



# OM1276

For Models: M1276A1 and M1276A2

# OPERATOR'S MANUAL

Marine Generators | Marine Diesel Engines | Land-Based Generators





— 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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PART NO.: M1276 7/13



**NORTHERN LIGHTS**

# OPERATOR'S MANUAL

## OM1276 for Models: M1276A1 and M1276A2

*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.*

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## Introduction

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Servicing of marine engines and generator sets presents unique problems. In many cases boats cannot be moved to a repair facility. Marine engines cannot be compared to the servicing of automobiles, trucks or even farm equipment. Failures often occur in remote areas far from competent assistance. Marine engines 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.

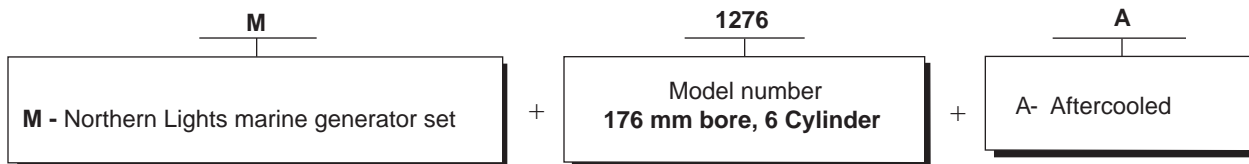
As operator, it is your obligation to learn about your equipment and its proper maintenance. This is not a comprehensive technical service manual. Nor will it make the reader into an expert mechanic. Its aim is to aid you in maintaining your unit properly.

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## Model Numbers

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



**M1276A1**

=

Northern Lights® aftercooled, 1800 or 1500 RPM marine diesel generator set with a John Deere Powertech engine block and an electronically controlled fuel system.

**M1276A2**

=

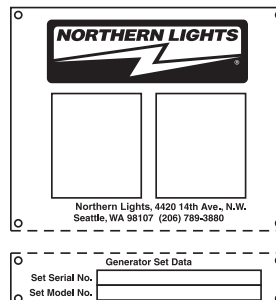
Northern Lights® aftercooled, 1800 or 1500 RPM marine generator set with a John Deere Powertech engine block and an electronically controlled fuel system, different generator end.

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## Serial Numbers

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When referencing Northern Lights 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



**NOTICE:** 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.

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.



**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.**

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

### Recognize Safety Symbols and Instructions

In addition to the information found in this section, this operator's manual uses three different signal words to outline potential dangers of a specific nature.

	<b>DANGER</b> DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
	<b>WARNING</b> WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
	<b>CAUTION</b> CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

### 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.

### 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

### Handle Fuel Safely - Avoid Flames



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

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



### Safety Rules (Continued)

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.

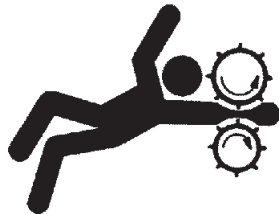
Prevent fires by keeping machine clean of accumulated trash, grease and debris. Always clean any spilled fuel as swiftly as possible. Do not store oily rags, which can ignite and burn spontaneously.

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.

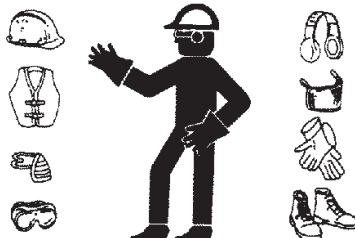
#### Wear Protective Clothing



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.

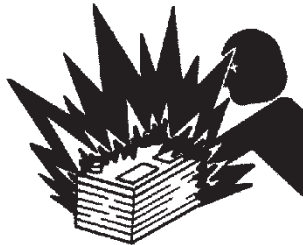
Do not allow anything on your person to dangle into or come in contact with a moving fan, belt, pulley or drive. Fans can act as vacuums and pull materials up from below, so avoid that area as well while in service.

### 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°C (60°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

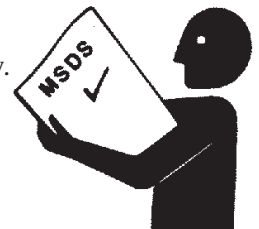


Battery posts, terminals, and related accessories can contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

### 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 Safety Data Sheet (MSDS). The MSDS provides specific details on chemical products, including physical hazards, safety procedures and emergency response techniques

## Safety Rules (Continued)

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.

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

### Work in Well Ventilated Areas

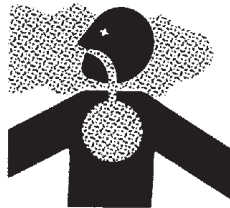


Exhaust fumes from engines contain carbon monoxide and can cause sickness or death. Work in well ventilated areas to avoid prolonged exposure to engine fumes. If it is necessary to run an engine in an enclosed area, route the exhaust fumes out of the area with an approved, leak proof exhaust pipe extension.

### 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



## Safety Rules (Continued)

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.**

### 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.

## Lock Out / Tag Out Procedures

### Scope

During maintenance, repairs or retooling of a Northern Lights generator set, simply turning the machine off or unplugging it while it is being worked on does not give enough protection to others who are not performing the maintenance or repair. Many serious accidents happen when someone thought the machine was turned off, or all of its energy was safely blocked or released.

### General Policy

#### CAUTION

To avoid dangerous or hazardous situations, refrain from any of the following:

- Removing or bypassing a guard or other safety device
- Placing any part of your body in a position where you could be caught by moving machinery.
- Cleaning or oiling machinery when in operation.
- Adjusting circuits, chillers, pumps, air handlers, valves, circuit breakers or fans while in operation.
- Working on piping or high pressure systems.

### Lock Out/Tag Out Instructions - Electrical Equipment

#### WARNING

Be sure the equipment's ON/OFF switch is in the OFF position and is unplugged from any electrical source before attempting to perform any type of work on the equipment. Obtain an electrical plug cap cover with a lockset. Secure the plug terminal end using the electrical plug lockout cap. Lock the cap and retain the key.

If the equipment is directly wired into an electrical box with a shut off switch, obtain a lock pad and/or the appropriate colored tags and place the lock and tag through the shut off lever. Retain the key until the repair is completed and the machine is safe to start. Be certain the shut off lever is in the OFF position before restarting. NEVER give a lock out key to unauthorized personnel.

If the equipment is directly wired into an electrical box without a shut off switch and lock out capability, then a circuit breaker lock out will be required. Obtain a circuit lock and tag set. Install the lock onto the circuit breaker box. Ensure the unit ON/OFF switch is in the OFF position before restarting.

### Lock Out/Tag Out Instructions - Pneumatic and Hydraulic Equipment

#### WARNING

For servicing pneumatic and hydraulic equipment, the following additional procedures must be implemented, following completion of lock out/tag out procedures for the unit to be serviced:

Shut off air, water or supply valves at the equipment to be serviced.

Check the local bleed-off point for completed release of pressurized air, water or oil.

If shutting off of air, water or other material cannot be achieved at the local supply valve, shut off valves further back in the system and re-check the bleed-off point until complete shut-off is achieved.

Affix a DO NOT OPERATE tag to each valve handle that requires shut off. Each DO NOT OPERATE tag must be signed and dated by the authorized technician servicing the equipment.

### Lock Out/Tag Out Instructions - Air Hose Connected Pneumatic Equipment

#### WARNING

Equipment connected to the compressed air system through an air hose with a detachable fitting must be shutdown and unplugged. Excess air must be bled prior to removing the air hose, prior to any maintenance or repair activities.

Affix a DO NOT OPERATE tag to the air hose near the detachable fitting. Each DO NOT OPERATE tag must be signed and dated by the authorized technician servicing the equipment. Check that the equipment cannot be operated by activating the ON switch.

