Operation manual

CM20-25 commercial mobile diesel generator sets with PCC 1302

Manufactured in De Pere, Wisconsin

Doc. A058M279
Rev. 1

CALIFORNIA

Proposition 65 Warning

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

This manual contains proprietary information to equipment produced by Cummins Inc. and is being supplied solely for the purpose of installing the diesel generator set purchased from Cummins Sales and Service in De Pere, Wisconsin. For warranty information, please visit our website at cummins.com.

This product has been manufactured under the controls established by a Bureau Veritas Certification approved management system that conforms with ISO 9001:2015.

Table of Contents

1 - IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS. These important instructions should be followed during installation, operation and maintenance of the generator set and batteries.

Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

1.1 Warning, caution, and note styles used in this manual

The following safety styles and symbols found throughout this manual indicate potentially hazardous conditions to the operator service personnel, or equipment.

⚠ DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTE: *Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).*

1.2 General information

This manual should form part of the documentation package supplied by Cummins Inc. with specific generator sets. If this manual has been supplied in isolation, please contact your authorized dealer.

NOTE: *It is in the operator's interest to read and understand all warnings and cautions contained in the documentation relevant to the generator set operation and daily maintenance.*

General safety precautions:

⚠ WARNING

Hot Pressurized Liquid - Contact with hot liquid can cause severe burns. Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

⚠ WARNING

Moving Parts - Moving parts can cause severe personal injury. Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

Toxic Hazard - Used engine oils have been identified by some state and federal agencies to cause cancer or reproductive toxicity. Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil. Wear protective gloves and face guard.

⚠ WARNING

Electrical Generating Equipment - Incorrect operation and maintenance can result in severe personal injury or death. Do not operate equipment when fatigued, or after consuming any alcohol or drug. Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

⚠ WARNING

Toxic Gases - Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity. Do not breathe in or come into contact with exhaust gases.

⚠ WARNING

High Noise Level - Generator sets in operation emit noise, which can cause hearing damage. Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces - Contact with hot surfaces can cause severe burns. The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Toxic Hazard - Ethylene glycol, used as an engine coolant, is toxic to humans and animals. Wear appropriate PPE. Clean up coolant spills and dispose of used coolant in accordance with local environmental regulations.

⚠ WARNING

Combustible Liquid - Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death. Do not store fuel, cleaners, oil, etc., near the generator set. Do not use combustible liquids like ether.

⚠ WARNING

Combustible Gases - Generator sets in operation have combustible gases under pressure, which if ignited can cause eye and ear damage. Wear appropriate eye and ear protection at all times.

⚠ WARNING

Combustible Gases - Generator sets in operation have combustible gases under pressure, which if ignited can cause severe injury. Do not operate the generator set with any doors open.

⚠ WARNING

Fire Hazard - Materials drawn into the generator set, as well as accumulated grease and oil, are a fire hazard. Fire can cause severe burns or death. Keep the generator set and the surrounding area clean and free from obstructions. Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.

⚠ WARNING

Automated Machinery - Accidental or remote starting of the generator set can cause severe personal injury or death. Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [-] first).

NOTE: *Keep multi-type ABC fire extinguishers close by. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in the applicable region.)*

NOTE: *Before performing maintenance and service procedures on enclosed generator sets, make sure the service access doors are secured open.*

NOTE: *Stepping on the generator set can cause parts to bend or break, leading to electrical shorts, or to fuel, coolant, or exhaust leaks. Do not step on the generator set.*

1.3 Electrical cautions

GenSet voltage is deadly. Generator set output connections must be made by a trained and experienced electrician in accordance with all applicable codes.

⚠ CAUTION

Improper connections can lead to electrocution of utility workers and damage to equipment. Make sure that the connections are installed properly by a trained technician.

Use caution when working on live electrical equipment. Remove jewelry, and make sure clothing and shoes are dry. Stand on a dry wooden platform.

1.4 Fuel hazards

Fuel and fumes are flammable. Fire, explosion, and personal injury or death can result from improper practices.To prevent an accident:

- Do not fill fuel tanks while the engine is running unless the tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- Do not permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the generator set should be made with a flexible line approved for use with diesel fuel. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.

1.5 Battery hazards

Batteries can explode, causing severe skin and eye burns and can release toxic electrolytes. Practice good safety with regard to batteries:

- Wear safety glasses.
- Do not smoke.
- Do not charge frozen batteries.
- Make sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

⚠ WARNING

Combustible Gases - Batteries can explode, causing severe skin and eye burns, and can release toxic electrolytes. Do not dispose of the battery in a fire, because it is capable of exploding. Do not open or mutilate the battery. Do not charge frozen batteries.

⚠ WARNING

Electric Shock Hazard - Batteries present the risk of high short circuit current. When servicing the generator set: remove watches, rings, or other metal objects. Use tools with insulated handles.

NOTE: *Servicing of batteries must be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.*

To prevent arcing when disconnecting the battery:

a. Press the **Off** switch from the display.

b. Disconnect AC power from any battery chargers.

c. Remove the negative (-) battery cable.

d. Remove the positive (+) battery cable.

To prevent arcing when connecting the battery:

a. Connect the positive (+) cable.

b. Connect the negative (-) cable.

c. Connect the battery charger to AC power supply.

When replacing the generator set battery, always replace it with a battery as specified in this manual.

1.6 Personal safety

Moving parts can cause severe personal injury or death. Ensure personal safety when in the area of moving parts:

- Do not wear loose clothing or jewelry near moving parts, such as cooling fans.
- Keep hands away from moving parts.
- Keep guards in place over fans.

1.7 Exhaust gas precautions

Exhaust gases are deadly. Expel discharged gases away from enclosed or sheltered areas, and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust system daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.

Make sure the unit is well-ventilated.

⚠ WARNING

Hot Exhaust Gases - Contact with hot exhaust gases can cause severe burns. Wear personal protective equipment when working on equipment.

⚠ WARNING

Hot Surfaces - Contact with hot surfaces can cause severe burns. The unit is to be installed so that the

risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Toxic Gases - Inhalation of exhaust gases can cause asphyxiation and death. Pipe exhaust gas outside and away from windows, doors, or other inlets to buildings. Do not allow exhaust gas to accumulate in habitable areas.

⚠ WARNING

Fire Hazard - Contaminated insulation is a fire hazard. Fire can cause severe burns or death. Remove any contaminated insulation and dispose of it in accordance with local regulations.

The exhaust outlet may be sited at the top or bottom of the generator set. Make sure that the exhaust outlet is not obstructed. Personnel using this equipment must be made aware of the exhaust position. Position the exhaust away from flammable materials - in the case of exhaust outlets at the bottom, make sure that vegetation is removed from the vicinity of the exhaust.

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated they must be replaced before the generator set is run.

To minimize the risk of fire, make sure that the engine is allowed to cool thoroughly before performing maintenance or operation tasks.

1.8 Carbon monoxide hazards

Carbon monoxide (CO) is hazardous. CO is an odorless, colorless, tasteless and non-irritating gas. You cannot see it or smell it. Red blood cells, however, have a greater affinity for CO than for oxygen. Therefore, exposure even to low levels of CO for a prolonged period can lead to asphyxiation (lack of oxygen) resulting in death. Mild effects of CO poisoning include eye irritation, dizziness, headaches, fatigue and the inability to think clearly. More extreme symptoms include vomiting, seizures and collapse.

Engine-driven generator sets produce harmful levels of carbon monoxide that can injure or kill you.

⚠ WARNING

Toxic Gases - Carbon monoxide (CO) gas can cause nausea, fainting, or death. Depending on air temperature and wind, CO can accumulate in the vicinity. To protect yourself and others from the dangers of CO poisoning, it is recommended that reliable, approved, and operable CO detector alarms are installed in proper locations as specified by their manufacturer.

To protect yourself from CO poisoning:

- Locate the generator set in an area where there are no windows, doors, or other access points into an occupied area.
- Make sure all CO detectors are installed and working properly.
- Pay attention for signs of CO poisoning.
- Check the exhaust system for corrosion, obstruction, and leaks every time you start the generator set and every eight hours when you run it continuously.

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2 - Introduction

2.1 About this manual

⚠ WARNING

Hazardous Voltage - Contact with high voltages can cause severe electrical shock, burns, or death. Make sure that only a trained and experienced electrician makes generator set electrical output connections, in accordance with the installation instructions and all applicable codes.

⚠ WARNING

Electrical Generating Equipment - Faulty electrical generating equipment can cause severe personal injury or death. Generator sets (GenSets) must be installed, certified, and operated by trained and experienced person in accordance with the installation instructions and all applicable codes.

The purpose of this manual is to provide the users with sound, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins Inc. cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Inc. policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that they have the latest information available before starting any work. The latest version of this manual is available on QuickServe Online (https://quickserve.cummins.com).

It is essential that the utmost care is taken with the application, installation, and operation of any GenSet due to their potentially hazardous nature. Careful reference should also be made to other Cummins Inc. literature. You must operate and maintain your GenSet properly if you are to expect safe and reliable operation.

For further assistance, contact your authorized Cummins dealer.

NOTE: *This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:*

- *This device may not cause harmful interferences.*
- *This device must accept any interference received, including interference that may cause undesired operation.*

2.2 Related literature

A GenSet 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 literature provided with the GenSet is as follows:

- Warranty statement (A042E778)
- Emissions component defect warranty statement (A048K395)
- GenSet installation manual (A058M278)
- GenSet operator manual (A058M279)
- PowerCommand 1302 controller owner's manual (900-0661)

The relevant manuals appropriate to your GenSet are also available. The documents below are in English:

- GenSet service manual (A058M280)
- Kubota V2403-CR-TIE4 engine service manual (A058M772)
- Kubota V2403-CR-TIE4 engine operator's manual (A058M771)
- Kubota V2403-CR-TIE4 engine diagnosis manual (A058M770)
- Kubota V2403-CR-TIE4 service specifications (A058M773)
- Kubota V2403-CR-TIE4 parts manual (A058M769)
- Application manual T-030 - for application information (A040S369)

2.3 GenSet identification

Each GenSet is provided with a datatag similar to that shown below. The datatag provides information unique to the GenSet.

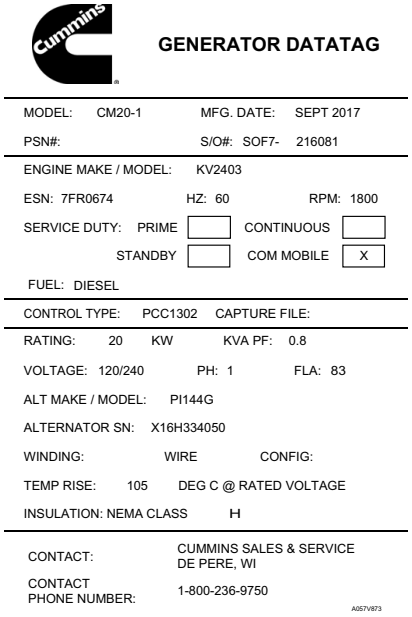


Figure 2-1 GenSet datatag

Be ready to provide the model, specification, and serial numbers on the GenSet nameplate when contacting Cummins Inc. for information, parts, and service. Record these numbers so that they are easy to find when needed. Each character in these numbers is significant for obtaining the right parts. Genuine Cummins Inc. replacement parts are recommended for best results.

NOTE: *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.*

2.4 Model specifications

Table 2-1. Model variations

	CM20	CM25
Engine	Kubota V2403-CR-TIE4	
Cylinder	4	
Hz	60	
RPM	1800	

Table 2-2. GenSet size specifications

Configuration	CM20	CM25
Open set	58 x 26 x 34 in. (1467 x 658 x 868 mm)	
Closed set	59 x 27 x 35 in. (1499 x 686 x 889 mm)	

Table 2-3. GenSet weight specifications

Configuration	CM20	CM25
Open set	1228 pounds	
Closed set	1450 pounds	

Table 2-4. Oil recommendations

	CM20	CM25
Temperature range	**Oil specification:** **Oil viscosity changes in cold temperature as crystallization of the wax element contained in oil proceeds, and fluidity is finally lost. Wrong selection of oil cannot only increase resistance for cold starting but also affect lubrication of each part. Oils for low temperature, containing additives for lowering the pour point, should be used. Oil used in the engine should have API classification and proper SAE engine oil viscosity according to the ambient temperatures where the engine is operated.** **NOTE: The use of synthetic oil is not recommended.** **Lubricating oil recommendation - CJ-4 or CK-4**	
Above 77 °F (25 °C)	10W-30 or 10W-40 or 15W-40	
Between 14 and 77 °F (-10 to 25 °C)	10W-30 or 10W-40 or 15W-40	
Below 14 °F (-10 °C)	10W-30 or 10W-40	

Table 2-5. Alternator specifications 60 Hz, 1800 RPM

	CM20	CM25
Generator	Cummins, brushless, drip proof construction - double-sealed, pre-lubricated ball bearing	
Power (kVA) 1-phase/3-phase-prime	20	25
Rated voltages (V)	120/240, 1-Ph	
	120/208, 3-Ph	
	277/480, 3-Ph	

Table 2-6. Fuel consumption

	CM20	CM25
Full load	1.75 gal/hr (6.62 L/hr)	2.18 gal/hr (8.25 L/hr)

Table 2-7. Engine specifications

	CM20	CM25
Engine	Kubota V2403-CR-TIE4	
Aspiration	Turbocharged	
Displacement	2434 cm^3 (149 in^3)	
Compression ratio	16:1	
Lube oil capacity	10 qt. (9.5 L)	
Fuel	Diesel fuel: Meeting European Norm (EN) 590 or American Society of Testing and Materials (ASTM) D975 recommended.	
	Cetane Rating: Minimum recommended is 45. A rating greater than 50 is preferred, especially in low ambient temperatures below -4 °F (-20 °C) and elevations above 5000 ft (1500 m).	
	DO NOT USE fuels that have sulfur content greater than 0.0015% (15 ppm).	
	The use of ultra-low sulfur diesel fuel is mandatory for Interim Tier 4 and/or later standards compliant engines, when operated in US EPA regulated areas. Therefore, use No. 2-D S15 diesel fuel as an alternative to No.2-D, and use No. 1-D S15 diesel fuel as an alternative to No. 1-D for ambient temperature below 14 °F (-10 °C).	
	If the engine is to be operated within the European Union on diesel or non-road gas-oil, a fuel with sulfur content not greater than 10 mg/kg (20 mg/kg at point of final distribution), a cetane number not less than 45 and a fatty acid methyl ester (FAME) content not greater than 7% volume per volume (v/v) shall be used.	

