

OL944D

For Model: L944D

OPERATOR'S MANUAL

Marine Generators | Marine Diesel Engines | Land-Based Generators



NORTHERN LIGHTS





— CALIFORNIA —
Proposition 65 Warning:

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

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NORTHERN LIGHTS

OPERATOR'S MANUAL

for Northern Lights® L944D Diesel

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

Table of Contents

INTRODUCTION	4	SERVICING (Continued)	
Model Numbers	4	V-Belts	15
Serial Numbers	4	Valve Clearances.....	16
WARRANTY	5	Fuels - General.....	17
SAFETY RULES	5	Fuel Filters	17
COMPONENT LOCATIONS		Bleeding the Fuel System.....	18
L944D	6 - 7	Injector Service.....	19
INSTRUMENT PANEL	8	Injection Pump.....	20
OPERATING PROCEDURES		Cooling System	21
Break-in Period.....	9	Heat Exchanger.....	22
Before Starting.....	9	Raw Water Pump	22
Starting.....	10	Zinc Electrodes	22
Operating	10	Electrical System - General	23
Stopping.....	10	Booster Batteries.....	23
Alarms.....	10 - 11	Battery Care	24
Spare Parts	11	Winterizing / Out-of-Service	24
SERVICING SCHEDULE CHART	12 - 13	TROUBLESHOOTING	
SERVICING		Electrical.....	25
Lubrication - General.....	14	Engine.....	26 - 28
Checking Oil.....	14	SPECIFICATIONS	29
Oil Changes	14	WIRING DIAGRAMS	
Changing Oil Filter.....	15	DC Electrical	30 - 31
Air Filter	15		

Proprietary Information

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Introduction

The 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.

Unit Identification

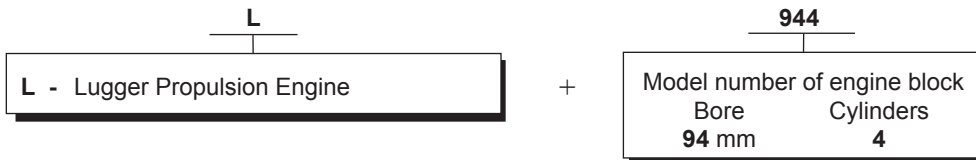
MODEL INCLUDED

This manual covers the operating instructions for:

L944D propulsion engine, which use the 944 engine block.

Model Numbers

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



L944D = Northern Lights marine diesel generator set with a 944 engine, naturally aspirated.

Serial Numbers

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



Warranty

A warranty registration certificate is supplied with your engine. 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.
- Remove the negative (-) battery terminal cable before servicing electrical components or welding.
- 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.



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

L944D Component Locations

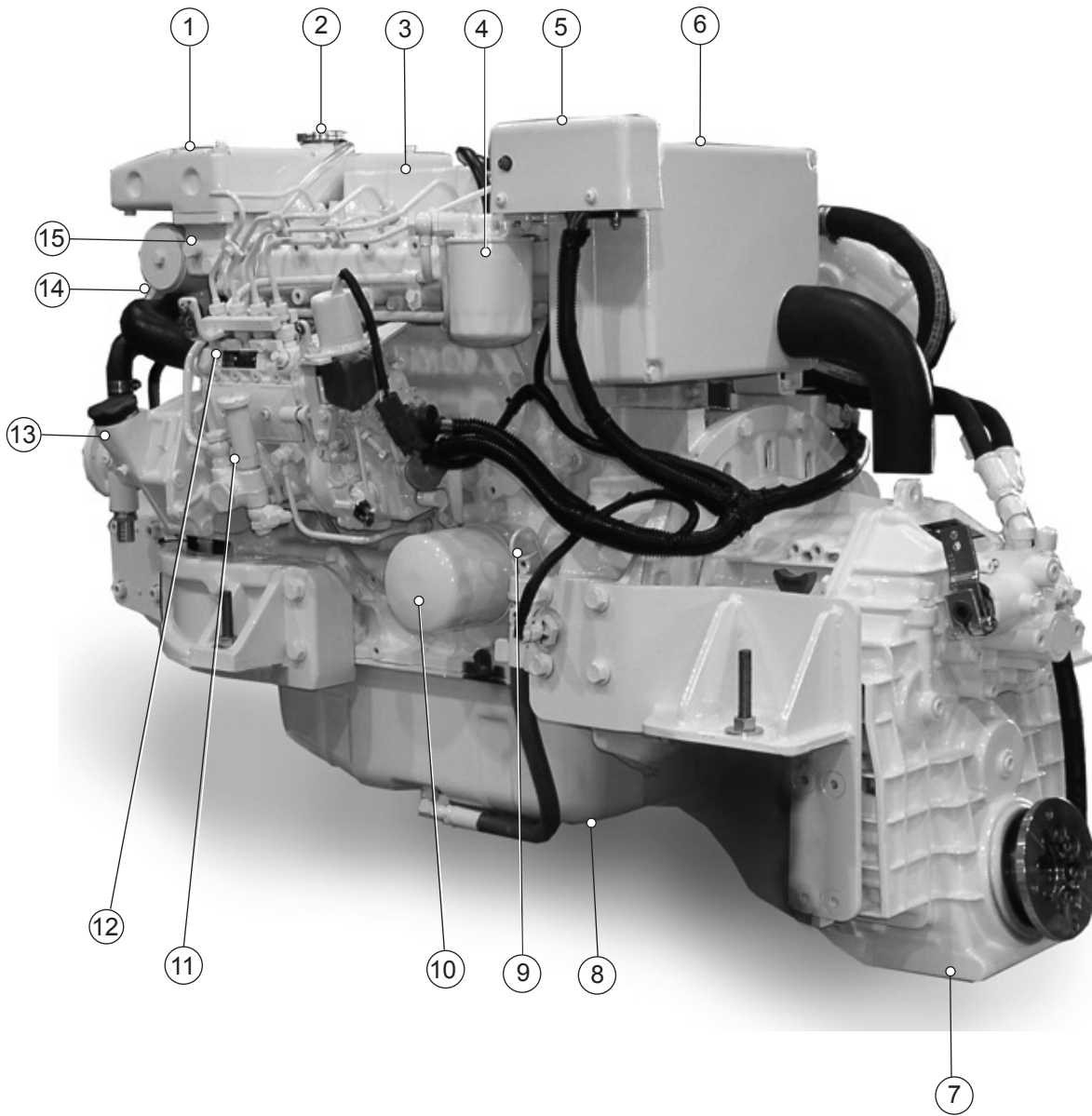


Figure 2: L944D Service Side

- | | | |
|----------------------|----------------------|--|
| 1. Expansion Tank | 8. Oil Pan | 14. Heat Exchanger Raw Water
Drain and Zinc |
| 2. Coolant Fill | 9. Lube Oil Dipstick | 15. Thermostat Housing |
| 3. Rocker Arm Cover | 10. Oil Filter | |
| 4. Fuel Filter | 11. Fuel Primer Pump | |
| 5. Relay Board Cover | 12. Injection Pump | |
| 6. Air Filter | 13. Lube Oil Fill | |
| 7. Transmission Gear | | |