### Stored Energy

#### WARNING

Immediately after applying Lock Out or Tag Out devices, ensure that all potentially hazardous stored or residual energy is relieved, disconnected, restrained and otherwise rendered safe.

### Verification of Isolation

#### CAUTION

Verify the machinery or equipment is actually isolated and de-energized prior to beginning work on a machine or on equipment that has been locked out.

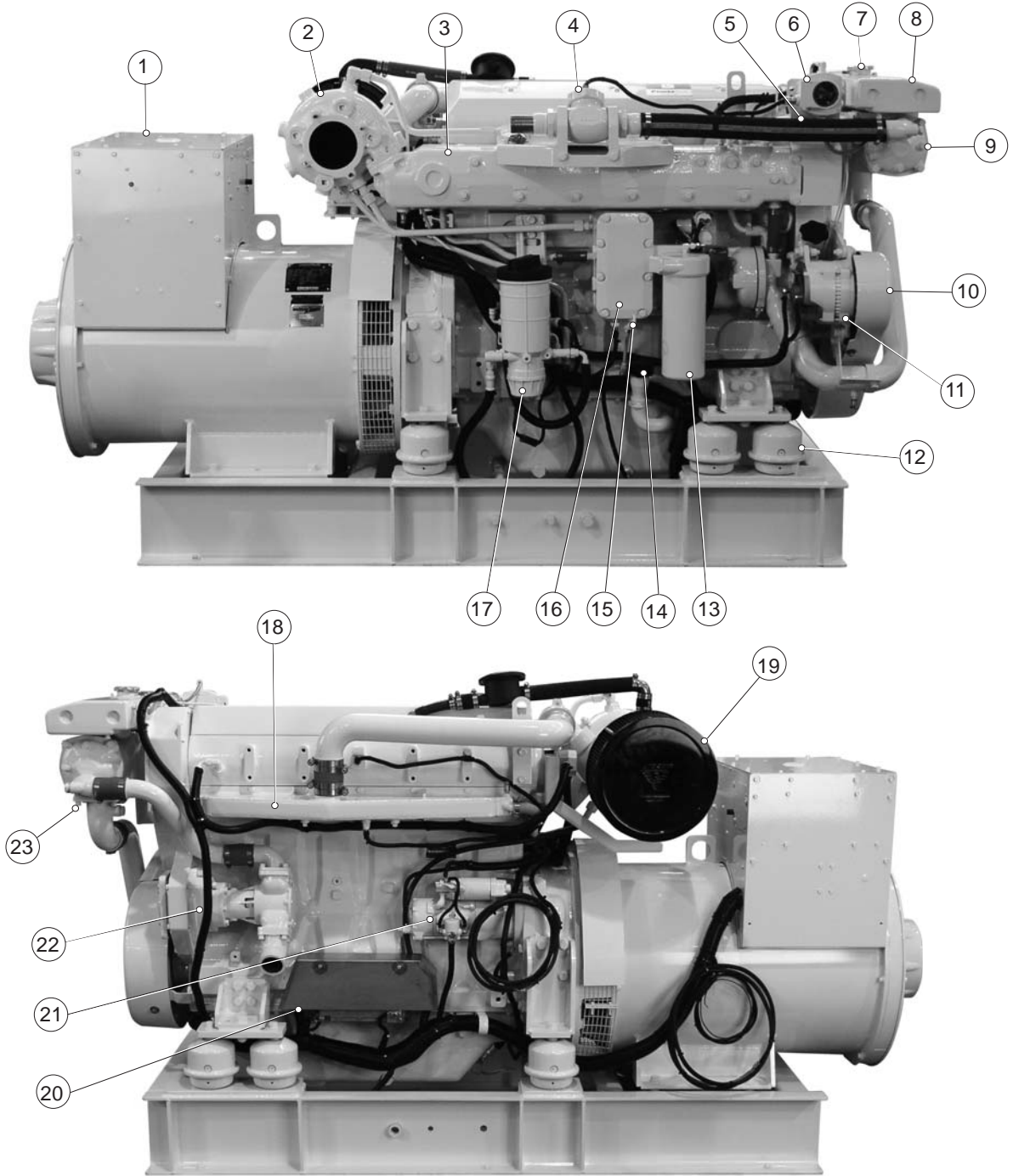
### Restarting Procedures

#### CAUTION

Follow the procedures below prior to restoring energy:

- Ensure that all machinery or equipment is properly reassembled. Inspect the machinery or equipment to verify non-essential items have been removed.
- Ensure that all personnel are safely outside danger zones. Notify personnel that lock out/tag out devices have been removed and energy will be reapplied.
- Only authorized personnel may remove lock out/tag out devices or notices.

## Component Locations



**Figures 1 & 2: M1276**

- |   |                                |                           |                         |
|---|--------------------------------|---------------------------|-------------------------|
| 1. Junction Box                               | 7. Coolant Fill                | 14. Oil Fill              | 20. Engine Control Unit |
| 2. Turbocharger                               | 8. Expansion Tank              | 15. Lube Oil Dipstick     | 21. Starter             |
| 3. Exhaust Manifold                           | 9. Heat Exchanger              | 16. Oil Cooler            | 22. Raw Water Pump      |
| 4. Low Water Flow Switch                      | 10. Belt Guard                 | 17. Fuel/ Water Separator | 23. Heat Exchanger Zinc |
| 5. Thermostat Housing                         | 11. Alternator                 | 18. Intake Manifold       |                         |
| 6. Low Coolant Level Switch/ Gauge (optional) | 12. Optional Hydrolastic Mount | 19. Air Cleaner           |                         |
|   | 13. Lube Oil Filter            |                           |                         |

## Northern Lights Control Panels



Figure 3: Series 3B Generator Control Panel

### 1. SHUTDOWN BYPASS SWITCH

This switch bypasses the safety shutdown feature during the starting process.

### 2. ENGINE CONTROL SWITCH

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

*NOTE: Excessive cranking of marine sets equipped with water lift muffler systems can cause engine damage.*

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.

### 3. OIL PRESSURE GAUGE

The oil pressure gauge shows the oil pressure in the engine lubricating system. If the pressure drops below 15 PSI at a speed higher than idling, stop the engine and investigate.

### 4. COOLANT TEMPERATURE GAUGE

Water temperature gauge shows the temperature of the cooling water. If the gauge registers over 200° or drops below 140°, stop the engine and investigate.

### 5. HOUR METER

Keeps track of the engine running time.

### 6. DC VOLTMETER

When the engine is running, it indicates the voltage output of the alternator.

## Northern Lights Control Panel



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

### 1. SHUTDOWN BYPASS SWITCH

This switch bypasses the safety shutdown feature during the starting process.

### 2. ENGINE CONTROL SWITCH

The control switch starts and stops the engine.

### 3. OIL PRESSURE GAUGE

The oil pressure gauge shows the oil pressure in the engine lubricating system. If the pressure drops below 15 PSI at a speed higher than idling, stop the engine and investigate.

### 4. COOLANT TEMPERATURE GAUGE

Water temperature gauge shows the temperature of the cooling water. If the gauge registers over 200° or drops below 140°, stop the engine and investigate.

### 5. HOUR METER

Keeps track of the engine running time.

### 6. DC VOLTMETER

When the engine is running, it indicates the voltage output of the alternator.

### 7. AC VOLTMETER

The voltmeter shows the generator output voltage, phase to phase. If the voltage fluctuates greatly from the normal reading, shut down the unit and investigate.

### 8. FREQUENCY METER

Indicates engine speed. The correct reading for 1800 and 1200 RPM sets is 60 Hz. For 1500 RPM sets, it is 50 Hz. If meter does not indicate correct hertz, stop and investigate.

### 9. AMMETER SELECTOR SWITCH

The ammeter switch is used for checking each phase for load condition. Leave it in the ON position while the engine is running.

