


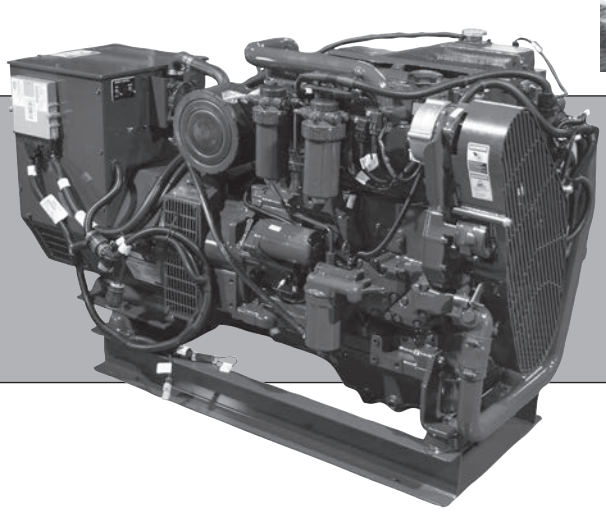

OM-C3

For Models: M50C13, M65C13
and M99C13

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.

Northern Lights
4420 14th Avenue N.W.
Seattle, WA 98107
Tel: (206) 789-3880
Fax: (206) 782-5455

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and M99C13

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

Table of Contents

Introduction

Servicing of 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

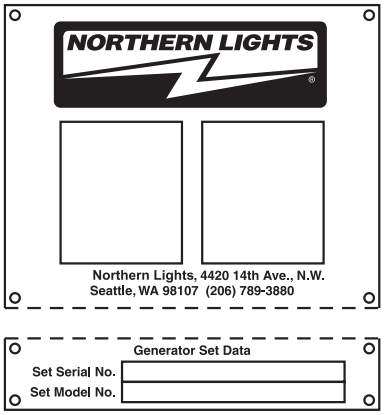
M50C13 = 50 kW Northern Lights® commercial marine generator set with a Northern Lights Powertech Tier III 6068 engine block and an electronically controlled fuel system.

M65C13 = 65 kW Northern Lights® commercial marine generator set with a Northern Lights Powertech Tier III 6068 engine block and an electronically controlled fuel system.

M99C13 = 99 kW Northern Lights® commercial marine generator with a Northern Lights Powertech Tier III 6068 engine block and an electronically controlled fuel system.

Serial Numbers

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



Warranty

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

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

Safety Rules

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

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

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

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

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

Follow All Safety Instructions

Carefully read and understand all safety messages in this manual and on your machine's safety signs. Keep signs in good and clean condition. Replace missing or damaged signs. Be sure new equipment components and repair parts include the current safety signs. For replacement signs, proper placement of safety signs or clarification on any safety issue, consult your Northern Lights dealer or the factory.
There can be additional safety information contained on parts and components from outside suppliers that is not reproduced in this manual. Consult the suppliers for additional safety information.

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

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

Prevent Bypass and Accidental Starting

WARNING

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

Start engine only from operator's station.

Handle Fuel Safely - Avoid Flames

WARNING

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

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

Safety Rules (Continued)

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

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

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

Service Machines Safely

⚠DANGER

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

Check for any loose electrical connections or faulty wiring.

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

Wear Protective Clothing

⚠WARNING

To prevent catching anything in moving machinery, always wear close fitting clothes and safety equipment appropriate to the job.
Prolonged exposure to loud noise can cause hearing loss or impairment.
Wear suitable authorized hearing protection, such as earmuffs or plugs to protect against loud noises

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

Practice Safe Maintenance

⚠CAUTION

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

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

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

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

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

Stay Clear of Rotating Drivelines

⚠DANGER

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

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

Safety Rules (Continued)

Install all Safety Guards

⚠ WARNING

Direct contact with rotating fans, belts, pulley and drives can cause serious injury.

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

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

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

Safe Battery Handling

⚠ WARNING

Prevent Battery Explosions

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

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

Frozen batteries may explode if charged. Never charge a battery that has not been allowed to warm to at least 16°C (60°F).
Always remove grounded (-) battery clamp first and replace ground clamp last.

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

To Avoid Hazards:

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

If acid is spilled on skin or in eyes:

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

If acid is swallowed:

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

⚠ WARNING

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

Handle Chemical Products Safely

⚠ WARNING

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

All potentially hazardous chemicals come with a Material Safety Data Sheet (MSDS). The MSDS provides specific details on chemical products, including physical hazards, safety procedures and emergency response techniques

Read and understand the MSDS for each chemical before you start any job that includes it. Follow the procedures and use appropriate equipment exactly as recommended.

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

Work in Well Ventilated Areas

⚠ CAUTION

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

Remove Paint Before Welding or Heating

⚠ WARNING

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

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

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

Service Cooling System Safely

⚠ WARNING

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

Avoid High Pressure Fluids

⚠ WARNING

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

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

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

Avoid Heating Near Pressurized Fluid Lines

⚠ WARNING

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

Do Not Open High-Pressure Fuel System

⚠ DANGER

Many Northern Lights engines use high-pressure fuel injection. High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt any repair of fuel lines, sensors, or other

components between the high-pressure fuel pump and nozzles on engines with high pressure fuel systems.

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

Avoid Hot Exhaust

WARNING

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

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

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

Avoid Harmful Asbestos Dust

WARNING

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

The asbestos used in these components is usually found in a resin or otherwise sealed. Normal handling of these components is not dangerous, as long as airborne dust containing asbestos is not generated.
Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding materials containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If this vacuum is not available, apply a mist of oil or water on the material containing asbestos. Keep all bystanders away from any area where asbestos dust may be generated.

Use Proper Lifting Equipment and Techniques

WARNING

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

Use Proper Tools

CAUTION

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

Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, always use the correct sized tools.

Do not use US measurement tools on metric fasteners, or vice versa. Use only service parts that meet Northern Lights specifications.

Dispose of Waste Properly

CAUTION

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

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

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

Lock Out / Tag Out Procedures

Scope

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

General Policy

⚠ CAUTION

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

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

Lock Out/Tag Out Instructions - Electrical Equipment

⚠ WARNING

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

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

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

Lock Out/Tag Out Instructions - Pneumatic and Hydraulic Equipment

⚠ WARNING

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

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

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

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

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

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

⚠ WARNING

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

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

Stored Energy

⚠ WARNING

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

Verification of Isolation

⚠ CAUTION

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

Restarting Procedures

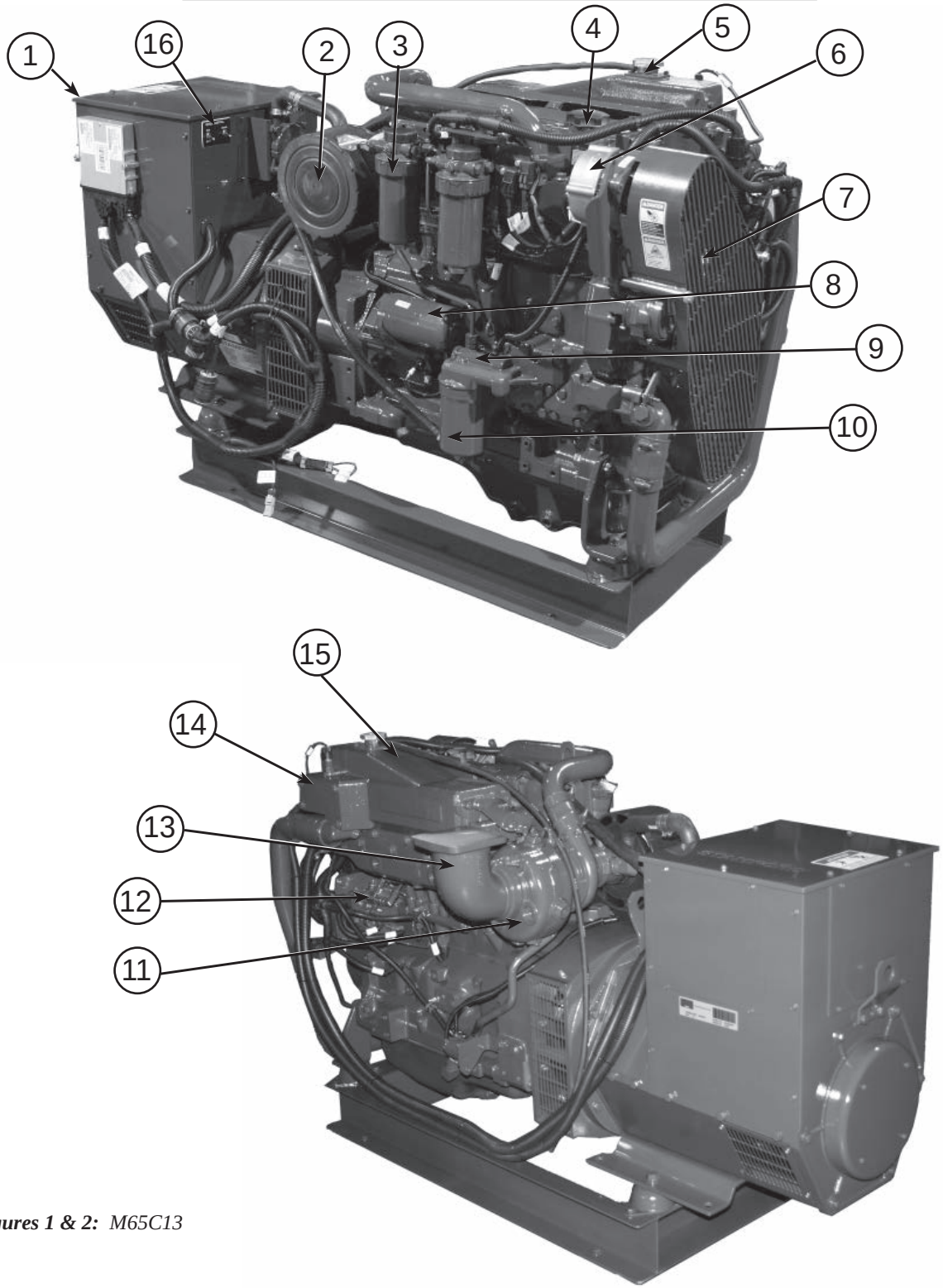
⚠ CAUTION

Follow the procedures below prior to restoring energy:

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

Notes

Component Locations



Figures 1 & 2: *M65C13*

1. Junction Box
2. Air Cleaner
3. Fuel Filter
4. Lube Oil Fill
5. Coolant Fill
6. Alternator
7. Belt Guard
8. Starter
9. Lube Oil Dipstick
10. Lube Oil Filter
11. Turbocharger
12. Fuel Injection Lines
13. Exhaust Elbow
14. Thermostat Cover
15. Expansion Tank
16. Stop / Start Panel

Component Locations

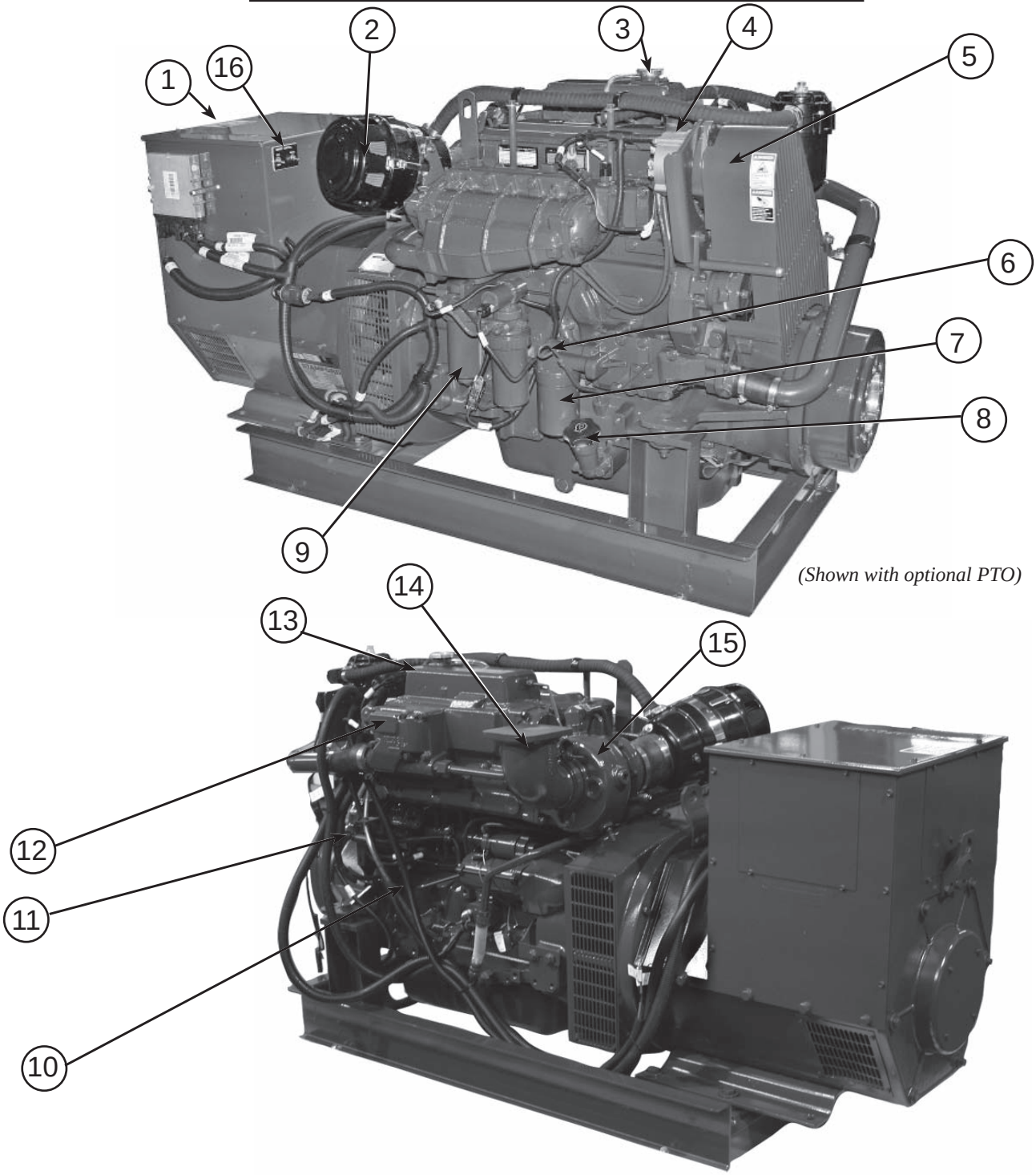


Figure 3 & 4: *M99C13*

1. Junction Box
2. Air Cleaner
3. Coolant Fill
4. Alternator
5. Belt Guard
6. Lube Oil Dipstick
7. Lube Oil Fill
8. Lube Oil Filter
9. Fuel Filter
10. Fuel Injection Lines
11. Starter
12. Thermostat Cover
13. Expansion Tank
14. Exhaust Elbow
15. Turbocharger
16. Stop / Start Panel

Northern Lights Control Panels

Figure 7: *Series 3B Generator Control Panel*

1. SHUTDOWN BYPASS SWITCH

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

2. ENGINE CONTROL SWITCH

   To start the engine, hold this switch in the START position until the engine is running.
   NOTE: Excessive cranking of marine sets equipped with water lift muffler systems can cause engine damage.
   After the engine starts, release the switch and it will return to RUN position. To stop the engine, hold the switch in the STOP position.

3. OIL PRESSURE GAUGE

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

4. COOLANT TEMPERATURE GAUGE

   Water temperature gauge shows the temperature of the cooling water. If the gauge registers over 200°F (93.3^0C) or drops below 140°F (60^0C), stop the engine and investigate.

5. HOUR METER

   Keeps track of the engine running time.

6. DC VOLTMETER

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

Normal Engine Operation

Observe engine coolant temperature and engine oil pressure. Temperatures and pressures will vary between engines and with changing operating conditions, temperatures, and loads. See GENERAL ENGINE SPECIFICATIONS in Specifications Section near end of manual for temperature and pressure specifications for your engine.

If coolant temperature rises above the maximum coolant temperature (see Specifications Section) reduce load on engine. Unless temperature drops quickly, stop engine and determine cause before resuming operation.

Operate the engine under a lighter load and at slower than normal speed for first 15 minutes after start-up. DO NOT run engine at slow idle unless necessary for maneuvering out of dock and harbor.

Stop engine immediately if there are any signs of part failure. Symptoms that may be early signs of engine problems are:

- Sudden drop in oil pressure
- Abnormal coolant temperatures
- High marine gear oil temperature
- Unusual noise or vibration
- Sudden loss of power
- Excessive black exhaust
- Excessive fuel consumption
- Excessive oil consumption
- Fluid leaks

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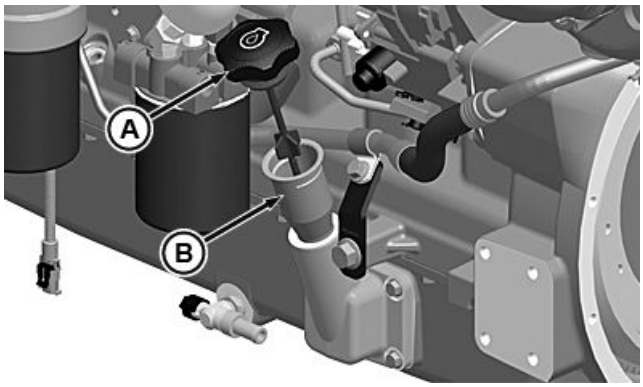
Break-In Service

The engine is ready for normal operation. However, extra care during the first 100 hours of operation will result in more satisfactory long-term engine performance and life. DO NOT exceed 100 hours of operation with break-in oil. See GENERAL ENGINE SPECIFICATIONS in Specifications Section near end of manual for oil pressure and coolant temperature specifications for your engine.

1. This engine is factory-filled with Northern Lights Engine Break-in Oil. Operate the engine at heavy loads with minimal idling during the break-in period.
2. If the engine has significant operating time at idle, constant speeds, and/or light load usage, or makeup oil is required in the first 100 hour period, a longer break-in period may be required. In these situations, an additional 100 hour break-in period is recommended using a new change of Northern Lights Engine Break-In Oil and a new Northern Lights oil filter.



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Check Engine Oil

A—Engine Oil Dipstick **B—Dipstick Tube**

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Marine Break-In Service

A proper break-in procedure is critical with marine diesel engines. A proper break-in will ensure optimal engine life. A proper break-in for marine engines is expected to take approximately 100 hours if performed correctly.

Constant speed engine operation such as generators. A similar process should be followed, except instead of changing speed, the engine load should be increased until the point of maximum engine fueling (100% load or maximum generator output). These 10% steps in engine percent load should be performed for a minimum of 5—10 minutes each or until engine temperature stabilizes while monitoring all engine criticals. If a fault code should occur, abort process and review application and installation guidelines.

Break-In Oil

The engine is factory filled with Northern Lights Diesel Engine Break-In Oil. This is a special formulation of oil that is designated to aid with the proper break-in of engine components. If performed correctly, it is expected the break-in process will take 100 hours. During this process some make-up oil may be required. As it is not unusual for some oil consumption during the break-in process; it is critical that the oil level be frequently monitored during this process. If make up oil is required use only Northern Lights Diesel Engine Break-In Oil.

Following the 100 hour break-in process it is recommended that change of oil and filter should occur. If the break-in procedure has been followed and sufficient extended loading of the engine has occurred it is acceptable to proceed with normal oil changes as advised in this operator's manual. However, if during the first 100 hours of operation the engine has operated at periods of light loading and/or idle it is recommended that the oil should be drained and replaced with Northern Lights Diesel Engine Break-In Oil, and the oil filter should be changed and replaced with a new Northern Lights oil filter. Following this, the break-in procedure should continue for an additional 100 hours.

IMPORTANT: DO NOT fill above the top of the crosshatch pattern or the FULL mark, whichever is present. Marine engines installed at an angle will have an alternate pattern as identified by the dipstick remarking process to compensate for installation angle. Oil levels anywhere within crosshatch are considered in the acceptable operating range. Northern Lights Break-In engine oil should be used to make up any oil consumed during the break-in period.

IMPORTANT: DO NOT use Plus-50 or Plus-50 II engine oil during the break-in period of a new engine or engine that has had a major overhaul. Plus-50 or Plus-50 II engine oil will not allow a new or overhauled engine to properly seat in during this break-in period.

IMPORTANT: If Northern Lights Break-In or Break-In Plus engine oils are not available, use a SAE 10W-30 viscosity grade diesel engine oil meeting one of the following:

API Service Classification CE *API Service Classification CD* *API Service Classification CC*
ACEA Oil Sequence E2 *ACEA Oil Sequence E1*

IMPORTANT: Do not use Plus-50 II, Plus-50, or engine oils meeting any of the following for the initial break-in of a new or rebuilt engine:

API CJ-4 *ACEA E9* *API CI-4 PLUS* *ACEA E7* *API CI-4* *ACEA E6* *API CH-4*
ACEA E5 *API CG-4* *ACEA E4* *API CF-4* *ACEA E3* *API CF-2* *API CF*

These oils do not allow the engine to break-in properly.

Break-In Procedure

During the 100 hour break-in period it is important to adequately work the engine to properly seat the engine components. Extended idle and light load operation should be minimized. Extended idle and/or light load operation intervals should not exceed 30 minutes during the break-in process. Minimum operating engine loads should be sufficient to result in coolant temperatures at or above the thermostat opening temperature.

IMPORTANT: It is critically important to properly break in the engine within the first 100 hours. Attempting a break-in at higher hour intervals may be unsuccessful. To correctly perform the break-in, extra effort is required to ensure that engine is heavily exercised and may include running the engine harder than normal usage. This is especially true with M1-M3 ratings and lightly loaded applications such as trawlers and oversized generator sets.

Constant Speed Applications — Minimum engine load factors1 during the break-in period should be greater than 30%. It is recommended that the engine operate between 50% and 90% load greater than 50% of the time during the break-in period.

IMPORTANT: Lightly Loaded Applications Post Break-In: Engine break-in will not compensate for the observable conditions of a lightly loaded engine such as black fuel oil residue in the exhaust system. These conditions can be common among trawler propulsion engines, oversized generator sets, applications that spend long intervals at idle, and will occur on any lightly loaded diesel engine. Northern Lights marine diesel engines are designed to operate at loaded conditions. To prevent exhaust system contamination in a lightly loaded application, regularly exercise the engine by periodically increasing the load.
For example, in a trawler propulsion application underway increase the throttle to achieve an engine speed of the break-in speeds defined above for a minimum of 10 minutes every 3 hours. For a generator application, increase the load to 50% load for a minimum of 10 minutes every 3 hours.

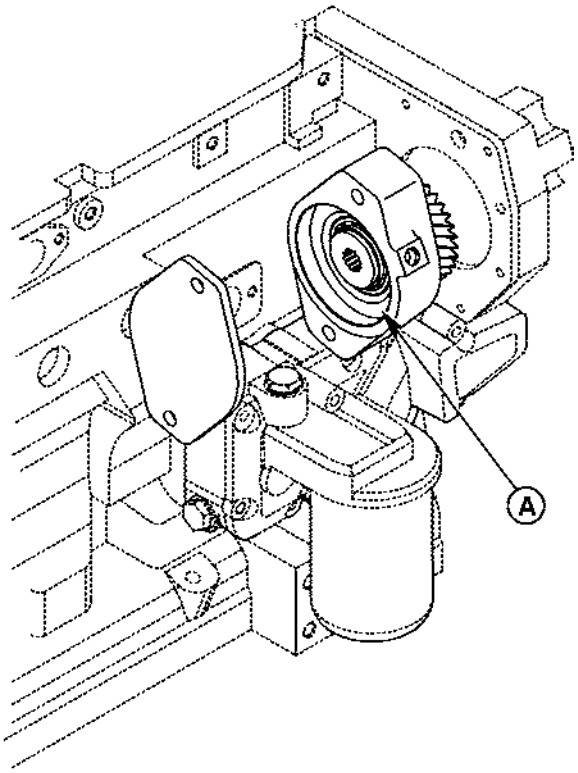
1 Load factor – is the actual fuel burned over a period of time divided by the full-power fuel consumption for the same period of time. For example, if an engine burns 160 L of fuel during an eight-hour run, and the full-power fuel consumption is 60 L per hour, the load factor is 160 L / (60 L per hour x 8 hours) = 33.3%.

Auxiliary Gear Drive Limitations

IMPORTANT: When attaching a sea water pump or other accessory to be driven by the auxiliary gear drive (A) (engine timing gear train at front of engine), power requirements of the accessory must be limited to values listed below:

- 30 kW (40 hp) Continuous Operation
- 37 kW (50 hp) Intermittent Operation

A—Auxiliary Gear Drive



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Auxiliary Gear Drive

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Engine Operation

IMPORTANT: DO NOT add makeup oil until the oil level is BELOW the ADD mark on dipstick. Northern Lights Engine Break-In Oil (TY22041) should be used to make up any oil consumed during the break-in period.

3. Check engine oil level more frequently during engine break-in period. If oil must be added during this period, Northern Lights Engine Break-In Oil is preferred. See ENGINE BREAK-IN OIL, in Fuels, Lubricants, and Coolant Section.

IMPORTANT: DO NOT use PLUS-50® Engine Oil during the break-in period of a new engine or engine that has had a major overhaul. PLUS-50 oil will not allow a new or overhauled engine to properly wear during this break-in period.

PLUS-50 is a trademark of Deere & Company

RG8028A —UN—15JAN99

Check Engine Oil

A—Crosshatch Pattern On Dipstick

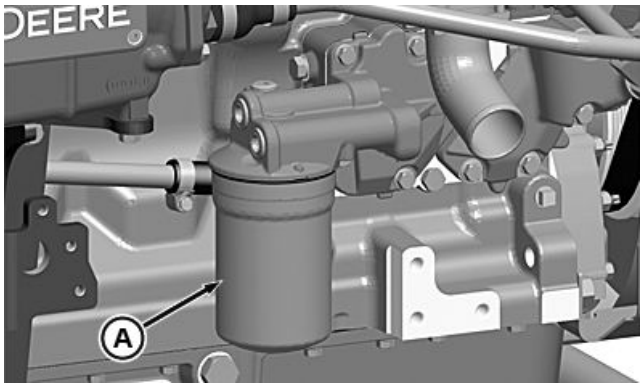
DO NOT fill above the crosshatch pattern (A) or the FULL mark, whichever is present. Oil levels anywhere within the crosshatch are considered in the acceptable operating range.

RG19661,00003BC -19-28FEB13-2/5

4. During the first 20 hours, avoid prolonged periods of engine idling. If engine will idle longer than 5 minutes, stop engine.
5. After the first 100 hours (maximum), change engine oil and replace engine oil filter (A). (See CHANGE ENGINE OIL AND FILTER in Lubrication and Maintenance/250 Hour Section.) Fill crankcase with seasonal viscosity grade oil. (See DIESEL ENGINE OIL, in Fuels, Lubricants, and Coolant Section.)

NOTE: Some increase in oil consumption may be expected when low viscosity oils are used. Check oil levels more frequently.

If air temperature is below -10°C (14°F), use an engine block heater.



RG22045 —UN—29NOV12

Remove Oil Filter

A—Oil Filter

RG19661,00003BC -19-28FEB13-3/5

6. Watch coolant temperature gauge (A) closely. If coolant temperature rises above maximum coolant temperature (see GENERAL ENGINE SPECIFICATIONS in Specifications Section), reduce load on engine. Check sea (raw) water strainer for plugging on heat exchanger engines. Unless temperature drops quickly, stop the engine and determine the cause before resuming operation.

A—Coolant Temperature Gauge

RG13133 —UN—07OCT03

Coolant Temperature Gauge - Electronically Controlled Engine

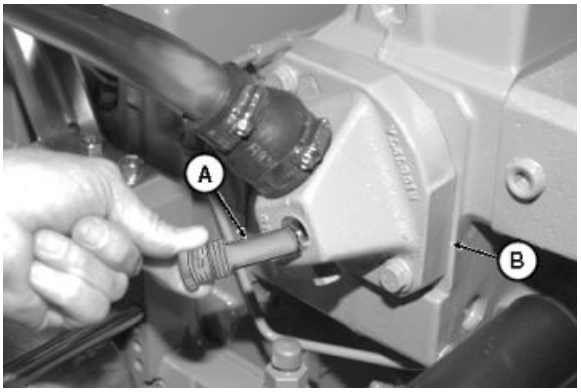
Continued on next page

RG19661,00003BC -19-28FEB13-4/5

7. Check poly-vee belt for proper alignment and seating in pulley grooves.

   Two zinc plugs (A) are installed in the sea water cooling system to help neutralize the corrosive action of salt water on internal cavities of marine engine components. The reaction of the zinc, when exposed to the salt water, causes the plugs to deteriorate instead of critical engine components.
8. After the first 50—100 hours or 2—4 weeks of operation, remove zinc plug from each heat exchanger end cap (B) and inspect for corrosion to get an idea of rate of deterioration in sea water.