Table 2-7. Engine specifications

	CM20	CM25
Cooling system	2.75 gal. (10 L)	
Coolant	50/50 coolant solution (50% distilled or de-ionized water and 50% ethylene glycol)	
Exhaust	Maximum allowable back pressure at the turbocharger 51 in. H_2O (12.7 kPa)	
	Exhaust flow at rated load: 155 cfm (4.4 m^3/min.)	
	Exhaust temperature: 932 °F (500 °C)	
Fuel connections	Fuel Supply: 1/4 in. female npt	
	Fuel Return: 1/4 in. female npt	

Table 2-8. GenSet derates

	CM20	CM25
Prime	Engine power available up to 9514 ft (2900 m) and ambient temperatures up to 77 °F (25 °C). Above these conditions, derate at 1% per 100 m (328 ft) and 7% per 18 °F (10 °C).	Engine power available up to 8200 ft (2500 m) and ambient temperatures up to 77 °F (25 °C). Above these conditions, derate at 1% per 100 m (328 ft) and 7% per 18 °F (10 °C).

Table 2-9. DC system specifications

	CM20	CM25
Nominal battery voltage	12 VDC	
Minimum cold crank	830	

Table 2-10. Cold weather starting specifications

CM20	CM25
Temperature range	**Starting specifications**
Above -4 °F (-20 °C)	No starting aids required.
Below -4 °F (-20 °C)	Coolant heater required. Factory option available.

2.5 After sales service

Cummins offers a full range of maintenance and warranty services.

2.5.1 Maintenance

For expert GenSet service at regular intervals, contact your Cummins Inc. service provider. See power.cummins.com/sales-service-locator for service locations that service this application. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your Cummins Inc. service provider.

⚠ WARNING

Electrical Generating Equipment - Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage. Make sure service personnel are qualified to perform electrical and mechanical service.

2.5.2 Warranty

For details of the warranty coverage and limitations for your GenSet, refer to the Warranty Statement listed in the Related Literature section.

Extended warranty coverage is also available. In the event of a breakdown, prompt assistance can normally be given by factory trained service technicians with facilities to undertake all minor and many major repairs to equipment on site.

For further warranty details, contact your authorized dealer.

NOTE: *Damage caused by failure to follow the manufacturer's recommendations will not be covered by the warranty. Please contact your authorized dealer.*

2.5.3 How to obtain service

For parts, service, and product information, contact the nearest authorized Cummins Inc. dealer. To easily locate the nearest certified distributor/dealer for Cummins GenSets in your area, or for more information, contact us at 1-800-CUMMINS (1-800-286-6467) or visit http://www.cummins.com/support.

3 - Control system

3.1 Introduction

Before attempting to start the generator set (GenSet), the operator should read through this entire manual and the specific engine manual provided either as part of the documentation package supplied with the GenSet or on Quick Serve Online (QSOL). It is essential that the operator be completely familiar with the GenSet and the remote operator panel, if applicable.

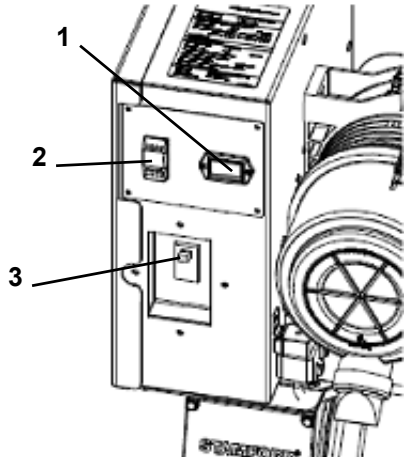
The GenSet may be operated manually using the GenSet control panel or using the remote operator panel. Access and operation of the GenSet must be restricted to qualified service personnel who have been instructed of the reasons for the restrictions applied to the location of the GenSet and any precautions that must be taken.

When using the GenSet control panel, the GenSet functionality is limited to starting and stopping. Fault diagnostics are only available using the *remote* operator panel.

3.2 Control panel

As shown in Figure 3-1, the control panel has the following features:

- Hour Meter - The hour meter records the total running time of the GenSet. It cannot be reset.
- Control Switch - This switch is used to start and stop the GenSet, as well as set the GenSet for remote operation. The Control Switch has three positions: **START** (in the **UP** position), **STOP** (in the **FLUSH** position), and **REMOTE OPERATION** (in the **DOWN** position).
- Line Circuit Breaker - The line circuit breaker protects the AC power leads connected to the GenSet.



1. Hour Meter
2. Control Switch
3. Line Circuit Breaker

Figure 3-1 GenSet control panel

3.3 Remote operator panel

The remote operator panel can be used to start and stop the GenSet and provides GenSet monitoring capability and fault indication. It monitors the GenSet for temperature, oil pressure, speed and voltage. In the event of a fault, the unit will indicate the fault type and, on critical faults, automatically shut down the GenSet.

All indicators, control buttons, and the display screen are on the face of the remote operator panel shown in Figure 3-2.

There are two fault level signals generated by the control system:

- **Warning**: Signals an imminent or non-critical fault for the GenSet. The control provides an indication only for this condition.
- **Shutdown**: Signals a potentially critical fault for the GenSet. The control will immediately take the engine off-load and automatically shuts it down.

As shown below, the remote operator panel includes six LED indicators, the graphical display, and six buttons used to navigate through the menus and adjust parameters.

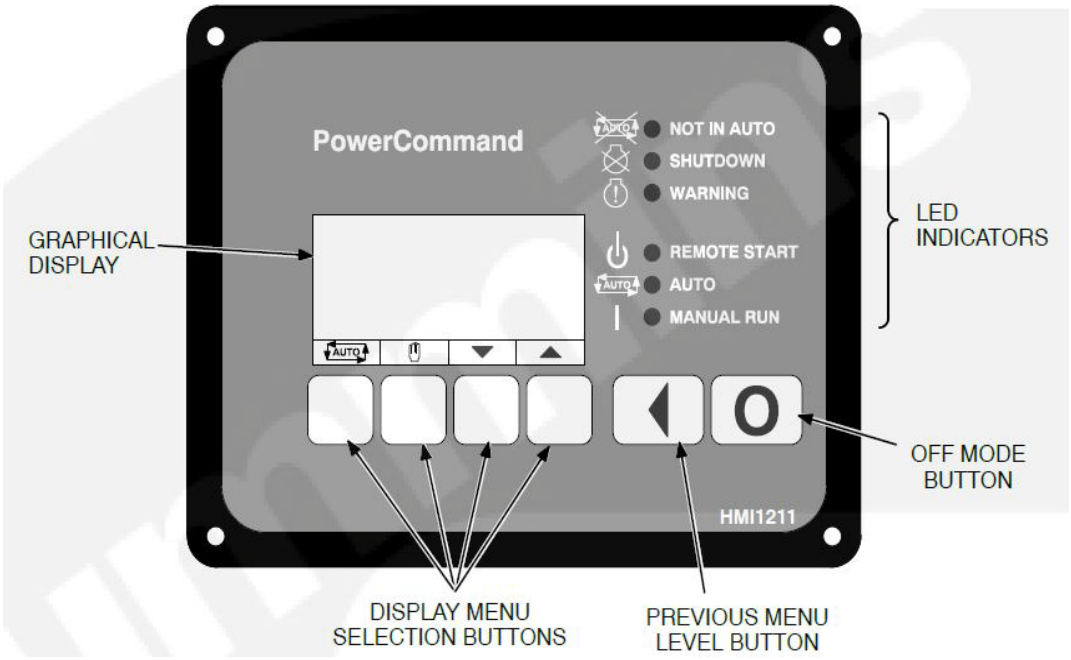


Figure 3-2 Remote operator panel

3.3.1 LED indicators

The operator panel includes six LED indicators:

Table 3-1. LED indicators

LED	LED meaning	LED definition
	**Not in Auto**	This red lamp is lit when the control is NOT in **Auto** mode.
	**Shutdown Status**	This red lamp is lit when the control detects a Shutdown condition. The GenSet cannot be started when this lamp is on. After the condition has been corrected, the lamp can be reset by pressing the **Off Mode Button**.
	**Warning**	This amber lamp is lit whenever the control detects a Warning condition. This lamp is automatically shut off when the Warning condition no longer exists.
	**Remote Start**	This green lamp indicates the control is receiving a remote run signal.
	**Auto**	**Auto** mode is not supported for this application.
	**Manual Run**	This green lamp indicates that the control is in the **Manual Run** mode.

3.3.2 Off Mode Button

Press the GenSet **Off Mode Button** to switch to **Off** mode. **Off** mode disables the control's **Auto** or **Manual Run** modes. Pressing the **Off Mode Button** resets the control.

If the **Off Mode Button** is pressed during GenSet operation, the engine immediately shuts down. If possible, hot shutdown under load should be avoided to help prolong the life of the GenSet.

3.3.3 Previous Menu Level Button

Press the **Previous Menu Level Button** to view the previous main menu.

3.3.4 Display Menu Selection buttons (four) - for use with the Menu Bar

Four momentary soft-key buttons are used to step through the various menus and to adjust parameters. These selection buttons are "active" when a word or symbol in the graphical display is shown in the menu bar above the button. Some sub menus do not include any active buttons.

The function of the four selection buttons varies with each menu.

Table 3-2. Menu Bar icons

Menu Bar display icon/information	**Purpose of the Selection button below the Menu Bar**
	**Auto** mode is not supported for this application.
	The selection button below can be used to switch to **Manual Run** mode.
▲ and ▼	The selection button below the UP or DOWN arrow is used to navigate between a series of sub menus. **NOTE:** *When any Operator menu is displayed, a series of Service menus can be viewed by simultaneously pressing the UP. and DOWN selection buttons for two seconds.*
◀	The selection button below the left arrow icon can be used to abort the **Auto** or **Manual Run** mode and return to the Operator menu that was displayed before the **Auto** or **Manual Run** mode was selected.
ADJUST	The selection button below the word ADJUST is used to display an adjustable menu. When the **ADJUST Button** is pressed, the first adjustable parameter or value in the sub-menu is highlighted.
--->	The selection button below the right directional arrow is used to navigate to an editable field within a menu.
+ and -	The selection button below the + or - symbol is used to increase or decrease a parameter or value shown on the screen. Pressing the button below the + symbol increases the value and pressing the button below the - symbol decreases the value.
SAVE	The selection button below the word SAVE is used to save changes made in a sub-menu. *If the **Previous Menu Button** is pressed before pressing SAVE, the changes are not saved.*
“1”, “2”, etc.	Some menus include a list of numbered subjects. These menus include numbers in parenthesis (for example, (1)) displayed above the selection buttons. The selection buttons are then used to display sub menus of the subjects included in the list.
■	When a black box is displayed, the selection button below it has no function.

3.3.5 Graphical Display

The operator panel graphical display can be set to show text (English only) or symbols for fault messages, operator menus, and the Mode Change Menu. Descriptions of commonly used symbols are included in the following table. Combinations of symbols are used to display some fault conditions.

NOTE: *When shipped from the factory, the display is set to display symbols. Qualified service personnel are required to change the default setting.*

NOTE: *The operator panel can display SAE or Metric units of measurement and should be set during the initial setup of the GenSet. Only trained and experienced personnel are allowed to change the default setting. Contact your authorized dealer.*

Symbol	
	Generator Warning Fault
	Generator Shutdown Fault
	Coolant Temperature
	Oil Pressure
	Voltage Alternating Current (VAC)
	Voltage Direct Current (VDC)
	AC Current
Hz	Frequency
	Battery
	Out of Range
	High or Pre-High
	Low or Pre-Low
	Annunciator
	Over Speed
	Crank Fail
	Emergency Stop

3.4 Remote menus

The remote operator panel manual (PowerCommand 1302 controller owner's manual (900-0661)) that was included in the GenSet shipment provides detailed information for navigating the operator panel menus.

3.5 Remote operating modes

The remote operator panel supports **Off** mode, **Manual Run** mode and **Sleep** mode. **Auto** mode is not supported for this application.

3.5.1 Off mode

When in the **Off** mode, the remote operator panel does not allow the GenSet to start.

If the **Off Mode Button** is pressed during GenSet operation, the engine immediately shuts down. If possible, hot shutdown under load should be avoided to help prolong the life of the GenSet.

After the GenSet is stopped, pressing the **Off Mode Button** resets all active faults.

3.5.2 Manual Run mode

When in **Manual Run** mode, the GenSet starts and continues to run until the control is put into the **Off** mode.

3.5.3 Sleep mode

The PowerCommand control enters a low power (**Sleep**) mode of operation where the current draw is less than 60 milliamps (DC) at normal battery voltage levels. The operator panel turns itself off (goes to sleep) after five minutes of keypad inactivity in the **Off** or **Auto** mode. It awakes from the **Sleep** mode if any button is pressed.

