


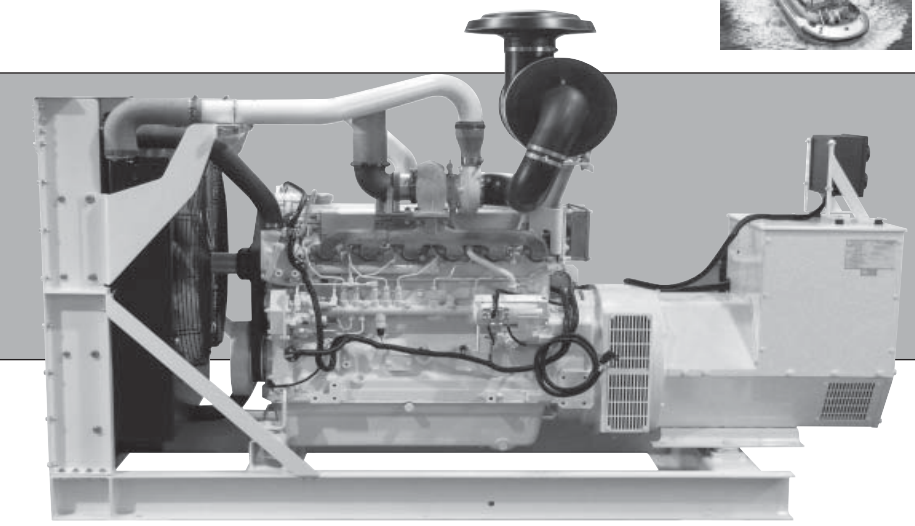

ONL2-4

For Models: NL1064H2
and NL1066H4

OPERATOR'S MANUAL

Marine Generators | Marine Diesel Engines | Land-Based Generators

NORTHERN LIGHTS




— CALIFORNIA —
Proposition 65 Warning:

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

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Printed in U.S.A.
PART NO.: ONL2-4 1/13

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OPERATOR'S MANUAL

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NL1064H2 and NL1066H4

Read this operator's manual thoroughly before starting to operate your equipment.
This manual contains information you will need to run and service your new unit.

Table of Contents

Introduction

Servicing of generator sets presents unique problems. In many cases boats cannot be moved to a repair facility. Generator sets cannot be compared to the servicing of automobiles, trucks or even farm equipment. Failures often occur in remote areas far from competent assistance. Generator sets are taxed far more severely than auto or truck engines; therefore, maintenance schedules must be adhered to more strictly.

Failures begin with minor problems that are overlooked and become amplified when not corrected during routine maintenance.

As operator, it is your obligation to learn about your equipment and its proper maintenance. This is not a comprehensive technical service manual. Nor will it make the reader into an expert mechanic. Its aim is to aid you in maintaining your unit properly.

Model Numbers

Model numbers give the unit's application, block model, aspiration, and RPM:

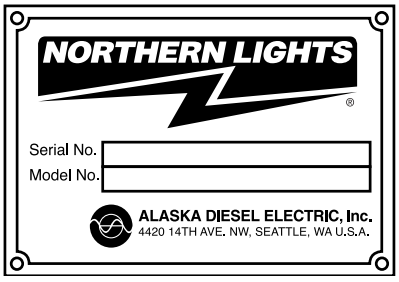
NL	+	1064 or 1066	+	H
NL - Northern Lights industrial generator set		Model number **106 mm bore, 4 Cylinder** or **106 mm bore, 6 Cylinder**		H - High output

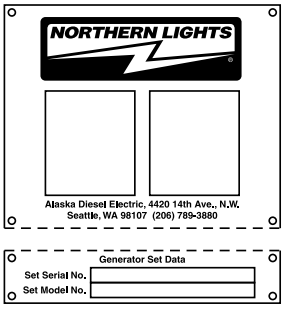
NL1064H2 = Northern Lights® turbocharged,1800 RPM industrial diesel generator set with a John Deere Powertech Tier II 4045 engine block and an electronically controlled fuel system, 4 valve.

NL1066H4 = Northern Lights® turbocharged industrial generator set with a John Deere Powertech Tier II 6068 engine block with an electronically controlled fuel system, 4 valve.

Serial Numbers

When referencing Alaska Diesel Electric equipment by serial number, please refer only to the number stamped on the Northern Lights® serial number plate.





Warranty

A warranty registration certificate is supplied with your set. The extent of coverage is described in the Limited Warranty Statement. We recommend that you study the statement carefully.

NOTE: If the warranty is to apply, the servicing instructions outlined in this manual must be followed. If further information is needed, please contact an authorized dealer or the factory.

Safety Rules

CAUTION: ***Accident reports show that careless use of engines causes a high percentage of accidents. You can avoid accidents by observing these safety rules. Study these rules carefully and enforce them on the job.***

IMPORTANT SAFETY INSTRUCTIONS. Electromagnetic equipment, including generator sets and their accessories, can cause bodily harm and life threatening injuries when improperly installed, operated or maintained. To prevent accidents be aware of potential dangers and act safely.

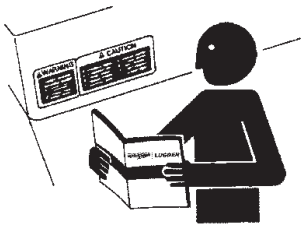
READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN THIS MANUAL, PRIOR TO THE INSTALLATION OF ANY GENERATOR SET OR ACCESSORY. KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE.

Recognize Safety Symbols and Instructions

In addition to the information found in this section, this operator's manual will use the CAUTION warning to outline potential dangers of a specific nature.

CAUTION indicates the presence of a potential hazard that can or will cause severe or minor property damage, personal injury or death.

Follow All Safety Instructions



Carefully read and understand all safety messages in this manual and on your machine's safety signs. Keep signs in good and clean condition. Replace missing or damaged signs. Be sure new equipment components and repair parts include the current safety signs. For replacement signs, proper placement of safety signs or clarification on any safety issue, consult your Northern Lights dealer or the factory.

There can be additional safety information contained on parts and components from outside suppliers that is not reproduced in this manual. Consult the suppliers for additional safety information.

Learn how to operate the machine and how to use the controls properly. Only trained personnel should operate machines, or work on or around them.

Keep you machine in proper working condition. UNAUTHORIZED MODIFICATIONS TO THE MACHINERY MAY IMPAIR ITS FUNCTION AND SAFETY PARAMETERS.

Prevent Bypass and Accidental Starting

Do not start engine by shorting across start terminal. Engine will start if normal circuitry is bypassed, creating a hazard by runaway machinery.

Start engine only from operator's station.

Handle Fuel Safely - Avoid Flames

Diesel is highly flammable and should be treated with care at all times. Do do not refuel while smoking or when near sparks or open flame.

Safety Rules

ALWAYS STOP ENGINE BEFORE FUELING MACHINE. Always fill portable fuel tank outdoors. Never fuel a hot engine.

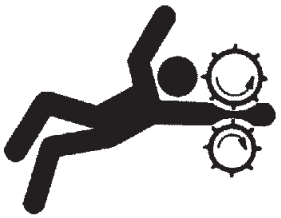
Prevent accidental discharge of starting fluids by storing all cans in a cool, safe place, away from sparks or open flame. Store with cap securely on container. Never incinerate or puncture a fuel container.

Prevent fires by keeping machine clean of accumulated trash, grease and debris. Always clean any spilled fuel as swiftly as possible. Do not store oily rags, which can ignite and burn spontaneously.

Be prepared if a fire starts. Keep a first aid kit and fire extinguisher handy. Keep emergency contact numbers for fire department, doctors, ambulance and hospital near the telephone.

Service Machines Safely

Do not wear a necktie, scarf, necklace, rings or other jewelry, or any loose clothing when working near moving parts. Tie long hair behind your head. If any of these items get caught in moving machinery, severe injury or death could result.



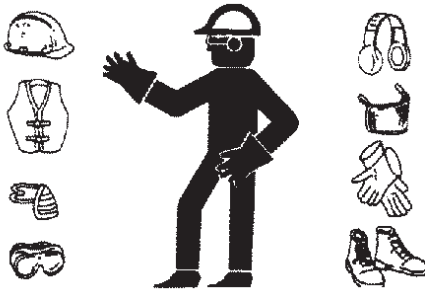
Check for any loose electrical connections or faulty wiring.

Look completely around engine to make sure that everything is clear before starting.

Wear Protective Clothing

To prevent catching anything in moving machinery, always wear close fitting clothes and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause hearing loss or impairment. Wear suitable authorized hearing protection, such as earmuffs or plugs to protect against loud noises.



Operating equipment requires the full attention of the operator. Do not use radio or music headphones while operating machinery.

Practice Safe Maintenance

Understand all service procedures before starting work. Keep area clean and dry. Never lubricate, service, or adjust machine while it is in operation.

Keep hands, feet and clothing away from power-driven equipment. When shutting down an engine, disengage all power and operator controls. Allow the engine to cool completely before beginning any service work.

Securely support any machinery elements that must be raised for service work with support or lifting machinery specifically intended for that purpose.

Keep all parts in good conditions and properly installed. Fix damage immediately. Replace any worn or broken parts. Remove any build up of grease, oil or debris.

Disconnect battery ground cable (-) before making any adjustments or service work.

Stay Clear of Rotating Drivelines

Entanglement in rotating drivelines can cause serious injury or death. Keep shields in place at all times. Make sure that rotating shields turn freely in pace with the drivelines.

Do not wear loose fitting equipment around rotating drivelines. Stop the engine and make sure that all moving parts have stopped before making any adjustments, connections, or performing any other type of service to the engine or other driven equipment.

Safety Rules (Continued)

Install all Safety Guards
Direct contact with rotating fans, belts, pulley and drives can cause serious injury.

Keep all guards in place at all times during engine operation.

Wear close-fitting clothes. Stop the engine and be sure all fans, belts, pulleys and drives are stopped before making adjustments, connections, or cleaning near fans and their components.

Do not allow anything on your person to dangle into or come in contact with a moving fan, belt, pulley or drive. Fans can act as vacuums and pull materials up from below, so avoid that area as well while in service.

Safe Battery Handling

Prevent Battery Explosions

Battery gas is highly flammable. Battery explosions can cause severe injury or death. To help prevent battery explosions, keep sparks, lighted matches and open flame away from the top of battery. When checking battery electrolyte level, use a flashlight.

Never check battery charge by contacting the posts with a metal object. Use a volt-meter or hydrometer.

