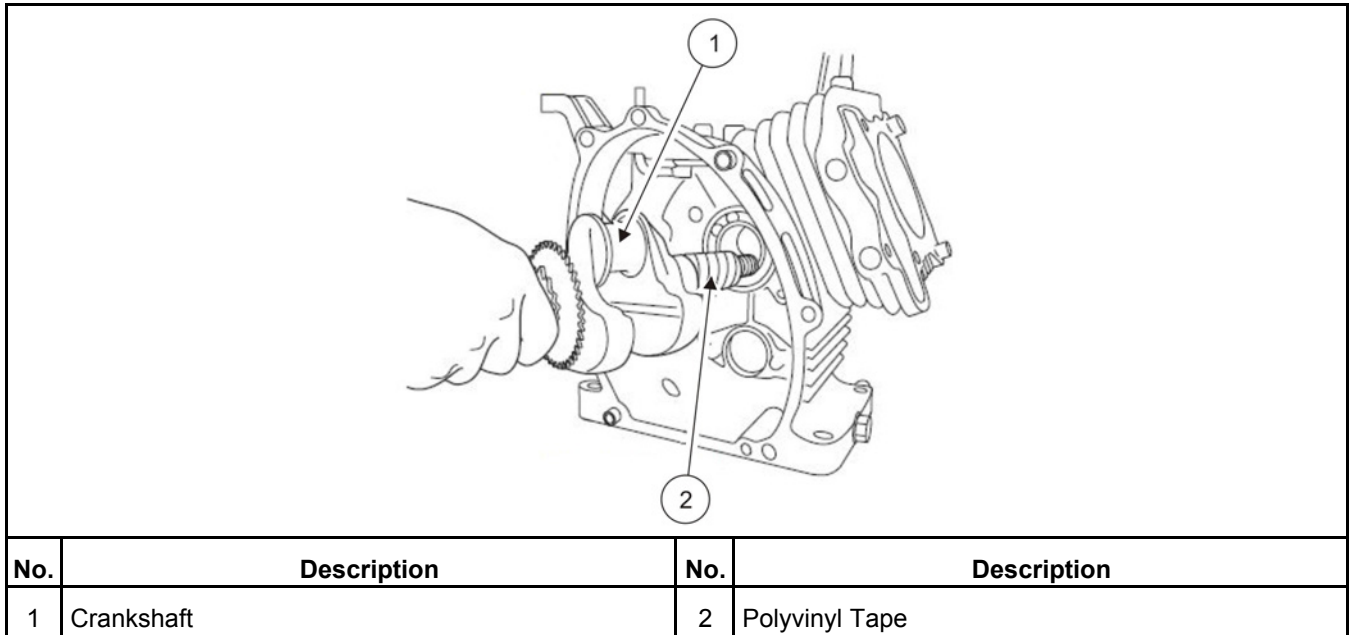


FIGURE 70. CRANKSHAFT ASSEMBLY

5.4.13 Oil Sensor

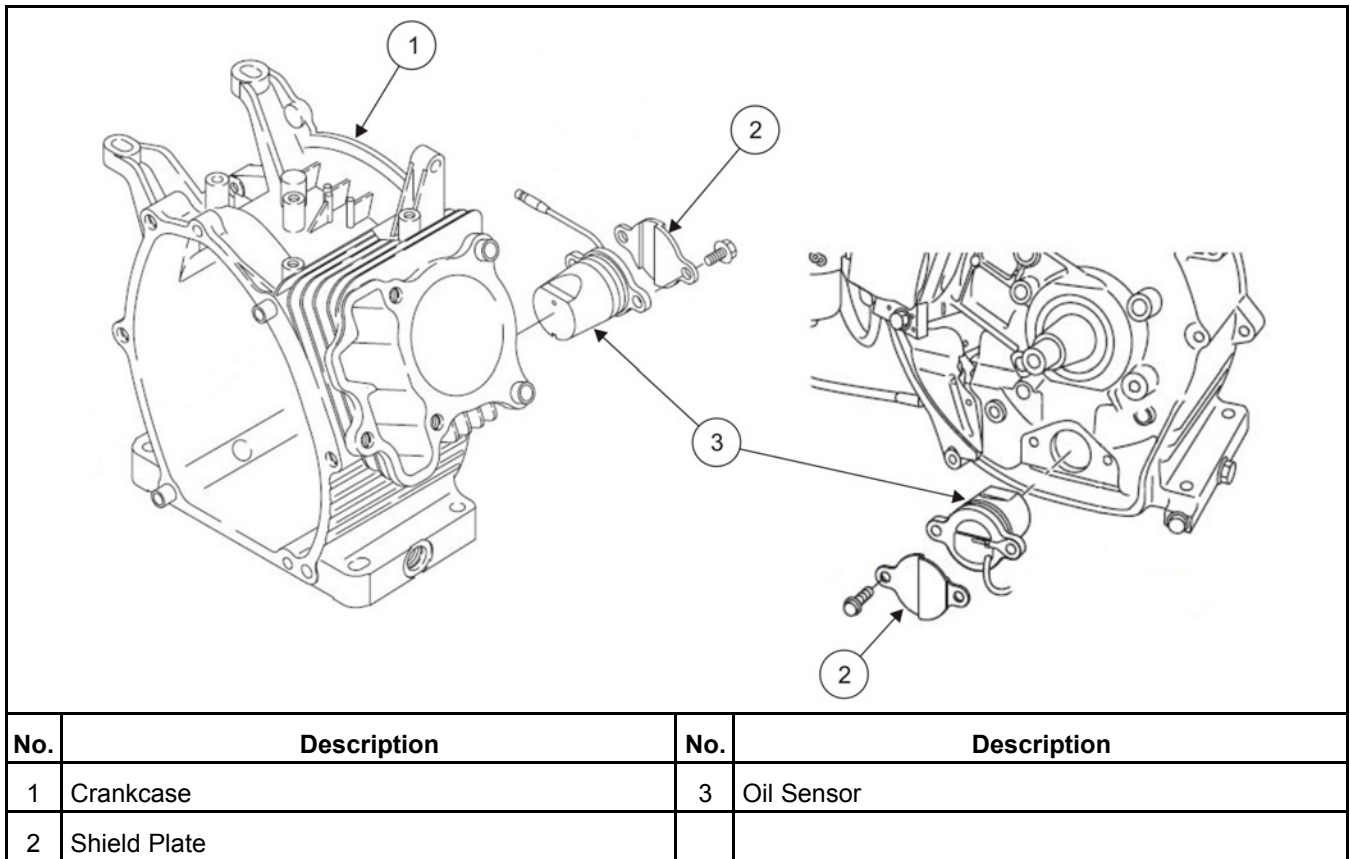


FIGURE 71. OIL SENSOR

5.4.13.1 Disassembly

Remove the oil sensor from the crankcase.

5.4.13.2 Assembly

1. Mount the oil sensor.
2. Mount the shield plate and tighten to 10 Nm (7.2 ft-lb).
3. Mount the control unit and fix the earth wire.

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6 Troubleshooting

⚠ WARNING

Hot engine parts can cause severe burns. Always allow the engine time to cool before performing any maintenance or service.

The Fault Codes are listed in numerical order along with step-by-step instructions for corrective action.

First note the following:

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

6.1 Fault Codes

The generator set controller provides extensive diagnostics by causing the status indicator light on the Control Switch to blink in a coded fashion. Proper procedure for obtaining the last recorded fault code:

1. To wake the control: Press and hold the STOP/Prime button until the indicator light illuminates (3-4 seconds). Then release.
2. Press the STOP/Prime button 3 times within 5 seconds to display the first level shutdown fault code. The indicator light will repeatedly blink 1, 2, 3, or 4 blinks at a time:
 - **2 Blinks:** indicates a low oil level fault. For Example: blink-blink--*long pause*--blink-blink--*long pause*--repeat
 - **3 Blinks:** indicates a service fault. For example: blink-blink-blink-*long pause*-repeat
 - **4 Blinks:** indicates that cranking exceeded 30 seconds without the engine starting. For example: blink-blink-blink-blink-*long pause*-repeat

NOTICE

Fault Code Nos. 1, 2, 3, and 4 are first level faults. Pay close attention to the pause sequence to avoid interpreting first level faults as second level Fault Codes Nos. 11, 22, 33, or 44.

