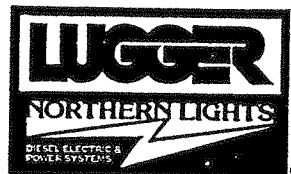
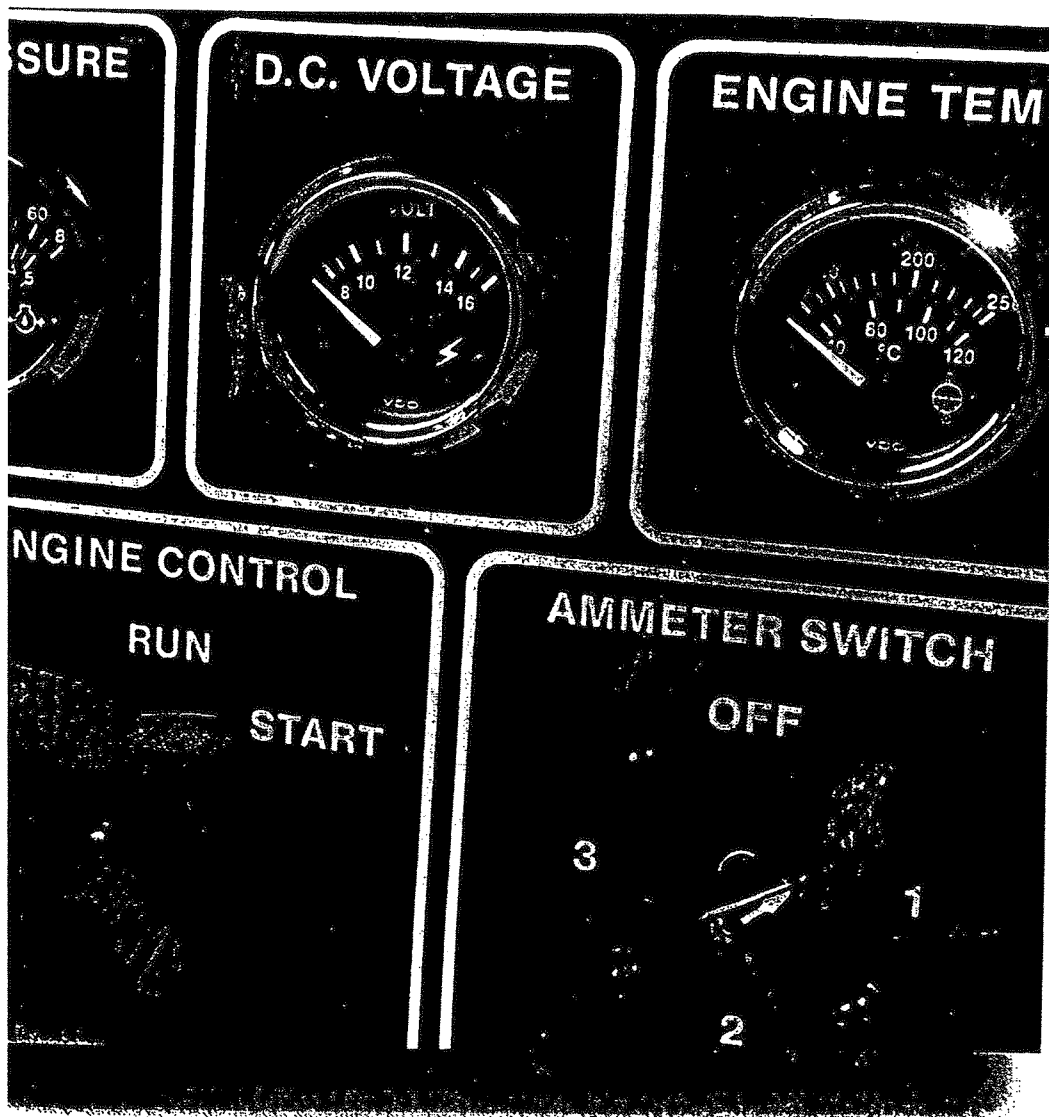


OPERATOR'S MANUAL

O300

L439, L668, M439, M445, M668, M40C,
M65C, M99C





O300 L439, L668
M439, M445 & M668
M40C, M65C & M99C

OPERATOR'S MANUAL

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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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.

Proprietary Information

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INTRODUCTION

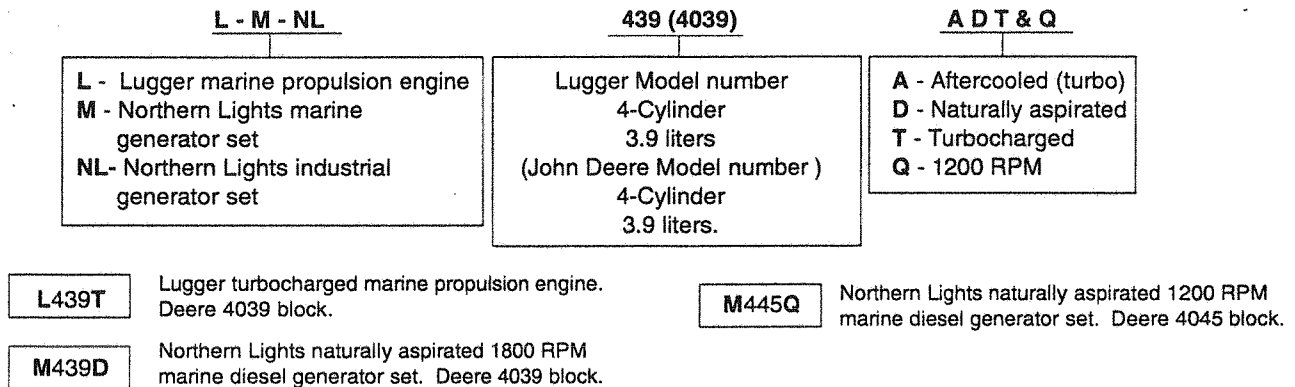
Servicing of marine engines and generator sets presents unique problems. In many cases, boats cannot be moved to a repair facility. Failures often occur in remote areas far from competent assistance. Since marine engines are taxed far more severely than auto or truck engines, strict adherence to the servicing schedule must be maintained. Failures usually begin with minor problems that are overlooked and become amplified when not corrected during routine maintenance.

As owner-operator, it is your obligation to learn about your equipment and its proper maintenance. This manual is not a comprehensive technical service manual. Nor will it turn the reader into an expert mechanic. The aim of this manual is to aid you in maintaining and servicing your set properly.

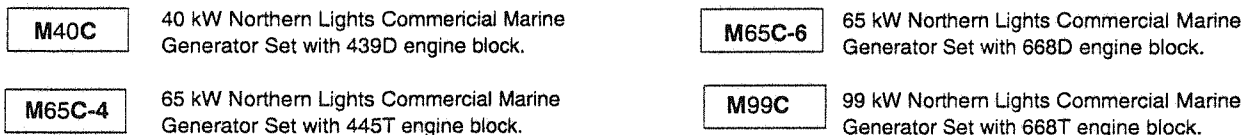
UNIT IDENTIFICATION

MODEL NUMBER

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

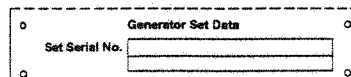
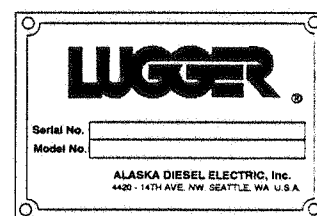
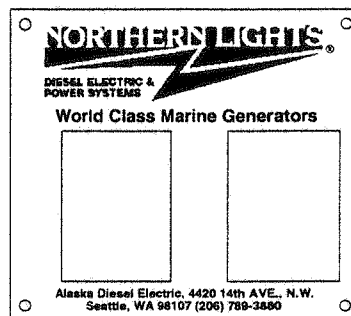
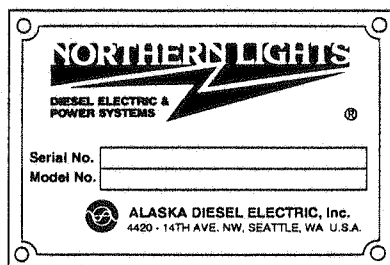


Commercial Marine Series



SERIAL NUMBERS

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



WARRANTY

A warranty registration certificate is supplied with your set. It entitles the original purchaser of our equipment to a warranty covering material or assembly faults. The extent of coverage is described in the Limited Warranty Statement. We recommend that you study the statement carefully.

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

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

- Never leave engine without proper security.
- Turn the coolant tank cap slowly to relieve pressure before removing. Add coolant only when the engine is idling or stopped.
- Mount fire extinguisher near engine.
- Always disconnect the battery ground strap before making adjustments.
- Operate engines in properly ventilated areas.
- Keep trash and other objects away from engine.
- Escaping fluids under pressure can penetrate your skin. Use a piece of cardboard or wood, not your hands, to search for leaks.
- Avoid wearing loose clothing without a belt when working around engines.
- Do not oil or grease engine while it is running.
- Use caution in handling fuel. Never refuel a hot or running engine. Do not smoke while filling fuel tank or servicing fuel system.
- Keep your hands, feet, hair and clothing away from power-driven parts.
- Check for any loose electrical connections or faulty wiring.
- Engines should be operated only by knowledgeable, qualified personnel.
- Walk completely around engine to make sure that everything is clear before starting the engine.
- Do not operate an engine that isn't in proper working order. If an unsafe operating condition is noted, tag the engine so others will also know about it.
- Provide first aid kits.



CAUTION: *This Symbol is used throughout this book to alert you to possible danger areas. Please take special notice of these sections.*

LUGGER COMPONENT LOCATIONS

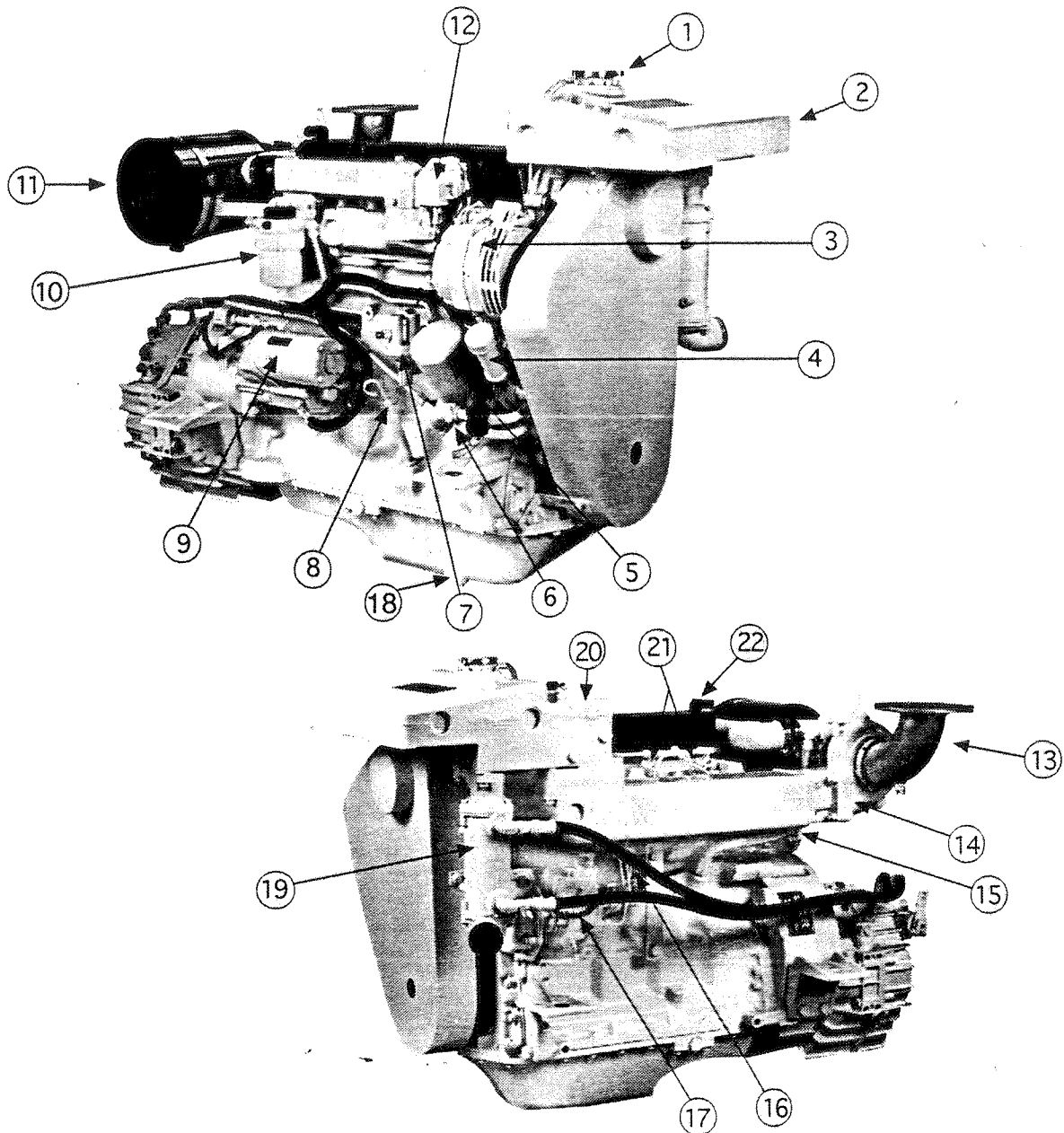


Fig. 1. L439T KC shown with gear. (Note: The components of the L439D are in a similar location.)