   If rate of corrosion is slight at 50—100 hours or 2—4 weeks initial inspection, zinc plugs should be inspected at 250 hour intervals thereafter. (See INSPECT AND REPLACE ZINC PLUGS in Lubrication & Maintenance/250 Hour Section)



A—Zinc Plugs **B—End Cap**

RG19661,00003BC -19-28FEB13-5/5

Generator Set Power Units

To assure that your engine will deliver efficient generator operation when needed, start engine and run at rated speed (with 50%—70% load) for 30 minutes every 2 weeks. DO NOT allow engine to run extended period of time with no load.

RG,RG34710,5556 -19-20MAY96-1/1

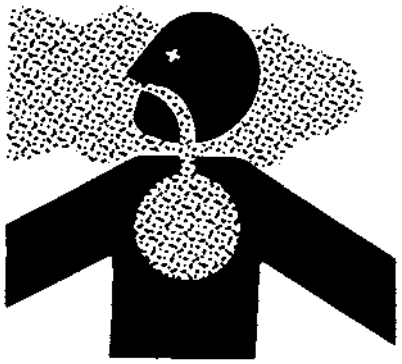
Starting the Engine

The following instructions apply to the optional controls and instruments available through the Northern Lights Parts Distribution Network. The controls and instruments for your engine may be different from those shown here; always follow manufacturer's instructions.

⚠ CAUTION: Before starting engine in a confined engine room, install proper outlet exhaust ventilation equipment. Always use safety approved fuel storage and piping.

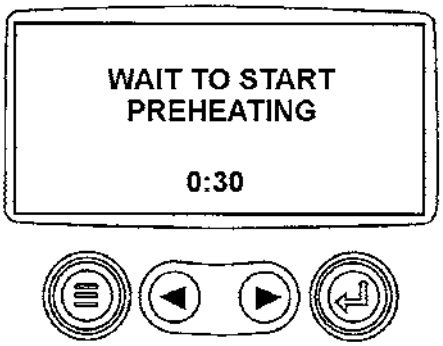
NOTE: If temperature is below 0°C (32°F), it may be necessary to use cold weather starting aids (See COLD WEATHER OPERATION, later in this section).

1. Perform all prestarting checks outlined in Lubrication & Maintenance/Daily Section later in this manual.
2. Open the fuel supply shut-off valve.
3. Set marine gear control lever in the “NEUTRAL” position on propulsion units.
4. Move the throttle control lever approximately 1/3 of the way off the idle position.
5. Turn the key switch to the ON position. The "Wait To Start Preheating" message will be displayed when ambient temperatures require preheating (for engines with preheating options). The timer will display minutes and seconds, counting down to zero. Once the timer has reach 0:00 and the "Wait to Start" message is no longer displayed, you may start the engine.



Use Proper Ventilation

TS220 —UN—23AUG88



Wait To Start Screen

RG13233 —UN—29SEP03

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RG19661,00003BD -19-23JAN13-1/2

IMPORTANT: Do not operate the starter for more than 30 seconds at a time. To do so may overheat the starter. If the engine does not start the first time, wait at least 2 minutes before trying again. If engine does not start after four attempts, see Troubleshooting Section.

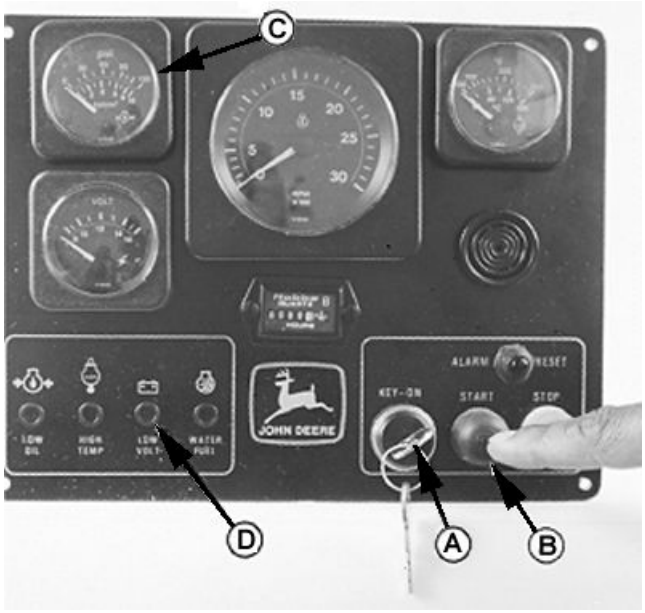
If the start switch button is released before the engine starts, wait until the starter and the engine stop turning before trying again. This will prevent possible damage to the starter and/or flywheel.

NOTE: Key switch (A) on main (standard) instrument panel must be in "ON" position to start engine using fly bridge (optional) instrument panel.

6. Press start button (B) to crank the engine. When the engine starts, release the button.
7. After the engine starts, observe the oil pressure gauge (C) until it reads at least the slow idle pressure specified for your engine in the Specifications Section.
8. Warm up the engine at or below 1200 rpm with no load for 1-2 minutes. See following guidelines.
9. Check all gauges for normal engine operation. If operation is not normal, stop the engine and determine the cause.
10. Check sea water outlet for water flow. Check exhaust pipe for water flow on engines with wet exhaust systems.

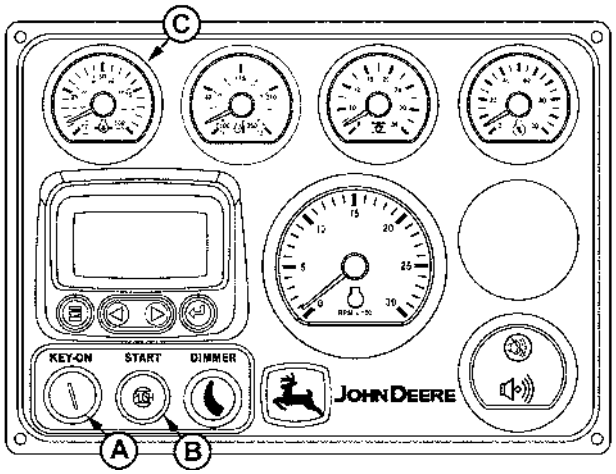
    If sea water does not flow within one minute after engine starts, stop engine and check sea cock, sea water strainer, and sea water pump for restrictions.

A—Key Switch
B—Start Button
C—Oil Pressure Gauge
D—Warning Light



RG13291 —UN—06NOV03

Start Engine - Mechanically Controlled Engine



RG13134 —UN—07OCT03

Start Engine - Electronically Controlled Engine

RG19661,00003BD -19-23JAN13-2/2

Engaging And Disengaging Front PTO (If Equipped)

CAUTION: Entanglement in rotating driveline can cause serious injury or death. Keep shield on PTO driveshaft between clutch housing and the engine driven equipment at all times during engine operation. Wear close fitting clothing. Stop the engine and be sure PTO driveline is stopped before making adjustments.

CAUTION: Metal surfaces of PTO housing may be hot to the touch during operation or at shutdown.

The optional front power take-off (PTO) from Northern Lights transfers engine power to auxiliary equipment or moving components.

The PTO clutch is electric and engaged by a switch. Engage the clutch on propulsion engines at engine speeds below 1200 rpm. Engage Gen-Set engines at no load rpm.

TS198 —UN—23AUG88

Avoid Entanglement

If the power take-off does not work properly, contact your authorized servicing dealer or engine distributor.

OURGP11,0000144 -19-08DEC03-1/1

Cold Weather Operation

Additional information on cold weather operation is available from your engine distributor or authorized servicing dealer.

Some engines are equipped with an air intake heater which will make starting the engine easier in cold weather. If equipped, follow steps 1–4 as listed under STARTING THE ENGINE, earlier in this section. Switch on the air intake heater for 30 seconds and then proceed to operate the starter. Follow remaining steps 5–11.

Synthetic oils improve flow at low temperatures, especially in arctic conditions.

CAUTION: Starting fluid is highly flammable. DO NOT use starting fluid on engines equipped with air intake heaters.

DO NOT use starting fluid near fire, sparks, or flames. DO NOT incinerate or puncture a starting fluid container.

TS1356 —UN—18MAR92

Starting Fluid is Flammable

OUOD006,0000080 -19-22JUN07-1/1

Using a Booster Battery or Charger

A 12-volt booster battery can be connected in parallel with battery(ies) on the unit to aid in cold weather starting. ALWAYS use heavy duty jumper cables.

CAUTION: Gas given off by battery is explosive. Keep sparks and flames away from battery. Before connecting or disconnecting a battery charger, turn charger off. Make last connection and first disconnection at a point away from battery. Always connect NEGATIVE (–) cable last and disconnect this cable first.

IMPORTANT: Be sure polarity is correct before making connections. Reversed polarity will damage electrical system. Always connect positive to positive and negative to ground. Always use 12-volt booster battery for 12-volt electrical systems and 24-volt booster battery(ies) for 24-volt electrical systems.

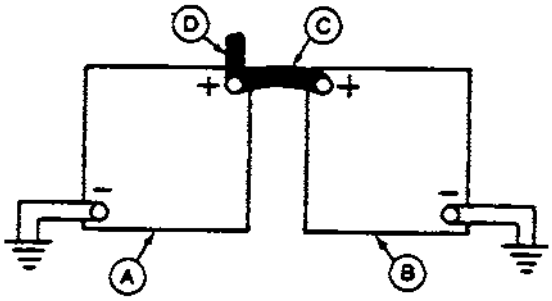
1. Connect booster battery or batteries to produce the required system voltage for your engine application.

NOTE: To avoid sparks, DO NOT allow the free ends of jumper cables to touch the engine.

2. Connect one end of jumper cable to the POSITIVE (+) post of the booster battery.
3. Connect the other end of the jumper cable to the POSITIVE (+) post of battery connected to starter.
4. Connect one end of the other jumper cable to the NEGATIVE (–) post of the booster battery.
5. ALWAYS complete the hookup by making the last connection of the NEGATIVE (–) cable to a good ground on the engine frame and away from the battery(ies).
6. Start the engine. Disconnect jumper cables immediately after engine starts. Disconnect NEGATIVE (–) cable first.

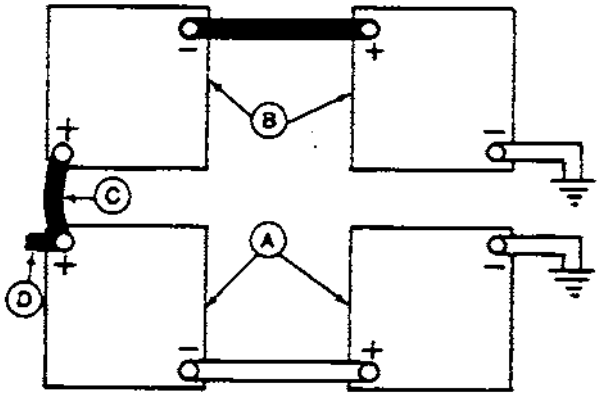
TS204 —UN—23AUG88

Exploding Battery



RG4678 —UN—14DEC88

12-Volt System



RG4698 —UN—14DEC88

24-Volt System

A—12-Volt Machine Battery (ies)
B—12-Volt Booster Battery (ies)
C—Booster Cable
D—Cable to Starting Motor

RG,RG34710,5564 -19-03JAN02-1/1

Welding Near Electronic Control Units

IMPORTANT: Do not jump-start engines with arc welding equipment. Currents and voltages are too high and may cause permanent damage.

1. Disconnect the negative (-) battery cable(s).
2. Disconnect the positive (+) battery cable(s).
3. Connect the positive and negative cables together. Do not attach to vehicle frame.
4. Clear or move any wiring harness sections away from welding area.
5. Connect welder ground close to welding point and away from control units.

TS953 —UN—15MAY90

6. After welding, reverse Steps 1—5.

DX,WW,ECU02 -19-14AUG09-1/1

Keep Electronic Control Unit Connectors Clean

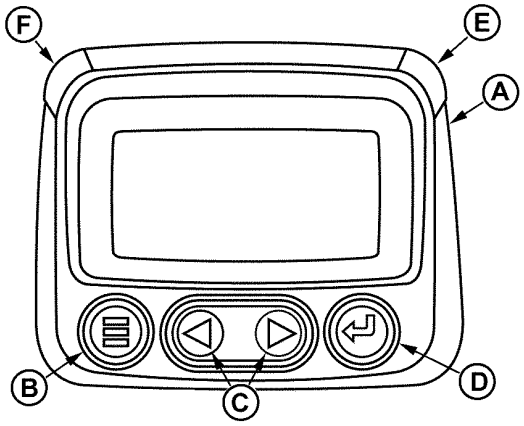
IMPORTANT: Do not open control unit and do not clean with a high-pressure spray. Moisture, dirt, and other contaminants may cause permanent damage.

1. Keep terminals clean and free of foreign debris. Moisture, dirt, and other contaminants may cause the terminals to erode over time and not make a good electrical connection.
2. If a connector is not in use, put on the proper dust cap or an appropriate seal to protect it from foreign debris and moisture.
3. Control units are not repairable.
4. Since control units are the components LEAST likely to fail, isolate failure before replacing by completing a diagnostic procedure. (See your Northern Lights dealer.)
5. The wiring harness terminals and connectors for electronic control units are repairable.

DX,WW,ECU04 -19-11JUN09-1/1

Using Diagnostic Gauge to Access Engine Information

Diagnostic Gauge
A - Diagnostic Gauge
B - Menu Key
C - Arrow Keys
D - Enter Key
E - Red “STOP ENGINE” Indicator Light
F - Amber “WARNING” Indicator Light



RG13132-UN-09SEP03

The diagnostic gauge (A) allows the operator to view many readouts of engine functions and trouble codes (DTCs). The gauge is linked to the electronic control system and its sensors. This allows the operator to monitor engine functions and to troubleshoot the engine systems when needed. Press the menu key (B) to access the various engine functions in sequence. The displays can be selected as either customary English or metric units.

The following menu of engine parameters can be displayed on the diagnostic gauge window:

- *Engine hours*
- *Engine rpm*
- *System voltage*
- *Percent engine load at the current rpm*
- *Coolant temperature*
- *Oil pressure*
- *Throttle position*
- *Intake manifold temperature*
- *Current fuel consumption*
- *Active service (diagnostic) codes*
- *Stored service (diagnostic) codes from the engine*
- *Set the units for display*
- *View the engine configuration parameters*

The diagnostic gauge includes a graphical backlit Liquid Crystal Display (LCD) screen. The display can show either a single parameter or a quadrant display showing four parameters simultaneously. The diagnostic gauge uses two arrow keys (C) for scrolling through the engine parameter list and viewing the menu list and an enter key (D) for selecting highlighted items. The red (E) and amber (F) lights are used to signal active trouble code received by the diagnostic gauge.

Lubrication and Maintenance

Use Correct Fuels, Lubricants, and Coolant

IMPORTANT: Use only fuels, lubricants, and coolants meeting specifications outlined in Fuels, Lubricants, and Coolant Section when servicing your Northern Lights Engine.

Consult your Northern Lights engine distributor, servicing dealer or your nearest Northern Lights Parts Network for recommended fuels, lubricants, and coolant. Also available are necessary additives for use when operating engines in tropical arctic, or any other adverse conditions.

TS100 —UN—23AUG88

Parts Network

DPSG,OUOE003,20 -19-19JUN07-1/1

Diesel Fuel

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended. Renewable diesel fuel produced by hydrotreating animal fats and vegetable oils is basically identical to petroleum diesel fuel. Renewable diesel that meets EN 590 or ASTM D975 is acceptable for use at all percentage mixture levels.

Required Fuel Properties

In all cases, the fuel shall meet the following properties:

Cetane number of 43 minimum. Cetane number greater than 47 is preferred, especially for temperatures below –20°C (–4°F) or elevations above 1500 m (5000 ft.).

Cold Filter Plugging Point (CFPP) should be at least 5°C (9°F) below the expected lowest temperature or **Cloud Point** below the expected lowest ambient temperature.

Fuel lubricity should pass a maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

Diesel fuel quality and sulfur content must comply with all existing emissions regulations for the area in which the engine operates. DO NOT use diesel fuel with sulfur content greater than 10 000 mg/kg (10 000 ppm).

Sulfur content for Interim Tier 4 and Stage III B engines

- Use ONLY ultra low sulfur diesel (ULSD) fuel with a maximum of 15 mg/kg (15 ppm) sulfur content.

Sulfur Content for Tier 3 and Stage III A Engines

- Use of diesel fuel with sulfur content less than 1000 mg/kg (1000 ppm) is RECOMMENDED
- Use of diesel fuel with sulfur content 1000–5000 mg/kg (1000–5000 ppm) REDUCES oil and filter change intervals.
- BEFORE using diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm), contact your Northern Lights dealer

Sulfur Content for Tier 2 and Stage II Engines

- Use of diesel fuel with sulfur content less than 500 mg/kg (500 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 500–5000 mg/kg (500–5000 ppm) REDUCES the oil and filter change interval
- BEFORE using diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm), contact your Northern Lights dealer

Sulfur Content for Other Engines

- Use of diesel fuel with sulfur content less than 5000 mg/kg (5000 ppm) is recommended.
- Use of diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm) REDUCES the oil and filter change intervals.

IMPORTANT: Do not mix used diesel engine oil or any other type of lubricating oil with diesel fuel.

IMPORTANT: Improper fuel additive usage may cause damage on fuel injection equipment of diesel engines.

DX,FUEL1 -19-11APR11-1/1

Supplemental Diesel Fuel Additives

Diesel fuel can be the source of performance or other operational problems for many reasons. Some causes include poor lubricity, contaminants, low cetane number, and a variety of properties that cause fuel system deposits. These and others are referenced in other sections of this Operator's Manual.

To optimize engine performance and reliability, closely follow recommendations on fuel quality, storage, and handling, which are found elsewhere in this Operator's Manual.

To further aid in maintaining performance and reliability of the engine's fuel system,Northern Lights has developed a family of fuel additive products for most global markets. The primary products include Fuel-Protect Diesel Fuel Conditioner (full feature conditioner in winter and summer formulas) and Fuel-Protect Keep Clean (fuel injector deposit removal and prevention). Availability of these and other products varies by market. See your local dealer for availability and additional information about fuel additives that might be right for your needs.

DX,FUEL13-19-20140207

Lubricity of Diesel Fuel

Most diesel fuels manufactured in the United States, Canada, and the European Union have adequate lubricity to ensure proper operation and durability of fuel injection system components. However, diesel fuels manufactured in some areas of the world may lack the necessary lubricity.

IMPORTANT: Make sure the diesel fuel used in your machine demonstrates good lubricity characteristics.

Fuel lubricity should pass a maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

If fuel of low or unknown lubricity is used, add Northern Lights Fuel-Protect Diesel Fuel Conditioner (or equivalent) at the specified concentration.

Lubricity of Biodiesel Fuel

Fuel lubricity can improve significantly with biodiesel blends up to B20 (20% biodiesel). Further increase in lubricity is limited for biodiesel blends greater than B20.

DX,FUEL5 -19-14APR11-1/1

Handling and Storing Diesel Fuel

CAUTION: Reduce the risk of fire. Handle fuel carefully. DO NOT fill the fuel tank when engine is running. DO NOT smoke while you fill the fuel tank or service the fuel system.

Fill the fuel tank at the end of each day's operation to prevent water condensation and freezing during cold weather.

Keep all storage tanks as full as practicable to minimize condensation.

Ensure that all fuel tank caps and covers are installed properly to prevent moisture from entering. Monitor water content of the fuel regularly.

When using biodiesel fuel, the fuel filter may require more frequent replacement due to premature plugging.

Check engine oil level daily prior to starting engine. A rising oil level may indicate fuel dilution of the engine oil.

IMPORTANT: The fuel tank is vented through the filler cap. If a new filler cap is required, always replace it with an original vented cap.

When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and prevent water condensation. Contact your fuel supplier for recommendations.

DX,FUEL4 -19-14APR11-1/1

Biodiesel Fuel

Biodiesel fuel is comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Biodiesel blends are biodiesel mixed with petroleum diesel fuel on a volume basis.

Before using fuel containing biodiesel, review the Biodiesel Use Requirements and Recommendations in this Operator's Manual.

Environmental laws and regulations can encourage or prohibit the use of biofuels. Operators should consult with appropriate governmental authorities prior to using biofuels.

All Northern Lights Engines with Exhaust Filter (Released 2011 and After)

While 5% blends (B5) are preferred, biodiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. Biodiesel blends up to B20 can be used ONLY if the biodiesel (100% biodiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

Biodiesel concentrations above B20 can harm the engine's emission control systems and should not be used. Risks include, but are not limited to, more frequent stationary regeneration, soot accumulation, and increased intervals for ash removal.

Northern Lights approved fuel conditioners, which contain detergent and dispersant additives, are required when using B20, and are recommended when using lower biodiesel blends.

All Northern Lights Engines Excluding Exhaust Filter (Primarily Released Prior to 2012)

While 5% blends (B5) are preferred, biodiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. Biodiesel blends up to B20 can be used ONLY if the biodiesel (100% biodiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

These Northern Lights engines can operate on biodiesel blends above B20 (up to 100% biodiesel). Operate at levels above B20 ONLY if the biodiesel is permitted by law and meets the EN 14214 specification (primarily available in Europe). Engines operating on biodiesel blends above B20 might not fully comply with or be permitted by all applicable emissions regulations. Expect up to a 12% reduction in power and an 18% reduction in fuel economy when using 100% biodiesel.

Northern Lights approved fuel conditioners, which contain detergent and dispersant additives, are required when using B20, and are recommended when using lower biodiesel blends.

Biodiesel Use Requirements and Recommendations

The petroleum diesel portion of all biodiesel blends must meet the requirements of ASTM D975 (US) or EN 590 (EU) commercial standards.

Biodiesel users in the U.S. are strongly encouraged to purchase biodiesel blends from a BQ-9000 Certified Marketer and sourced from a BQ-9000 Accredited Producer (as certified by the National Biodiesel Board). Certified Marketers and Accredited Producers can be found at the following website: http://www.bq9000.org.

Biodiesel contains residual ash. Ash levels exceeding the maximums allowed in either ASTM D6751 or EN14214 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present).

The fuel filter can require more frequent replacement, when using biodiesel fuel, particularly if switching from diesel. Check engine oil level daily prior to starting engine. A rising oil level can indicate fuel dilution of the engine oil. Biodiesel blends up to B20 must be used within 90 days of the date of biodiesel manufacture. If used, biodiesel blends above B20 must be used within 45 days from the date of biodiesel manufacture.

When using biodiesel blends up to B20, the following must be considered:

- Cold weather flow degradation
- Stability and storage issues (moisture absorption, microbial growth)
- Possible filter restriction and plugging (usually a problem when first switching to biodiesel on used engines.)
- Possible fuel leakage through seals and hoses (primarily an issue with older engines)
- Possible reduction of service life of engine components

Request a certificate of analysis from your fuel distributor to ensure that the fuel is compliant with the specifications provided in this Operator's Manual.

Consult your Northern Lights dealer for approved fuel conditioners to improve storage and performance with biodiesel fuels.

The following must also be considered if using biodiesel blends above B20:

- Possible coking or blocked injector nozzles, resulting in power loss and engine misfire if Northern Lights approved fuel conditioners are not used
- Possible crankcase oil dilution (requiring more frequent oil changes)
- Possible lacquering or seizure of internal components
- Possible formation of sludge and sediments
- Possible thermal oxidation of fuel at elevated temperatures
- Possible compatibility issues with other materials (including copper, lead, zinc, tin, brass, and bronze) used in fuel handling equipment
- Possible reduction in water separator efficiency
- Possible damage to paint if exposed to biodiesel

Continued on next page

- Possible corrosion of fuel injection equipment
- Possible elastomeric seal and gasket material degradation (primarily an issue with older engines)
- Possible high acid levels within fuel system
- Because biodiesel blends above B20 contain more ash, using blends above B20 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present)

IMPORTANT: Raw pressed vegetable oils are NOT acceptable for use as fuel in any concentration in Northern Lights engines. Their use could cause engine failure.

DX,FUEL7 -19-29AUG12-2/2

Testing Diesel Fuel

A fuel analysis program can help to monitor the quality of diesel fuel. The fuel analysis can provide critical data such as cetane number, fuel type, sulfur content, water content, appearance, suitability for cold weather operations, bacteria, cloud point, acid number, particulate contamination, and whether the fuel meets specification.

Contact your Northern Lights dealer for more information on diesel fuel analysis.

Fuel Filters

The importance of fuel filtration cannot be overemphasized with modern fuel systems. The combination of increasingly restrictive emission regulations and more efficient engines requires fuel system to operate at much higher pressures. Higher pressures can only be achieved using fuel injection components with very close tolerances. These close manufacturing tolerances have significantly reduced capacities for debris and water.
Northern Lights brand fuel filters have been designed and produced specifically for Northern Lights engines.
To protect the engine from debris and water, always change engine fuel filters as specified in this manual.

Minimizing the Effect of Cold Weather on Diesel Engines

Northern Lights diesel engines are designed to operate effectively in cold weather.

However, for effective starting and cold weather operation, a little extra care is necessary. The information below outlines steps that can minimize the effect that cold weather may have on starting and operation of your engine. See your Northern Lights dealer for additional information and local availability of cold weather aids.

Use Winter Grade Fuel

When temperatures fall below 0°C (32°F), winter grade fuel (No. 1-D in North America) is best suited for cold weather operation. Winter grade fuel has a lower cloud point and a lower pour point.

Cloud point is the temperature at which wax will begin to form in the fuel and this wax causes fuel filters to plug. **Pour point** is the lowest temperature at which movement of the fuel is observed.

NOTE: On average, winter grade diesel fuel has a lower Btu (heat content) rating. Using winter grade fuel may reduce power and fuel efficiency, but should not cause any other engine performance effects. Check the grade of fuel being used before troubleshooting for low power complaints in cold weather operation.

Air Intake Heater

An air intake heater is an available option for some engines to aid cold weather starting.

Ether

An ether port on the intake is available to aid cold weather starting.

CAUTION: Ether is highly flammable. Do not use ether when starting an engine equipped with glow plugs or an air intake heater.

Coolant Heater

An engine block heater (coolant heater) is an available option to aid cold weather starting.

Seasonal Viscosity Oil and Proper Coolant Concentration

Use seasonal grade viscosity engine oil based on the expected air temperature range between oil changes and a proper concentration of low silicate antifreeze as recommended. (See DIESEL ENGINE OIL and ENGINE COOLANT requirements in this section.)

Diesel Fuel Flow Additive

Use Northern Lights Fuel-Protect Diesel Fuel Conditioner (winter formula), which contains anti-gel chemistry, or equivalent fuel conditioner to treat non-winter grade fuel (No. 2-D in North America) during the cold weather season. This generally extends operability to about 10°C (18°F) below the fuel cloud point. For operability at even lower temperatures, use winter grade fuel.

IMPORTANT: Treat fuel when outside temperature drops below 0°C (32°F). For best results, use with untreated fuel. Follow all recommended instructions on label.

BioDiesel

When operating with biodiesel blends, wax formation can occur at warmer temperatures. Begin using Northern Lights Fuel-Protect Diesel Fuel Conditioner (winter formula) at 5°C (41°F) to treat biodiesel fuels during the cold weather season. Use B5 or lower blends at temperatures below 0°C (32°F). Use only winter grade petroleum diesel fuel at temperatures below -10°C (14°F).

Winterfronts

Use of fabric, cardboard, or solid winterfronts is not recommended with any Northern Lights engine. Their use can result in excessive engine coolant, oil, and charge air temperatures. This can lead to reduced engine life, loss of power and poor fuel economy. Winterfronts may also put abnormal stress on fan and fan drive components potentially causing premature failures.

If winterfronts are used, they should never totally close off the grill frontal area. Approximately 25% area in the center of the grill should remain open at all times. At no time should the air blockage device be applied directly to the radiator core.

Radiator Shutters

If equipped with a thermostatically controlled radiator shutter system, this system should be regulated in such a way that the shutters are completely open by the time the coolant reaches 93°C (200°F) to prevent excessive intake manifold temperatures. Manually controlled systems are not recommended.

If air-to-air aftercooling is used, the shutters must be completely open by the time the intake manifold air temperature reaches the maximum allowable temperature out of the charge air cooler.

For more information, see your Northern Lights dealer.

DX,FUEL10 -19-20APR11-1/1

Diesel Engine Break-In Oil

New engines are filled at the factory with either Northern Lights Break-In™ or Northern Lights Break-In Plus™ Engine Oil. During the break-in period, add Northern Lights Break-In™ or Break-In Plus ™ Engine Oil, respectively, as needed to maintain the specified oil level.

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

If Northern Lights Break-In Engine Oil is used during the initial operation of a new or rebuilt engine, change the oil and filter at a maximum of 250 hours.

If Northern Lights Break-In Plus Engine Oil is used, change the oil and filter at a minimum of 100 hours and a maximum equal to the interval specified for Northern Lights Plus-50™ II or Plus-50 oil.

After engine overhaul, fill the engine with either Northern Lights Break-In™ or Break-In Plus™ Engine Oil.