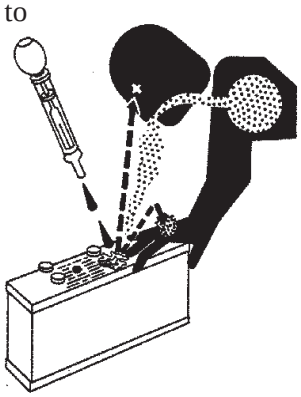
Frozen batteries may explode if charged. Never charge a battery that has not been allowed to warm to at least 16^{O}C (60^{O}F).

Always remove grounded (-) battery clamp first and replace ground clamp last.

Sulfuric acid in battery electrolyte is poisonous and strong enough to burn skin, eat holes into clothing and other materials, and cause blindness if splashed into eyes.

To Avoid Hazards:
- Fill batteries only in well-ventilated areas.
- Wear appropriate eye protection and rubber gloves.
- Never use air pressure to clean batteries.
- Wear appropriate ventilation equipment to avoid inhaling fumes when adding electrolyte.
- Do not spill or drip electrolyte.
- Use correct jump-start procedure if required.

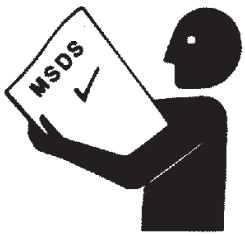
If acid is spilled on skin or in eyes:
1. Flush skin with water.
2. Apply baking soda or lime to help neutralize acid.
3. Flush eyes with water for 15-30 minutes.
4. Get medical attention immediately.



If acid is swallowed:
1. DO NOT induce vomiting.
2. Drink large amounts of water or milk, without exceeding 2 liters (2 quarts)
3. Get medical attention immediately

WARNING: Battery posts, terminals, and related accessories can contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

Handle Chemical Products Safely
Direct exposure to hazardous chemicals can cause serious injury. Among the potentially hazardous chemicals that may be used with Northern Lights products are lubricants, coolants, paints and adhesives.



All potentially hazardous chemicals come with a Material Data Safety Sheet (MSDS). The MSDS provides specific details on chemical products, including physical hazards, safety procedures and emergency response techniques
.
Read and understand the MSDS for each chemical before you start any job that includes it. Follow the procedures and use appropriate equipment exactly as recommended.

Safety Rules (Continued)

Contact your Northern Lights dealer or Northern Lights factory for MSDS's used on Northern Lights products.

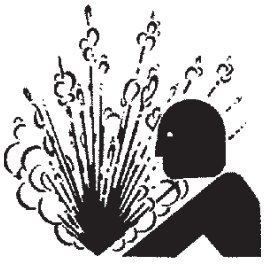
Work in Well Ventilated Areas
Exhaust fumes from engines contain carbon monoxide and can cause sickness or death. Work in well ventilated areas to avoid prolonged exposure to engine fumes. If it is necessary to run an engine in an enclosed area, route the exhaust fumes out of the area with an approved, leak proof exhaust pipe extension.

Remove Paint Before Welding or Heating
Hazardous fumes can be generated when paint is heated by welding, soldering or using a torch. To avoid potentially toxic fumes and dust, remove paint before heating.

- Remove paint a minimum of 100 mm (4 in.) from the area that will be affected by heat.
- If paint cannot be removed, wear an approved respirator.
- If you sand or grind paint, use an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers from the area.
- Allow at least 15 minutes for fumes to disperse before welding or heating.

Do not use a chlorinated solvent in an area where welding will occur. Work only in areas that are well ventilated. Dispose of paint and solvent properly.

Service Cooling System Safely
Opening a pressurized cooling system can release explosive fluids and causing serious burns.



Before opening any pressurized cooling system, make sure the engine has been shut off. Do not remove a filler cap unless it is cool enough to comfortably grip with bare hands. Slowly loosen cap to relieve pressure before opening fully.

Avoid High Pressure Fluids
Relieve pressure prior to disconnecting pressurized lines. Escaping fluid under pressure can penetrate the skin causing serious injury. Always relieve pressure before disconnecting hydraulic or other pressurized lines. Tighten all connections firmly before re-applying pressure.

If searching for leaks, use a piece of cardboard. Always protect your hands and other body parts from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any high pressure spray injected into the skin must be removed within a few hours to prevent the risk of gangrene or other infection.

Avoid Heating Near Pressurized Fluid Lines
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns and bodily injury. Pressurized lines can rupture when heat goes beyond the immediate flame area. Do not weld, solder or use a torch or open flame near pressurized lines or other flammable fluids.

Do Not Open High-Pressure Fuel System
Many Northern Lights engines use high-pressure fuel injection. High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt any repair of fuel lines, sensors, or other components between the high-pressure fuel pump and nozzles on engines with high pressure fuel systems.

ONLY AUTHORIZED TECHNICIANS CAN PERFORM REPAIRS ON AN HIGH PRESSURE FUEL INJECTION SYSTEMS.

Safety Rules (Continued)

Avoid Hot Exhaust
Avoid exposure to and physical contact with hot exhaust gases. Exhaust parts and streams can reach high temperatures during operation, leading to burns or other serious injury.

Cleaning exhaust filters can also lead to exposure to hot exhaust gas and the injury risk associated with it. Avoid exposure to and physical contact with hot exhaust gases when cleaning exhaust filters.

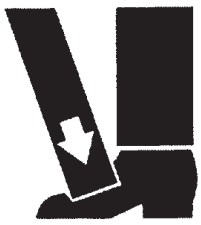
During auto or manual/stationary exhaust filter cleaning operations, the engine will run at elevated temperatures for an extended period of time. Exhaust parts and streams can reach high temperatures during operation, leading to burns or other serious injury.

Avoid Harmful Asbestos Dust
Inhaling asbestos fibers may cause lung cancer. Avoid breathing any dust that may be generated when handling components containing asbestos fibers, including some gaskets.

The asbestos used in these components is usually found in a resin or otherwise sealed. Normal handling of these components is not dangerous, as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding materials containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If this vacuum is not available, apply a mist of oil or water on the material containing asbestos. Keep all bystanders away from any area where asbestos dust may be generated.

Use Proper Lifting Equipment and Techniques



Lifting heavy components incorrectly can cause severe injury or damage to machinery. Avoid unbalanced loads. Do not use lifting eyes. Lift the generator set using lifting bars inserted through the lifting holes on the skid. Follow all recommended removal and installation procedures in this and associated Northern Lights manuals.

Use Proper Tools
Makeshift tools and procedures can create safety hazards. Always use appropriate tools for the job.

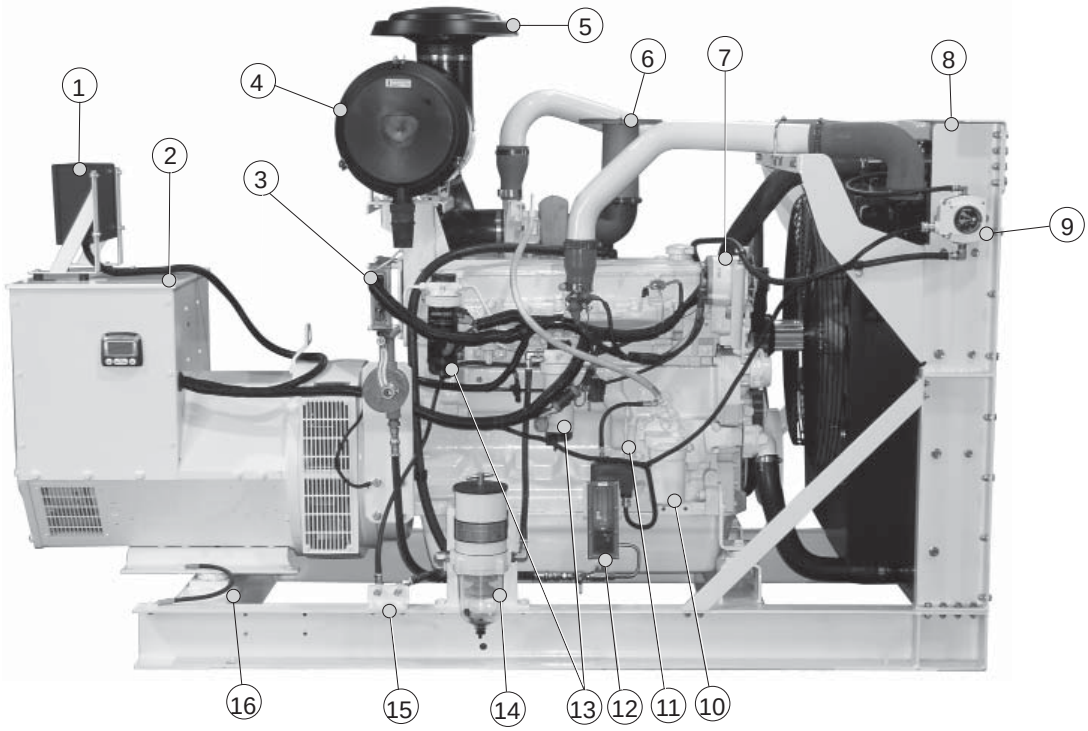
Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, always use the correct sized tools. Do not use US measurement tools on metric fasteners, or vice versa. Use only service parts that meet Northern Lights specifications.

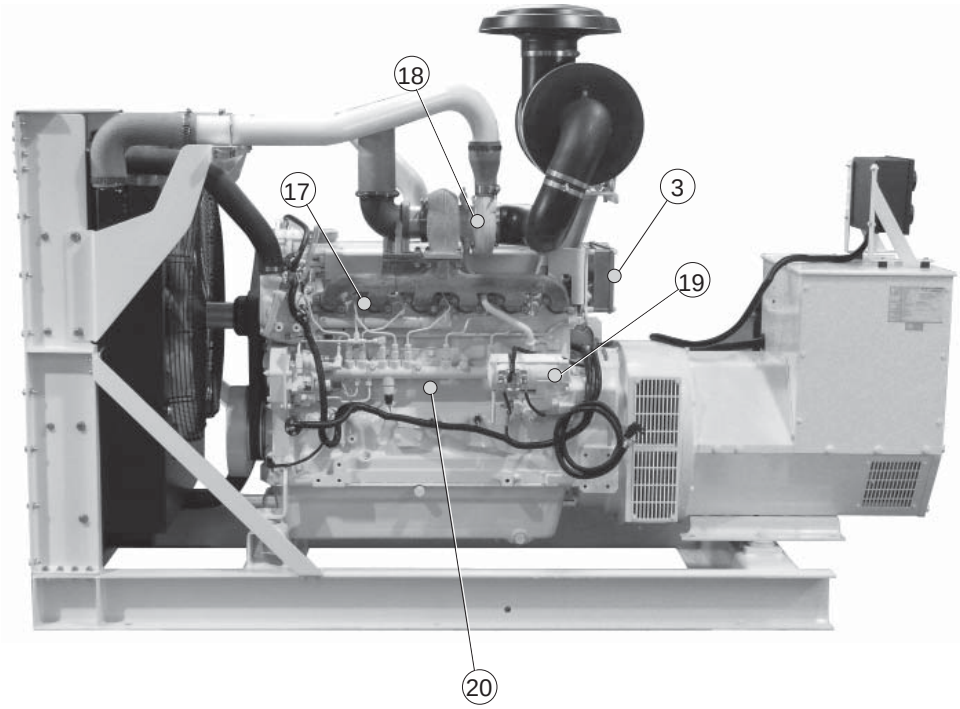
Dispose of Waste Properly
Disposing of waste improperly can threaten the environment and lead to unsafe working conditions. Potentially harmful waste used in Northern Lights equipment can include oil, fuel, coolant, filters and batteries.

