



OLP

For Models: LP445, LP455T, LP668D and LP668T

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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OPERATOR'S MANUAL

#OLP for Models

LP445D, LP445T, LP668D, and LP668T

*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

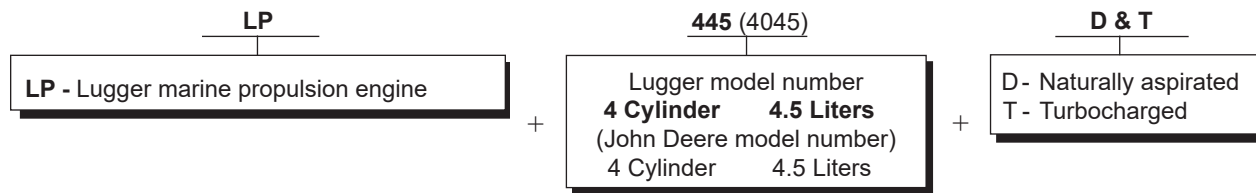
Servicing of marine engines and generator sets presents unique problems. In many cases boats cannot be moved to a repair facility. Marine engines cannot be compared to the servicing of automobiles, trucks or even farm equipment. Failures often occur in remote areas far from competent assistance. Marine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

Model Numbers

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



LP445T = Lugger® turbocharged marine propulsion engine with a John Deere Powertech 4045 engine block.

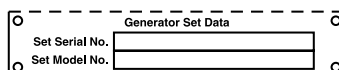
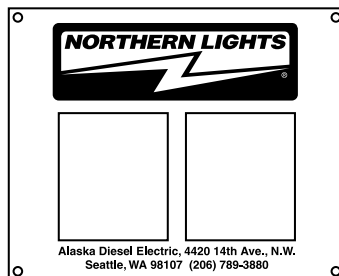
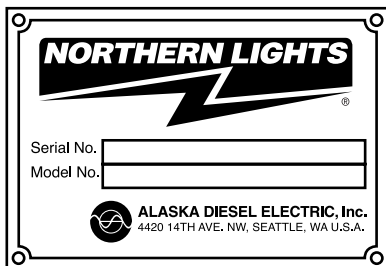
LP668T = Lugger® turbocharged marine propulsion engine with a John Deere Powertech 6068 engine block.

LP445D = Lugger® naturally aspirated marine propulsion engine with a John Deere Powertech 4045 engine block.

LP668D = Lugger® naturally aspirated marine propulsion engine with a John Deere Powertech 6068 engine block.

Serial Numbers

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



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.

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

Safety Rules



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

- Never leave engine without proper security.
- Turn the coolant tank cap slowly to relieve pressure before removing. Add coolant only when the engine is stopped and cool.
- Mount a 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.
- Look completely around engine to make sure that everything is clear before starting.
- Do not operate an engine that isn't in proper working order. If an unsafe operating condition is noted, tag the set and control panel so others will also know about the problem.
- Provide first aid kits.

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.



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

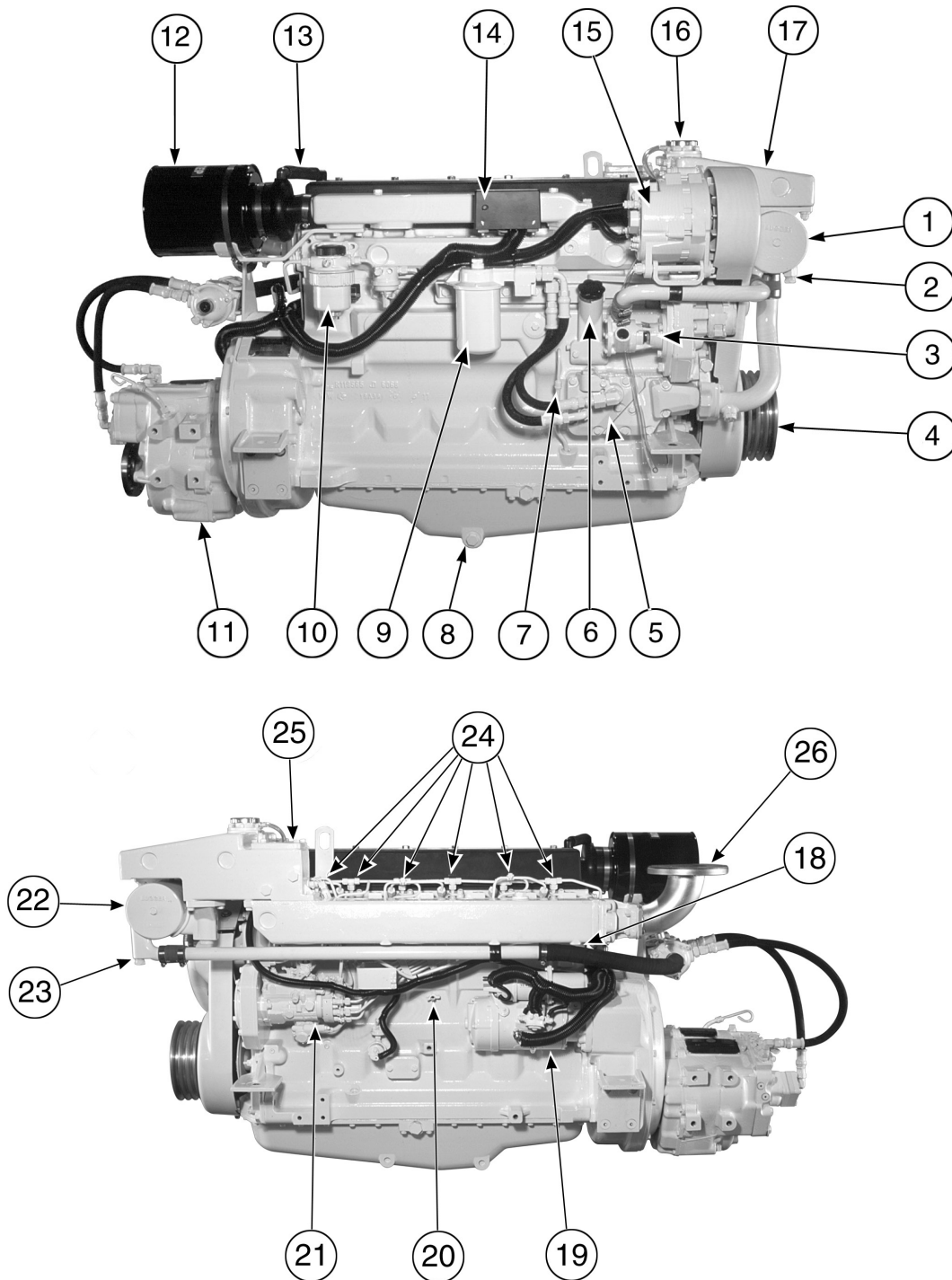


Figure 1: LP668D1 HE with gear (note: components of LP445 are in a similar location).