- | | | | |
|--------------------|---------------------------|---------------------------------|------------------------|
| 1. Water fill | 7. Fuel lift pump | 13. Dry exhaust | 18. Lube oil drain |
| 2. Expansion tank | 8. Lube oil dipstick | 14. Turbocharger | 19. Gear oil cooler |
| 3. DC alternator | 9. Electric starter | 15. Exhaust manifold drain cock | 20. Thermostat cover |
| 4. Lube oil fill | 10. Secondary fuel filter | 16. Block drain cock | 21. Fuel injectors (4) |
| 5. Lube oil filter | 11. Air cleaner | 17. Fuel injection pump | 22. Crankcase vent |
| 6. Lube oil cooler | 12. DC circuit breaker | | |

LUGGER COMPONENT LOCATIONS

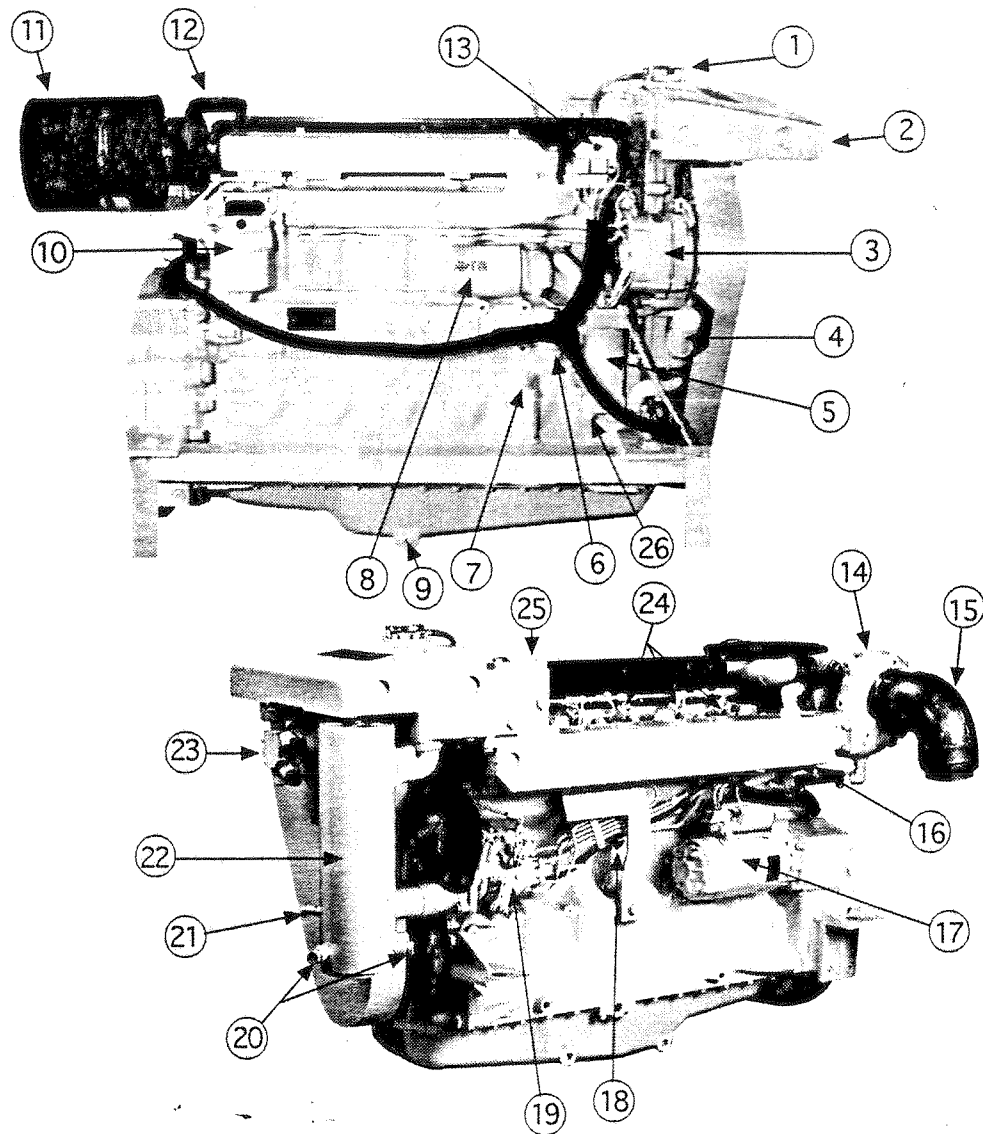


Fig. 2. L668T HE without gear. (Note: The components of L668D are in a similar location.)

- | | | | |
|----------------------|---------------------------|-----------------------------|-------------------------------|
| 1. Water fill | 8. Lube oil filter | 15. Wet exhaust | 21. Heat exchanger drain cock |
| 2. Expansion tank | 9. Lube oil drain | 16. Manifold drain cock | 22. Heat exchanger |
| 3. DC alternator | 10. Secondary fuel filter | 17. Electric starter | 23. Seawater pump |
| 4. Lube oil fill | 11. Air cleaner | 18. Block drain cock | 24. Fuel injectors (6) |
| 5. Lube oil cooler | 12. Crankcase vent | 19. Fuel injection pump | 25. Thermostat housing |
| 6. Fuel lift pump | 13. DC circuit breaker | 20. Heat exchanger zinc (2) | |
| 7. Lube oil dipstick | 14. Turbocharger | | |

NORTHERN LIGHTS COMPONENT LOCATIONS

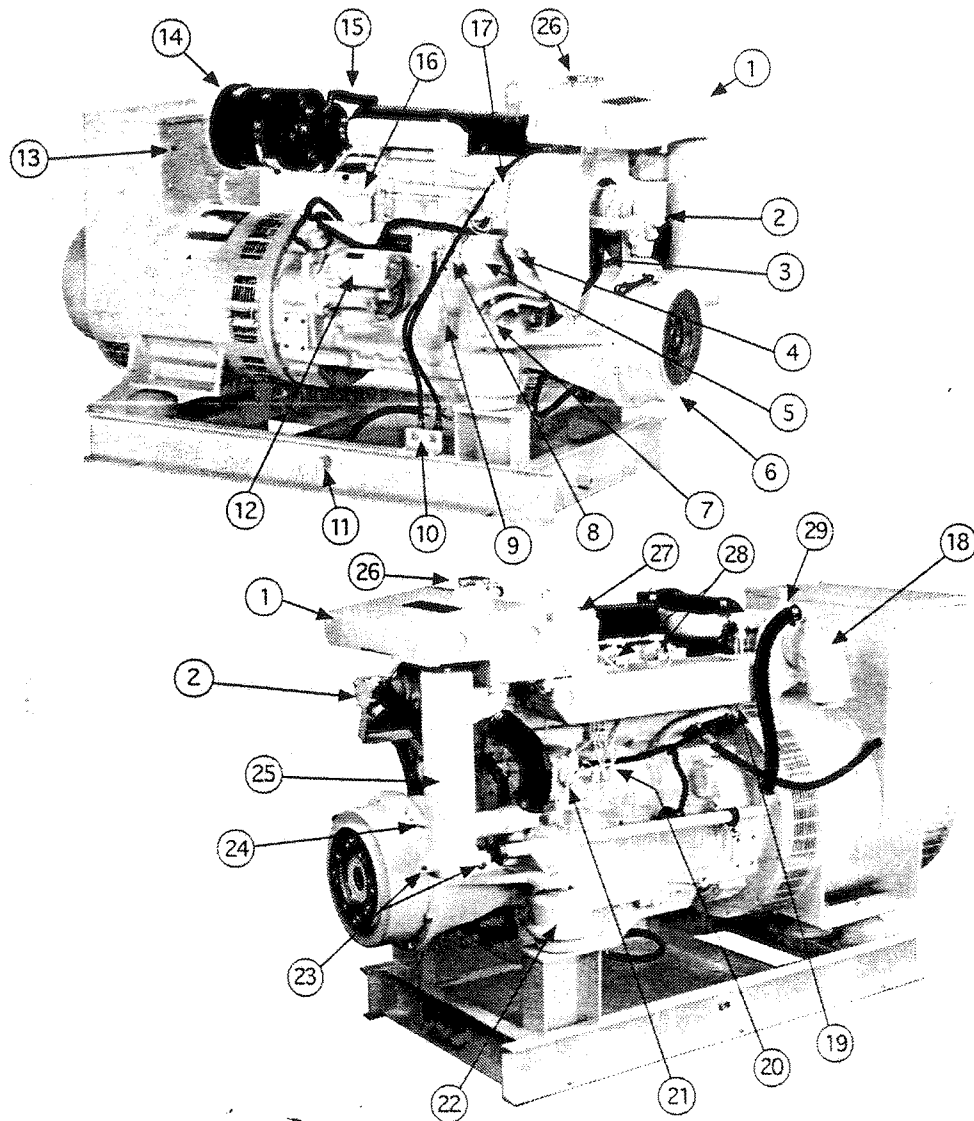


Fig. 3, (Note: Other M439 and M445 models have similar component locations.)

- | | | | |
|---------------------------|---------------------------|--------------------------------|--------------------------|
| 1. Expansion tank | 9. Lube oil dipstick | 17. DC alternator | 24. Heat exchanger drain |
| 2. Sea water pump | 10. Fuel manifold | 18. Wet exhaust elbow | 25. Heat exchanger |
| 3. Drive belts | 11. Lube oil drain | 19. Exhaust manifold drain | 26. Coolant fill |
| 4. Lube oil fill | 12. Electric starter | 20. Engine block drain | 27. Thermostat cover |
| 5. Lube oil filter | 13. DC circuit breaker | 21. Fuel injection pump | 28. Fuel injectors (4) |
| 6. Optional power takeoff | 14. Air cleaner | 22. Optional hydrolastic mount | 29. Turbocharger |
| 7. Lube oil cooler | 15. Crankcase vent | 23. Heat exchanger zinc (2) | |
| 8. Fuel lift pump | 16. Secondary fuel filter | | |

NORTHERN LIGHTS COMPONENT LOCATIONS

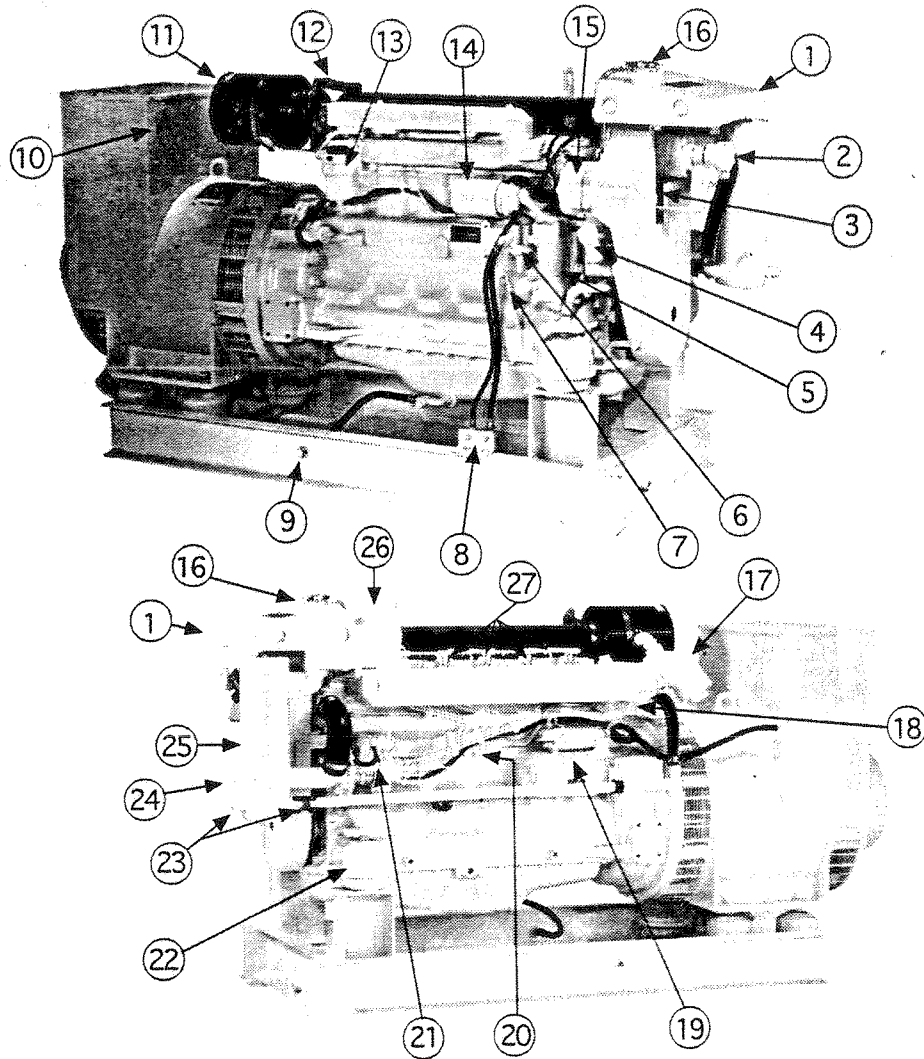


Fig. 4. M668D (Note: Other M668 models have similar component locations.)

- | | | | |
|----------------------|---------------------------|--------------------------------|--------------------------|
| 1. Expansion tank | 8. Fuel manifold | 16. Coolant fill | 23. Heat exchanger zincs |
| 2. Sea water pump | 9. Lube oil drain | 17. Wet exhaust elbow | 24. Heat exchanger drain |
| 3. Drive belts | 10. DC circuit breaker | 18. Exhaust manifold drain | 25. Heat exchanger |
| 4. Lube oil fill | 11. Air cleaner | 19. Electric starter | 26. Thermostat cover |
| 5. Lube oil cooler | 12. Crankcase vent | 20. Engine block drain | 27. Fuel injectors (6) |
| 6. Fuel lift pump | 13. Secondary fuel filter | 21. Fuel injection pump | |
| 7. Lube oil dipstick | 14. Lube oil filter | 22. Optional hydrostatic mount | |
| | 15. D.C. alternator | | |