L944D Component Locations

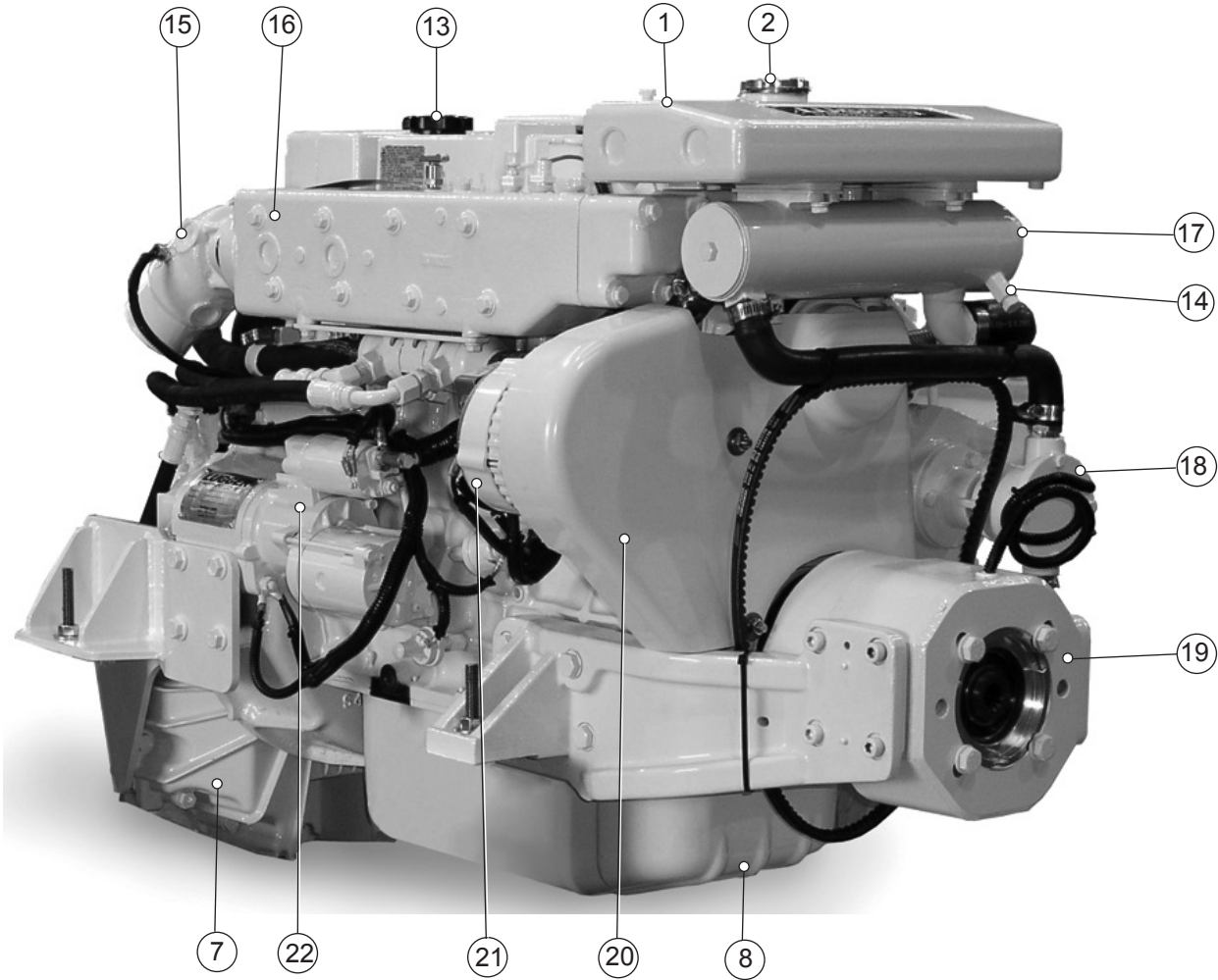


Figure 3: L944D Non-Service Side

- 15.** Wet Exhaust Elbow
- 16.** Exhaust Manifold
- 17.** Heat Exchanger
- 18.** Raw Water Pump
- 19.** PTO Housing
- 20.** Belt Guard
- 21.** Alternator
- 22.** Starter

Instrument Panel

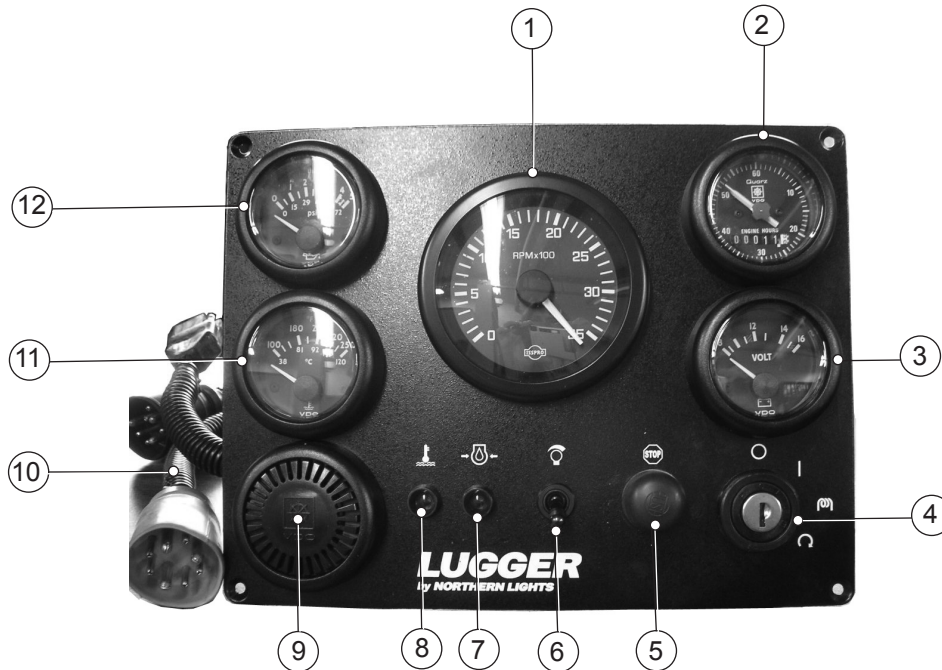


Figure 4: Lugger Main Instrument Control Panel

1. TACHOMETER

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

2. HOUR METER

Keeps track of the engine running time.

3. D.C. 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.

4. KEY SWITCH

Turning the key clockwise to the first position will switch on the current. Continue turning the key clockwise to preheat the engine, then again 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 counter clockwise as far as possible to stop the engine.

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

5. COVER

(Stop button not used for this application.)

6. INSTRUMENT PANEL LIGHTING

The switch turns on the instrument panel lights.

7. OIL PRESSURE FAULT LIGHT

Indicates low oil pressure. Activates in conjunction with alarm horn.

8. ENGINE TEMPERATURE FAULT LIGHT

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

9. ALARM HORN

Shut down engine if possible and investigate immediately.

10. WIRE HARNESS

11. COOLANT TEMPERATURE GAUGE

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

12. 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.

Operating Procedures

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 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 (consult Lubricants section for oil recommendation).

Operating Instructions:

Maintain at least a 75% load on your engine 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 the rings.