- Flashing at a high frequency - Generator set is operating in Engine Run Only (ERO) mode. AC output is disabled.

Press STOP/Prime once more to cause the two-digit, second-level fault to blink. (Pressing STOP/Prime again will stop the blinking.) The two-digit code consists of 1, 2, 3, 4, or 5 blinks, a short pause, and then 1 to 9 blinks. The first set of blinks represents the tens digit and the second set of blinks represents the ones digit of the fault code number. The second set of blinks for the ones digit will blink slightly slower than the tens digit. For example, Fault Code No. 36 appears as: blink-blink-blink-*shortpause*-blink-blink-blink-blink-blink-*long pause*-repeat

NOTICE

Generator systems equipped with an AutoGen Start of AGS feature may experience shutdowns with no Fault Codes. This is because the AutoGen Start control is sending the generator control a signal that is sensed as a normal shutdown signal.

Because different fault logics are used on different products, refer to the appropriate product's service manual to translate the blink code shutdown fault. Each fault will have a description of the shutdown reason and a list of step by step corrective actions.

Restoring Fault Code Blinking - The fault code stops blinking after five minutes, or after clearing the fault by pressing Stop once for a Level 1 fault or twice for a Level 2 fault. Press Stop three times within five seconds to restore blinking. *Note that the last fault logged will blink, even after the condition that caused the shutdown has been corrected.*

6.2 Generator Set Starts or Stops Without Command - No Fault Code

⚠ WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: To start or stop - control receives ground at start or stop input on control, DC voltage drops below 9V and controller de-energizes (shuts down in sleep mode)

Possible Cause: Low battery voltage, shorted harness connection, faulty start/stop switch, Auto Gen Start (AGS) is enabled

Diagnosis and Repair:

1. Check last fault and record.
2. Measure battery voltage at battery and generator set.
3. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
4. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
5. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run generator set for symptom: repair or replace pins in connector as necessary.
7. Measure battery voltage at generator set while attempting to start from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, test and service generator set battery charger if so equipped, increase battery cable size or run parallel cables.
8. Measure battery voltage and check for charger increase while generator set is running.
9. Measure for continuity change across start/stop switch. Disconnect connector P9 from the back of the switch for access to the terminals.

Replace the switch if it does not:

- Close across terminals 2 and 3 when the switch is held in the Start position.

- Close across terminals 1 and 2 when the switch is held in the Stop position.

Perform the same test at connector P9 with the switch installed.

10. Measure for continuity from start and stop inputs to ground at switches and at connector P1: Repair or replace damaged harness.
11. Measure for continuity from the start and stop inputs to ground at the switches and at connector P1 by testing the harness for continuity between:
 - P9.1 to P1.32
 - P9.3 to P1.9
 - P9.2 to GND

If any of these paths aren't continuous, repair or replace the damaged harness.

6.3 No Response - Status Indicator Light Dead

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: To start - control receives ground via start/stop switch to start or stop input on control

Possible Cause: Low/No battery voltage, poor battery connection, faulty battery, open harness connection, faulty start/stop switch, faulty LED

Diagnosis and Repair:

1. Measure battery voltage at battery, at generator set and at connector P1 (P1.10 and P1.11). Reconnect, clean, repair and replace connections as necessary.
2. Measure battery voltage at generator set while attempting to start or prime from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, increase battery cable size or run parallel cables.
3. Measure for continuity change across start/stop switch between neutral and start position and neutral and stop position at switches and at connector P1: reconnect or repair connections, replace switches as necessary.
4. Test switches LED by energizing with 12 VDC: replace switches as necessary.
5. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run generator set for start and prime operation: replace control as necessary.

6.4 Starting Batteries Run Down

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: Low/No battery voltage

Possible Cause: Battery connections, battery, charging system, excessive cranking, excessive priming

Diagnosis and Repair:

1. Measure battery voltage at battery and generator set.
2. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
3. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
4. Measure battery voltage and check for charging increase while generator set is running.
5. Check last fault and record: troubleshoot as necessary.
6. Perform a parasitic load test.
 - a. Remove the negative battery terminal lead and connect a multimeter into the circuit. One lead on the battery post and one on the terminal.
 - b. Leave the test in this setup for 5 minutes and observe the current reading.

NOTICE

There is a parasitic load from the control of 100mA. If there is more power being pulled from the battery, begin testing for faulty electrical component(s) that are causing the drain, such as the fuel pump, fuel solenoid, starter solenoid, etc. and connected coach loads. Replace the control if necessary.

6.5 Starter Engages - Disengages

⚠ WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: Cranking voltage dips below 6 VDC: microprocessor aborts start attempt

Possible Cause: Battery connections, battery, charging system, start/stop switches, engine compression

Diagnosis and Repair:

1. Measure battery voltage at battery and generator set.
2. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
3. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
6. Measure battery voltage at generator set while attempting to start from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, test and service generator set battery charger if so equipped, increase battery cable size or run parallel cables.

7. Measure battery voltage and check for charger increase while generator set is running.

6.6 No AC Power - Generator Set Running Status LED on Steady or Flashing Rapidly

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See the Specifications section.

Logic: The generator set control is in normal or Engine Run Only (ERO) mode.

Possible Cause: Circuit breakers, ERO mode due to faulty generator

Diagnosis and Repair:

- If the Status light is on:
 1. Measure the AC output at the generator set circuit breaker.
 2. Reset or turn on the generator set circuit breaker, and diagnose faulty loads as necessary
- If the Status light is rapidly flashing and the generator set is in ERO mode:
 1. Remove Connector P1 from the control and re-install it.
 2. Start the generator set. Inspect, repair or replace Connector P1 pins as necessary.
 3. While running in ERO mode, externally excite field with 12 VDC or 24 VDC. Measure the main and quadrature winding AC output.
 4. Measure field, quadrature and main winding resistance. Clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 5. Measure field, quadrature and main winding resistance to ground. Clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 6. Measure field, quadrature and main winding resistance to each other. Clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 7. Check brush alignment per CPGF-S-00000258-0.

6.7 Generator Set Cranks but Does Not Start - No Fault Code

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: Fault codes are based on time lapse between events

Possible Cause: Not holding start switch long enough to cause fault

Diagnosis and Repair:

1. Check and record last fault code.

2. Crank generator set and hold switch until control stops cranking and displays fault code (approximately 30 seconds): troubleshoot fault code and reference last fault code recorded above if necessary.

6.8 Generator Set Runs but Stops When Switch is Released - No Fault Code

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Chapter 1](#).

Logic: Fault codes are based on time lapse between events

Possible Cause: Not holding start switch long enough to cause fault

Diagnosis and Repair:

1. Check and record last fault code.
2. Start generator set and hold switch until control shuts down and displays fault code (approximately 30 seconds): troubleshoot fault code and reference last fault code recorded above if necessary.

6.9 Low Oil Level Fault - Fault Code 2

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See [Safety Precautions](#).

Logic: Ground at control for oil level for 30 continuous seconds.

Possible Cause: Low oil level, faulty sensor, faulty connection/harness.

Diagnosis and Repair:

1. Verify that Last Fault is FC 2: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure oil level: add or drain oil as necessary.
3. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
4. Measure continuity at oil level switch (normally closed). If the oil is low, or there is no oil, there should be continuity. If the oil level is full, there should be no continuity. Replace the sensor as necessary.
5. Measure continuity between ground and P1-6. If there is low or no oil, the level sensor will be closed, making the path continuous. If the oil level is full, there should be no continuity. Repair or replace the harness as necessary.
6. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.

6.10 Service Check Fault - Fault Code 3

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See the Safety Precautions section.

Logic: There is a single-digit fault that indicates a shutdown due to a two-digit fault.

Possible Cause: Any two-digit fault code

Diagnosis and Repair:

1. Verify that the last fault is FC 3:
 - If "Yes", continue the diagnosis.
 - If "No", troubleshoot the actual last fault.
2. While the LED is flashing three times, press stop once (1 second duration). Troubleshoot the two-digit fault code.