NORTHERN LIGHTS COMPONENT LOCATIONS

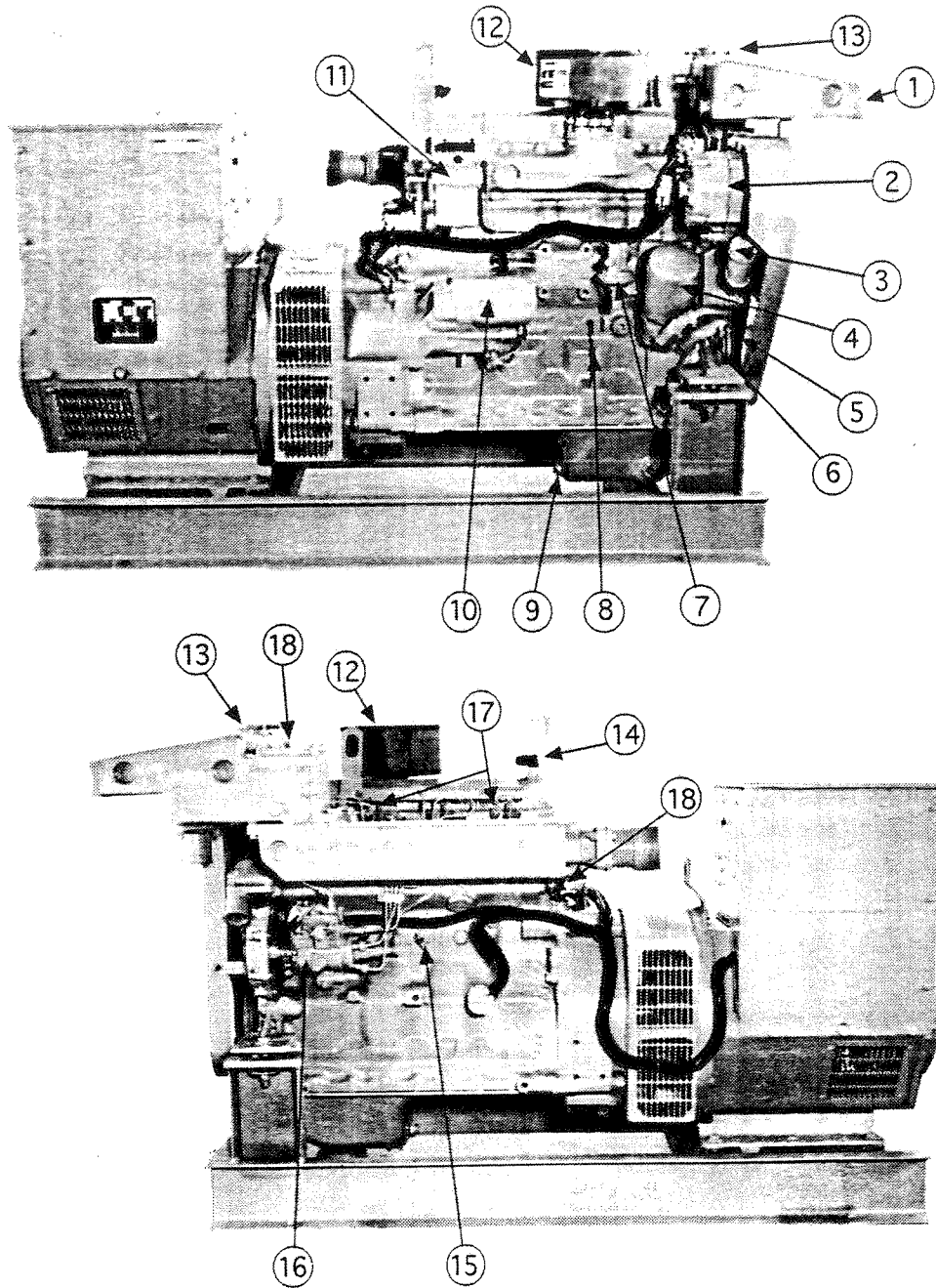


Fig. 5. M40C KC (Note: The components of M65C-4 are in a similar location)

- | | | | |
|------------------------------------|----------------------|---------------------------|----------------------------|
| 1. Expansion tank | 6. Lube oil cooler | 11. Secondary fuel filter | 16. Fuel injection pump |
| 2. DC alternator | 7. Fuel lift pump | 12. Air cleaner | 17. Fuel injectors (4) |
| 3. Lube oil fill | 8. Lube oil dipstick | 13. Coolant fill | 18. Exhaust manifold drain |
| 4. Lube oil filter | 9. Lube oil drain | 14. Crankcase vent | |
| 5. Drive belts (behind belt guard) | 10. Electric Starter | 15. Engine block drain | |

NORTHERN LIGHTS COMPONENT LOCATIONS

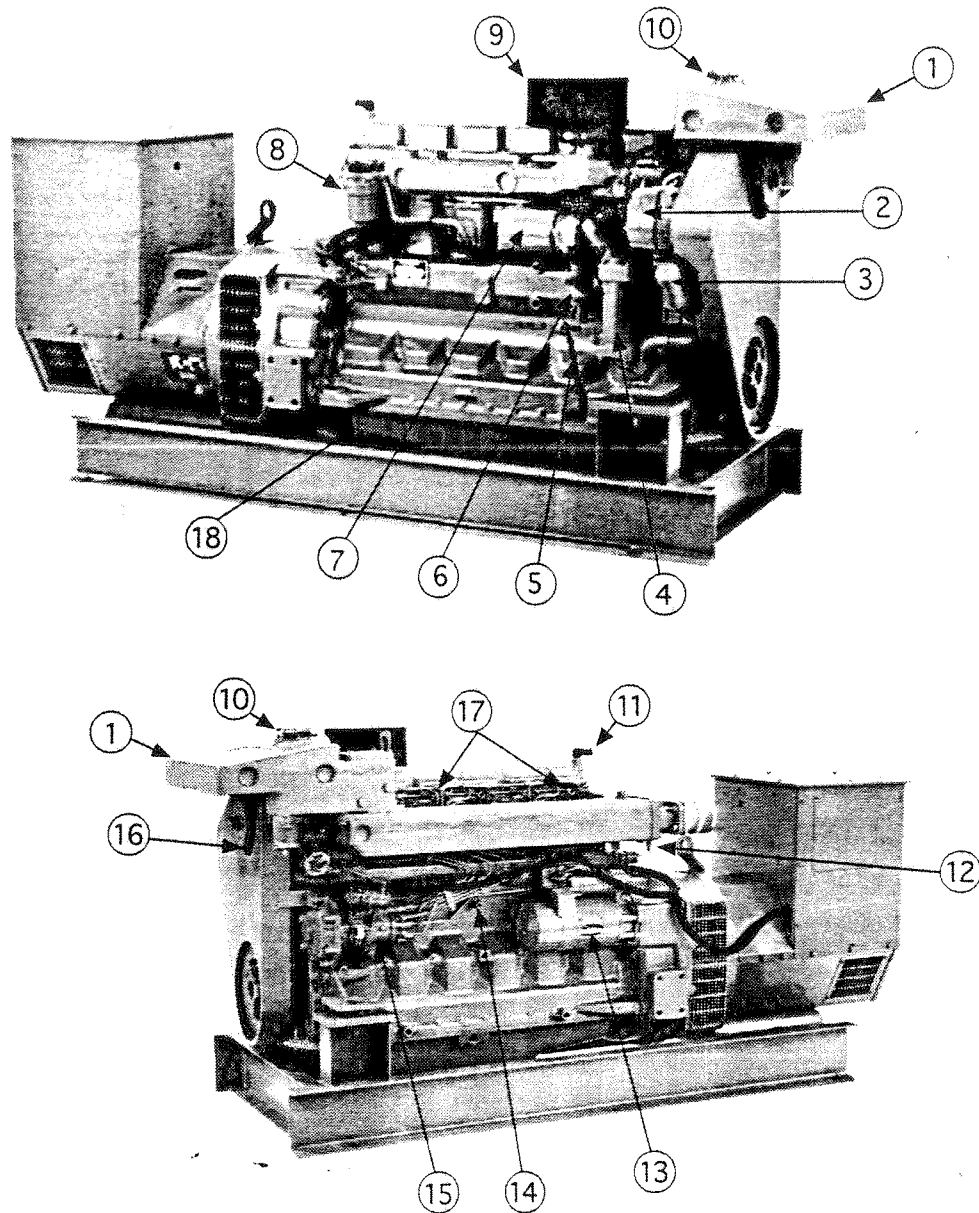


Fig. 6. M65C-6 KC (Note: The components of M99C are in a similar location.)

- | | | | |
|----------------------|--------------------------|----------------------------|------------------------|
| 1. Expansion tank | 6. Fuel lift pump | 11. Crankcase vent | 16. V-Belts |
| 2. DC alternator | 7. Lube oil filter | 12. Exhaust manifold drain | 17. Fuel injectors (6) |
| 3. Lube oil fill | 8. Secondary fuel filter | 13. Starter | 18. Lube oil drain |
| 4. Lube oil cooler | 9. Air cleaner | 14. Engine block drain | |
| 5. Lube oil dipstick | 10. Coolant fill | 15. Fuel injection pump | |

CONTROL PANELS

Lugger Propulsion Engines

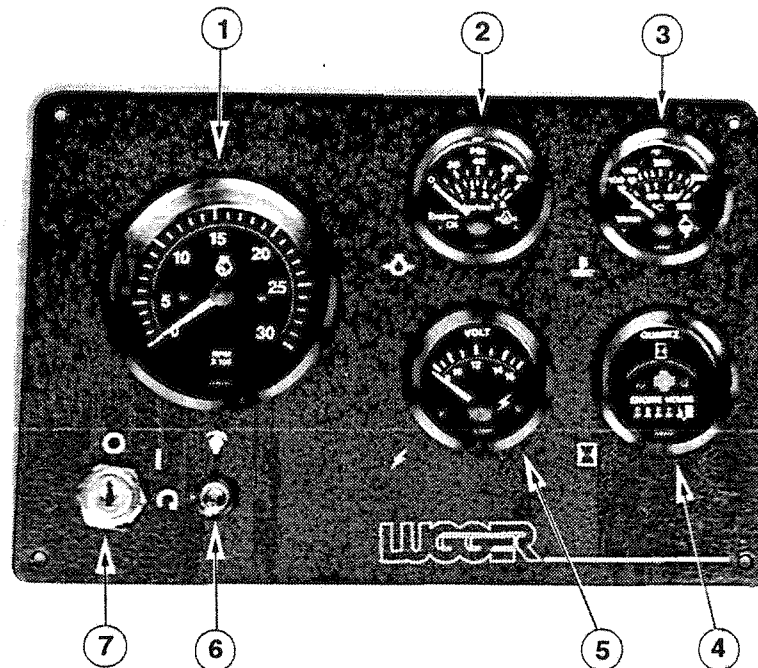


Fig. 7 *Lugger Instrument Control Panel*

1. TACHOMETER

The tachometer shows the engine speed in revolutions per minute (RPM). Numbers are multiples of 100.

2. 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 immediately.

3. COOLANT TEMPERATURE GAUGE

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

4. HOURMETER

Keeps track of engine running time.

5. D.C. VOLTMETER

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

6. INSTRUMENT PANEL LIGHTING

The switch turns on the instrument panel lights.

7. KEY SWITCH

Turning the key clockwise to the first position will switch on the current. Continue turning the key clockwise to start the engine. When the engine starts, immediately turn the key back to the first position while the engine is running.

The key must be kept in the ON or FIRST position while the engine is running.

Turn the key counterclockwise as far as possible to stop the engine.

Note: Optional flybridge panels have engine start switches instead of key switches.

CONTROL PANELS

Northern Lights Generator Sets

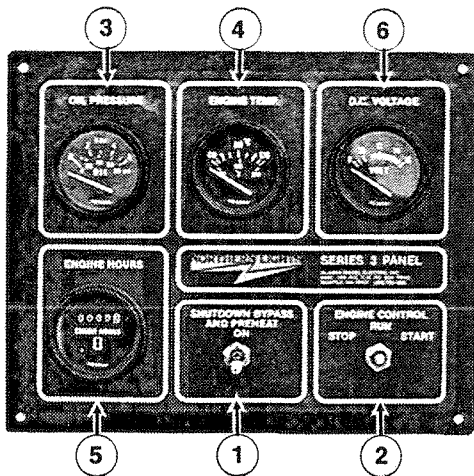


Fig. 8A Series 3 Generator Control Panel

1. SHUTDOWN BYPASS SWITCH

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

2. ENGINE CONTROL SWITCH

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 immediately.

4. COOLANT TEMPERATURE GAUGE

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

5. HOURMETER

Keeps track of engine running time.

6. D.C. VOLTMETER

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

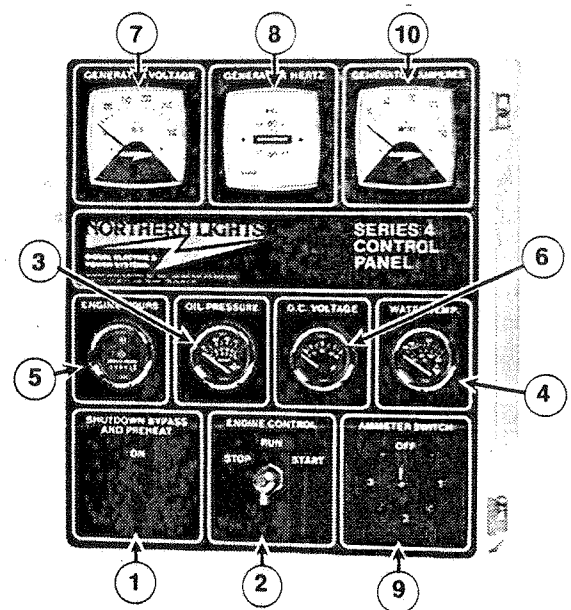


Fig. 8B Series 4 Generator Control Panel

7. A.C. 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 1500RPM 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 *ON* position while the engine is running.


10. A.C. AMMETER

The ammeter indicates the phase load. Check for load unbalance. If the unbalance is greater than 10%, have an electrician balance the load properly. This will ensure longer generator life and better economy.

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. (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 "o o". Never allow the level to go below the "o o". 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. *Propulsion Only:* Check the oil level in the reverse gear. Methods may vary from gear to gear. See your Gear Owner's Manual.
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.

GENERATOR

Starting

1. While holding the Shutdown Bypass switch in ON position, push the Engine Control switch to 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 reengaging.

Operating

1. Check Gauges Often: Oil pressure must be above 29 PSI. D.C. voltmeter should read between 13 and 14 volts (26-28 volts, 24 volt systems) at 60°F (16°C) ambient temperature. Water temperature gauge must be below 200°F (94°C).
2. Check AC voltage and frequency meters (Series 4 Panel). If gauges deviate from normal levels, shut down the set and investigate.
3. Let the unit run unloaded for a three to five minute warm-up period.

4. Do not add full electrical load until engine is at maximum operating temperature.

Shutdown

1. Unload the generator and run for three to five minutes for cool down period.
2. Turn the Engine Control Switch to off position.
3. Close the sea cock, fuel valves and put the battery switch in OFF position.

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

PROPULSION ENGINE

Starting

1. Put the gear control in the neutral position.
2. Move the throttle control to the full speed position and return back to idle.
3. Turn the key switch to the first position. Check the voltage meter to see the condition of the batteries. For starting, the voltmeter should not read below 12 volts (24 volts for 24 volt systems).
4. Turn the key to the starting position and as soon as the engine starts, release the key. Move the throttle up until the engine is running at approximately 1000 RPM.
5. Do not crank the starter for more than 15 seconds consecutively. If the engine fails to start with the first attempt, be sure that the starter has stopped completely before reengaging.

NOTE: Never race a cold engine. Operate at 1000 RPM for a 3-5 minute warm-up period.