4 - Operation

4.1 Introduction

This section covers pre-start checks and starting and stopping the Generator Set (GenSet). Each operator should read through this entire section before attempting to start the GenSet. It is essential that the operator be completely familiar with the GenSet and its controls. The text should be read in conjunction with the Control System section of this manual.

4.2 Operating recommendations

This GenSet shall be operated as a prime unit. For warranty and rating specifications, refer to the GenSet warranty statement (A042E778).

4.2.1 Running-In

Proper engine oil and oil level are especially critical during break-in because of the higher engine temperatures that can be expected. Change the oil, if the current oil is not appropriate for the ambient temperatures during break-in. Check the oil level twice a day or every four hours during the first 24 hours of operation and change the oil and oil filter after the first 50 hours of operation.

4.2.2 No load operation

If the engine is kept running under no load or light load (load factor below 30%), unburnt fuel or carbon builds up in the exhaust system. As a result, the engine may get damaged or cause a fire. Run the engine under enough load at regular intervals to remove unburnt fuel and carbon deposits.

If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a load of at least 30% rated load, but not to exceed rated load. Such a load could consist of a heater element or load bank.

4.2.3 Loading the GenSet

The GenSet can power AC motors, air conditioners, AC/DC converters, battery chargers and other appliances. How much appliance load can be powered depends upon the GenSet power rating. The GenSet will shut down or its circuit breakers will trip if the sum of the loads exceeds the rated GenSet power.

⚠ WARNING

Before doing the load operation, make sure there is nothing flammable around the engine.

NOTE: *Appliance load and GenSet power are measured in terms of kilowatts (kW) or watts (W), where 1 kW = 1000 W.*

To avoid overloading the GenSet and causing shut- downs, compare the sum of the loads of the appliances that are likely to be used at the same time to the power rating of the GenSet. It may be necessary to run fewer appliances at the same time. The sum of the loads must not be greater than GenSet power rating. The derates for this GenSet are found in Table 2-8. GenSet derates.

IMPORTANT: *The GenSet may shut down due to overload when a large motor or air conditioner is started or cycles off and then on again, even though the sum of the loads is less than the GenSet rating. The reason for this is that a motor's startup load is much larger than its running load. It may be necessary to run fewer appliances when large motors and air conditioners are cycling on and off.*

NOTE: *The GenSet will continue to run after a circuit breaker trips.*

⚠ WARNING

Electrical appliances and tools must be used and maintained properly and be properly grounded to cause the line circuit breakers to trip when short circuits occur.

⚠ WARNING

Short circuits in electrical appliances and tools can cause fire and electrical shock leading to severe personal injury or death. Read and follow the equipment and tool manufacturer's instructions and warnings regarding use, maintenance and proper grounding.

4.2.4 Low temperature operation

NOTE: *Incorrectly operating engines in cold ambient temperatures can waste fuel and accelerate wear, and can result in serious engine damage.*

In cold climates it is critical that the following items be appropriately maintained and selected based on ambient operating temperatures. Check to be sure:

- The battery is properly sized.
- An appropriate mixture of antifreeze is used in the cooling system.
- The proper grade of fuel is being used.
- The engine oil viscosity is appropriate for the cold weather temperatures.
- The engine is at operating temperature prior to applying a load (140 °F or ten minutes of no-load warm up).

Use a coolant heater if a separate source of power is available. The optional heater available from Cummins will help provide reliable starting under adverse weather conditions. Make sure the voltage of the separate power source is correct for the heater element rating.

4.2.5 High temperature operation

The open-set GenSet is qualified to operate at a maximum ambient temperature of 70 °C (158 °F) at 25kWe output. The closed-set GenSet is qualified to operate at a maximum ambient temperature of 50 °C (121 °F) at 25kWe output. If operation in high temperature environments is anticipated, increase the frequency of checks for coolant level, obstructions of cooling air inlets and outlets, and debris at the radiator. Pay particular attention to the following items when operating the GenSet in hot weather:

- Make sure nothing blocks the airflow to and from the GenSet.
- Keep the GenSet clean.
- Ensure the engine oil viscosity is appropriate for the hot weather temperatures. Be sure to change the oil if a sudden drop in temperature occurs. Refer to Table 2-4. Oil recommendations.
- Perform all necessary maintenance.

4.2.6 High altitude operation

For the effect of altitude on maximum power, see Table 2-8. GenSet derates.

4.3 Pre-start checklist

Before starting the GenSet, check the following items to ensure the unit is ready for operation.

4.3.1 Lubrication

Check the engine oil level. Keep the oil level within the operating range of the dip stick. Refer to Table 2-4. Oil recommendations.

NOTE: *GenSets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check the oil level before initial start. Failure to fill to the recommended level can result in equipment damage.*

4.3.2 Coolant

GenSets are normally shipped with coolant already added. Check the engine coolant level at the expansion tank and ensure that the appropriate level is always maintained. Fill the cooling system to the bottom of the fill neck of the radiator and to the “full cold” level of the expansion tank. Do not check coolant levels while the engine is hot. It is essential to comply with the recommended type and concentration of anti-freeze. Refer to Table 2-7. Engine specifications.

⚠ WARNING

Do not attempt to remove a radiator pressure cap while the GenSet is running, or is still hot. Hot coolant is under pressure in the radiator system. Contact with hot coolant can result in severe burns. Always allow it to cool before releasing the pressure and removing the cap.

4.3.3 Fuel

Verify that the fuel piping and flex are installed correctly. Make sure that there are no leaks and that all fittings are tight. Refer to Table 2-7. Engine specifications.

⚠ WARNING

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

IMPORTANT: *Incorrect fuel usage may affect the GenSet warranty.*

4.3.4 Ventilation

Verify that the GenSet cooling inlet/outlet and exhaust ventilation openings are unobstructed and operational.

Remove all loose debris from the surrounding area of the GenSet. Air flow from the radiator fan can blow loose items around and into ventilation openings.

Ensure that the exhaust components are secured and not warped. Clear the area of all combustible materials. Clear the ventilation and exhaust outlets of any snow buildup or other obstructions. Ensure that gases are to be discharged away from building openings. Make sure that there are no exhaust outlet leaks and that all fittings are tight.

⚠ DANGER

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

- ***Dizziness or inability to think coherently***
- ***Nausea or vomiting***
- ***Headache***
- ***Weakness and sleepiness***
- ***Throbbing in temples***
- ***Muscular twitching***

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 unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspection of the complete exhaust system.

4.3.5 Batteries

Refer to Table 2-9. DC system specifications.

4.4 Local and/or remote operation

Before attempting to start the GenSet, the operator should read through this entire manual. It is essential that the operator be completely familiar with the GenSet and the remote operator panel (if equipped).

The following sub-sections cover the procedures used to start and stop the GenSet. Before starting the GenSet, make sure that the proper maintenance and pre-start checks have been performed.

⚠ CAUTION

One operator should be in complete charge, or working under the direction of someone who is in complete charge. Remember that, upon starting the GenSet, cables and switchgear will become energized, possibly for the first time. Furthermore, equipment that does not form part of the GenSet installation may become electronically charged. Only authorized and competent personnel should carry out this work.

⚠ CAUTION

Avoid off-load running for other than short periods. A minimum loading of 30% is recommended. This loading will help to prevent the build up of carbon deposits. The engine must be shut down as soon as possible after the appropriate functions have been checked.

Before the first start of the day and after every eight hours of operation, inspect the GenSet. Keep a log of maintenance and the hours run and perform any maintenance that may be due.

Before each start:

- Make sure all vehicle carbon monoxide (CO) detectors are working.
- Check for fuel, oil and coolant leaks and damage to the exhaust system.
- To prevent overheating and to reduce fouling with dust and debris, make sure the GenSet's normal ground clearance is not reduced by sloping ground, curbs, logs or other objects. Relocate the GenSet, if necessary, and/or remove any objects blocking the air inlet or air outlet.

- Turn off all loads.
- Make sure that nothing is stored in the area around the GenSet and make sure that nothing is interfering with GenSet operation.

The GenSet may be operated manually using the GenSet control panel or automatically using a remote start signal from the operator panel. Access and operation of the GenSet must be restricted to qualified service personnel who have been instructed of the reasons for the restrictions applied to the location of the GenSet and any precautions that must be taken.

The control switch (shown in Figure 4-1) on the control panel has three positions:

- Paddled UP - **Start** (**ON**)
- Paddled FLUSH - **Stop (OFF)**
- Paddled DOWN - **REMOTE OPERATION**

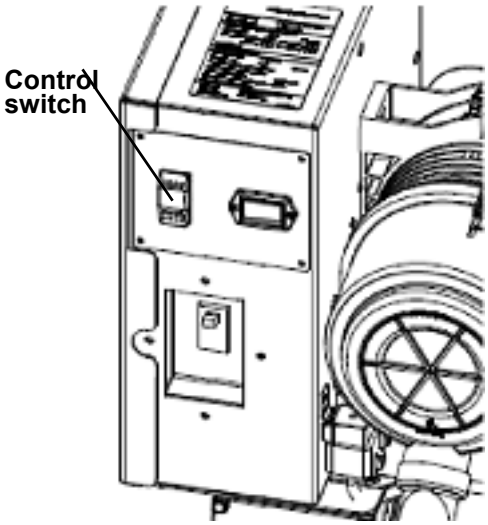


Figure 4-1 GenSet control panel

4.4.1 Local operation

⚠ CAUTION

Make sure that all Pre-start Checks are carried out before starting the GenSet. Do not attempt to start the GenSet until it is safe to do so. Cummins Sales and Service recommends regular inspections and cleaning of discharge hoods. Snow buildup on or around the GenSet and other obstructions can cause GenSet failure and possible damage to the equipment. Warn all others in the vicinity that the GenSet is about to start.

To start the GenSet at GenSet control panel:

1. Turn off all electrical loads.

2. As shown in Figure 4-2, press the control switch **UP** (**Manual Run**) to initiate the GenSet start sequence. The control switch should remain in the **UP** position until the operator chooses to stop the GenSet.

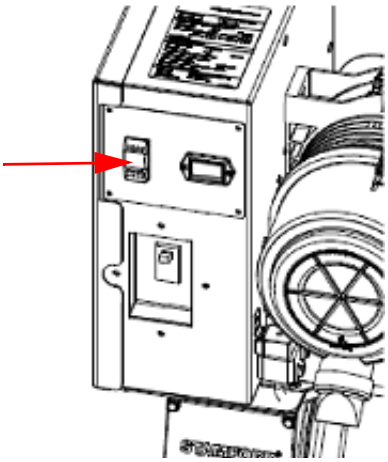


Figure 4-2 GenSet control switch

IMPORTANT: *The GenSet will crank for ten seconds and rest for thirty seconds in three attempts. If the GenSet fails to start after three attempts, a fault will occur. Clear the fault prior to re-initiating the start sequence. Excessive cranking can overheat and damage the starter motor. Before initiating a re-start sequence, wait a minimum of two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second sequence, refer to 6 - Troubleshooting of this manual.*

3. Allow the GenSet to warm up for a few minutes until it is running smoothly before connecting any vehicle electrical loads (appliances).

4. Check for fuel, oil, coolant and exhaust leaks. If a leak is identified, stop the GenSet immediately and have it repaired.

5. Run the GenSet at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

6. To stop the GenSet, paddle the control switch flush to the **OFF** position.

4.4.2 Remote operation

⚠ CAUTION

Make sure that all Pre-start Checks are carried out before starting the GenSet. Do not attempt to start the GenSet until it is safe to do so. Cummins Sales and Service recommends regular inspections and cleaning of discharge hoods. Snow buildup on or around the GenSet and other obstructions can cause GenSet failure and possible damage to the equipment. Warn all others in the vicinity that the GenSet is about to start.

To start the GenSet using the remote operator panel:

1. Turn off all electrical loads.

2. As shown in Figure 4-3, press the control switch **DOWN** (**REMOTE OPERATION**) on the GenSet. The control switch must remain in the **DOWN** position while the GenSet is being operated remotely.

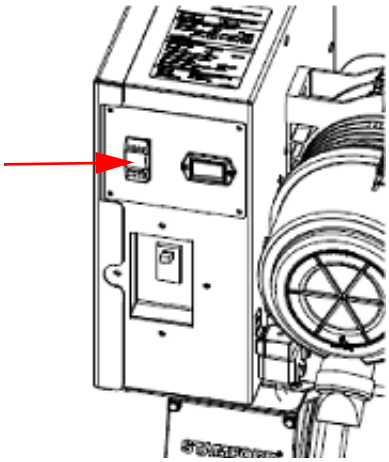


Figure 4-3 GenSet control switch

3. As shown in Figure 4-4, press the **Off Mode Button** (the “O”) on the remote operator panel. The graphical LCD panel will wake up and enter an initializing mode.

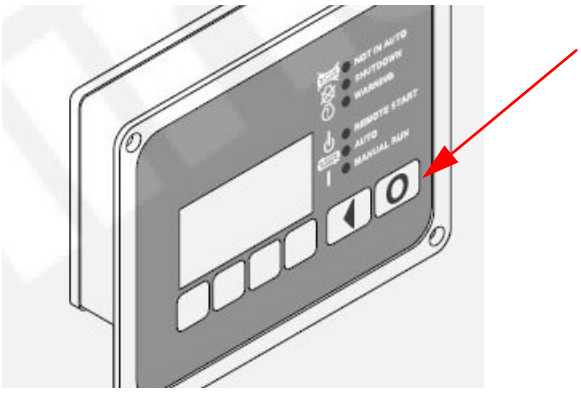


Figure 4-4 GenSet control switch

4. The electric fuel pump will start to run.

5. As shown in Figure 4-5, when the graphical LCD panel initializing is completed, press the **Manual Run Button** (the button underneath the hand symbol).