### 10. AC AMMETER

The ammeter indicates the phase load. Check for load unbalance. If the unbalance is greater than 30%, have an electrician balance the load properly. This will ensure longer generator life and better economy.

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## Operating Procedures

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### 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 (**see Service Point #14**).



**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 between the “waffled area” and the “oo”. Never allow the level to go below the “oo”. Always add the same viscosity of oil as is already in the crankcase (**see Service Point #1**).
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. While holding the Shutdown Bypass switch in the ON position, 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.

**NOTE:** Avoid prolonged periods of engine idling or sustained running time at maximum load during the first 20 hours. Stop the engine if idling longer than 5 minutes. The engine should have an oil pressure of at least 138 kPa (20 PSI) at low idle.

### 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 45 ± 15 PSI at rated load speed (1800 to 2500 RPM). Coolant temperature should be 82°- 94°C (180°- 202°F) for normal operating temperature. 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.

### Shutdown

1. Turn the Engine Control Switch to the OFF position.
2. Close the sea cock and 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 temperature gauge. If the temperature is above 205°F (97°C), shut off the engine immediately.
  - b. Use the Trouble Shooting Guide on pages 23- 27 to isolate the cause of the overheat.

## Operating Procedures

### SHUTDOWNS AND ALARMS *continued*



**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.**

- 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. 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 Luggar dealer for assistance.

### BREAK-IN PERIOD

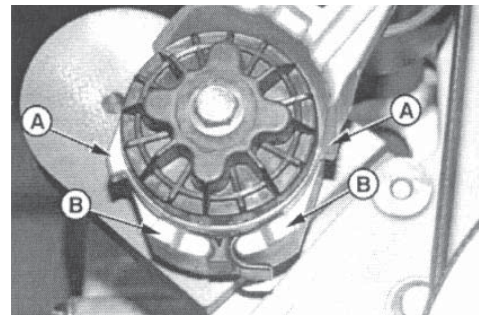
1. The first 100 hours on a new or reconditioned engine are critical to its life and performance.
2. Operate the engine under various conditions, particularly heavy loads with minimal idling, to help seat engine components properly.
3. Constantly check the engine temperature and oil pressure gauges.
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, then at every 250 hours. (See Gear Owner's Manual for break-in oil change procedures. Consult Lubricants Section for oil recommendation).

### SP5. Belt Tension and Wear

1. Automatic belt tensioners on belt drive systems cannot be repaired - they have to be replaced as a whole assembly. If the tensioner spring tension does not meet the specification then it would need to be replaced.

The cast stops "A" and "B" on the figure below show where the limit of the arm movement of the belt tensioner is designed to operate within. (Assuming correct belt length and geometry have been used.)

Inspect the cast stops "A" and "B" to see if the tensioner stop on the swing arm (A) is hitting the fixed stop (B). If it is check the mounting brackets of the alternator, belt tensioner, idler pulley, etc..., and the belt length. Replace belt if needed.



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A- Swing Arm Cast Stops  
B- Fixed Cast Stops

## 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

**DAILY:**

- SP1 Check oil level in engine
- SP8 Check primary fuel filter
- SP15 Check coolant 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 <sup>5</sup>:**

- 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.
- SP7 Check crankshaft vibration damper<sup>7</sup>
- SP4 Check air cleaner valve & restriction indicator gauge<sup>6</sup>

**EVERY 200 HOURS:**

- SP4 Replace air cleaner
- SP2 Change engine oil & filters (fuel filter/water bowl)
- SP9 Change primary filter element (Racor)
- SP10 Change secondary fuel filter
- SP14 Check turbocharger boost pressure
- SP22 Check the state of the charge of the batteries

- SP25 Check engine mounts
- SP26 Clean crankcase vent tube
- SP27 Check air intake hoses
- SP30 Check engine speeds

**EVERY 500 HOURS:**

- SP5 Check belt condition
- SP16 Check cooling system
- SP17 Check and clean heat exchanger
- SP18 Check and clean gear oil cooler
- SP20 Change impeller in raw water pump
- SP31 Adjust variable speed (droop)

**EVERY 2000 HOURS:**

- SP7 Check crankshaft vibration damper
- SP6 Check & adjust valve clearance<sup>8</sup>
- SP16 Check and flush cooling system
- SP23 Test thermostats

SERVICE POINT	PAGE	OPERATION	DAILY	50 Hours	100 Hours	200 Hours	500 Hours	2000 Hours
<b>ENGINE:</b>								
SP1	13	Check oil level	•					
SP2	13	Change engine oil 1) 2) 8)			•	•		
SP3	13	Change lube oil filters 1) 2) 8)			•	•		
SP4	13	Check air cleaner valve 2) 4) 6) 8)			•	•		
SP5	10	Check belt condition 2)					•	
SP6	14	Check valve clearances 2)						•
SP7	18	Check crankshaft vibration damper 7)						•
SP25	18	Check engine mounts				•		
SP27	19	Check air intake hoses				•		
SP30	9	Check engine speeds				•		
<b>FUEL SYSTEM:</b>								
SP8	16	Check primary filter (Racor) 3)	•			•		
SP9	16	Change primary filter element (Racor) 3) 4)					•	
SP10	16	Change secondary fuel filter 2) 4)					•	
SP11	15	Check injectors 8) 9)						
<b>TURBOCHARGER:</b>								
SP13	19	Check air, oil & cooling water lines for leakage 2)			•			
SP14	19	Check boost pressure				•		
<b>COOLING SYSTEM:</b>								
SP15	21	Check coolant level	•			•		
SP16	21	Check and flush cooling system 2)					•	•
SP17	21	Check and clean heat exchanger 2)					•	
SP18		Check and clean gear oil cooler 2)					•	
SP19	21	Check zinc electrodes 2) 4)			•			
SP20	22	Change impeller in raw water pump 2) 4)					•	
SP23	18	Test thermostats						•
<b>ELECTRICAL SYSTEM:</b>								
SP21	23	Check electrolyte level in batteries 2) 4)		•		•		
SP22	23	Check condition of batteries with hydrometer 2)				•		

1) Change the oil & filter before the first 100 hours of operation at 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 min. at least.

6) Replace air cleaner element when restriction indicator shows vacuum of 625 mm (25 in.) H<sub>2</sub>O.  
 7) Replace damper every 4500 hours or after 60 months.  
 8) At 2500 hrs. an electronic injector preload adjustment must be made.  
 9) Check at 5000 hours.



**Service Record Notes**

<b>SERVICE</b>	<b>OPERATION</b>	<b>HOURS/DATE</b>

## 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, & CE oil
  - c. ACEA Specification E1, E2
2. *Do not use* John Deere PLUS-50 oil or engine oils meeting API CG-4, API CF-4, API CF-2, API CI-4, API CI-4 Plus, API CH-4, ACEA E3, E4, E5, E6, & E7 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. ACEA Oil Sequence E4, E5, E6, or E7.
  - b. API Service Category CI-4, CH-4, CI-4 Plus.
  - c. ACEA Oil Sequence E3 multi-viscosity oil. (Multi-viscosity oils are preferred.)
3. Use the proper weight oil for your average operation temperature.

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.
6. If using diesel fuel with sulfur content of 0.05% to 0.5%, service interval for oil changes increases to every 150 hours.

#### 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 “oo”. Never allow the level to go below the “oo”.
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. Run engine about 5 minutes to warm up oil then shut off engine.
  - b. Remove plug from outlet in base frame. Screw in owner-supplied drain hose.
  - c. Open valve at oil pan outlet. After warm oil has been drained into suitable container, close valve, remove drain hose and replace plug in base frame outlet.
  - d. Refill engine with recommended oil.
4. Engine Lube Oil Capacity:  
42.3 qts. (40.0 L)

#### SP3. CHANGING OIL FILTER

1. Change the lube oil filter every 200 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. Install oil pan drain plug with a new o-ring, torque to:  
1-1/4" plug torque.....46 N•m (34 ft/lbs.)  
1-1/2" plug torque.....64 N•m (47 ft/lbs.)
7. 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 filter every 250 hours, or yearly, whichever comes first.
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.