- | | | | |
|----------------------------|---------------------------|-------------------------|-------------------------------|
| 1. Heat Exchanger | 8. Lube Oil Drain | 15. DC Alternator | 22. Heat Exchanger |
| 2. Heat Exchanger Zinc (2) | 9. Lube Oil Filter | 16. Water Fill | 23. Heat Exchanger Drain Cock |
| 3. Raw Water Pump | 10. Secondary Fuel Filter | 17. Expansion Tank | 24. Fuel Injectors (6) |
| 4. Optional Pulley | 11. Marine Transmission | 18. Manifold Drain Cock | 25. Thermostat Housing |
| 5. Oil Cooler | 12. Air Cleaner | 19. Starter | 26. Dry Exhaust Elbow |
| 6. Lube Oil Fill | 13. Crankcase Vent | 20. Block Drain Cock | |
| 7. Lube Oil Dipstick | 14. DC Circuit Breaker | 21. Fuel Injection Pump | |



Figure 2: Lugger Instrument Control Panel

1. 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.

2. TACHOMETER

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

3. HOUR METER

Keeps track of the engine running time.

4. DC VOLTMETER

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

5. 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.

6. STOP BUTTON

Stops engine immediately.

7. INSTRUMENT PANEL LIGHTING

The switch turns on the instrument panel lights.

8. OIL PRESSURE FAULT LIGHT

Indicates low oil pressure.

9. ENGINE TEMPERATURE FAULT LIGHT

Indicates engine is over-heating. Activates in conjunction with alarm horn.

10. ALARM HORN

Shut down engine if possible and investigate immediately.

11. 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.

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 “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. 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.

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 re-engaging.

NOTE: Never race a cold engine. Operate at 1000 RPM for a 3 to 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. **LP445** – Low idle is 700 RPM. Maximum working engine speed is: 2500 RPM for pleasure craft, 2400 RPM for light commercial craft, 2200 RPM for continuous duty applications.
LP668 – Low idle is 700 RPM. Maximum working engine speed is 2400 RPM for pleasure craft, 2400 RPM for light commercial craft, 2200 RPM for continuous duty applications.
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 25).
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 to OFF while engine is running.

ALARMS

1. Your unit is fitted with a warning system to indicate high water temperature or low oil pressure.

Propulsion engines 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.

NOTE: Do not rely on your warning 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 - 24 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 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

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.

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

AFTER FIRST 50 HOURS:

- SP2 Change engine oil
- SP3 Change lube oil filter

EVERY 50 HOURS:

- SP22 Check electrolyte in batteries

AFTER 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

AFTER FIRST 600 HOURS:

- SP6 Adjust valves

EVERY 600 HOURS / YEARLY:

- SP4 Replace air cleaner
- SP5 Check V-belt condition
- SP9 Change secondary fuel filter
- SP10 Check injectors
- SP13 Check turbocharger boost pressure
- SP15 Check and flush cooling system
- SP19 Change impeller in raw water pump
- SP23 Check the state of the charge of the 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	7 & 11	Check oil level	•					
SP2	11	Change engine oil 1)						
SP3	11	Change lube oil filters 1)			•			
SP4	11	Check (replace) air cleaner 1) 3)			•	•		
SP5		Check belt condition 1)				•		
SP6	12	Check valve clearances 1)				•		
FUEL SYSTEM:								
SP7	13	Check primary filter (Racor) 2)	•					
SP8	13	Change primary filter element (Racor) 2) 3)			•			
SP9	13	Change secondary fuel filter 1) 3)				•		
SP10	14 -15	Check injectors 1)				•		
SP11	15 -17	Check fuel injection pump						•
TURBOCHARGER:								
SP12	18	Check air, oil & cooling water lines for leakage 1)			•			
SP13	18	Check boost pressure				•		
COOLING SYSTEM:								
SP14	7 & 18	Check cooling water level	•					
SP15	20	Check and flush cooling system 1)				•		
SP16	20	Check and clean heat exchanger 1)						•
SP17	26	Check and clean gear oil cooler 1)						•
SP18	21	Check zinc electrodes 1) 3)			•			
SP19	21	Change impeller in raw water pump 1) 3)				•		
DRIVEN EQUIPMENT:								
SP20	27	Check oil level in reverse gear	•					
SP21	27	Change oil in reverse gear 2)						
ELECTRICAL SYSTEM:								
SP23	22	Check electrolyte level in batteries 1) 3)		•				
SP23	22	Check condition of batteries with hydrometer 1)				•		
OUT OF SERVICE:								
SP24	22	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) Whenever necessary.

Service Record

Service Point	OPERATION	HOURS/DATE									
50 HOURS											
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										
SP5	Check belt condition										
SP9	Change secondary fuel filter										
SP10	Check injectors										
SP13	Check turbocharger boost pressure										
SP15	Check and flush cooling system										
SP19	Change impeller in raw water 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

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 CE oil
 - c. ACEA Specification E1
2. *Do not use* John Deere PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3, or ACEA E2 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

Lubrication - General

1. Use only clean, high quality lubricants stored in clean containers in a protected area.
2. These oils are acceptable after the first 100 hours:
 - a. API Service CC/CD single viscosity oils.
 - b. API Service CD/CG-4/CF-4 multi-viscosity oils.
 - c. ACEA Specification E3/E2 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°F to 32°F (-23°C to 0°C)	SAE-10W	SAE10-30W
Below -10°F (-23°C)	SAE-5W	SAE5-20W

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

SP1. CHECK ENGINE OIL LEVEL

1. Check the oil level in the crankcase, with the oil dipstick, daily.
2. The oil level must be between the “Waffled area” and the “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 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:

445 Series	14 qts.	13.2 liters
668 Series	18 qts.	17.0 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.*

SP6. VALVE CLEARANCES

The following special tools will be needed:

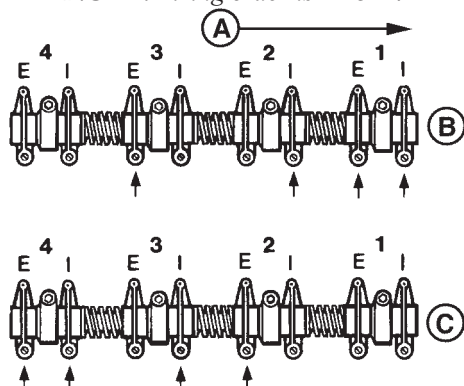
JDE 820 or JDE 83 Flywheel Turning Tool.