NOTE: *If the Mode Change Access Code is enabled (shown in Figure 4-5), a prompt for the **Mode Change Access Code** will be displayed and the operator will have to enter the **Mode Change Access Code**. Refer to the PC1302 Owner Manual (*900-0661*).*

6. As shown in Figure 4-5, a menu with two down-facing arrows will be displayed above a second **Manual Run** symbol. Press the second **Manual Run Button** (the button underneath the hand symbol) and the GenSet will now begin the manual start sequence.

NOTE: *Depending on the GenSet ambient temperature, the unit may have to pre-heat prior to starting.*

7. As shown in Figure 4-5, the Operator menu (that was displayed before **Manual Run** mode was selected) will be re-displayed, but with the symbol blacked out.

NOTE: ***Auto*** *mode is not supported for this application. It is possible for the operator to select **Auto** mode while in **Manual Run** mode, but the GenSet will shut down.*

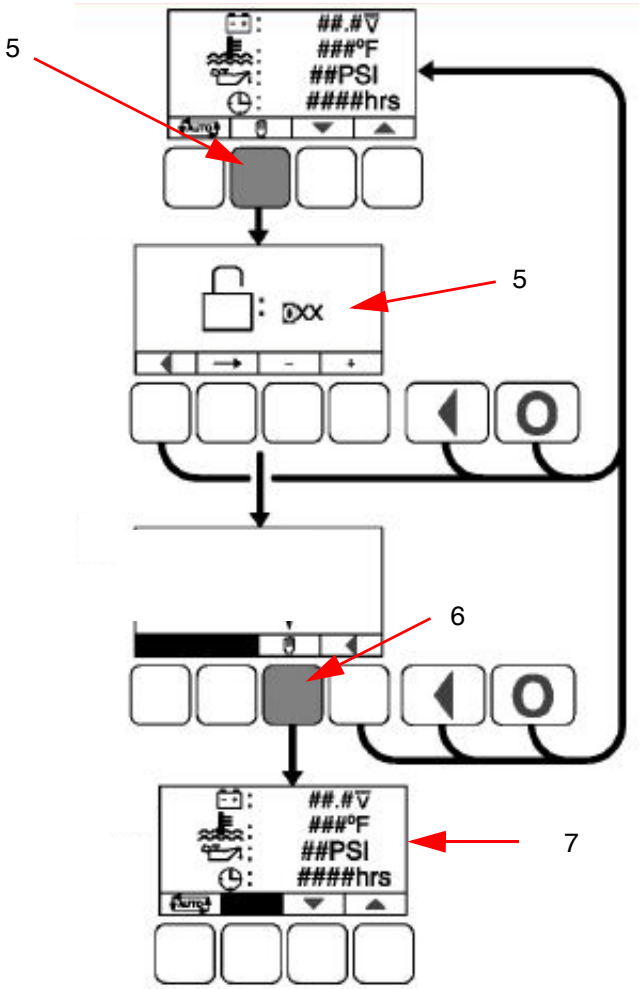


Figure 4-5 Manual run

There are two ways to stop the operation of the GenSet when it has been running in **Manual Run** mode (from the remote operator panel). The operator can shut down the GenSet remotely from the remote operator panel, or manually from the GenSet control panel.

IMPORTANT: *Make sure that it is safe to do so before proceeding to stop the GenSet.*

To ***remotely*** stop operation of the GenSet from the remote operator panel:

1. As shown in Figure 4-6, press the **Off Mode Button** (the “O”) on the remote operator panel. The GenSet will complete its normal shutdown sequence incorporating a cool down run. An “ECM data save” message will appear on the display. After the ECM data is saved, the remote operator panel will stay awake for five minutes. The fuel pump will run while the panel is awake and will shut down 30 seconds after the panel goes to sleep.

NOTE: *If the Mode Change Access Code is enabled (shown in Figure 4-6), a prompt for the **Mode Change Access Code** will be displayed and the operator will have to enter the **Mode Change Access Code**. See the PC1302 Owner Manual (*900-0661*).*

2. As shown in Figure 4-6, the basic screen will re-appear, and the GenSet will stop immediately.

NOTE: *Make sure that there is no danger to personnel or equipment if the GenSet is stopped.*

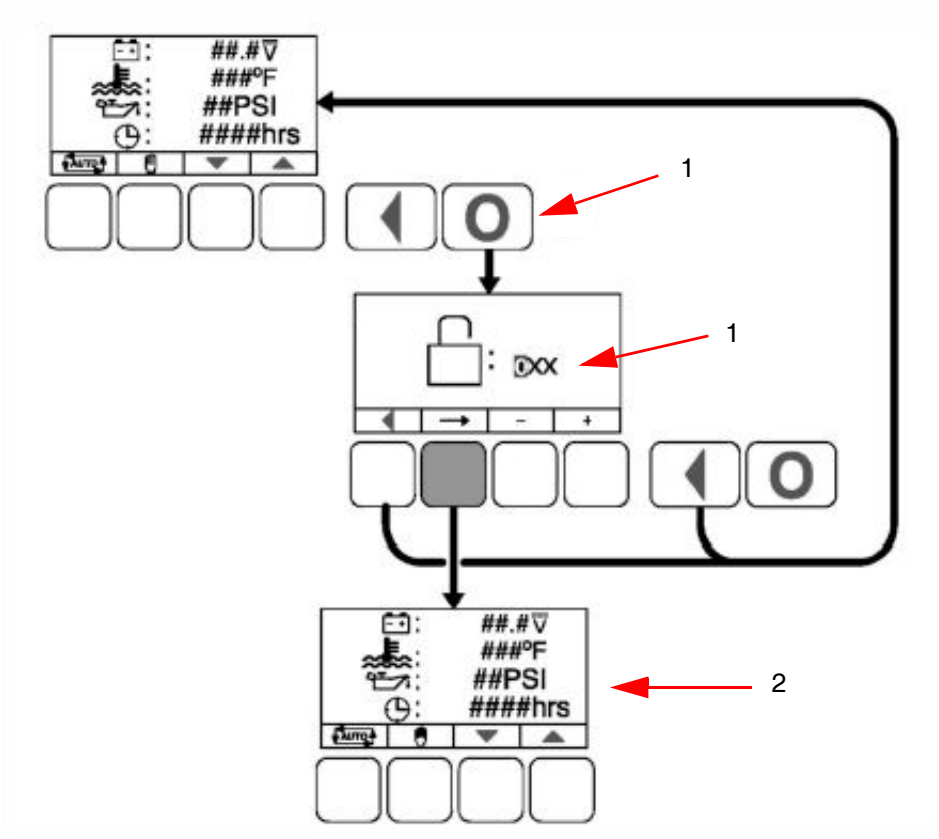


Figure 4-6 Off mode

3. To completely turn the GenSet off, paddle the control switch (on the GenSet control panel) flush to the **OFF** position.

4. The GenSet will then enter the **Off** mode.

To ***manually*** stop operation of the GenSet from the control panel:

1. To reduce engine heat, remove the load.

2. Run the GenSet for five minutes with no load for cool-down.

3. Paddle the control switch (on the GenSet control panel) flush to the **OFF** position.

4. The GenSet will then enter the **Off** mode.

NOTE: *Hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a* ***Hot Shutdown Warning.***

4.5 Engine overspeed air shutoff device, if equipped

If flammable gas or vapor is present in the atmosphere surrounding a diesel engine, it can be ingested into the engine and become an ungoverned fuel supply, resulting in an overspeed condition, which can lead to mechanical failure or explosion. As shown in Figure 4-7, the air shutoff (ASO) valve, which is electrically controlled via the GenSet PowerCommand Control (PCC), provides emergency overspeed shutdown of a diesel engine by starving the engine of air and shutting down the engine.

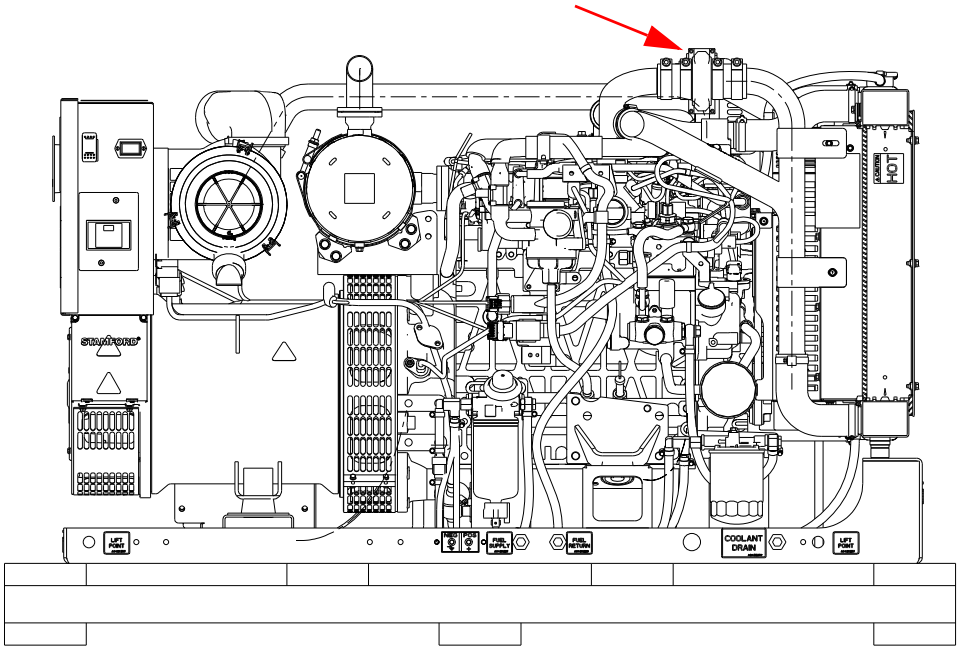


Figure 4-7 Air shutoff (ASO) valve

If an overspeed condition occurs, and the ASO valve is activated, “Overspeed/ASO Lockout” will appear on the remote operator panel graphical display. To reset this fault:

1. Press the **OFF MODE** button on the remote operator panel.
2. A “Reset ASO” message will display on the remote operator panel graphical display. To reset the unit, rotate the actuation lever clockwise until the lever clicks into place.
3. Press the **RESET** button on the remote operator panel.

NOTE: *The remote operator panel MUST be used on GenSets equipped with an ASO.*

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5 - Maintenance

5.1 Introduction

The engine and generator set (GenSet) are to be operated in accordance with all manufacturer's guidelines and recommendations. The following sections outline the steps and guidelines for general inspections and maintenance repairs.

All maintenance tasks must be assessed for health and safety risks and the preventative measures identified must be actioned. Accompaniment is required for tasks where the presence of someone else will add significantly to the safety of the task. Read, understand, and comply with all Caution and Warning notes in this manual. Ensure adequate lighting and staging (where required) are installed.

All warranty work must be completed by an authorized Cummins distributor. For additional engine maintenance information that is not contained in this manual, see the engine Operator's Manual.

5.2 Recommended maintenance schedules

It is recommended that an annual maintenance check be performed by a qualified Service Center.The GenSet should be maintained according to the maintenance schedules outlined in Table 5-1. Perform maintenance tasks as specified using hourly or daily periods - whichever occurs first. Use the running time meter to keep an accurate log of all service performed.

Some maintenance procedures require special tools or must be completed by qualified personnel. Contact your local Cummins Authorized Repair Location for detailed information. For additional information on engine-specific maintenance procedures, reference the engine Operator's Manual.

If the GenSet will be subjected to any extreme operating conditions, consult with your local Authorized Cummins Distributor and determine a suitable schedule of maintenance. The time between service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule include:

- Extremes in ambient temperature
- Exposure to weather
- Exposure to salt water
- Exposure to dust, sand, or other airborne contaminates

Regularly performing the following periodic maintenance tasks greatly reduces the chances of a GenSet shutdown:

- Maintain an appropriate oil level.
- Keep battery connections clean and tight.
- Do not overload the GenSet.
- Keep the air inlet and outlet openings clear.

NOTE: *Perform maintenance tasks as specified using the period of operation that occurs first.*

Table 5-1. Scheduled maintenance

Maintenance item	Daily or after 24 hours	100 hours	12 months or after 200 hours	Two years	400 hours	500 hours	800 hours	1500 hours
Check operation of operator panel: Check display (the system will perform a control panel test on initial activation).	X							
Check coolant level of radiator(s): If low, top up to coolant system specifications level, with recommended coolant mix.	X							
Check cooling fan blades: Visually inspect the blades through the guarding for signs of wear or damage. To replace, contact your authorized distributor.	X							
Check drive belt condition and tension: Visually check belt for evidence of wear or slippage. To replace, contact your authorized distributor.	X							
Check coolant lines and radiator hoses for leaks, wear and cracks: Visually check the hoses. Replace worn or damaged components	X							
Check radiator airflow: Visually inspect the radiator through the guarding for blockage, debris or signs of wear or damage. To replace, contact your authorized distributor.	X							
Verify that the coolant heater has power and is running (where fitted). Check for evidence of leaks. Remove any corrosion from fittings	X							
Check engine oil level: If low, top up to engine specifications level, with recommend ed oil.	X							
Check fuel level in fuel tank. Refill as required.	X							
Check charge alternator: Check visually and audibly when the GenSet is running. To replace, contact your authorized distributor.	X[1]							
Check all exhaust components, and hardware (fittings, clamps, fasteners, etc.): Visually inspect the exhaust system for signs of wear or damage. Check audibly when the GenSet is running.	X							

Table 5-1. Scheduled maintenance

Maintenance item	Daily or after 24 hours	100 hours	12 months or after 200 hours	Two years	400 hours	500 hours	800 hours	1500 hours
Check GenSet enclosure: Visually check enclosure, walk around inspection of GenSet. Make sure no inlets/outlet s are covered/ restricted, service access doors are operational and safety systems are in place and operational. To replace damaged parts, contact your authorized distributor.	X							
Check fuel lines and hoses: Visually check for leaks, worn or damaged hoses. To replace, contact your authorized distributor.	X							
Drain water separator.	X							
Check battery: Check connections to verify that they are secure.	X							
Clean air cleaner element.		X[1]						
Adjust fan belt tension.		X						
Check air intake system for leaks: Visually inspect for signs of wear or damage. Check audibly when the GenSet is running. Replace worn or damaged components			X					
Clean radiator core.			X					
Replace air cleaner element.			X[2]					
Check coolant concentration.			X					
Replace cooling system coolant.				X				
Replace coolant hoses and clamps.				X				
Check engine ground. Clean as necessary.				X				
Check engine mounts general condition and for signs of excessive wear.				X				
Check starting motor for general condition, wiring connections				X				
Replace fuel hoses and clamps				X				
Check battery general condition. Remove any corrosion on terminals with wire brush.				X				
Check electrical connections (battery, starter motor, alternator connections). Check for tight connections, general condition and remove any corrosion.				X				
Flush the cooling system.				X				

Table 5-1. Scheduled maintenance

Maintenance item	Daily or after 24 hours	100 hours	12 months or after 200 hours	Two years	400 hours	500 hours	800 hours	1500 hours
Replace engine oil and filter. Refer to the Engine oil section for the procedure.					X			
Replace fuel filter and water separator.					X			
Replace fan belt.						X		
Check valve clearance.							X	
Replace oil separator (breather) element.								X
[1]Schedule may be reduced depending on operating conditions.								
[2]Replace air cleaner element after the element has been cleaned six times.								