Operating

1. Check oil pressure as soon as the engine has started. Oil pressure should be above 15 PSI. The engine must never be run if the oil pressure is below 15 PSI.
2. Check the voltmeter. It should read 13 to 14 volts (26-28 volts, 24 volt systems) at 60°F (16°C).
3. Water temperature should not rise over 200°F (94°C). If it does, shut down the engine and investigate the cause of overheating.
4. Do not exceed 800 RPM when shifting marine gear. Repeated shifts at higher engine speeds can damage the reverse gear.
5. **L439D&T** Low idle is 850 RPM. Maximum working engine speed is: 2500 RPM for pleasure craft, 2500 RPM for light commercial craft, 2200 RPM for continuous duty applications.
L668D&T Low idle is 850 RPM. Maximum working engine speed is 2400 RPM for pleasure craft, 2400 RPM for light commercial craft, 2200 RPM for continuous duty applications.

OPERATING PROCEDURES

6. If the proper propeller is used, the engine should reach its appropriate maximum RPM's at full throttle. If the maximum rated RPM's for your engine application is exceeded at full throttle, then your propeller is too small. If you cannot reach your maximum rated RPM's at full throttle, either your propeller is too large or bottom growth is slowing the boat. (See Prop Chart, page 32).
7. To Establish Maximum Cruising RPM: Establish the RPM at full throttle and subtract 200-300 RPM. This will promote engine life and reduce fuel consumption.

Shutdown

1. Run engine three to five minutes in neutral at 1000 RPM, for cool down period.
2. Return engine to low idle.
3. Turn the key switch counterclockwise as far as possible to stop the engine.
4. Close the sea cock and fuel valves and put the battery switch in OFF position.

NOTE: Do not turn battery switch of OFF while 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. Propulsion engine have warning horns to sound and warn you of a problem. Remember: When engine is not running the horn will sound when key is in the "ON" position because there is no oil pressure. Propulsion engines do not have shutdown systems.
 - b. Generator sets have shutdown systems to stop the engine. They have no warning horns.
 - c. 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 warning or 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 page 28-29 to isolate the cause of the overheat.

! **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 warning or 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 is normal, DO NOT restart the engine. Call your Northern Lights or Luger 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. Constantly check the engine temperature and oil pressure gauges.
3. Oil consumption is greater during break-in as piston rings and cylinder liners take time to seat.
4. Break-In Oil Changes: Change engine oil and filter at 50 hours. Change oil and filter again at 100 hours. (See Gear Owner's Manual for break-in oil change procedures. Consult Lubricants Section for oil recommendation).

Operating Instructions

Propulsion engine: Never run full speed for more than 5 minutes during the first 50 hours. Run engine at 50 to 75% of maximum working speed for the first 20 hours with as little idling time as possible. Extended idling can inhibit ring seating, causing cylinder walls to glaze.

Generator sets: Maintain at least a 75% load on your set for the first 100 hours. If this is not possible, maintain no less than a 50% load to ensure proper seating of the piston rings. Vary the load to help seat rings.

SERVICING 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
- SP7 Check primary fuel filter
- SP14 Check cooling water level
- SP20 Check oil level in reverse gear (propulsion only)

FIRST 50 HOURS

- SP2 Change engine oil
- SP3 Change lube oil filter

EVERY 50 HOURS:

- SP5 Check V-belt tension
- SP22 Check electrolyte in batteries

FIRST 100 HOURS:

- SP2 Change engine oil
- SP3 Change lube oil filter

EVERY 200 HOURS:

- SP2 Change engine oil
- SP3 Change lube oil filter
- SP4 Check air cleaner
- SP8 Change primary fuel filter element
- SP12 Check turbocharger air, oil & cooling lines for leakage

SP18 Check zinc electrodes

FIRST 600 HOURS

SP6 Adjust valves

EVERY 600 HOURS (or yearly, whichever occurs first):

- SP4 Replace air cleaner
- SP9 Change secondary fuel filter
- SP10 Check injectors
- SP13 Check turbocharger boost pressure
- SP15 Check and flush cooling system
- SP19 Change impeller in sea water pump
- SP23 Check state of charge of batteries

EVERY 1200 HOURS:

SP6 Adjust valves

EVERY 2400 HOURS:

- SP11 Check fuel injection pump
- SP16 Check and clean heat exchanger
- SP17 Check and clean gear oil cooler

SERVICE POINT	PAGE	OPERATION	DAILY	50 Hours	200 Hours	600 Hours	1200 Hours	2400 Hours
ENGINE:								
SP1	12&16	Check oil level	•					
SP2	16	Change engine oil 1)						
SP3	16	Change lube oil filter 1)			•			
SP4	16	Check (replace) air cleaner 1) 3)			•	•		
SP5	17	Check V-Belt tension 1)		•				
SP6	17	Check valve clearances 1)				•		
FUEL SYSTEM:								
SP7	18	Check primary filter (Racor) 2)	•					
SP8	18	Change primary filter element 2) 3)			•			
SP9	18	Change secondary filter 1) 3)				•		
SP10	19-20	Check injectors 1)				•		
SP11	20-23	Check fuel injection pump						•
TURBOCHARGER:								
SP12	23	Check air lines, oil and cooling water lines for leakage 1)			•			
SP13	23	Check boost pressure				•		
COOLING SYSTEM:								
SP14	12&25	Check cooling water level	•					
SP15	25-26	Check and flush cooling system 1)				•		
SP16	26	Check and clean heat exchanger 1)						•
SP17	26	Check and clean gear oil cooler 1)						•
SP18	26	Check zinc electrodes 1) 3)			•			
SP19	26	Change impeller in seawater pump 1) 3)				•		
DRIVEN EQUIPMENT								
SP20	27	Check oil level in reverse gear	•					
SP21	27	Change oil in reverse gear 2)						
ELECTRICAL SYSTEM:								
SP22	27	Check electrolyte level in batteries 1) 3)		•				
SP23	27	Check condition of batteries with hydrometer 1)				•		
OUT OF SERVICE:								
SP24	27	Winterizing or out-of-service 3)						

1) Perform all maintenance once a year even if hour level has not been reached.
 2) Consult manufacturer's maintenance schedule, note on chart.
 3) When necessary.

SERVICE RECORD

Service Point	OPERATION	HOURS/DATE									
50 HOURS											
SP5	Check V-belt tension										
SP23	Check electrolyte in batteries										
200 HOURS											
SP2	Change engine oil										
SP3	Change lubricating oil filters										
SP4	Check air cleaner										
SP7	Change primary fuel filter element										
SP12	Check turbocharger air, oil & cooling lines for leakage										
SP18	Check zinc electrodes										
600 HOURS											
SP4	Replace air cleaner										
SP9	Change secondary fuel filter										
SP10	Check injectors										
SP13	Check turbocharger boost pressure										
SP15	Check and flush cooling system										
SP19	Change impeller in seawater pump										
SP23	Check state of charge of batteries										
EVERY 1200 HOURS											
SP6	Check valve clearances										
2400 HOURS											
SP11	Check fuel injection pump										
SP16	Check and clean heat exchanger										
SP17	Check and clean reverse gear oil cooler										

SERVICING

LUBRICATION - GENERAL

1. Use only clean, high quality lubricants stored in clean containers in a protected area.
2. These lubricants are acceptable:
 - a. API Service CC/CD single viscosity oils.
 - b. API Service CC/CD/SF multi-viscosity oils.
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 to 32° -23 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 "o o". Never allow the level to go below the "o o".
3. Always add the same viscosity of oil as is already in the crankcase.

SP2. OIL CHANGES

1. Using the oil recommended in the above diagram, change the engine oil and filter after the first 50 hours of operation, the first 100 hours and every 200 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.

Propulsion Engines w/Optional Drain Pump:

- a. Remove dipstick.
- b. Unscrew dipstick tube and insert the hand pump to the bottom of the oil pan. Drain by pumping.

- c. Replace dipstick tube and dipstick.
- d. Refill engine with recommended oil.

Marine Generator Sets:

- 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:

L439D	9 qt.	(8.5 liters)
L439T	14 qt.	(13.2 liters)
445 Series	14 qt.	(13.2 liters)
668 Series	18 qt.	(17 liters)

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. 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 600 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

SP5. V-BELTS

1. Check the tension and wear on the V-belts after every 50 hours.
2. Use your thumb to press on the belt at the midpoint between the crankshaft and alternator pulleys. The tension is correct if the belts can be depressed about 1/2 - 3/4" in. (13-19 mm).
3. Belts that operate in pairs should both be replaced in pairs, even if only one of them needs to be replaced.

SP6. VALVE CLEARANCES

The following special tools will be needed:

JDE 81-1 or JDE 83 Flywheel Turning Tool.

JDE 81-4 Timing Pin.

1. Check the valve clearances after the first 600 hours, the first 1200 hours and every 1200 hours thereafter.
2. Remove rocker arm cover with ventilator tube.
3. Remove plastic plugs in engine timing holes on front side of flywheel.
4. 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.
5. Valve clearances can be checked with the engine either hot or cold.

Intake Valve 0.014 in. (0.35 mm)

Exhaust Valve 0.018 in. (0.45 mm)

4 Cylinder models

1. Position No. 1 piston at TDC on compression stroke.
2. Adjust valve clearance for valves marked with an "X" in Fig. 9.

FRONT	Cylinder No.	1	2	3	4
	Intake Valve	X	X	O	O
	Exhaust Valve	X	O	X	O

Figure 9 All 4 cylinder models

3. Rotate crankshaft in a clockwise direction one complete revolution so that No. 4 piston is at TDC, reinsert timing pin and adjust valves marked with an "O" in Fig. 9.

4. To adjust valve clearance, insert feeler gauge between valve stem and rocker arm and adjust clearance with the adjustment screw until the feeler gauge slides with a slight drag.

6 Cylinder models:

1. Position No. 1 piston at TDC on compression stroke.
2. Adjust valve clearance for valves marked with an "X" in Fig. 10.
3. Rotate crankshaft in a clockwise direction one complete revolution, so that No. 6 piston is at TDC, reinsert timing pin and adjust valves marked with an "O" in Fig. 10.

FRONT	Cylinder No.	1	2	3	4	5	6
	Intake Valve	X	X	O	X	O	O
	Exhaust Valve	X	O	X	O	X	O

Figure 10. All 6 cylinder models

4. To adjust the valve clearance, insert feeler gauge between valve stem and rocker arm and adjust clearance with the adjustment screw until the feeler gauge slides with a slight drag.

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. Use fuel having less than 1% sulphur (preferably less than 0.5%).
3. The cetane number should be a minimum of 45.
4. 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.

SERVICING

5. 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.

SP7-9. 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 200 hours or whenever necessary.
 - c. If the bowl fills with water, change the primary and secondary elements immediately.
2. Change secondary fuel filter every 600 hours.

Note: The fuel filter on the engine is considered the "secondary fuel filter". The engine will be fitted with a spin-on disposable secondary fuel filter.

 - a. Open the filter drain plug (Fig. 11,A) and drain the filter.

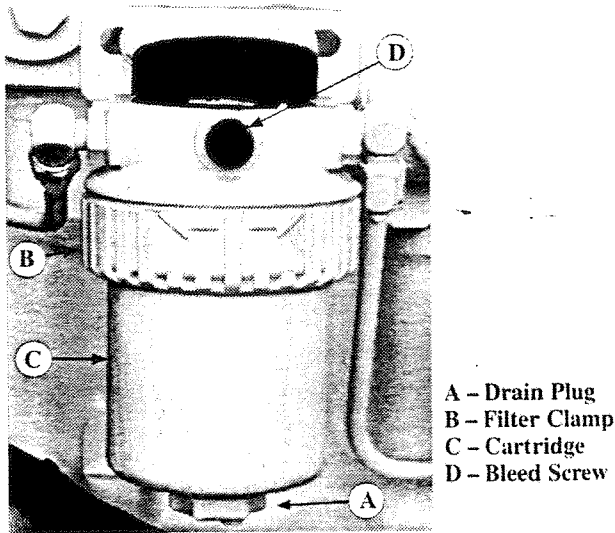


Figure 11. Secondary Fuel filter

- b. Remove the secondary fuel filter by turning the filter clamp (Fig. 11,B) counter clock-

wise until the filter cartridge (Fig. 11,C) slides out.

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.

- c. Install new filter cartridge.
 - d. Fuel filter cartridge number: 24-51005

BLEEDING THE FUEL SYSTEM

! **CAUTION:** Escaping diesel fuel under pressure can penetrate the skin, causing serious personal injury. Before disconnecting lines be sure to relieve all pressure. Before applying pressure to the system be sure all connections are tight and the lines, pipes and hoses are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood rather than the hands to search for suspected leaks. If injured by escaping fuel, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

1. Whenever the fuel system has been opened for service, (lines disconnected, filter changed, etc.) it should be bled.
 - a. To bleed the fuel system, loosen the bleed plug (Fig. 11,C) on the fuel filter cartridge. Operate the primer pump lever on fuel transfer pump (see component locations) until most of the air bubbles are expelled and clear fuel escapes the bleed plug. Tighten the bleed plug.
 - b. If the engine will not start, it may be necessary to loosen the fuel supply pipe at the pump. Operate primer lever of fuel supply pump until fuel flow is free from air bubbles. Retighten fuel supply line to 22 ft. lb. (30 N•m).
 - c. If engine still doesn't start, loosen fuel line connection at injection nozzle. Always use a back up wrench when loosening or tightening fuel lines at nozzles and injection pump to avoid damage. With throttle on full, crank the engine over with the starter until fuel without air flows from the

SERVICING

loose fuel pipe connection. Repeat procedure for remaining nozzles, if necessary, until engine starts or until air has been removed from system. Tighten the connections to 20 foot lb. (27 N•m).

SPI10. INJECTORS

1. Fuel injectors should be checked by a Luggert-Northern Lights dealer or qualified fuel injection shop every 600 hours.
2. Injector Removal:
You will need the following special tools:
JDE38A—Injection Nozzle Puller
JDE39—Nozzle Bore Cleaning Tool
JD258—Pilot Tool
 - a. Before removal, carefully remove all dirt from the cylinder head around fuel injection nozzles. Clean with compressed air to prevent dirt from entering the cylinders or valve seats. Plug the bore in the cylinder head after each fuel injection nozzle has been removed. Cap fuel line openings as soon as they are disconnected.
 - b. Immediately fit protective caps over the nozzle tips and the line connections to avoid handling damage.
 - c. Do not bend the fuel delivery lines. When loosening the fuel pressure lines, hold male union of nozzle line stationary with a backup wrench.
 - d. Loosen nuts to remove leak-off lines and T-fittings and disconnect fuel injection line from nozzle.