6.11 Overcrank - Fault Code 4

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Controller unable to sense generator set frequency after 30 seconds of holding start switch

Possible Cause: Faulty switch, faulty external start command, fuel supply, air fuel mixture, exhaust system, wire connections, starter, ignition system

Diagnosis and Repair:

1. Verify that Last Fault is FC 4: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure for continuity change across the start/stop switch. Disconnect connector P9 from the back of the switch for access to the terminals. Replace the switch if it does not:
 - Close across terminals 2 and 3 when the switch is held in the Start position.
 - Close across terminals 1 and 2 when the switch is held in the Stop position.

Perform the same test at connector P9 with the switch installed. Replace switches as necessary or disconnect the external device (if so equipped).
3. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
4. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
5. Verify engine rotation manually: repair engine damage as necessary.
6. Measure DC voltage at starter during start attempt: repair wire connections, replace start solenoid and starter as necessary.
7. Check air filter cleanliness; replace air filter as necessary.

-
8. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
 9. **All Gasoline Models**
 - a. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
 - b. Measure steady DC voltage at fuel pump while generator set is cranking: repair wiring as necessary.
 - c. Try to start generator set on shop fuel supply: verify tank level and fuel line condition in vehicle.
 10. **All Gasoline Carburetor Models**

At elevations greater than 7,500 ft, it is recommended to install a high altitude kit (A042V579) to avoid performance degradation. There is no further adjustment.
 11. **Propane Models**
 - a. When ambient temperatures are less than 40°F vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
 - b. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD-5 grade Propane.
 - c. Measure steady DC voltage at fuel solenoid while generator set is running; repair wiring as necessary.
 - d. Verify clear vent hose.
 - e. Run generator set on shop fuel supply; verify tank level and fuel line condition in vehicle.
 - f. Check generator set fuel lines for damage: replace fuel line as required.
 - g. Measure regulator lock off pressure.
 12. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
 13. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
 14. Measure DC voltage from ignition kill lead greater than 1 VDC: repair or replace leads, pins or magnetos as necessary.
 15. Inspect ignition kill leads in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
 16. Test Magnetos:
 - a. Disconnect Connector P1.
 - b. Connect positive(+) meter lead to chassis ground.
 - c. Measure continuity to negative lead at pin P1-4 and P1-5: replace magnetos as necessary.
 17. Measure spark plug gap: set gap or replace spark plugs as necessary.
 18. Verify ignition spark condition by using an inline spark tester.
 19. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 20. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 21. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
 22. Check brush alignment per PSB-682a.
 23. Dealers contact Distributor for technical support, Distributors contact factory for technical support.
-

6.12 Overvoltage - Fault Code 12

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic (60 Hz):

- Instantaneous Fault - AC voltage S1-S2 greater than 150 VAC
- Delayed Fault - AC voltage S1-S2 greater than 138 VAC, but less than 150 VAC, for 3 continuous seconds

Logic (50 Hz):

- Instantaneous Fault - AC voltage S1-S2 greater than 288 VAC
- Delayed Fault - AC voltage S1-S2 greater than 265 VAC for 3 seconds

Possible Causes: Generator set loads, Inverter/Charger, wire connections, AC sense transformer, windings

Diagnosis & Repair:

1. Verify that Last Fault is FC 12: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Cycle loads to determine if a particular load causes fault: diagnose faulty load as necessary.
4. Determine Inverter/Charger battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
5. Verify balanced loads: balance loads within 10 percent line-to-line as required.
6. Use breakout board to perform tests in Instruction Sheet R1098.
7. Remove connector P1 from control and re-install and try to start generator set: inspect, repair or replace P1 connector pins as necessary.
8. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
9. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
10. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Check brush alignment per PSB-682a.
12. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.13 Undervoltage - Fault Code 13

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic (60 Hz): AC voltage S1-S2 less than 108 VAC for 5 continuous seconds

Logic (50 Hz): AC voltage S1-S2 less than 207 VAC for 5 continuous seconds

Possible Causes: Generator set loads, Inverter/Charger, wire connections, generator drive system, windings, AC sense transformer, windings

Diagnosis & Repair:

1. Verify that Last Fault is FC 13: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Measure AC voltage in and out of sense transformer (if so equipped): repair wire connection, replace sense transformer as necessary.
4. Cycle loads to determine if a particular load will cause fault: diagnose faulty load as necessary.
5. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
6. Verify balanced loads: balance loads within 10 percent line-to-line as required.
7. Use breakout board to perform tests in Instruction Sheet R1098.
8. Remove connector P1 from control and re-install and try to start generator set: inspect, repair or replace P1 connector pins as necessary.
9. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
10. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
12. Check brush alignment per PSB-682a.
13. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.14 Overfrequency - Fault Code 14

⚠ WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic (60 Hz):

- Instantaneous Fault - Frequency greater than 70 Hz
- Delayed Fault - Frequency greater than 66 Hz, but less than 70 Hz, for 3 continuous seconds

Logic (50 Hz):

- Instantaneous Fault - Frequency greater than 58 Hz
- Delayed Fault - Frequency greater than 55 Hz, but less than 58 Hz for 3 continuous seconds

Possible Causes: Generator set loads, Inverter/Charger, engine governor function, fuel supply, air fuel mixture, exhaust system, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 14: Yes, continue diagnosis; No, troubleshoot actual last fault.

2. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Measure generator set load capability with shop load bank (derate for altitude and temperature as necessary).
5. Measure generator set frequency and droop while running.
6. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response.
7. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
8. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
9. Check all grounds and neutral leads for looseness at battery, generator set, inverter/converter; run generator set on separate battery: tighten or replace terminals and leads as necessary.
10. Check air filter cleanliness; replace air filter as necessary.
11. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
12. Verify P1-29 (if present) is not grounded on 60 Hz generator sets: remove lead termination, tape and isolate.
13. Use breakout board to perform tests in Instruction Sheet R1098.
14. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
15. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
16. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
17. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
18. Check brush alignment per PSB-682a.
19. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
20. Test Magnetos:
 - a. Disconnect Connector P1.
 - b. Connect positive(+) meter lead to chassis ground.
 - c. Measure continuity to negative lead at pin P1-4: replace magneto as necessary.
21. Measure spark plug gap: set gap or replace spark plugs as necessary.
22. Verify ignition spark condition using an inline spark tester.
23. Inspect spark plug cables, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magnetos as necessary.
24. Measure the temperature of the air intake and temperature rise across the generator set. The rise in inlet air temperature over ambient air temperature must not exceed 15 °F (8 °C). A rise in inlet air temperature indicates hot air recirculation. See hot air recirculation test in the Installation Manual for the test procedure. Remove blockage or prevent air recirculation.
25. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.15 Underfrequency - Fault Code 15

 **WARNING**

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic (60 Hz): Delayed Fault – Frequency less than 54Hz for more than 8 continuous seconds

Logic (50 Hz): Delayed Fault – Frequency less than 45Hz for more than 8 continuous seconds

Possible causes: Generator set loads, Inverter/Charger, engine governor function, fuel supply, air fuel mixture, exhaust system, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 15: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Measure generator set load capability with shop load bank (derate for altitude and temperature as necessary).
5. Measure generator set frequency and droop while running.
6. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response.
7. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
8. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
9. Check air filter cleanliness; replace air filter as necessary.
10. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
11. Use breakout board to perform tests in Instruction Sheet R1098.
12. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
13. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
14. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
15. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
16. Check brush alignment per PSB-682a.
17. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
18. Test Magnetos:
 - a. Disconnect Connector P1.
 - b. Connect positive(+) meter lead to chassis ground.