5.3 General maintenance inspections while in operation

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. Preventative maintenance begins with day-to-day awareness of the condition of the GenSet. Look and listen for changes in engine performance, sound, or appearance that can indicate service or repair is needed. Check the GenSet mounting bolts for any signs of wear. The following sections cover several areas that should be frequently inspected for continued safe operation.

STAY ALERT!

Look!

Listen!

Assess!

Monitor fluid levels (engine oil, engine coolant and fuel), oil pressure, and coolant temperature frequently.

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine or GenSet appearance.

IMPORTANT: *Components that have guards against inadvertent touching must be visually inspected only. Do not remove the guards to do the inspection.*

5.3.1 Engine operation

The engine must be maintained in good mechanical condition if the operator is to obtain optimum satisfaction from its use. Monitor fluid levels and oil pressure and coolant temperatures frequently. Most engine problems give an early warning. Look and listen for changes in engine performance, sound, or appearance that can indicate service or repair is needed:

- Misfire
- Significant vibration
- Unusual noises
- Sudden changes in engine operating temperatures or pressures
- Excessive exhaust smoke
- Low lubricating oil pressure
- Loss of (or low) power
- Abnormal engine coolant temperature
- Excessive use of coolant, fuel, or lubricating oil
- Any coolant, fuel, or lubricating oil leaks
- Unexplained frequency fluctuation

To prevent overheating and to reduce fouling with dust and debris, make sure the GenSet's normal ground clearance is not being reduced by sloping ground, curbs, logs or other objects. Relocate the GenSet, if necessary, and/or remove any objects blocking the air inlet or air outlet.

5.3.2 Lubrication system

Look for any oil leaks.

5.3.3 Fuel system

Inspect the fuel supply lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks, and abrasions and make sure they are not rubbing against anything that could cause breakage. If any fuel leaks are detected, shut down the GenSet, turn off the supply valves, and have any fuel leaks corrected immediately.

⚠ WARNING

Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, arcing switch or equipment, pilot light, or other igniter near the fuel system or in any areas sharing ventilation.

5.3.4 Cooling system

⚠ CAUTION

Operating the GenSet when coolant level is low can cause serious engine damage.

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

Periodically check the antifreeze concentration to ensure it is sufficient for the ambient operating conditions.

5.3.5 AC electrical system (on the remote operator panel, if equipped)
It is important to regularly check to see that all aspects of the GenSet are receiving adequate electricity. Be sure to check the following values on the remote operator panel:

- **Frequency/RPM**: The generator frequency should be stable under load and the reading should be the same as the GenSet nameplate rating.
- **AC voltmeter (Alternator menu):** At no load, the line-to-line or line-to-neutral voltage(s) should be the same as the GenSet nameplate rating.
- **AC ammeter (Alternator menu):** At no load, the current readings should be zero. With a load applied, each line current should be similar.

5.3.6 Exhaust system

Inspect the entire exhaust system visually and audibly, including the exhaust manifold. Check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust components are not heating surrounding areas excessively. If any leaks are detected, shut down the GenSet and have the leaks corrected immediately.Look for openings or holes between the GenSet compartment and occupied areas if the GenSet engine sounds louder than usual. Have all such openings or holes closed off or sealed to prevent exhaust gases from entering the occupied areas.

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

⚠ DANGER

Inhalation of exhaust gases can result in severe personal injury or death. Be sure deadly exhaust gas is piped outside and away from any windows, doors, vents or other inlets to building. Do not allow exhaust gases to accumulate in habitable areas.

5.4 General maintenance inspections while not in operation

5.4.1 Accidental restart prevention

Before any work is carried out for significant maintenance, the GenSet must be immobilized. Even if the GenSet(s) is put out of service by pressing the **Stop Button**, the GenSet(s) cannot be considered safe to work on until the engine(s) are properly immobilized.

To immobilize the engine:

1. Press the **Stop Button** on the Control Panel to shut down the GenSet.
2. Disconnect all component heaters and the battery charger, as applicable, from the external power supply.

⚠ CAUTION

Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes which are damaging to DC control circuits of the GenSet.

3. Disconnect the starting batteries. Disconnect the negative (-) cable first, using an insulated wrench.

⚠ WARNING

Accidental starting of the GenSet can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.

4. Lock the cables (with a padlock) to prevent reconnection during maintenance.

5. Place warning notice - “GenSet immobilized for safe working conditions” - at the Operator Panel to indicate that maintenance is in progress.

⚠ DANGER

Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Keep the output box covers in place during troubleshooting.

⚠ WARNING

Lead-acid batteries present a risk of fire because they generate hydrogen gas. Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switches, or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

Ventilate battery area before working on or near battery. Wear goggles. Stop the GenSet and disconnect the battery charger before disconnecting the battery cables. Disconnect the negative (-) cable first and reconnect last.

5.4.2 Lubrication system

The use of quality engine oils, combined with appropriate oil and filter change intervals, are critical factors in maintaining engine performance and durability. Extending the oil and filter change interval beyond the recommendations will decrease engine life due to factors such as corrosion, deposits, and wear. It is the responsibility of the operator to change the engine oil at the recommended interval.

⚠ DANGER

Engine components (drains, filters, hoses, etc.) can be hot and cause severe burns, lacerations of the skin, and liquid splash. Use personal protective equipment when working with or around hazardous materials. Examples of personal protective equipment include (but are not limited to) safety glasses, protective gloves, hard hats, steel-toed boots, and protective clothing.

⚠ DANGER

Crankcase pressure can blow hot engine oil out the fill opening causing, severe burns. Always stop the GenSet before removing the oil fill cap.

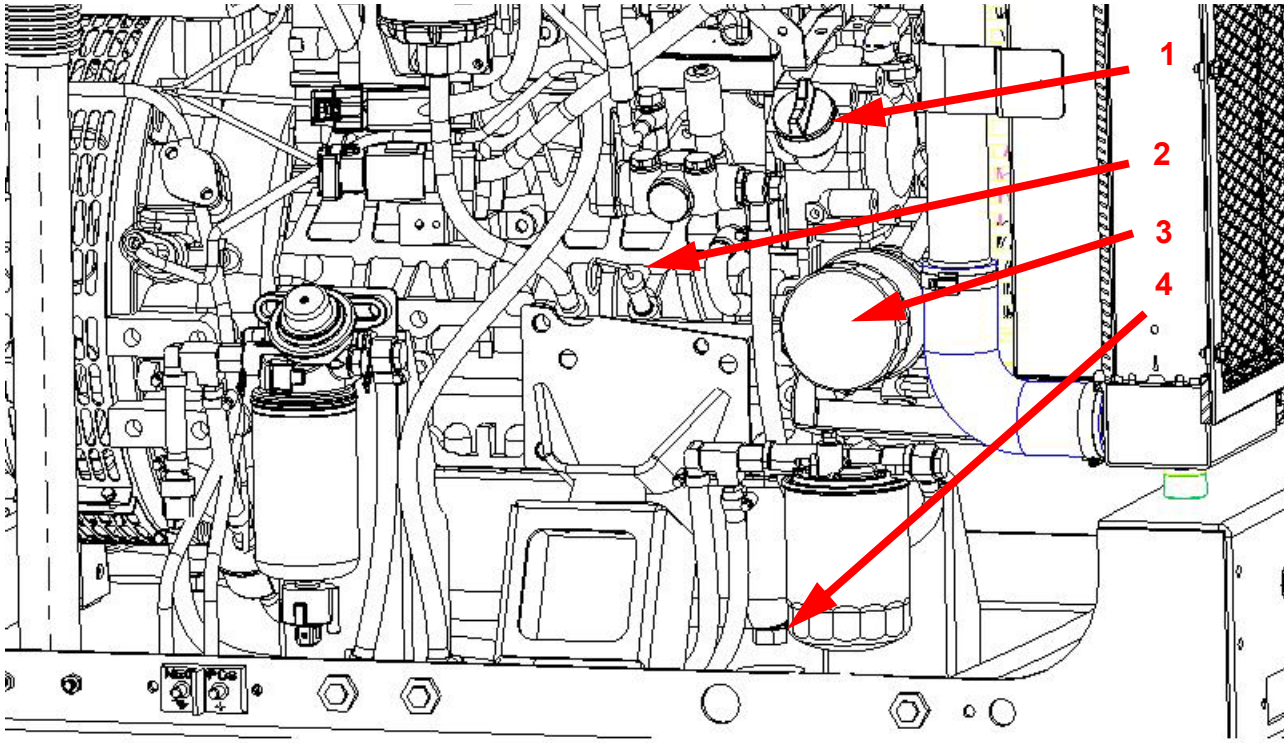
⚠ WARNING

State and federal agencies have determined that contact with used engine oil can cause cancer or reproductive toxicity. A void skin contact and breathing of vapors. Use rubber gloves.

⚠ DANGER

Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.

The GenSet lubrication system is shown in Figure 5-1.



1. Oil fill
2. Dipstick
3. Oil filter
4. Oil drain

Figure 5-1 Engine oil components

5.4.2.1 Checking the engine oil level

For accurate readings, ensure the GenSet is level. Shut off the engine and wait approximately ten minutes before checking the engine oil level. This allows oil in the upper portion of the engine to drain back into the crankcase (oil pan).

The dipstick is stamped with **FULL** and **ADD** to indicate the level of oil in the crankcase. As shown in Figure 5-2, check the oil level while the engine is cold and keep the oil level ***halfway*** between the **FULL** and **ADD** marks on the dipstick. Remove the oil fill cap and add oil, when necessary.

⚠ CAUTION

Do not operate the engine with the oil level below the ADD mark or above the FULL mark.

⚠ CAUTION

A void prolonged or repeated skin contact. Comply with all local health and safety regulations/codes during handling or disposal.

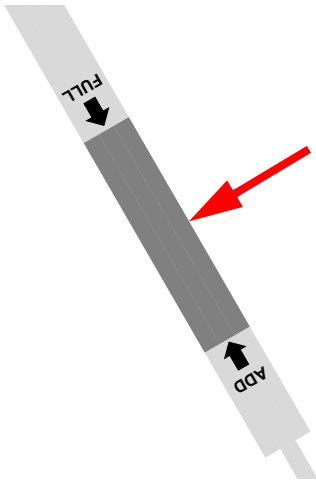


Figure 5-2 Normal oil level (cold engine) on the dipstick

If the oil level is found to be insufficient, oil must be added:

1. Make sure GenSet is off.
2. Prior to removal, ensure that the oil fill cap area is clean to prevent debris from entering the engine.
3. Add the appropriate amount of oil and replace the cap.
4. Recheck the engine oil level. Based on the results, add or drain additional oil.
5. Clean up and dispose of any waste oil in accordance with local environmental regulations.

If the oil level is found to be excessive, oil must be drained from the engine:

1. Ensure the GenSet is off.
2. Turn off the DC disconnect switch, if applicable.
3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
4. Remove the oil plug and/or open the oil drain valve.
5. Allow oil to drain into the container.
6. When sufficient amount of oil has been drained from the system, reinstall the drain plug and/or close the oil drain valve.
7. Recheck the engine oil level.
8. Add or drain additional oil until the correct oil level is achieved.

9. Dispose of used oil in accordance with local environmental guidelines.

NOTE: *High oil level may be caused by fuel in the oil. If fuel is suspected to be present in the oil, contact your local distributor for troubleshooting and or repair information.*

5.4.2.2 Changing the engine oil and oil filter

Change the lubricating oil and filter at the specified oil change interval. Change the oil more often in hot or dusty environments.

To change the oil:

1. Run the GenSet under load until it is up to operating temperature, 60° C (140° F).
2. Make sure the engine is off and on a level surface.
3. Turn off the DC disconnect switch, if applicable.
4. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
5. Remove the oil plug and/or open the oil drain valve and allow oil to drain into the container.
6. When oil has stopped flowing, install the oil plug and/or the oil drain valve.Torque to 32.4 to 37.2 N-m (23.9 to 27.4 lb-ft).
7. Place a container or rag under the oil filter to catch residual oil when the filter is removed.
8. Clean the area around the oil filter head, remove the oil filter, and clean the filter mounting surface on the engine block. Remove the old gasket if it remains.
9. Make sure the gasket is in place on the new filter and apply a thin film of clean oil to the gasket.
10. Install the new filter until the gasket just touches the block. Turn it an additional 1/2 to 3/4 turn. Do not over-tighten.