NOTE: When all fuel injection nozzles have to be removed, disconnect leak-off line assembly at fuel tank, at injection pump, and at each nozzle T-fitting. Lift off complete leak-off line as an assembly.

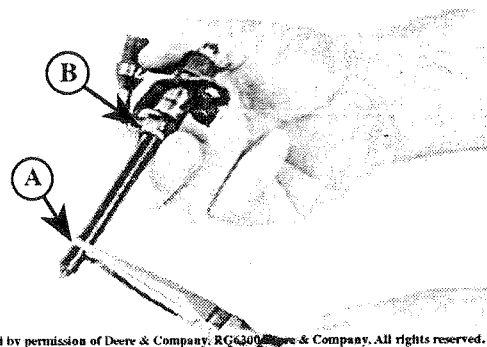
- e. Remove cap screw, clamp and spacer.
- f. Pull injection nozzle out of cylinder head with JDE38A Injection Nozzle Puller.

NOTE: Do not use screwdrivers, pry bars, or similar tools for this as they might damage the injection nozzle.

3. Clean Injector Bore:
Always turn the tool clockwise through the bore even when removing from bore, otherwise tool may become dull.
 - a. Clean nozzle bore with JDE39 Nozzle Bore

Cleaning Tool. Blow debris from bore with compressed air and plug the bore to prevent entry of foreign material.

4. Clean injection nozzles:
 - a. Remove carbon stop seal (Fig. 12,A) and upper sealing washer (12,B), using a needle-nose pliers. Discard seals.
 - b. Clean exterior of nozzle by soaking in clean solvent or diesel fuel. Clean tip with brass wire brush.



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Fig. 12

NOTE: Do not scrape or disturb the teflon coating on the nozzle body above the carbon stop seal groove. This coating will become discolored during normal operation, but this is not harmful. Do not use a motor driven brush to clean up nozzle body.

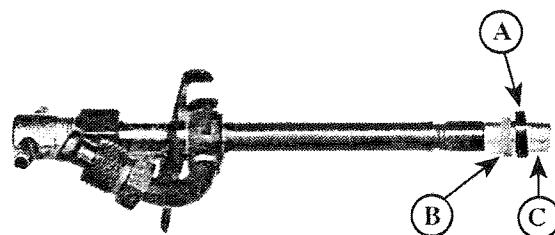


Fig. 13.

5. Install seals on injection nozzle.
NOTE: Each time an injection nozzle is removed from the cylinder head, replace carbon stop seal (B) with a new one.
 - a. Position JD258 (ROS16477) Pilot Tool (Fig. 13,C) over nozzle tip. If Pilot Tool (included in cleaning kit) is not available, use a No. 16189 Nozzle Protector Cap found on every new or replacement nozzle.

SERVICING

- b. Position a new carbon stop seal (Fig. 13,B) on pilot tool. Use a new seal washer (13,A) to help slide the carbon seal into place until it seats in its groove on nozzle body.
- c. Continue to slide upper sealing washer onto nozzle body until it seats against inlet fitting.

6. Install injection nozzles:

NOTE: Before installing injection nozzles, make sure nozzles are clean and free from oil or grease. Do not grease or oil the nozzles.

- a. Remove plug (if installed previously) from nozzle bore in cylinder head and blow out bore with compressed air.
- b. Make sure that the sealing surface of the cylinder head (on which the seal washer will be resting) is smooth and free of damage or dirt. This could prevent proper sealing. Dirt and roughness could also cause distortion to nozzle when the attaching screw is tightened, making the valve stick.
- c. Install nozzle in cylinder head using a slight twisting motion as nozzle is seated in bore.

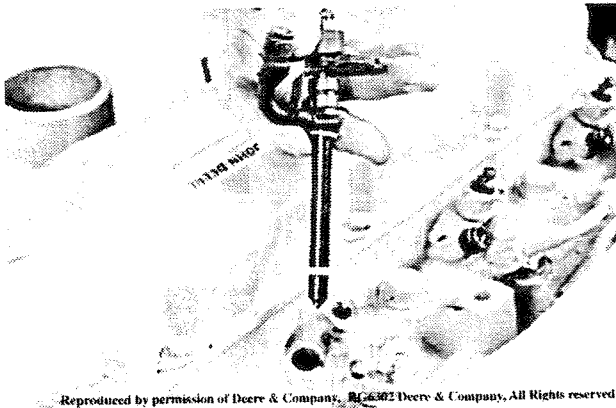


Figure 14. Shows relationship of parts required for installation.

- d. Install spacer and cap screw. Do not tighten capscrew at this stage.
- e. Connect fuel pressure line to nozzle. Leave connection slightly loose until air is bled from system.
- f. Tighten nozzle hold-down cap screws to 27 foot lb. (37 N•m).

- g. Install leak-off assembly.
- h. Bleed air from loose injection line connection. Tighten connection using two wrenches.

SPI3. INJECTION PUMP

1. Since operating conditions may vary considerably, it is difficult to give a definite service interval. But, as a rule, the pump settings, maximum speed, idle speed and exhaust smoke should be checked by your dealer after every 2400 hours of operation. 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 servicing pump, check the other possible causes.
 - a. Check cleanliness of air filter.
 - b. Check valve clearances.
 - c. Clean and check injectors.
3. Any repair which involves disassembly of the injection pump must be carried out by specially-trained mechanics with the proper tools and test devices.

NOTE: All warranties on the engine become null and void if the injection pump seals are broken by unauthorized persons.

DB4 INJECTION PUMP - REMOVAL

1. Clean the fuel injection pump, lines and area around the pump with cleaning solvent or a steam cleaner.

IMPORTANT: Never steam clean or pour cold water on a fuel injection pump while the pump is running or while it is warm. Doing so may cause seizure of internal rotating pump parts.
2. Disconnect shutoff cable and speed control linkage, if equipped. Disconnect electrical connection to shutoff solenoid or throttle positioning solenoid. Tag electrical wires for correct reassembly.

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel lines at injection pump so that discharge fittings are not altered which will prevent internal pump damage.
3. Disconnect fuel return line (Fig. 15,A) and fuel supply line (C).

SERVICING

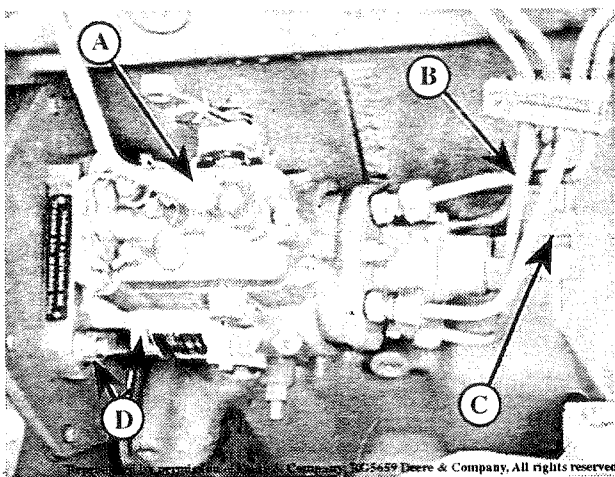


Figure 15.

4. Disconnect all fuel delivery (pressure) lines (Fig. 15,B) from injection pump using a suitable 17mm deep-well crowsfoot socket.
5. Remove injection pump drive gear cover. Remove drive gear retaining nut and washer from end of pump shaft. **Be careful not to let washer fall inside timing gear cover.**
NOTE: The injection pump drive gear fits snugly onto a tapered drive shaft and indexed by a hollow pin or Woodruff key installed in drive shaft
6. Attach JDG670A Drive Gear Puller (Fig. 16,A) to injection pump drive gear as shown.
NOTE: Replace 6mm Grade 12.9 cap screws (C) as needed.
7. Evenly tighten the two 6mm, Grade 12.9 screws (threaded in drive gear) and snugly tighten center forcing screw (Fig. 16,B) against end of pump shaft.

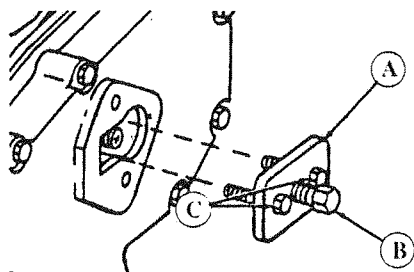


Figure 16.

8. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove

JDG670A puller (Fig. 16,A) and screws from drive gear.

9. Check to make sure that timing marks on back side of front plate (Fig. 17,A) and injection pump flange (B) are present and properly aligned. This assures that repaired or replacement pump can be properly times to engine when installed.

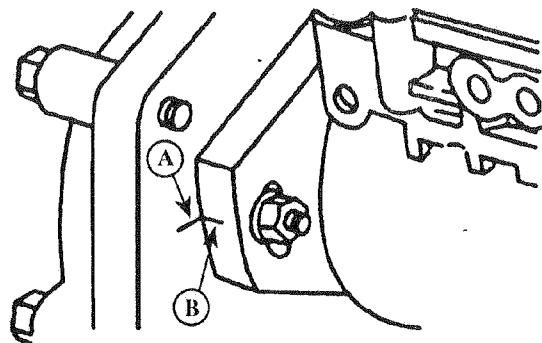


Figure 17.

IMPORTANT: Injection pump mounting flange timing mark (Fig. 17,A) and front plate timing mark (B) presence and alignment MUST be verified before removing pumps from engine.. DO NOT reference internal timing marks (on pump cam ring and governor weight retainer). If timing mark is not clearly visible on front plate, scribe a visible reference mark as accurately as possible in-line with mark on pump flange.

10. Remove three injection pump mounting stud nuts. Remove injection pump from mounting studs.
11. Plug or cap all openings on injection pump and take pump to dealer for service

DB4 INJECTION PUMP - INSTALLATION

1. Lubricate a new square sealing ring with clean engine oil. Install ring into groove on front face of pump mounting flange. Slide injection pump onto mounting studs while inserting pump shaft into drive gear.
2. Check pump shaft and index pin for proper alignment with pump drive gear key slot.
IMPORTANT: Shaft roll pin may be easily damaged if improperly assembled. Pump drive gear should not move when initially installing pump index pin into drive gear key slot.

SERVICING

3. Install injection pump partially onto mounting studs without engaging pump pilot hub into engine front plate.

IMPORTANT: DO NOT tighten hex nuts more than three full turns on mounting studs. Pump drive shaft index pin may be damaged if pin is not properly aligned with drive gear key slot and if the nuts are tightened more than three turns.

4. Install three flat washers, lock washers, and hex nuts onto pump mounting studs. Tighten nuts three turns only so that pump will not fall off mounting studs.

NOTE: The pump drive gear should begin to move forward (away from engine front plate) with the pump when flange is approximately 1/8 in. (3.2mm) away from engine front plate.

5. Install pump mounting flange flush to engine front plate with drive gear held flush against front side of engine front plate.

IMPORTANT: DO NOT use tightening force of pump mounting stud nuts to pull pump shaft into drive gear I.D.

6. With the pump shaft index pin properly engaged in the drive gear key slot, finger tighten mounting stud nuts.
7. Push pump drive gear firmly onto shaft taper. Install washer and retaining nut (Fig. 18,A) onto end of shaft. Tighten retaining nut to 150 foot lbs. (200 N•m).

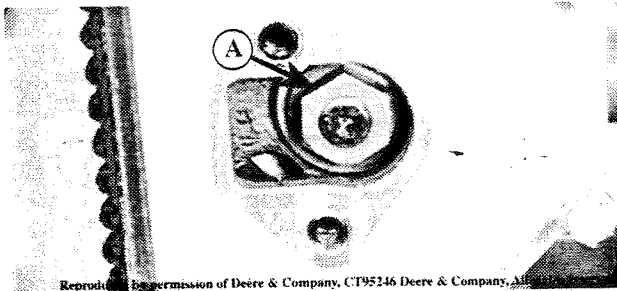


Figure 18.

8. Install access cover plate using a new gasket. Apply LOCITE 242 (TY9370) to cap screw threads and tighten to 1.7 foot lbs. (2 N•m).
9. Align timing mark on the pump flange (Fig. 19,B) with timing mark on the cylinder block front plate (A).

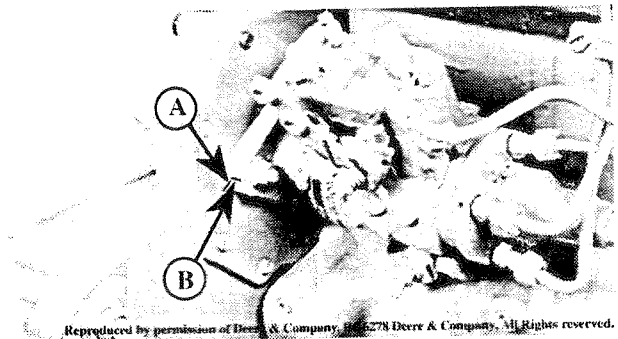


Figure 19.

10. Tighten the three hex nuts securing the pump to the front plate to 20 foot lbs. (27 N•m).
11. Connect injection pump pressure lines (Fig. 20,E). Beginning with outlet (21,B) and continue around the pump head in counterclockwise direction, attaching lines in same order as engine firing. (1-5-3-6-2-4 on 6-cylinder engines and 1-3-4-2 on 4-cylinder engines).

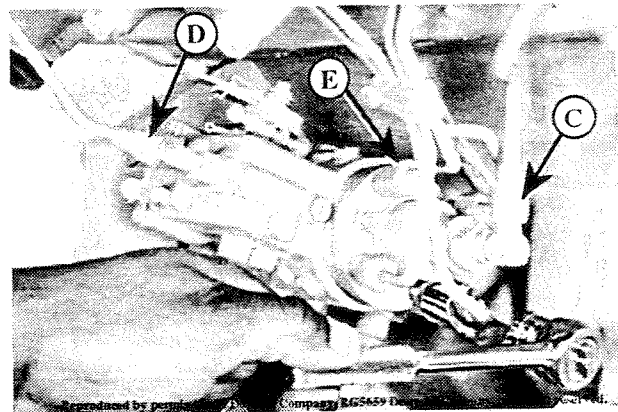
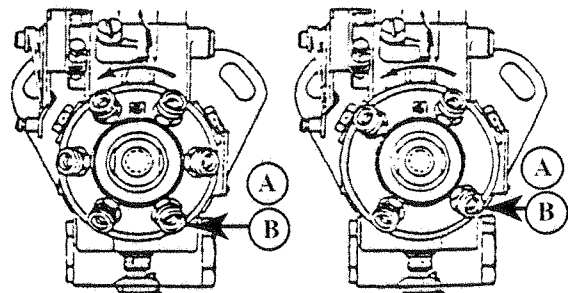


Figure 20.