BEFORE STARTING

1. Check the water level by removing the pressure cap from the expansion tank. In order to give the cooling water an opportunity to expand, the level should be about 1 in. (2.5 cm) below the filler cap sealing surface when the engine is cold.



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 must be between high and low marks on the stick. Never allow the level to go below this area. Always add the same viscosity of oil as is already in the crankcase.
3. Check the fuel tank level and open any fuel valves on the tank and at the secondary fuel filter.
4. Close the sea-cock, check and clean the sea strainer, and reopen the sea-cock.
5. 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 alternator could be damaged.

Operating Procedures

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 next position; preheat for 5 to 10 seconds. Then 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 the oil pressure as soon as the engine has started. Oil pressure must be above 15 PSI. The engine must never be run if the oil pressure is below 15 PSI.
2. The D.C. voltmeter should read between 13 and 14 volts at 60° F (16° C) ambient temperature. (26 to 28 volts for 24 volt systems.)
3. The water temperature gauge should not rise above 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. If the proper propeller is used, the engine should reach its appropriate maximum RPM's at full throttle (2500 RPM). If the maximum rated RPM's for your engine application are 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.
6. 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 the engine for a three to five minute cool-down period in neutral at 1000 RPM.
2. Return engine to low idle.
3. Turn the key switch counter clockwise 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 the battery switch to OFF while the engine is running.

ALARMS

1. Your unit is fitted with a warning system to indicate high water temperature and low oil pressure. Propulsion engines have warning horns to sound and warn you of a problem.

Note: When the engine is not running the horn will sound when the key is in the "on" position because there is no oil pressure.

Do not rely on the alarms to the exclusion of careful gauge monitoring. Checking the gauges could prevent damage to the unit and dangerous power losses.

ALARMS (continued)

2. If the alarm system is activated:
 - a. Check the temperature gauge, if the temperature is above 205°F (97°C) shut the engine off immediately.
 - b. Use the Trouble Shooting Guide on page 25 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 200° F (94° C).
 - d. Watch the temperature gauge regularly and turn off the unit if the temperature rises above 205° F (96° C). Repeat troubleshooting.
3. If alarm 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 (20-60 PSI) after a few seconds of operation.
 - c. If the oil level is normal, DO NOT restart the engine. Call your Northern Lights or Lugger dealer for assistance.

SPARE PARTS

1. ADE recommends that you keep the following spare parts on hand for field service. The parts are available from your local Northern Lights dealer. Some marine models may already have “On-Board Kits,” a handy box that contains the most common parts you will need.
 - a. Primary and secondary fuel filter elements
 - b. Oil filters
 - c. Air filter elements
 - d. Alternator belt
 - e. Thermostat and gaskets
 - f. Seawater pump impeller and gaskets
 - g. Glow plugs
 - h. Injector and washer
 - i. Rocker Arm Cover gasket
 - j. Zinc Anode
 - k. Relay, SPDT 12 VDC 50 Amp
 - l. Engine overhaul gasket set
2. If your engine is operating a long distance from a servicing dealer, add the following:
 - a. Complete set of injectors
 - b. Complete set of glow plugs
 - c. Fuel lift pump

Servicing Schedule Chart

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

DAILY:

- SP1 Check oil level in engine
- SP8 Check primary fuel filter
- SP14 Check cooling water level
Check sea strainer

AFTER FIRST 50 HOURS:

- SP2/3 Change engine oil and filter
- SP5 Check V-belt tension
- SP7 Adjust valves
- SP19 Check electrolyte level in batteries

EVERY 50 HOURS:

- SP5 Check V-belt tension
- SP19 Check electrolyte level in batteries

AFTER FIRST 100 HOURS:

- SP2/3 Change engine oil and filter

EVERY 250 HOURS:

- SP2/3 Change engine oil and filter
- SP4 Check air cleaner
- SP18 Check zinc electrodes

EVERY 500 HOURS:

- SP6 Check valve clearances
- SP9 Change primary fuel filter element
- SP10 Change secondary fuel filter
- SP12 Check injectors
- SP15 Check cooling system
- SP17 Change impeller
- SP20 Check state of charge of batteries

EVERY 2000 HOURS or as needed:

- SP13 Check fuel injection pump
- SP16 Check and clean heat exchanger
- SP24 Inspect starter and alternator

SERVICE POINT	PAGE	OPERATION	DAILY	50 Hours	100 Hours	250 Hours	500 Hours	2000 Hours
ENGINE:								
SP1	12	Check oil level	●					
SP2	12	Change engine oil ^{1, 5, 6}		●		●		
SP3	13	Change lube oil filters ^{1, 5}		●		●		
SP4	13	Check air cleaner ^{1, 4}				●		
SP5	13	Check V-belt tension ¹					●	
SP7	14	Check valve clearances ⁵					●	
FUEL SYSTEM:								
SP8	15	Check primary filter ²	●					
SP9	15	Change primary filter element ^{1, 3}					●	
SP10	15	Change secondary fuel filter ^{1, 3}					●	
SP11	16	Bleed the fuel system ³						
SP12	17	Check injectors ¹					●	
SP13	18	Check fuel injection pump						●
COOLING SYSTEM:								
SP14	20	Check cooling water level	●					
SP15	20	Check and flush cooling system ⁷					●	●
SP16	21	Check and clean heat exchanger						●
SP17	21	Change impeller in raw water pump ^{1, 3}					●	
SP18	21	Check zinc electrodes ⁴				●		
ELECTRICAL SYSTEM:								
SP19	23	Check electrolyte level in batteries ^{1, 4}		●				
SP20	23	Check condition of batteries with hydrometer ¹					●	
SP24	24	Inspect alternator and starter						
OUT OF SERVICE:								
SP23	23	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.

4) More often if necessary.

5) After first 50 hours.

6) Adjust at first 100 hours.

7) Or every 1 year

Service Record

Service Point	OPERATION	HOURS/ DATE										
50 HOURS												
SP5	Check V-belt tension											
SP19	Check electrolyte in batteries											
250 HOURS												
SP2	Change engine oil											
SP3	Change lubricating oil filters											
SP4	Check air cleaner											
SP18	Check zinc electrodes											
EVERY 500 HOURS												
SP7	Check valve clearances											
SP8	Change primary filter element											
SP10	Change secondary fuel filter											
SP12	Check injectors											
SP15	Check cooling system											
SP17	Change impeller in seawater pump											
SP20	Check condition of batteries with hydrometer											
2000 HOURS or as required												
SP13	Check fuel injection pump											
SP15	Flush cooling system											
SP16	Check and clean heat exchanger											

Service Notes:

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 CD, CE, and CF-4 single viscosity oils.
 - b. API Service CD, CE, and CF-4 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	SAE 15-40W
-10° to 32° F (-23° to 0° C)	SAE 10W	SAE 10-30W

Figure 5: Lube Oils

4. Never put additives or flushing oil in crankcase.

SP1. CHECKING OIL LEVEL

1. While the engine is stopped, check the oil level in the crankcase with the dipstick daily. The oil level must be between the high and low marks on the stick. Fill with the recommended oil, and fill only to the high mark on the dipstick. Follow the lubrication recommendations in Figure 5.