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 must be checked with the engine cold.
Intake Valve: 0.012-0.015 in. (0.31-0.38 mm)
Exhaust Valve: 0.016-0.019 in. (0.41-0.48 mm)

4-CYLINDER ENGINES:

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



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

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

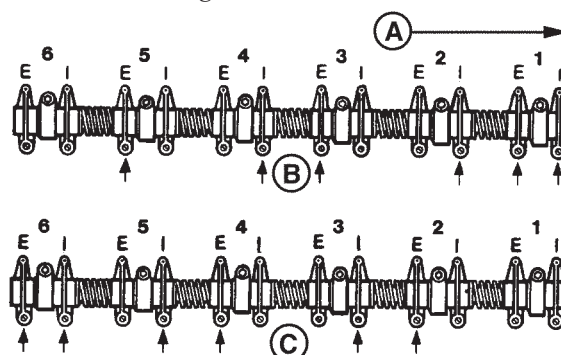
Adjust valve clearance on No. 1 and No. 3 exhaust valves and No. 1 and No. 2 intake valves.

Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).

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

6-CYLINDER ENGINES:

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



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

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

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

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

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

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.
 - f. JP4

Servicing

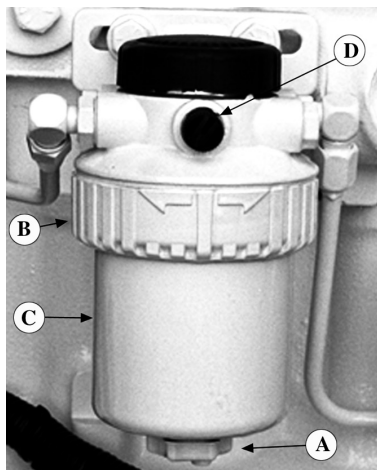
5. Storing fuel:
 - a. Keep dirt, scale, water and other foreign matter out of fuel.
 - b. Avoid storing fuel for long periods of time.
 - c. Fill the fuel tank at the end of each day's operation. This will reduce condensation.

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 quick change disposable secondary fuel filter.

- a. Turn off the fuel.
- b. Open the filter drain plug (Figure 11-A) and drain the filter.



A – Drain Plug
B – Filter Clamp
C – Cartridge
D – Bleed Screw

Figure 11: Secondary Fuel filter

- c. Remove the secondary fuel filter by turning the filter clamp (Figure 11-B) counter clockwise until the filter cartridge (Figure 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.
- d. Install new filter cartridge.
 - e. Fuel filter cartridge number is: **24-51005**
 - f. Turn on the fuel.

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 will be necessary to bleed air from the system.
 - a. To bleed the fuel system, loosen the bleed plug (Figure 11-D) on the fuel filter. Operate the primer pump lever on fuel transfer pump (see component locations) until 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 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).

SP10. INJECTORS

- Fuel injectors should be checked by a Lugger-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

- 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.
- Immediately fit protective caps over the nozzle tips and the line connections to avoid handling damage.
- Do not bend the fuel delivery lines. When loosening the fuel pressure lines, hold male union of nozzle line stationary with a backup wrench.
- 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.

- Remove cap screw, clamp and spacer.
- 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:

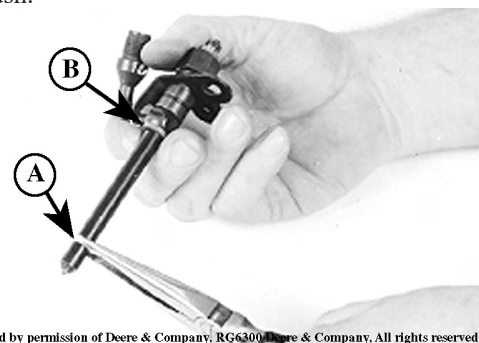
Always turn the tool clockwise through the bore even when removing from bore, otherwise tool may become dull.

- 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:

- Remove carbon stop seal (Figure 12-A) and upper sealing washer (Figure 12-B), using a needle-nose pliers. Discard seals.

- Clean exterior of nozzle by soaking in clean solvent or diesel fuel. Clean tip with brass wire brush.



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Figure 12 Reprinted by permission of Deere & Company, RG6300 Deere & Company, All rights reserved.

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.

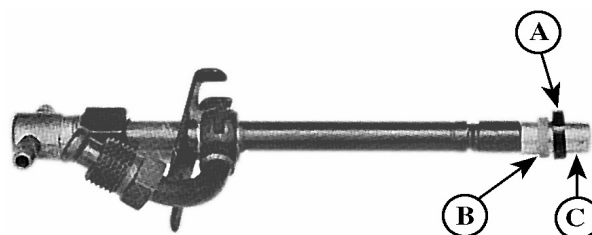


Figure 13

- 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.

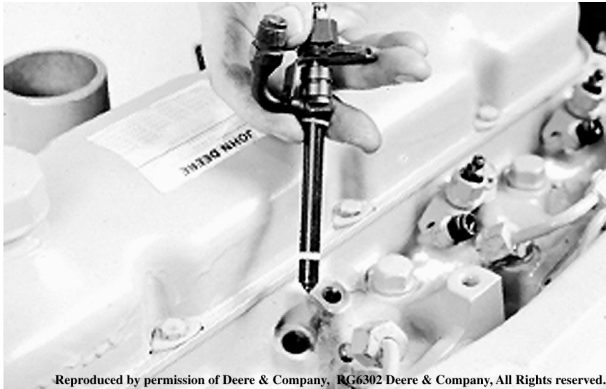
- Position JD258 (ROS16477) Pilot Tool (Figure 13-C) over nozzle tip. If Pilot Tool (included in cleaning kit) is not available, use a No. 16189 Nozzle Protector Cap found on every new or re-placement nozzle.
- Position a new carbon stop seal (Figure 13-B) on pilot tool. Use a new seal washer (Figure 13-A) to help slide the carbon seal into place until it seats in its groove on nozzle body.
- Continue to slide upper sealing washer onto nozzle body until it seats against inlet fitting.

Servicing

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.

- Remove plug (if installed previously) from nozzle bore in cylinder head and blow out bore with compressed air.
- 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.
- Install nozzle in cylinder head using a slight twisting motion as nozzle is seated in bore.



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Figure 14: Shows relationship of parts required for installation.

- Install spacer and cap screw. Do not tighten capscrew at this stage.
- Connect fuel pressure line to nozzle. Leave connection slightly loose until air is bled from system.
- Tighten nozzle hold-down cap screws to 27 foot lb. (37 N•m).
- Install leak-off assembly.
- Bleed air from loose injection line connection. Tighten connection using two wrenches.