- c. Measure continuity to negative lead at pin P1-4 and P1-5: replace magnetos as necessary.
19. Measure spark plug gap: set gap or replace spark plugs as necessary.
20. Verify ignition spark condition using an inline spark tester.
21. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magnetos as necessary.
22. Measure temperature of air intake and temperature rise across generator set. The rise in inlet air temperature over ambient air temperature must not exceed 15 °F (8 °C). A rise in inlet air temperature indicates hot air recirculation. See hot air recirculation test in the Installation Manual for the test procedure. Remove blockage or prevent air recirculation.
23. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.16 Voltage Sense Lost - Fault Code 27

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: No Sense Voltage (0 VAC across T1-T2) for 1 continuous second after start disconnect

Possible Causes: Generator set loads, Inverter/Charger, VAC sense transformer, engine governor function, fuel supply, choke, demand regulator, carburetor, generator windings, ignition, wire connections, temperature

Diagnosis & Repair:

1. Verify that Last Fault is FC 27: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
6. Check air filter cleanliness; replace air filter as necessary.
7. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
8. Use breakout board to perform tests in Instruction Sheet R1098.
9. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
10. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
12. Check brush alignment.
13. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.17 High Battery Voltage - Fault Code 29

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: DC voltage to controller greater than 19 VDC for 1 second.

Possible Causes: Incorrect battery configuration, wire damage, faulty charger, control

Diagnosis & Repair:

1. Verify that Last Fault is FC 29: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure DC voltage at battery, generator set and connector P1: reconnect battery or repair wiring as necessary.
3. If generator set shares batteries with propulsion engine, check for fault using shop battery (voltage spike may cause fault): diagnose fault or voltage spikes from propulsion engine charging system.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair, or replace pins as necessary.
5. Verify the following ground:
 - HGJBB at P1.27
6. Reconnect P1 connector and test run generator set for fault occurrence.

6.18 Overspeed Fault - Fault Code 31

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Engine Run Only (ERO) mode -Engine RPM via ignition pulse greater than 3960 rpm.

Possible Causes: Engine governor function, fuel supply, air fuel mixture, exhaust system, choke, demand regulator, carburetor, generator drive system, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 31: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure generator set frequency and droop while running.
3. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
4. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
5. Check air filter cleanliness; replace air filter as necessary.
6. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
7. Use breakout board to perform tests in Instruction Sheet R1098.

8. All Gasoline Models

- a. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
- b. Measure steady DC voltage at fuel pump while generator set is cranking: repair wiring as necessary.
- c. Try to start generator set on shop fuel supply: verify tank level and fuel line condition in vehicle.

9. All Gasoline Carburetor Models

At elevations of 7,500 ft or greater, it is recommended that a high altitude kit (A042V579) is installed to avoid performance degradation. There is no further adjustment.

10. Propane Models

- a. When ambient temperatures are less than 40°F vapor-withdrawal, propane tanks should be at least half full to provide proper vaporization rate.
 - b. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD-5 grade propane.
 - c. Measure steady DC voltage at fuel solenoid while generator set is running; repair wiring as necessary.
 - d. Verify clear vent hose.
 - e. Run generator set on shop fuel supply; verify tank level and fuel line condition in vehicle.
 - f. Check generator set fuel lines for damage: replace fuel line as required.
 - g. Measure regulator lock off pressure.
11. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
 12. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
 13. Inspect ignition kill leads in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
 14. Test Magneto
 - a. Disconnect Connector P1.
 - b. Connect positive(+) meter lead to chassis ground.
 - c. Measure continuity to negative lead at pin P1-4: replace magneto as necessary.
 15. Measure spark plug gap: set gap or replace spark plugs as necessary.
 16. Verify ignition spark condition using an inline spark tester.
 17. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magnetos as necessary.
 18. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.19 Low Cranking Speed Sense - Fault Code 32**⚠ WARNING**

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Quadrature frequency less than or equal to 3 Hz and engine RPM less than or equal to 100 rpm for 12 continuous seconds after pressing start.

Possible Causes: Cylinder at TDC, fuel supply, air fuel mixture, exhaust system, starter, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 32: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure battery voltage at battery and generator set: recharge or replace battery as necessary.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
6. Measure DC voltage at starter during start attempt: repair wire connections, replace start solenoid and starter as necessary.
7. Check air filter cleanliness; replace air filter as necessary.
8. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
9. Use breakout board to perform tests in Instruction Sheet R1098.
10. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
11. **All Gasoline Models**
 - a. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
 - b. Measure steady DC voltage at fuel pump while generator set is cranking: repair wiring as necessary.
 - c. Try to start generator set on shop fuel supply: verify tank level and fuel line condition in vehicle.
12. **All Gasoline Carburetor Models**
 - a. Verify carburetor altitude setting: readjust as necessary.
 - b. Verify choke operation, setting, linkage, vacuum pull off assembly and sustain valve: readjust, repair or replace as necessary.
 - c. Measure fuel pump pressure/flow: replace fuel filter or fuel pump as necessary.
 - d. Inspect carburetor butterfly for binding: replace carburetor as necessary.
13. **Propane Models**
 - a. When ambient temperatures are less than 40°F vapor-withdrawal, propane tanks should be at least half full to provide proper vaporization rate.
 - b. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD-5 grade propane.
 - c. Measure steady DC voltage at fuel solenoid while generator set is running; repair wiring as necessary.
 - d. Verify clear vent hose.
 - e. Run generator set on shop fuel supply; verify tank level and fuel line condition in vehicle.
 - f. Check generator set fuel lines for damage: replace fuel line as required.
 - g. Measure regulator lock off pressure.

14. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
15. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
16. Inspect ignition kill leads in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
17. Test Magneto
 - a. Disconnect Connector P1.
 - b. Connect positive (+) meter lead to chassis ground.
 - c. Measure continuity to negative lead at pin P1-4: replace magneto as necessary.
18. Measure spark plug gap: set gap or replace spark plugs as necessary.
19. Verify ignition spark condition using an inline spark tester.
20. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magnetos as necessary.
21. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.20 Control Card Failure - Fault Code 35

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: EEPROM (programming variables) error during self test

Possible Causes: Faulty program

Diagnosis & Solution:

1. Verify that Last Fault is FC 35: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Make sure latest software version is installed. Install or reinstall software as necessary.
3. Replace control.

6.21 Generator Set Stopped Without Fault Condition - Fault Code 36

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: RPM less than 500 and Sense Voltage T1-T2 at 0 VAC when no other fault condition occurred

Possible Causes: Auto Gen Start (AGS), fuel supply, air fuel mixture, exhaust system, loads, Inverter/Charger, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 36: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Verify whether AGS stopped generator set: Yes, disable AGS or explain AGS function to customer (see PSB-666); No, continue diagnosis.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
6. Check air filter cleanliness; replace air filter as necessary.
7. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
8. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
9. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
10. Measure generator set load capability with shop load bank.
11. Run generator set in Engine Run Only (ERO) and externally excite field F1-F2 with 12 VDC or 24 VDC and measure main and quadrature winding AC output. Verify generator set operation and outputs with Break-Out Tool 420-0603 and Instruction Sheet R1098.
12. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
13. Conduct hot air recirculation test (Refer to Installation Manual).
14. **All Gasoline Models**
 - a. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
 - b. Measure steady DC voltage at fuel pump while generator set is cranking: repair wiring as necessary.
 - c. Try to start generator set on shop fuel supply: verify tank level and fuel line condition in vehicle.
15. **All Gasoline Carburetor Models**
 - a. Verify carburetor altitude setting: readjust as necessary.
 - b. Verify choke operation, setting, linkage, vacuum pull off assembly and sustain valve: readjust, repair or replace as necessary.
 - c. Measure fuel pump pressure/flow: replace fuel filter or fuel pump as necessary.
 - d. Inspect carburetor butterfly for binding: replace carburetor as necessary.
16. **Propane Models**
 - a. When ambient temperatures are less than 40°F vapor-withdrawal, propane tanks should be at least half full to provide proper vaporization rate.
 - b. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD-5 grade propane.
 - c. Measure steady DC voltage at fuel solenoid while generator set is running; repair wiring as necessary.
 - d. Verify clear vent hose.
 - e. Run generator set on shop fuel supply; verify tank level and fuel line condition in vehicle.