If Northern Lights Break-In or Break-In Plus Engine Oil is not available, use an SAE 10W-30 viscosity grade diesel engine oil meeting one of the following and change the oil and filter at a maximum of 100 hours of operation:

- API Service Classification CE
- API Service Classification CD
- API Service Classification CC
- ACEA Oil Sequence E2
- ACEA Oil Sequence E1

IMPORTANT: Do not use Plus-50™ II, Plus-50 or engine oils meeting any of the following for the initial break-in of a new or rebuilt engine:

API CJ-4	**ACEA E9**
API CI-4 PLUS	**ACEA E7**
API CI-4	**ACEA E6**
API CH-4	**ACEA E5**
API CG-4	**ACEA E4**
API CF-4	**ACEA E3**
API CF-2	
API CF	

These oils will not allow the engine to break in properly.

Northern Lights Break-In Plus™ Engine Oil can be used for all Northern Lights diesel engines at all emission certification levels.

After the break-in period, use Northern Lights Plus-50™ II, Northern Lights Plus-50, or other diesel engine oil as recommended in this manual.

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Break-In Plus is a trademark of Deere & Company
Plus-50 is a trademark of Deere & Company.

DX,ENOIL4 -19-20APR11-1/1

Diesel Engine Oil

Use oil viscosity based on the expected air temperature range during the period between oil changes.

Northern Lights Plus-50™ II oil is preferred.

Northern Lights Plus-50™ is also recommended.

Other oils may be used if they meet one or more of the following:

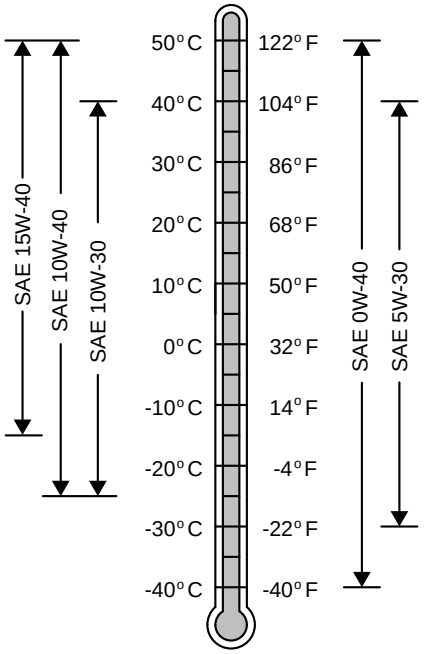
- Northern Lights Torq-Gard™
- API Service Category CJ-4
- API Service Category CI-4 PLUS
- API Service Category CI-4
- ACEA Oil Sequence E9
- ACEA Oil Sequence E7
- ACEA Oil Sequence E6
- ACEA Oil Sequence E5
- ACEA Oil Sequence E4

Multi-viscosity diesel engine oils are preferred.

Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.

DO NOT use diesel fuel with sulfur content greater than 10 000 mg/kg (10 000 ppm).

Plus-50 is a trademark of Deere & Company
Torq-Gard is a trademark of Deere & Company



Oil Viscosities for Air Temperature Ranges

DX,ENOIL11 -19-11APR11-1/1

Diesel Engine Oil and Filter Service Intervals

The oil and filter service intervals in the following table should be used as guidelines. Actual service intervals also depend on operation and maintenance practices. It is suggested to use oil analysis to determine the actual useful life of the oil and to aid in selection of the proper oil and filter service interval.

Oil and filter service intervals are based on a combination of oil pan capacity, type of engine oil and filter used, and sulfur content of the diesel fuel.

Engine Oil and Filter Service Intervals	
	Standard Drain Oil Pan
Fuel Sulfur	Less than 0.05% (500 mg/kg)
Plus-50	375 hours
Other Oils	250 hours
Fuel Sulfur	0.05 - 0.50% (500 - 5000 mg/kg)
Plus-50	275 hours
Other Oils	150 hours
Fuel Sulfur	0.50 - 1.00% (5000 - 10 000 mg/kg)
Plus-50	187 hours
Other Oils	125 hours
The service interval of “Other Oils” may be extended only if oil analysis is performed to determine the actual service life, to a maximum not to exceed that of Plus-50.	

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Torq-Gard Supreme is a trademark of Deere & Company

Diesel fuel sulfur level will affect engine oil and filter service intervals. Higher fuel sulfur levels reduce oil and filter service intervals as shown in the table.

- Use of diesel fuel with sulfur content less than 0.05% (500 mg/kg) is strongly recommended.
- Use of diesel fuel with sulfur content 0.05% (500 mg/kg) to 0.50% (5000 mg/kg) may result in REDUCED oil and filter change intervals as shown in the table.
- BEFORE using diesel fuel with sulfur content greater than 0.50% (5000 mg/kg), contact your Northern Lights dealer.

IMPORTANT: When using biodiesel blends greater than B20, reduce the oil and filter service interval by 50% or monitor engine oil based on test results from Oilscan.

Oil types in the table include:

- Northern Lights Plus-50™ II and John Deere Plus-50 oils.
- “Other Oils” include John DeereTorq-Gard Supreme™,

  API CJ-4, API CI-4 PLUS, API CI-4, ACEA E9, ACEA E7, ACEA E6, ACEA E5, ACEA or E4 oils.

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Mixing of Lubricants

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your Northern Lights dealer to obtain specific information and recommendations.

DX,LUBMIX -19-18MAR96-1/1

Alternative and Synthetic Lubricants

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual.

Some Northern Lights brand coolants and lubricants may not be available in your location.

Consult your Northern Lights dealer to obtain information and recommendations.

Synthetic lubricants may be used if they meet the performance requirements as shown in this manual.

The temperature limits and service intervals shown in this manual apply to both conventional and synthetic lubricants.

Re-refined base stock products may be used if the finished lubricant meets the performance requirements.

DX,ALTER -19-11APR11-1/1

Lubricant Storage

Your equipment can operate at top efficiency only when clean lubricants are used.

Use clean containers to handle all lubricants.

Store lubricants and containers in an area protected from dust, moisture, and other contamination. Store containers on their side to avoid water and dirt accumulation.

Make certain that all containers are properly marked to identify their contents.

Properly dispose of all old containers and any residual lubricant they may contain.

DX,LUBST -19-11APR11-1/1

Oil Filters

Filtration of oils is critically important for proper operation and lubrication. Northern Lights brand oil filters have been designed and produced specifically for Northern Lights applications.

Northern Lights filters adhere to engineering specifications for quality of the filter media, filter efficiency rating, strength of the bond between the filter media and the element end cap, fatigue life of the canister (if applicable), and pressure capability of the filter seal. Non-Northern Lights branded oil filters might not meet these key Northern Lights specifications.

Always change oil filters regularly as specified in this manual.

Diesel Engine Coolant (engine with wet sleeve cylinder liners)

Preferred Coolants

The following pre-mix engine coolants are preferred:
• Northern Lights COOL-GARD™II
• Northern Lights COOL-GARD II PG

COOL-GARD II pre-mix coolant is available in several concentrations with different freeze protection limits as shown in the following table.

COOL-GARD II pre-mix	Freeze Protection Limit
COOL-GARD II 20/80	-9 °C (16 °F)
COOL-GARD II 30/70	-16 °C (3 °F)
COOL-GARD II 50/50	-37 °C (-34 °F)
COOL-GARD II 55/45	-45 °C (-49 °F)
COOL-GARD II PG 60/40	-49 °C (-56 °F)
COOL-GARD II 60/40	-52 °C (-62 °F)

Not all COOL-GARD II pre-mix products are available in all countries.

Use COOL-GARD II PG when a non-toxic coolant formulation is required.

Additional Recommended Coolants

The following engine coolant is also recommended:

• Northern Lights COOL-GARD II Concentrate in a 40-60% mixture of concentrate with quality water.

IMPORTANT: When mixing coolant concentrate with water, do not use less than 40% or greater than 60% concentration of coolant. Less than 40% gives inadequate additives for corrosion protection. Greater than 60% can result in coolant gelation and cooling system problems.

Other Coolants

Other ethylene glycol or propylene glycol base coolants may be used if they meet the following specification:

• Pre-mix coolant meeting ASTM D6210 requirements
• Coolant concentrate meeting ASTM D6210 requirements in a 40-60% mixture of concentrate with quality water

If coolant meeting one of these specifications is unavailable, use a coolant concentrate or pre-mix coolant that has a minimum of the following chemical and physical properties:

• Provides cylinder liner cavitation protection according to either the Northern Lights Cavitation Test Method or a fleet study run at or above 60% load capacity
• Is formulated with a nitrite-free additive package
• Protects the cooling system metals (cast iron, aluminum alloys, and copper alloys such as brass) from corrosion

Water Quality

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

Coolant Drain Intervals

Drain and flush the cooling system and refill with fresh coolant at the indicated interval, which varies with the coolant used.

When COOL-GARD II or COOL-GARD II PG is used, the drain interval is 6 years or 6000 hours of operation.

If a coolant other than COOL-GARD II or COOL-GARD II PG is used, reduce the drain interval to 2 years or 2000 hours of operation.

IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.

Do not mix ethylene glycol and propylene glycol base coolants.

Do not use coolants that contain nitrites.

Water Quality for Mixing with Coolant Concentrate

Engine coolants are a combination of three chemical components: ethylene glycol (EG) or propylene glycol (PG) antifreeze, inhibiting coolant additives, and quality water.

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

All water used in the cooling system should meet the following minimum specifications for quality:

Chlorides	<40 mg/L
Sulfates	<100 mg/L
Total solids	<340 mg/L
Total dissolved I hardness	<170 mg/L
pH	5.5—9.0

IMPORTANT: Do not use bottled drinking water because it often contains higher concentrations of total dissolved solids.

Freeze Protection

The relative concentrations of glycol and water in the engine coolant determine its freeze protection limit.

Ethylene Glycol	Freeze Protection Limit
40%	-24 °C (-12 °F)
50%	-37 °C (-34 °F)
60%	-52 °C (-62 °F)
Propylene Glycol	**Freeze Protection Limit**
40%	-21 °C (-6 °F)
50%	-33 °C (-27 °F)
60%	-49 °C (-56 °F)

DO NOT use a coolant-water mixture greater than 60% ethylene glycol or 60% propylene glycol.

Operating in Warm Temperature Climates

Northern Lights engines are designed to operate using recommended engine coolants.

Always use a recommended engine coolant, even when operating in geographical areas where freeze protection is not required.

IMPORTANT: Water may be used as coolant in emergency situations only.

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended engine coolant as soon as possible.

Lubrication and Maintenance Service Interval Chart—Propulsion and Prime Power Units

	Lubrication and Maintenance Service Intervals				
Item	Daily/Before Every Startup	250 Hour/6 Month	500 Hour/12 Month	2000 Hour/24 Month	Service As Required
Check Engine Oil Level and Coolant Level	•				
Check Sea Water Strainer	•				
Check Air Cleaner Dust Unloader Valve & Restriction Indicator Gauge [a]	•				
Visual Walkaround Inspection	•				
Drain Water From Fuel Filter	•				•
Change Engine Oil And Replace Oil Filter [b]		•			
Service Fire Extinguisher		•			
Service Battery		•			
Inspect and Replace Zinc Plugs		•			
Check Belt Tension and Wear (Manual Tensioner)		•			
Check Engine Mounts		•			
Replace Crankcase Vent Filter (If Equipped)			•		
Clean Crankcase Ventilation Assembly			•		
Check Air Intake Hoses, Connections, & System			•		
Replace Fuel Filter Elements			•		
Check Automatic Belt Tensioner and Belt Wear			•		
Check Cooling System			•		
Coolant Solution Analysis-Add SCAs as required			•		
Inspect and Clean Heat Exchanger Core and Aftercooler Core (If Equipped)			•		
Check Engine Speeds			•		
Check Engine Electrical Ground			•		
Check Crankshaft Vibration Damper (6-Cylinder)				•	
Pressure Test Cooling System				•	
Inspect and Repair Sea Water Pump				•	
Check and Adjust Engine Valve Clearance				•	
Flush And Refill Cooling System [c]				•	
Test Thermostats				•	
Add Coolant					•
Replace Air Cleaner Element					•
Service Dry Air Cleaner Element					•
Replace Alternator Drive Belt					•
Check Front PTO (If Equipped)					•
Bleed Fuel System					•

[a] Replace primary air cleaner element when restriction indicator shows a vacuum of 625 mm (52 in.) H2O, or when reset button has popped up (6068SFM75 / AFM75 only).

[b] Change the oil for the first time before 100 hours maximum of (break-in) operation, then every 250 hours thereafter. If Northern Lights PLUS-50 or ACEA-E7, ACEA-E6, ACEA-E5 or ACEA-E4 oil is used along with the specified Northern Lights oil filter, the oil change interval may be extended by 50 percent to 375 hours.

[c] If Northern Lights COOL-GARD is used, the flushing interval may be extended to 3000 hours or 36 months. If Northern Lights COOL-GARD is used and the coolant is tested annually AND additives are replenished as needed by adding a supplemental coolant additive, the flushing interval may be extended to 5000 hours or 60 months, whichever occurs first.

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Lubrication and Maintenance Service Interval Chart—Standby Generator Sets

Item	Lubrication and Maintenance Service Intervals				
	Daily/Before Every Startup	250 Hour/6 Month	500 Hour/12 Month	2000 Hour/24 Month	Service As Required
Operate Engine at Rated Speed and 50%—70% Load for a Minimum of 30 Minutes. Perform every 2 weeks.					
Check Engine Oil Level and Coolant Level	•				
Check Sea Water Strainer	•				
Check Air Cleaner Dust Unloader Valve & Restriction Indicator Gauge [a]	•				
Visual Walkaround Inspection	•				
Drain Water From Fuel Filter	•				•
Change Engine Oil And Replace Oil Filter [b]		•			
Service Fire Extinguisher		•			
Service Battery		•			
Inspect and Replace Zinc Plugs		•			
Check Belt Tension and Wear (Manual Tensioner)		•			
Check Engine Mounts		•			
Replace Crankcase Vent Filter (If Equipped)			•		
Clean Crankcase Ventilation Assembly			•		
Check Air Intake Hoses, Connections, & System			•		
Replace Fuel Filter Elements			•		
Check Automatic Belt Tensioner and Belt Wear			•		
Check Cooling System			•		
Coolant Solution Analysis-Add SCAs as required			•		
Inspect and Clean Heat Exchanger Core and Aftercooler Core (If Equipped)			•		
Check Engine Speeds			•		
Check Engine Electrical Ground			•		
Check Crankshaft Vibration Damper (6-Cylinder)				•	
Pressure Test Cooling System				•	
Inspect and Repair Sea Water Pump				•	
Check and Adjust Engine Valve Clearance				•	
Flush And Refill Cooling System [c]				•	
Test Thermostats				•	
Add Coolant					•
Replace Air Cleaner Element					•
Service Dry Air Cleaner Element					•
Replace Alternator Drive Belt					•
Check Front PTO (If Equipped)					•
Bleed Fuel System					•

[a] Replace primary air cleaner element when restriction indicator shows a vacuum of 625 mm (52 in.)H2O.

[b] During engine break-in, change the oil and filter for the first time before 100 hours of operation. Extended oil change interval of 375 hours can be used if Northern Lights PLUS-50 or ACEA-E7, ACEA-E6, ACEA-E5 or ACEA-E4 oil is used along with the specified Northern Lights oil filter.

[c] If Northern Lights COOL-GARD is used, the flushing interval may be extended to 3000 hours or 36 months. If Northern Lights COOL-GARD is used and the coolant is tested annually AND additives are replenished as needed by adding a supplemental coolant additive, the flushing interval may be extended to 5000 hours or 60 months, whichever occurs first.

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Daily Prestarting Checks

Do the following BEFORE STARTING THE ENGINE for the first time each day:

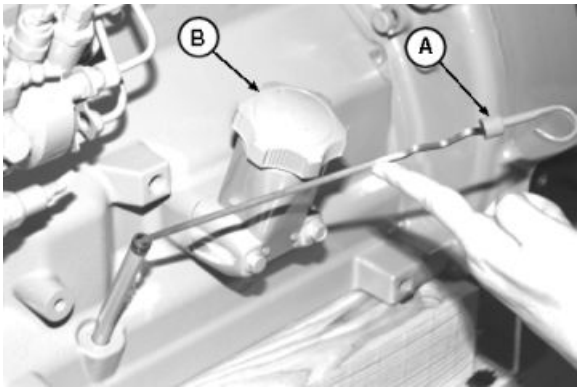
IMPORTANT: DO NOT add makeup oil until the oil level is BELOW the add mark.

Depending on application, oil dipstick (A) and oil filler cap (B) may be located on either the left or the right side of engine. In addition, oil may be added at rocker arm filler cap (C).

1. Check engine oil level on dipstick (A). Add as required, using seasonal viscosity grade oil. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section for oil specifications.)

IMPORTANT: DO NOT fill above the top mark on the dipstick. Oil levels anywhere within crosshatch (D) are considered in the acceptable operating range.

A—Dipstick
B—Left Side Oil Filler Cap
C—Rocker Arm Filler Cap
D—Crosshatch On Oil Dipstick



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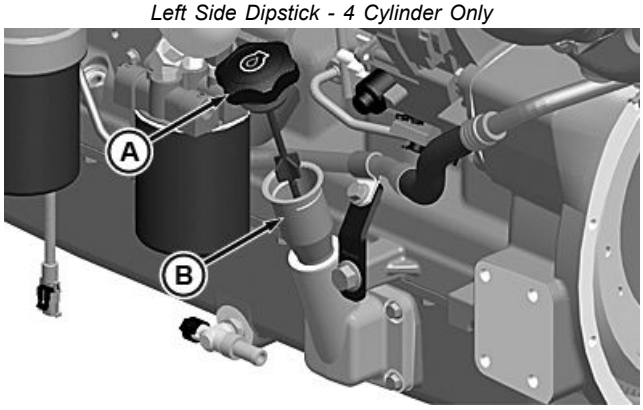
Left Side Dipstick - 4 Cylinder Only



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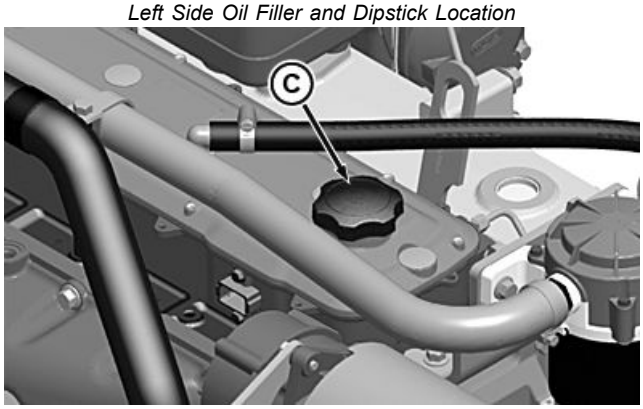
Left Side Oil Filler and Dipstick Location



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Rocker Arm Cover Filler Cap

RG22039 —UN—08JAN13

Oil Fill Level on Dipstick

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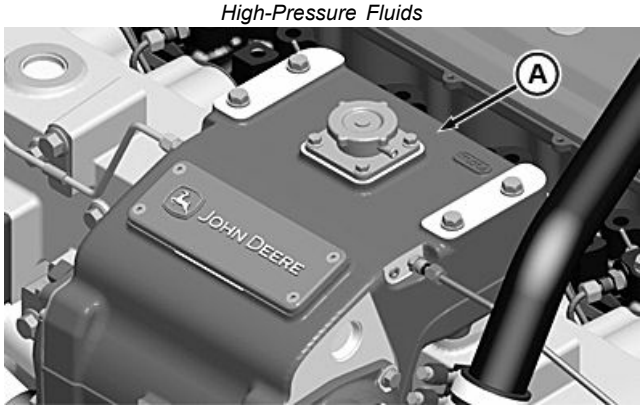
TS281 —UN—23AUG88

High-Pressure Fluids



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A—Engine Top Tank

Engine Top Tank

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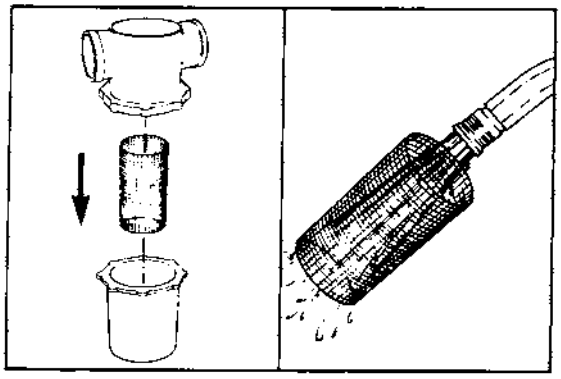
IMPORTANT: A restricted or clogged sea water strainer will result in hotter than normal (or overheated) engine coolant and marine gear oil temperatures.

3. The sea water strainer should be checked daily and cleaned as required, depending upon the operating environment.



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Sea Water Strainer

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4. If equipped with air intake restriction indicator gauge (A), check gauge to determine if air cleaner needs to be serviced. The reset button will pop up when air cleaner needs to be serviced.

IMPORTANT: Maximum air intake restriction is 625 mm (25 in. H_2O). A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine.

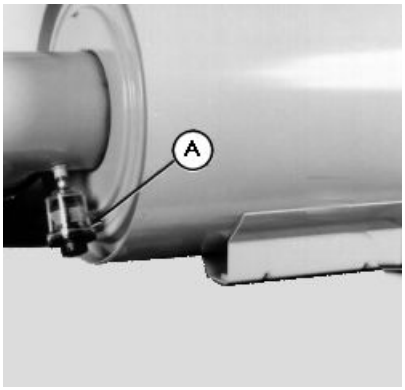
5. Make a thorough inspection of the engine compartment. Look for oil or coolant leaks, worn drive belts, loose connections and trash build-up. Remove trash buildup and have repairs made as needed if leaks are found.

NOTE: Wipe all fittings, caps, and plugs before performing any maintenance to reduce the chance of system contamination.

Inspect:

- Engine shields and guards for trash build-up.
- Air intake system hoses and connections for cracks and loose clamps.
- Alternator drive belt for cracks, breaks or other damage.
- Water pump for coolant leaks.
- Coolant system for leaks.

NOTE: It is normal for a small amount of leakage to occur as the engine cools down and parts contract.



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Air Intake Restriction Gauge

A—Air Intake Restriction Gauge

Excessive coolant leakage may indicate the need to replace the water pump seal. Contact your engine distributor or servicing dealer for repairs.

6. Turn key switch to “ON” position and check instruments for proper operation. Turn key switch “OFF”.

7. Refer to manufacturer's literature for marine gear and generator set daily service recommendations.

RG19661,00003D3 -19-29JAN13-4/4

Changing Engine Oil and Replacing Oil Filter

NOTE: Change engine oil and filter for the first time before 100 hours maximum of operation, then every 250 hours thereafter.

If Northern Lights PLUS-50™ or ACEA-E7/E6/E5/E4 engine oil and a Northern Lights oil filter are used, the oil and filter change interval may be extended by 50 percent or to 375 hours.

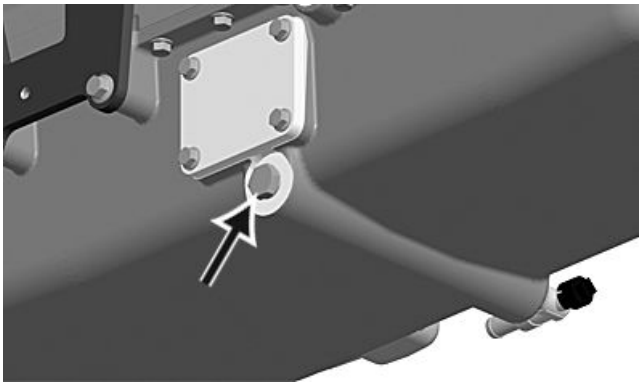
IMPORTANT: If using BIODIESEL blends greater than B20, shorten oil change interval to half the recommended service interval or monitor engine oil using OILSCAN to ensure that fuel dilution does not exceed 5%.

NOTE: On Gen Set engines used as standby units, oil and filter change can be extended to 350 hours. ***No*** *extended interval for oil/filter change is allowed beyond 350 hours.*

OILSCAN™ or OILSCAN PLUS™ is a Northern Lights sampling program to help you monitor machine performance and identify potential problems before they cause serious damage. OILSCAN™ or OILSCAN PLUS™ kits are available from your Northern Lights dealer. Oil samples should be taken prior to the oil change. Refer to instructions provided with kit.

To change engine oil and oil filter:

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.



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Oil Pan Drain Plug

2. Remove oil pan drain plug (arrow).
3. Drain crankcase oil from engine while warm.

NOTE: Drain plug location may vary, depending on the application.

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OILSCAN is a trademark of Deere & Company.
OILSCAN PLUS is a trademark of Deere & Company.

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RG19661,00003D4 -19-28FEB13-1/3

4. Turn filter element (A) using a suitable filter wrench to remove. Discard oil filter element.

NOTE: Depending on engine application, oil filter may be located on either side of the engine in a high- or low-mount location.

IMPORTANT: Filtration of oils is critical to proper lubrication. Always change filter regularly. Use filter meeting Northern Lights performance specifications.

5. Apply clean engine oil to the new filter at the inner (B) and outer (C) seals and to filter threads.

6. Wipe both sealing surfaces of the header (D, E) with a clean rag. Ensure that the notches in dust seal (F) are properly installed in the slots of the housing. Replace if damaged.

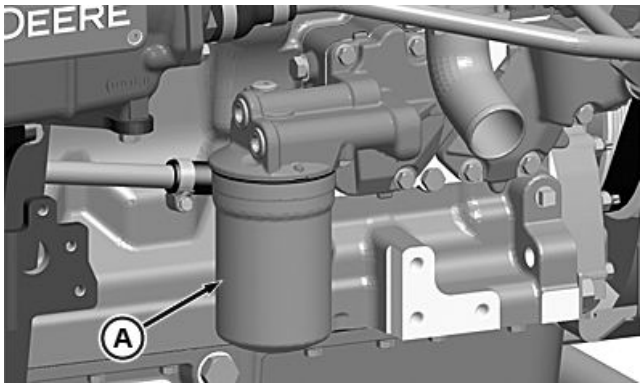
IMPORTANT: When installing filter element, HAND TIGHTEN only. A filter wrench may be used for REMOVAL ONLY.

7. Install and tighten oil filter by hand until firmly against dust seal (F). DO NOT apply an extra 3/4 to 1-1/4 turn after gasket contact as done with standard filters.

8. Tighten drain plug to specifications.

Specification	
Oil Pan Drain Plug With Copper Washer—Torque	70 N·m (52 lb-ft)
Oil Pan Drain Plug With O-Ring—Torque	50 N·m (37 lb-ft)

A—Oil Filter Element
B—Inner Seal
C—Outer Seal
D—Sealing Surface On Header
E—Sealing Surface On Header
F—Dust Seal



RG22045 —UN—29NOV12

Oil Filter

RG11617 —UN—24OCT01

Oil Filter Seals

RG22046 —UN—29NOV12

Oil Filter Mounting Header

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RG19661,00003D4 -19-28FEB13-2/3

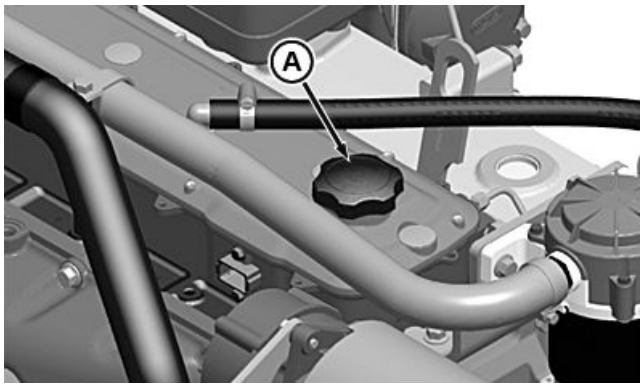
9. Fill engine crankcase with correct Northern Lights engine oil through rocker arm cover opening (A). (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section for determining correct engine oil.)

   To determine the correct oil fill quantity for your engine, see ENGINE CRANKCASE OIL FILL QUANTITIES in the Specifications Section of this manual.

IMPORTANT: Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

NOTE: Crankcase oil capacity may vary slightly. ALWAYS fill crankcase within crosshatch marks on dipstick. DO NOT overfill.

10. Start engine and run to check for possible leaks.
11. Stop engine and check oil level after 10 minutes. Oil level reading should be within crosshatch on dipstick.



A—Rocker Arm Cover Oil Filler Opening

RG19661,00003D4 -19-28FEB13-3/3

Servicing Battery

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded NEGATIVE (–) battery clamp first and replace it last.

TS204 —UN—23AUG88

Exploding Battery

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

1. On regular batteries, check electrolyte level. Fill each cell to bottom of filler neck with distilled water.

NOTE: Low-maintenance or maintenance-free batteries should require little additional service. However, electrolyte level can be checked by cutting the center section of decal on dash-line, and removing cell plugs. If necessary, add clean, soft water to bring level to bottom of filler neck.

2. Keep batteries clean by wiping them with a damp cloth. Keep all connections clean and tight. Remove any corrosion, and wash terminals with a solution of 1 part baking soda and 4 parts water. Tighten all connections securely.

NOTE: Coat battery terminals and connectors with a mixture of petroleum jelly and baking soda to retard corrosion.