SP13. INJECTION PUMP

- 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.

- Black smoke can be an indication of pump malfunctions. Before servicing pump, check the other possible causes.
 - Check cleanliness of air filter.
 - Check valve clearances.
 - Clean and check injectors.
- 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 AND DB2 INJECTION PUMPS – REMOVAL

All Stanadyne DB2 and DB4 injection pumps will have a retained drive shaft (shaft stays in pump when pump is removed from engine).

- 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.

- Disconnect shutoff cable and speed control linkage or cold start switch, 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.

- Disconnect fuel return line (Figure 15-A) and fuel supply line (Figure 15-C).

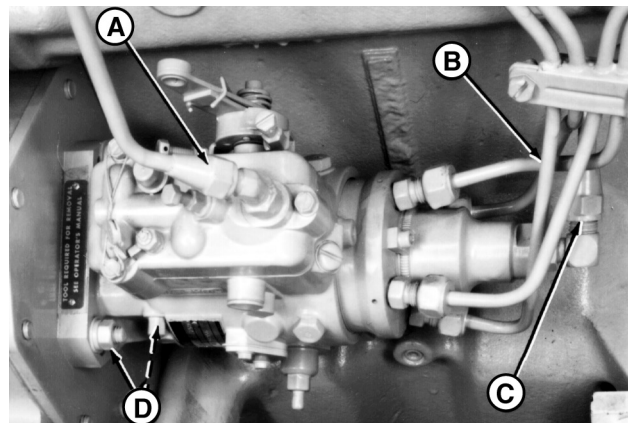


Figure 15 Reproduced by permission of Deere & Company, c2000. Deere & Company, All rights reserved.

4. Disconnect all fuel delivery (pressure) lines (Figure 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 (Figure 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 (Figure 16-B) against end of pump shaft.

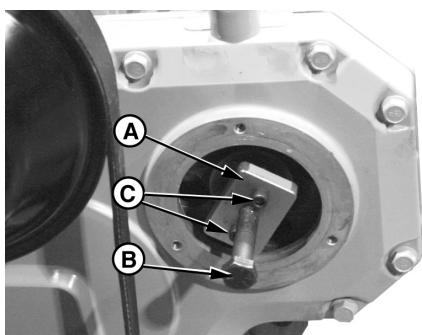


Figure 16. Reproduced by permission of Deere & Company, c2000. Deere & Company. All rights reserved.

8. Tighten center forcing screw until pump drive gear is free from tapered shaft. Remove JDG670A puller (Figure 16-A) and screws from drive gear.
9. Check to make sure that timing marks on back side of front plate (Figure 17-A) and injection pump flange (Figure 17-B) are present and properly aligned. This assures that repaired or replacement pump can be properly timed to engine when installed.

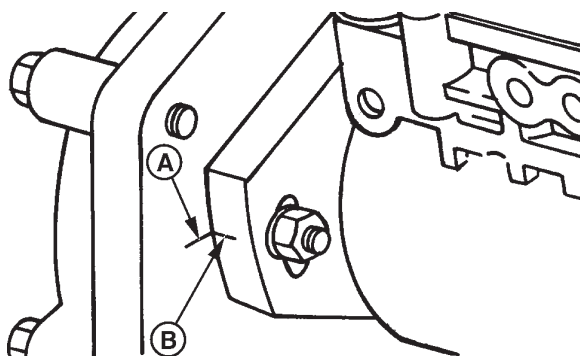


Figure 17. Reproduced by permission of Deere & Company, c2000. Deere & Company. All rights reserved.

IMPORTANT: Injection pump mounting flange timing mark (Figure 17-A) and front plate timing mark (Figure 17-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 & DB2 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.

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.

Servicing

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 (Figure 18-A) onto end of shaft. Tighten retaining nut to 90 lb-ft. (122 N•m) for DB2, 150 lb-ft. (203 N•m) for DB4.

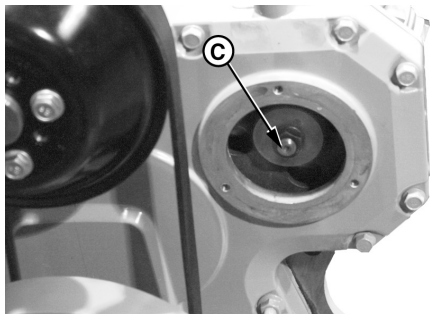


Figure 18 Reproduced by permission of Deere & Company, c2000. Deere & Company, All rights reserved.

IMPORTANT: Do not overtighten cap screws on pump cover plate to avoid damage to O-ring.

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

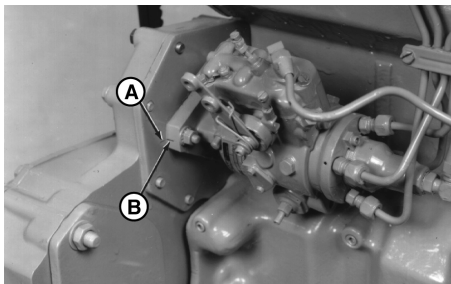


Figure 19 Reproduced by permission of Deere & Company, c2000. Deere & Company, All rights reserved.

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 (Figure 20-E). Beginning with outlet (Figure 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).

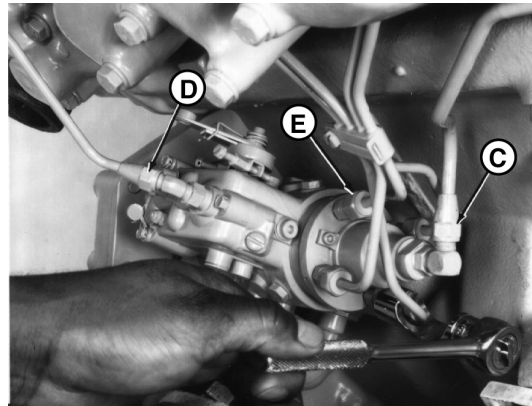


Figure 20 Reproduced by permission of Deere & Company, c2000. Deere & Company, All rights reserved.

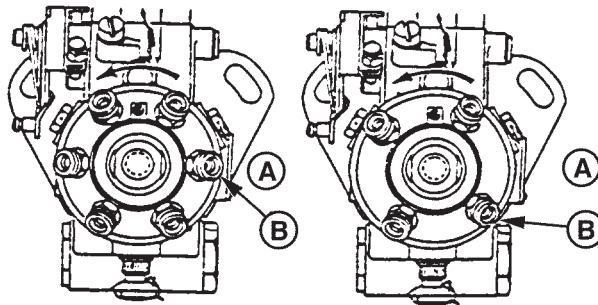


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12. Tighten fuel delivery (pressure) lines to 20 foot lbs. (27 N•m), using a suitable 17mm deep-well crows-foot socket.