NOTE: *Mechanical over-tightening of the filter can distort the threads or damage the filter element seal. Do not over tighten.*

11. Fill the engine with clean lubricating oil to the proper level.

NOTE: *Too much oil can cause high oil consumption. Too little oil can cause severe engine damage. Keep the oil level between the FULL and ADD marks on the dipstick.*

12. Install the oil fill cap securely.

NOTE: *Be careful that no debris is poured into the engine. If using an oil supply with a metallic or plastic seal under the cap, be careful to peel the seal back. Puncturing the seal with a knife or sharp object can create debris in the oil container.*

13. Connect the starting batteries.

NOTE: *If oil pressure is not registered within 10 seconds, the engine will shut down to avoid engine damage. Recheck the oil level.*

14. Run the GenSet at idle to inspect for leaks at the oil drain valve and oil filter seal. Tighten connections only as much as is necessary to eliminate leaks. Do not over tighten.

15. Shut off the engine.

16. Wait approximately 5 minutes to let the oil drain from the upper parts of the engine and recheck the oil level.

17. Add or drain oil, as necessary, to bring the oil level to ***halfway*** between the **FULL** and **ADD** marks on the dipstick.

18. Dispose of the used oil and oil filter in accordance with local environmental regulations.

⚠ WARNING

Used oil and filters must be disposed of properly to avoid environmental damage and clean-up liability. Check all federal, state and local regulations for disposal requirements.

5.4.3 Cooling system

It is the responsibility of the operator to inspect the GenSet cooling system on a daily basis.

⚠ DANGER

Standing on the engine, bed frame, alternator or other generator set parts may cause severe personal injury, death, and/or equipment. Always work from a secure platform.

5.4.3.1 Checking the coolant level

As shown in Figure 5-3 and Figure 5-4, check the coolant level in the expansion bottle before the first startup of each day and fill to the COLD mark, if necessary.

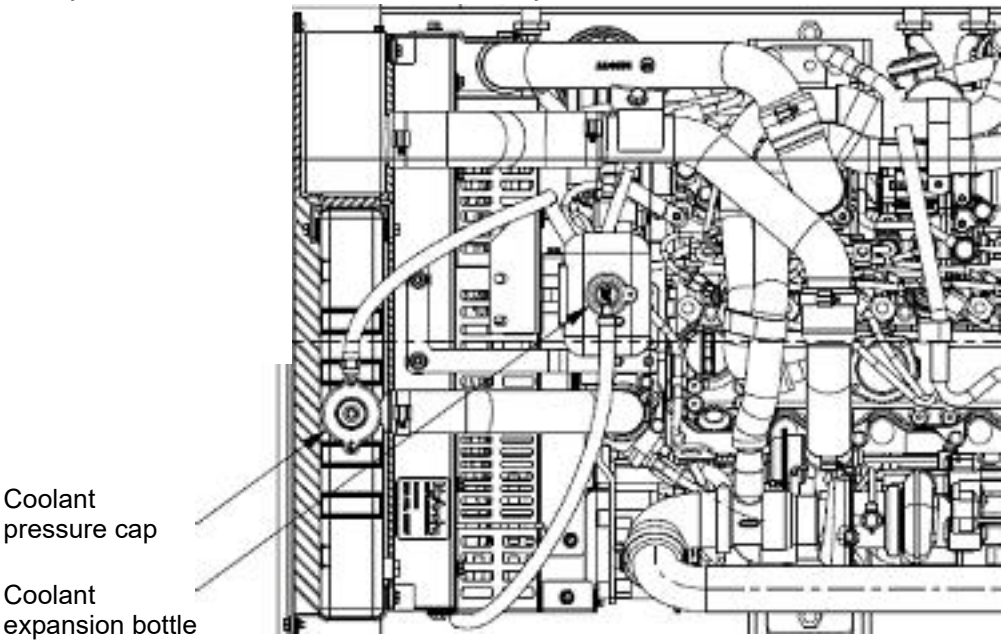


Figure 5-3 Coolant system

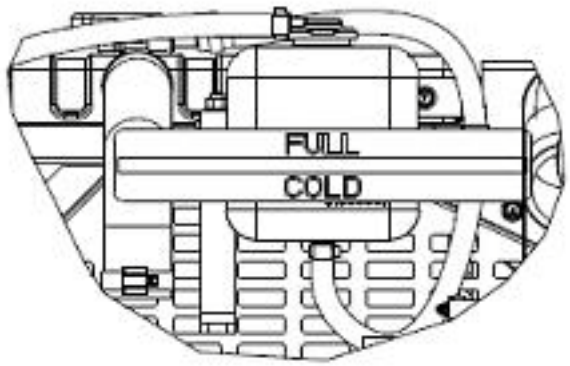


Figure 5-4 Coolant expansion bottle

⚠ WARNING

Loss of coolant can allow the engine to overheat without protection of a shutdown device and cause severe damage to the engine. Maintain the coolant level for proper operation of the high engine temperature shutdown system.

⚠ CAUTION

The engine can overheat and be damaged if coolant is filled improperly.

5.4.3.2 Adding coolant

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50 °C (120 °F) before adding coolant. When the engine is first started, monitor the coolant level. As trapped air is expelled from the system, the coolant level may drop and additional coolant must be added.

⚠ WARNING

To prevent severe scalding, let the engine cool before removing the radiator fill cap. Turn the cap slowly, and do not open it fully until the pressure has been relieved.

To add coolant using the radiator fill cap:

1. Make sure the engine is off and ensure the GenSet is level.
2. Turn off the DC disconnect switch, if applicable.
3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
4. Check to make sure that all drain cocks are closed and all hose clamps secure.
5. Slowly remove the radiator fill cap to release any residual pressure in the cooling system.
6. Slowly add engine coolant until the coolant level reaches the full level.
7. Install the radiator fill cap. Push down and twist clockwise until the cap lip hits the tank stop flange.
8. Fill the expansion bottle to the full mark.

9. Connect the starting batteries.

10. Operate the GenSet for fifteen minutes or until the engine reaches normal operating temperature. Turn off the GenSet and allow the engine to cool.

11. Recheck the coolant level. To add additional coolant repeat the steps above, as necessary.

5.4.3.3 Draining and flushing the cooling system

To maintain adequate corrosion protection and remove rust and scale deposits, drain and flush the radiator at the recommended interval.

⚠ WARNING

Some coolant is toxic. Keep coolant away from children and animals. Follow local environmental regulations for disposal.

⚠ CAUTION

The heater element will burn out if the engine coolant is removed with the heater connected to a power source.

To drain and flush the cooling system:

1. Disconnect the engine coolant heater (if equipped) from the power source.

2. Make sure the engine is off and ensure the GenSet is level.

3. Turn off the DC disconnect switch, if applicable.

4. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.

5. Check to make sure that all drain cocks are closed and all hose clamps secure.

6. Allow the engine to cool and then remove the radiator fill cap.

7. Open the cooling system drain.

8. After the coolant has completely drained, place the end of a water hose into the radiator fill port and turn on the water supply.

9. Regulate the flow of water into the radiator until it is equal to the outflow from the drain openings.

10. Continue flushing until the outflow from the drains is clear of rust sediment.

11. Close the cooling system drain when flushing is complete.

12. Refill the cooling system with the recommended coolant (refer to 5.4.3.1 Checking the coolant level).

⚠ DANGER

Some coolant is toxic. Keep coolant away from children and animals. Follow local environmental regulations for disposal. Ethylene glycol antifreeze is considered toxic. Dispose of it according to local regulations for hazardous substances.

13. If applicable - after the cooling system has been properly filled - connect the engine coolant heater plug to a power source.

⚠ CAUTION

The heater element will burn out if the power is connected before it is filled with coolant or if straight antifreeze solution is used for coolant. Before connecting the power, fill the engine with coolant and run it for a while to circulate the coolant through the heater.

5.4.3.4 Inspecting the radiator

Proper air flow through the radiator is required for proper engine operation. A blocked or restricted radiator leads to the engine overheating as well as decreased engine performance.

The engine cooling fan pushes large amounts of air through the radiator whenever the GenSet is running. In addition to pushing air through the radiator, the fan also pushes environmental debris, such as dust, dirt, straw, and lint through the radiator which may build up on the radiator core. Buildup of debris on the core will restrict air flow, reducing the ability to cool.

Inspect the radiator core for debris. Remove all dirt or foreign material with a soft brush or cloth. Use care to avoid damaging the fins. If available, use a low pressure compressed air or stream of water (maximum of 242 kPa [35 psi]) in the opposite direction of normal air flow to clean the radiator. If using water, protect the engine and the generator from over spray.

⚠ WARNING

Improper use of compressed air can cause minor bodily injury from flying debris and dirt. Wear appropriate eye and face protection when using compressed air.

Also inspect the radiator core for the following items:

- damaged or bent fins
- radiator core leaks
- damaged or cracked hoses
- loose or damaged hose clamps

5.4.3.5 Inspecting the cooling fan

Perform a visual inspection of the cooling fan daily to ensure no loose hardware or damaged blades. Do not operate the GenSet with a damaged fan. Contact your authorized distributor for repair or replacement of a damaged fan.

⚠ DANGER

Moving parts can cause severe personal injury. Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

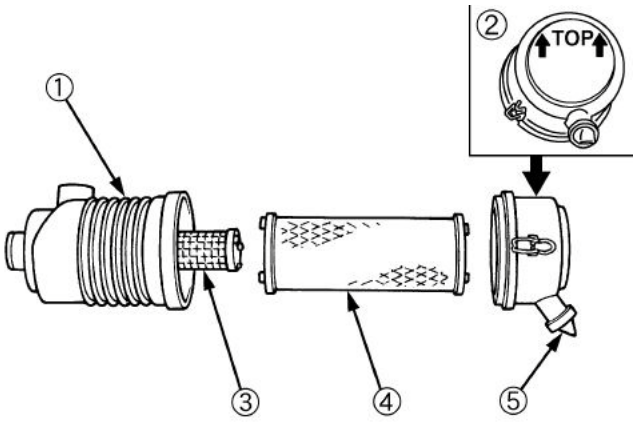
Never pull or pry on the fan, this can damage the fan blade(s) and cause fan failure

5.4.4 Air intake system - cleaning the air filter

Since the air cleaner employed on this engine is a dry type, never apply oil to it. As shown in Figure 5-5, open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place. This will get rid of large particles of dust and dirt.

To clean the air filter:

1. Ensure the GenSet is off.
2. Turn off the DC disconnect switch, if applicable.
3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
4. Unlatch the clips and remove the air cleaner dust cup (shown in Figure 5-5).
5. Wipe the inside of the air cleaner clean with cloth if it is dirty or wet.
6. Remove the primary element, only (shown in Figure 5-5). Leave the secondary element in place unless it is being replaced.
7. When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205 kPa (2.1 kg f/cm, 30 psi).
8. Replace the primary element every year or after six cleanings. If the primary element is stained heavily, replace it. The secondary element should be replaced any time the primary element is replaced.
9. Reinstall the primary element and dust cup. Install latch clips to be sure it is secure to prevent debris from entering the air intake system.



1. Air cleaner body
2. Dust cup
3. Secondary element
4. Primary element
5. Evacuator valve

Figure 5-5 GenSet air cleaner

IMPORTANT: *Do not overservice the air cleaner element. Overservicing may cause dirt to enter the engine causing premature wear.*

5.4.5 Fan/alternator belt drive

It is the responsibility of the operator to ensure that the fan/alternator belt is operating properly.

5.4.5.1 Inspecting the fan/alternator belt

Visually inspect the belt through the guarding and check for:

- Intersecting cracks. Small transverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are NOT acceptable
- Frays or pieces of material missing.
- Glazed or cracked side walls.
- Uneven wear on sidewalls of belt.

Visually inspect sheaves through the guarding and check for:

- Damaged or worn grooves.
- Breaks on flanges of grooves.
- Frays or pieces of material missing.

If a belt shows any sign of damage, replace it.

5.4.5.2 Adjusting the belt tension

To ensure optimal GenSet operation, it may be necessary to adjust the belt tension.