3. Keep battery fully charged, especially during cold weather. If a battery charger is used, turn charger off before connecting charger to battery(ies). Attach POSITIVE (+) battery charger lead to POSITIVE (+) battery post. Then attach NEGATIVE (–) battery charger lead to a good ground.

Continued on next page

RG,RG34710,5568 -19-20MAY96-1/2

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

Avoid the hazard by:

1. **Filling batteries in a well-ventilated area.**
2. **Wearing eye protection and rubber gloves.**
3. **Avoiding breathing fumes when electrolyte is added.**
4. **Avoiding spilling or dripping electrolyte.**
5. **Use proper jump start procedure.**

If you spill acid on yourself:

1. **Flush your skin with water.**
2. **Apply baking soda or lime to help neutralize the acid.**
3. **Flush your eyes with water for 10–15 minutes. Get medical attention immediately.**

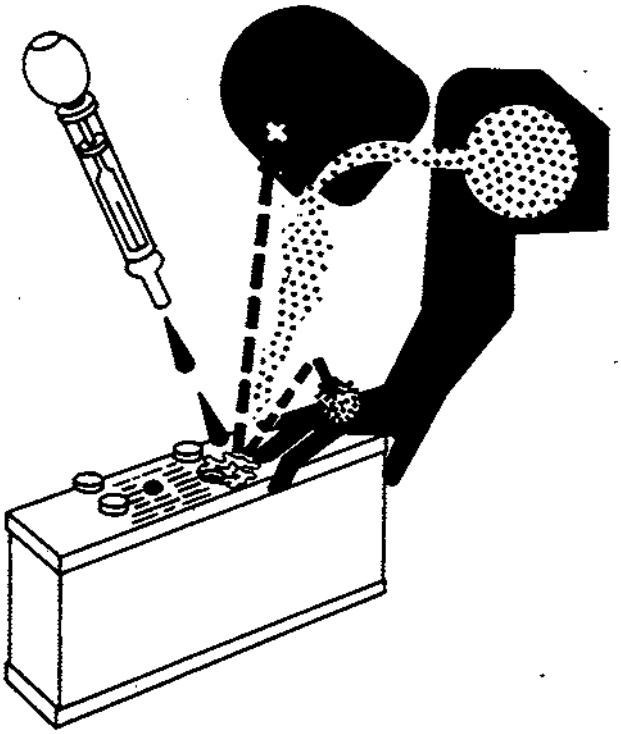
If acid is swallowed:

1. **Drink large amounts of water or milk.**
2. **Then drink milk of magnesia, beaten eggs, or vegetable oil.**
3. **Get medical attention immediately.**

In freezing weather, run engine at least 30 minutes to assure thorough mixing after adding water to battery.

If necessary to replace battery(ies), replacements must meet or exceed the following recommended capacities at -18°C (0°F):

Specification	
12 Volt Standard Duty Starter—Cold Cranking Amps	640
12 Volt Heavy Duty Starter—Cold Cranking Amps	800
24 Volt Standard Duty Starter—Cold Cranking Amps	570



TS203 —UN—23AUG88

Sulfuric Acid

RG,RG34710,5568 -19-20MAY96-2/2

Inspect and Replacing Zinc Plugs

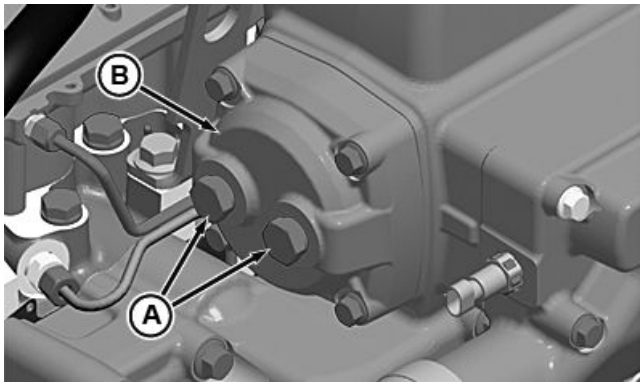
Two zinc plugs (A) are installed in the sea water cooling system to help reduce the corrosive action of salt in the sea water. The reaction of the zinc to sea water causes the plugs to deteriorate, instead of the more critical cooling system parts. Therefore, the zinc plugs MUST BE inspected every 250 Hours.

NOTE: Zinc plugs are located in each heat exchanger end cap and are mounted on hex-head pipe plug.

1. Remove zinc rod from each end cap (B) and observe condition of each.

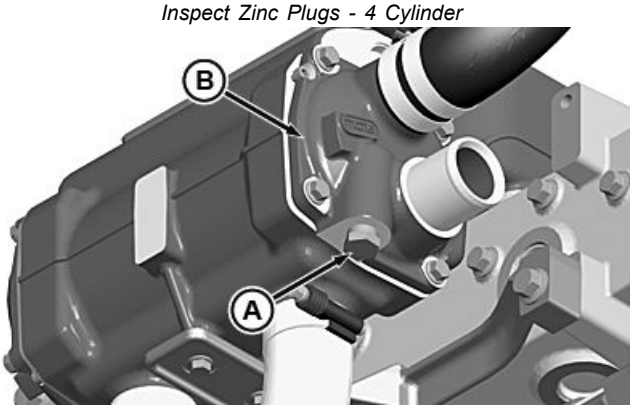
2. Tap the zinc rods lightly with a hammer. If rod flakes apart when tapped, install a new zinc plug.

A—Zinc Plugs **B—End Cap**



RG22137 —UN—06DEC12

Inspect Zinc Plugs - 4 Cylinder



RG22048 —UN—29NOV12

Inspect Zinc Plugs - 6 Cylinder

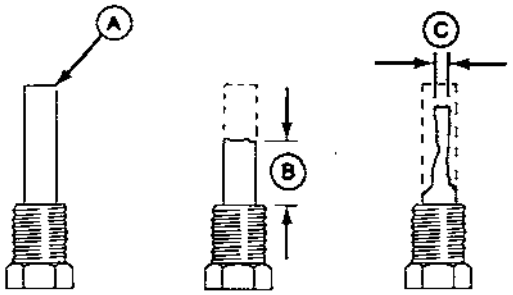
RG19661,00003D5 -19-29JAN13-1/2

3. Measure zinc plugs (A) to determine the amount of erosion on length (B) and outer diameter (C).

If length is less than 15.9 mm (0.63 in.) or outer diameter is less than 4.8 mm (0.19 in.) on either plug, replace all zinc plugs.

NOTE: Zinc plug new part dimensions are 31.8 mm (1.25 in.) long and 9.5 mm (0.38 in.) outer diameter.

A—Measure Zinc Plugs
B—Measure Length
C—Measure Diameter



RG6007 —UN—27JAN92

Zinc Plug Erosion

RG19661,00003D5 -19-29JAN13-2/2

Checking Belt Wear

1. Remove belt guard (A).

2. Swing tensioner arm (C) to remove all belt slack.

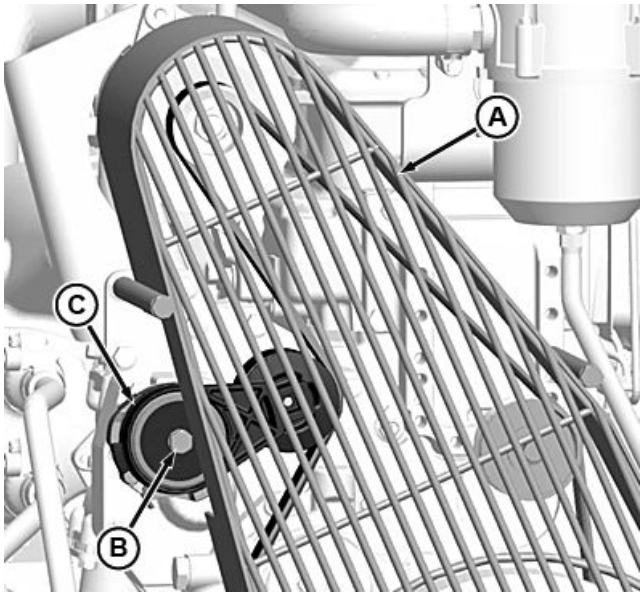
3. Remove and inspect belt for cracks, fraying, or stretched-out areas. Replace if necessary.

NOTE: While belt is removed, inspect pulleys and bearings. Rotate and feel for hard turning or any unusual sounds. If pulleys or bearings need replacement, see your Northern Lights dealer.

4. If tensioner has been removed, tighten tensioner mounting cap screw (B) to 70 N·m (52 lb-ft).

5. Install belt guard.

A—Belt Guard
B—Mounting Cap Screw
C—Tensioner Arm



RG22049 —UN—29NOV12

Check Belt Wear

RG19661,00003D6 -19-09MAR13-1/1

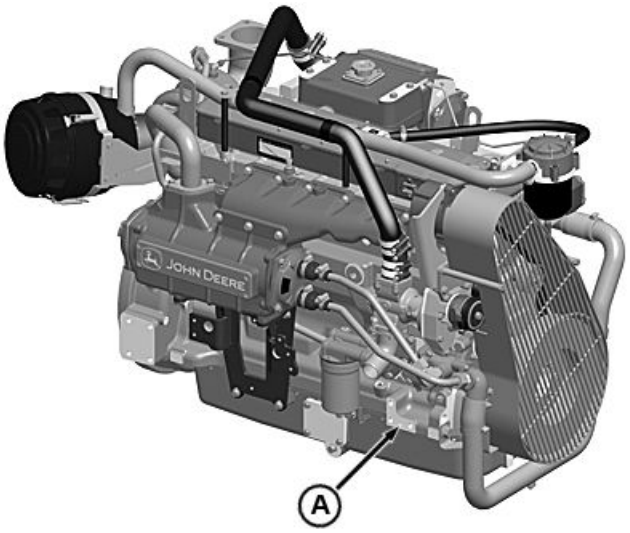
Checking Engine Mounts

Engine mounting is the responsibility of the vessel or generator manufacturer. Follow manufacturer's guidelines for mounting specifications. Front engine mounts (A) only are available from Northern Lights.

IMPORTANT: Use only SAE Grade 8 or higher grade of hardware for engine mounting.

1. Check the engine mounting bolts on support frame and engine block for tightness. Tighten as necessary.

2. Inspect overall condition of vibration isolators, if equipped. Replace isolators, as necessary, if rubber has deteriorated or mounts have collapsed.



RG22051 —UN—29NOV12

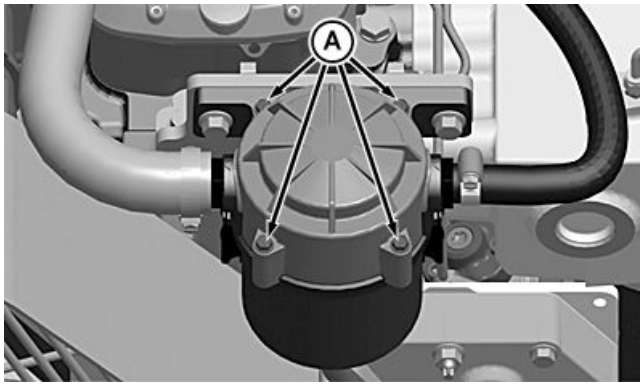
Check Mounting Holes

RG19661,00003D7 -19-29JAN13-1/1

Replace Crankcase Vent Filter

1. Remove screws (A) and remove the crankcase vent lid.
2. Remove old filter and discard.
3. Install new filter into crankcase vent housing and snap into place.
4. Install lid and lock down screws.

A—Screws



RG22052 —UN—29NOV12

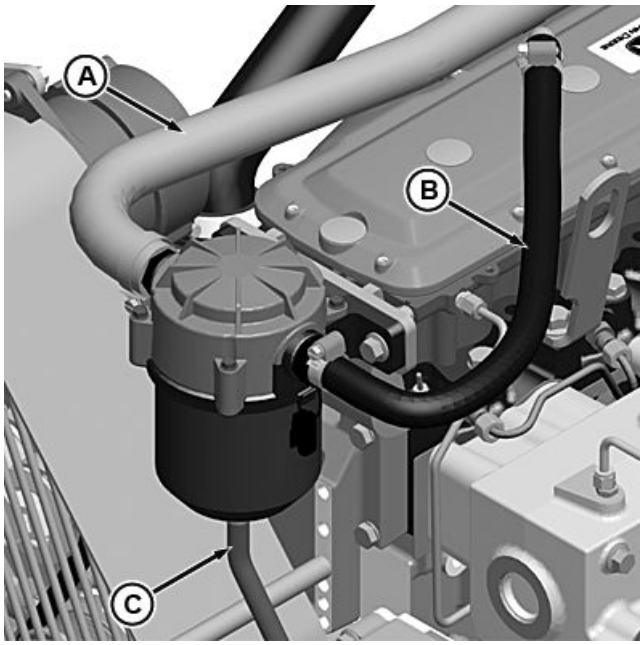
Replace Crankcase Vent Filter

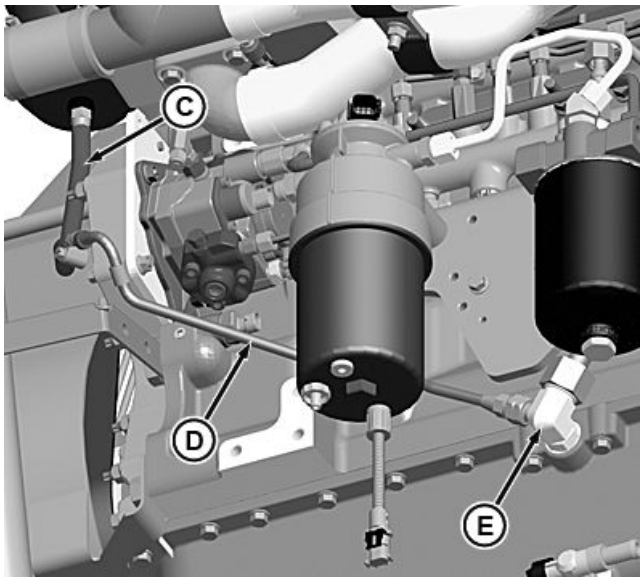
RG19661,00003D8 -19-13FEB13-1/1

Checking Closed Crankcase Vent System

1. Inspect hoses (A)(B) (C) and oil drain line (D) for kinks, blockage, or other damage.
2. Inspect crankcase fitting (E) for damage and make sure it is not plugged.
3. Verify that the crankcase vent system bypass port (E) is not plugged.
4. Inspect turbocharger compressor coupling for cracks, blockage or other damage.

A—Hose, Compressor to Filter Housing
B—Hose, Rocker Arm Cover to Filter Housing
C—Hose, Oil Drain
D—Oil Drain Line
E—Crankcase Vent System Fitting





RG22054 —UN—29NOV12

Crankcase Vent System Fitting

RG19661,00003D9 -19-13FEB13-1/1

Replace Fuel Filter

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Close fuel shut-off valve at bottom of fuel tank (not illustrated).

2. Clean entire area surrounding fuel filter assembly to keep debris from entering fuel system.

3. Loosen drain plug and air vent screw. Drain fuel into a suitable container.

4. Firmly grasp the filter or filer housing and rotate it clockwise 1/4 turn (when viewed from the top to remove from base.

5. Inspect filter mounting base for cleanliness. Clean as required.

NOTE: Raised locators on fuel filter canister must be indexed properly with slots in mounting base for correct installation.

6. Install new filter element onto mounting base. Be sure element is properly indexed and firmly seated on base. It may be necessary to rotate filter for correct alignment.

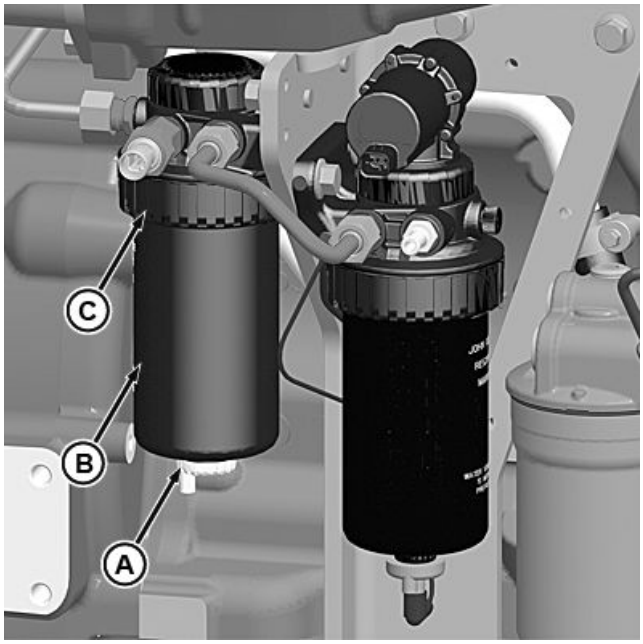
If equipped with a water separator bowl, remove separator bowl from filter element. Drain and clean separator bowl. Dry with compressed air. Install bowl onto new filter element. Tighten securely.

7. Align keys on filter element with slots in filter base.

8. Install retaining ring onto mounting base making certain dust seal is in place on filter base. Hand tighten ring (about 1/3 turn) until it “snaps” into the detent. DO NOT overtighten retaining ring.

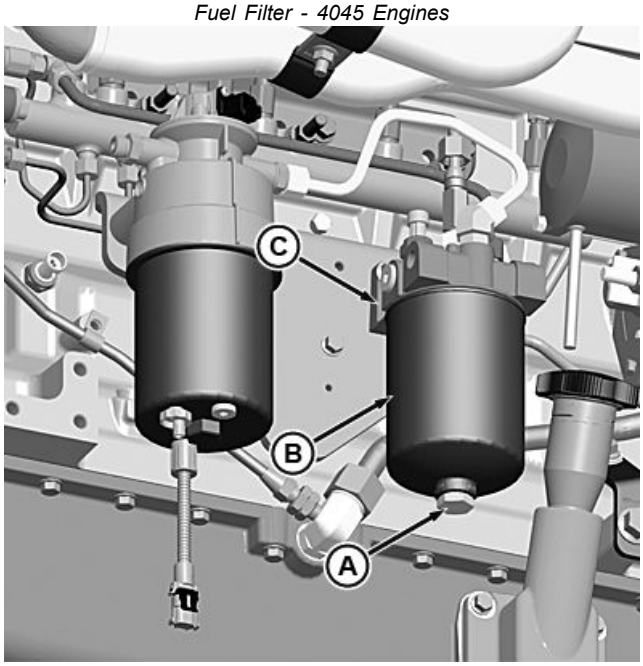
NOTE: The proper installation is indicated when a "click" is heard and a release of the retaining ring is felt.

A plug is provided with the new element for plugging the used element.



RG22096 —UN—05DEC12

Fuel Filter - 4045 Engines



RG22079 —UN—15FEB13

Fuel Filter - 6068 Engines

A—Drain
B—Filter/Filter Housing
C—Filter Base

9. Open fuel shut-off valve. Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system. (See BLEEDING THE FUEL SYSTEM in Service as Required Section.)

RG19661,00003E4 -19-13FEB13-1/1

Replacing Fuel Filter/Water Separator

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Close fuel shut-off valve at bottom of fuel tank (not illustrated).
2. Clean entire area surrounding fuel filter assembly to keep debris from entering fuel system.
3. Disconnect water in fuel sensor.
4. Drain fuel into a suitable container.
5. Firmly grasp the filter or filter housing and rotate it counterclockwise 1/4 turn. Remove ring with filter element (E).
6. Inspect filter mounting base for cleanliness. Clean as required.

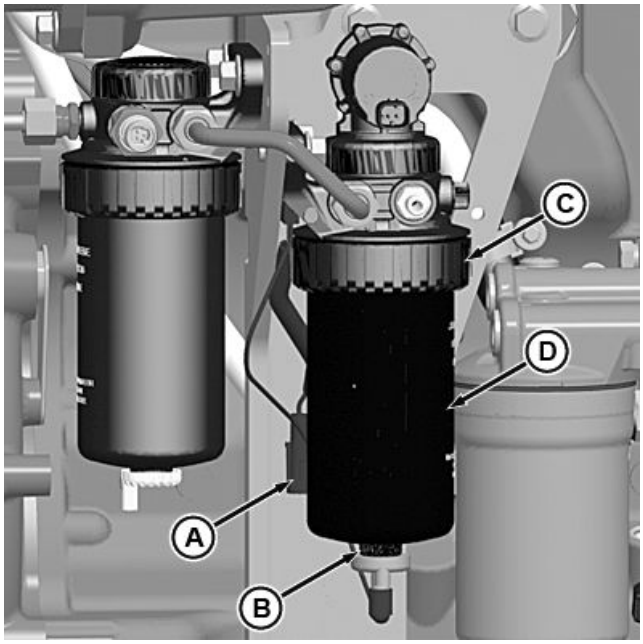
NOTE: Raised locators on fuel filter canisters must be indexed properly with slots in mounting base for correct installation.

7. Install new filter element onto mounting base. Be sure element is properly indexed and firmly seated on base. It may be necessary to rotate filter for correct alignment.
8. Align keys on filter element with slots in filter base.
9. Install retaining ring onto mounting base making certain dust seal is in place on filter base. Hand tighten ring (about 1/3 turn) until it “snaps” into the detent. DO NOT overtighten retaining ring.

NOTE: The proper installation is indicated when a "click" is heard and a release of the retaining ring is felt.

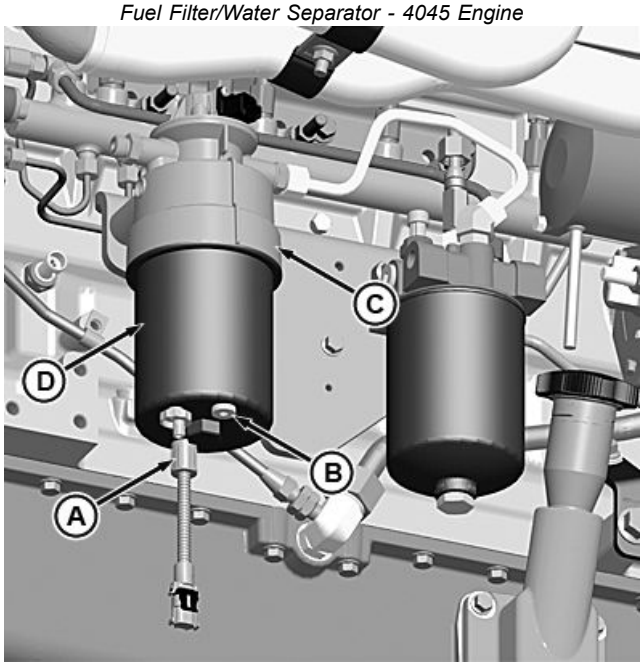
A plug is provided with the new element for plugging the used element.

10. Connect water in fuel sensor.
11. Open fuel shut-off valve. Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system. (See BLEEDING THE FUEL SYSTEM in Service as Required Section.)



RG22097 —UN—15FEB13

Fuel Filter/Water Separator - 4045 Engine



RG22078 —UN—03DEC12

Fuel Filter/Water Separator

A—Electrical Connector
B—Drain
C—Filter Base
D—Filter/Water Separator

RG19661,00003E5 -19-13FEB13-1/1

Checking Belt Tensioner Spring Tension and Belt Wear (Automatic Tensioner)

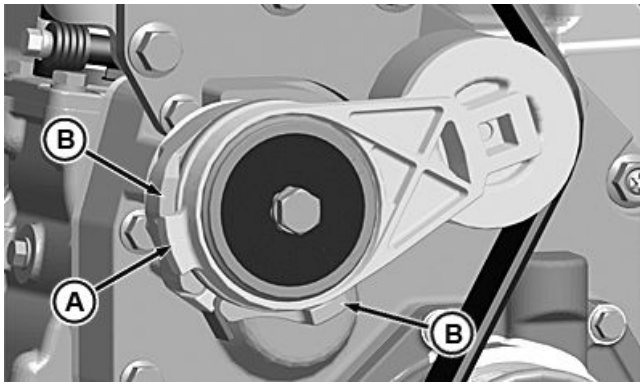
Belt drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner assembly.

Checking Belt Wear

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A and B) when correct belt length and geometry is used.

Visually inspect cast stops (A and B) on belt tensioner assembly.

If the tensioner cast stop (A) on swing arm is hitting either fixed cast stop (B), check mounting brackets (alternator, belt tensioner, idler pulley, etc.) and the belt length. Replace belt as needed (see REPLACING FAN AND ALTERNATOR BELTS in Service As Required Section).



RG22080 —UN—03DEC12

Cast Stops - Tensioner Arm

A— Tensioner Cast Stops **B— Fixed Cast Stops**

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RG19661,00003E6 -19-13FEB13-1/2

Checking Tensioner Spring Tension

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

1. Release tension on belt using a long handled 1/2 inch drive tool in square hole in tensioner arm. (Earlier tensioner arms have bolt in place of square hole, and require breaker bar with socket.) Remove belt from pulleys.

NOTE: While belt is removed, inspect pulleys and bearings. Rotate and feel for hard turning or any unusual sounds. If pulleys or bearings need replacement, see your Northern Lights dealer.

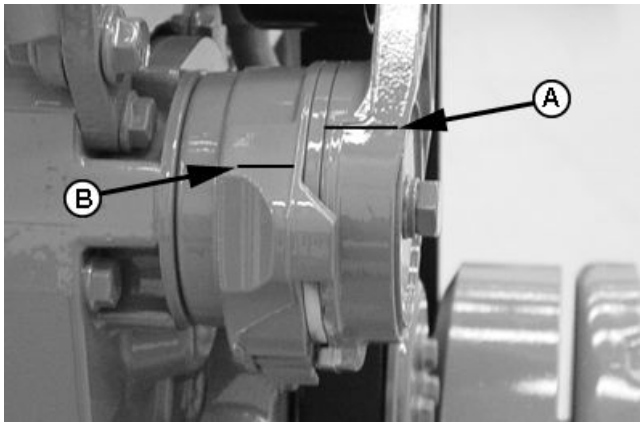
2. Release tension on tension arm and remove drive tool.
3. Put a mark (A) on swing arm of tensioner as shown.
4. Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.
5. Install torque wrench (C) so that it is aligned with centers of pulley and tensioner. Rotate the swing arm using a torque wrench until marks (A and B) are aligned.
6. Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.

Specification

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

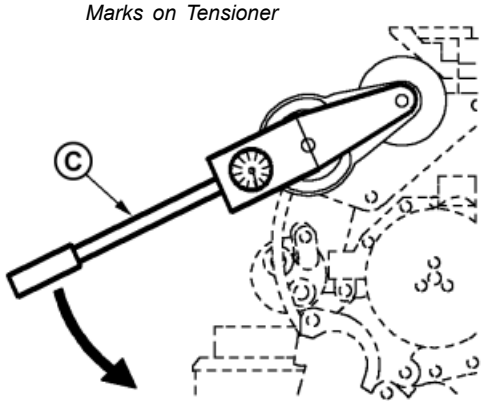
NOTE: Threads on belt tensioner roller cap screw are LEFT-HAND threads

A—Mark On Swing Arm
B—Mark On Tensioner Mounting Base
C—Torque Wrench



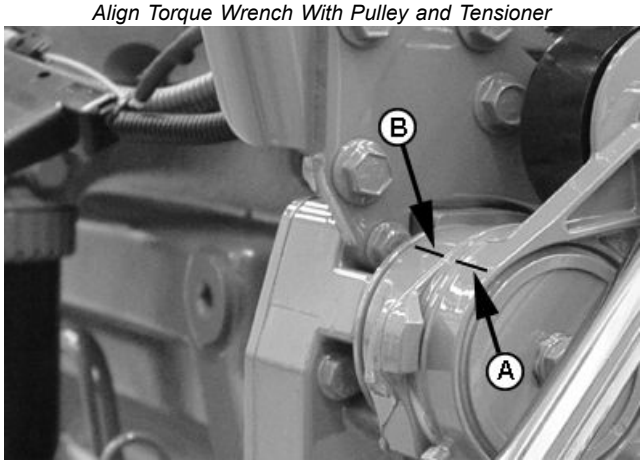
RG13745 —UN—11NOV04

Marks on Tensioner



RG12065 —UN—28JAN02

Align Torque Wrench With Pulley and Tensioner



RG13746 —UN—11NOV04

Align Marks

RG19661,00003E6 -19-13FEB13-2/2

Checking Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Retighten fitting or plug when all the air has been expelled.

1. Check entire cooling system for leaks. Tighten all clamps securely.

TS281 —UN—23AUG88

High-Pressure Fluids

2. Thoroughly inspect all cooling system hoses. Replace hoses when hard, flimsy, or cracked.

RG,RG34710,5580 -19-20MAY96-1/1

Replenishing Supplemental Coolant Additives (SCAs) Between Coolant Changes

IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with Northern Lights COOL-GARD®

NOTE: If system is to be filled with coolant that does not contain SCAs, the coolant must be precharged. Determine the total system capacity and premix with 3% Northern Lights Coolant Conditioner.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when Northern Lights COOL-GARD® is used. The cooling system must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.

Maintaining the correct coolant conditioner concentration (SCAs) and freeze point is essential in your cooling system to protect against rust, liner pitting and corrosion, and freeze-ups due to incorrect coolant dilution.

Northern Lights LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in Northern Lights engines.

DO NOT mix one brand of SCA with a different brand.