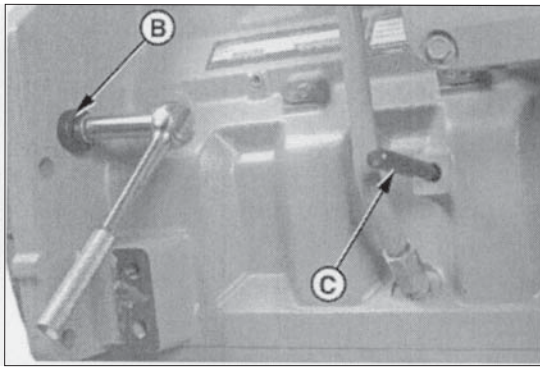
**NOTE:** *Make absolutely sure no impurities enter the engine while changing the element. Do not run the engine with the air cleaner removed.*

## Servicing

### SP6. VALVE CLEARANCES

After the first 2000 hours of operation it is required that the intake and exhaust valve clearance and electronic unit injector preload needs to be adjusted by your certified Northern Lights dealer.

1. Remove the rocker arm cover.
2. Then remove the plug from the cylinder block and install a JDG820 Flywheel turning tool (Fig. 5-B).

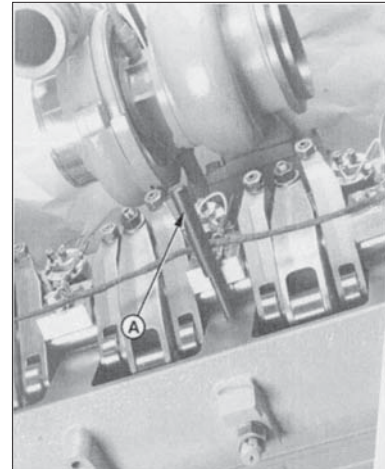


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Figure 5

*Note: First the timing pin must be installed in the slot of the camshaft, then by carefully rocking the flywheel back and forth install the second timing pin.*

3. Rotate the engine flywheel in the running direction (counterclockwise viewed from the rear) until the timing pin (Fig. 6-A) engages into the single timing slot (Fig. 7-D) camshaft. By looking through the camshaft timing pin bore while rotating the engine, the proper timing slot can be found. The double timing slot (Fig. 7-E) will be at 11:00 (from the rear of the engine) when the pin is installed in the slot (Fig. 7-D). This will ensure that the engine is locked at Top Dead Center of the No. 1 cylinder's compression stroke. The No. 1 cylinder's intake and exhaust rocker arms should be loose.
4. Take out the plug from the crankshaft timing hole below the oil cooler and filter housing assembly.

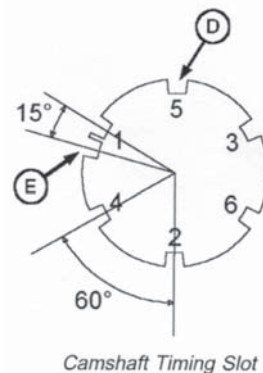


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Figure 6

*Note: Do Not insert the timing pin all the way into the cylinder block crankshaft timing hole when rotating the engine flywheel until the double slot on the camshaft timing lobe is approximately at 11 o'clock as viewed from the rear of the engine (Fig. 7). This will prevent the crankshaft counterweight from bending the timing pin.*

5. Move the engine flywheel slightly back and forth with a turning tool until a second timing pin (JDG971) can be installed in the slot in the crankshaft (Fig. 5-C). This is to ensure that the camshaft and crankshaft are in time; properly in sync. If the timing pin does not go into the crankshaft timing slot, the crankshaft is not properly timed with the camshaft. The crankshaft must be timed to the camshaft. If it is not, leave the timing pin in and remove the gear access cover from the timing gear cover. Loosen the camshaft gear retainer capscrews and rotate the crankshaft with a flywheel turning tool (JDG820) and install a second timing pin (JDG971) in the crankshaft timing slot.

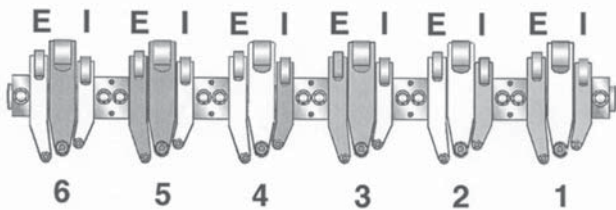


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Figure 7

## Servicing

6. Check and adjust, if need be, the valve stem-to-bridge clearance (also called "lash") on intake valves numbers 1, 2, and 4, and exhaust valves numbers 1,3, and 5. (Shaded on Fig. 8). Adjust the preload on electronic unit injectors numbers 3, 5, and 6. (Shaded on Fig. 8).



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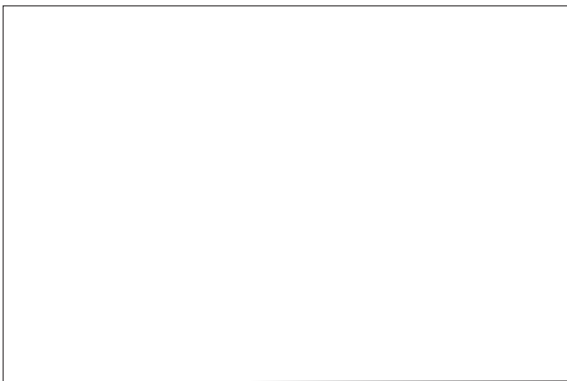
Adjust the valve clearance using a JDG1333 Feeler Gauge Set or a 1/4 inch (6 mm) wide automotive ignition feeler gauge (point type). Install the gauge at the joint between the valve bridge and valve stem tip (Fig. 9-B) near the exhaust side of the engine. Loosen the lock nuts and set the clearance with the adjusting screw. Tighten the lock nut to the below specified torque while holding the adjusting screw stationary.

Valve Stem-to-Bridge Clearance (Cold Engine):

Intake Valve clearance.....0.58 ± 0.05 mm (0.023 ± 0.002 in.)  
 Exhaust Valve clearance.....1.08 ± 0.05 mm (0.043 ± 0.002 in.)

7. Tighten the intake and exhaust valve adjusting screw lock nuts to below specification.

Intake & Exhaust Valve Adjusting Screw Lock Nuts Torque:  
 50 N•m (37 ft-lbs.)



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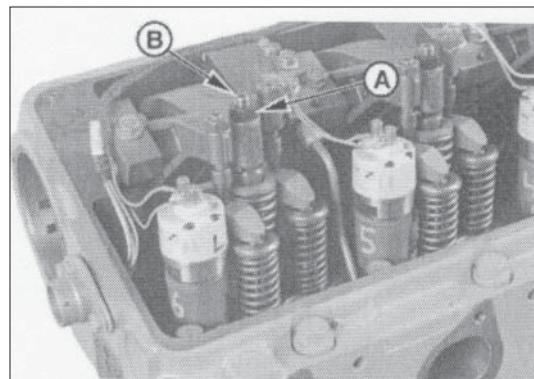
### Electronic Unit Injector Preload Adjustment

8. For preload adjustment, when the crankshaft is timed to the camshaft, loosen lock nut (Fig. 10-A) and rocker arm injector adjusting screws for cylinders 3, 5, and 6 to relieve the tension.
9. Slowly tighten the adjusting screw until the rocker arm roller contacts the camshaft lobe at a 0.0 clearance.
10. Then tighten the adjusting screw an additional 1/2 turn (180°) to preload injector. Tighten the adjusting screw lock nut to below specification while holding the adjusting screw from moving.