SP2. OIL CHANGES

1. The set is delivered with special break-in oil. Change the engine oil and oil filter after 50 hours of operation. Use Service CC30 weight oil during the first 100 hours.
2. Change the oil and filter again at 100 hours using the oil recommended in the above diagram. After this, change oil and filter every 250 hours.
3. During intermittent cold weather operation, change oil every 100 hours or six weeks, whichever comes first.
4. Change oil at any seasonal change in temperature when a new viscosity of oil is required.
5. Change oil when engine is warm but not hot.
6. Dispose of waste oil in an approved manner.
7. Never use a flushing oil.
8. Loosen clamp on oil change tube. Remove cap. Drain oil. Replace cap and tube.
9. Refill engine with recommended oil.
10. Engine capacity with new oil filter is:
 Model L944D.....2.64 gallons
 (10 liters)

SP3. CHANGING LUBE OIL FILTER

1. Change the lube oil filter every 250 hours.
2. Use a filter wrench to remove old filter. Dispose of filter in approved manner.
3. Make sure the gasket from the old filter is removed and discarded. Clean mount face.
4. Spread a thin film of engine oil on the rubber gasket on the new filter and screw it on nipple until gasket meets 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, wait 3 minutes, and check oil level. Add additional oil if necessary.
7. Oil filter part number is:
Model L944D.....#24-01201

SP4. AIR CLEANER

1. Visually inspect air cleaner every 250 hours. In dusty conditions, check more often.
2. Remove the cover on the rear of the air intake manifold. Remove and inspect the foam element. If dirty, wash element in soapy water. Rinse and dry thoroughly before reinstalling.

Note: Make absolutely sure no impurities enter the engine while changing the element, and do not run the engine with the air cleaner removed.

Do not clean the filter with diesel fuel, solvent, or gasoline. Serious engine damage can result.

SP5. V-BELTS

1. Check the tension and wear on the V-belt 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 belt can be depressed about .39 to .47 in. (10 - 12 mm) with 22 lbs. (10 kg) force.

Servicing

SP7. VALVE CLEARANCES

1. Readjust valve clearance after first 50 hours of operation. Check valves every 500 hours thereafter.
2. Check the valves when the engine is cold.
3. Rotate the crankshaft in a clockwise direction, using a turning socket, from the front of the engine to bring the first piston to the top dead center on the compression stroke. When the mark on the crankshaft pulley aligns with the pointer on the timing gear case stop turning. Make sure the rocker arms of the No. 1 cylinder are loose at TDC. If they are not, rotate the crankshaft one complete turn.

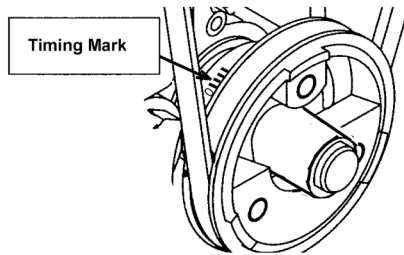


Figure 6: Timing Mark

4. Measure the valve clearance for No. 1 cylinder, with a feeler gauge.
Standard valve clearances for a cold engine are:
Intake (IN).....0.0098 in. (0.25 mm)
Exhaust (EX).....0.0098 in. (0.25 mm)
5. To adjust valve clearance, loosen the lock nut on the adjustment screw. Insert a feeler gauge between the rocker arm and the valve stem cap. Adjust, while measuring the clearance, until the feeler gauge slides with a slight drag. Tighten the lock nut and recheck the clearance (Figure 7).

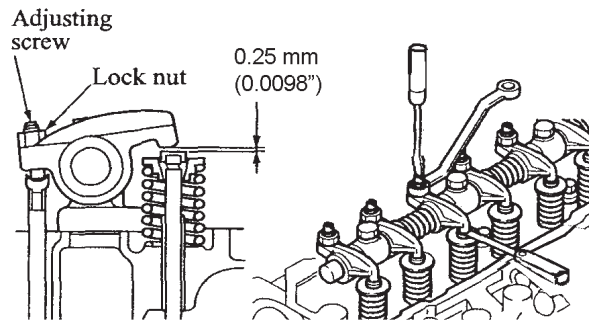


Figure 7: Valve Adjustment

6. Adjust the remaining valves turning the engine 180° in the cylinder order of 1-3-4-2.
7. Replace the rocker arm cover.

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 32° F (0° C).
 - b. Use grade No. 1 at ambient temperatures below freezing.
 - c. International fuel specifications:
 - JIS K2204
 - ISO-8217-DMA
 - BS 2869 Part 1 Class A1
 - BS 2869 Part 2 Class A2
2. Use fuel having less than .2% sulphur of weight (less than 0.05% recommended).
3. The cetane number should be 45 or higher.
4. Particulate contaminate should be 5.0 mg/l (0.00018 oz/U.S. gal) or lower.
5. 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.
6. Storing fuel:
 - a. Keep dirt, scale, water, and other foreign matter out of fuel.
 - b. Avoid storing fuel for long periods of time.
 - c. Fill the fuel tank at the end of each day's operation. This will reduce condensation.

SP8-10. FUEL FILTER

1. Your Luggie engine has a fuel filter installed. We recommend the Northern Lights brand of fuel filters.
 - a. Check the primary fuel filter daily as recommended by the filter manufacturer.
 - b. Change the filter as often as necessary or every 250 hours.
 - c. Remove the fuel filter with a filter wrench.
 - d. Apply a coating of fuel to the o-ring of the new fuel filter.
 - e. Tighten the new filter by hand, do not use a filter wrench for tightening.
 - f. The filter should be dry.
 - g. Do not add fuel to the fuel filter before installation, as this could cause unfiltered fuel to enter the fuel pump.
 - h. Bleed the air out of the filter.

The fuel filter part number is:

L944D.....24-51201

Servicing

SP11. BLEEDING THE FUEL SYSTEM



CAUTION: Escaping diesel fuel under pressure can penetrate skin causing serious personal injury. Before disconnecting lines be sure to relieve all pressure. Before applying pressure, be sure all connections are tight and lines, pipes and hoses aren't damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than 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.

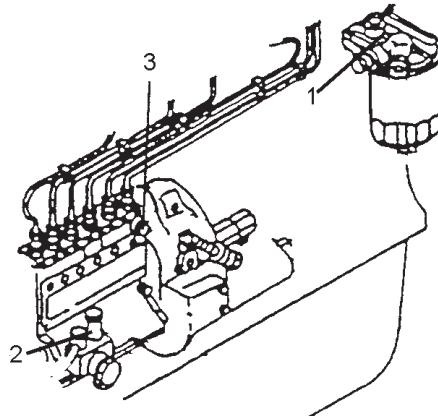


Figure 8 Fuel Feed Pump

- Fuel system air bleeding may be needed when:
 - After fuel has been added to a newly installed engine.
 - A new fuel filter is installed.
 - The engine has run out of fuel.
 - The fuel lines, injection pump, or any other fuel system component has been removed and installed.
- After changing the fuel filter, air only needs to be bled from the fuel filter. To do this:
 - Loosen the air vent plug (#1 on Figure 8) on the fuel filter by about 1-1/2 turns. (Be sure to cover the vent with a cloth to prevent fuel from splashing.)
 - Turn the priming pump cap on the fuel feed pump counterclockwise to unlatch it. Move the priming pump plunger (#2 on Figure 8) up and down. To close the pump turn the cap clockwise while depressing it.
 - Close the air vent plug when no more air bubbles can be seen in the fuel flowing from the air vent plug hole.
- To bleed air at the fuel injection pump:
 - Turn the air vent plug (#3 on Figure 8) about 1-1/2 turns to loosen it. (Cover the vent with a cloth to prevent fuel from splashing.)
 - Pump the feed pump cap up and down.
 - When there are no air bubbles to be seen in the fuel flowing from the air vent plug hole, push down the priming pump cap and turn it clockwise to lock it in place.
- If the engine does not start after this bleeding process, loosen a fuel line at the injector while cranking the engine with the starter motor until pure fuel escapes. Then tighten the connections. Do each line one-at-a-time. After the engine has started, use a piece of cardboard to look for fuel leaks.