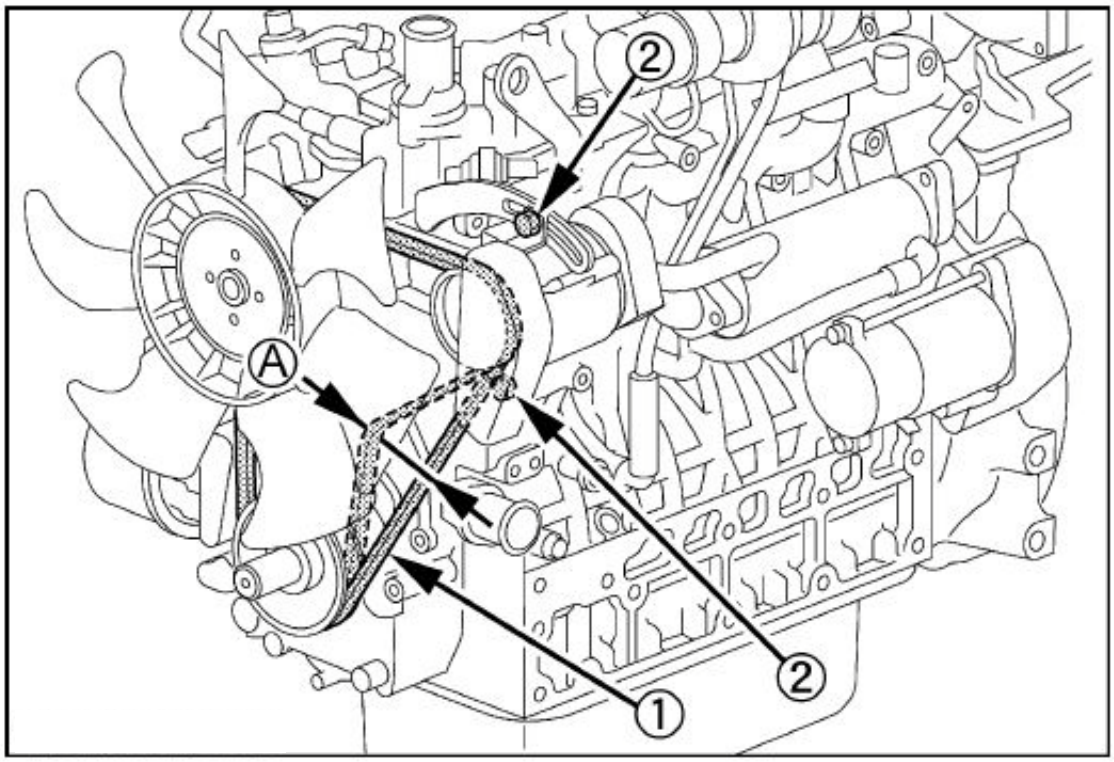
⚠ WARNING

To avoid personal injury or death, be sure to stop the engine and remove the key before checking the belt tension. Be sure to reinstall the detached safety shield after maintenance or checking.

To adjust the belt tension:

1. Ensure the GenSet is off.
2. Turn off the DC disconnect switch, if applicable.
3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
4. Apply moderate thumb pressure to belt between the pulleys.

5. If tension is incorrect, the belt must be adjusted. As shown in Figure 5-6, loosen the alternator mounting bolts (2) and - using a lever placed between the alternator and the engine block - pull the alternator out until the deflection of the belt falls within acceptable limits. Proper fan belt tension is the deflection (A) (when the belt is pressed in the middle of the span) 7 to 9 mm (0.28 to 0.35 in.) (under load of 10 kg f (22.1 lbs)).



1. Fan/alternator belt
2. Bolt and nut

Figure 5-6 GenSet belt

IMPORTANT: *A loose belt could result in overheating or insufficient charging. Correct or replace belt.*

5.4.5.3 Replacing a belt

To replace the fan/alternator belt:

1. Ensure the GenSet is off.
2. Turn off the DC disconnect switch, if applicable.
3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.
4. Remove the guards.
5. Loosen the two alternator bolts (shown in Figure 5-6).

6. Remove the fan/alternator belt.

7. Replace the fan belt with a new one.

8. Install the alternator and tighten the bolts. Adjust the tension of belt halfway between the fan drive pulley and alternator pulley at a specified force to measure the deflection to 10.0 to 12.0 mm (0.394 to 0.472 in.) (under load of 98 N (22.1 lb-ft))

5.4.6 Batteries

Batteries require attention at all times, even when not working. Maintain the GenSet batteries according to the manufacturer's specifications to ensure the battery requirements in Table 2-9 are met.

5.4.7 Oil separator

Figure 5-7 shows the location of the GenSet oil separator.

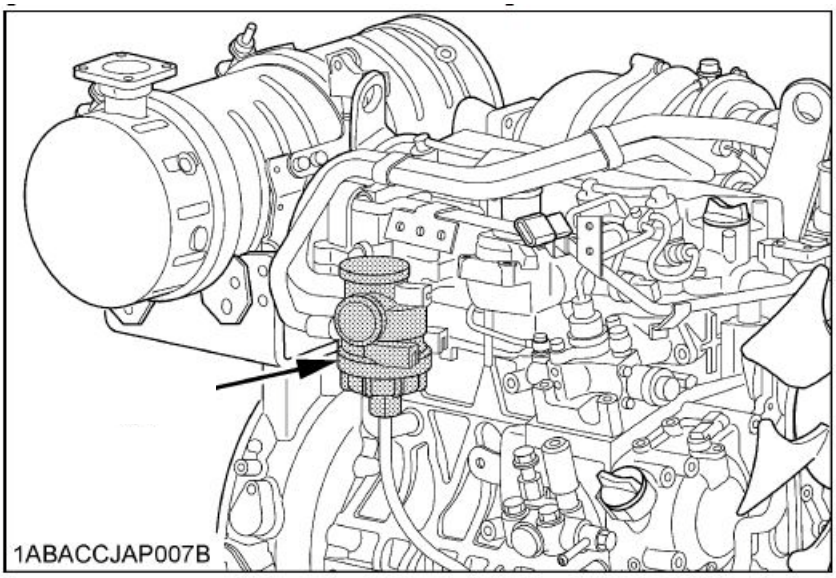


Figure 5-7 GenSet oil separator location

To change the oil separator:

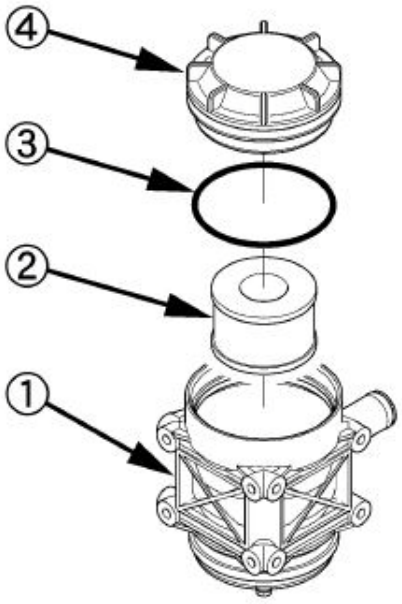
1. Ensure the GenSet is off.

2. Turn off the DC disconnect switch, if applicable.

3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench. Lock out and tag out.

4. As shown in Figure 5-8, remove the cover and take out the oil separator element and gasket. Wipe oil and grease off the zone in question.

5. Fit a new oil separator element and gasket into position.



1. Body
2. Oil separator element
3. Gasket
4. Cover

Figure 5-8 GenSet oil separator

5.4.8 Fuel/water separator

The GenSet is equipped with a fuel/water separator to provide protection for the engine fuel injection system, as water-free fuel supplies cannot be guaranteed.

5.4.8.1 Purging the fuel/water separator

The fuel/water separator must be drained of water and sediment daily. Drain water and sediment more often than scheduled if fuel quality is poor or condensation cannot be avoided. Dispose of the water, sediment and fuel drained off in accordance with local environmental regulations.

To purge the fuel/water separator:

1. Ensure the GenSet is off.

2. Turn off the DC disconnect switch, if applicable.

3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench.

4. Disconnect the fuel/water separator Water In Fuel (WIF) sensor electrical connection.

5. Place a suitable container under the fuel filter.

6. Unscrew/remove the WIF sensor on the bottom of the filter to drain the water.

7. Continue draining the fuel filter until clean fuel is visible.

8. Re-install the WIF sensor into the filter. Do not overtighten.Overtightening can damage the threads. Remove the container and dispose of the fuel/water waste in accordance with local environmental guidelines.

9. Clean up any fuel spillage.

10. Re-connect the fuel/water separator WIF sensor electrical connection.

11. Connect the starting batteries.

12. Turn DC disconnect switch (if applicable) to the ON position.

13. Start the engine and check for leaks.

NOTE: *Depending on the amount of fluid drained, priming of the fuel system may be required to prevent hard starting.*

5.4.8.2 Changing the fuel filters

The GenSet is equipped with two fuel filters, a primary (water separator) and secondary, which are located near the engine block. Replace the fuel filters if the engine lacks power.

IMPORTANT: *Close any fuel line shutoff valve before disconnecting the fuel line from the filter. Keep dirt, water and other contaminants from entering the fuel system and corroding or clogging fuel injection components.*

To change the fuel filters:

1. Ensure the GenSet is off.

2. Turn off the DC disconnect switch, if applicable.

3. Disconnect the starting batteries by disconnecting the negative (-) cable using an insulated wrench.

4. Clean the area around the fuel filters to prevent debris from entering the fuel system

5. Loosen and remove the fuel filter.

6. Remove o-ring if necessary.

7. Dispose of used fuel filters in accordance with local environmental guidelines.

8. Do not pre-fill the pressure-side fuel filter with fuel unless a clean side block-off plug is used.

NOTE: *Pre-filling the pressure-side fuel filter can result in debris entering the fuel system and damaging fuel system components.*

NOTE: *Do not pour fuel directly in the center of the filter, since this will allow unfiltered fuel to enter the system and can cause damage to fuel system components.*

9. Lubricate the fuel filter 0-ring with clean lubricating oil.

10. Install the filter on the filter head until the gasket contacts the filter head surface.

11. Hand tighten the fuel filter an additional turn after contact, or follow the filter manufacturer's instructions.

NOTE: *Mechanical over tightening can distort the threads as well as damage the filter element seal or filter can.*

12. Fuel/water separator only: connect the water-in-fuel sensor wire harness.

13. Connect the starting batteries.

14. Turn DC disconnect switch (if applicable) to the **ON** position.

15. Prime the fuel system using the priming pump. See the Installation manual for priming instructions.

16. Start the engine and check for leaks.

NOTE: *When the engine does start, it may operate erratically and with increased noise levels for a few minutes. This is a normal condition, as air is being removed from the system. It is possible for fault code **559** to become active after fuel filter replacement due to air introduced in the system. Refer to your local authorized repair facility for assistance.*

5.4.8.3 Inspecting the hoses and fuel lines

With the GenSet operating, visually inspect the fuel lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and ensure they are not rubbing against anything that could cause breakage. If any leaks are detected, shut down the GenSet. Contact your authorized Service Center and have the leaks corrected immediately.

5.4.9 Air shutoff (ASO) valve (optional)

The valve should be operated annually to assure that the moving parts are free and operational. Exercise the valve by manually depressing the plunger and ensuring the valve operates. To reset the unit, rotate the actuation lever clockwise until the lever clicks into place.

NOTE: *This must be performed with the engine off.*

Lubricate the reset lever shaft when normal engine service work is done.

5.4.10 Heaters (optional)

Check to ensure that all wiring is intact (no shorts or frayed wires) and there are no obstructions around all heaters:

- Battery heater
- Breather heater
- Control heater
- Coolant heater
- Oil heater

5.4.11 Base drains (optional)

Some units are equipped with drain extensions that allow for oil or coolant (or both) drains to be brought out to the base edge for convenient maintenance. These drains have valves installed for control. Remove the cap and open the valve to drain. Close the valve and restore the cap before refilling. Check the end of the drain line/valve for obstructions. Check all drain connections for leaks or worn parts.

5.5 Out-of-service maintenance

When the GenSet will be stored or removed from operation for an extended period of time, preventative maintenance must be performed to avoid rust accumulation, corrosion of bearing surfaces within the engine, and gum formation in the fuel system. To prepare the GenSet for storage, be sure to do the following:

1. Disable the automatic GenSet starting feature of an inverter-charger or other automatic starting device.

⚠ WARNING

Carbon monoxide is deadly and can accumulate to dangerous levels in garages and other confined spaces. Disable the automatic GenSet starting feature of an inverter-charger or other automatic starting device before storing the vehicle.

2. Push the GenSet line circuit breaker to **OFF**.
3. Change the engine oil and attach a tag indicating oil viscosity.
4. Disconnect the battery cables (negative [-] cable first) from the starting battery and store the battery according to the battery manufacturer's recommendations.
5. Plug the exhaust tail pipe to keep out dirt, moisture, bugs, etc.
6. Close the fuel supply valve (if so equipped).

5.6 Returning the GenSet to service preparation

NOTE: *Always wear protective clothing and goggles before starting GenSet.*

To return the GenSet to service:

1. Check the oil tag on the GenSet and change the oil if the viscosity indicated is not appropriate for the temperatures expected. See 5.3.2 Lubrication system.
2. Remove the plug from the exhaust tailpipe.
3. Replace the air filter element if it is dirty.
4. Open the fuel supply valve (if so equipped).
5. Reconnect the starting battery (negative [-] cable last).
6. Inspect the GenSet.
7. Push the GenSet line circuit breaker ON when the GenSet is ready to power appliances.
8. Enable the automatic GenSet starting feature of an inverter-charger or other automatic starting device following the device manufacturer's instructions and safety precautions.

6 - Troubleshooting

6.1 Avoiding Generator Set Shutdowns

By regularly performing the following periodic maintenance, you will greatly reduce the chances of a generator set (GenSet) shutdown:

- Maintain an appropriate oil level.
- Keep battery connections clean and tight.
- Do not overload the GenSet.
- Keep the air inlet and outlet openings clear.

Refer to 5 - Maintenance for more information. Fault codes are only available on the remote operator panel. For GenSets without the remote operator panel, contact your authorized dealer for troubleshooting assistance.

6.2 Safety Considerations

⚠ WARNING

Contact with high voltages can cause severe electrical shock, burns, or death. Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the GenSet and perform maintenance on it.

⚠ WARNING

Accidental or remote starting of the GenSet can cause severe personal injury or death. Make sure that the GenSet cannot be started accidentally or remotely before starting work on the generator.

⚠ WARNING

Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death. Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the GenSet and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (-) cable first and reconnect it last.

⚠ CAUTION

Contact with high voltages can cause severe electrical shock, burns, or death. Isolate all external electrical supplies prior to access of the control panel. Internal components have live exposed terminations even when the GenSet is not running.