Use leakproof containers to drain fluid. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain or into any water source.

Component Locations





Figures 1 & 2: *NL1066H4 (Electronically Controlled Fuel System)*

1. Control Panel
2. Junction Box
3. Electronic Control Unit
4. Air Cleaner
5. Rain Cap
6. Exhaust Elbow
7. Alternator
8. Radiator Shroud
9. Low Coolant Level Switch/Gauge
10. Lube Oil Filter
11. Lube Oil Dipstick
12. Low Oil Level Switch/Gauge (optional)
13. Fuel Filter
14. Fuel/ Water Separator
15. Fuel Manifold
16. Vibration Mount
17. Exhaust Manifold
18. Turbocharger
19. Starter
20. High Pressure Common Rail

Figure 3: *Series 3-B Generator Control Panel*

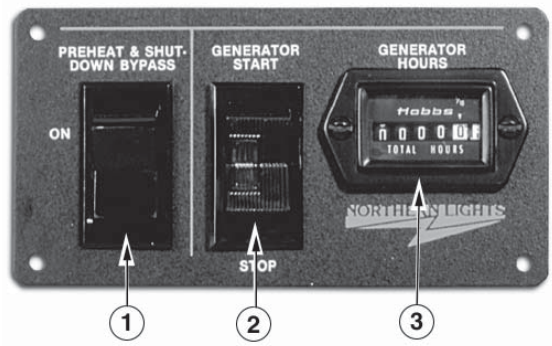


Figure 4: *Series 1-B Generator Control Panel*

1. SHUTDOWN BYPASS-PREHEAT SWITCH

Two functions are built into this switch: the preheating of the engine, and bypassing of the engine safety shutdown circuit. Hold switch in the ON position 10 - 20 seconds before starting the engine, and continue holding on during engine cranking. Release the switch as soon as the engine is running. Holding the switch on too long can burn out the heater element.

2. ENGINE CONTROL SWITCH

To start the engine, hold this switch in the START position until the engine is running.

After the engine starts, release the switch and it will return to RUN position. To stop the engine, hold the switch in the STOP position until the engine has completely stopped.

NOTE: The rocker switch is used on Series 1 panels only, and has a light that glows when the set is running.

3. HOUR METER

Keeps track of engine running time.

4. OIL PRESSURE GAUGE

Shows the oil pressure in the engine lubricating system.

5. ENGINE TEMPERATURE GAUGE

Registers the temperature of the engine coolant.

6. D.C. VOLTMETER OR AMMETER

When the engine is stopped, the voltmeter indicates the condition of the battery. When the engine is running, the voltmeter indicates the voltage output of the alternator.

Operating Procedures

BEFORE STARTING

1. Check the water level by removing the pressure cap from the expansion tank. In order to give the cooling water room to expand, the level should be about 1 3/4 in. (4-5 cm) below the filler cap sealing surface when the engine is cold. When filling with coolant, the venting cock on top of the turbocharger should be opened to ensure that no air pockets form in the cooling system.

CAUTION: *Use protective clothing and open the filler cap carefully when the engine is warm to prevent burns.*

2. Check the oil level in the crankcase with the dipstick. The oil level should be in the "waffled area" or on or below "full". Always add the same viscosity of oil as is already in the crankcase.
3. Check the fuel tank level and open any fuel valves.
4. Disengage clutch, if equipped.
5. Close the seacock, check and clean the strainer and reopen the seacock.
6. Place the battery switch in the ON position.

NOTE: *The battery switch must always be kept ON while the engine is running. If the switch is turned OFF while the engine is running, the battery charging regulator could be ruined.*

Starting

1. Hold the Preheat Bypass switch in the ON position for 15-20 seconds, then push the Engine Control switch to the START position.
2. As soon as the engine starts, release both switches. **Do not crank the starter for more than 20 seconds.**
3. If the engine fails to start the first time, be sure the starter has stopped before re-engaging.
4. Operate engine at or below 1200 RPM with no load for 1 to 2 minutes to ensure proper lubrication. When operating at below freezing temperatures extend this period to 2 to 4 minutes.

NOTE: *If there is a governor locked at a specific speed on the generator set, there may not be a slow idle function, so in that case operate the engine at high idle for 1 to 2 minutes before adding load. If the stand-by generator set is loaded as soon as it reaches rated speed, this procedure would not apply.*

Operating

1. Check Gauges Often: Oil pressure must be above 29 PSI (if not above 15 PSI within 5 seconds of starting, the engine should be stopped and the problem should be explored). Normal oil pressure is 50 PSI at rated load speed (1800 to 2500 RPM). Oil temperature should be 115^0C (240^0F) for normal operating temperature. Coolant temperature should be 82 - 94°C (180 - 202°F) for electronically controlled fuel systems. The D.C. voltmeter should read between 13 and 14 volts (26-28 volts, 24 volt systems).
2. Check AC voltage and frequency meters (Series 4 Panel). If gauges deviate from normal levels, shut down the set and investigate.
3. Check belt for good alignment.
4. Let the unit run unloaded for a three to five minute warm-up period before applying load.
5. Do not add full electrical load until engine is at maximum operating temperature.
6. If the air temperature is below -10°C (14°F) use an engine block heater.

Shutdown

1. Turn the Engine Control Switch to the OFF position.
2. Close the fuel valves, and put the battery switch in the OFF position if the unit will be off for an extended period.

NOTE: *Do not turn the battery switch to OFF while the engine is running.*

SHUTDOWNS AND ALARMS

1. Your unit is fitted with a system to protect it from high water temperature or low oil pressure.
   a. Generator sets have shutdown systems to stop the engine. They have no warning horns.
   b. Other alarms and shutdowns are available as optional equipment.

NOTE: *Do not rely on your warning or shutdown system to the exclusion of careful gauge monitoring. Watching your gauges can prevent damage to the unit and dangerous power losses.*

2. Do the following when your shutdown system is activated:
   a. Check the coolant temperature gauge. If the temperature is above 205°F (97°C), shut off the engine immediately.

Operating Procedures

CAUTION: *Do not remove the water fill cap of an overheated engine. Escaping high temperature steam can cause severe burns. Allow the engine to cool and then remove the cap slowly,* ***using protective clothing.***

b. Use the Trouble Shooting Guide on pages 27- 29 to isolate the cause of the overheat.
c. Make repairs and restart after the temperature gauge registers below 180°F (83°C).
d. Watch the temperature gauge regularly and turn off the unit if the temperature rises above 200°F (94°C). Repeat the troubleshooting process.

3. If the shutdown is activated and the temperature gauge shows temperature within normal temperature range:

a. Check the engine crankcase oil level.
b. If the oil level is low, fill with recommended lubricating oil and restart. Do not add oil above the crosshatch pattern or "full" mark. Watch the oil pressure gauge carefully and shut off the engine if it does not show a normal reading after a few seconds of operation.
c. If the oil level was normal, DO NOT restart the engine. Call your Northern Lights or Lugger dealer for assistance.

BREAK-IN PERIOD

1. The first 100 hours on a new or reconditioned engine are critical to its life and performance.

2. Operate the engine under various conditions, particularly heavy loads with minimal idling, to help seat engine components properly.

3. Constantly check the engine temperature and oil pressure gauges.

4. Oil consumption is greater during break-in as piston rings and cylinder liners take time to seat.

5. Break-In Oil Changes: Change engine oil and filter at 50 hours. Change oil and filter again at 100 hours (Consult Lubricants Section for oil recommendation).

Cold Weather Operation

1. Cold weather starting aids are required for air temperatures below 0°C (32°F). These might include intake air heaters, coolant heaters, fuel heaters, or ether injectors. Additional starting aids may be needed in temperatures below -30°C (-22°F) or above 1500 m (5000 ft) in altitude.

CAUTION: *Do not use starting fluid on engines with air intake heaters or glow plugs. Ether injector starting fluid is highly flammable and may explode. Do not incinerate or puncture a starting fluid container.*

2. Four valve cylinder head engines are equipped with glow plugs as cold weather starting aids.

Service Schedule Chart

The Servicing Schedule Chart below shows the service schedule required for proper maintenance of your marine engine or generator set. More detailed coverage of each Service Point (SP) is listed on the page noted in the 'page' column.