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 (Figure 20-C) and fuel return line (Figure 20-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, if equipped. Connect cold start switch, if equipped.
15. Bleed air from fuel system as outlined on page 19. Start engine and run for several minutes. Check the entire system for leaks.

SP12. 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.

SP13. 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 manifold there is a 1/8" NPT threaded port. Remove the plug and install the boost gauge hose. Refer to your engine specifications for correct pressure.

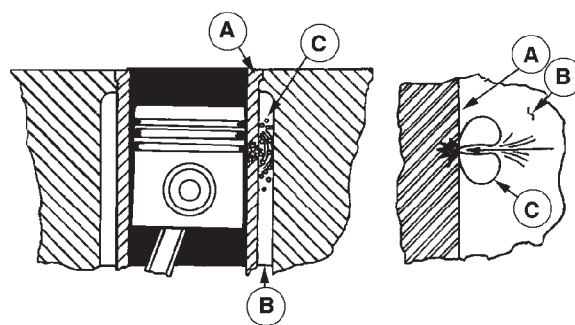
COOLING REQUIREMENTS

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

LINER EROSION (PITTING)

1. Cylinder liner walls (Figure 22-A) which are in contact with engine coolant (Figure 22-B) can be eroded or pitted unless the proper concentration and type of SCA's are present in the coolant. Water pump impellers are also susceptible to pitting.

2. Vapor bubbles (Figure 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

Figure 22.

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

- 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.
- 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.

- Ethylene glycol coolant concentrate is commonly mixed with water to produce an engine coolant with a low freeze point and high boiling point.
- A **low silicate** form of ethylene glycol coolant is recommended for all diesel engines.
- Use an ethylene glycol coolant concentrate meeting ASTM D 4985P, SAEJ1941, General Motors Performance Specification GM1899M, or formulated to GM6038M.
- This product is concentrated and should be mixed to the following specification.
- 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

- 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.
- DO NOT** use an EGC containing sealer or stop-leak additives.
- 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.

- 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 heat transfer and coolant flow.
- 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.
- SCA is available from your Northern Lights dealer in the following sizes.
Pint - Part Number.....20-00002
1/2 gallon - Part Number.....20-00003
- DO NOT** use any coolant system additives containing soluble oil.

COOLANT TESTING

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

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 4-5).
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.

SP16. HEAT EXCHANGER CLEANING

1. Drain the cooling system. (Drawing on page 27.)
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.

SP18. ZINC ANODES

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.
 3. 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.

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.

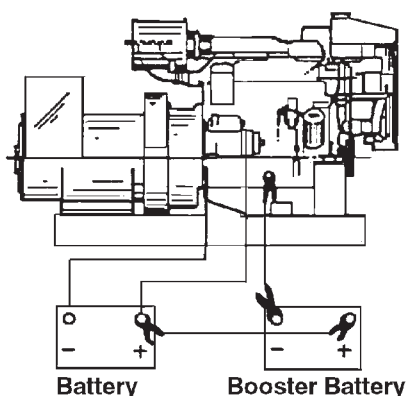


Figure 24: Booster Battery Connections

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

SP16-17. BATTERY CARE - LEAD/ACID TYPE BATTERIES

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

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.

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.

✓ **Starter Inoperative**

Check DC circuit breaker:

- If the breaker is tripped, reset it.

Loose or corroded connections:

- Clean and tighten loose battery and harness plug connection.

Low battery output:

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

Defective electrical system ground wire:

- Repair or replace.

✓ **Starter Cranks Slowly**

Low battery output:

- Battery is too small.
- Battery cables are too small.

Check specific gravity of each battery cell:

- Replace battery if necessary.

Check electrolyte level of each battery cell:

- If low, fill cells with distilled water.

Crankcase oil too heavy:

- Fill with oil of appropriate viscosity.

Loose or corroded connections:

- Clean and tighten loose connections.

✓ **Entire Electrical System Does Not Function**

Check DC circuit breaker:

- If breaker is tripped, reset it.

Faulty connection:

- Clean and tighten battery and harness plug connections.

Sulfated or worn out batteries:

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

ENGINE

✓ **Engine Hard to Start or Will Not Start**

Improper starting procedure:

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

No fuel:

- Check level of fuel in fuel tank.

Low battery output:

- Check electrolyte level and condition.

Excessive resistance in starting circuit:

- Clean and tighten all battery connections.

Crankcase oil too heavy:

- Use oil of proper viscosity.

Improper type of fuel:

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

Water, dirt or air in fuel system:

- Drain, flush, fill and bleed system.

Clogged primary fuel filter element:

- Clean or replace filter element.

Clogged secondary fuel filter element:

- Replace filter element.

Dirty or faulty injection nozzles:

- Have your dealer check injection nozzles.

✓ **Engine Runs Irregularly or Stalls Frequently**

Below normal engine temperature:

- Remove and check thermostat.

Clogged primary fuel filter element:

- Clean or replace filter element.

Clogged secondary fuel filter element:

- Replace secondary filter element.

Water or dirt in the fuel system:

- Drain, flush, fill and bleed system.

Dirty or faulty injection nozzles:

- Have your dealer check injection nozzles.

Air in fuel system:

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

Improper type of fuel:

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

✓ **Lack of Engine Power**

Intake air restriction:

- Service air cleaner.

Clogged primary fuel filter element:

- Clean or replace filter element.

Clogged secondary fuel filter element:

- Replace filter element.

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

✓ **Lack of Engine Power** (continued)

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.

Improper valve clearance:

- Reset valves. Best done by dealer.

Dirty or faulty injection nozzles:

- Replace injectors. Best done by dealer.
- See your local dealer.

✓ **Engine Overheats**

Low coolant level:

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

Keel cooling tubes have been painted (marine):

- Remove paint from tubes.

Cooling system needs flushing:

- Flush cooling system.

Defective thermostat:

- Remove and check thermostat.

Defective temperature gauge:

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

Water pump impeller worn/broken:

- Check impeller and replace if necessary.

✓ **Engine Knocks**

Insufficient oil:

- 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**

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.

✓ **High Fuel Consumption** (continued)

Injection pump out of time:

- See your dealer.

Engine not at proper temperature:

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

✓ **Below Normal Engine Temperature**

Thermostats not working properly:

- Check thermostats.

Temperature gauge not working properly:

- Check water temperature with thermometer.

✓ **Low Oil Pressure**

Low oil level:

- Fill crankcase to proper level.

Improper type of oil:

- Drain and fill crankcase with correct oil.

Partially plugged oil filter:

- Replace filter.