NOTE:

Do not close the air vent plug before locking the priming pump cap in place, because the internal pressure in the pump will prevent the priming pump cap from returning to the original position.

SP12. INJECTOR SERVICE

1. Injectors should be checked every 500 hours. This check should be made by a Northern Lights dealer or local injection repair station.



CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin causing serious personal injury. If injured by escaping fuel, see a doctor at once.

2. Injector removal:
 - a. Clean loose dirt from around the injectors and the fuel lines.
 - b. Relieve high pressure in the fuel lines by loosening the delivery line flare nuts at each injector.
 - c. Remove delivery lines by disconnecting them from the injectors and injection pump. Remove all lines as an assembly; do not remove the spacers. Cover the ends of the lines, the injector inlets, and the injection pump outlets to keep dirt out.
 - d. Remove the return line retaining bolts, washers, and return line.
 - e. Loosen the injector retaining nuts at the same time a little at a time. Remove the injector.
 - f. Remove the injector seat. Cover the holes to prevent debris from entering the cylinders.

Note: Do not use pry bars to remove injectors from the cylinder head.

3. Injector repair and cleaning:
 - a. Take injectors to your Northern Lights dealer or local injection repair station for testing and service.
4. Injector installation:
 - a. Install new injector seal washer seat and injector. Evenly tighten the injector retaining nuts to 39.1 to 47.7 ft/lbs (53.0 to 64.7 N•m), or 5.4 to 6.6 kgf•m. Do not overtighten.
 - b. Reinstall the return line using new sealing washers. Tighten bolts to 13.0 to 15.9 ft/lbs (17.7 to 21.6 N•m), or 1.8 to 2.2 kgf•m.

NOTE: Overtightening can damage injectors.

- c. Reinstall injection lines. Tighten flare nuts at injection pump to 19.5 to 23.9 ft/lbs (26.5 to 32.4 N•m), or 2.7 to 3.3 kgf•m. Leave the lines loose at injectors for bleeding.
- d. Bleed the injection lines. Crank the engine to fill the lines. Tighten flare nuts at injectors to 15.2 to 18.1 ft/lbs (20.6 to 24.5 N•m), 2.1 to 2.5 kgf•m.
- e. Start the engine and check for leaks using a piece of paper or cardboard. Do not use your hand to check for leaks.

Servicing

SP13. INJECTION PUMP

1. Since operating conditions may vary considerably, it is difficult to give a definite interval for checking the injection pump. But as a rule, pump settings, maximum speed, idle speed and exhaust smoke should be checked after every 2000 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 malfunction. Before servicing the pump, check other possible causes:
 - a. Check cleanliness of the 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 equipment.

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

4. Injection Pump Removal:



CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious personal injury. If injured by escaping diesel fuel, see a doctor at once.

- a. Clean the injection pump, hoses, and area around the pump with a cleaning solvent or steam cleaner.

NOTE: Never steam clean or pour cold water on an injection pump while the engine is running or the pump is warm.

- b. Remove the injection lines from the pump and injectors. Remove all lines as an assembly. Do not remove the spacers. Cover the ends of the lines, the injector inlets, and the injection pump outlets to keep dirt out of the injectors, lines, and pump.
- c. Align timing marks on timing gear by engaging

c. (cont.)

- the turning socket (part #5830973100) with the crankshaft pulley nut and turn it clockwise (when viewed at the front of the engine). Stop where the "O" mark on the outside of the crankshaft pulley is aligned with the pointer on the timing gear case. To check Top Dead Center of the No. 1 cylinder, move the rocker arms of the inlet and exhaust valves up and down, checking that the push rods do not push up the rocker arms of the valves. This is Top Dead Center of the No. 1 piston. If the pushrods do push up the rocker arms, rotate the crankshaft one more turn.
- d. Remove the pump support bracket on rear of pump.
 - e. Remove the 4 mounting nuts.
 - f. Take the pump to your Northern Lights dealer or an injection pump repair station for testing and service.

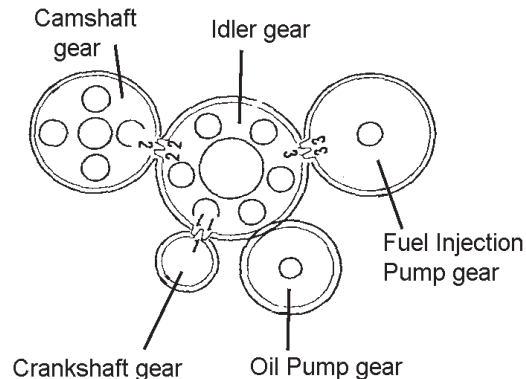


Figure 9: Timing Marks

5. Injection Pump Installation:

- a. Install the fuel injection pump after having aligned its gear alignment mark with that of the idler gear alignment mark as shown in Figure 9 above. When the alignment marks of the timing gears align as in the diagram above, the No. 1 piston is top dead center in the compression stroke.
- b. Install the injection pump to the side of the engine first then put in the end bolts, and then the tube with its bolts, and then the side bracket.
- c. Torque mounting bolts to 13.0 - 18.1 ft/lbs (17.7 to 24.5 N•m), 1.8 to 2.5 kgf•m.

Servicing

COOLING SYSTEM - GENERAL

NOTE: Be sure to close the sea-cock before working on the engine 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.

WATER QUALITY

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

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

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

SP14. CHECK THE COOLANT LEVEL

1. Check the coolant level each day before starting the engine.
 - a. Check the water level by removing the pressure cap from the expansion tank. In order to give the

cooling water an opportunity to expand, the level should be about 1 in. (2.5 cm) below the filler cap sealing surface when the engine is cold.

- b. Soft water with about a pH about 6.5 to 8.5 combined with an antifreeze in a 30% to 50% (maximum) solution should be used. 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.
- c. The antifreeze should not contain amine, silicate, or borate.
- d. Test kits are available through your Northern Lights or Luggar dealer to check the coolant condition. Part numbers are 20-00005 for a 4 pack and 20-00010 for a 50 pack.