DAILY:
- SP1 Check oil level in engine
- SP8 Check primary fuel filter
- SP15 Check cooling water level

AFTER FIRST 50 HOURS:
- SP2 Change engine oil
- SP3 Change lube oil filter

EVERY 50 HOURS:
- SP21 Check electrolyte in batteries

AFTER FIRST 100 HOURS/ EVERY TWO WEEKS [5]:
- SP2 Change engine oil after first 100 hrs., then check every 2 wks.
- SP3 Change oil filter after first 100 hrs., then check every 2 wks.
- SP4 Check air cleaner valve & restriction indicator gauge [6]
- SP7 Check crankshaft vibration damper[7]
- SP15 Check coolant level

EVERY 250 HOURS
- SP2&3 Change engine oil & filters (fuel filter/water bowl)

EVERY 500 HOURS / YEARLY:
- SP4 Replace air cleaner
- SP5 Check V-belt condition
- SP9 Change primary filter element (Racor)
- SP10 Change secondary fuel filter
- SP11 Check injectors
- SP14 Check turbocharger boost pressure
- SP16 Check cooling system
- SP22 Check the state of the charge of the batteries
- SP25 Check engine mounts
- SP26 Clean crankcase vent tube
- SP27 Check air intake hoses
- SP29 Check electrical ground connection
- SP30 Check engine speeds

EVERY 2000 HOURS:
- SP6 Check & adjust valve clearance
- SP7 Check crankshaft vibration damper
- SP12 Check fuel injection pump
- SP16 Flush cooling system
- SP18 Check and clean radiator
- SP23 Test thermostats

SERVICE POINT	PAGE	OPERATION		DAILY	50 Hours	100 Hours	250 Hours	500 Hours	2000 Hours
		ENGINE:							
SP1	13	Check oil level		●					
SP2	13	Change engine oil	1) 2)		●	●	●		
SP3	13	Change lube oil filters	1) 2)		●	●	●		
SP4	13	Check air cleaner valve & change element	2) 4) 6)			●		●	
SP5		Check belt condition	2)					●	
SP6	15	Check valve clearances	2)						●
SP7	17	Check crankshaft vibration damper	7)						●
SP25		Check engine mounts						●	
SP27		Check air intake hoses						●	
SP30		Check engine speeds						●	
		FUEL SYSTEM:							
SP8	16	Check primary filter (Racor)	3)	●					
SP9	16	Change primary filter element (Racor)	3) 4)					●	
SP10	17	Change secondary fuel filter	2) 4)					●	
SP11		Check injectors						●	
SP12		Check fuel injection pump							●
		TURBOCHARGER:							
SP13	22	Check air, oil & cooling water lines for leakage	2)			●			
SP14	22	Check boost pressure						●	
		COOLING SYSTEM:							
SP15	24	Check cooling water level		●					
SP16	24	Check and flush cooling system	2)					●	●
SP18		Check and clean radiator							●
		ELECTRICAL SYSTEM:							
SP21	26	Check electrolyte level in batteries	2) 4)		●				
SP22	26	Check condition of batteries with hydrometer	2)					●	
SP23		Test thermostats							●
SP29		Check electrical ground connection						●	

1) Change the oil and filter before the first 100 hours of operation during engine break-in.
2) Perform all maintenance once a year even if hour level has not been reached.
3) Consult manufacturer's maintenance schedule, note on chart.
4) Whenever necessary.
5) Operate engine at rated speed with 50-70% load for 30 minutes at least.
6) Replace air cleaner element when restriction indicator shows vacuum of 625 mm (25 in.) H_20.
7) Replace damper every 4500 hours or after 60 months.

Service Record

Service Point	OPERATION	HOURS/DATE									
50 HOURS											
SP21	Check electrolyte in batteries										
250 HOURS											
SP2	Change engine oil*										
SP3	Change lubricating oil filters*										
500 HOURS											
SP4	Check air cleaner*, replace as needed										
SP5	Check belt condition										
SP9	Change primary fuel filter element										
SP10	Change secondary fuel filter										
SP11	Check injectors										
SP13	Check turbocharger air, oil & cooling lines for leakage										
SP14	Check turbocharger boost pressure										
SP16	Check cooling system										
SP22	Check state of charge of batteries										
2000 HOURS											
SP6	Check valve clearance										
SP7	Check crankshaft vibration damper										
SP12	Check fuel injection pump										
SP16	Flush cooling system										
SP18	Check radiator										

* After first 50 and then 100 hours.

Servicing

LUBRICATION

Break-in oil

1. Use one of the following during the first 100 hours of operation:
   a. John Deere Engine Break-In Oil
   b. API Service CC, CD, or CE oil
   c. ACEA Specification E1 or E2
2. *Do not use* John Deere PLUS-50 oil or engine oils meeting API CI-4, CH-4, CG-4, CF-4, or CF-2, ACEA E5, E4, or E3 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

Lubrication - General

1. Use only clean, high quality lubricants stored in clean containers in a protected area.
2. These oils are acceptable after the first 100 hours:
   a. API Service Catagory CI-4 or CH-4 oils.
   b. ACEA Oil Sequence E4 or E5.
   d. ACEA Oil Sequence E3.
3. Use the proper weight oil for your average operation temperature, multi-viscosity diesel engine oils are preferred. Quality and sulfur content must comply with local existing emission regulations.

Air Temperature	Single Viscosity	Multi Viscosity
Above 32°F (0°C)	SAE-30W	SAE15-40W
-10°F to 32°F (-23°C to 0°C)	SAE-10W	SAE10-30W
Below -10°F (-23°C)	SAE-5W	SAE5-20W

4. Some increase in oil consumption may be expected when SAE 5W and SAE 5-20W oils are used. Check oil level frequently.
5. Never put additives or flushing oil in crankcase.

SP1. CHECK ENGINE OIL LEVEL

1. Check the oil level in the crankcase, with the oil dipstick, daily.
2. The oil level must be between the “Waffled area” and the “add”. Never allow the level to go below the “add”.
3. Always add the same viscosity of oil as is already in the crankcase.

SP2. OIL CHANGES

1. Using the oil recommended above, change the engine oil and filter after the first 50 hours of operation, the first 100 hours and every 250 hours thereafter.
2. During intermittent cold weather operation, change oil every 100 hours or six weeks, whichever comes first.
3. Change oil at any seasonal change in temperature when a new viscosity of oil is required.
   a. Remove plug from outlet in base frame. Screw in owner-supplied drain hose.
   b. Open valve at oil pan outlet. After oil has been drained into suitable container, close valve, remove drain hose and replace plug in base frame outlet.
   c. Refill engine with recommended oil.
4. Engine Lube Oil Capacity:

NL1064H2	20.5 liters	21.6 qts.
NL1066H4	31.5 liters	33.3 qts.

SP3. CHANGING OIL FILTER

1. Change the lube oil filter every 250 hours.
2. Use a filter wrench to remove old filter. Dispose of filter in approved manner.
3. Make sure the gasket from the old filter is removed and discarded.
4. Lubricate the rubber gasket on the new filter and screw it on nipple until gasket meet the sealing surface.
5. Using hands only, no wrench, tighten filter one-half turn farther. Overtightening can do damage to filter housing.
6. Fill engine with recommended oil. Start engine and check for leakage. Stop engine and check oil level. Add additional oil if necessary.

SP4. AIR CLEANER

1. Inspect air cleaner every 100 hours. Replace air cleaner element every 500 hours.
2. Clean the rubber tube at the cleaner. Loosen the hose clamp and the attaching strip for the cleaner.
3. Make sure the rubber tube is in good condition and that new filter is absolutely clean and installed properly.
4. Start the engine and check for leaks.

NOTE: *Make absolutely sure no impurities enter the engine while changing the element. Do not run the engine with the air cleaner removed.*

SP5. BELT TENSION

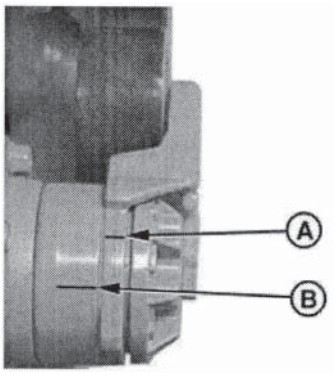
1. Inspect the belt for cracks, stretched out areas, or frays and replace if needed.

   Measure the spring tensioner's tension, as follows.

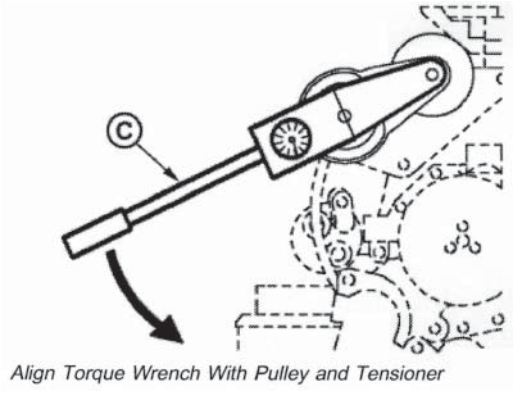
2. Using a torque wrench, remove the belt from the pulleys using a breaker bar and socket on the tension arm.
3. Check the pulleys and bearings while the belt is off. See dealer if replacements are needed.
4. Release the tension on the tension arm and remove the breaker bar.
5. Mark a line as shown (Figure 5A).
6. Measure 21 mm (.83 in.) down from (A) and put a line (B) on the tensioner mounting base.
7. Install a torque wrench (Figure 6C) and align the center of the pulley and tensioner, aligning marks.
8. Record the torque wrench measurement and compare it with the below specification.

Spring Tension Torque .....18 -22 N•m (13-16 lb.-ft.)

Note: The belt tensioner roller capscrew threads are Left-Hand threads.



 RG7977 *Figure 5*



Align Torque Wrench With Pulley and Tensioner

 RG12065 *Figure 6*

SP6. VALVE CLEARANCES

The following special tools will be needed:

JDE 820 or JDE 83 Flywheel Turning Tool.
JDG1571 or JDE81-4 Timing Pin.

CAUTION: Make sure the negative battery terminal is disconnected before starting valve adjustments. Engine must be cold to check and adjust valve clearances.

1. Remove rocker arm cover with ventilator tube.
2. Remove plastic plugs in engine timing holes on front side of flywheel.
3. Rotate flywheel in clockwise direction (viewed from water pump) with the Flywheel Turning Tool until the Timing Pin engages timing hole in the flywheel. Both rocker arms for No. 1 cylinder will be loose at Top Dead Center. If they are not, remove the timing pin and rotate the flywheel one complete turn and reinstall the timing pin in the flywheel.
4. Check contact surfaces of valve tips and rocker arm pads for cracks or excessive wear, replace damaged parts.
5. Valve Clearances for checking:

   Intake Valve: 0.012-0.015 in. (0.31-0.38 mm)

   Exhaust Valve: 0.016-0.019 in. (0.41-0.48 mm)

   Valve Clearances for adjusting:

   Intake Valve: 0.014 (0.36 mm)

   Exhaust Valve: 0.018 in. (0.46 mm)

5. If the valves need adjusting, loosen the jam nut (A on Figure 7) on the rocker arm adjusting screw. Turn the adjusting screw until you feel a slight drag when the feeler gauge slips. With a screwdriver, hold the adjusting screw from turning while tightening the jam nut to specifications Check the clearance again after tightening the jam nut. Re-adjust as needed.