✓ **High Oil Consumption**

Break-in period:

- Oil consumption decreases after break in.

Crankcase oil too light:

- Use proper viscosity oil.

Oil leaks:

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

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

Clogged or dirty air cleaner:

- Service air cleaner.

Defective muffler (back pressure too high):

- Have dealer check back pressure.

Improper fuel:

- Use correct fuel for temperature.

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.

Specifications

PERFORMANCE AND SPECIFICATIONS

Model Number	LP445D	LP445T	LP668D	LP668T
Performance ¹				
High Output Rating	85 FWHP @ 2500 rpm (63 kW @ 2500 rpm)	135 FWHP @ 2500 rpm (100 kW @ 2500 rpm)	130 FWHP @ 2400 rpm (96 kW @ 2400 rpm)	174 FWHP @ 2400 rpm (130 kW @ 2400 rpm)
Medium Duty Rating	75 FWHP @ 2400 rpm (55 kW @ 2400 rpm)	120 FWHP @ 2400 rpm (89 kW @ 2400 rpm)	113 FWHP @ 2400 rpm (87 kW @ 2400 rpm)	154 FWHP @ 2400 rpm (114 kW @ 2400 rpm)
Continuous Duty Rating	65 FWHP @ 2200 rpm (48 kW @ 2200 rpm)	105 FWHP @ 2200 rpm (78 kW @ 2200 rpm)	105 FWHP @ 2200 rpm (78 kW @ 2200 rpm)	140 FWHP @ 2200 rpm (103 kW @ 2200 rpm)
Maximum Flywheel Torque	223 ft lbs @1200 rpm	339 ft lbs @1500 rpm	340 ft lbs @1500 rpm	507 ft lbs @1800 rpm
Fuel Consumption ²				
1500 rpm @ High Output	0.8 US gph (2.6 ℓ ph)	1.0 US gph (3.8 ℓ ph)	1.7 US gph (6.4 ℓ ph)	2.4 US gph (9.1 ℓ ph)
1800 rpm @ High Output	1.7 US gph (6.7 ℓ ph)	2.5 US gph (9.4 ℓ ph)	3.0 US gph (11.4 ℓ ph)	3.8 US gph (14.3 ℓ ph)
2000 rpm @ High Output	2.4 US gph (9.2 ℓ ph)	3.5 US gph (13.2 ℓ ph)	4.0 US gph (15.1 ℓ ph)	5.1 US gph (19.3 ℓ ph)
2200 rpm @ High Output	3.1 US gph (11.7 ℓ ph)	4.6 US gph (17.4 ℓ ph)	5.3 US gph (20.1 ℓ ph)	6.8 US gph (25.8 ℓ ph)
2400 rpm @ High Output	-----	-----	6.9 US gph (26 ℓ ph)	9.2 US gph (34.7 ℓ ph)
2500 rpm @ High Output	4.5 US gph (17.0 ℓ ph)	6.9 US gph (26.1 ℓ ph)	-----	-----
Specifications				
Cylinders	4 Inline	4 Inline	6 Inline	6 Inline
Displacement CID (ltr)	276 (4.5)	276 (4.5)	414 (6.78)	414 (6.78)
Operating Cycle	4	4	4	4
Aspiration	Natural	Turbocharged	Natural	Turbocharged
Bore	4.19 in (106 mm)	4.19 in (106 mm)	4.19 in (106 mm)	4.19 in (106 mm)
Stroke	5.0 in (127 mm)	5.0 in (127 mm)	5.0 in (127 mm)	5.0 in (127 mm)
Approximate Weight WITHOUT Gear				
Keel cooled	1070 lbs (485 kg)	1160 lbs (526 kg)	1450 lbs (660 kg)	1475 lbs (670 kg)
Heat Exchanger	1100 lbs (499 kg)	1190 lbs (540 kg)	1490 lbs (675 kg)	1515 lbs (685 kg)

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.

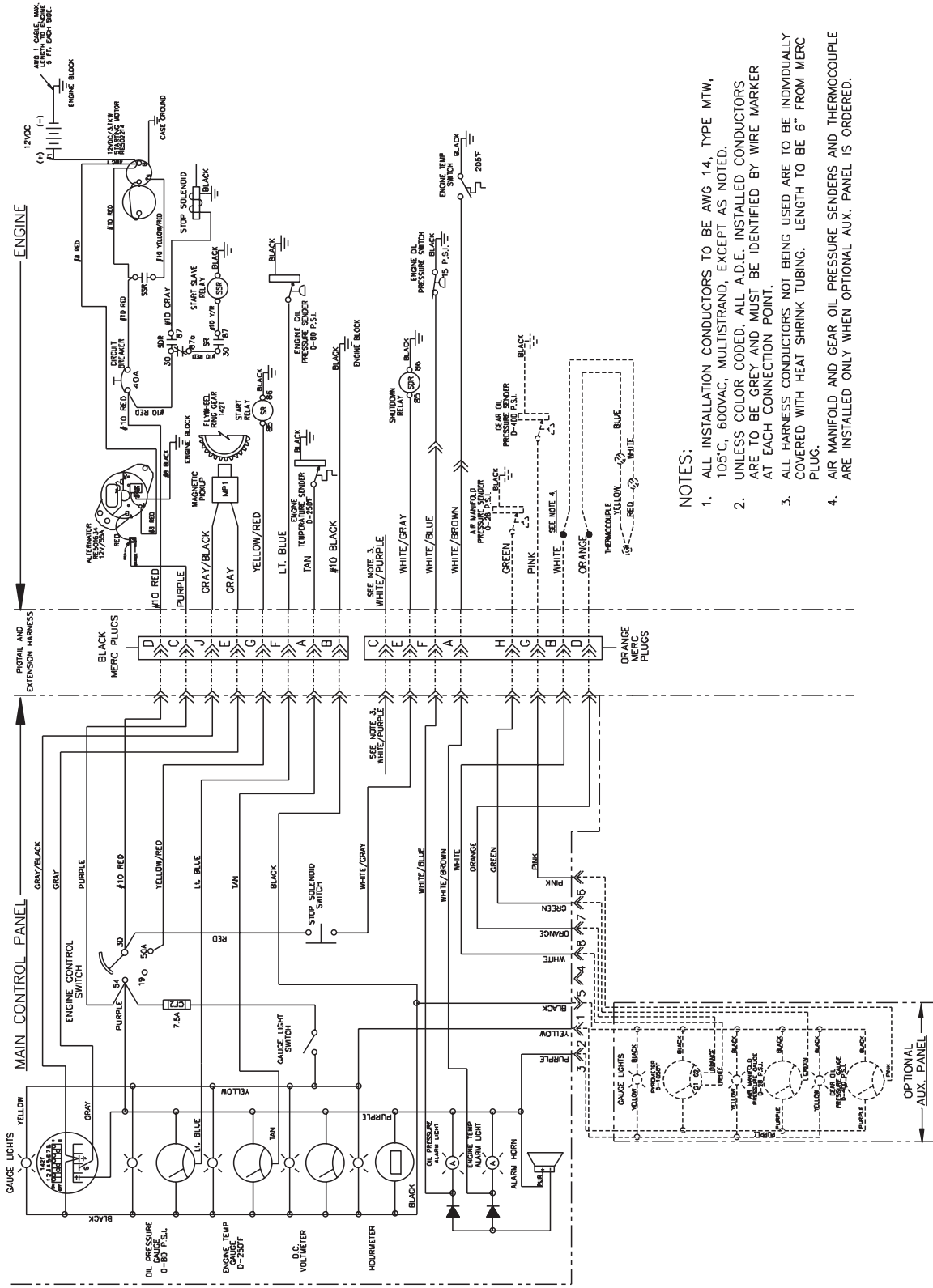
Example: L668D in a 18 kt boat uses 1:1 gear ratio and turns a 16 X 14 prop at 2500 rpm.