SP15. COOLING SYSTEM FLUSHING

1. Flush the cooling system every 2000 hours or every 12 months, whichever comes first.
2. Remove fill cap and open drains on engine block. The engine block drain is on the service side of the engine above the dipstick, next to the flywheel housing.
3. Pour clean water into the engine until water coming from engine is clear of discoloration. Close drains and refill the engine with recommended coolant mixture.
4. Use 50% water / 50% (maximum) ethylene glycol antifreeze mix. Antifreeze mixture is recommended as a good year-round coolant.
5. Coolant capacity is approximately 3 gal. (11.4 liters).
6. Check hoses and connections and repair any leakage.
7. Start the engine and check for leaks. Run the engine for five minutes, then shut it down. Let engine cool, and then check the coolant level in the engine. Add coolant as needed.

NOTE: Be sure to open the sea-cock after working on the engine cooling system and starting the engine.

Servicing

SP16. HEAT EXCHANGER

1. Clean the heat exchanger core once a year or after 2000 hours of operation.
2. Drain the expansion tank and heat exchanger.
3. Remove the heat exchanger end covers.
4. Clean the inside of the exchanger core tubes using a metal rod. Flush, inspect, and clean again if necessary.
5. Reassemble the heat exchanger. Fill the cooling system. Start the engine and check for leaks.

SP17. RAW WATER PUMP

1. Change the raw water pump impeller every 500 hours, or as needed.
2. Remove the pump cover. Pry out the impeller using needle-nose pliers or two screwdrivers. Be sure to remove all pieces of the failed impeller.

NOTE: Place some kind of protection under the screwdrivers in order to not damage the pump housing.

3. Clean the inside of the housing.
4. Press in the new impeller and place the sealing plug in the outer end of the impeller center if this has not already been done.

NOTE: Make sure that there is always an extra impeller and cover gasket in reserve on board.

SP18. ZINC ANODES

1. A zinc anode is installed in the heat exchanger cooling system to protect the engine from electrolysis. Check it faithfully every 250 hours. If you are in warm saltwater, or where electrolysis is a known problem, check it more often.
2. Remove the zinc holder from the bottom of the exchanger. This will drain raw water from the exchanger.
3. Scrape or wire brush the zinc anode clean. If more than 50% of the anode is corroded away, replace it with a new zinc. The anode screws out of the holder.
4. Reinstall the zinc holders. Be sure the threads are clean for good metal-to-metal contact. Do not use thread sealant.
5. Start the engine and check for leaks.

ELECTRICAL SYSTEM - GENERAL

1. Never switch the battery switch off or break the circuit between the alternator and the batteries while the engine is running. Alternator damage can result.
2. Do not reverse the polarity of the battery cables when installing the battery.
3. When welding on the unit, disconnect the regulator and battery. Isolate the leads.
4. Disconnect the battery cables when servicing the DC alternator.
5. Never test with a screwdriver, etc... against any terminal to see if it emits sparks.

BOOSTER BATTERIES

! *CAUTION: Battery gas can explode. Keep all flames and sparks away from batteries.*

1. Before changing or using booster batteries, check the battery electrolyte level. Add distilled water if necessary.
2. Booster and main batteries must have the same voltage rating.
3. First, connect the positive (+) terminal of the booster battery to the positive (+) terminal of the main battery. Then, connect the negative (-) terminal of the booster battery to ground on the engine block (Figure 10).
4. Remove the booster battery after starting the engine.
5. Sealed Batteries:
See the manufacturer's charging and booster instructions.

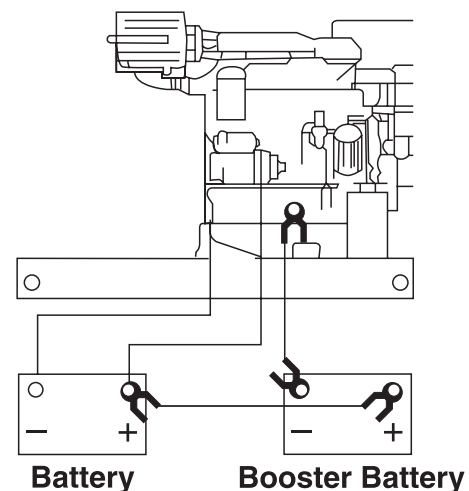


Figure 10: Booster Battery Connections

Servicing

SP19-20. BATTERY CARE

1. Check the electrolyte level every 50 hours, or once a month. Add distilled water to the 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 future corrosion.
3. Check the battery condition with a hydrometer every 500 hours.
6. Cover the terminals and openings of the starter and alternator with adhesive fabric tape. Cover the starter and alternator with polyethylene sheets and put desiccant inside covering.
7. Disconnect and clean the battery. Remove the battery to a cool dry storage place, if possible.
8. Clean the outside of the unit. Paint any scratched or chipped surfaces. Put corrosion preventative on all exposed metal surfaces.
9. Cover the engine.

SP23. WINTERIZING / OUT-OF-SERVICE

NOTE: Remember to close the sea-cock before opening drain cocks.

For engines not going to be used for more than 3 months:

1. Change the crankcase oil and filter. Fill with rust preventative oil, and make a mixture of rust preventative oil and fuel 1:1 and fill the fuel tank with the mixture. Start the engine and operate it with no load for 5 to 10 minutes. Stop the engine, spray rust preventative agent into intake pipe. Drain the rust preventative oil and fuel.
2. Drain fresh water and seawater cooling systems completely. Flush fresh water systems and refill with the proper antifreeze mixture.
3. Drain the water supply lines and wet exhaust line. Cover the intake and exhaust ports with adhesive fabric tape.
4. Loosen the seawater pump cover and drain the pump.
5. Loosen the alternator belt.

DC ELECTRICAL SYSTEM

PROBLEM	POSSIBLE CAUSE	RECOMMENDATION(S)
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.
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 condition	• 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 condition	• Battery is too small. • Battery cables are too small.
	Check specific gravity of each battery	• Replace battery if necessary.
	Check electrolyte level of each battery	• 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.

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

Troubleshooting

ENGINE

PROBLEM	POSSIBLE CAUSE	RECOMMENDATION(S)
Engine Hard to Start or Will Not Start	Improper starting procedure	• See starting section of this manual.
	No fuel	• Check level of fuel in fuel tank.
	Low battery condition	• 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.
Engine Runs Irregularly or Stalls Frequently	Clogged secondary fuel filter element	• Replace filter element.
	Dirty or faulty injection nozzles	• Have your dealer check injection nozzles.
	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.
Lack of Engine Power	Improper type of fuel	• Consult fuel supplier and use proper type of fuel for operating condition.
	Engine overloaded	• Reduce the 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.
	Improper valve clearance	• Reset valves. Best done by dealer.
Dirty or faulty injection nozzles	• Replace injectors. Best done by dealer.	

ENGINE

PROBLEM	POSSIBLE CAUSE	RECOMMENDATION(S)
Lack of Engine Power <i>(continued)</i>	Low compression pressure (worn piston rings, etc...)	• Consult dealer.
Engine Overheats	Engine overloaded	• Check propeller size or pitch.
	Low coolant level	• Fill tank to proper level. • Check hoses for loose connections and leaks.
	Keel cooling tubes have been painted	• 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 or broken	• Check the 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.
	Faulty fuel injector	• Call your dealer.
	Engine overheating	• See “Engine Overheating” section.
High Fuel Consumption	Improper type of fuel	• Use correct fuel for temperature.
	Clogged or dirty air cleaner	• Service air cleaner.
	Engine overloaded	• Reduce the electrical 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 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.