NOTE: *Do not open the output box while the GenSet is running. Keep the output box covers in place during troubleshooting.*

NOTE: *Always disconnect a battery charger from its AC source before disconnecting the battery cables. Failure to do so can result in voltage spikes high enough to damage the DC control circuits of the GenSet.*

NOTE: *Ventilate the battery area before working on or near the battery. Wear goggles. Stop the GenSet and disconnect the battery charger before disconnecting the battery cables using an insulated wrench. Disconnect the negative(-) cable first and reconnect it last.*

All maintenance tasks must be assessed for health and safety risks; the preventive measures identified must be performed. An additional person is required for any task where doing so significantly adds to the safety of the task.

The installation of a GenSet can be designed for remote starting. When troubleshooting a GenSet that is shut down, make sure that the GenSet cannot be accidentally re-started. Refer to the Locking the GenSet Out of Service section.

6.3 Line circuit breaker

A line circuit breaker is mounted in the generator output box. If the load exceeds the circuit breaker current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, disconnect the load(s), locate the source of the overload or short circuit, and correct as necessary. Manually reset the breaker to reconnect the load to the generator (push the circuit breaker to **OFF** to reset it and then to **ON** to reconnect the circuit). Reconnect the appliances, one by one, up to a total load that does not overload the GenSet or cause the circuit breaker to trip. Call a qualified electrician, if necessary.

6.4 Fault code troubleshooting

⚠ WARNING

Troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions listed in this manual together with the documentation supplied with the GenSet.

The GenSet remote control system continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will light a yellow Warning lamp or a red Shutdown lamp and will display a message on the graphical display panel. In the event of an engine shutdown fault (red Shutdown LED), the control will stop the engine immediately. The LED status indicators/warnings are outlined in 3.3.1 LED indicators. For any symptom not listed, contact your authorized dealer for assistance.

Before starting any fault finding, ensure that the following basic checks are carried out:

- All switches and controls are in their correct positions
- Fuel system is connected and fuel is available
- The lubricating oil level is correct
- The coolant level is correct
- The radiator cooling air flow is free from obstruction
- The battery charge condition is satisfactory and the connections are secure
- The GenSet electrics and alternator connections are secure
- The panel connections are secure
- The protection circuits have been reset
- Blown fuses have been replaced

- Tripped contactors or circuit breakers have been reset

Fault code information, together with warning and shutdown information, is provided in this section to assist in locating and identifying the possible causes of faults in the GenSet system.

Refer also to the engine-specific operator manual. The engine operator manual contains additional information regarding the running and care of the engine as well as specific equipment instructions that may differ from the standard GenSet.

⚠ WARNING

Incorrect installation or servicing can result in severe personal injury or death. Make sure that only suitably trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards perform electrical and/or mechanical service.

⚠ WARNING

Accidental or remote starting of the GenSet can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables, negative (-) cable first.

6.4.1 Fault messages

A Fault message is an indicator of a Warning or Shutdown condition. It includes the fault type (Warning or Shutdown), fault number, and a short description. It also includes where the fault occurred if the GenSet control did not detect the fault and is simply reporting the fault.

Active and acknowledged faults may be viewed in the **Faults** menu.

6.4.2 Fault acknowledgment

Shutdown faults must be acknowledged after the faults have been corrected. If in **Auto** or **Manual Run** mode, the control must be set to "O" (off). Also, faults are acknowledged when in **Auto** and the Remote Start command is removed. Faults are cleared from the operator panel display by pressing the **UP** arrow, **DOWN** arrow or **LEFT** arrow button.

Faults are re-announced if they are detected again after being acknowledged.

6.4.3 Fault code descriptions

For any fault codes that occur but are not listed, contact your Cummins service representative.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
No Fault Message	Fault description	**Engine Does Not Crank in Manual Mode**
	Logic	N/A
	Possible cause	Battery voltage
	Diagnosis and repair	1. Check the battery connections. 2. Verify the battery charge.
143	Fault description	**Engine Oil Pressure Low (Warning)**
	Logic	Engine oil pressure is below the low oil pressure shutdown threshold.
	Possible cause	Low lubricating oil level or external leak
	Diagnosis and repair	Low lubricating oil level - check the oil level. Add or drain oil, if necessary. External leak - inspect the engine and surrounding area for external oil leaks. Contact your local dealer if a leak is present.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
146	Fault description	**Engine Coolant Temperature Above Normal (Warning)**
	Logic	Engine coolant temperature has exceeded the alarm (warning) threshold for high coolant temperature.
	Possible cause	1. High ambient temperature 2. Coolant level is below specification 3. Cooling system components are damaged or obstructed
	Diagnosis and repair	1. High ambient temperature - reduce loads or recirculation of discharge air to generator in elevated ambient. 2. Coolant level is below specification - inspect the engine, cooling system, and surrounding area for external coolant leaks: a. Add coolant as necessary. b. Contact your local dealer if a leak is present. 3. Cooling system components are damaged or obstructed: a. Inspect radiator, charge air cooler, and other cores (if used). Check for damaged fins. Inspect for dirt, debris, or obstructions. Remove blockages. b. Inspect fan shroud and air recirculation baffles for damage and clearance. Contact your local dealer if repair or replacement is required. c. Inspect fan belt(s) for damage, wear, and proper tension. Inspect pulleys and belt tensioner for damage or wear. Contact your local dealer if repair or replacement is required. d. Inspect radiator cap and gasket for damage and proper pressure operation. Contact your local dealer if repair or replacement is required. e. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks. Contact your local dealer if repair or replacement is required. f. Inspect cooling system components for internal contaminates (dirt, scale, or sludge) and clean as required. Open the radiator cap and inspect for contaminated coolant and scale. Contact your local dealer if flushing of cooling system is required.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
151	Fault description	**Engine Coolant Temperature High (Shutdown)**
	Logic	Engine coolant temperature has exceeded the alarm (shutdown) threshold for high coolant temperature.
	Possible cause	1. High ambient temperature 2. Coolant level is below specification 3. Cooling system components are damaged or obstructed
	Diagnosis and repair	1. High ambient temperature - reduce loads or recirculation of discharge air to generator in elevated ambient. 2. Coolant level is below specification a. Inspect the engine, cooling system, and surrounding area for external coolant leaks. Contact your local dealer if a leak is present. b. Verify the coolant level is correct via the sight glass. Add coolant as necessary. 3. Cooling system components are damaged or obstructed a. Inspect the radiator, charge air cooler, and other cores (if used). Inspect for damaged fins. Inspect for dirt, debris, or obstructions. Remove blockage. b. Inspect the fan shroud and air recirculation baffles for damage and clearance. Contact your local dealer if repair or replacement is required. c. Inspect the fan belt(s) for damage, wear, and proper tension. Inspect pulleys and belt tensioner for damage or wear. Contact your local dealer if repair or replacement is required. d. Inspect the radiator cap and gasket for damage and proper pressure operation. Contact your local dealer if repair or replacement is required. e. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks. Contact your local dealer if repair or replacement is required. f. Inspect cooling system components for external contaminates and clean as required. Open the radiator cap and inspect for contaminated coolant and scale. Contact your local dealer if flushing of cooling system is required.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
415	Fault description	**Engine Oil Pressure Low (Shutdown)**
	Logic	Engine oil pressure is below the low oil pressure shutdown threshold.
	Possible cause	1. Lubricating oil level is low 2. External leak
	Diagnosis and repair	1. Lubricating oil level is low. a. Check the oil level. b. Add oil, if necessary. 2. External leak a. Inspect the engine and surrounding area for external oil leaks. b. If a leak is present, contact your Cummins service representative.
441	Fault description	**Battery Voltage Low (Warning)**
	Logic	Battery voltage low.
	Possible cause	Damaged battery cable connections
	Diagnosis and repair	Inspect the battery cable connections for loose connections, corrosion, and repair as necessary.
559	Fault description	**(Warning)**
	Logic	Injector Metering Rail 1 Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
	Possible cause	Air introduced in the system after fuel filter replacement
	Diagnosis and repair	Contact your local Cummins authorized dealer.
1246	Fault description	**Unrecognized Engine Fault (Warning)**
	Logic	An engine warning fault has occurred.
	Diagnosis and repair	Contact your local Cummins authorized dealer.
1248	Fault description	**Unknown Engine Warning (Warning)**
	Logic	An engine warning fault has occurred.
	Diagnosis and repair	Contact your local Cummins authorized dealer.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
1317	Fault description	**Coolant Level Low (Warning or Shutdown)**
	Logic	Coolant level sensor signal is showing a low coolant level for greater 10 seconds.
	Possible cause	Low coolant
	Diagnosis and repair	1. Stop the engine and allow the engine to cool down. 2. Visually inspect and verify that the engine coolant is at the appropriate level. 3. If the coolant level is too low, add coolant per specifications.
1318	Fault description	**Low Fuel (Warning or Shutdown)**
	Logic	
	Possible cause	1. Low fuel level 2. Faulty or inoperable switch
	Diagnosis and repair	1. Low fuel level - add the manufacturer's prescribed fuel. 2. Faulty or inoperable switch a. Remove the switch and verify proper switch operation. If either of the following conditions is demonstrated, the switch is defective: • When the float is at the bottom of the switch, the wires do not show continuity. • When the float is raised, the wires do not show an open circuit. b. Contact your local dealer if repair or replacement is required.
1438	Fault description	**Fail to Crank (Shutdown)**
	Logic	The engine failed to crank after the GenSet control received a start signal.
	Possible cause	Dead or weak battery
	Diagnosis and repair	1. Verify battery voltage is at least 12 VDC (24 VDC, where applicable). 2. Charge or replace the battery as necessary.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
1471	Fault description	**High AC Current (Warning)**
	Logic	The GenSet output current has exceeded the warning limit threshold for greater than the fixed time delay.
	Possible cause	GenSet overload
	Diagnosis and repair	Reduce the GenSet load by powering off unnecessary electrical loads.
1472	Fault description	**High AC Current (Shutdown)**
	Logic	The GenSet output current has exceeded the shutdown limit threshold for greater than the fixed time delay.
	Possible cause	GenSet overload
	Diagnosis and repair	Reduce the GenSet load by powering off unnecessary electrical loads.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
5134	Fault description	**Unknown Shutdown**
	Logic	PCC has detected that engine RPM has decreased to zero, while not in run at rated mode
	Possible cause	1. Incorrect calibration in the PowerCommand control 2. Air intake or exhaust restriction 3. Magnetic Pickup (MPU) signal loss - faulty MPU sensor connections and wiring 4. MPU signal loss - improper installation of the MPU sensor 5. MPU signal loss - faulty MPU sensor 6. Improper start disconnect 7. Fuel supply issue 8. Faulty control board
	Diagnosis and repair	1. Recalibrate the PowerCommand control 2. Air intake or exhaust restriction a. Inspect air intake system and filter for debris. b. Inspect exhaust system for debris or leaks. 3. MPU signal loss - faulty MPU sensor connections and wiring - inspect the MPU sensor and the main harness connector pins. a. Disconnect the main harness connector from the MPU sensor. b. Inspect for corroded, bent, broken, pushed back, expanded, or loose pins. c. Inspect for evidence of moisture in or on the connector. Dry the connectors with Cummins electronic cleaner, Part Number 3824510. d. Inspect for missing or damaged connector seals. e. Inspect for dirt or debris in or on the connector pins. f. Inspect the wiring for any damage or shorting

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
5134	Diagnosis and repair	4. MPU signal loss - improper installation of the MPU sensor - inspect the installation of the MPU sensor. a. Check if the clearance between the MPU sensor tip and the flywheel teeth is correct. b. Adjust if not as per specification. Set the clearance from the MPU tip to the ring gear teeth to 0.5- 0.6 mm. The preferred method of setting the MPU tip clearance is to use a feeler gauge. An alternate method is to rotate the flywheel until the ring gear tooth is directly over the center of the MPU hole; then gently rotate the MPU until it touches the tooth. Back off ¼ turn and tighten the jam nut. **NOTE:** *Prevent the MPU from rotating when tightening the lock nut. Failure to do so may cause damage to the sensor tip.* Check for the correctness of orientation of the MPU sensor mounting as applicable. Verify linear alignment of the MPU sensor with the flywheel ring gear. 5. Faulty MPU sensor - check the MPU sensor output voltage. a. Disconnect the main harness connector from the MPU sensor. b. Remove the MPU sensor connectors and check for 3.5 to 15 VAC at the MPU while cranking. If no output, check for damage or debris on the end of the MPU, and for proper installation of MPU (see above). If there is still no output, replace the MPU sensor. c. Verify that the MPU sensor feature is enabled in calibration.

Table 6-1. Fault Code Descriptions and Troubleshooting

Fault code	Fault Code Troubleshooting	
5134	Diagnosis and repair	6. Improper start disconnect - one or more start disconnect signal is activating too soon after cranking, causing the starter to drop out, and the engine to stop. a. Starter disconnect set incorrectly in InPower. • 12V Charging Alternator Disconnect Voltage: 9 VDC • Starter Disconnect Speed: 450 RPM • Flywheel Teeth: 110 b. connect with InPower, and monitor Battery Charging Alternator Voltage during cranking. If voltage exceeds 9 VDC, increase 12V Charging Alternator Disconnect Voltage to just above the peak seen during cranking.
		7. Fuel supply issue a. Restricted fuel supply • The fuel level is below the pickup tube in tank. Add fuel if low. Prime the fuel system. • The shutoff valve in the supply line is closed. Open any closed shutoff valve in the fuel line supplying the engine. • The fuel filter or strainer is plugged. Replace the fuel filter or strainer b. The fuel solenoid fuse is open. Check fuse. • Set multimeter to VDC. • Attempt to start the engine and check for B+ at the fuel solenoid coil. • If B+ is present, the fuel solenoid is defective and must be replaced. c. There is air in the fuel system. Bleed air from the fuel system. d. Fuel injectors are clogged. Refer to the engine service manual.
		8. Faulty control board - if none of the previous steps solved the issue, replace the PCC board.