SPEED (kts)	15 - 18		14 - 17		13 - 15		12 - 14		10 - 13		8 - 10		8 - 10		
GEAR RATIO	1:1		1.5:1		2:1		2.5:1		3:1		3.8:1		4.5:1		
Model #	HP/Max RPM														
LP445D	85/2500	13 x 11	2800	16 x 13	1866	19 x 15	1400	22 x 18	1120	25 x 20	933	—	—		
LP445T	135/2500	14 x 12	2800	17 x 15	1866	20 x 16	1400	23 x 18	1120	25 x 23	933	—	—		
LP668D	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
LP668T	174/2400	17 x 17	2200	21 x 78	1467	25 x 23	1100	29 x 27	880	35 x 28	733	37 x 29	579	41 x 38	489

INSTALLATION DATA

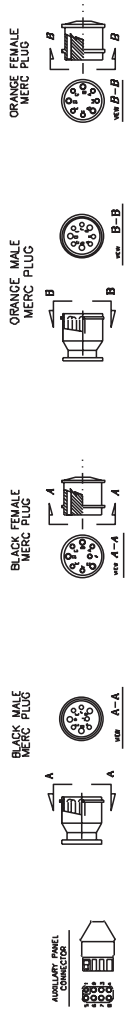
Model Number	LP445D	LP445T	LP668D	LP668T
Cooling (General)				
Freshwater circulating pump flow	54 US gal @ 2500 rpm (204 ltr @ 2500 rpm)	54 US gal @ 2500 rpm (204 ltr @ 2500 rpm)	61 US gal @ 2400 rpm (229 ltr @ 2400 rpm)	61 US gal @ 2400 rpm (229 ltr @ 2400 rpm)
Heat rejection to jacket water	2563 BTU-min	3630 BTU-min	3628 BTU-min	4972 BTU-min
Cooling (Heat Exchanger)				
Raw water intake & discharge dia.	1.25 inch NPT	1.25 inch NPT	1.25 inch NPT	1.25 inch NPT
Raw water pump flow @ RPM	31 gpm @ 2500 rpm (117 ℓ pm @ 2500 rpm)	31 gpm @ 2500 rpm (117 ℓ pm @ 2500 rpm)	30 gpm @ 2400 rpm (113 ℓ pm @ 2400 rpm)	30 gpm @ 2400 rpm (113 ℓ pm @ 2400 rpm)
Raw water pump max. suction head	39 in (1 m)	39 in (1 m)	39 in (1 m)	39 in (1 m)
Max. raw water temp. at inlet	85° F (30° C)	85° F (30° C)	85° F (30° C)	85° F (30° C)
Freshwater system capacity	5 US gal (18.9 ltr)	5 US gal (18.9 ltr)	6 US gal (22 ltr)	6 US gal (22 ltr)
Cooling (Keel Cooled)				
Water hose inside diameter	2-3/8 in (60 mm)	2-3/8 in (60 mm)	2-3/8 in (60 mm)	2-3/8 in (60 mm)
Head diameter	1-1/2 in (38 mm)	1-1/2 in (38 mm)	1-1/2 in (38 mm)	1-1/2 in (38 mm)
Turbo tube length*	12 ft (4 m)	16 ft (5 m)	18 ft (5.5 m)	24 ft (7.3 m)
One inch plain round tube length*	28 ft (8.5 m)	44 ft (13.4 m)	42 ft (12.8 m)	57 ft (17.3 m)
Skin cooler				
Aluminum*	12 sq ft (1.3 m ²)	20 sq ft (1.8 m ²)	19.5 sq ft (1.8 m ²)	26 (2.4 m ²)
Steel*	42.5 sq ft (4.0 m ²)	65 sq ft (6.0 m ²)	65 sq ft (6.0 m ²)	87 sq ft (8.1 m ²)
<i>*Based on 70° F seawater and minimum boat speed of 8 knots at full speed. Return water on keel cooling 70° to 130° F.</i>				
Electrical				
Minimum battery capacity - 12V	640 CCA	640 CCA	800 CCA	800 CCA
Battery cable size up to 10 ft run	"0"	"0"	"0"	"0"
Standard harness length	20 ft (6 m)	20 ft (6 m)	20 ft (6 m)	20 ft (6 m)
Air				
Engine air consumption	166 cfm @ 2500 rpm (4.7 m ³ /min @ 2500 rpm)	321 cfm @ 2500 rpm (9.1 m ³ /min @ 2500 rpm)	220 cfm @ 2400 rpm (6.2 m ³ /min @ 2500 rpm)	436 cfm @ 2400 rpm (12.3 m ³ /min @ 2200 rpm)
Minimum engine room vent area	48 sq in (.031 m ²)	93 sq in (.060 m ²)	64 sq in (.041 m ²)	127 sq in (.081 m ²)
Exhaust gas flow	487 cfm @ 2500 rpm (13.8 m ³ /min @ 2500 rpm)	771 cfm @ 2500 rpm (21.8 m ³ /min @ 2500 rpm)	643 cfm @ 2400 rpm (18.2 m ³ /min @ 2400 rpm)	1067 cfm @ 2400 rpm (30.2 m ³ /min @ 2400 rpm)
Exhaust gas temperature at rpm	920° F @ 2500 rpm (493° C @ 2500 rpm)	738° F @ 2500 rpm (392° C @ 2500 rpm)	1000° F @ 2400 rpm (537° C @ 2400 rpm)	975° F @ 2400 rpm (523° C @ 2400 rpm)
Maximum exhaust back pressure	48 in (1219 mm) H ₂ O	30 in (750 mm) H ₂ O	48 in (1219 mm) H ₂ O	30 in (750 mm) H ₂ O
Suggested dry exhaust I.D.				
Dry	3 in (75 mm)	3 in (75 mm)	3 in (75 mm)	4 in (100 mm)
Wet	4 in (100 mm)	4 in (100 mm)	4 in (100 mm)	5 in (127 mm)
Fuel and Oil				
Min. fuel suction and return line	3/8 in (9 mm)	3/8 in (9 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Maximum fuel pump head	39 in (1 m)	39 in (1 m)	39 in (1 m)	39 in (1 m)
Crankcase oil capacity	14 US qts (13.2 ltr)	14 US qts (13.2 ltr)	18 US qts (17 ltr)	18 US qts (17 ltr)
Gear, PTO, Engine Angle				
Engine rotation (facing flywheel)	Counter-Clockwise	Counter-Clockwise	Counter-Clockwise	Counter-Clockwise
Flywheel housing size	SAE #4	SAE #4	SAE #2	SAE #2
Front PTO size (optional)	SAE #5	SAE #5	SAE #5	SAE #5
Max. intermittent operating angle				
Front down	0°	0°	0°	0°
Rear down	15°	15°	15°	15°