Electronic Unit Inj. Adjusting Screw Lock Nut  
 Torque.....65N•m (48 ft/lb.)

11. Remove both timing lock pins, rotate crankshaft one full revolution (360°) and pin the crankshaft only. The engine will now be locked at No. 6 Top Dead Center.
12. Set injector preload on the cylinders Nos. 1, 2, and 4.
13. Install the plug in the timing pin hole in the block and tighten to below specification.

Timing Pin Plug in Cylinder Block Torque .....33 N•m (24 ft/lb.).



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 Figure 10

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## Servicing

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### FUELS -GENERAL

1. Use only clean, high quality fuels of the following specifications, as defined by ASTM designation D975 or EN590 for diesel fuels.
2. Sulfur content should be less than 0.10% (1000 ppm). Use of diesel fuel with sulfur content of 0.10% to 0.50% (1000 to 5000 ppm) may result in reduced oil change intervals. Do not use diesel fuel with sulfur content greater than 1.0%.
3. The cetane number should be a minimum of 45, greater than 50 is preferred especially for temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft.)
4. Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078.
5. Do not mix used diesel engine oil or any type of lubricating oil with diesel fuel, it may cause injection equipment damage.
6. Bio-diesel fuels maybe used only if the bio-diesel fuel properties meet the latest edition of ASTM D6751 EN14214 or equivalent. Bio-diesel fuel blended with B100 from a BQ-9000 accredited producer or certified marketer could be used in a **maximum of 5%** blend (B5). Engine oil must be checked daily with this blend, especially in cold weather. Any concentration above 5% can damage engine components and reduce performance levels.  
*Note: Raw pressed vegetable oils are not acceptable for use as fuel in any concentration.*
7. Aviation fuels may be used such as Jet A, Jet A1, JP-5, JP-7, and JP-8 but a power loss up to 10% could be expected. Jet B and JP-4 are not recommended for use.
8. 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.
  - b. Change the element every 500 hours (every 12 months.)

### 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 (every 12 months), or whenever necessary if alarm or diagnostic codes indicate plugged filter (fuel supply pressure low).
  - c. If the bowl fills with water, change the primary and secondary elements immediately.
2. Change secondary fuel filter every 500 hours (every 12 months).

## Servicing

### SP8-10. FUEL FILTERS *continued*

3. To replace the fuel filter/ cleaning water separator, first close the fuel shut-off valve (if equipped).
4. Clean the area surrounding the fuel filter assembly to keep debris from entering the fuel system.



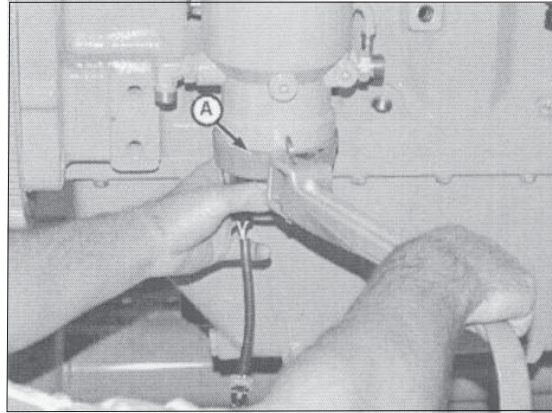
**CAUTION:** Escaping fluid under pressure can penetrate the skin, possibly causing gangrene. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Use a piece of cardboard to search for leaks, keeping hands and body away from pinholes and nozzles that eject fluids under pressure.

*If the engine has been running, the engine and fuel filter housing may be hot, wait until cool.*

5. Take the cap off the fuel filter housing by turning it counterclockwise by hand. Relieve the vacuum in filter housing by operating the hand primer until the fuel filter pops up. If it does not pop up after priming it for about 30 strokes, carefully pry under the filter flange with a small screwdriver to relieve the vacuum pressure.
6. Hold the filter over the housing while it drains, turning it to drain fully.
7. Dispose of the filter properly, do not reuse the filter as it could now have trapped air bubbles. These could cause the fuel to overflow in the housing or cause engine stalling and not re-starting.

#### Water Separator Bowl Removal & Cleaning

1. Disconnect the wiring connector from the water-in-fuel sensor.
2. First drain the fuel from the separator bowl.
3. Then place a strap wrench (Fig. 11-A) right up next to the top edge of the separator bowl. While holding and applying pressure with the strap wrench, twist the bowl with the other hand to remove it.
4. Clean the separator bowl and dry it.
5. Install the separator bowl and tighten by hand until the seal makes contact. Hand tighten to about 44 lb/in. (5 N•m).
6. Then connect back the wiring to the water-in-fuel sensor.



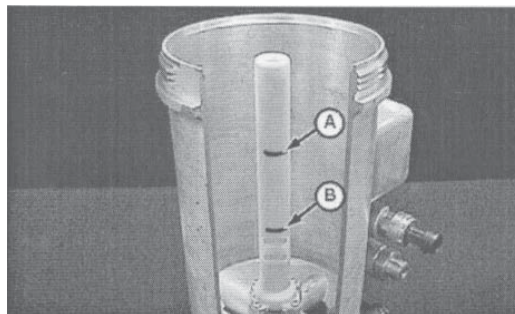
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#### Installing the new Fuel Filter Element

1. Make sure the fuel level in the filter housing is between the minimum and maximum (Fig. 12-B is minimum level, 5 inches from top of housing, Fig. 12-A is maximum level, 2.5 inches from top of housing). If the fuel is below the minimum level, carefully open the fuel supply shut-off valve a small amount (if equipped) to add fuel, or the hand primer to add more fuel.

*Note: If the fuel level is below the minimum mark it may result in trapped air in the filter and cause the engine to stall. If the fuel level is above the maximum mark the fuel could overflow the filter housing when the element is installed.*

2. Install the new dry fuel filter in the filter housing and reinstall the fuel filter cap and tighten to "hand-tight".
3. Open the fuel supply shut-off valve if equipped with one.
4. Restart the engine and run it for five minutes at least.

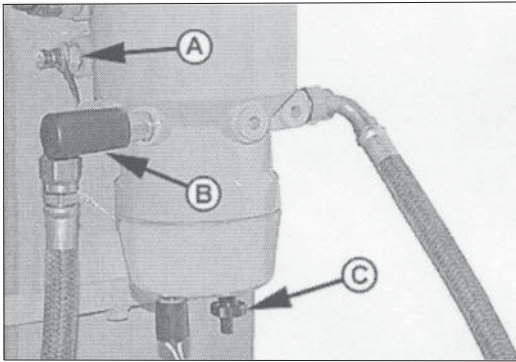


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## Servicing

### Bleeding the Fuel System

1. Normally, just priming the fuel system with the hand primer (Fig. 13-B) is sufficient but if there are still problems it may be necessary to bleed the fuel system.
2. First drain the water and the contaminants from the water separator sediment bowl by opening the drain valve (Fig. 13-C) and using the primer (Fig. 13-B) until fuel is clear of water.
3. Attach an open line to the diagnostic port (Fig. 13-A) and put the end of the line in a container for diesel fuel.
4. Pump the hand primer (Fig. 13-B) until the fuel flows without bubbles.
5. Then disconnect the line from the diagnostic port and start the engine and run it for five minutes.