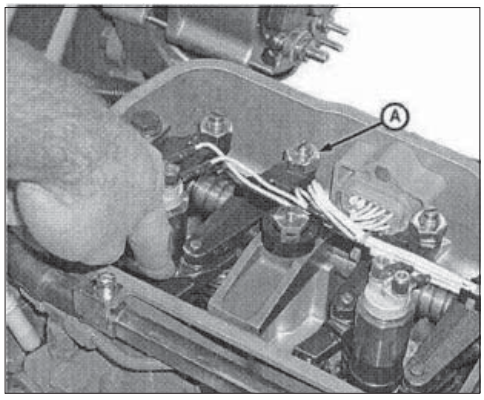
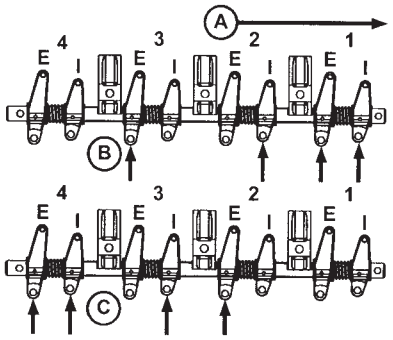


Figure 7

4-CYLINDER ENGINES:

Lock No. 1 piston at TDC compression stroke (B).
Adjust valve clearance on No. 1 and No. 3 exhaust valves and No. 1 and No. 2 intake valves.
Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).

NOTE: *Firing order is 1 - 3 - 4 - 2*



4-Cylinder Valve Adjustment

Figure 8

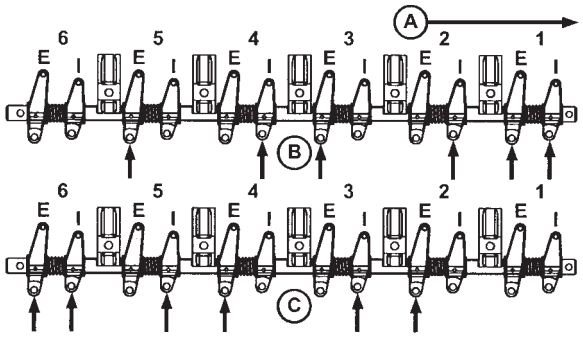
A - Front of Engine
B - No. 1 Piston at TDC Compression Stroke
C - No. 4 Piston at TDC Compression Stroke
E - Exhaust Valve
I - Intake Valve

Adjust valve clearance on No. 2 and No. 4 exhaust valves and No. 3 and No. 4 intake valves. Replace rocker arm cover and crankcase ventilator tube.

Rocker Arm Adjusting Screw Jam Nut
Torque: .....27 N•m (20 lb-ft)

6-CYLINDER ENGINES:

NOTE: *Firing order is 1 - 5 - 3 - 6 - 2 - 4*



6-Cylinder Valve Adjustment

 RG12170

Figure 9

A - Front of Engine
B - No. 1 Piston at TDC Compression Stroke
C - No. 6 Piston at TDC Compression Stroke
E - Exhaust Valve
I - Intake Valve

Lock No. 1 piston at TDC compression stroke (B).

Adjust valve clearance on No. 1, No. 3, and No. 5 exhaust valves and No. 1, No. 2, and No. 4 intake valves.

Rotate flywheel 360°. Lock No. 6 piston at TDC compression stroke (C).

Adjust valve clearance on No. 2, No. 4, and No. 6 exhaust valves and No. 3, No. 5, and No. 6 intake valves.

Replace rocker arm cover and crankcase ventilator tube.

Rocker Arm Adjusting Screw Jam Nut
Torque: .....27 N•m (20 lb-ft)

FUELS - GENERAL

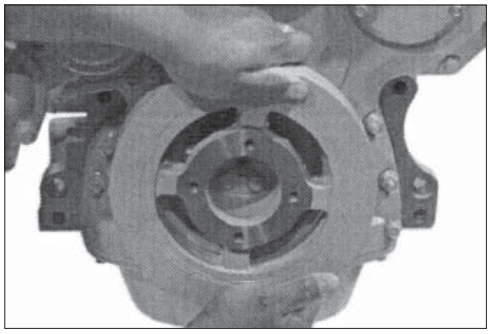
1. Use only clean, high quality fuels of the following specifications, as defined by ASTM designation D975 for diesel fuels:
   a. Use Grade No. 2 diesel at ambient temperatures above freezing 30°F (0°C).
   b. Use Grade No.1 at ambient temperatures below freezing and for all temperatures at an altitude of above 5,500 ft. (1500 meters).
2. Sulphur content should not exceed 0.5% (preferably less than 0.5%). Diesel fuel for highway use has a sulfur content of less than 0.05% (500 ppm) in the United States and Canada and less than 0.035% (350 ppm) in the European Union.
3. The cetane number should be a minimum of 45.
4. Very low sulfur content diesel fuels may have inadequate lubricity and may cause accelerated wear, injection nozzle corrosion, low power, and smoke. Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078. Add premium diesel fuel conditioner at the specified concentration to compensate.
5. Grade No. 1-D fuel is best for cold weather operation - when temperature is below 5°C (40°F), also add premium diesel fuel conditioner when outside temperature is below 0°C (32°F).
6. DO NOT use these unsuitable grades of fuel:
   a. Domestic heating oils, all types.
   b. Class B engine.
   c. Class D domestic fuels.
   d. Class E, F, G or H industrial or marine fuels.
   e. ASTM-D975-60T No. 4-D and higher number fuels.
   f. JP4
7. Storing fuel:
   a. Keep dirt, scale, water and other foreign matter out of fuel.
   b. Avoid storing fuel for long periods of time.
   c. Fill the fuel tank at the end of each day's operation. This will reduce condensation.

SP8-10. FUEL FILTERS

1. Your engine or generator set should have a primary fuel filter installed. We recommend the Racor brand of fuel filter - water separators.
   a. Check the primary fuel filter daily as recommended by the filter manufacturer. Empty the collection bowl as necessary.
   b. Change the element every 500 hours or whenever necessary, hand tighten filter element when installing - use a filter wrench just for removal.
   c. If the bowl fills with water, change the primary and secondary elements immediately.
2. Change secondary fuel filter every 500 hours. ***NOTE:*** *The fuel filter on the engine is considered the "secondary fuel filter". The engine will be fitted with a quick change disposable secondary fuel filter.*

SP7. CRANKSHAFT VIBRATION DAMPER (6 Cylinder Engines Only)

1. Remove belts.
2. Try to turn the vibration damper in both directions while grasping it with both hands. If rotation can be felt, the damper is defective and should be replaced.



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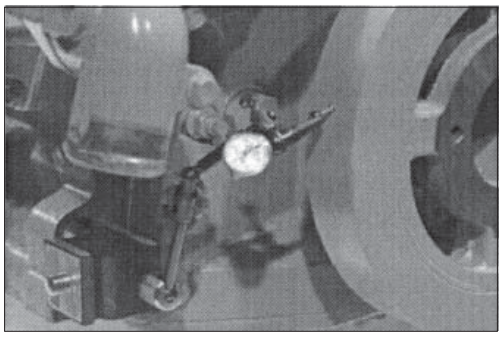
NOTE: *The vibration damper assembly should be replaced every 4500 hours or 60 months, whichever occurs first, as the vibration damper assembly is <u>not</u> repairable.*

3. Place a dial indicator (Figure 11) so that the probe contacts the damper's outer diameter in order to check the damper radial runout.
4. Make sure the engine is at operating temperature, then rotate the crankshaft using the JD281A, JDE81-4, or the JDE83 Flywheel Turning Tool.
5. If the runout reading exceeds the below specification, replace the vibration damper.

Vibration Damper Maximum
Radial Runout .....1.50 mm (0.060 in.)



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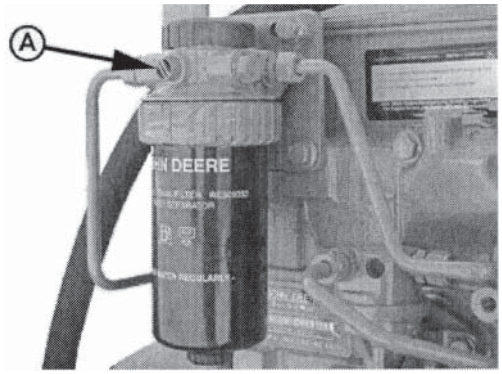
SP8-10. FUEL FILTERS *(Continued)*

Important*: Do not crack any fuel lines to bleed the fuel system. Four valve cylinder head engines are especially sensitive to fuel contamination.*



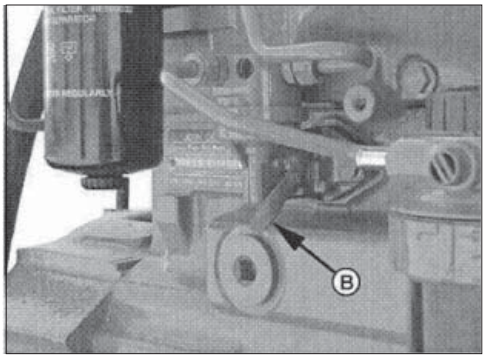
Reproduced by permission of Deere & Company, c2006. Deere & Company. All rights reserved. RG12220 *Figure 12*: *Secondary Fuel filter*

a. Turn the air bleed vent screw (Fig. 12-A) two full turns by hand on the filter base.

NOTE: *Before installing a new filter cartridge make sure the surfaces where the cartridge comes in contact with the mounting plate are absolutely clean. Dirt can be washed into the fuel injection system. This may result in severe damage to the fuel injection pump or nozzles. Also, never pre-fill fuel filters. Your generator set may have two secondary filters, depending on the fuel supply system.*

b. Pump the fuel supply pump primer lever (B on Fig. 13) or primer button on the fuel filter base (if equipped) until the fuel flows out of the bleed vent screw.

c. Tighten the bleed vent screw securely. Operate the primer until pumping action is not felt. Start the engine and check for leaks.



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RG12221 *Figure 13*: *Fuel Supply Pump Primer Lever*

BLEEDING THE FUEL SYSTEM

CAUTION: *High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt repair of fuel lines, sensors, or any other components between the high-pressure fuel pump and nozzles on engines with the High Pressure Common Rail fuel system. Only technicians familiar with this type of system should perform repairs.*

Fluid under pressure could penetrate skin and cause serious injury. Relieve the pressure before disconnecting hydraulic or other lines to avoid such hazards. Tighten all connections before applying pressure. Search for leaks using a piece of cardboard. Protect hands and body from high pressure fluids. If an accident occurs - see a doctor immediately. Fluid injected into the skin has to be surgically removed within a few hours or gangrene could result.

d. Any time the fuel system has been opened for service, i.e.; lines disconnected or filters removed, it is necessary to bleed air from the system.