Test the coolant solution at 500 hours or 12 months of operation using either Northern Lights coolant test strips or a COOLSCAN® or COOLSCAN PLUS® analysis. If a COOLSCAN® or COOLSCAN PLUS® analysis is not available, recharge the system per instructions printed on label of Northern Lights Liquid Coolant Conditioner.

IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant even for a few minutes.

If frequent coolant makeup is required, the glycol concentration should be checked with JT07298 Coolant/Battery Tester to ensure that the desired freeze point is maintained. Follow manufacturer's instructions provided with Coolant/Battery Tester.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

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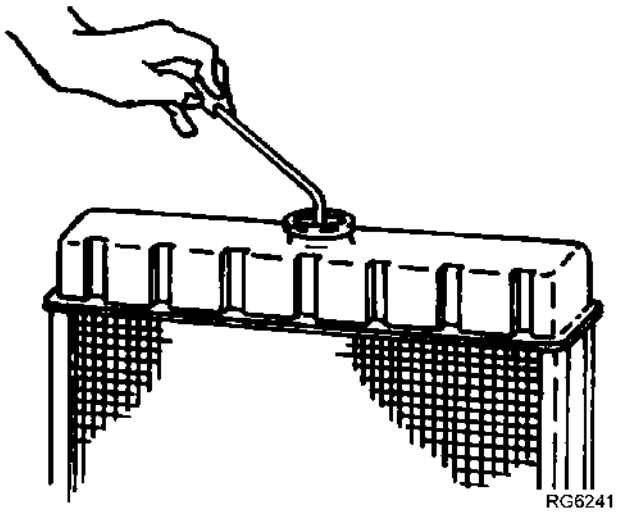
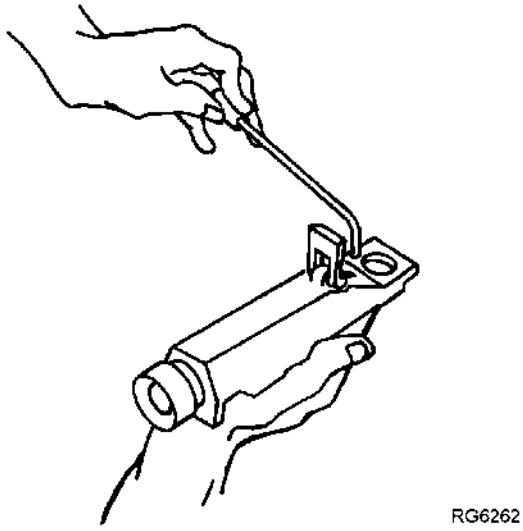
COOLSCAN is a registered trademark of Deere & Company
COOLSCAN PLUS is a registered trademark of Deere & Company
COOLSCAN PLUS is a registered trademark of Deere & Company



Coolant Check



JT07298 Coolant/Battery Tester

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See DIESEL ENGINE COOLANTS AND SUPPLEMENTAL ADDITIVE INFORMATION for proper mixing of coolant ingredients before adding to the cooling system.

DPSG,OUOD002,1921 -19-23NOV01-1/1

Testing Diesel Engine Coolant

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion, and cylinder liner erosion and pitting.

Test the coolant solution at intervals of 12 months or less and whenever excessive coolant is lost through leaks or overheating.

Coolant Test Strips

Coolant test strips are available from your John Deere dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more Northern Lights COOLANT CONDITIONER should be added.

COOLSCAN Or COOLSCAN PLUS

For a more thorough evaluation of your coolant, perform a COOLSCAN or COOLSCAN PLUS analysis. See your Northern Lights dealer for information about COOLSCAN or COOLSCAN PLUS.

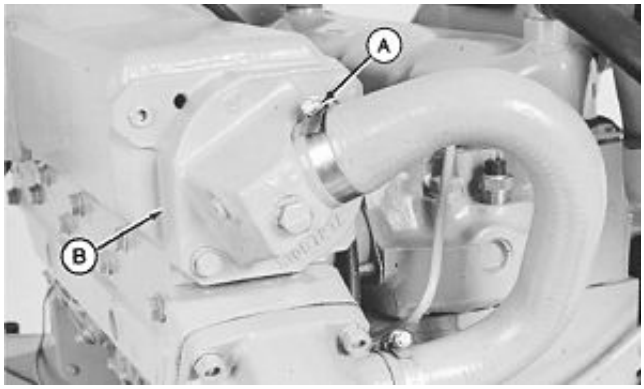
OUOD002,0000175 -19-23NOV01-1/1

Remove, Inspect and Clean Engine Heat Exchanger Core

IMPORTANT: Initially remove and inspect the engine heat exchanger core at 250 hour or three month service interval on a new engine. Then, remove and clean at every 500 hour or 12 month interval thereafter.

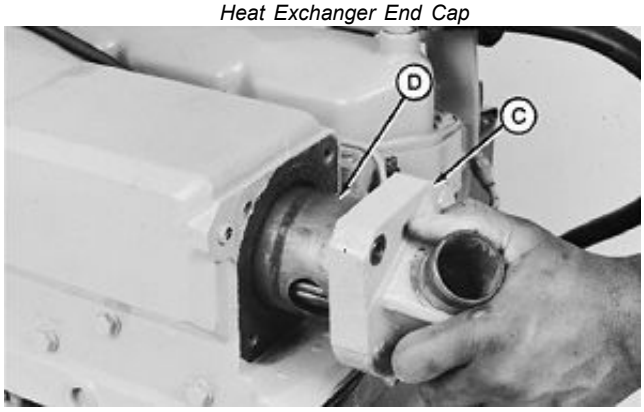
1. Close sea cocks and drain the sea water system.
2. Open drain cock on cylinder block and drain approximately two gallons of engine coolant into a clean container. Close drain cock.
3. Loosen hose clamp (A) and remove hose from rear end cap (B).
4. Remove two end cap mounting cap screws and remove end cap (C) with heat exchanger core (D) from rear of engine.

A—Clamp
B—End Cap
C—End Cap
D—Heat Exchanger Core



Heat Exchanger End Cap

RG6063 —UN—23JAN92



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RG19661,000040B -19-10MAR13-1/2

On All Engines:

NOTE: The heat exchanger core may be removed from housing when either end cap is removed. It is strongly recommended that both end caps be removed for cleaning when cleaning the heat exchanger core.

5. Remove remaining end cap from water manifold/heat exchanger housing. Remove end cap from heat exchanger core.

6. Thoroughly clean all buildup from both end caps and inspect zinc plug in each. Replace plugs as needed. (See INSPECT AND REPLACE ZINC PLUGS in 250 Hour Section.)

7. Use a 4.76 mm (3/16 in.) diameter brass rod to clean out any buildup in each heat exchanger tube. Run the rod the entire length of each tube to push debris out.

8. Flush the heat exchanger tubes with clean water, making sure all tubes are cleared of debris. Clean (with brass rod) and flush heat exchanger again if necessary to remove any remaining debris from tubes.

RG6066 —UN—23JAN92

Clean Heat Exchanger

If you suspect that your heat exchanger core is defective, have your authorized servicing dealer or engine distributor pressure test for leaks. Replace heat exchanger core as required.

9. Remove and thoroughly clean water manifold/heat exchanger housing if needed.

RG19661,000040B -19-10MAR13-2/2

Install Heat Exchanger Core

Thoroughly inspect condition of end cap sealing O-rings (A). Sealing O-rings may be reused if not excessively worn or damaged during disassembly. Replace sealing rings as necessary.

Lubricate front and rear end cap O-rings with clean multi-purpose grease.

1. Install rear end cap, install cap screws and evenly tighten until end cap (B) is about 6.4 mm (0.25 in.) from housing (C). Index end cap in same position as removed.

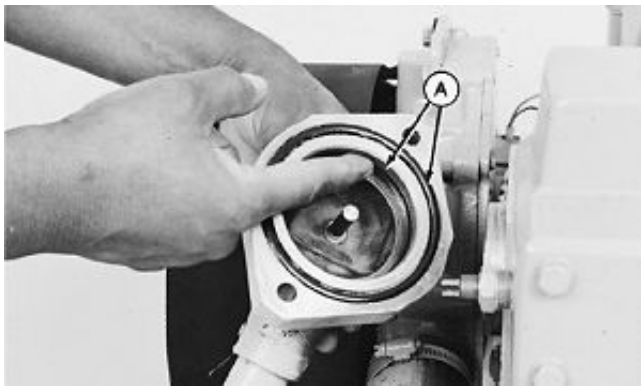
2. Install heat exchanger core. Make sure core is properly seated in rear end cap to avoid cutting O-ring.

3. Install front end cap with heat exchanger core properly seated in cap and cap properly indexed in same position as removed.

4. Install and evenly tighten front end cap screws until cap contacts housing. Evenly tighten rear end cap screws until cap contacts housing. Tighten front and rear end cap screws to 24 N·m (18 lb-ft).

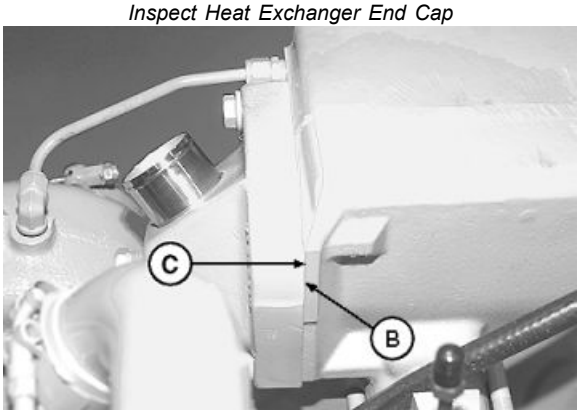
5. Connect all water piping and tighten hose clamps securely. Fill cooling system with the proper amount and concentration of ethylene-glycol base antifreeze.

6. Open sea cock, start engine and check for leaks.



RG6067 —UN—23JAN92

Inspect Heat Exchanger End Cap



RG9848 —UN—06JAN99

Install Heat Exchanger

A—O-Rings
B—End Cap
C—Housing

Continued on next page

RG19661,000040F -19-10MAR13-1/2

1. Insert two O-rings into front and rear end caps.

2. Lubricate ends of tube bundle lightly with clean multi-purpose grease.

NOTE: For proper orientation of the tube bundle, the core divider plate must be in line with inlet end cap divider slot with arrow pointing in the correct direction.

3. Install rear end cap (A) over tube bundle with core divider plate in slot on cap.

4. Guide heat exchanger core into heat exchanger tank. Align core divider vertically with stamped note indicating “This side up”. (Core shown separated from cap for illustration purposes.)

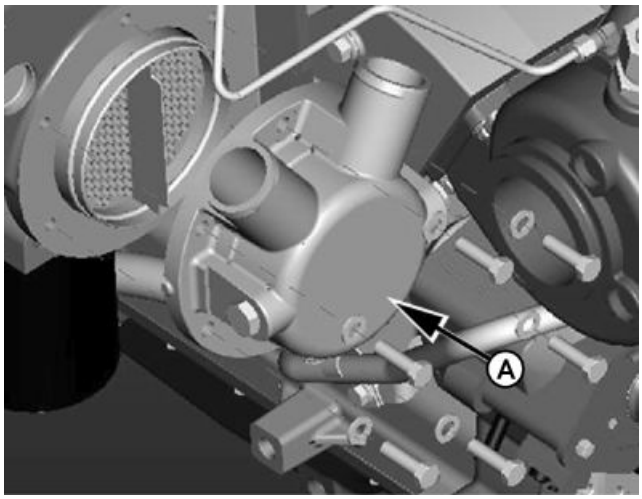
5. Fasten rear end cap and core to tank with bolts and washers. Tighten bolts to 24 +/- 3 N·m (18 +/- 2 lb-ft).

6. Install front end cap (B) over core and bolt to tank. Ensure core holes are aligned with heat exchanger tank holes. Tighten bolts to 24 +/- 3 N·m (18 +/- 2 lb-ft).

7. Connect all water piping and tighten hose clamps securely. Fill cooling system with the proper amount and concentration of ethylene-glycol base antifreeze.

8. Open sea cock, start engine and check for leaks.

A—Rear End Cap **B—Front End Cap**



RG15325 —UN—19JUL07

Install Core and Rear End Cap

RG15326 —UN—19JUL07

Install Front End Cap

RG19661,000040F -19-10MAR13-2/2

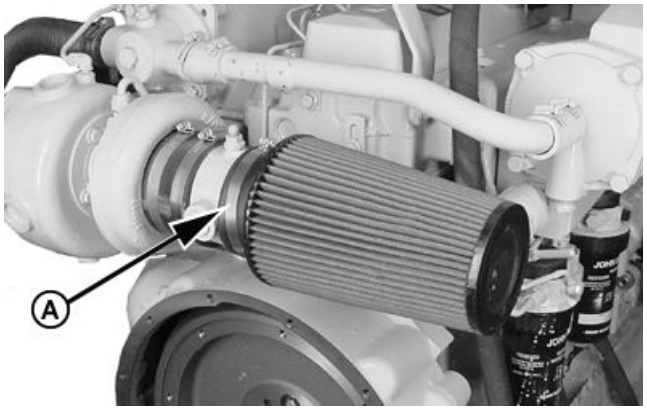
Remove, Inspect and Clean Engine Aftercooler Core

IMPORTANT: Initially remove and inspect the aftercooler core at 250 hour or three month service interval on a new engine. Then, remove and clean at every 500 hour or 12 month interval thereafter.

IMPORTANT: Ensure Service Kit RE18060 is readily available before removing aftercooler core. Air side seals will be destroyed during core removal, and RE18060 kit includes required replacement seals, as well as end cap O-rings.

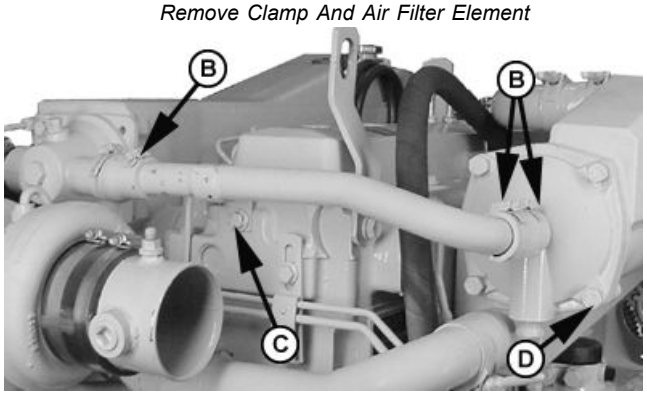
1. Close sea cocks and drain the sea water system.
2. Loosen clamp (A) and remove air filter.
3. Loosen clamps (B), remove mounting bolt (C) and remove water line from rear of aftercooler.
4. Remove four cap screws (D) and remove rear cap and O-ring.
5. Remove clamps (E) and remove hoses from front cap.
6. Remove four cap screws (F), front cap and O-ring.
7. Remove aftercooler core from the rear of the engine.

A—Clamp
B—Clamps
C—Mounting Bolt
D—Cap Screws
E—Clamps
F—Cap Screws



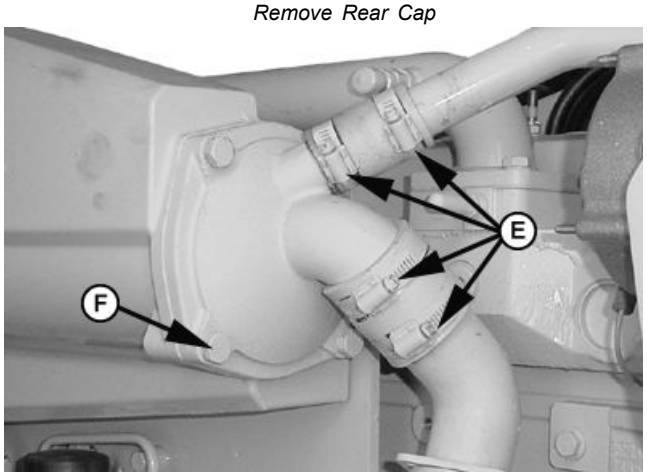
RG12190 —UN—25FEB02

Remove Clamp And Air Filter Element



RG12182 —UN—25FEB02

Remove Rear Cap



RG12183 —UN—25FEB02

Remove Front Cap

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RG19661,000040D -19-10MAR13-1/2

8. Thoroughly clean all buildup from both end caps.

9. Use a 4.76 mm (3/16 in.) diameter brass rod to clean out any buildup in each tube. Run the rod the entire length of each tube to push debris out.

10. Flush the tubes with clean water, making sure all tubes are cleared of debris. Clean (with brass rod) and flush aftercooler core again if necessary to remove any remaining debris from tubes.

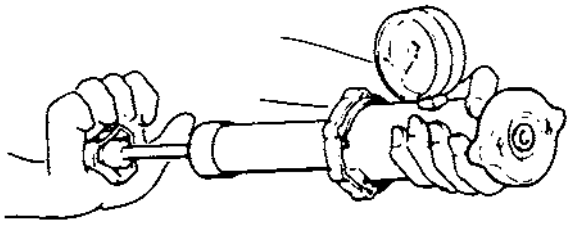
If you suspect that your aftercooler core is defective, have your authorized servicing dealer or engine distributor pressure test for leaks. Replace aftercooler core as required.

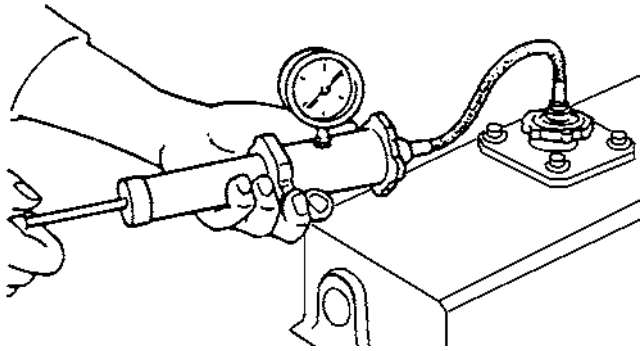
RG12181 —UN—25FEB02

Clean Aftercooler Core

RG19661,000040D -19-10MAR13-2/2

Pressure Testing Cooling System





⚠ CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

Test Coolant Filler Cap

1. Remove coolant filler cap and attach to an appropriate tester as shown.
2. Pressurize cap to specifications. Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

   If gauge does not hold pressure, replace pressure cap.

Specification	
Radiator Cap—Pressure	110kPa (1.1 bar) (16 psi)

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System

NOTE: Engine should be warmed up to test overall cooling system.

1. Allow engine to cool, then carefully remove coolant filler cap.
2. Fill tank with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage coolant tank and hoses.

3. Connect gauge and adapter to filler neck. Pressurize cooling system to specifications.

Specification	
Cooling System—Pressure	110kPa (16 psi)

4. With pressure applied, check all cooling system hose connections, coolant tank, and overall engine for leaks.

   If leakage is detected, correct as necessary and pressure test system again.

   If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

RG19661,0000409 -19-08MAR13-1/1

Checking Engine Electrical Ground Connections

Keep all engine ground connections clean and tight to prevent electrical arcing which can damage electronic components.

Also see precautions in Troubleshooting Section when welding on engine or machine.

OUOD002,0000169 -19-23NOV01-1/1

Checking and Adjusting Engine Valve Clearance

CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (—) battery terminal.

IMPORTANT: Valve clearance MUST BE checked and adjusted with engine COLD.

1. Remove rocker arm cover and crankcase ventilator tube.

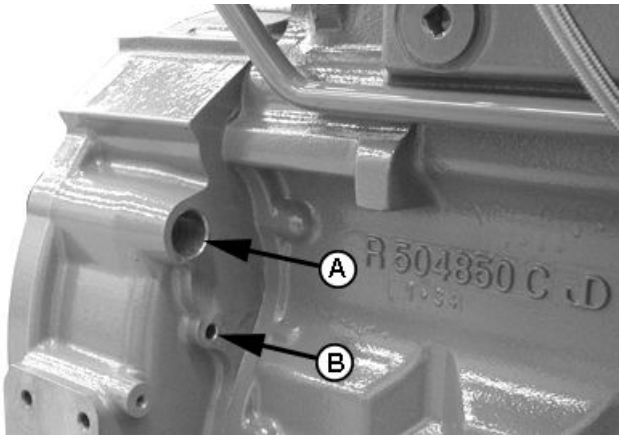
IMPORTANT: Visually inspect contact surfaces of valve tips, bridges and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms that exhibit excessive valve clearance should be inspected more thoroughly to identify damaged parts.

2. Remove plastic plugs or cover plate from engine timing/rotation hole (A) and timing pin hole (B).

NOTE: Some engines are equipped with flywheel housings which do not allow use of an engine flywheel rotation tool. These engines with straight nose crankshafts may be rotated from front nose of engine, using JDG966 Crankshaft Front/Rear Rotation Adapter.

3. Using JDE83 or JDG820 Flywheel Turning Tool, rotate engine flywheel in running direction (clockwise viewed from front) until No. 1 (front) cylinder is at TDC compression stroke. Insert JDG1571 or JDE81-4 Timing Pin in flywheel.



RG13749 —UN—11NOV04

Flywheel Housing Timing Holes

A—Timing/Rotation Hole **B—Timing Pin Hole**

If No. 1 cylinder rocker arms are loose, the engine is at No. 1 TDC compression.

If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°) to No. 1 TDC compression.

RG19661,00003D0 -19-29JAN13-1/4

4. Adjust valves to specifications below using the valve clearance adjustment procedure in the following blocks. Loosen the jam nut (A) on rocker arm adjusting screw. Turn adjusting screw until feeler gauge (B) slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten jam nut to specifications. Recheck clearance again after tightening jam nut. Readjust clearance as necessary.

	Specification
Intake Valve Clearance Adjustment (Rocker Arm-to-Bridge) (Engine Cold)—Clearance	0.36 mm (0.014 in.)
Exhaust Valve Clearance Adjustment (Rocker Arm-to-Bridge) (Engine Cold)—Clearance	0.46 mm (0.018 in.)
Rocker Arm Adjusting Screw Jam Nut—Torque	27 N·m (20 lb-ft)

5. Install rocker arm cover and crankcase ventilator tube.

6. Reconnect battery terminal.

RG13809 —UN—07DEC04

Adjusting Valves

A—Adjusting Screw Jam Nut **B—Feeler Gauge**

Continued on next page

RG19661,00003D0 -19-29JAN13-2/4

4-Cylinder Engine

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

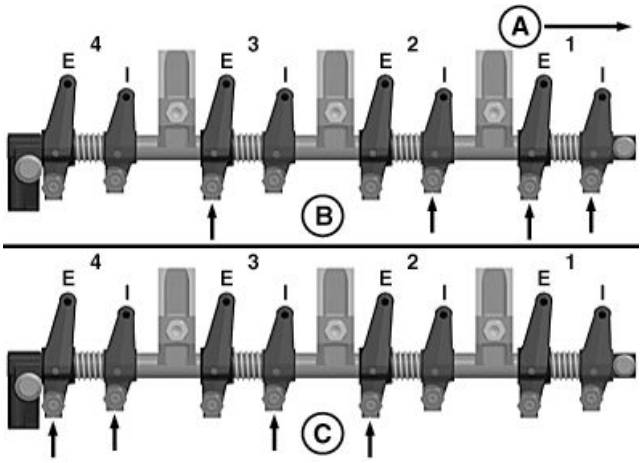
Lock No. 1 piston at TDC compression stroke (B).

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

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

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

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



RG22378 —UN—28JAN13

4-Cylinder Engine Valve Adjustment

RG19661,00003D0 -19-29JAN13-3/4

6-Cylinder Engine:

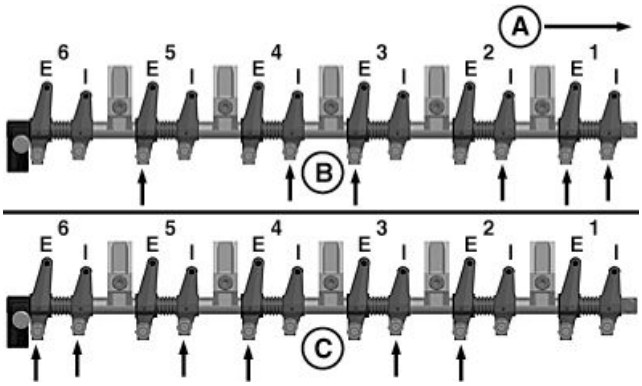
NOTE: Firing order is 1-5-3-6-2-4.

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

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

Turn crankshaft 360°. Lock No. 6 piston at TDC compression stroke (C).

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



RG22377 —UN—28JAN13

6-cylinder Engine Valve Adjustment

RG19661,00003D0 -19-29JAN13-4/4

Flushing And Refilling Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

NOTE: When Northern Lights COOL-GARD is used, the drain interval is 3000 hours or 36 months. The drain interval may be extended to 5000 hours or 60 months of operation, ***provided that the coolant is tested annually AND additives are replenished, as needed, by adding a supplemental coolant additive (SCA)****.*

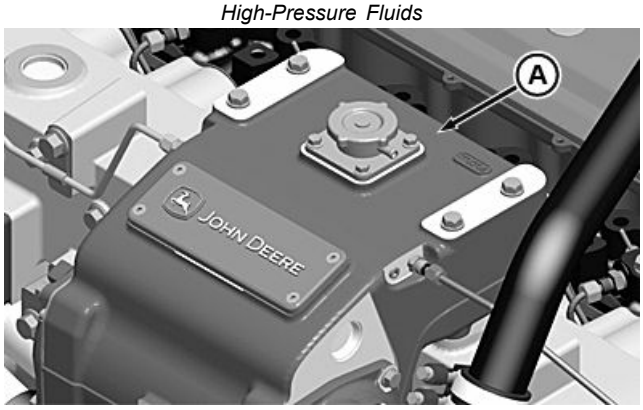
If COOL-GARD is not used, the flushing interval is 2000 hours or 24 months of operation.

Drain old coolant, flush the entire cooling system, test thermostats, and fill with recommended clean coolant using the following procedure.

1. Pressure test entire cooling system and pressure cap if not previously done. (See PRESSURE TESTING COOLING SYSTEM, in the Lubrication and Maintenance/500 Hour/12 Month Section.)
2. Slowly open the cap on the top tank (A) or heat exchanger to relieve pressure and allow coolant to drain faster.

High-Pressure Fluids

TS281 —UN—23AUG88



Engine Top Tank

RG22040 —UN—28NOV12

A—Top Tank Cap

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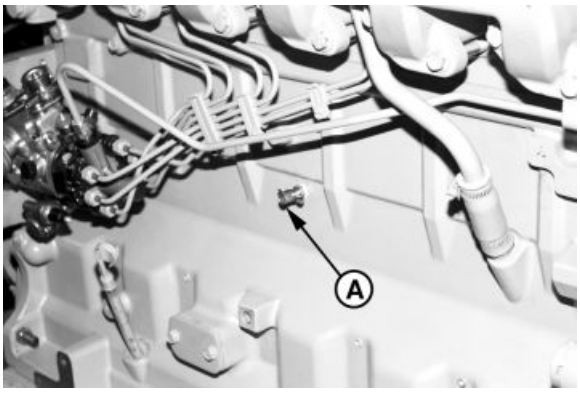
RG19661,00003D1 -19-28JAN13-1/2

3. Open engine block drain valve (A) on left side of engine. Drain all coolant from engine block.
4. Open heat exchanger or top tank drain valve. Drain all coolant from heat exchanger or top tank.
5. Remove thermostats at this time, if not previously done. Install cover (without thermostats) using old gasket and tighten cap screws to 47 N·m (35 lb-ft).
6. Test thermostat opening temperature. (See Inspecting Thermostats And Testing Opening Temperature following in this section).
7. Close all drain valves after coolant has drained.

CAUTION: Do not run engine longer than 10 minutes. Doing so may cause engine to overheat, causing burns when cooling system is draining.

8. Fill the cooling system with clean water. Run the engine about 10 minutes to stir up possible rust or sediment.
9. Stop engine, pull off lower cooling system hose and remove heat exchanger or top tank cap. Immediately drain the water from system before rust and sediment settle.
10. After draining water, close drain valves. Reinstall cap, lower cooling system hose and clamp. Fill the cooling system with clean water and a heavy duty cooling system cleaner such as Fleetguard® RESTORE™ and RESTORE PLUS™.
11. After cleaning the cooling system, drain cleaner and fill with water to flush the system. Run the engine about 10 minutes, remove heat exchanger or top tank cap and pull off lower cooling system hose to drain out flushing water.
12. Close all drain valves. Reinstall hoses and tighten clamps securely. Install thermostats using a new gasket.