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Figure 13

### SP23. THERMOSTATS

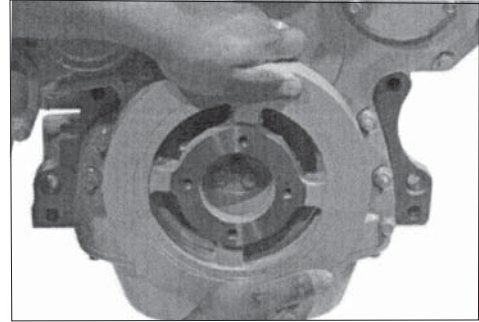
1. Remove the thermostats and suspend them in a container that can be heated to boiling. Do not allow the thermostat to rest against the side or bottom of the container while it is heating. Stir the water as it heats and observe the opening action of the thermostat. For a 180°F (82°C) rated thermostat the initial opening range of temperature should be from 175-182°F (80-84°C) and the temperature at full open should be close to 202°F (94°C). Observe the thermostat's closing action when it is out of the water and cooling, it should close smoothly and slowly. If any thermostat is defective on a multiple thermostat engine, replace them all.

### SP25. ENGINE MOUNTS

1. Inspect for fluid leakage or other failures.

### SP7. CRANKSHAFT VIBRATION DAMPER

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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Figure 14

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

3. Place a dial indicator (Figure 15) 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 JDG280 Flywheel Turning Tool.
5. If the runout reading exceeds the below specification, replace the vibration damper.

#### Vibration Damper Maximum

Radial Runout .....0.76 mm (0.030 in.)



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Figure 15

## Servicing

### SP13. TURBOCHARGER

1. Check for air leaks every 100 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 250 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

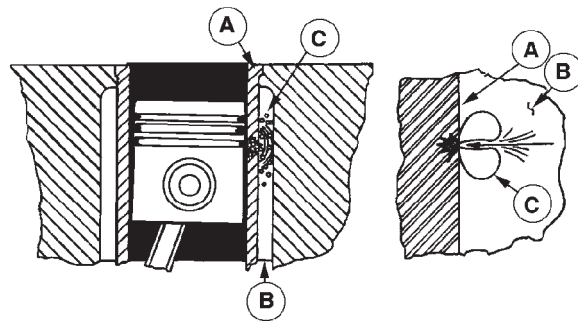
1. To meet cooling system protection requirements, the coolant solution must consist of:
  - a. **Quality water**
  - b. **Ethylene glycol concentrate (EGC ) commonly known as antifreeze.**
  - c. **Supplemental coolant additives (SCA's).**
2. A coolant solution of ethylene glycol concentrate (EGC-antifreeze), 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.**
4. Coolant capacity is 54 L (14.5 gal).

### LINER EROSION (PITTING)

1. Cylinder liner walls (Figure 16-A) which are in contact with engine coolant (Figure 16-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.

### LINER EROSION (PITTING) (continued)

2. Vapor bubbles (Figure 16-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 16

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		



## Servicing

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 D 4985P, SAEJ1941, General Motors Performance Specification GM1899M, or formulated to GM6038M.
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

### 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. **Important heat exchanger cooled engines**  
Additional SCA's should NOT be added to the mixture of EGC/H<sub>2</sub>O 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<sub>2</sub>O/EGC mixture (1.0 fl oz of SCA per qt of H<sub>2</sub>O/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 concentration 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.

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## Servicing

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### 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 Luggier Dealer.  
4 Pack - Part Number.....20-00005  
50 Pack - Part Number.....20-00010

### 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

1. Flush the cooling system every 2000 hours or yearly and check for leaks and blockage every 500 hours.  
**The engine must be stopped and cold.**
2. Close the seacock.

3. Remove the pressure cap from the expansion tank with caution. If applicable, open the cooling system air vent on top of turbocharger.
4. Open the drains on the exhaust manifold and engine block. Drain the fresh water system (see Component Locations, pages 6).
5. For vessels with keel cooling, the vessel must be out of the water to allow draining of the keel cooler.
6. With drains open, pour clean water into the expansion tank. When the water from drain is clear and free from discoloration and sediment, close that drain. When all drains are closed, flushing is complete.
7. Fill the fresh water system by pouring the recommended coolant mixture as described in previous sections.
8. Close cooling system air vent on turbocharger.
9. Open the seacock.
10. Start the engine. Check hoses and connections and repair any leakage.

### SP17. HEAT EXCHANGER CLEANING

1. Drain the cooling system.
2. Remove the cooling water pipes between the heat exchanger and the water pump inlet.
3. Disconnect hose to seawater pump.
4. Unscrew the attaching bolts holding the heat exchanger to the expansion tank.
5. Remove bolts holding heat exchanger cover.
6. Wash the core inside and out. If necessary, chemical agents can be used. Also clean the accessible parts of the heat exchanger housing.
7. Reassemble, using new gaskets and sealing rings.

### SP19. ZINC ANODES

1. Zincs are installed in the cooling system to protect your engine from electrolysis. Check them faithfully every 100 hours. If you are in warm salt water or where electrolysis is a known problem, check them more often.

## Servicing

### Heat exchanger cooled engine:

- a. Drain the raw water from heat exchanger (see Component Locations).
- b. Remove zinc holders from back of the tank and from front and port side of the heat exchanger (see Component Locations).

### Keel Cooled engines.

- a. Drain expansion tank and remove zinc holder from tank (see Component Locations).
2. Scrape or steel brush the zinc electrode clean. If more than 50% of the electrode has eroded away, replace it with a new one. The electrode screws out of the holder.
3. Reinstall the zinc holders. Be sure the threads are clean and have good metal to metal contact.

### SP20. RAW WATER PUMP

#### Heat exchanged cooled engines only.

1. Change the sea water pump impeller as needed.
2. Remove the pump end cover. Remove impeller with water pump pliers. Be sure you remove all pieces of a failed impeller.
3. Clean the inside of the housing.
4. Press in the new impeller and place the sealing washer in the outer end of the impeller center if this has not already been done.
5. Replace the cover using a new gasket.

**Note:** Make sure there is always an extra impeller and cover gasket in reserve and on-board.

### DRIVEN EQUIPMENT

#### Gears and PTO's

1. Manufacturer's service recommendations vary. See your Owner's Manual for service information. If you do not have a manual, see your local dealer for the equipment in question.

**NOTE:** Some PTO and marine gears have rigid lubrication requirements. Follow service recommendations closely.

### Generator Ends

2. 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

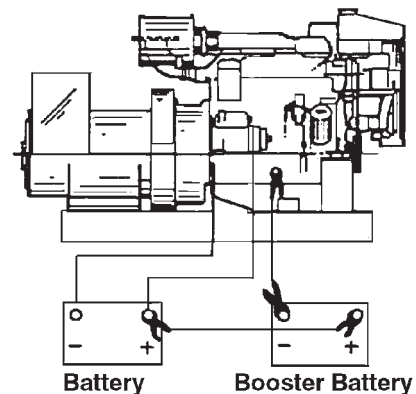
1. Never switch battery switch off or break the circuit between the alternator and batteries while the engine is running. Regulator damage can result.
2. DO NOT reverse the polarity of battery cables when installing the battery.
3. When welding on the unit, disconnect the regulator and battery. Isolate 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.



**Figure 17:** Booster Battery Connections

4. Then, connect negative (-) terminal of booster battery to ground on the engine block (see Figure 17).

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## Servicing & Troubleshooting

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### **BOOSTER BATTERIES** *continued*

5. Remove booster battery after starting engine.
6. Sealed batteries: see manufacturer charging and booster instructions.

### **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 250 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.
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.

### **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**

PTO engaged.

- Disengage PTO.

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.

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## Servicing

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### 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.

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Excessive electrical load from added accessories:

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- Inspect connections and clean if necessary.

Defective battery.

- Test battery.

Battery charging rate too high.

- Test charging system.

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PTO engaged.

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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.

Faulty connection:

- Replace filter element.

Dirty or faulty injection nozzles:

- Have your dealer check injection nozzles.

Electronic Fuel System problem:

- See your dealer.

Starter or starter solenoid defective:

- 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

Engine starting under load.

- Disengage PTO if applicable.