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

Troubleshooting

ENGINE

PROBLEM	POSSIBLE CAUSE	RECOMMENDATION(S)
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.
	Crankcase over full	• Remove excess oil.
Engine Emits Black or Gray Exhaust Smoke	Clogged or dirty air cleaner	• Service air cleaner.
	Defective muffler	• Have dealer check back pressure. (back pressure too high)
	Improper fuel	• Use correct fuel for temperature.
	Fuel pump faulty	• See your dealer.
	Injection nozzles dirty	• See your dealer.
	Engine overloaded	• Reduce the electrical load.
	Injection nozzles dirty	• See your dealer.
	Injection pump faulty	• Consult your dealer.
	Engine out of time	• See your dealer.
Incorrect valve clearance	• Consult 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.
	Low Compression Pressure	• See your dealer.
	Low engine oil viscosity	• Use proper viscosity of oil to ambient temperature.
	Excessive amount of engine oil	• Maintain correct oil level.
	Fuel injection nozzles faulty (uneven injection)	• See your dealer.

Specifications

Hp/ RPM **65 Hp**
2500 RPM

General Information

Engine Type	
Cylinders	Inline 4
Displacement	203 in ³ (3.33 liters)
Cycles	4
Bore x Stroke	3.7 x 4.72 in (94 x 120 mm)
Rotation (Facing Flywheel)	counter-clockwise
Crankcase Capacity including Oil Filter	11 qts (10 liter)
Aspiration	Natural
Flywheel Housing Size	SAE 4
Optional PTO Size	SAE B- Pad
Rated Crankshaft Hp ¹	65 Hp @ 2500 RPM
Rated Crankshaft kW ²	48.5 kW @ 2500 RPM
Weight w/Heat Exchanger without gear	620 lbs. (281 kg)
Weight Keel cooled without gear	600 lbs. (272 kg)
Length	40.1 in (1018 mm)
Width	24.9 in (682 mm)
Height	29.0 in (737 mm)

Cooling System

Approx. Coolant Cap.	3 gal (11 liter)
Minimum Sea Water Discharge Dia.	3/4 in (20 mm)
Heat Rejection to Jacket Coolant	2588 BTU/min
Coolant Pump Flow	16 gpm (61 lpm)
Seawater Pump Flow	16 gpm (61 lpm)
Maximum Seawater Pump Suction Head	39 in (990 mm)
Keel Cooler TurboTube Length	19 feet (0.48 M)
Keel Cooler Head Diameter	1.25 in (31.75 mm)
Keel Cooler Water Hose ID	1.5 in (38 mm)

D.C. Electrical

Minimum Battery Capacity	200 Amp Hour - 640 CCA
Battery Cable Size	"00"
Voltage, Standard Ground	12 Volt

Air Intake and Exhaust

Air Consumption	132 cfm (3.74 M ³ /m)
Maximum Exhaust Backpressure	27 in (686 mm) H ₂ O
Wet Exhaust Elbow ID	3 in (76 mm)
Exhaust Gas Flow Volume	360 cfm (10.19 M ³ /m)

Fuel System

Minimum Suction Line	.375 in (10 mm)
Minimum Return Line	.375 in (10 mm)
Maximum Fuel Pump Suction Head	39 in (990 mm)

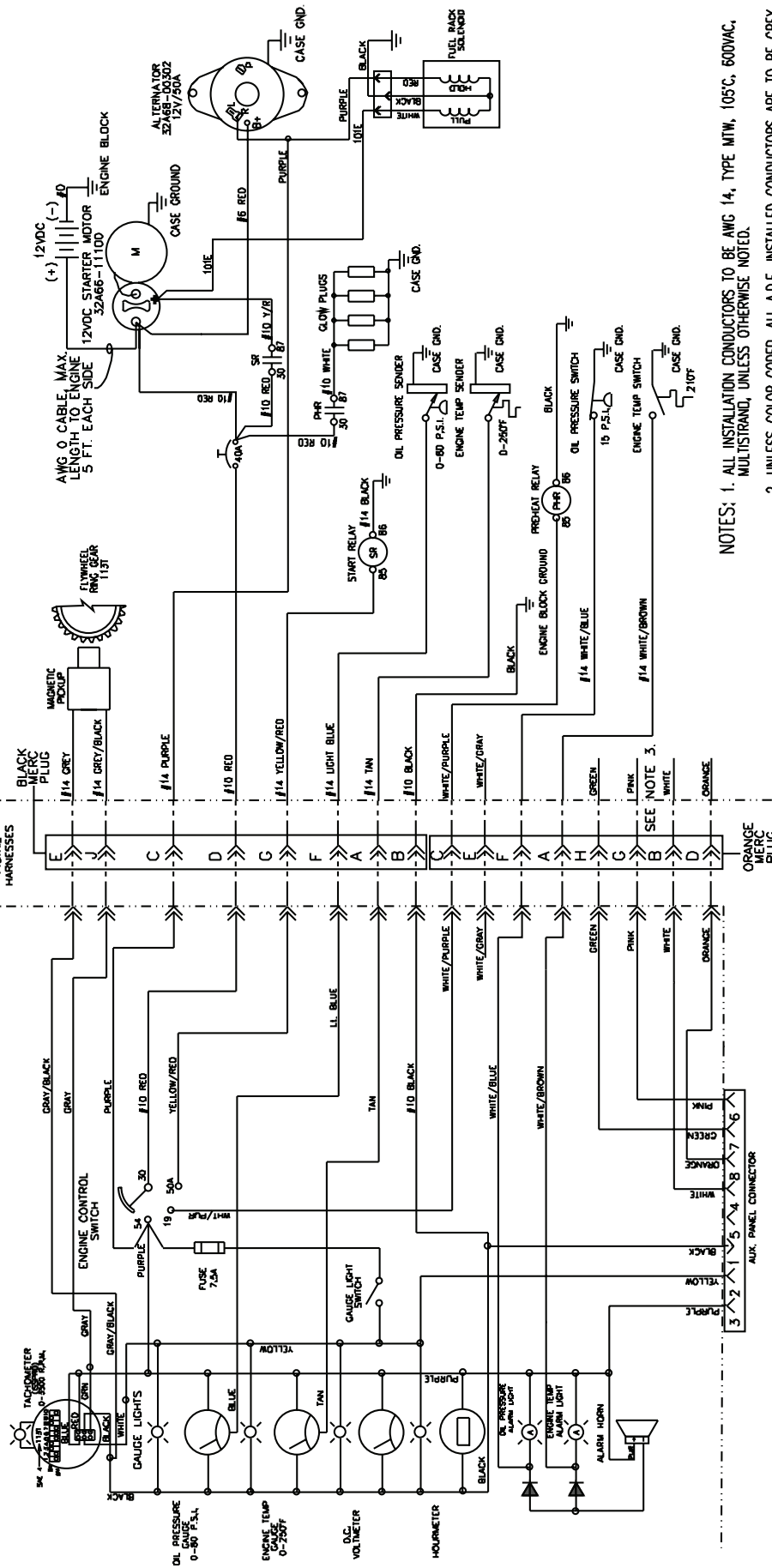
Maximum Engine Operating Angle

Continuous Operation	Front Down	Rear Down
(More than 2 minutes requires use of a remote expansion tank)	0°	0° - 10°
Intermittent Operation (Sustained up to two minutes)	0° - 35°	0° - 35°