RG68019A —UN—19JUN00

Engine Block Drain Valve

A—Engine Block Drain Valve

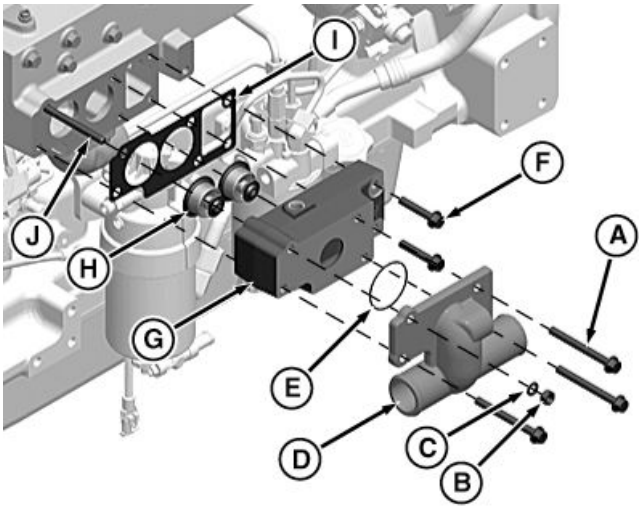
RG19661,00003D1 -19-28JAN13-2/2

Remove Thermostats

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely. DO NOT drain coolant until it has reached ambient temperature.

1. Visually inspect area around thermostat housing and cover for leaks.
2. Remove coolant tank pressure cap and partially drain coolant system.
3. Remove cap screws (A), nut (B) and washer (C) attaching coolant cover (D) with sealing O-ring (E) to the thermostat housing (G) and exhaust manifold.
4. Remove cap screws (F) attaching thermostat housing to the exhaust manifold.
5. Remove thermostat housing with gasket (I). Remove and disgard all gasket material. Clean all sealing surfaces.
6. Inspect and test thermostats for proper opening temperature.
7. Install thermostats with a new gasket and pilot housing on stud (J). Install thermostat housing cap screws finger-tight.



RG22482 —UN—04MAR13

Remove and Install Thermostats

A—Cap Screws (Thermostat Cover)
B—Nut
C—Washer
D—Thermostat Cover
E—O-ring
F—Cap Screws (Thermostat Housing)
G—Thermostat Housing
H—Thermostats
I— Gasket
J—Stud

8. Inspect thermostat cover sealing O-ring and replace if necessary. Install thermostat cover with O-ring, cap screws, washer and nut. Tighten nut and all cap screws to 35 N·m (25 lb.-ft.)

RG19661,0000405 -19-08MAR13-1/1

Inspecting Thermostats and Testing Opening Temperature

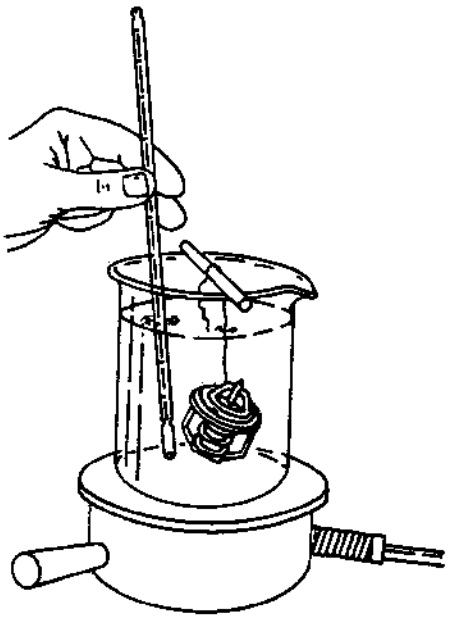
1. Remove thermostats. (See REMOVING THERMOSTATS earlier in this section.)
2. Visually inspect thermostats for corrosion or damage. Replace thermostats as a matched set as necessary.
3. Inspect thermostat with wiggle wire in vent notch. If wire movement is restricted, replace thermostat if cleaning does not free movement.

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

4. Suspend thermostats and a thermometer in a container of water.
5. Stir the water as it heats. Observe opening action of thermostat and compare temperatures with specifications. See GENERAL ENGINE SPECIFICATIONS in Specification Section.

NOTE: Due to varying tolerances of different supplies, initial opening and full open temperatures may vary slightly from specified temperatures.

6. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.



RG5971 —UN—23NOV97

Thermostat And Thermometer In Water

7. If any one thermostat is defective, replace both thermostats.

OUOD006,0000095 -19-19JUN07-1/1

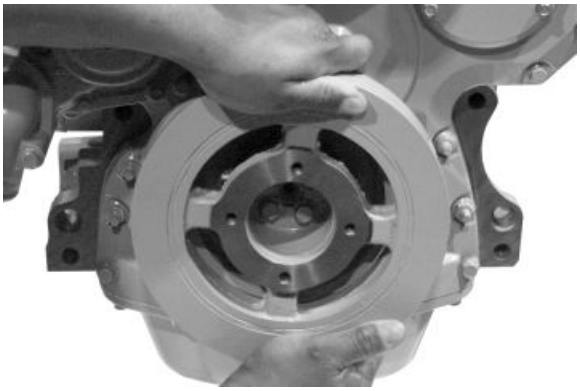
Checking Crankshaft Vibration Damper (6-Cylinder Engine Only)

1. Remove belts (shown removed).
2. Grasp vibration damper with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.

IMPORTANT: The vibration damper assembly is not repairable. For all except 6068SFM75/AFM75, replace damper every 4500 hours or 60 months, whichever occurs first. Replace viscous damper on 6068SFM75/AFM75 engines every 8000 hours.

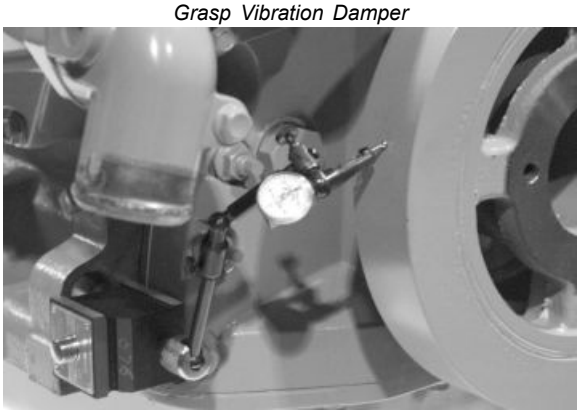
3. Check vibration damper radial runout by positioning a dial indicator (A) so probe contacts damper outer diameter.
4. With engine at operating temperature, rotate crankshaft using either JDE83 or JDE81-1 Flywheel Turning Tool.
5. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

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



RG8018 —UN—15JAN99

Grasp Vibration Damper



RG7508 —UN—23NOV97

Check Runout

OUOD006,0000096 -19-09DEC09-1/1

Inspect and Repair Sea Water Pump (4045TFM85)

• Inspect pump housing for seal leakage

1. Inspect the sea water pump housing weep hole (A), if equipped, for evidence of water or oil indicating seal leakage.

If water leakage is evident, order a RE49490 Impeller Repair Kit and replace impeller and front housing/shaft seal.

If oil leakage is evident, order a RE49491 Major Repair Kit and replace all internal components except shaft. An arbor press and drivers are needed to install this kit. Have an experienced technician install this kit.

RG9852 —UN—05JAN99

Inspect Sea Water Pump

A—Weep Hole (Earlier Engines Only)

Continued on next page

RG19661,0000401 -19-06MAR13-1/3

Remove and Inspect Impeller

1. Close sea cock and drain sea water system if not previously done.

2. Remove six cover plate cap screws with washers and remove cover plate (A) with O-ring. Remove impeller end cap from end of impeller bore.

NOTE: Normally the impeller can be removed by using two pair of pliers to grip impeller vanes on opposite sides of impeller. Rotating the pump shaft by hand may help free the impeller. Petroleum based lubricants can cause the impeller to swell, and are not recommended to free a stuck impeller.

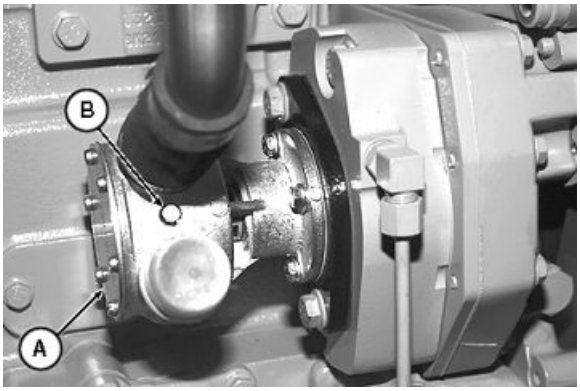
3. Carefully remove impeller with cam plate. Be careful not to damage impeller if in reusable condition. Remove key from shaft keyway.

The impeller must be installed in the same direction as removed. Mark the impeller to ensure installation in proper direction of rotation if impeller is reused.

4. Inspect impeller for damages such as tears, stress cracks, excess abrasions on vane ends, or chunks of material missing. Impellers that are run dry will overheat and fail the impeller blades at the root. Impellers that swell and stick, fail the impeller in the middle of the blade. If impeller replacement is necessary, order an impeller repair kit.

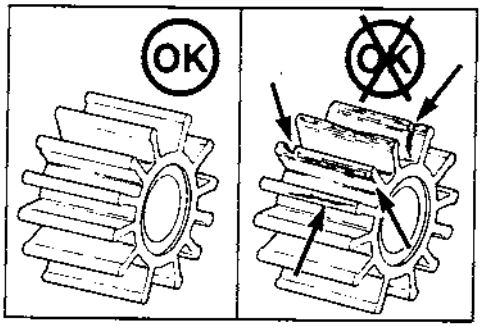
IMPORTANT: If impeller has chunks of material missing, the heat exchanger, marine gear oil cooler and any other circuit that are cooled by raw water should be thoroughly cleaned and flushed.

5. Remove cam screw (B) holding cam plate to impeller housing bore.



Remove Cover Plate

RG9853 —UN—05JAN99



Inspect Sea Water Pump Impeller

RG6243 —UN—23MAR92

A—Cover Plate **B—Cam Screw**

6. Thoroughly clean impeller housing bore and cam plate (if cam plate is reused).

Continued on next page

Install Impeller

1. Apply LOCTITE® 242 (Deere Part No. TY9370) to curved side of cam plate near threaded hole and install cam plate into impeller housing bore, be sure holes in cam plate and housing are aligned. Apply LOCTITE® 242 to cam screw (B), install, and tighten.

The cam plate should be inspected to insure that none of the cam fingers are protruding which could cause impeller damage. The cam screw should also be inspected to insure that it does not protrude below the cam plate. Replace cam plate and cam screw or grind screw flush as needed.

IMPORTANT: Petroleum based lubricants can cause the impeller to swell, and are not recommended to lubricate the impeller before installation.

2. Lubricate impeller blades with a non-petroleum based lubricant such as silicone or soapy water. Install impeller using a twisting motion and be sure the impeller blades are bent in the same direction as they were upon removal.

Be sure impeller is installed in same direction as removed if reusing existing impeller.

3. Rotate impeller to align keyway and slide the key in place. Install impeller end cap in end of impeller bore.

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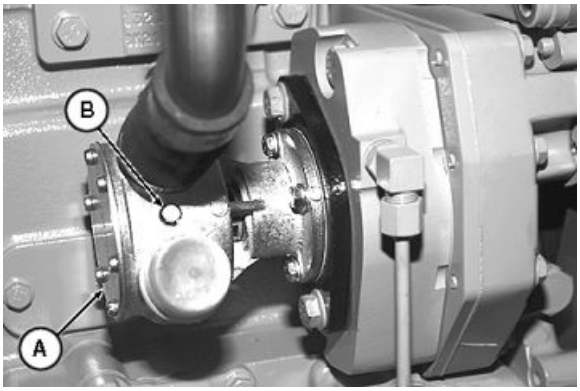


RG9853 —UN—05JAN99

Install Cover Plate

A—Cover Plate **B—Cam Screw**

4. Using a new O-ring, install cover plate (A) onto impeller housing. Install six screws with washers. Tighten screws evenly.

5. Reconnect all water piping, if disconnected.

6. Open sea cock and prime sea water pump with water. Start engine and check for leaks.

RG19661,0000401 -19-06MAR13-3/3

Inspect And Repair Sea Water Pump (4045AFM85/6068AFM85)

NOTE: Sea water pump with shaft key is illustrated. Sea water pumps with a splined shaft follow the same procedure

1. Close sea cocks and drain sea water system.
2. Remove cover plate (A) from sea water pump.

NOTE: Special impeller puller tool is provided with minor and major sea water pump rebuild kits. If tool is not available, the impeller can normally be removed by using two pair of pliers to grip impeller vanes on opposite sides of impeller. Rotating the pump shaft by hand may help free the impeller. Petroleum based lubricants can cause the impeller to swell, and are not recommended to free a stuck impeller.

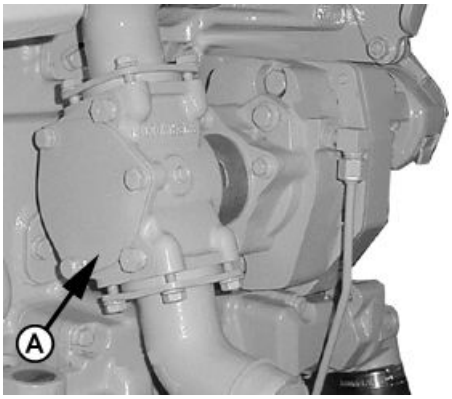
3. Remove impeller (B) and shaft key (C) (if equipped) from pump housing.
4. Remove O-ring (D).
5. Inspect cam plate (E) for evidence of heavy pitting or wear. Replace as needed.
6. Inspect impeller for damages such as tears, stress cracks, excess abrasions on vane ends, or chunks of material missing. Impellers that are run dry will overheat and fail the impeller blades at the root. Impellers that swell and stick, fail the impeller in the middle of the blade. If impeller replacement is necessary, order an impeller repair kit.

IMPORTANT: If impeller has chunks of material missing, the heat exchanger, aftercooler, marine gear oil cooler and any other circuit that are cooled by raw water should be thoroughly cleaned and flushed.

7. Install shaft key (C) (if equipped) on shaft.

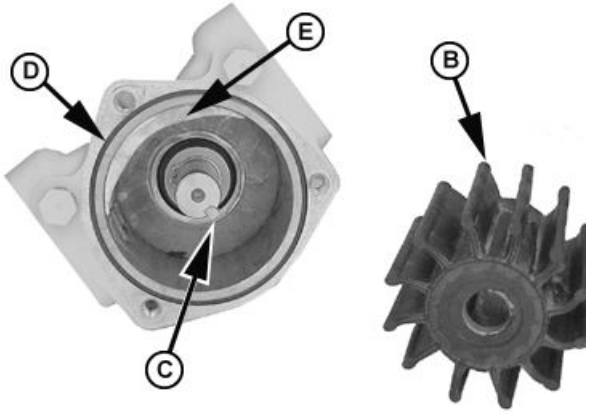
IMPORTANT: Petroleum based lubricants can cause the impeller to swell, and are not recommended to lubricate the impeller before installation.

8. Lubricate new impeller blades with a non-petroleum based lubricant such as silicone or soapy water. Install impeller using a twisting motion and be sure the impeller blades are bent in the same direction as they were upon removal to prevent damage at startup. Rotate impeller on shaft to align keyways/splines and slide the impeller onto the shaft.
9. Using a new O-ring (D), install cover plate and tighten cap screws with washers securely.
10. Install sea water pump and tighten cap screws to 73 N·m (54 lb-ft).
11. Connect sea water inlet and outlet tubes. Tighten mounting cap screws **evenly** until secure.



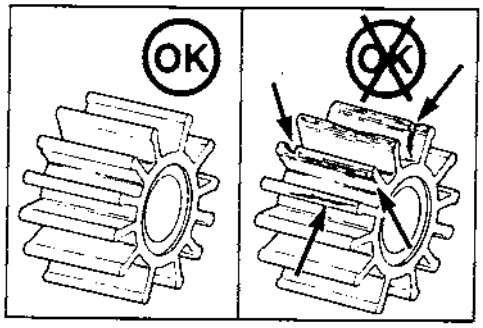
RG14949 —UN—20JUN07

Remove Cover Plate



RG12189 —UN—25FEB02

Remove and Inspect Components



RG6243 —UN—23MAR92

Inspect Sea Water Pump Impeller

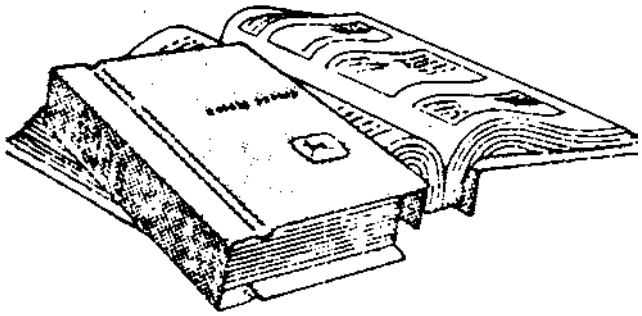
A—Cover Plate
B—Impeller
C—Shaft Key
D—O-Ring
E—Cam Plate

12. Replace O-rings on oil tubes and install oil filter housing and oil tubes. Tighten mounting cap screws to 35 N·m (26 lb-ft).
13. Open sea cocks, start engine and check pump operation.

RG19661,0000402 -19-09MAR13-1/1

Additional Service Information

This is not a detailed service manual. If you want more detailed service information, use the form in the back of this manual to order a component technical manual.



RG4624 —UN—15DEC88

RG,RG34710,5591 -19-20MAY96-1/1

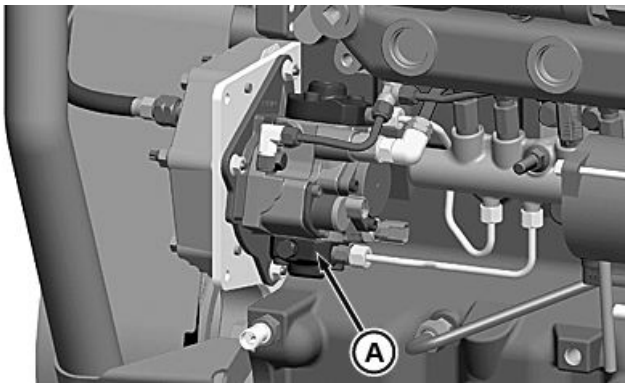
Do Not Modify Fuel System

IMPORTANT: Modification or alteration of the injection pump (arrow), the injection pump timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.

In addition, tampering with fuel system which alters emission-related equipment on engines may result in fines or other penalties, per EPA regulations or other local emission laws.

Do not attempt to service injection pump or fuel injectors yourself. Special training and special tools are required. (See your authorized servicing dealer or engine distributor.)

IMPORTANT: Never steam clean or pour cold water on a high-pressure fuel pump while it is still warm. To do so may cause seizure of pump parts.



RG22161 —UN—06DEC12

Fuel Injection Pump

A—Fuel Injection Pump

RG19661,00003C1 -19-23JAN13-1/1

Adding Coolant

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

IMPORTANT: Never pour cold liquid into a hot engine, as it may crack cylinder head or block. DO NOT operate engine without coolant for even a few minutes.

Northern Lights TY15161 Cooling System Sealer may be added to the cooling system to stop leaks. DO NOT use any other stop-leak additives in the cooling system.

Air must be expelled from cooling system when coolant is added.

1. Loosen temperature sending unit fitting at rear of cylinder head or plug in side of thermostat housing to allow air to escape when filling system.

IMPORTANT: When adding coolant to the system, use the appropriate coolant solution. (See ENGINE COOLANT SPECIFICATIONS in Fuels, Lubricants, and Coolant Section for mixing of coolant ingredients before adding to cooling system.)

TS281 —UN—23AUG88

High-Pressure Fluids

Do not overfill cooling system. A pressurized system needs space for heat expansion without overflowing at top of coolant tank.

2. Fill until coolant level touches bottom of coolant tank filler neck.
3. Tighten plugs and fittings when air has been expelled from system.

RG,RG34710,5593 -19-04JAN02-1/1

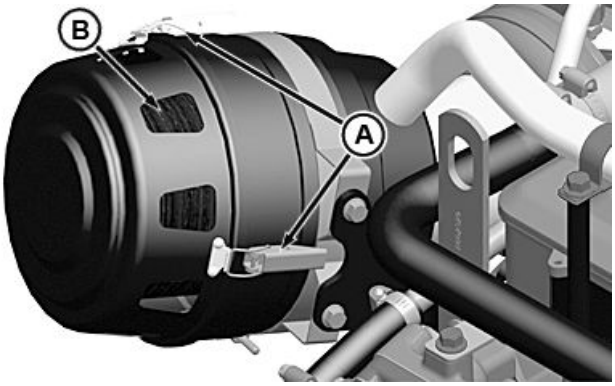
Replacing Dry Air Cleaner Element

IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator (A) shows vacuum of 625 mm (25 in.) H_2O, or when reset button has popped up (if equipped). Also replace element if it is torn, or visibly dirty.

1. Release air filter assembly clamps (A) and remove cover.

IMPORTANT: Insure all air intake connections are secure to prevent ingestion of abrasive dirt and dust into the system, causing possible engine damage.

2. Install new air filter element (B), install cover and engage clamps.



RG22155 —UN—21FEB13

Replace Air Filter Element

A—Air Filter Assembly Clamps B—Air Filter Element

RG19661,00003F5 -19-22FEB13-1/1

Servicing Air Cleaner Filter Element

IMPORTANT: Always service primary air cleaner element when air restriction indicator shows a vacuum of 625 mm (25 in.) H_2O, or when reset button has popped up (6068SFM75/AFM75 only). Also replace element if it is torn, or visibly dirty.

NOTE: This procedure applies to Northern Lights air cleaner kits. Refer to manufacturers' instructions for servicing air cleaners not supplied by Northern Lights.

1. Loosen clamp (A) and remove filter element.

IMPORTANT: Replace filter element after 10 cleanings. (See following blocks.)

2. Tap end of filter GENTLY on hard surface to dislodge loose dirt.
3. Brush dirt side of filter GENTLY with soft bristle brush.

IMPORTANT: Use kit RE504585 to service filter element. DO NOT clean element with gasoline, solvents, parts cleaners, strong detergents, or caustic cleaning solutions. DO NOT steam clean or use high-pressure washers to clean element. These processes will damage filter media and/or rubber base or end cap.

Air Cleaner Restriction Indicator

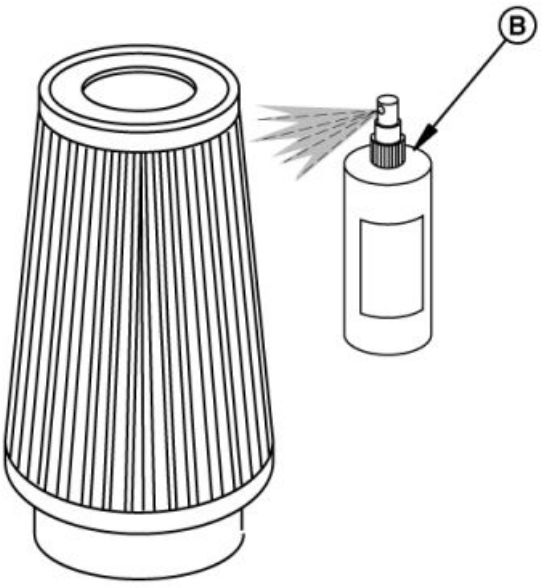
RG12749 —UN—24DEC02

Remove Filter Element

RG9926 —UN—18NOV99

OUOD006,0000098 -19-10DEC09-1/5

4. Spray air filter cleaner (B) (from kit RE504585) liberally onto entire element. Let soak into filter media for 10 minutes.



Spray Filter with Cleaner

RG9943 —UN—17NOV99

Continued on next page

OUOD006,0000098 -19-10DEC09-2/5

5. Rinse filter with low pressure water, flushing opposite the direction of air flow (from clean side to dirty side).

IMPORTANT: Let element dry at room temperature. Compressed air will damage filter media. Heat will shrink filter media and may damage rubber base or end cap.

6. Shake off excess water and let the element dry at room temperature.

IMPORTANT: Never put filter in service without oiling it. The filter will not function properly without being oiled with oil provided in kit RE504585.

Do not use automatic transmission fluid, motor oil, diesel fuel, or any type light-weight spray lubricant. These products will damage filter or degrade its performance.

NOTE: Red dye is added to oil to show areas of oil application.

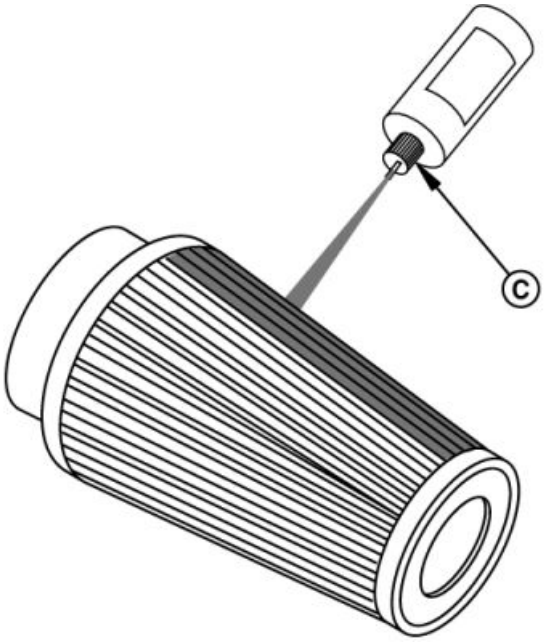
RG9944 —UN—17NOV99

Rinse Filter

OUOD006,0000098 -19-10DEC09-3/5

7. Spray air filter oil from squeeze bottle (C) in kit from distance of 25 cm (10 in.) onto a group of pleats until the pleats become reddish in color. Respray any areas that are still white 10 minutes after initial application.

8. Install filter and tighten clamp.



RG9945 —UN—17NOV99

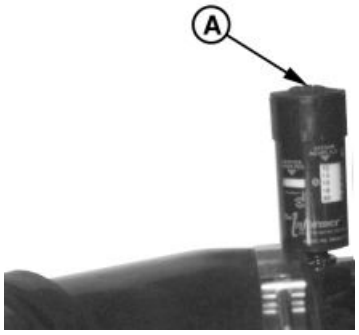
Apply Oil To Filter

Continued on next page

OUOD006,0000098 -19-10DEC09-4/5

IMPORTANT: Whenever the air cleaner has been serviced, ALWAYS fully depress the air restriction indicator reset button (if equipped) to assure accurate readings.

9. If equipped, fully depress air restriction indicator reset button (A) and release to reset indicator.



RG9927 —UN—18NOV99

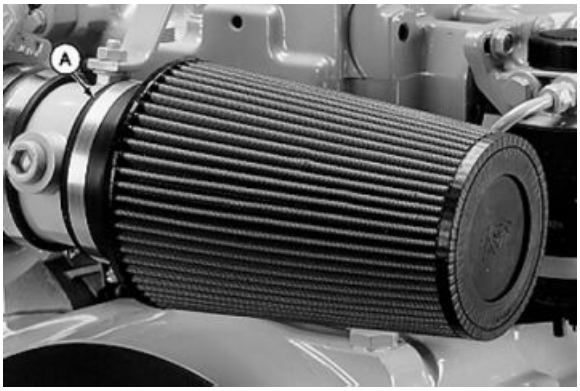
Air Restriction Indicator Reset Button

OUOD006,0000098 -19-10DEC09-5/5

Replacing Air Cleaner Filter Element

IMPORTANT: Replace the element after 10 cleanings.

1. Loosen clamp (A) and remove filter element.
2. Install new filter element and tighten clamp.



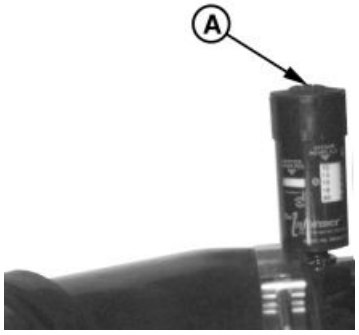
RG9926 —UN—18NOV99

Remove Filter Element

DPSG,OUOD007,2908 -19-24DEC02-1/2

IMPORTANT: Whenever the air cleaner has been serviced, ALWAYS fully depress the air restriction indicator reset button (if equipped) to assure accurate readings.

3. If equipped, fully depress air restriction indicator reset button (A) and release to reset indicator.



RG9927 —UN—18NOV99

Air Restriction Indicator Reset Button

DPSG,OUOD007,2908 -19-24DEC02-2/2

Replacing Alternator Belt (With Automatic Tensioner)

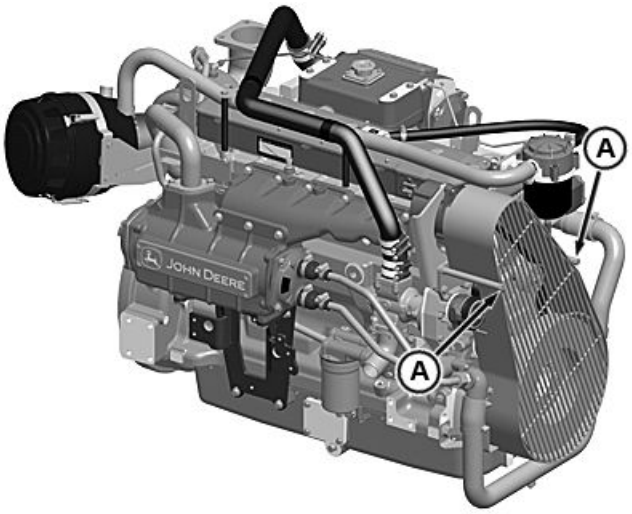
Refer to CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR in Lubrication and Maintenance/500 Hour/12 Month Section for additional information on the belt tensioner.