Improper starting procedure:

- See starting section of this manual.
- 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.

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## Troubleshooting

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

Electronic Fuel System problem:

- See your dealer.

Starter or starter solenoid defective:

- Replace.

✓ **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.

Electronic fuel control system problem:

- See dealer.

✓ **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, or worn Electronic Unit Injector o-ring:

- See your dealer.

Turbocharger not functioning (if equipped).

- 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.

## Troubleshooting

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

### ✓ Engine Overheats

Engine overloaded.

- Reduce the load.

Low coolant level:

- Fill tank to proper level.
- Check hoses for loose connections and leaks.

Keel cooling tubes have been painted (marine):

- Remove paint from tubes.

Stretched belt or defective belt tensioner.

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

Damaged cylinder head gasket:

- Replace gasket.

Low engine oil level.

- Check oil level, add oil as needed.

Incorrect grade of fuel.

- Use correct grade of fuel.

Defective coolant pump or cooling system needs flushing:

- Repair and flush cooling system.

Defective thermostat:

- Remove and check thermostat.

Defective temperature gauge:

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

Water pump impeller worn/broken:

- Check impeller and replace if necessary.

### ✓ Engine Knocks

Low oil level:

- Add oil to engine crankcase.

Worn camshaft lobes:

- Inspect camshaft, see dealer.

Worn rocker arm shaft:

- Inspect rocker arm shaft, see dealer.

Turbocharger noise:

- Bearings not lubricated, see dealer.

Main or connecting rod bearings worn:

- Determine bearing clearance, see dealer.

Excessive crankshaft end play:

- Check, see dealer.

Loose main bearing caps:

- Check bearing clearance, replace bearings and bearing capscrews as needed.

Worn connecting rod bushings, piston pins, or scored pistons:

- Inspect, see dealer.

Worn timing gears or excess backlash:

- Check timing gear backlash, see dealer.

Excessive valve clearance:

- See 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.

Compression too low:

- Determine cause and repair, see your dealer.

Electronic fuel system problem.

- See your dealer.

Leaks in fuel supply system:

- Find leak, repair.

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.

Oil temperature too high:

- Inspect oil cooler.

Partially plugged oil filter:

- Replace filter.

Excessive main or connecting rod bearing clearance:

- Determine bearing clearance, see dealer.

### ✓ High Oil Consumption

Break-in period:

- Oil consumption decreases after break in.

Crankcase oil too light:

- Use proper viscosity oil.

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## Troubleshooting

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

Oil leaks:

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

Worn valve guides or stems:

- Inspect and repair.

Piston rings stuck or ring grooves worn:

- Remove and inspect pistons, see dealer.

Front or rear crankshaft oil seal faulty:

- Replace oil seals.

### ✓ **Engine Emits Black or Gray Exhaust Smoke**

Clogged or dirty air cleaner:

- Service air cleaner.

Clogged aftercooler:

- Service aftercooler.

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.

Engine compression too low:

- Have cause determined and have repaired as required.

Coolant entering combustion chamber (failed cylinder head gasket or cracked cylinder head)

- Repair or replace, see your dealer.

Aftercooler failure:

- Remove and inspect aftercooler/ intake manifold.

### ✓ **Coolant in Crankcase**

Cylinder head gasket defective:

- Replace gasket.

Cylinder head or block cracked:

- Locate crack, repair or replace.

Cylinder liner seals leaking:

- Inspect, see dealer.

Oil cooler leaking:

- Pressure test, check o-rings, see dealer.

Coolant pump seal leaking, bearing leaking:

- Replace seals.

Injector sleeve or o-rings, or Electronic Unit

Injector o-rings damaged:

- Replace. See dealer.



## On Board Spare Parts

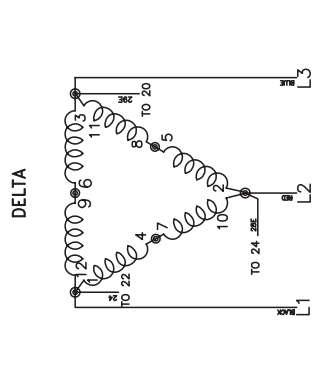
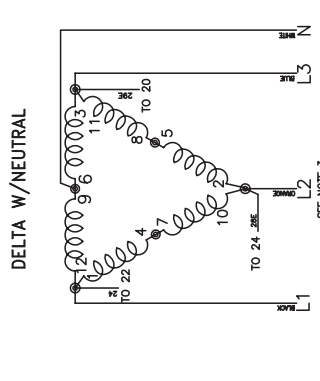
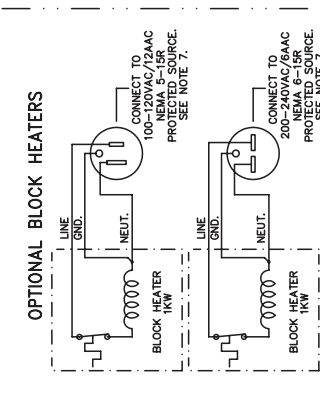
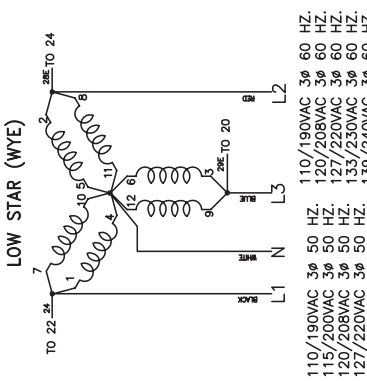
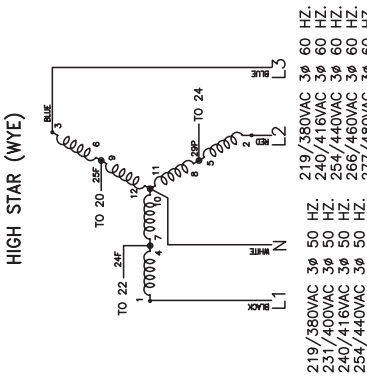
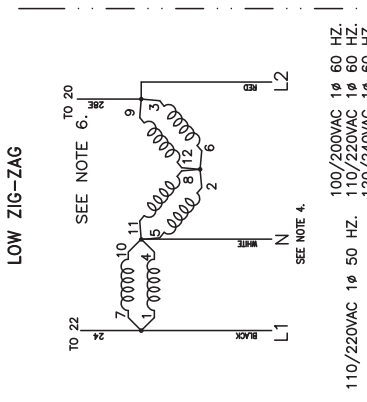
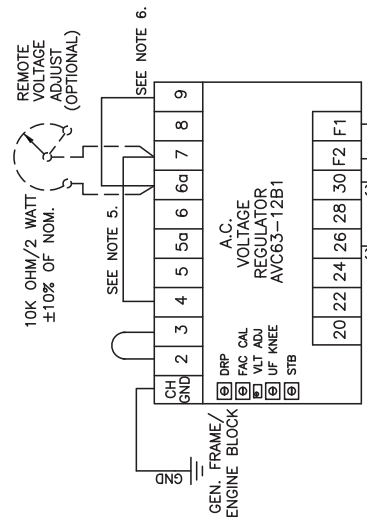
Safety at sea depends on careful preparation, product knowledge, and having the right tools and parts. Below is a list of parts Alaska Diesel Electric, Inc. recommends you carry onboard at all times.

Onboard Parts Kits are available from your dealer. We consider these minimum quantities. Your vessel's operating conditions may require more of a given part. Consult your dealer.