1. Based on SAE J816b.
2. Based on EN ISO 8665: 2006.

ENGINE

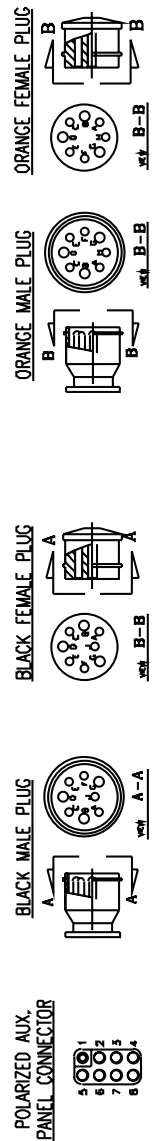
MAIN CONTROL PANEL

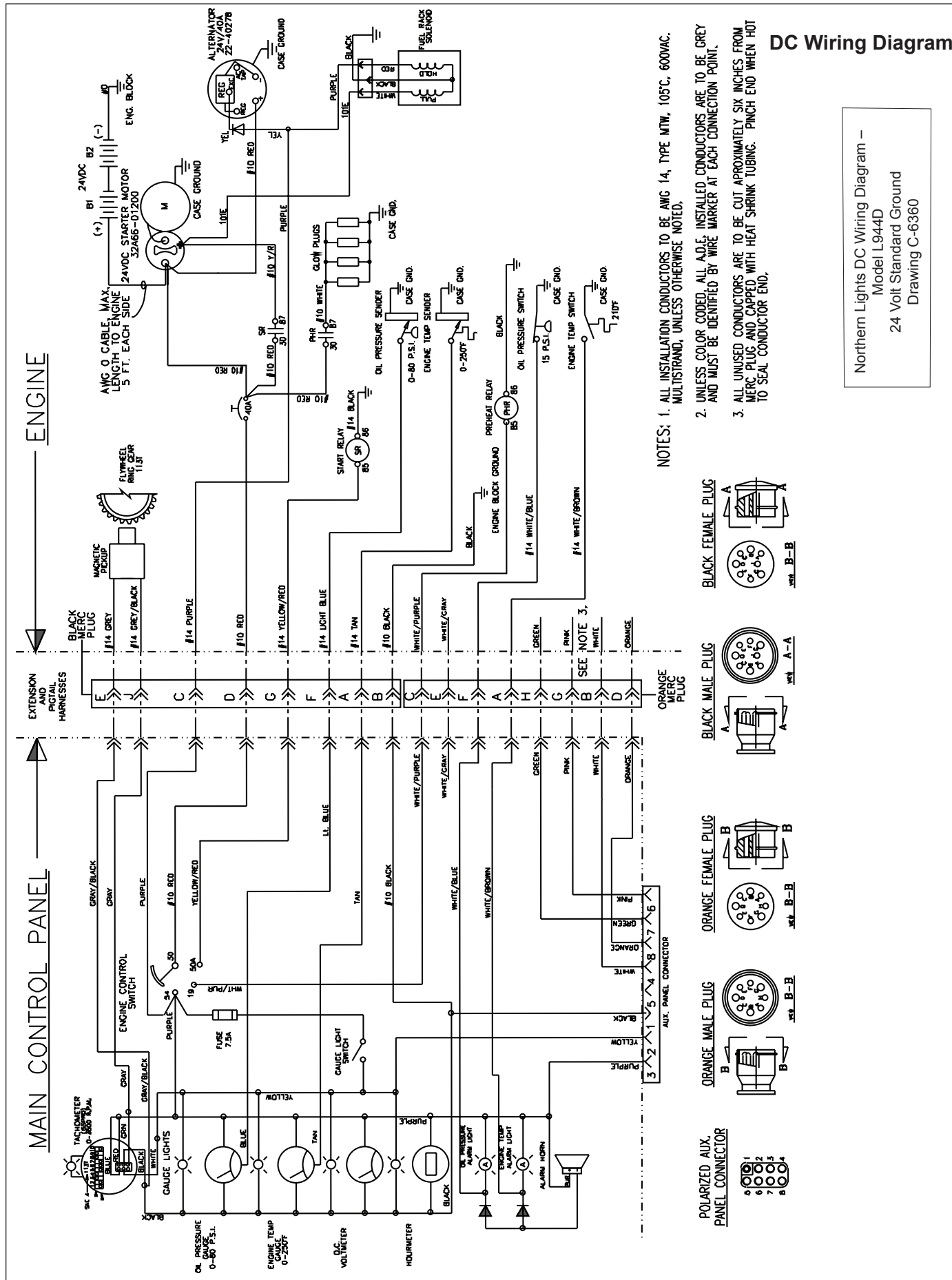


- NOTES:**
1. ALL INSTALLATION CONDUCTORS TO BE AWG 14, TYPE MTW, 105°C, 600VAC, MULTISTRAND, UNLESS OTHERWISE NOTED.
 2. UNLESS COLOR CODED, ALL A.D.E. INSTALLED CONDUCTORS ARE TO BE GREY AND MUST BE IDENTIFIED BY WIRE MARKER AT EACH CONNECTION POINT.
 3. ALL UNUSED CONDUCTORS ARE TO BE CUT APPROXIMATELY SIX INCHES FROM MERC PLUG AND CAPPED WITH HEAT SHRINK TUBING. PINCH END WHEN HOT TO SEAL CONDUCTOR END.

DC Wiring Diagram

Northern Lights DC Wiring Diagram –
 Model L944D
 12 Volt Standard Ground
 Drawing C-6359

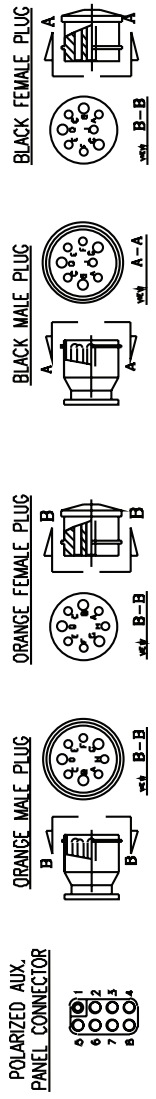




DC Wiring Diagram

Northern Lights DC Wiring Diagram -
 Model L944D
 24 Volt Standard Ground
 Drawing C-6360

- NOTES: 1. ALL INSTALLATION CONDUCTORS TO BE AWG 14, TYPE MTW, 105°C, 600VAC, MULTISTRAND, UNLESS OTHERWISE NOTED.
2. UNLESS COLOR CODED, ALL A.D.C. INSTALLED CONDUCTORS ARE TO BE GREY AND MUST BE IDENTIFIED BY WIRE MARKER AT EACH CONNECTION POINT.
3. ALL UNUSED CONDUCTORS ARE TO BE CUT APPROXIMATELY SIX INCHES FROM MERC PLUG AND CAPPED WITH HEAT SHRINK TUBING. PINCH END WHEN HOT TO SEAL CONDUCTOR END.





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