SP11. INJECTORS

CAUTION: *Do not open the high-pressure fuel system, or modify the fuel system. Do not disconnect or attempt repair of fuel lines, sensors, or any other components between the high pressure fuel pump and nozzles on engines with the high pressure common rail fuel system. Only technicians familiar with this system should perform repairs. Modification or alteration of the injection pump, the injection pump timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.*

Also, tampering with the fuel system and altering emission-related equipment on engines could result in fines or other penalties, per EPA regulations or other local regulations.

Do not attempt to service injection pump or fuel injectors yourself. Special training and tools are required. (See your dealer or contact Alaska Diesel Electric.)

SP12. INJECTION PUMP

1. Since operating conditions may vary considerably, it is difficult to give a definite service interval. Service of the fuel injection pump should only be done if checks indicate pump malfunction.
2. Black smoke can be an indication of pump malfunctions. Before having the pump serviced, check the other possible causes.

SP13. TURBOCHARGER

1. Check for air leaks every 100 (electronically controlled fuel system engines) hours. Air leakage will lower engine output and may cause black exhaust smoke and soot.
2. Listen along air line while engine is running. A whistling or hissing sound indicates leakage.
3. Leakage on the pressure side, between turbo and engine, can be found by applying soapy water to the air line.
4. Tighten the hose clamps, replace hose or gaskets as required.
5. Check to see that the lubrication and cooling lines are tight and without leaks.

SP14. TURBO BOOST

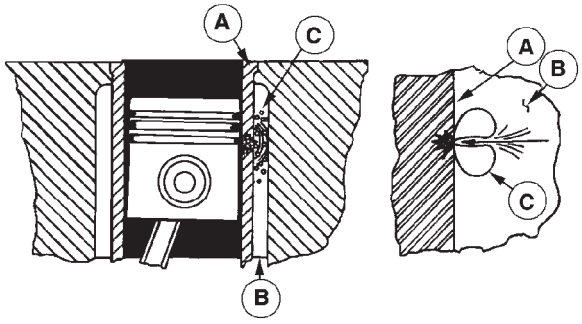
1. This check measures the amount of air the turbo is pushing into the engine. It should be done by an authorized dealer every 500 hours.
2. On the inlet manifold there is a 1/8" NPT threaded port. Remove the plug and install the boost gauge hose. Refer to your engine specifications for correct pressure.

COOLING REQUIREMENTS

1. To meet cooling system protection requirements, the coolant solution must consist of:
   a. Quality water
   b. Ethylene glycol concentrate (EGC) commonly known as antifreeze.
   c. Supplemental coolant additives (SCA's).
2. A coolant solution of ethylene glycol concentrate (EGC-antifreeze), quality water and supplemental coolant additives (SCA's) ***MUST*** be used ***YEAR ROUND*** to protect against freezing, boil-over, liner erosion or pitting and to provide a stable, noncorrosive environment for cooling system components.
3. **Ethylene glycol coolant concentrate (antifreeze) normally DOES NOT contain the SCA chemical inhibitors needed to control liner pitting or erosion, rust, scale, and acidity.**

LINER EROSION (PITTING)

1. Cylinder liner walls (Figure 14-A) which are in contact with engine coolant (Figure 14-B) can be eroded or pitted unless the proper concentration and type of SCA's are present in the coolant. Water pump impellers are also susceptible to pitting.
2. Vapor bubbles (Figure 14-C) are formed when the piston's impact causes the liner walls to vibrate, sending pressure waves into the coolant.
3. These tiny vapor bubbles collect on the surface of metal parts. As the bubbles collapse (pop) a microscopic piece of metal is eroded from the metal part. Over a period of time, this pitting may progress completely through the cylinder liner of a wet-sleeve, heavy-duty diesel engine. This allows coolant to enter the combustion chamber. Engine failure or other serious damage will result.



A - Cylinder Liner Walls **B** - Engine Coolant **C** - Vapor Bubbles

Figure 14

4. Unprotected engines with low quality water as coolant can have liner failure in as few as 500 hours.

WATER QUALITY

1. Distilled, deionized, soft water is preferred for use in cooling systems. Bottled distilled water from a food store or water supplier is recommended. Tap water often has a high mineral content. Tap water should NEVER be put in a cooling system unless first tested by a water quality laboratory. Do not use water made by the reverse osmosis method unless it has been PH neutralized.

2. Here are acceptable water quality specifications:

Contaminates	Parts per Million	Grains per Gallon
Maximum Chlorides	40	2.5
Maximum Sulfates	100	5.9
Maximum Dissolved Solids	340	20.0
Maximum Total Hardness	170	10.0
		PH Level 5.5 to 9.0

3. If chlorides, sulfates or total dissolved solids are higher than the above given specification, the water must be distilled, demineralized, or deionized before it is used in a cooling system.
4. If total hardness is higher than 170 ppm and all other parameters are within the given specifications, the water must be softened before it is used to make coolant solution.

EGC: ETHYLENE GLYCOL CONCENTRATE (ANTIFREEZE)

CAUTION: *EGC (Antifreeze) is flammable. Keep it away from any open flame. Avoid contact with eyes. Avoid contact with skin. Do not take internally. In case of contact, immediately wash skin with soap and water. For eyes, flush with large amounts of water for at least 15 minutes. Call a physician. KEEP OUT OF REACH OF CHILDREN. Follow all warnings on the container.*

1. Ethylene glycol coolant concentrate is commonly mixed with water to produce an engine coolant with a low freeze point and high boiling point.
2. A ***low silicate*** form of ethylene glycol coolant is recommended for all diesel engines.

3. Use an ethylene glycol coolant concentrate meeting ASTM D6210, D5345, D4985, SAEJ1941, General Motors Performance Specification GM1899M, or formulated to GM6038M. Do not use ASTM D3306 or D4656.
4. This product is concentrated and should be mixed to the following specification.
5. If additional coolant solution needs to be added to the engine due to leaks or loss, the glycol concentration should be checked with a hydrometer to assure that the desired freeze point is maintained.

	Distilled Water %	EGC % Antifreeze	Freeze Point	Boiling Point
Optimum	50%	50%	-37°C -34°F	+109°C +226°F
Minimum	60%	40%	-24°C -12°F	+106°C +222°F
Maximum	40%	60%	-52°C -62°F	+111°C +232°F

EGC: ETHYLENE GLYCOL CONCENTRATE (ANTIFREEZE)

IMPORTANT

1. **DO NOT** use methyl alcohol or methoxy propanol base EGC. These concentrates are not compatible with chemicals used in supplemental coolant additives. Damage can occur to rubber seals on cylinder liners which are in contact with coolant.
2. **DO NOT** use an EGC containing sealer or stop-leak additives.
3. **DO NOT** use EGC containing more than 0.1% anhydrous metasilicate. This type of concentrate, which is intended for use in aluminum engines, may cause a gel-like deposit to form that reduces heat transfer and coolant flow. Check container label or consult with supplier.

SUPPLEMENTAL COOLANT ADDITIVE (SCA)

CAUTION: *Supplemental coolant additive contains alkali. Avoid contact with eyes. Avoid contact with skin. Do not take internally. In case of contact immediately wash skin with soap and water. For eyes, flush with large amounts of water for at least 15 minutes. Call a physician. KEEP OUT OF REACH OF CHILDREN. Follow all warnings on the container.*

1. Additional SCA's should NOT be added to the mixture of EGC/H_20 on initial fill up of engines with a coolant conditioner-filter. A high SCA concentration will result and can cause silicate-dropout. When this happens, a gel-type deposit is created in the cooling system which retards heat transfer and coolant flow.
2. If additional SCA's are needed, prepare a mixture of 50% quality water and 50%EGC (antifreeze). Add liquid SCA at a rate of 3%, by volume. **Example:** 30 mL of SCA per liter of H_2O/EGC mixture (1.0 fl oz of SCA per qt of H_2O/EGC). Add the resulting mixture to the cooling system in quart increments. Run the engine for 2 hours and retest the coolant. Continue process until SCA c oncentration meets recommended levels.
3. SCA is available from your Northern Lights dealer in the following sizes.
   Pint - Part Number.....20-00002
   1/2 gallon - Part Number.....20-00003
4. ***DO NOT*** *use any coolant system additives containing soluble oil*.

COOLANT TESTING

1. Coolant test kits are available to allow on-site evaluation of the coolant condition.
2. The kits use small strips of paper which are dipped into the coolant. The paper changes color and indicates the SCA concentration. It also indicates the amount of EGC (antifreeze).
3. Test kits are available through your Northern Lights or Lugger Dealer.
   4 Pack - Part Number.....20-00005
   50 Pack - Part Number.....20-00010
   (Test strips have expiration dates - check container.)

SP15. CHECKING COOLANT LEVEL

CAUTION: *The cooling water in the engine reaches extremely high temperatures. You must use extreme caution when working on hot engines to avoid burns. Allow the engine to cool before working on the cooling system. Open the filler cap carefully, using protective clothing when the engine is warm.*

1. Check the coolant level each day before starting the engine.
2. Remove the pressure cap from the expansion tank and check water level. In order to give the coolant an opportunity to expand, the level should be about 1 3/4 in. (4-5 cm) below the filler cap sealing surface when the engine is cold. When filling with coolant, the venting cock on top of the turbocharger (for engines fitted with turbocharger) should be opened to ensure that no air pockets form in the cooling system.
2. The pressure valve in the filler cap releases when the pressure is approximately 7 PSI (0.5 bar). Use a cap pressure tester to check cap if you suspect it is faulty.
4. The makeup coolant, added to compensate for loss or leaks, must meet engine coolant requirements outlined in previous section.

SP16. FLUSHING THE COOLING SYSTEM

CAUTION: *The cooling water in the engine reaches extremely high temperatures. You must use extreme caution when working on hot engines to avoid burns. Allow the engine to cool before working on the cooling system. Open the filler cap carefully, using protective clothing when the engine is warm.*

1. Flush the cooling system and check for leaks and blockage after the first 3 years or 3000 hours. Then every 2 years or 2000 hours. **The engine must be stopped and cold.**
2. Remove the pressure cap from the expansion tank with caution. If applicable, open the cooling system air vent on top of turbocharger.
3. Open the drains on the exhaust manifold and engine block. Drain the fresh water system (see Component Locations, page 4).
4. Fill the fresh water system by pouring the recommended coolant mixture as described in previous sections.
5. Close cooling system air vent on turbocharger.
6. Start the engine. Check hoses and connections and repair any leakage.

DRIVEN EQUIPMENT

Generator Ends

1. The maintenance and operation recommendations for the generator end are in a separate Owner's Manual. If you do not have one of these manuals, contact your local Northern Lights dealer.