CAUTION: Belt guard should be in place at all times when engine is running.

NOTE: While belt is removed, inspect pulleys and bearings. Rotate and feel for hard turning or any unusual sounds. If pulleys or bearings need replacement, see your Northern Lights dealer.

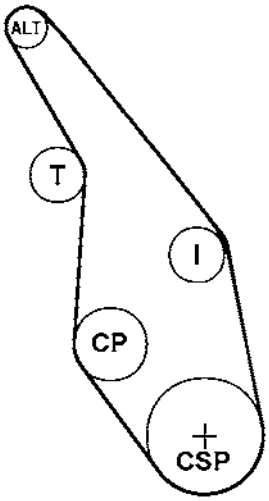
1. Remove cap screws (A) and carefully remove belt guard from engine.
2. Release tension on belt using a breaker bar and socket on tension arm and remove poly-vee belt from pulleys.
3. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.
4. Install new belt, making sure belt is correctly seated in all pulley grooves. Refer to belt routing at right.
5. Apply tension to belt with tensioner. Remove socket.
6. Start engine and check belt alignment.

A—Cap Screws
ALT— Alternator
CSP—Crankshaft Pulley
I— Idler Pulley
T—Tensioner
CP—Coolant Pump



RG22162 —UN—06DEC12

Remove Belt Guard



RG12077 —UN—26FEB02

Belt Routing

RG19661,00003F4 -19-20FEB13-1/1

Check Front Power Take-Off (PTO)

CAUTION: Entanglement in rotating driveline can cause serious injury or death. Keep shield on PTO driveshaft between clutch housing and the engine driven equipment at all times during engine operation. Wear close fitting clothing. Stop the engine and be sure PTO driveline is stopped before making adjustments.

CAUTION: Metal surfaces of PTO housing may be hot to the touch during operation or at shutdown.

The optional front power take-off (PTO) from Northern Lights transfers engine power to auxiliary equipment or moving components.

Proper performance of the power take-off unit will be related to the care it is given. Periodically check for any oil leaks that may occur.

TS1644 —UN—22AUG95

Rotating Drivelines

If the power take-off does not work properly, contact your authorized servicing dealer or engine distributor.

OURGP11,0000145 -19-09DEC03-1/1

Drain Water From Fuel Filter

IMPORTANT: When using BIODIESEL blends, monitor water quantity more closely in the fuel filter element. Water in the filter separator may need to be drained more frequently.

If instrument panel provides a water in fuel warning, drain water or debris from filter using the following steps.

1. Loosen thumb screw (A) and drain water and debris into a suitable container. Tighten thumb screw.
2. Dispose of water and debris in an environmentally safe manner.

A—Thumb Screw

RG13253 —UN—08DEC03

Drain Primary Fuel Filter - 6068SFM50 Shown

OUOD006,0000083 -19-16OCT07-1/1

Bleeding Fuel System

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

Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid hazards by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

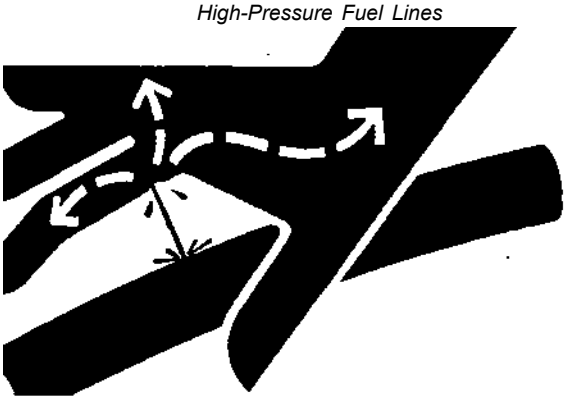
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

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

NOTE: Normally the fuel system on these engines is self-priming and self-bleeding, and does not require a bleeding procedure by the operator.

TS1343 —UN—18MAR92

High-Pressure Fuel Lines



X9811 —UN—23AUG88

High Pressure Fluids

If engine will not start after filter changes, turn ignition key ON for 60 seconds to prime the fuel system. It may be necessary to turn the key off and on again to reprime the system before starting.

RG19661,00003FD -19-01MAR13-1/1

Remove and Install Sea Water Pump (4045TFM85)

NOTE: Sea water pump may have two more mounting cap screws than illustrated. Remove/install procedure is unchanged.

• **Remove Sea Water Pump:**

1. Close sea cock and drain sea water system, if not previously done.

2. Remove water inlet tube (shown removed) and outlet tube (A) from sea water pump.

3. Remove two cap screws (B) attaching sea water pump to gear housing. Withdraw pump from housing until splined shaft (C) is free from splined drive gear ID (D).

4. Clean all gasket material from both mating surfaces.

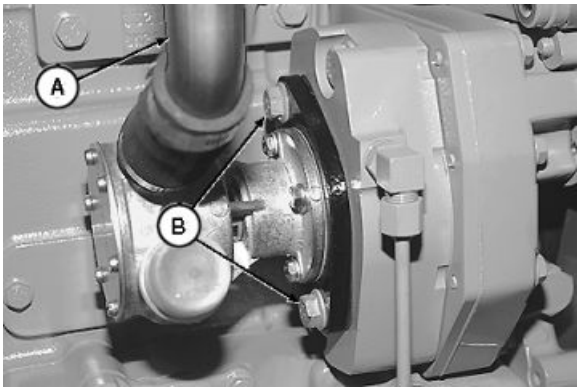
• **Install Sea Water Pump:**

1. Position a new gasket on water pump mounting flange. Install splined pump shaft in splined ID of drive gear.

2. Align mounting holes in water pump flange and gasket with threaded holes in gear housing. Install cap screws with washers and tighten cap screws to 47 N•m (35 lb-ft).

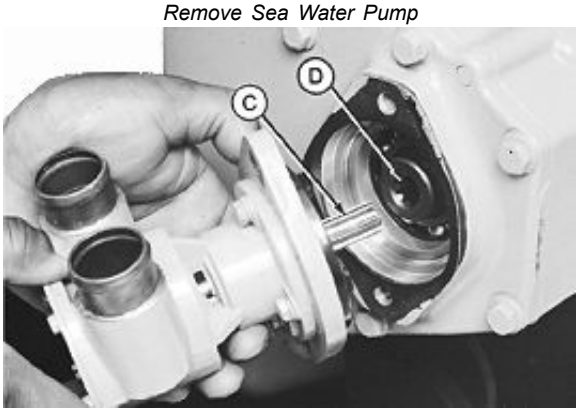
3. Connect water piping and tighten clamps.

4. Open sea cock, start engine, and check for leaks.



RG9861 —UN—06JAN99

Remove Sea Water Pump



RG9864 —UN—06JAN99

Install Sea Water Pump

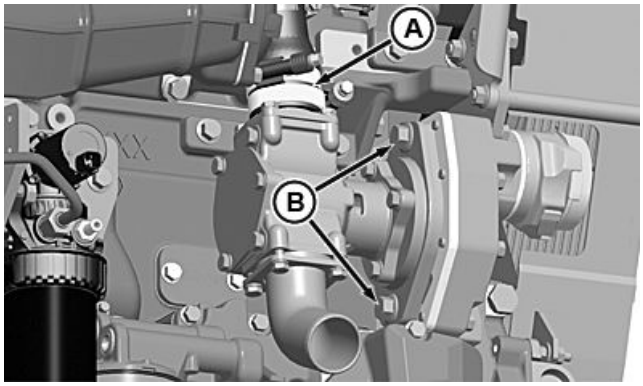
A—Outlet Tube
B—Mounting Screws
C—Splined Shaft
D—Drive Gear Splined ID

RG19661,00003FE -19-02MAR13-1/1

Remove And Install Sea Water Pump (4045AFM85/6068AFM85)

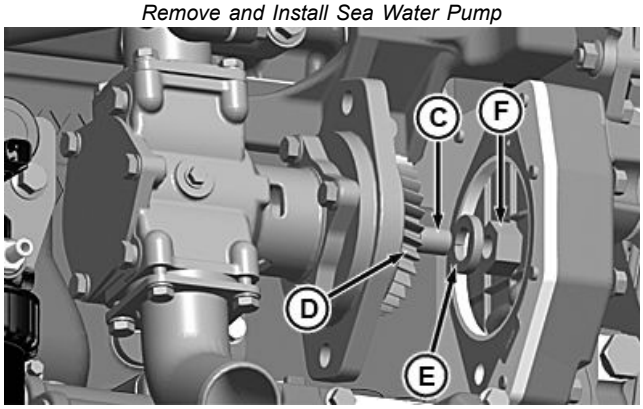
1. Close sea cock and drain sea water system.
2. Remove sea water outlet connection (A), remove sea water pump cap screws (B) and remove pump.
3. Clean all gasket material from both mating surfaces.
4. Inspect gear teeth for damage. Install new gear (D) by aligning key (C) to the pump shaft keyway.
5. Install lock washer (E) and hex nut (F) finger-tight and insure key is properly in place.
6. Tighten hex nut to 68 N·m (50 lb.-ft.).
7. Install sea water pump with new gasket to front plate and tighten cap screws (B) to 140 N·m (103 lb.-ft.).
8. Connect sea water inlet and outlet.
9. Open sea cock, start engine and check for leaks.

A—Sea Water Outlet
B—Cap Screws
C—Key
D—Gear
E—Lock Washer
F—Hex Nut



RG22172 —UN—10DEC12

Remove and Install Sea Water Pump

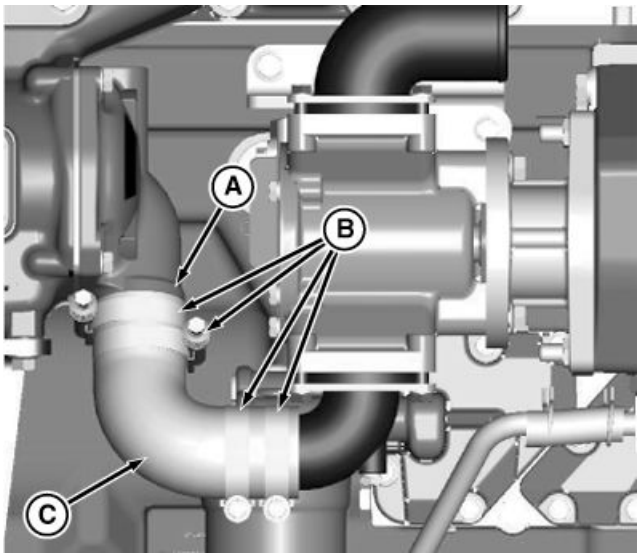


RG22173 —UN—10DEC12

Sea Water Pump Drive Gear

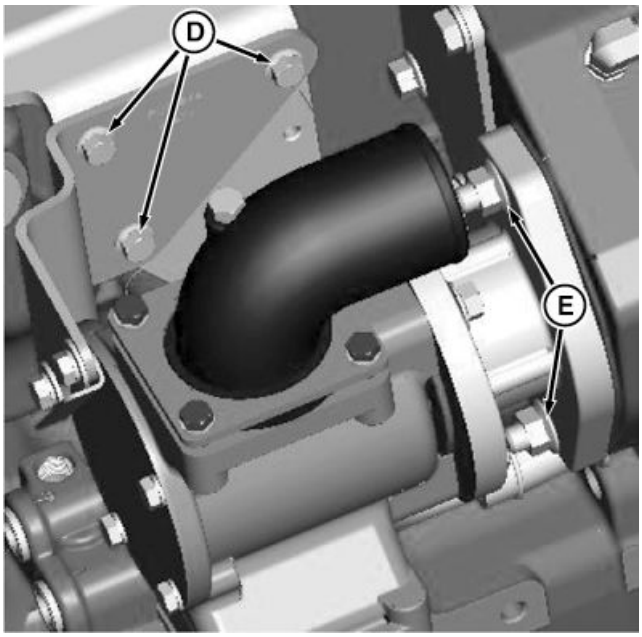
RG19661,00003FF -19-02MAR13-1/1

Remove and Install Sea Water Pump (6068SFM85)



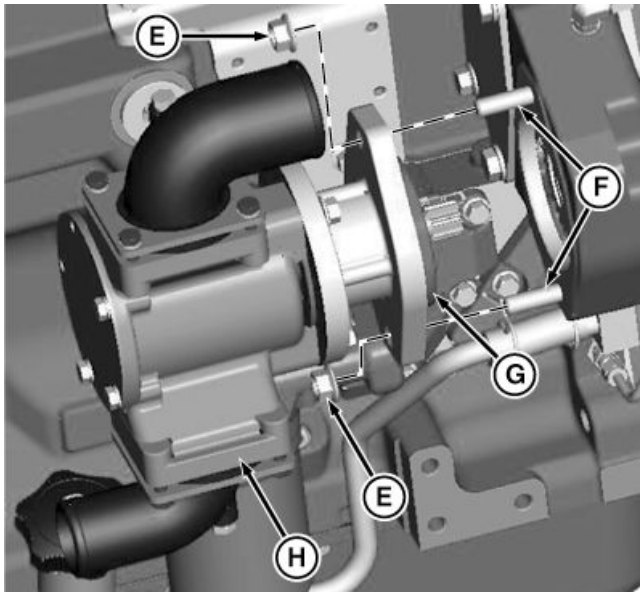
RG22485 —UN—04MAR13

Remove and Install Sea Water Pump



RG22484 —UN—07MAR13

1. Close sea cock and drain sea water system.
2. Remove sea water pump inlet connection. Loosen constant tension clamps (B) on formed hose (C) that is attached to the aftercooler inlet (A).
3. Remove sea water pump bracket cap screws (D). Remove pump mounting nuts (E) and remove sea water pump (H).
4. Clean sealing surfaces and inspect for defects. Replace O-ring (G) if necessary.
5. Install sea water pump with O-ring on studs (F). Install nuts (E) finger-tight evenly on both studs and tighten to 60 N·m (44 lb.-ft.).
6. Install bracket cap screws (D) and tighten to 35 N·m (26 lb.-ft.)
7. Install formed hose (C) and tighten constant tension clamps (B) to 12 N·m (9 lb.-ft.).
8. Connect sea water pump inlet.
9. Open sea cock, start engine and check for leaks.



RG22483 —UN—07MAR13

A—Aftercooler Inlet
B—Constant Tension Clamps
C—Formed Hose
D—Cap Screws
E—Nuts
F—Studs
G—O-ring
H—Sea Water Pump

RG19661,0000404 -19-07MAR13-1/1

General Troubleshooting Information

Troubleshooting engine problems can be difficult. Engine wiring diagrams are provided in this section to help isolate electrical problems on engines using Northern Lights wiring harness and instrument (gauge) panel.

Later in this section is a list of possible engine problems that may be encountered, accompanied by possible causes and corrections. The illustrated diagrams and troubleshooting information are of a general nature; final design of the overall system for your engine application may be different. See your engine distributor or servicing dealer if you are in doubt.

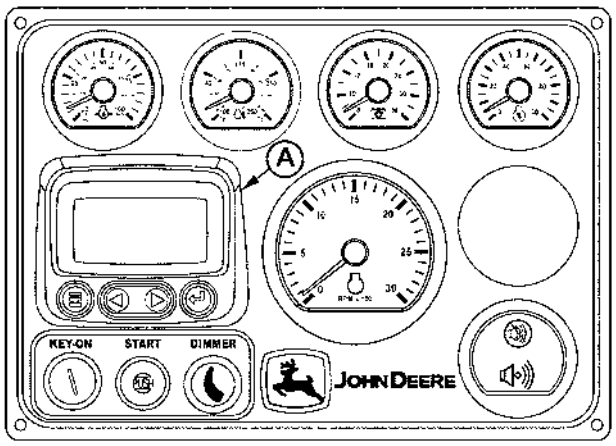
For Electronically Controlled Engines: The Engine Control Unit (ECU) has the ability to detect problems internally and in the electronic control system. This includes determining if any of the sensor input voltages are too high or too low, if the camshaft and crankshaft position sensor inputs are valid, and if the unit injector solenoids are responding properly.

If the ECU detects a problem with the electronic control system a Diagnostic Trouble Code (DTC) specific to the failed system will be stored in the ECU's memory.

There are two types of DTCs:
- Active
- Inactive (Stored)

Active DTCs indicate that the failure is occurring. These type of failures are sometimes called "hard" failures. They can be accessed on the diagnostic gauge (A) on the instrument panel.

Inactive or stored DTCs indicate that a failure has occurred in the past, but is not currently occurring. This type of "stored" DTC can be caused by an "intermittent" failure.



RG13140 —UN—07OCT03

Diagnostic Gauge

A—Diagnostic Gauge - Electronically Controlled Engine

These could be problems such as a bad connection or a wire intermittently shorting to ground.

To access DTC's with the diagnostic gauge (A), see section 15 of this manual.

If a sensor or wiring fails and a DTC is active for the sensor, the ECU will use a substitute "limp home" value in its calculations to continue engine operation.

A list of DTCs is given later in this section with a description of each. Contact your engine servicing dealer to correct any DTCs which are displayed on the instrument panel.

OUOD006,00000F8 -19-25SEP07-1/1

Precautions for Welding

Remove paint before welding or heating (see Safety Section in this manual for more information on paint removal and high-pressure lines).

CAUTION: Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. If you sand or grind paint, avoid breathing the dust by wearing an approved respirator. If you use solvent or paint stripper, remove with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area before welding. Allow fumes to disperse at least 15 minutes before welding or heating.

IMPORTANT: Welding on the engine is NOT ALLOWED. If welding must be performed on the machine, follow these precautions.

IMPORTANT: High currents or electrostatic discharge into electronic components from welding may cause permanent damage.

1. Remove paint from the area to be welded and ground cable clamp location.
2. Disconnect the negative (-) battery cable(s) or open battery (-) switch if equipped.
3. Disconnect the positive (+) battery cable(s) or open battery (+) switch if equipped.
4. Clear or move any wiring harness sections away from the welding area.
5. Welding on engine components is not allowed.
6. Never connect the welder ground to any engine component or engine driven components that may be connected to the engine.
7. After welding, reverse steps 2—3.

TS953 —UN—15MAY90

DX,WELDING,PRECAUTIONS -19-06DEC10-1/1

Precautions For Welding On Vessels Equipped With Electronic Engine Control Unit (ECU)

IMPORTANT: ALWAYS disconnect Electronic Control Unit (ECU) connectors and engine control system-to-vessel ground before welding. High currents or electro-static discharge in electronic components from welding may cause permanent damage.

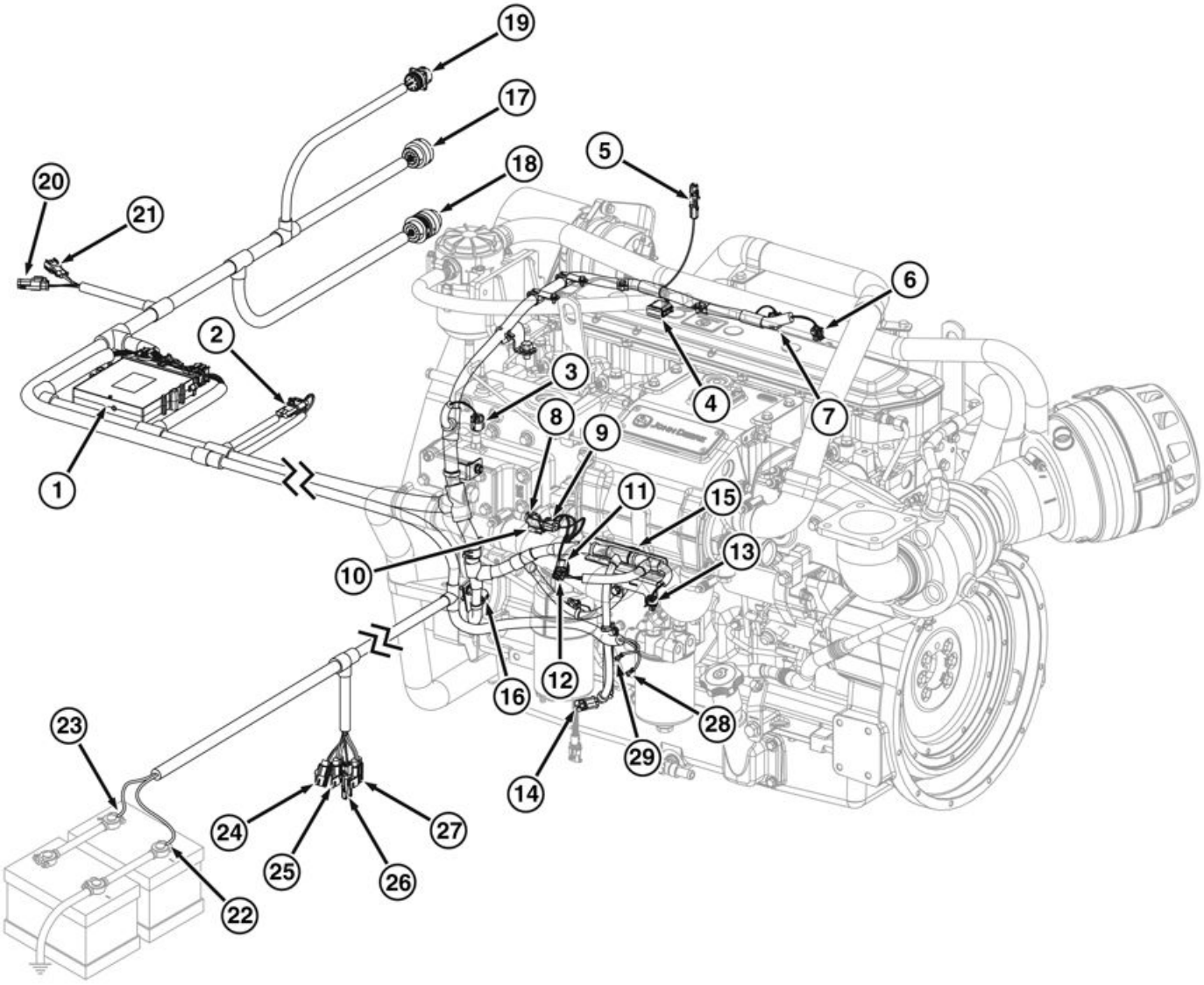
1. Remove the ground connection for the engine control system-to-vessel frame.
2. Disconnect the connectors from the ECU.
3. Connect the welder ground close to the welding point and be sure ECU or other electronic components are not in the ground path.

Welding Precautions

TS953 —UN—15MAY90

DPSG,OUOD007,2898 -19-04NOV99-1/1

Electronically Controlled Engine Electrical System Layout

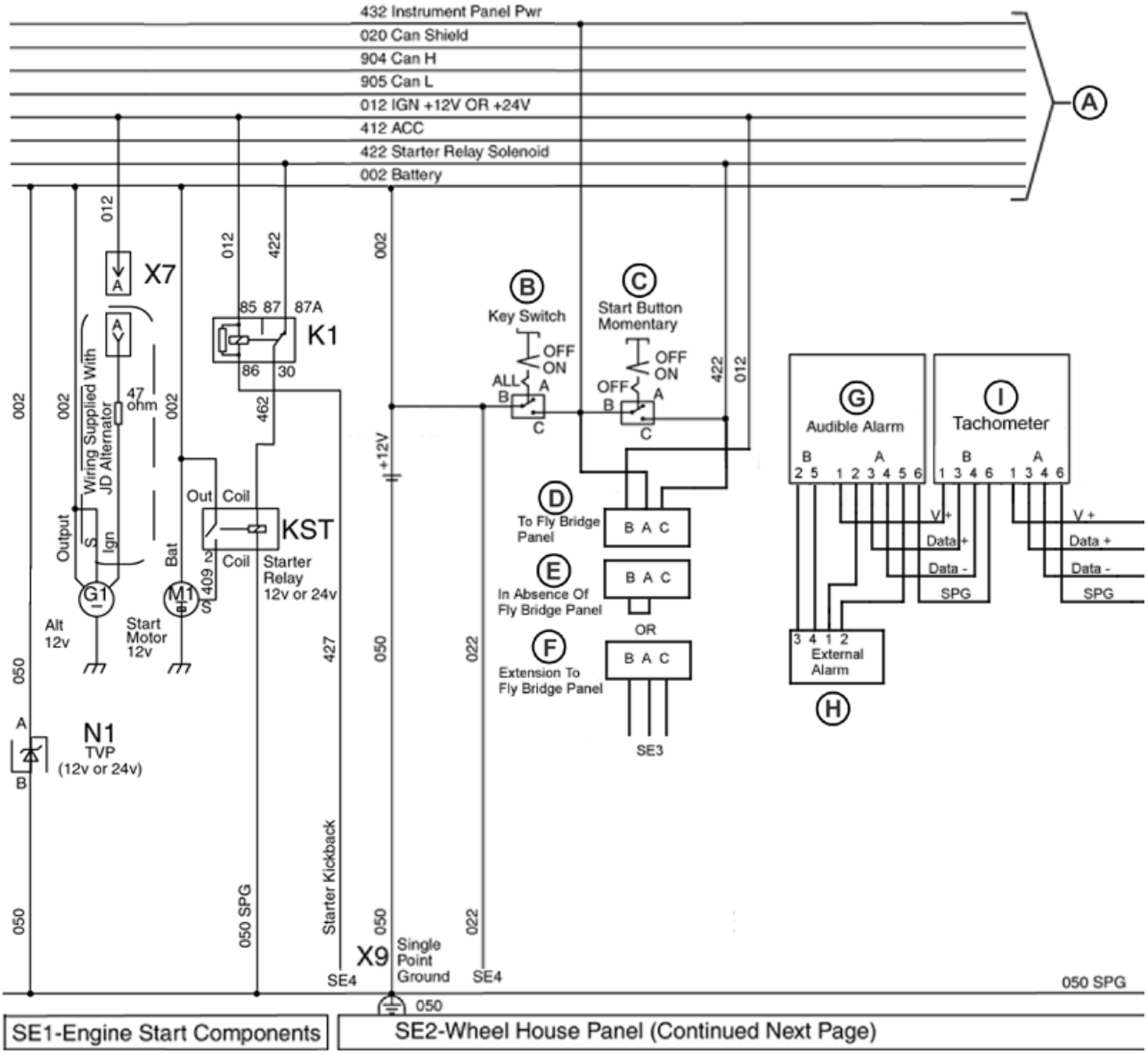


RG22346 —UN—05FEB13

1— Engine Control Unit (ECU)
2— Auxiliary Power Connector
3— Coolant Temperature Sensor Connector
4— Fuel Injection Harness Connector
5— Alternator Connector
6— Manifold Air Pressure Sensor Connector
7— Manifold Air Temperature Sensor Connector
8— Suction Control Valve Sensor Connector
9— Fuel Temperature Sensor Connector
10— Camshaft Position Sensor Connector
11— Low-Pressure Fuel Pump Connector
12— Oil Pressure Sensor Connector
13 — Fuel Pressure Sensor Connector
14— Water-in-Fuel Sensor Connector
15— Fuel Rail Pressure Sensor Connector
16— Crankshaft Position Sensor Connector
17— Control Panel Connector
18— Auxiliary Connector
19— Diagnostic Connector
20— CAN Terminator Connector
21— Remote On/Off Connector
22— Unterminated Ground (Battery)
23— Unterminated Power (Battery)
24— Low-Pressure Fuel Pump Fuse (15 Amp)
25— ECU Fuse (20 Amp)
26— Transient Voltage Protection Connector
27— System Fuse (30 Amp)
28— Starter Relay Coil Connector (Power)
29— Starter Relay Coil Connector (Ground)