Wiring Diagrams

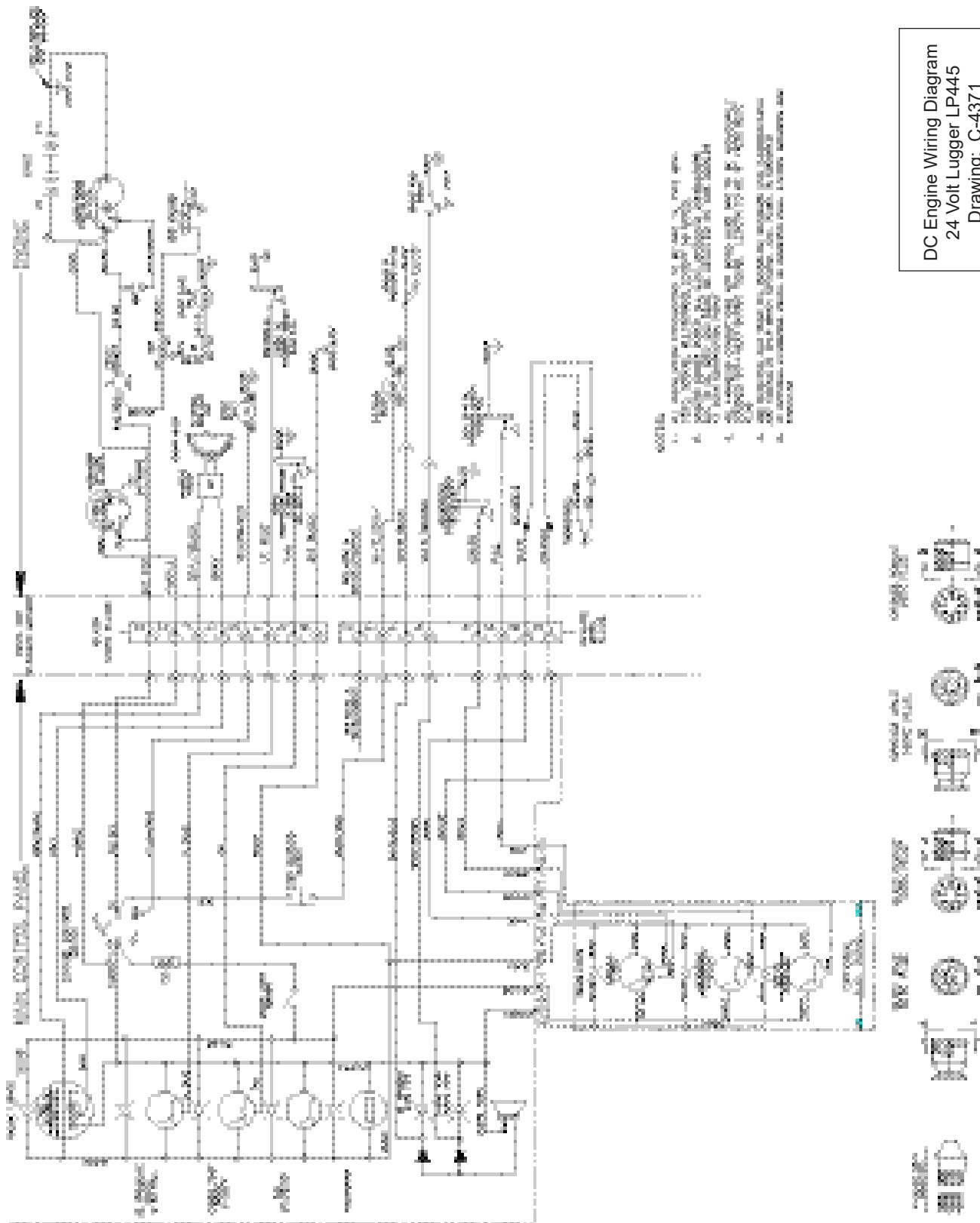


- NOTES:**
1. ALL INSTALLATION CONDUCTORS TO BE AWG 14, TYPE MTW, 105°C, 600VAC, MULTISTRAND, EXCEPT AS NOTED.
 2. UNLESS COLOR CODED, ALL A.D.E. INSTALLED CONDUCTORS ARE TO BE GREY AND MUST BE IDENTIFIED BY WIRE MARKER AT EACH CONNECTION POINT.
 3. ALL HARNESS CONDUCTORS NOT BEING USED ARE TO BE INDIVIDUALLY COVERED WITH HEAT SHRINK TUBING. LENGTH TO BE 6" FROM MERC PLUG.
 4. AIR MANIFOLD AND GEAR OIL PRESSURE SENDERS AND THERMOCOUPLE ARE INSTALLED ONLY WHEN OPTIONAL AUX. PANEL IS ORDERED.

DC Engine Wiring Diagram
12 Volt Luger LP445
Drawing: C-4364A



Wiring Diagrams



- NOTES:
1. ALL WIRING CONNECTIONS TO BE MADE TO THE 24VDC BATTERY BANK.
 2. ALL WIRING CONNECTIONS TO BE MADE TO THE 24VDC BATTERY BANK.
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 10. ALL WIRING CONNECTIONS TO BE MADE TO THE 24VDC BATTERY BANK.

DC Engine Wiring Diagram
 24 Volt Luger LP445
 Drawing: C-4371

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. “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



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