ELECTRICAL SYSTEM - GENERAL

1. Never switch battery switch off or break the circuit between the alternator and batteries while the engine is running. Regulator damage can result.
2. DO NOT reverse the polarity of battery cables when installing the battery.
3. When welding on the unit, disconnect the regulator and battery. Isolate the leads.
4. Disconnect battery cables when servicing the DC alternator.
5. Never test with a screwdriver, etc., against any terminal to see if it emits sparks.
6. A DC circuit breaker protects your control panel and wiring harness.

BOOSTER BATTERIES

CAUTION: *Battery Gas Can Explode. Keep all flames and sparks away from batteries.*

1. Before changing or using booster batteries, check battery electrolyte level. Add distilled water.
2. Booster and main batteries must have the same voltage rating.
3. First, connect positive (+) terminal of booster battery to positive (+) terminal of main battery.
4. Then, connect negative (-) terminal of booster battery to ground on the engine block (see Figure 15).
5. Remove booster battery after starting engine.
6. Sealed batteries: see manufacturer charging and booster instructions.

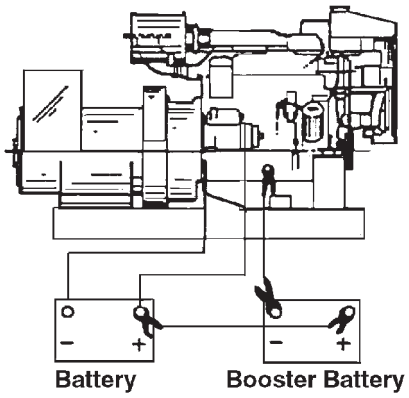


Figure 15: Booster Battery Connections

SP21-22. BATTERY CARE - LEAD/ACID TYPE BATTERIES

1. Check electrolyte level every 50 hours or once per month. Add distilled water to manufacturer's recommended level.
2. Batteries, cables and cable terminals should be checked and cleaned every 100 hours. Clean corrosion with a water and baking soda solution. Flush with clean water. Tighten terminals and grease them to inhibit corrosion.
3. Check the battery condition with a hydrometer every 750 hours.

SP24. WINTERIZING, OUT-OF-SERVICE

If the generator set will not be used for more than 6 months the following preparations should be taken for long term storage.

1. Change the engine oil and replace the filter. Service the air cleaner.
2. Drain, flush, and refill the cooling system, if the engine is to be stored for a year or longer.
3. Crank the engine a few times with a starter, without starting the engine.
4. Remove and clean batteries.
5. All engine openings should be sealed with plastic bags and tape.
6. Store in a dry protected place.

To Remove Generator Set from Long-Term Storage:

1. Take off all protective coverings and unseal all the openings that were covered up.
2. Install batteries that are fully charged and connect the terminals.
3. Install the fan and alternator belts if they had been removed.
4. Fill the fuel tank.
5. Perform all pre-start checks.
6. Crank the engine for 20 seconds with the starter, without letting the engine start. Wait 2 minutes and crank the engine an additional 20 seconds to make sure all bearing surfaces are well coated.
7. Start the engine and run at no load in a low idle for several minutes. Make sure the engine is warmed up and check gauges before going under load.
8. Check all gauges and check for leaks.

Troubleshooting

If you cannot correct problems with these procedures, see your **Lugger or Northern Lights** dealer.

DC ELECTRICAL SYSTEM

✔ Battery Will Not Charge

Loose or corroded connections:
- Clean and tighten battery connections.

Sulfated or worn out batteries:
- Check specific gravity of each battery cell.
- Check electrolyte level of each battery cell.

Loose or defective alternator belt:
- Adjust belt tension.
- Replace belt.

✔ Undercharged Electrical System

Excessive electrical load from added accessories:
- Take off accessories or install higher output alternator.

Engine idling excessively.
- Increase the engine RPM when there is a heavy electrical load.

Poor electrical connections on battery, ground strap, starter, or alternator.
- Inspect connections and clean if necessary.

Defective battery.
- Test battery.

Battery charging rate too high.
- Test charging system.

✔ Starter Inoperative

Check DC circuit breaker:
- If the breaker is tripped, reset it.

Faulty start circuit relay.
- See dealer.

Blown main system fuse.
- Replace fuse.

Loose or corroded connections:
- Clean and tighten loose battery and harness plug connection.

Low battery output:
- Check specific gravity of each battery cell.
- Check electrolyte level of each battery cell.

Defective electrical system ground wire:
- Repair or replace.

✔ Starter Cranks Slowly

Low battery output:
- Battery is too small.
- Battery cables are too small.

Check specific gravity of each battery cell:
- Replace battery if necessary.

Check electrolyte level of each battery cell:
- If low, fill cells with distilled water.

Crankcase oil too heavy:
- Fill with oil of appropriate viscosity.

Loose or corroded connections:
- Clean and tighten loose connections.

✔ Starter and Hour Meter Function but rest of Electrical System Does Not Function

Blown fuse on magnetic switch.
- Replace fuse.

✔ Entire Electrical System Does Not Function

Check DC circuit breaker:
- If breaker is tripped, reset it.

Faulty connection:
- Clean and tighten battery and harness plug connections.

Sulfated or worn out batteries:
- Check specific gravity and electrolyte level of each battery cell.

ENGINE

✔ Engine Hard to Start or Will Not Start

Improper starting procedure:
- See starting section of this manual. Take special note of Bypass Switch operation.

No fuel:
- Check level of fuel in fuel tank.

Low battery output:
- Check electrolyte level and condition.

Excessive resistance in starting circuit:
- Clean and tighten all battery connections.

Crankcase oil too heavy:
- Use oil of proper viscosity.

Improper type of fuel:
- Consult fuel supplier and use proper type of fuel for operating condition.

Water, dirt or air in fuel system:
- Drain, flush, fill and bleed system.

Clogged primary fuel filter element:
- Clean or replace filter element.

Clogged secondary fuel filter element:
- Replace filter element.

Dirty or faulty injection nozzles:
- Have your dealer check injection nozzles.

Electronic Fuel System problem (if equipped):
- See your dealer.

Injection pump not getting fuel or air in fuel system.
- Check fuel flow at supply pump or bleed fuel system.

Troubleshooting

If you cannot correct problems with these procedures, see your **Lugger or Northern Lights** dealer.

✔ Engine Runs Irregularly or Stalls Frequently

Below normal engine temperature:
- Remove and check thermostat.

Clogged primary fuel filter element:
- Clean or replace filter element.

Clogged secondary fuel filter element:
- Replace secondary filter element.

Water or dirt in the fuel system:
- Drain, flush, fill and bleed system.

Dirty or faulty injection nozzles:
- Have your dealer check injection nozzles.

Air in fuel system:
- Inspect clamps and hoses on suction side of fuel pump for air leak, bleed fuel system.

Improper type of fuel:
- Consult fuel supplier and use proper type of fuel for operating condition.

✔ Lack of Engine Power

Intake air restriction:
- Service air cleaner.
- Service aftercooler.

Clogged primary fuel filter element:
- Clean or replace filter element.

Clogged secondary fuel filter element:
- Replace filter element.

Improper type of fuel:
- Consult fuel supplier and use proper type of fuel for operating conditions.

Overheated engine:
- See “Engine Overheats” in next category.

Below normal engine temperature:
- Remove and check thermostat.

Injection pump out of time.
- See your dealer.

Electronic fuel system problem.
- See your dealer.

Turbocharger not functioning.
- See your dealer.

Leaking exhaust manifold gasket.
- See your dealer.

Defective aneroid control line.
- See your dealer.

Restricted fuel hose.
- Clean or replace fuel hose.

Low fast idle speed.
- See your dealer.

Improper valve clearance:
- Reset valves. Best done by dealer.

Dirty or faulty injection nozzles:
- Replace injectors. Best done by dealer.
- See your local dealer.

✔ Engine Overheats

Engine overloaded.
- Reduce the load.

Low coolant level:
- Fill tank or radiator to proper level.
- Check hoses for loose connections and leaks.

Faulty radiator cap.
- Have technician check.

Stretched belt or defective belt tensioner.
- Check automatic belt tensioner and check belts for stretching. Replace as required.

Low engine oil level.
- Check oil level, add oil as needed.

Incorrect grade of fuel.
- Use correct grade of fuel.

Cooling system needs flushing:
- Flush cooling system.

Defective thermostat:
- Remove and check thermostat.

Defective temperature gauge:
- Check water temperature with thermometer and replace gauge if necessary.

✔ Engine Knocks

Low oil level:
- Add oil to engine crankcase.

Injection pump out of time:
- Call your dealer.

Below normal engine temperature:
- Check your thermostats.
- Check water temperature to see if temperature gauge is working properly.

Engine overheating:
- See “Engine Overheating” section.

Troubleshooting

If you cannot correct problems with these procedures, see your **Lugger or Northern Lights** dealer.

✔ High Fuel Consumption

Engine overloaded.
- Reduce load.

Air in fuel system:
- Bleed fuel system.

Improper type of fuel:
- Use correct fuel for temperature.

Clogged or dirty air cleaner:
- Service air cleaner.

Improper valve clearance:
- See your dealer.

Injection nozzles dirty:
- See your dealer.

Injection pump out of time:
- See your dealer.

Electronic fuel system problem.
- See your dealer.

Engine not at proper temperature:
- Check your thermostats.
- Check water temperature with thermometer and replace gauge if necessary.

✔ Below Normal Engine Temperature

Thermostats not working properly:
- Check thermostats.

Temperature gauge not working properly:
- Check water temperature with thermometer.

✔ Low Oil Pressure

Low oil level:
- Fill crankcase to proper level.

Improper type of oil:
- Drain and fill crankcase with correct oil.

Partially plugged oil filter:
- Replace filter.

✔ High Oil Consumption

Break-in period:
- Oil consumption decreases after break in.

Crankcase oil too light:
- Use proper viscosity oil.

Oil leaks:
- Check for leaks in lines around gaskets and drain plug.

✔ Engine Emits Black or Gray Exhaust Smoke

Clogged or dirty air cleaner:
- Service air cleaner.

Defective muffler (back pressure too high):
- Have dealer check back pressure.

Improper fuel:
- Use correct fuel for temperature.

Engine overloaded.
- Reduce load.

Electronic fuel system problem.
- See your dealer.

Turbocharger not functioning.
- See your dealer.

Injection nozzles dirty:
- See your dealer.

Engine out of time:
- See your dealer.