Item	Description	Amount
1	Lube Oil Filter	4
2	Air Filter Element	1
3	Fuel Filter	2
4	Injector	6
5	Thermostat	2
6	Thermostat Ring	2
7	Valve Cover Gasket	2
8	Gasket Kit	1
9	Zinc*	12
10	Raw Water Pump Impeller*	2
11	Raw Water Pump Cover Gasket*	2
12	Raw Water Pump*	1
13	Workshop Manual	1
14	Set of Alternator Belts	1

\*Heat exchanger cooled engines only

# AC Wiring Diagrams



## NOTES:

1. ALL INSTALLATION CONDUCTORS ARE TO BE AWG 14, TYPE MTW, 600VAC, 105°C, STRANDED.
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. LINE TWO (HIGH LEG) TO BE MARKED ORANGE IN COMPLIANCE WITH ARTICLE 215-8 OF THE NATIONAL ELECTRIC CODE. VOLTAGE BETWEEN LINE TWO AND NEUTRAL IS FOUND BY DIVIDING THE LINE TO LINE VOLTAGE BY 1.73.
4. IF LOWER (L-N) VOLTAGE IS NOT REQUIRED DO NOT BRING OUT NEUTRAL POINT (NO NEUTRAL CONDUCTOR).
5. REMOVE JUMPER BETWEEN TERMINALS 4 AND 7 IF A REMOTE VOLTAGE ADJUST RHEOSTAT IS USED. TURN THE INTERNAL VOLTAGE ADJUST POTENTIOMETER FULLY CLOCKWISE FOR PROPER REMOTE VAR OPERATION.
6. REMOVE JUMPER BETWEEN TERMINALS 6d AND 9 FOR SINGLE PHASE SENSING.
7. DO NOT ENERGIZE HEATERS WHILE UNIT IS IN OPERATION.

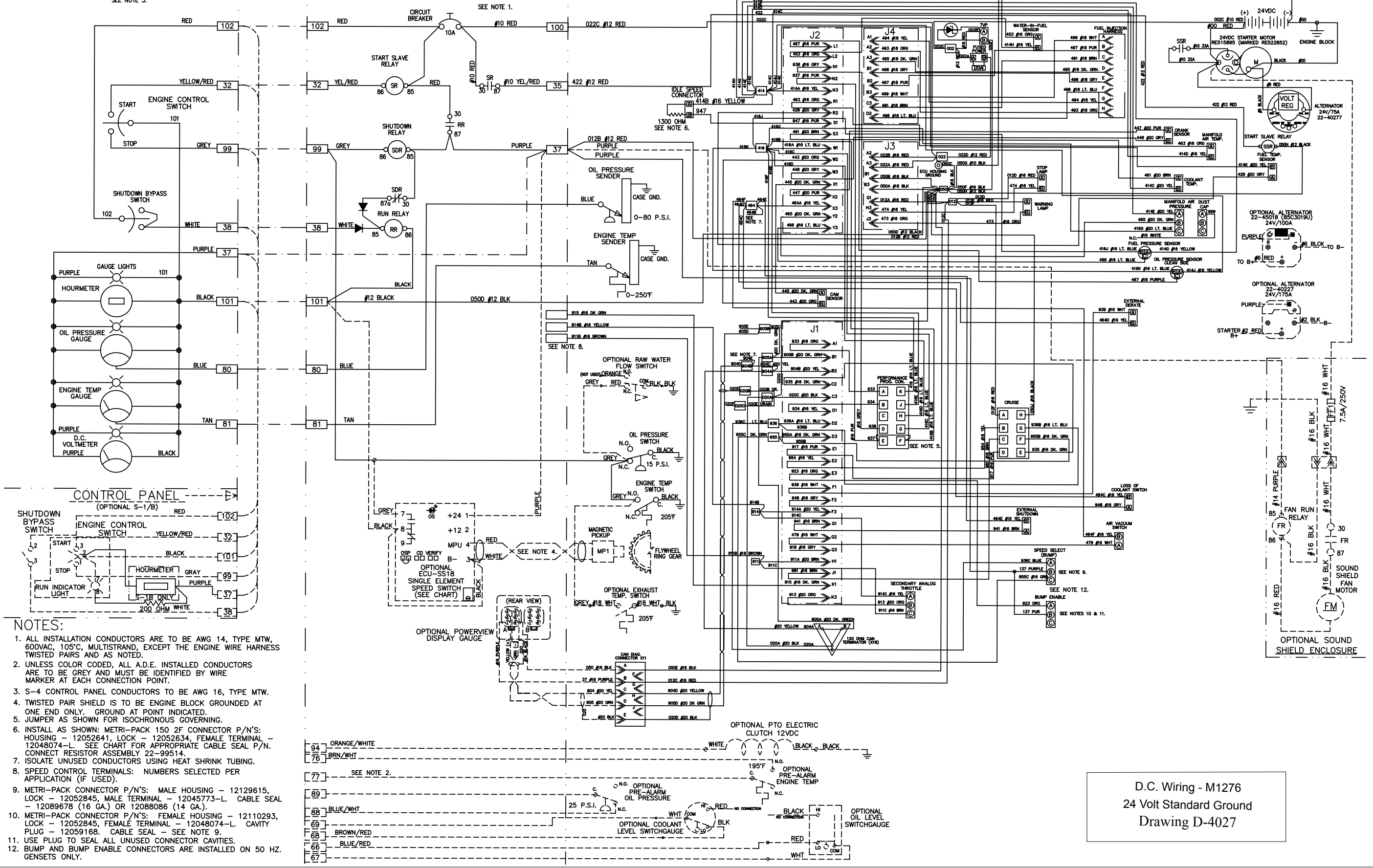
A.C. Wiring - M1276  
 AVC63-12B1 Voltage Regulator  
 Drawing B-7429J

**CONTROL PANEL**  
(S-3 OR OPTIONAL S-4)  
SEE NOTE 3.

**RELAY BOARD**  
(LOCATED IN GENERATOR J-BOX)  
SEE NOTE 1.

**ENGINE**

AWG 2/0 BATTERY CABLES,  
MAX. LENGTH TO ENGINE  
5 FT. EACH SIDE.



**NOTES:**

1. ALL INSTALLATION CONDUCTORS ARE TO BE AWG 14, TYPE MTW, 600VAC, 105°C, MULTISTRAND, EXCEPT THE ENGINE WIRE HARNESS TWISTED 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. S-4 CONTROL PANEL CONDUCTORS TO BE AWG 16, TYPE MTW.
4. TWISTED PAIR SHIELD IS TO BE ENGINE BLOCK GROUNDED AT ONE END ONLY. GROUND AT POINT INDICATED.
5. JUMPER AS SHOWN FOR ISOCHRONOUS GOVERNING.
6. INSTALL AS SHOWN: METRI-PACK 150 2F CONNECTOR P/N'S: HOUSING - 12052641, LOCK - 12052634, FEMALE TERMINAL - 12048074-L. SEE CHART FOR APPROPRIATE CABLE SEAL P/N. CONNECT RESISTOR ASSEMBLY 22-99514.
7. ISOLATE UNUSED CONDUCTORS USING HEAT SHRINK TUBING.
8. SPEED CONTROL TERMINALS: NUMBERS SELECTED PER APPLICATION (IF USED).
9. METRI-PACK CONNECTOR P/N'S: MALE HOUSING - 12129615, LOCK - 12052845, MALE TERMINAL - 12045773-L. CABLE SEAL - 12089678 (16 GA.) OR 12088086 (14 GA.).
10. METRI-PACK CONNECTOR P/N'S: FEMALE HOUSING - 12110293, LOCK - 12052845, FEMALE TERMINAL - 12048074-L. CAVITY PLUG - 12059168. CABLE SEAL - SEE NOTE 9.
11. USE PLUG TO SEAL ALL UNUSED CONNECTOR CAVITIES.
12. BUMP AND BUMP ENABLE CONNECTORS ARE INSTALLED ON 50 HZ. GENSETS ONLY.

D.C. Wiring - M1276  
24 Volt Standard Ground  
Drawing D-4027



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