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Figure 21.

SERVICING

12. Tighten fuel delivery (pressure) lines to 25 foot lbs. (34 N•m), using a suitable 17mm deep-well crowsfoot socket.

IMPORTANT: ALWAYS use a backup wrench when loosening or tightening fuel delivery lines at fuel injection pump, so that the pump discharge fittings are not altered. This prevents possible internal pump damage.

13. Connect fuel supply line (Fig. 20,C) and fuel return line (D).
14. Connect fuel shutoff cable and speed control linkage, if equipped. Install and securely tighten electrical connections to shutoff solenoid and throttle positioning solenoid.
15. Bleed air from fuel system as outlined on page 19. Start engine and run for several minutes. Check the entire system for leaks.

SPI2. TURBOCHARGER

1. Check for air leaks every 200 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.

SPI3. 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 600 hours.
2. On the inlet pipe there is a 1/8" NPT threaded outlet. Remove the plug and install the boost gauge hose. Refer to your engine specifications for correct pressure.

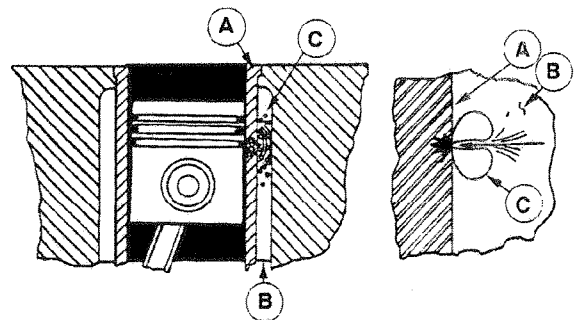
COOLING REQUIREMENTS

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 (anti-freeze) 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 (22,A) which are in contact with engine coolant (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 (22,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

Fig. 22.

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

SERVICING

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.
2. Here are acceptable water quality specifications

Contaminates	Parts Per Million	Grains Per Gallon
Maximum Chlorides	40	2.5
Maximum Sulfates	100	5.9
Max Dissolved Solids	340	20
Max Total Hardness	170	10
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.

ETHYLENE GLYCOL CONCENTRATE -EGC (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/H₂O 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

SERVICING

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 H₂O/EGC mixture. (1.0 fl oz of SCA per qt of H₂O/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.

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 Luger Dealer.
4 Pack - Part Number.....20-00005
50 Pack - Part Number.....20-00010

SP14. 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.

SP15. 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 every 600 hours, or yearly. **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 1-9.)
5. For heat exchanged units, drain the raw water circuit by opening the drain cock at the bottom of the heat exchanger. (See Component Locations pages 1-9.)
6. For vessels with keel cooling, the vessel must be out of the water to allow draining of the keel cooler.
7. 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.
8. Fill the fresh water system by pouring the recommended coolant mixture as described in previous sections.
9. Close cooling system air vent on turbocharger.
10. Open the seacock.
11. Start the engine. Check hoses and connections and repair any leakage.

SERVICING

SP16. HEAT EXCHANGER CLEANING

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

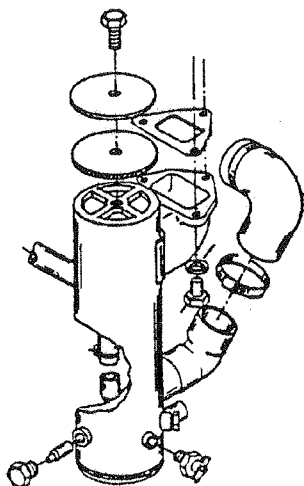


Fig. 23. Heat Exchanger

SP17. CLEANING GEAR OIL COOLERS

For propulsion engine only:

1. Clean the core once a year or after every 2400 hours of operation.
2. Drain fresh water cooling circuit.
3. Remove end covers of gear oil cooler.
4. Wash the core in diesel fuel or cleaning solvent and blow it dry with compressed air. Clean the end covers of the core with a steel brush and use a metal rod to clean inside of tubes.
5. Reassemble using new sealing rings. Fill the cooling system, start the engine and check for leaks.

SP18. ZINC ELECTRODES

1. Zincs are installed in the cooling system to protect your engine from electrolysis. Check them faithfully every 200 hours. If you are in

warm salt water or where electrolysis is a known problem, check them more often.

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.
 5. Reinstall the zinc holders. Be sure the threads are clean and have good metal to metal contact.

SP19. 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.

SP20,21. 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.

SERVICING

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. Do not polarize the alternator or regulator.
7. 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.

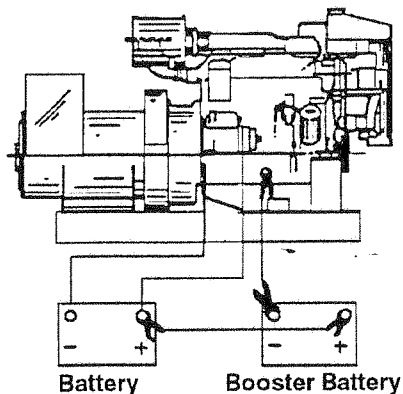


Figure 24. Booster Battery Connections

4. Then, connect negative (-) terminal of booster battery to ground on the engine block. (See Fig. 23).
5. Remove booster battery after starting engine.
6. Sealed batteries: see manufacturer charging and booster instruction.

SP16-17. BATTERY CARE

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.

SP27. WINTERIZING, OUT-OF-SERVICE

1. Drain seawater cooling systems completely. Remember to shut off sea cocks before opening drain cocks.
2. Drain seawater supply lines and wet exhaust line.
3. Loosen the seawater pump cover and drain pump.
4. Check freshwater antifreeze mixture. If refilling water if necessary.

TROUBLESHOOTING

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

ELECTRICAL

✓ **Battery will not charge**

Loose or corroded connections:

- Clean and tighten battery connections.

Sulfated or worn out batteries:

- Check specific gravity of each battery.
- Check electrolyte level of each battery.

Loose or defective alternator belt:

- Adjust belt tension.
- Replace belt.
- Defective alternator

✓ **Starter inoperative**

Check DC circuit breaker.

Loose or corroded connections:

- Clean and tighten loose battery and harness plug connection.

Low battery output:

- Check specific gravity of each battery.
- Check electrolyte level of each battery.

Defective electrical system ground wire:

- Repair or replace.

✓ **Starter cranks slowly**

Low battery output:

- Batteries too small.
- Battery cables too small.

Check specific gravity of each battery.

Check electrolyte level of each battery.

Crankcase oil too heavy.

Loose or corroded connections:

- Clean and tighten loose connections.

✓ **Entire electrical system does not function**

Check DC circuit breaker.

Faulty connection:

- Clean and tighten battery and harness plug connections.

Sulfated or worn out batteries:

- Check specific gravity and electrolyte level of each battery.

ENGINE

✓ **Engine hard to start or will not start**

Improper starting procedure.

No fuel.

Low battery output:

- Check electrolyte level and specific gravity of battery.

Excessive resistance in starting circuit:

- Clean and tighten all connections on batteries.

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.

Fuel pump primer lever lift on upward end of stroke.

✓ **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.

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.

Improper type of fuel:

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

✓ **Lack of engine power**

Engine overloaded:

- Reduce load.

Intake air restriction:

- Service air cleaner.

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.

TROUBLESHOOTING

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

Improper valve clearance:

- See your local dealer.

Dirty or faulty injection nozzles:

- See your local dealer.

Injection pump out of time:

- See your local dealer.

Turbocharger malfunction:

- Stop the engine.
- Remove the air cleaner.
- Make sure the compressor wheel is stationary and then rotate it with your hand to see whether it is stiff to rotate.
- First rotate the wheel under light pressure, then by lightly pulling axially. If the wheel is stiff to rotate, blades are damaged or blades hit housing, the turbocharger should be replaced as soon as possible.

✓ Engine overheats

Engine overloaded:

- Reduce load

Low coolant level:

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

Cooling system needs flushing.

Defective thermostat:

- Remove and check thermostat.

Defective temperature gauge:

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

✓ Engine knocks

Insufficient oil:

- Check dipstick
- Call your dealer.

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.

✓ High fuel consumption

Improper type of fuel.

Clogged or dirty air cleaner:

- Service air cleaner.

Engine overloaded:

- Reduce load.

Improper valve clearance:

- See your dealer.

Injection nozzles dirty:

- See your dealer.

Injection pump out of time:

- See your dealer.

Engine not at proper temperature:

- Check your thermostats.
- Check water temperature with thermometer to see if temperature gauge is working properly.

✓ 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.

Improper type of oil:

- Drain and fill crankcase with correct oil.

Partially plugged oil filter:

- Replace filter.

✓ High oil consumption

Break-in period.

Crankcase oil too light:

- Use proper viscosity oil.

Oil leaks:

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

Engine overheats:

- See "Engine Overheats".

✓ Engine emits black or gray exhaust smoke

Clogged or dirty air cleaner:

- Service air cleaner.

Defective muffler (back pressure too high).

Improper fuel.

Engine overloaded:

- Reduce load.

Injection nozzles dirty:

- See your dealer.

Engine out of time:

- See your dealer.

✓ Engine emits white smoke

Improper fuel.

Cold engine:

- Warm up engine to normal operating temperature.

Defective thermostat:

- Remove and check thermostat.

Engine out of time:

- See your dealer.

SPECIFICATIONS

PERFORMANCE AND SPECIFICATIONS

Model Number		L439D	L439T	L668D	L668T
Performance¹					
High Output Rating	FWHP (kW)/rpm	80 (59)/2500	110 (81)/2500	130 (96)/2400	175 (130)/2400
Medium Duty Rating	FWHP (kW)/rpm	71 (53)/2500	95 (70)/2500	117 (87)/2400	165 (122)/2400
Continuous Duty Rating	FWHP (kW)/rpm	65 (48)/2200	76 (56)/2200	105 (78)/2200	120 (89)/2200
Maximum Flywheel Torque	ft lbs/rpm	213/1200	295/1700	389/1000	459/1500
Fuel Consumption²					
1500 RPM at High Output	US gph (lph)	0.7 (2.6)	1.0 (3.8)	1.7 (6.4)	2.7 (10.2)
1800 RPM at High Output	US gph (lph)	1.2 (4.5)	1.7 (6.4)	2.9 (11)	4.7 (17.8)
2000 RPM at High Output	US gph (lph)	1.7 (6.4)	2.3 (8.7)	4.0 (15.1)	6.5 (24.6)
2200 RPM at High Output	US gph (lph)	2.3 (8.7)	3.1 (11.7)	5.5 (20.8)	8.9 (33.7)
2500 RPM at High Output	US gph (lph)	3.5 (13.2)	4.7 (17.8)	8.4 (31.8)	—
2800 RPM at High Output	US gph (lph)	5.1 (19.3)	7.5 (28.4)	—	—
Specifications					
Cylinders		4 Inline	4 Inline	6 Inline	6 Inline
Displacement	CID (ltr)	239 (3.92)	239 (3.92)	414 (6.78)	414 (6.78)
Operating Cycle/Aspiration		4/Natural	4/Turbocharged	4/Natural	4/Turbocharged
Bore	in (mm)	4.19 (106)	4.19 (106)	4.19 (106)	419 (106)
Stroke	in (mm)	4.33 (110)	4.33 (110)	5.0 (127)	5.0 (127)
Approx. Wt. w/o gear	lbs (kg)	1070 (485)	1160 (526)	1450 (660)	1475 (670)
Keel cooled Heat Exchanger	lbs (kg)	1100 (499)	1190 (540)	1490 (675)	1515 (685)

THREE BLADED PROPELLER RECOMMENDATIONS

- Use this chart to find the **approximate, three bladed** propeller size for your vessel. Use this chart as a guideline only. Contact factory for actual propeller recommendation for your vessel and for medium and continuous duty propeller sizes.
- In the left column find the engine, then find the boat speed your builder expects from an engine of this HP on the top line. Locate the point where the two columns intersect for propeller size and shaft rpm. **Example:** L668D in a 18 kt boat uses 1:1 gear ratio and turns a 16 X 14 prop at 2500 rpm.

Engine Model HP/Max RPM	Speed (kts) Gear Ratio	15 - 18 1:1	14 - 17 1.5:1	13 - 15 2:1	12 - 14 2.5:1	10 - 13 3:1	8 - 10 3.8:1	8 - 10 4.5:1
L439D 80/2500		13 x 11 2800	16 x 13 1866	19 x 15 1400	22 x 18 1120	25 x 20 933	—	—
L439T 110/2500		14 x 12 2800	17 x 15 1866	20 x 16 1400	23 x 18 1120	25 x 23 933	—	—
L668D 130/2400		16 x 14 2500	19 x 18 1666	23 x 18 1250	28 x 24 1000	32 x 25 833	34 x 27 657	38 x 36 555
L668T 175/2400		17 x 17 2200	21 x 78 11467	25 x 23 1100	29 x 27 880	35 x 28 733	37 x 29 579	41 x 38 489