✔ Engine Emits White Smoke

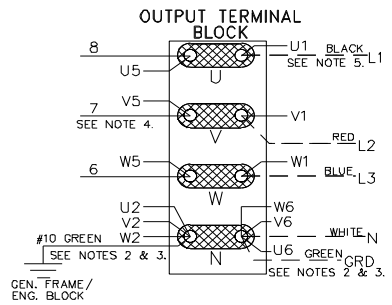
Improper fuel:
- Use correct fuel for temperature.

Cold engine:
- Warm up engine to normal operating temperature.

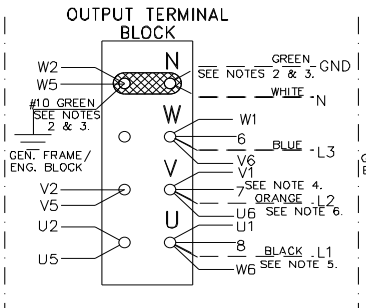
Defective thermostat:
- Remove and check thermostat.

Engine out of time:
- See your dealer.

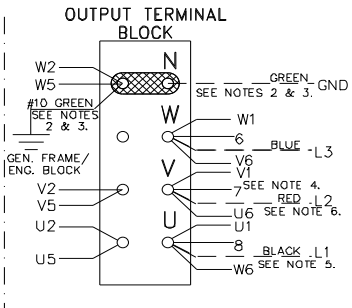
Defective injection nozzles.
- See your dealer.



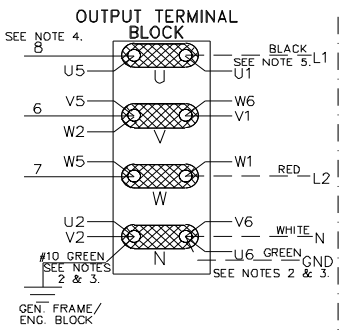
12 WIRE LOW WYE 3Ø
110/190VAC – 127/220VAC 50 HZ.
120/208VAC – 139/240VAC 60 HZ.



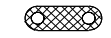
12 WIRE DELTA W/NEUTRAL 3Ø
110/220VAC – 147/254VAC 50 HZ.
120/240VAC – 170/277VAC 60 HZ.
L2 IS HIGH LEG



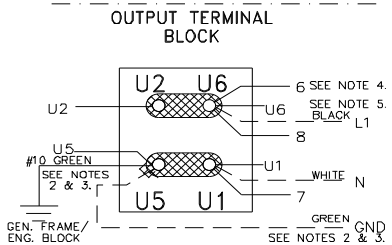
12 WIRE DELTA 3Ø
220VAC – 254VAC 50 HZ.
240VAC – 277VAC 50 HZ.



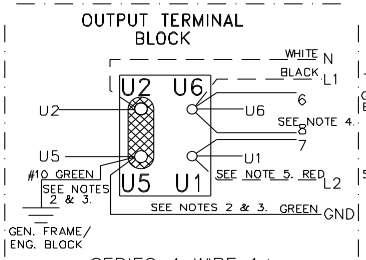
12 WIRE ZIG ZAG 1ø
120/240VAC 1ø 60 HZ.
110/220VAC 1ø 50 HZ.



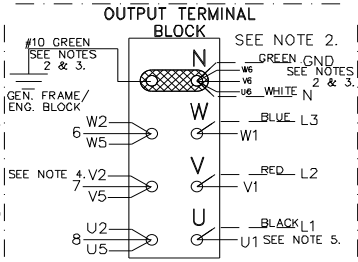
INDICATES LINK BAR USED.



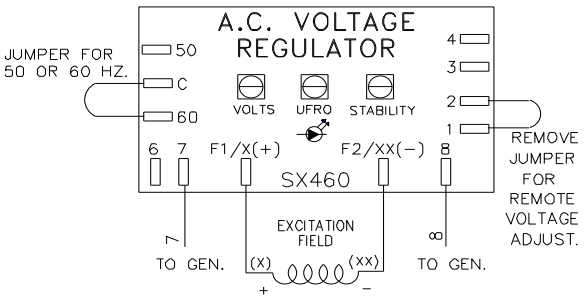
PARALLEL 4 WIRE 1ø
110VAC 50 HZ.
120VAC 60 HZ.



SERIES 4 WIRE 1ø
110/220VAC 50 HZ.
120/240VAC 60 HZ.



12 WIRE HIGH WYE 3Ø
220/380VAC – 254/440VAC 50 HZ.
240/416VAC – 277/480VAC 50 HZ.

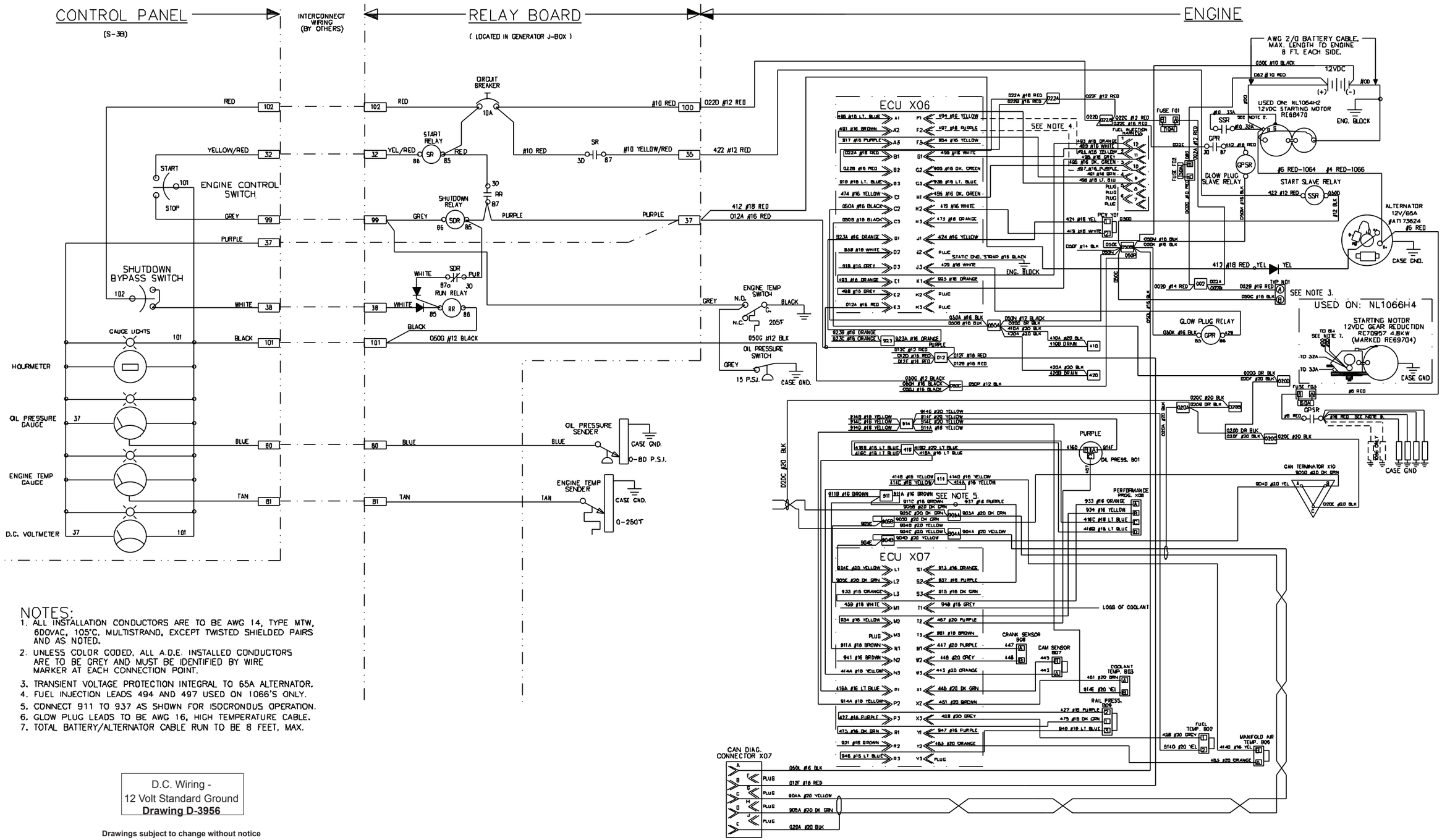


NOTES:

1. ALL INSTALLATION CONDUCTORS TO BE AWG 14, TYPE MTW, 105°C, MULTISTRAND, 600VAC, EXCEPT AS NOTED.
2. INDUSTRIAL GENSETS ONLY: GROUNDING IS TO BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND ANY APPLICABLE LOCAL CODES.
3. MARINE GENSETS ARE TO BE GROUNDED BY CUSTOMER ONLY, AT CUSTOMER'S DISCRETION.
4. CONNECT LEADS SEVEN AND EIGHT TO TERMINALS SEVEN AND EIGHT ON THE SX460. ISOLATE LEAD SIX USING ELECTRICAL TAPE OR A WIRE NUT.
5. HIDDEN (DASHED) LINES INDICATE CUSTOMER SUPPLIED AND CONNECTED MAIN OUPUT CONDUCTORS. SIZING DETERMINED PER INSTALLATION.
6. HIGH LEG IS TO BE MARKED ORANGE WHEREVER NEUTRAL IS PRESENT, IN ACCORDANCE WITH ARTICAL 215-8 OF THE NATIONAL ELECTRICAL CODE.
7. DELETE NEUTRAL CONNECTION IF L-N VOLTAGE IS NOT REQUIRED.

A.C. Wiring - All voltages
with a SX460 Voltage Regulator
Drawing B-5703C

AC Wiring Diagram



NOTES:

1. ALL INSTALLATION CONDUCTORS ARE TO BE AWG 14, TYPE MTW, 600VAC, 105°C, MULTISTRAND, EXCEPT TWISTED SHIELDED PAIRS AND AS NOTED.
2. UNLESS COLOR CODED, ALL A.D.E. INSTALLED CONDUCTORS ARE TO BE GREY AND MUST BE IDENTIFIED BY WIRE MARKER AT EACH CONNECTION POINT.
3. TRANSIENT VOLTAGE PROTECTION INTEGRAL TO 65A ALTERNATOR.
4. FUEL INJECTION LEADS 494 AND 497 USED ON 1066'S ONLY.
5. CONNECT 911 TO 937 AS SHOWN FOR ISOCRONOUS OPERATION.
6. GLOW PLUG LEADS TO BE AWG 16, HIGH TEMPERATURE CABLE.
7. TOTAL BATTERY/ALTERNATOR CABLE RUN TO BE 8 FEET, MAX.

D.C. Wiring -
12 Volt Standard Ground
Drawing D-3956

Drawings subject to change without notice

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