- f. Check generator set fuel lines for damage: replace fuel line as required.
 - g. Measure regulator lock off pressure.
17. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
18. Verify that spark plug cables are secure on spark plugs: reconnect or replace as necessary.
19. Inspect ignition kill leads in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
20. Test Magnetos
 - a. Disconnect Connector P1.
 - b. Connect positive (+) meter lead to chassis ground.
 - c. Measure continuity to negative lead at pin P1-4 and P1-5: replace magnetos as necessary.
21. Measure spark plug gap: set gap or replace spark plugs as necessary.
22. Verify ignition spark condition using an inline spark tester.
23. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magnetos as necessary.
24. Measure temperature of air intake and temperature rise across generator set; remove blockage or prevent air recirculation.
25. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.22 Invalid Set Configuration - Fault Code 37

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Configuration is determined by RMP/frequency.

Possible Causes: Wire connections, windings, ignition system, drive belt slippage, generator drive system

Diagnosis & Repair:

1. Verify that Last Fault is FC 37: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Alternating FC 37 and FC 47: Magneto gap to wide: reset magneto gap, retest.
3. Check the control board on the generator set and ensure that it has the right board (Controller A1).
4. Verify proper control configuration.
5. Make sure latest software version is installed. Install or reinstall software as necessary.
6. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.23 Field Overload (Overvoltage) - Fault Code 38

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Field voltage (F1-F2) greater than 73 VDC for 10 continuous seconds

Possible Causes: Loads, Inverter/Charger, windings, fuel supply, governor system

Diagnosis & Repair:

1. Verify that Last Fault is FC 38: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure F1-F2 DC voltage.
3. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
4. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
5. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
7. Measure generator set load capability with shop load bank (derate for altitude and temperature as necessary).
8. Measure generator set frequency and droop while running.
9. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
10. Check air filter cleanliness; replace air filter as necessary.
11. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
12. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
13. Use breaker board to perform tests in Instruction Sheet R1098.
14. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
15. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
16. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
17. Check brush alignment per PSB-682a.
18. Measure temperature of air intake and temperature rise across generator set. The rise in inlet air temperature over ambient air temperature must not exceed 15 °F (8 °C). A rise in inlet air temperature indicates hot air recirculation. See hot air recirculation test in the Installation Manual for test procedure. Remove blockage or prevent air recirculation.
19. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.24 Generator Rotor Fault - Fault Code 41

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Field Voltage F1-F2 at 0 VDC and Sense Voltage L1-L2 at 0 VAC for 1 continuous second

Possible Causes: Loads, windings, fuel supply

Diagnosis & Repair:

1. Verify that Last Fault is FC 41: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure F1-F2 DC voltage.
3. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
4. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
5. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
7. Measure generator set load capability with shop load bank (derate for altitude and temperature as necessary).
8. Use breakout board to perform tests in Instruction Sheet R1098.
9. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
10. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
12. Check brush alignment per PSB-682a.
13. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.25 Processor Fault - Fault Code 42

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions section.

Logic: There is a ROM (programming variables) error during self-test.

Possible Cause: Faulty program

Diagnosis and Solution:

1. Verify that the last fault is FC 42:
 - If "Yes", continue the diagnosis.
 - If "No", troubleshoot the actual last fault.
2. Replace the control.

6.26 Processor Fault - Fault Code 43

 **WARNING**

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions section

Logic: RAM (programming variables) error during self test

Possible Cause: Faulty program

Diagnosis and Solution:

1. Verify that the last fault is FC 43:
 - If "Yes", continue the diagnosis.
 - If "No", troubleshoot the actual last fault.
2. Replace the control.

6.27 Speed Sense Fault - Fault Code 45

 **WARNING**

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: While running quadrature frequency dropped to 0 Hz for 1 continuous second

Possible Causes: Auto Gen Start (AGS), fuel supply, air fuel mixture, exhaust system, loads, Inverter/Charger, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 45: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Verify whether AGS stopped generator set: Yes, disable AGS or explain AGS function to customer (see PSB-666); No, continue diagnosis.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.

6. Measure AC current while running generator set with vehicle loads: identify faulty or short cycling loads.
7. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
8. Measure generator set load capability with shop load bank (derate for altitude and temperature as necessary).
9. Use breakout board to perform tests in Instruction Sheet R1098.
10. Measure generator set frequency and droop while running.
11. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
12. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

6.28 Field Sense Fault - Fault Code 48

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See the Safety Precautions section.

Logic: The controller is unable to sense field voltage.

Possible Cause: Faulty control

Diagnosis and Solution:

1. Verify that the last fault is FC 48:
 - If "Yes", continue the diagnosis.
 - If "No", troubleshoot the actual last fault.
2. Replace the control.

6.29 Processor Failure - Fault Code 51

WARNING

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See the Safety Precautions section.

Logic: Processor error

Possible Cause: Faulty control

Diagnosis and Solution:

1. Verify that the last fault is FC 51:
 - If "Yes", continue the diagnosis.
 - If "No", troubleshoot the actual last fault.
2. Use the breakout board to perform tests in Instruction Sheet R1098.
3. Replace the control.

6.30 Overprime Fault - Fault Code 57

 **WARNING**

Some generator set service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform generator set service. See Safety Precautions.

Logic: Generator set priming: 3 consecutive minutes

Possible Causes: Wiring harness, faulty switch, AGS

Diagnosis & Repair:

1. Verify that Last Fault is FC 57: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Check for an object holding switch in stop position: remove object.
3. Disconnect generator set control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB-676: insert, repair or replace pins as necessary.
4. Reconnect P1 connector and test run generator set for fault occurrence: repair or replace pins in connector as necessary.
5. Measure for continuity change across start/stop switch. Disconnect connector P9 from the back of the switch for access to the terminals. Replace the switch if it does not:
 - Close across terminals 2 and 3 when the switch is held in the Start position.
 - Close across terminals 1 and 2 when the switch is held in the Stop position.

Perform the same test at connector P9 with the switch installed. Replace switches as necessary or disconnect the external device if so equipped.

6. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

7 Service Checklist

WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless, colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

- **Dizziness**
- **Muscular Twitching**
- **Weakness and Sleepiness**
- **Throbbing in Temples**
- **Headache**
- **Inability to Think Clearly**
- **Nausea**
- **Vomiting**

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

Never occupy the vehicle with the generator set running unless the vehicle is equipped with a working carbon monoxide detector. Primary protection against inhaling carbon monoxide, however, is proper installation of the exhaust system, daily (every eight hour) inspection for visible and audible exhaust system leaks.

7.1 General

After the generator set has been serviced and reinstalled, inspect the installation and test the generator set to confirm that the generator set will operate properly and produce rated power. Check each of the following areas before putting the generator set into service.

7.2 Mounting

Examine all mounting bolts and supporting members to verify that the generator set is properly mounted. Tighten all fasteners securely.

7.3 Lubrication

If the engine oil was drained, fill the crankcase with oil of the recommended classification and viscosity. Refer to the operator's manual for the specific recommendations and procedures. Always be sure the vehicle is on a flat, level surface when checking the oil level.

7.4 Wiring

Verify that all wiring connections are tight and installed properly. Make certain that wires do not run over hot, sharp or rough surfaces and are not kinked or worn. Check:

- Load wires
- Control wires
- Ground strap
- Battery cables

7.5 Initial Start Adjustments

CAUTION

Voltage or frequency-sensitive equipment such as VCRs, televisions, computers, etc. can be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet even if the device is not in actual operation. For this reason, disconnect all devices that are voltage- or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set.

Start the generator set, then immediately adjust the governor speed for a safe no-load operating speed. With no load applied, listen for unusual sounds or vibrations. Warm up the generator set for at least 15 minutes at 50% to 75% of rated load and check that the choke is completely open. Adjust the governor if necessary (see [Section 5.3](#)).

7.6 Exhaust System

With the generator set operating, inspect the entire exhaust system. Make certain that the exhaust tail pipe terminates beyond the perimeter of the vehicle and not near vents or openable windows or doors. Look and listen for leaks at all connections, welds, gaskets, and joints. Also make sure that exhaust pipes do not heat surrounding areas excessively. If leaks are detected, correct immediately. Test the on-board CO alarm(s). See the Installation Manual for important considerations concerning the installation of an exhaust system.

7.7 Fuel System

With the generator set operating, inspect the fuel supply line and fittings for leaks. Check flexible section for cuts, cracks and abrasions and make sure it is not rubbing against anything that could cause damage.