SPECIFICATIONS

INSTALLATION DATA

Model Number		L439D	L439T	L668D	L668T
Cooling (General)					
Freshwater circulating pump flow	US gal (ltr)/rpm	39 (148)/2800	77 (291)/2800	65 (246)/2500	57 (216)/2200
Heat rejection to jacket water	BTU-min	2194	3465	4032	4536
Cooling (Heat Exchanger)					
Raw water intake and discharge dia.	inch NPT	1.5	1.5	1.5	1.5
Raw water pump flow @ RPM	gpm (lpm)/rpm	29 (110)/2800	29 (110)/2800	27 (102)/2500	24 (91)/2200
Raw water pump max. suction head	in (m)	39 (1)	39 (1)	39 (1)	39 (1)
Maximum raw water temp. at inlet	°F (°C)	85° (30°)	85° (30°)	85° (30°)	85° (30°)
Freshwater system capacity	US gal (ltr)	5 (18.9)	5 (18.9)	5 (19)	5 (19)
Cooling (Keel Cooled)					
Water hose inside diameter	in (mm)	2 (50)	2-3/8 (60)	2-3/8 (60)	2-3/8 (60)
Head diameter	in (mm)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)
Turbo tube length*	ft (m)	12 (4)	16 (5)	18 (5.5)	24 (7.3)
One inch plain round tube length*	ft (m)	24 (8)	32 (10)	40 (12)	50 (15.3)
Skin cooler aluminum / steel*	sq ft (m ²)	12 (1.3) / 30 (3.3)	15 (1.6) / 50 (5.6)	18 (1.7) / 52 (4.8)	24 (2.3) / 65 (6)
*Based on 70 degree F seawater and minimum boat speed of 8 knots at full speed. Return water on keel cooling 70 to 130 degrees F.					
Electrical					
Minimum battery capacity	amp hours	160	160	172	172
Battery cable size up to 10 ft run		"0"	"0"	"0"	"0"
Standard harness length	ft (m)	20 (6)	20 (6)	20 (6)	20 (6)
Air					
Engine air consumption at rpm	cfm (m ³ /min)/rpm	192 (5.4)/2800	287 (8.1)/2800	210 (6)/2500	360 (10.2)/2200
Minimum engine room vent area	sq in (m ²)	36 (.023)	68 (.044)	90 (.065)	110 (.071)
Exhaust gas flow at rpm	cfm (m ³ /min)/rpm	493 (14)/2800	857 (24)/2800	515 (14.5)/2500	885 (25)/2200
Exhaust gas temperature at rpm	°F (°C)/rpm	1200° (648°)/2500	950°(496°)/2500	1000°(593°)/2500	975°(523°)/2200
Maximum exhaust back pressure	in (mm) H ₂ O	48 (1219)	30 (750)	48 (1219)	30 (750)
Suggested dry exhaust I.D.	in (mm)	3 (75) dry, 4 (100) wet	3 (75) dry, 4 (100) wet	3 (75) dry, 4 (100) wet	4 (100) dry, 5 (127) wet
Fuel and Oil					
Minimum fuel suction and return line	in (mm)		3/8 (9)	3/8 (9)	3/8 (9.5) 3/8 (9.5)
Maximum fuel pump head	in (m)	39 (1)	39 (1)	39 (1)	39 (1)
Crankcase oil capacity	US qts (ltr)	10 (9.4)	14 (13.2)	18 (17)	18 (17)
Gear, PTO, Engine Angle					
Engine rotation (facing flywheel)		Counter-CW	Counter-CW	Counter-CW	Counter-CW
Flywheel housing size	SAE #	4	4	2	2
Front PTO size (optional)	SAE #	5	5	5	5
Max. intermittent operating angle ... front down/rear down		0° / 15°	0° / 15°	0° / 15°	0° / 15°

SPECIFICATIONS

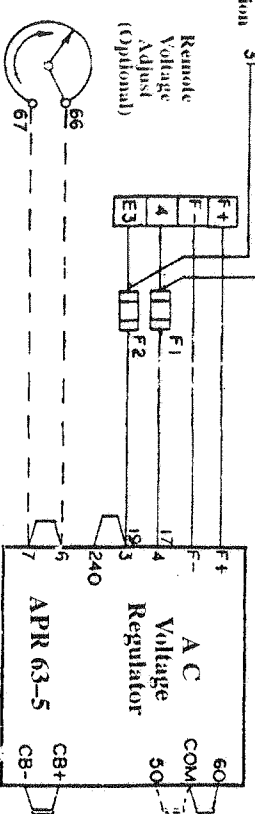
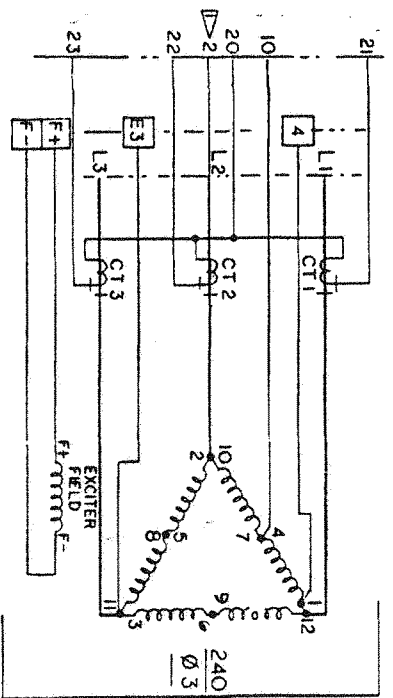
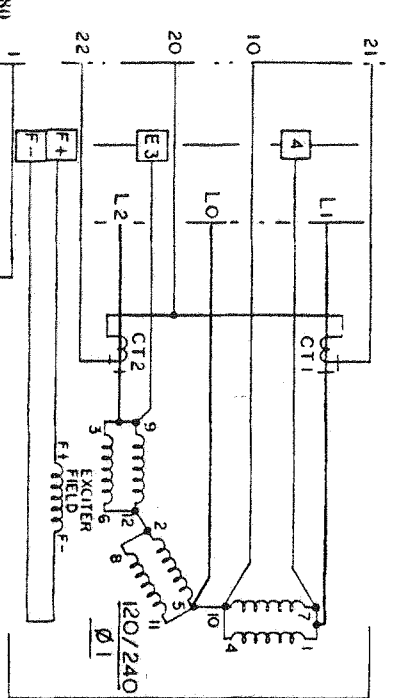
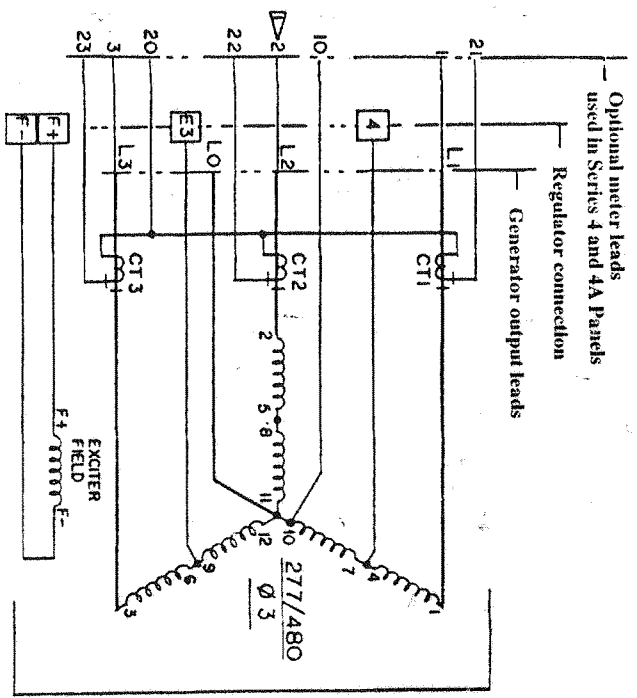
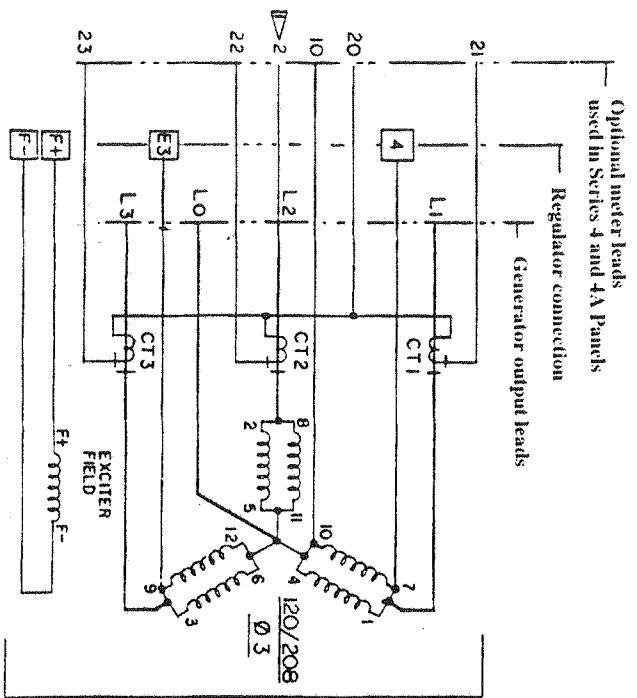
1800 and 1500 RPM GENERATOR SETS

Model Number	M439D	M445D	M439T	M445T	M668D	M668T	M668TH	
AC Output¹								
1800 RPM, 60 Hz	40 kW	45 kW	55 kW	65 kW	65 kW	80 kW	99kW	
1500 RPM, 50 Hz	33 kW	35 kW	45 kW	50 kW	50 kW	66 kW	80kW	
Phase	Available in Single or Three Phase Output							
RPM/ Hz	Available in 1800 RPM/60 Hz and 1500 RPM/ 50 Hz							
Voltages 60 Hz	60 Hz- 120/208, 120/240, 127/220, 139/240, 220/380, 240/416, 254/440 and 277/480							
Voltages 50 Hz	50 Hz- 110/190, 110/220, 115/230, 120/208, 127/220, 220/380, 240/416							
Engine								
Aspiration	Natural	Natural	Turbo	Turbo	Natural	Turbo	Turbo	
Cylinders	Inline 4	Inline 4	Inline 4	Inline 4	Inline 6	Inline 6	Inline 6	
Displacement	cu. in. (l)	239 (3.9)	276 (4.5)	239 (3.9)	276 (4.5)	414 (6.8)	414 (6.8)	414 (6.8)
Bore	in (mm)	4.2 (106)	4.2 (106)	4.2 (106)	4.2 (106)	4.2 (106)	4.2 (106)	4.2 (106)
Stroke	in (mm)	4.3 (110)	5.0 (127)	4.3 (110)	5.0 (127)	5.0 (127)	5.0 (127)	5.0 (127)
HP at 1800 RPM ²		58	66	82	97	97	147	147
Specific Fuel Rate ³	lb/bhp/hr	0.353	0.355	0.369	0.353	0.344	0.332	0.332
Approx. Fuel Rate ⁴	gal/hr(lph)	2.9 (10.8)	3.3 (12.5)	4.8 (18.2)	4.8 (18.2)	4.7 (17.8)	6.9 (26.1)	6.9 (26.1)
Dimensional Data⁵								
Length	in (mm)	66.9(1699)	66.9(1699)	70.9(1800)	70.9 (1800)	81 (2057)	81.4 (2067)	81.4 (2067)
Width	in (mm)	27.5 (698)	27.5 (698)	27.5 (698)	27.5 (698)	27.5 (698)	27.5 (698)	27.5 (698)
Height	in (mm)	37.7 (958)	38.9 (988)	38.9 (988)	38.9 (998)	38.7 (983)	39.7 (1008)	39.7 (1008)
Approximate Weight	lbs (kgs)	1720 (781)	1865 (847)	1920 (872)	2250 (1021)	2590 (1176)	2805 (1273)	2805 (1273)

1200 RPM GENERATOR SETS

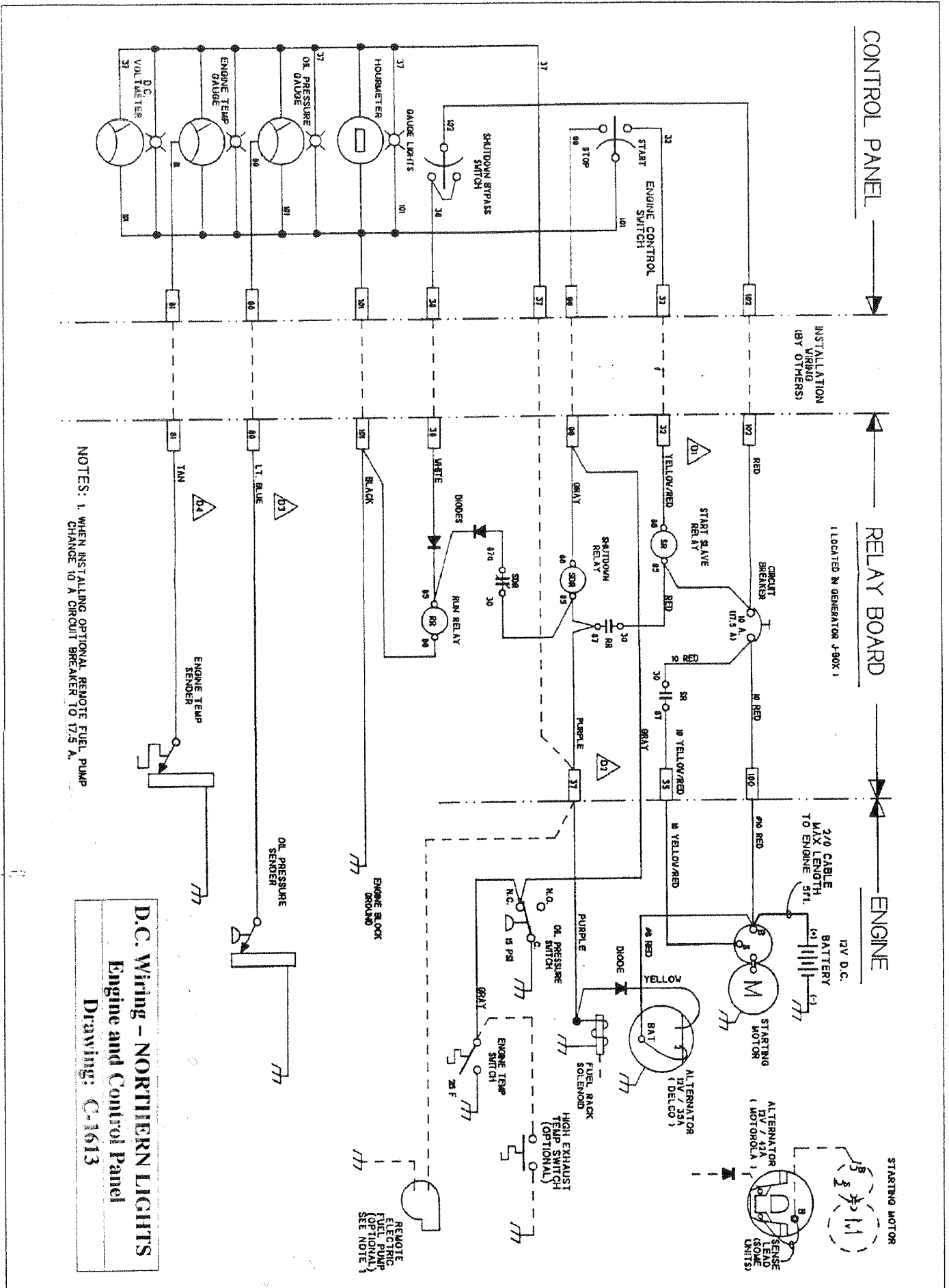
Model Number	M439Q	M445Q	M668Q	M668QT	
AC Output⁽¹⁾					
1200 RPM, 60 Hz	22 kW	30 kW	40 kW	50 kW	
Phase	Available in single or three phase				
Voltages 60 Hz	120/208, 120/240, 127/220, 139/240, 220/380, 240/416, 254/440 and 277/480				
Engine					
Aspiration	Natural	Natural	Natural	Turbo	
Cylinders	Inline 4	Inline 4	Inline 6	Inline 6	
Displacement	cu. in. (l)	239 (3.9)	276 (4.5)	414 (6.8)	414 (6.8)
Bore	in (mm)	4.2 (106)	4.2 (106)	4.2 (106)	4.2 (106)
Stroke	in (mm)	4.3 (110)	5.0 (127)	5.0 (127)	5.0 (127)
HP at 1200 RPM ⁽²⁾		33	45	60	75
Specific Fuel Rate ⁽³⁾	lb/bhp/hr	0.378	0.395	0.378	0.370
Approx. Fuel Rate ⁽⁴⁾	gal/hr(lph)	1.8 (6.8)	2.5 (9.5)	3.2 (12.1)	3.9 (14.8)
Dimensional Data⁽⁵⁾					
Length	in (mm)	66.9 (1699)	66.9 (1699)	77 (1956)	81.4 (2068)
Width	in (mm)	27.5 (698)	27.5 (698)	27.5 (698)	27.5 (698)
Height	in (mm)	37.7 (957)	38.9 (988)	38.7 (983)	39.7 (1008)
Approx Weight	lbs (kgs)	1675 (760)	1855 (842)	2405 (1092)	2635 (1196)

1. Prime kW rating. 1 kW equals 1000 watts. 0.8 power factor.
2. Net flywheel hp rating for fully equipped engine at 1800 (1200) RPM under SAE J816b.
3. Based on prime HP rating at 1800 (1200) RPM.
4. Based on prime kW rating at 1800 (1200) RPM. Fuel rate may vary depending on operating conditions.
5. Installation data for units with standard mounts, heat exchanger cooling and 3 phase generator ends.
Dimensions and weight are effected by optional equipment, AC output and cooling configuration.
Contact factory for more information.