WARNING

Leaking fuel creates a fire hazard which can result in severe personal injury or death if ignited by flame, spark, pilot light, cigarette, arc-producing equipment, electrical switch, or other ignition source. If fuel leaks are detected, shut off the generator set and correct leak immediately.

7.8 Output Check

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

7.9 Control

Stop and start the generator set several times at the generator set control and remote control (if so equipped) to verify that it functions properly.

7.10 Mechanical

Stop the generator set and inspect it for leaking gaskets, loose fasteners, damaged components, or interference problems. Repair as required. Inspect the generator set 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 required. Make sure that all soundproofing material is in place.

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Appendix A. Diagrams

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A.0 Wiring Diagram - 50 and 60 Hz

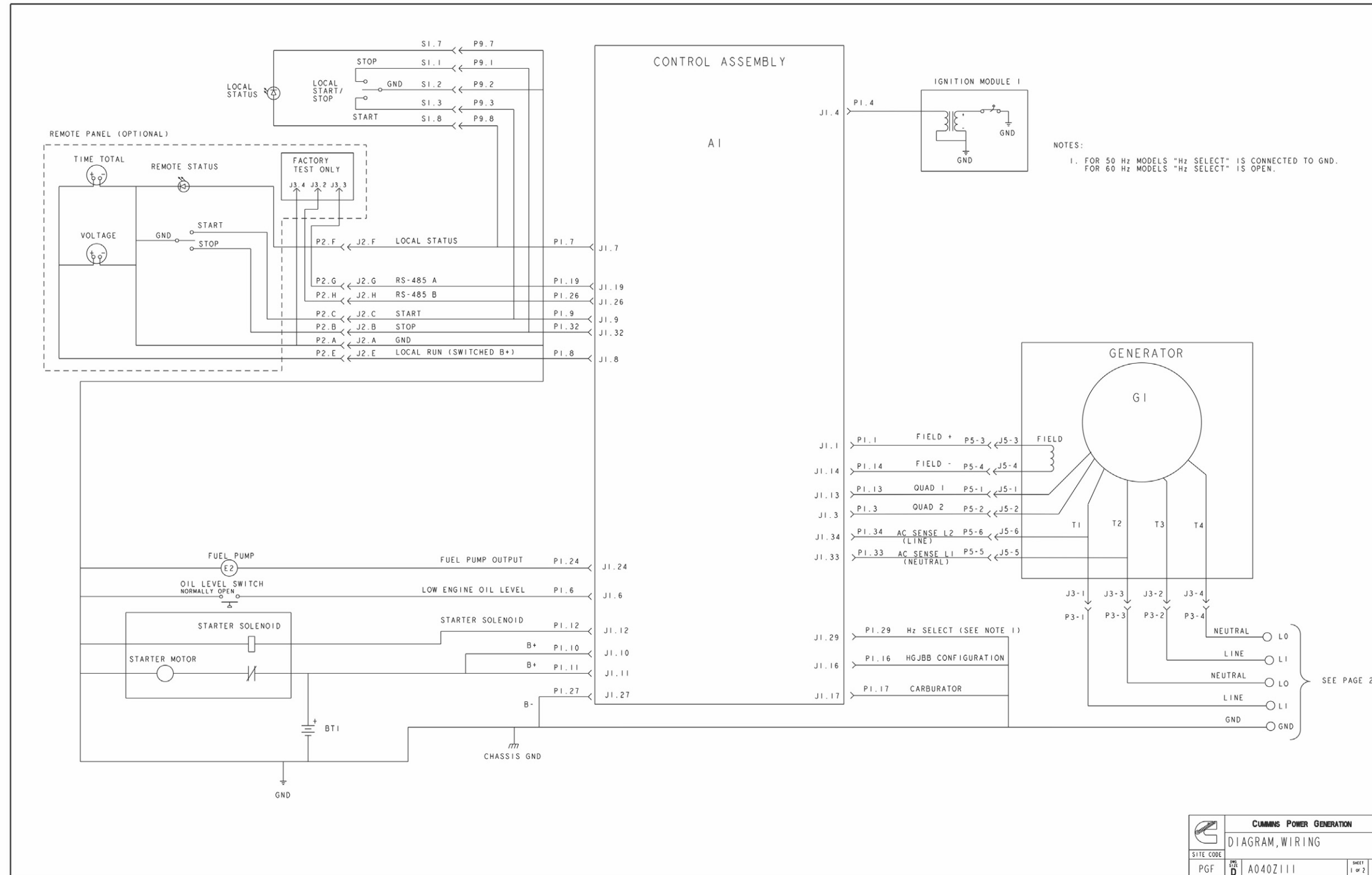