A.C. Wiring
Generator & Regulator
Drawing: B-3034

CTS Supplied with Series 4 & 4A panels.
Install lead 2 when AM/VMI selector switch is used in control panel.



INSTALLATION WIRING (BY OTHERS)

1 LOCATED IN GENERATOR J-BOX

3/0 CABLE MAX LENGTH TO ENGINE 571.

12V D.C. BATTERY

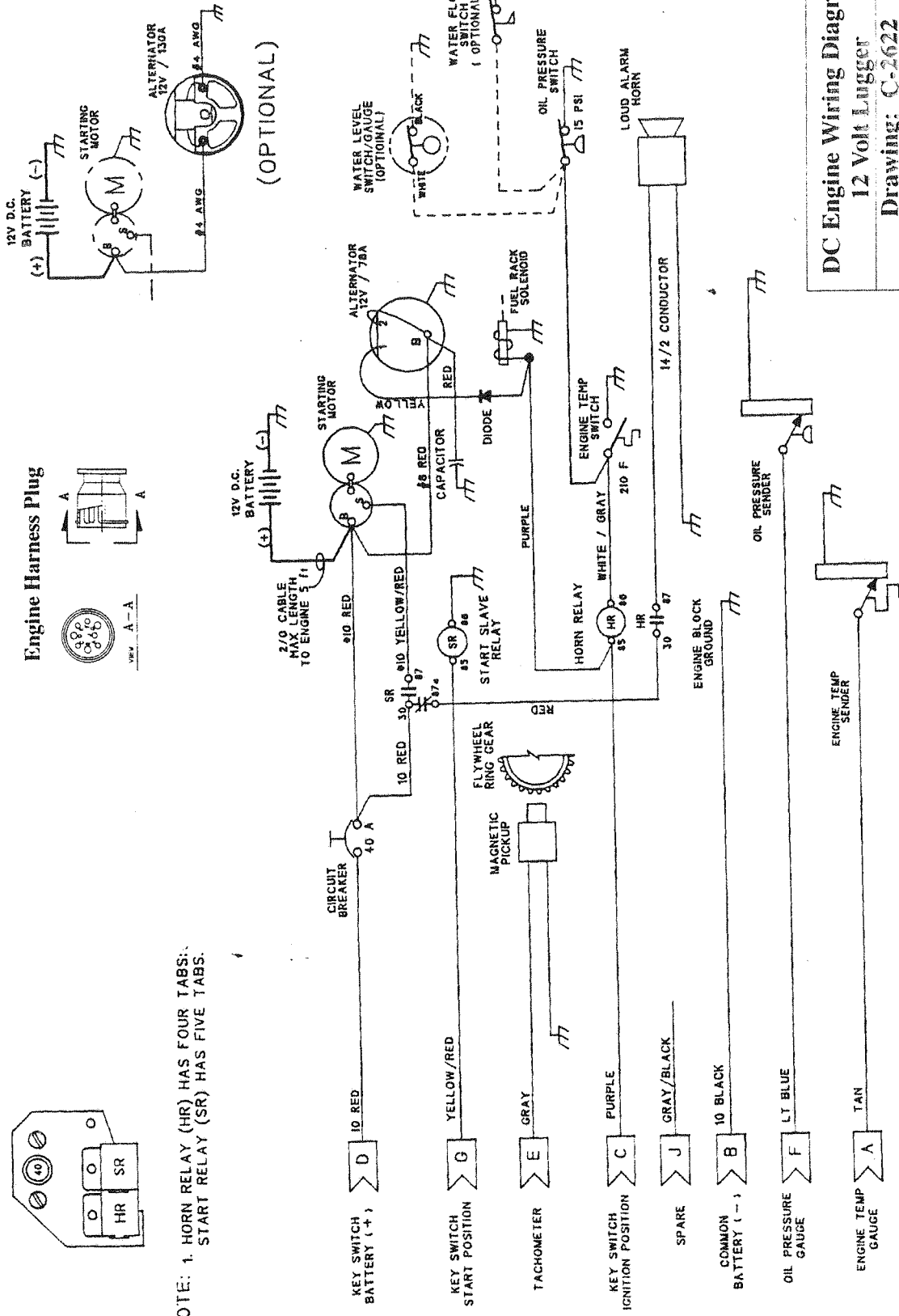
ALTERNATOR (DELCO) 12V / 35A

ALTERNATOR (MOTOROLA) 12V / 42A

REMOTE ELECTRIC FUEL PUMP (OPTIONAL) SEE NOTE 1

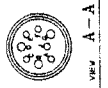
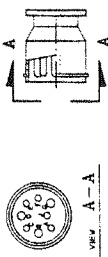
NOTES: 1. WHEN INSTALLING OPTIONAL REMOTE FUEL PUMP CHANGE TO A CIRCUIT BREAKER TO 17.5 A.

D.C. Wiring - NORTHERN LIGHTS
Engine and Control Panel
Drawing: C-1613



NOTE: 1. HORN RELAY (HR) HAS FOUR TABS.
 2. START RELAY (SR) HAS FIVE TABS.

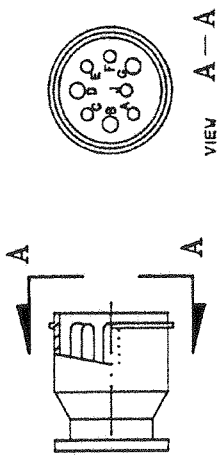
Engine Harness Plug



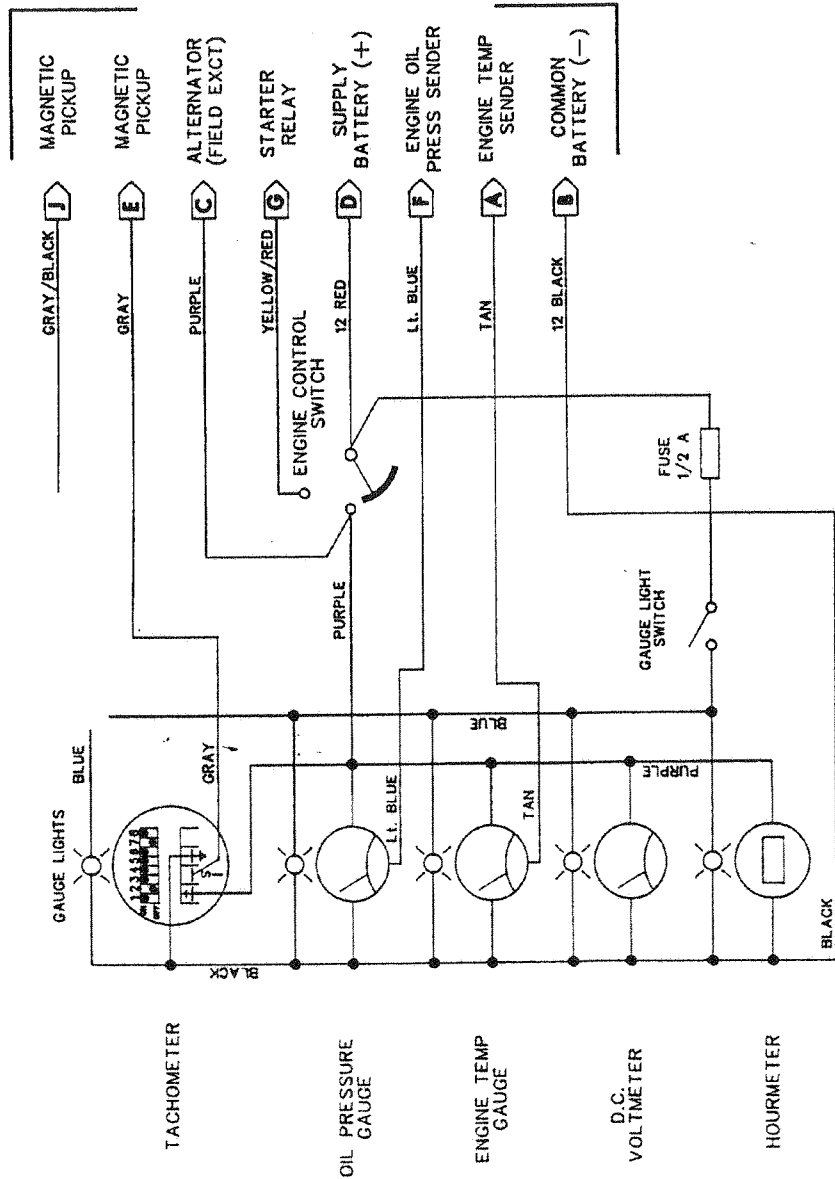
(OPTIONAL)

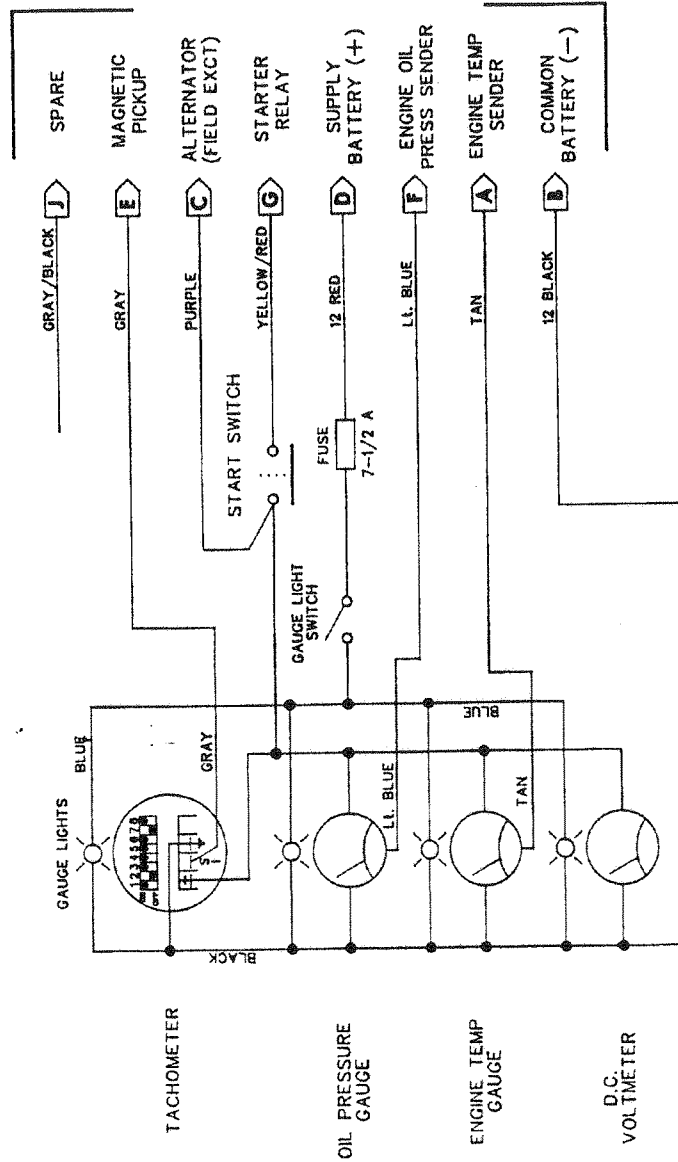
DC Engine Wiring Diagram
 12 Volt Lagger
 Drawing: C-2622

Black Male Plug

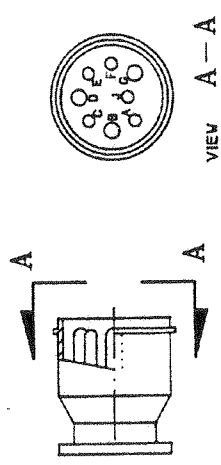


D.C. Wiring - LUGGER
 Engine Control Panel
 Drawing: C-1570





Black Male Plug



D.C. Wiring - LUGGER
Flybridge Panel
Drawing: C-1572

ONBOARD 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. "Standard" Kits are suitable for inland and offshore cruising. "World Class" Kits are for world cruising and trans-ocean cruising. We consider these minimum quantities. Your vessel's operating conditions may require more of a given part. Consult your dealer.

Item	Description	Standard	World Class
1	Lube Oil Filter	4	4
2	Air Filter Element	1	1
3	Fuel Filter	2	2
4	Injector	0	6
5	Thermostat	2	2
6	Thermostat Ring	2	2
7	Relay	0	2
8	Valve Cover Gasket	1	2
9	Gasket Kit Top	0	1
10	Gasket Kit Bottom	0	1
11	Zinc*	6	12
12	Raw Water Pump Impeller*	2	2
13	Raw Water Pump Cover Gasket*	2	2
14	Raw Water Pump*	0	1
15	Workshop Manual	0	1
16	Set of Alternator Belts	1	1
17	Fuel Washer Kit	Std.1	w/c 1
18	Glow Plug	0	6

* Heat Exchanger Cooled Engines Only

NOTES

NOTES

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**ALASKA
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