FIGURE 72. A040Z111 SHEET 1

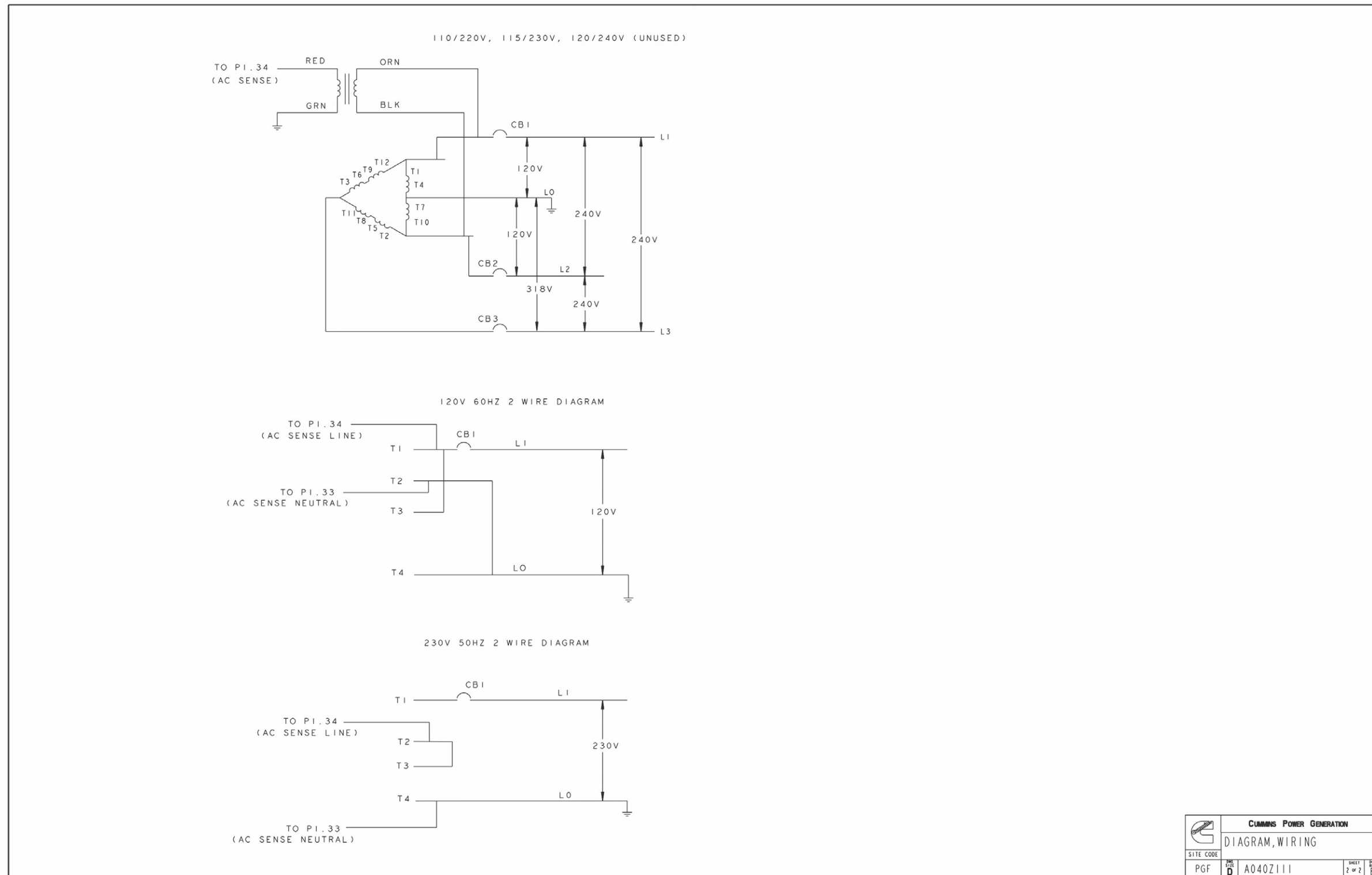


FIGURE 73. A040Z111 SHEET 2

A.1 Control Harness - 60 Hz

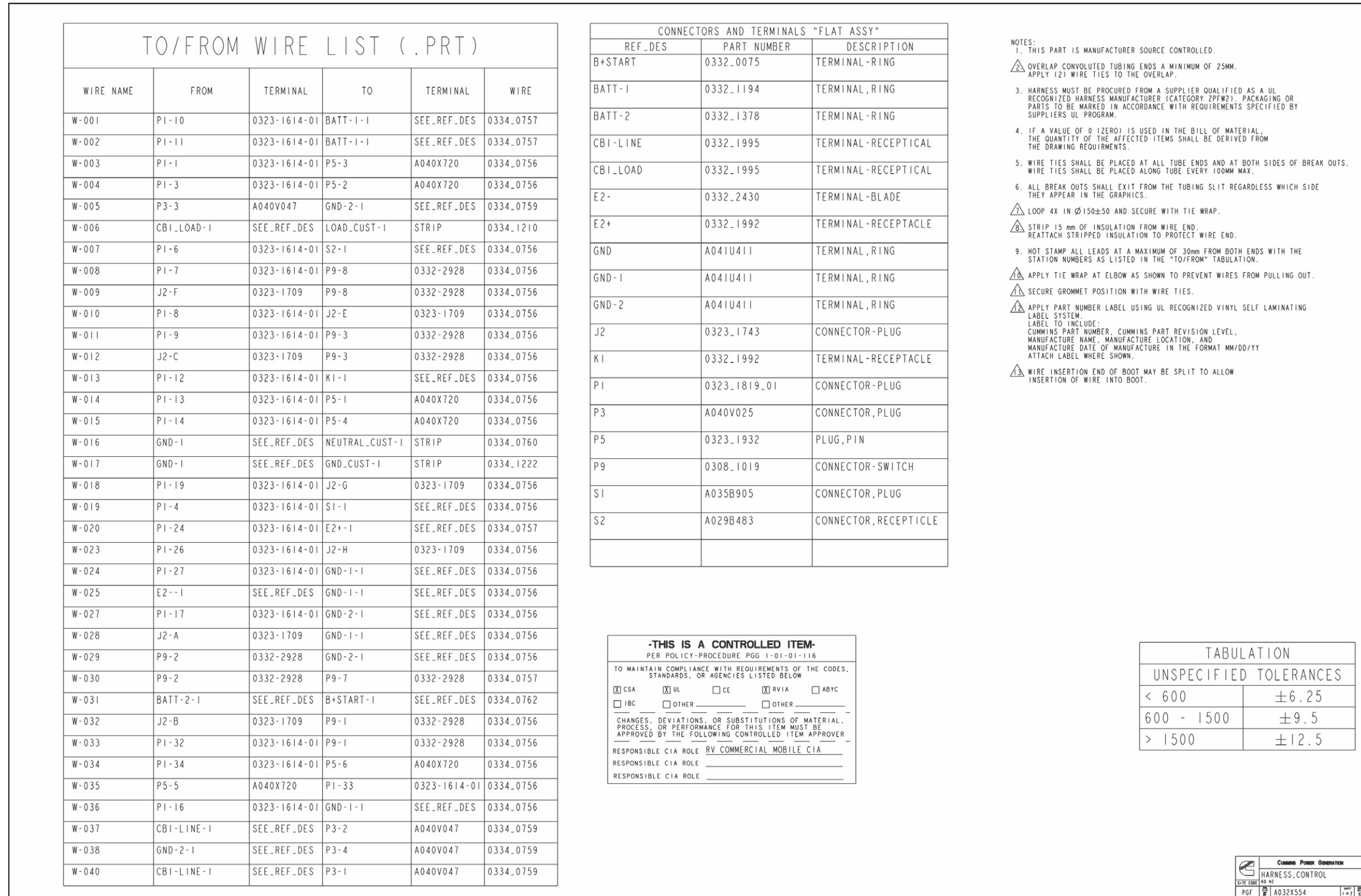


FIGURE 74. A032X554 SHEET 1

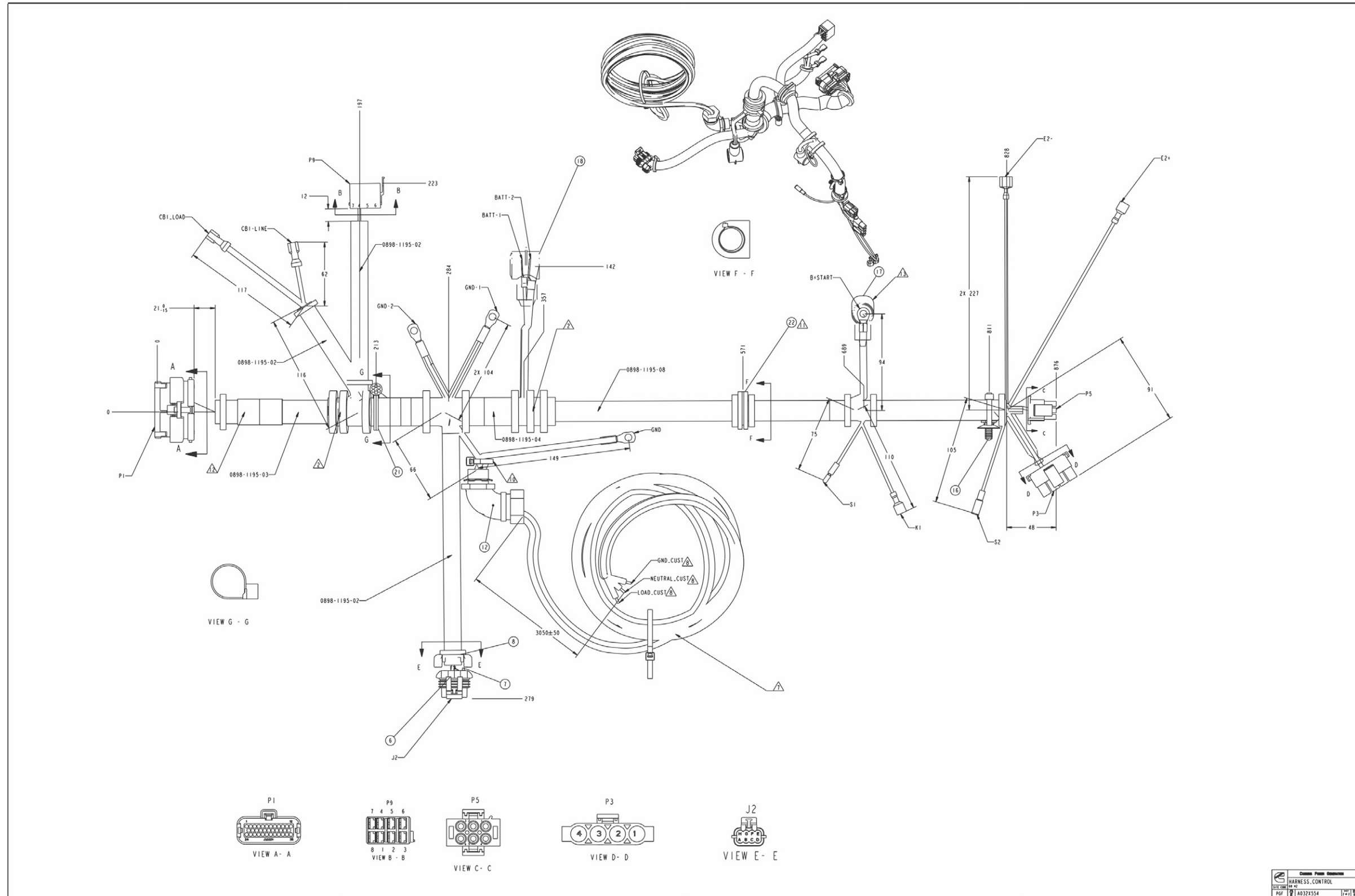


FIGURE 75. A032X554 SHEET 2

A.2 Control Harness - 50 Hz

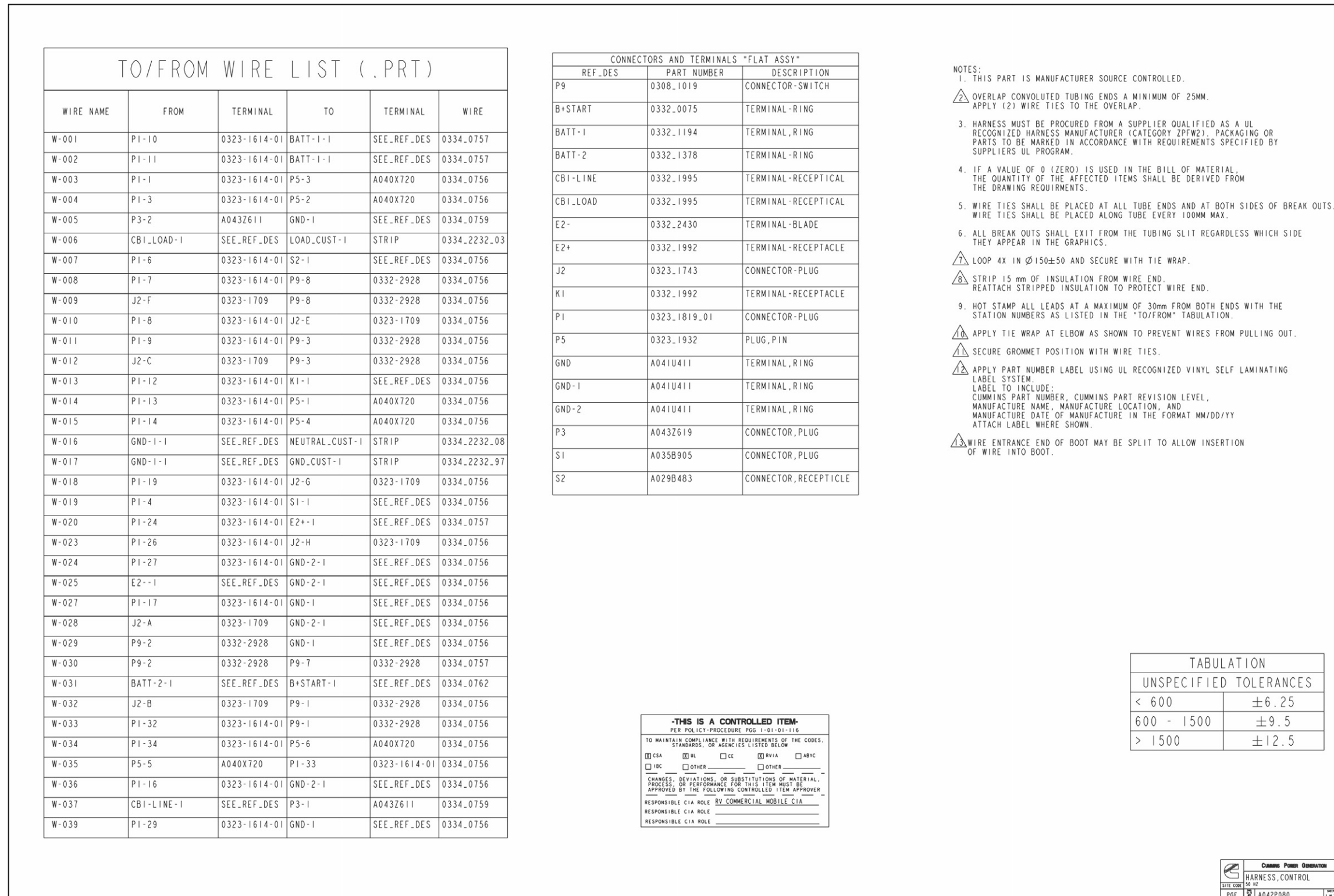


FIGURE 76. A042P080 SHEET 1

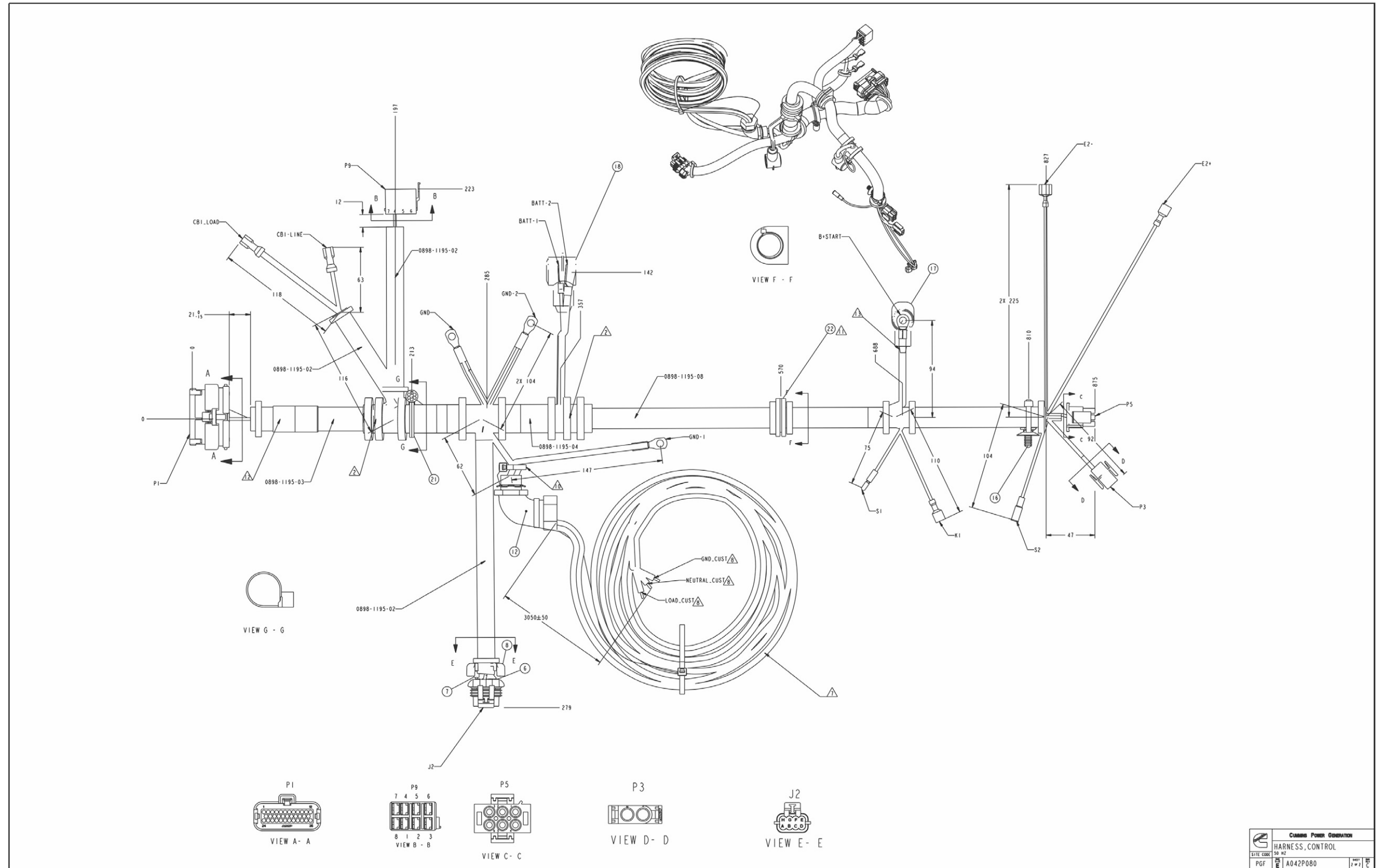


FIGURE 77. A042P080 SHEET 2

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