RG19661,00003DE -19-15FEB13-1/1

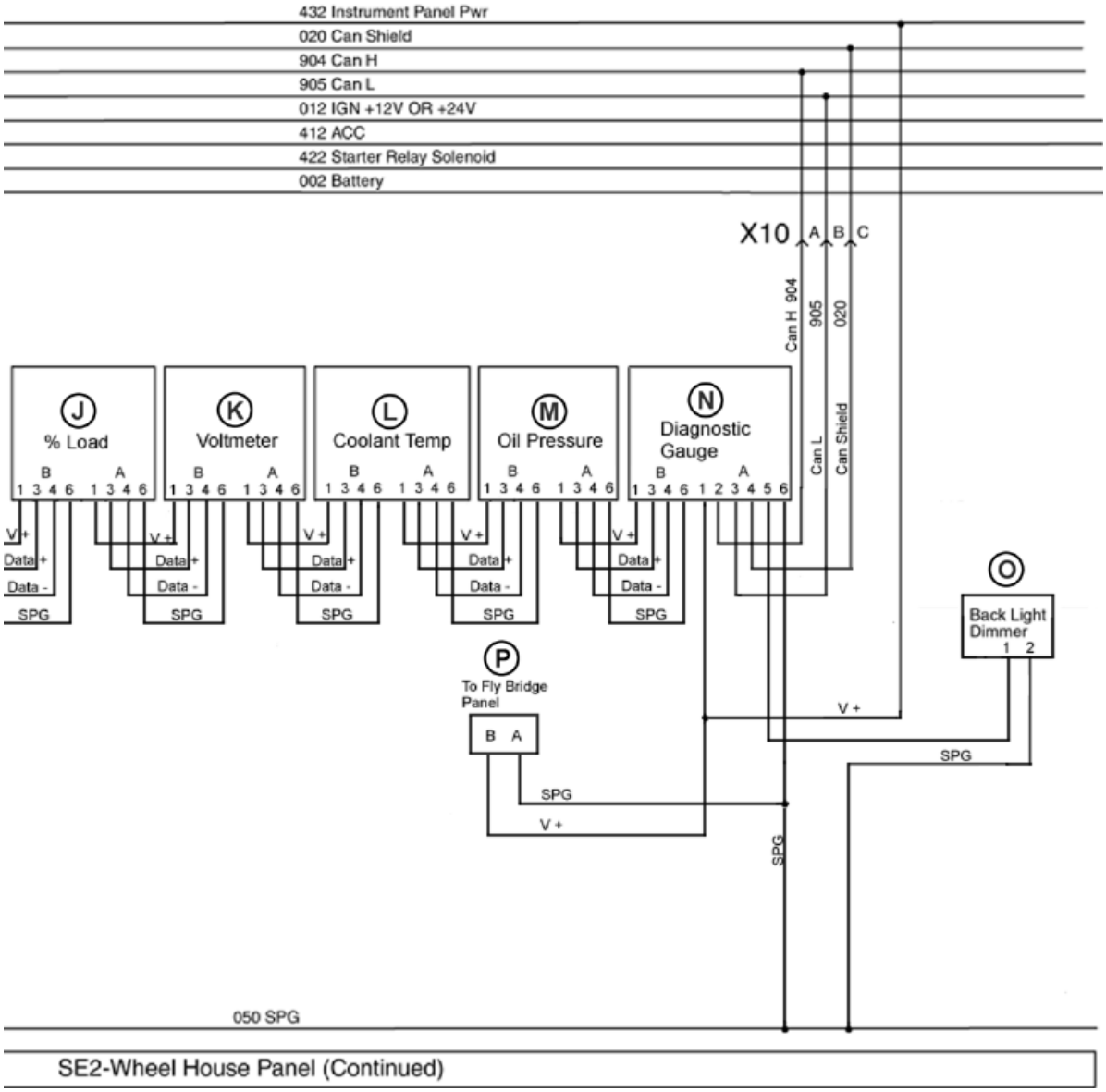
Wiring Diagram for Northern Lights Main Station (Wheel House) Instrument Panel - Electronically Controlled Engine



A—Vehicle Harness Connector
B—Key Switch
C—Start Button- Momentary
D—To Fly Bridge Panel
E—In Absence of Fly Bridge Panel
F—Extension to Fly Bridge Panel
G—Audible Alarm
G1—Alternator
H—External Alarm
I— Tachometer
J—% Load
K—Voltmeter
KST—Starter Relay
L—Coolant Temp
M—Oil Pressure
M1—Start Motor
N—Diagnostic Gauge
N1—Transient Voltage Protection
O—Back Light Dimmer
P—To Fly Bridge Panel
X7—Alternator Harness Connector
X9—Single Point Ground
X10— CAN Terminator
002— Battery
012— IGN +12V or +24V
020— CAN Shield
412— ACC
422— Starter Relay Solenoid
432— Instrument Panel Power
904— Can H
905— Can L

OUOD006,00000BC -19-25JUL07-1/1

Wiring Diagram for Northern Lights Main Station (Wheel House) Instrument Panel - Electronically Controlled Engine - Cont'd

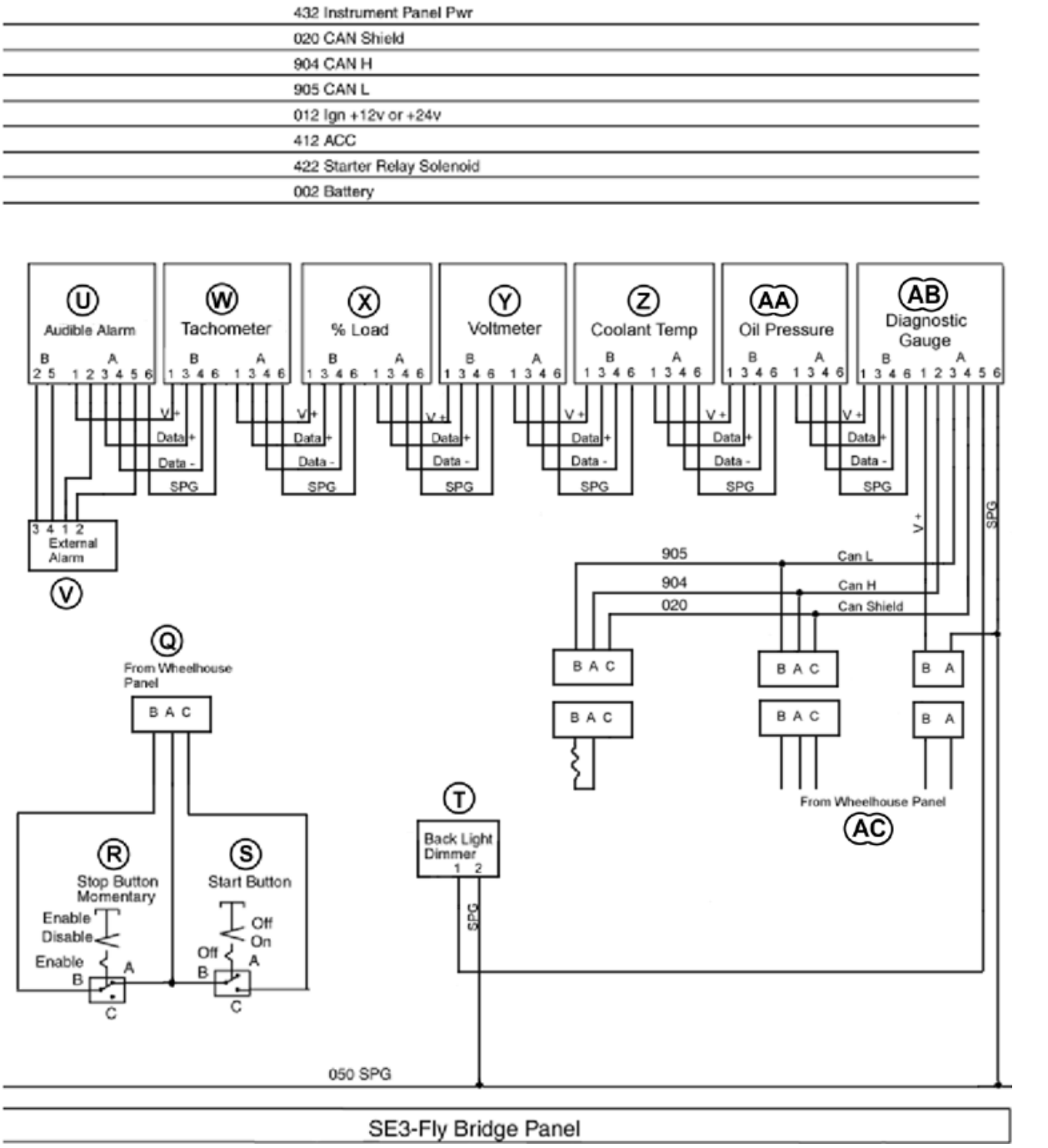


RG15470 —UN—04SEP07

A—Vehicle Harness Connector
B—Key Switch
C—Start Button- Momentary
D—To Fly Bridge Panel
E—In Absence of Fly Bridge Panel
F—Extension to Fly Bridge Panel
G—Audible Alarm
G1—Alternator
H—External Alarm
I— Tachometer
J—% Load
K—Voltmeter
KST—Starter Relay
L—Coolant Temp
M—Oil Pressure
M1—Start Motor
N—Diagnostic Gauge
N1—Transient Voltage Protection
O—Back Light Dimmer
P—To Fly Bridge Panel
X7—Alternator Harness Connector
X9—Single Point Ground
X10— CAN Terminator
002— Battery
012— IGN +12V or +24V
020— CAN Shield
412— ACC
422— Starter Relay Solenoid
432— Instrument Panel Power
904— Can H
905— Can L

OUOD006,00000BD -19-27SEP07-1/1

Wiring Diagram for Northern Lights Optional Fly Bridge Instrument Panel - Electronically Controlled Engine

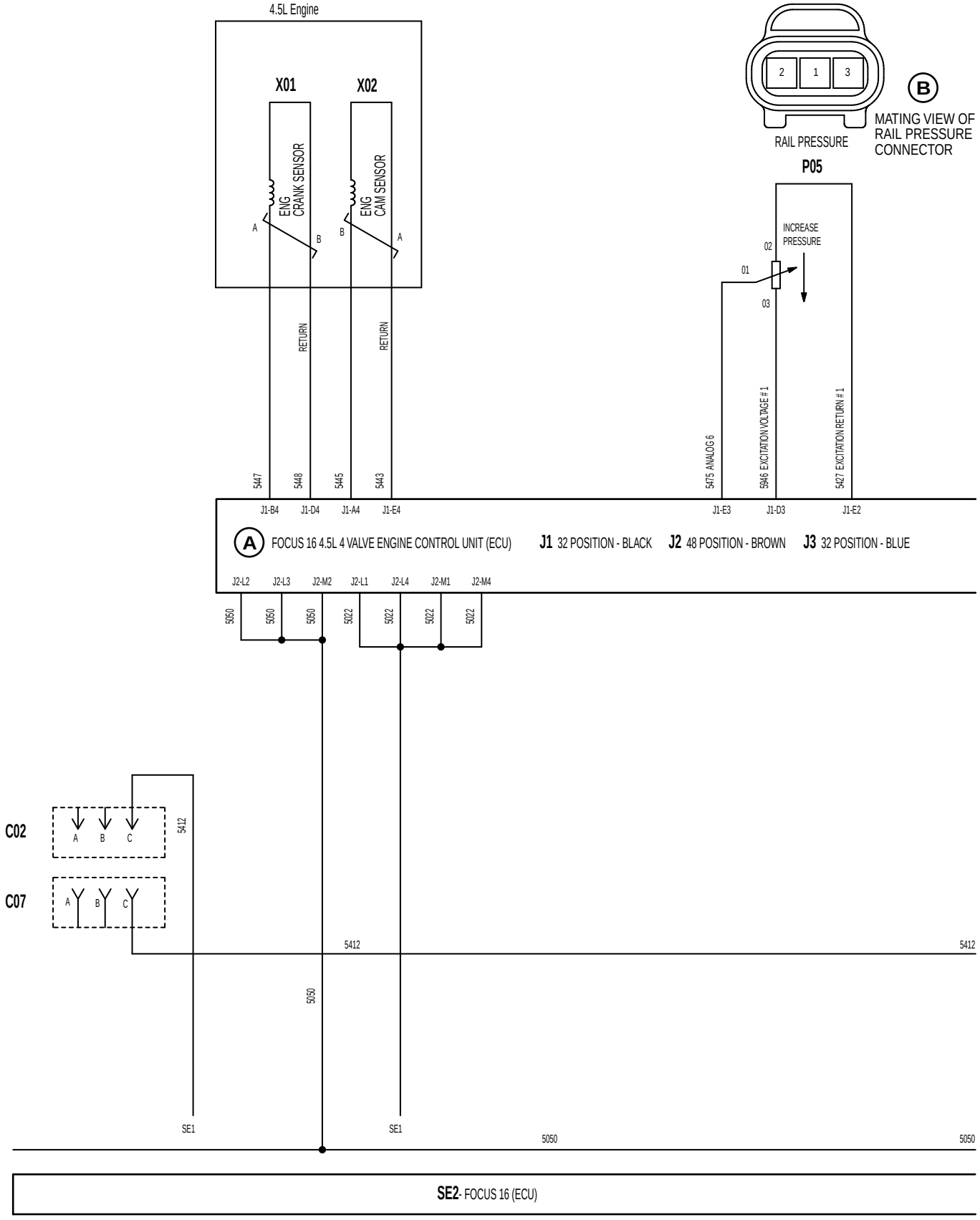


RG15471 —UN—04SEP07

Q—From Wheelhouse Panel
R—Stop Button- Momentary
S—Start Button- Momentary
T—Back Light Dimmer
U—Audible Alarm
V—External Alarm
W—Tachometer
X—% Load
Y—Voltmeter
Z—Coolant Temp
AA—Oil Pressure
AB—Diagnostic Gauge
AC—From Wheelhouse Panel
002— Battery
012— IGN +12V or +24V
020— CAN Shield
412— ACC
422— Starter Relay Solenoid
432— Instrument Panel Power
904— Can H
905— Can L

OUOD006,00000BE -19-25JUL07-1/1

4045TFM85 Marine Electronic Control System Wiring Diagram



RG22434 —UN—15FEB13

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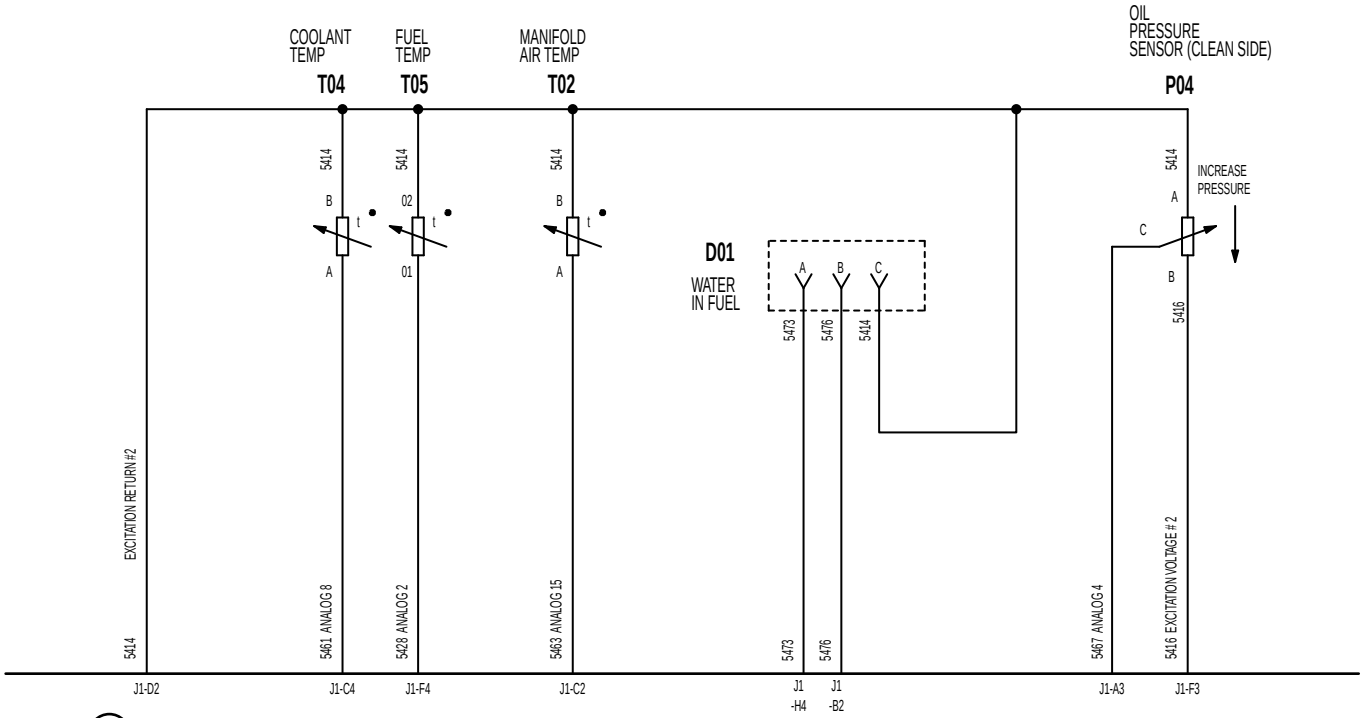
RG19661,00003EA -19-21FEB13-1/2

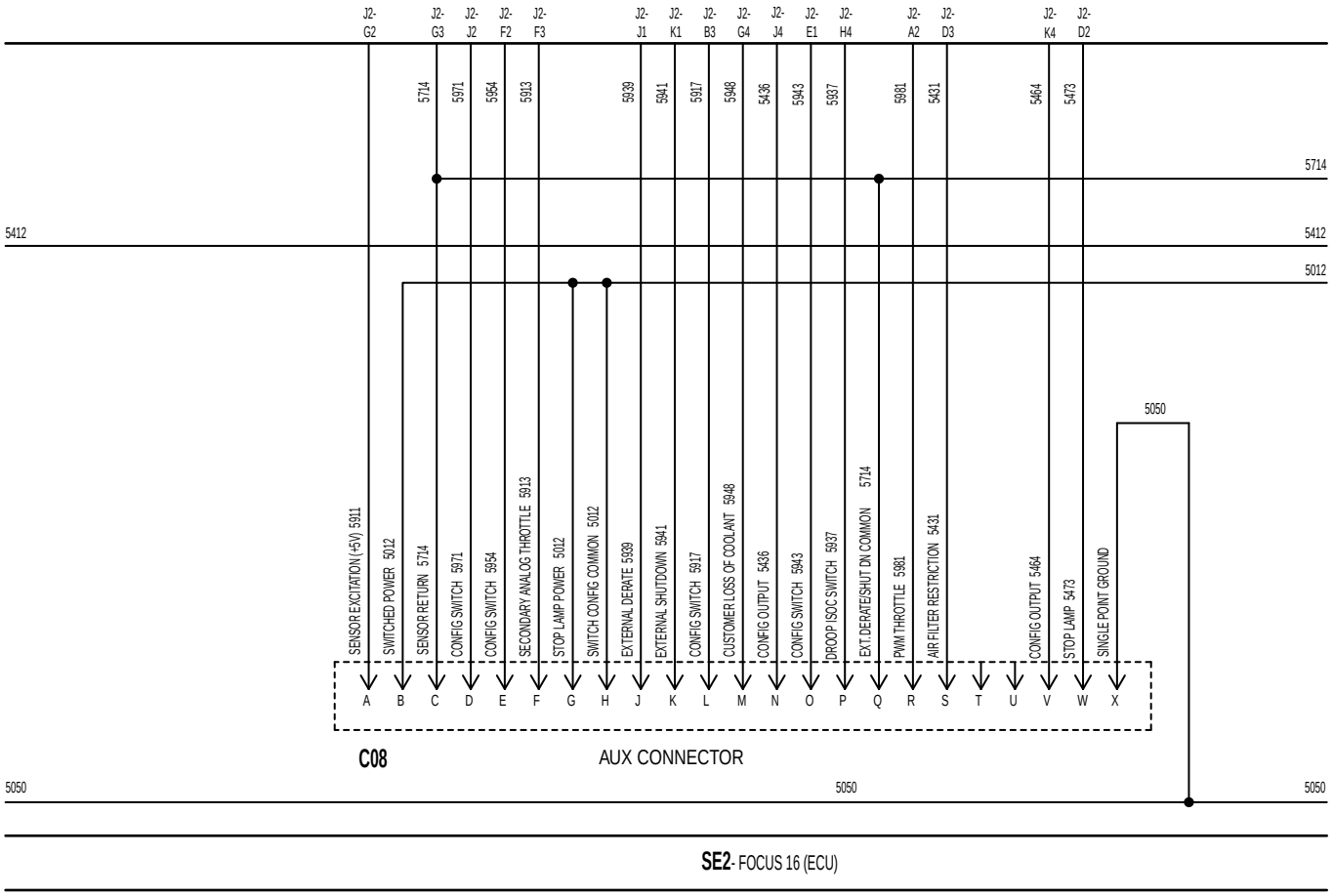
A— Focus 16, 4.5 L, 4 Valve, Engine Control Unit (ECU)
B— Mating View of Rail Pressure Connector
J1— 32 Position - Black
J1-D3— Excitation Voltage #1
J1-D4— Return
J1-E2— Excitation Return #1
J1-E3— Analog 6
J1-E4— Return
J2— 48 Position - Brown
J3— 32 Position - Blue
P05— Fuel Rail Pressure Sensor
SE2— Focus 16 (ECU)
X01— Crankshaft Position Sensor
X02— Camshaft Position Sensor

RG19661,00003EA -19-21FEB13-2/2

4045TFM85 Marine Electronic Control System Wiring Diagram - Cont-d



A FOCUS 16 4.5L 4 VALVE ENGINE CONTROL UNIT (ECU) **J1** 32 POSITION - BLACK **J2** 48 POSITION - BROWN **J3** 32 POSITION - BLUE



RG22435 —UN—15FEB13

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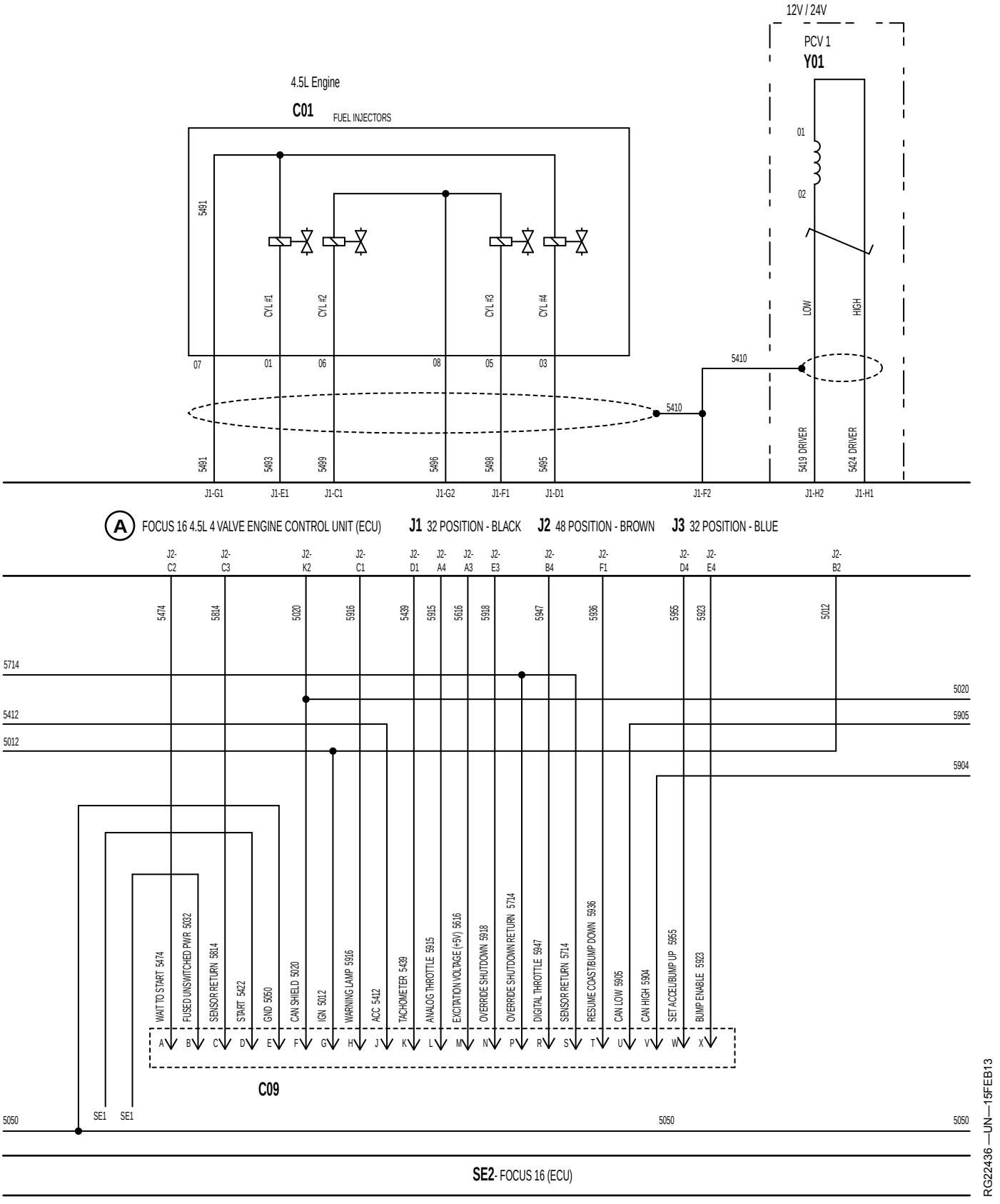
RG19661,00003EC -19-21FEB13-1/2

A— Focus 16, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C08— Auxiliary Connector
C08-A— Sensor Excitation (+5 V)
C08-B— Switched Power
C08-C— Sensor Return
C08-D— Configurable Switch
C08-E— Configurable Switch
C08-F— Secondary Analog Throttle
C08-G— Stop Lamp Power
C08-H— Common Configurable Switch
C08-J— External Derate
C08-K— External Shutdown
C08-L— Configurable Switch
C08-M— Customer Loss of Coolant
C08-N— Configurable Output
C08-O— Configurable Switch
C08-P— Droop Isochronous Switch
C08-Q— External Derate/Shutdown Common
C08-R— PWM Throttle
C08-S— Air Filter Restriction
C08-V— Configurable Output
C08-W— Stop Lamp
C08-X— Single Point Ground
D01— Water-In-Fuel Sensor
J1— 32 Position - Black
J1-A3— Analog 4
J1-C2— Analog 15
J1-C4— Analog 8
J1-D2— Excitation Return #2
J1-F3— Excitation Voltage #2
J1-F4— Analog 2
J2— 48 Position - Brown
J3— 32 Position - Blue
P04— Engine Oil Pressure Sensor (Clean Side)
SE2— Focus 16 (ECU)
T02— Manifold Air Temperature Sensor
T04— Engine Coolant Temperature Sensor
T05— Fuel Temperature Sensor

RG19661,00003EC -19-21FEB13-2/2

4045TFM85 Marine Electronic Control System Wiring Diagram - Cont-d



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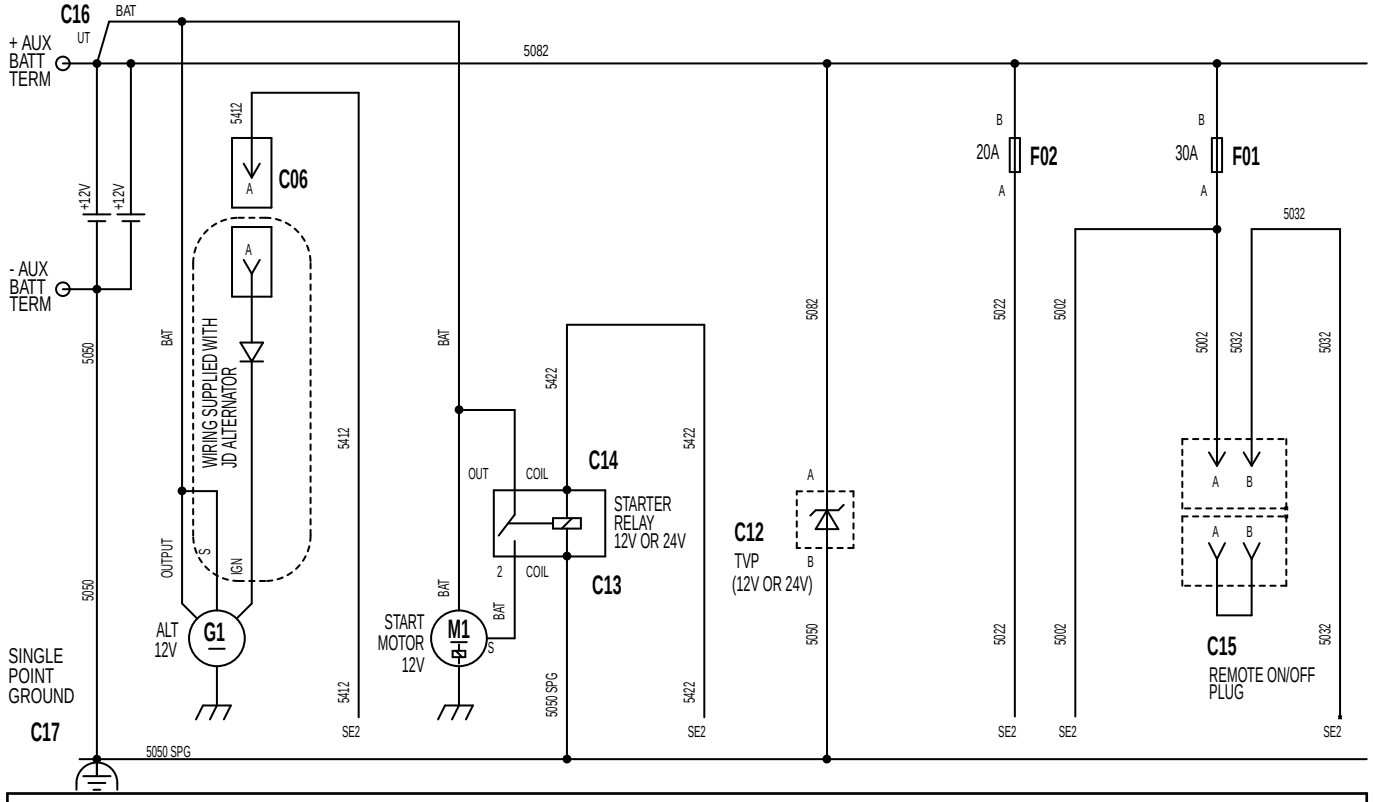
RG19661,00003ED -19-21FEB13-1/2

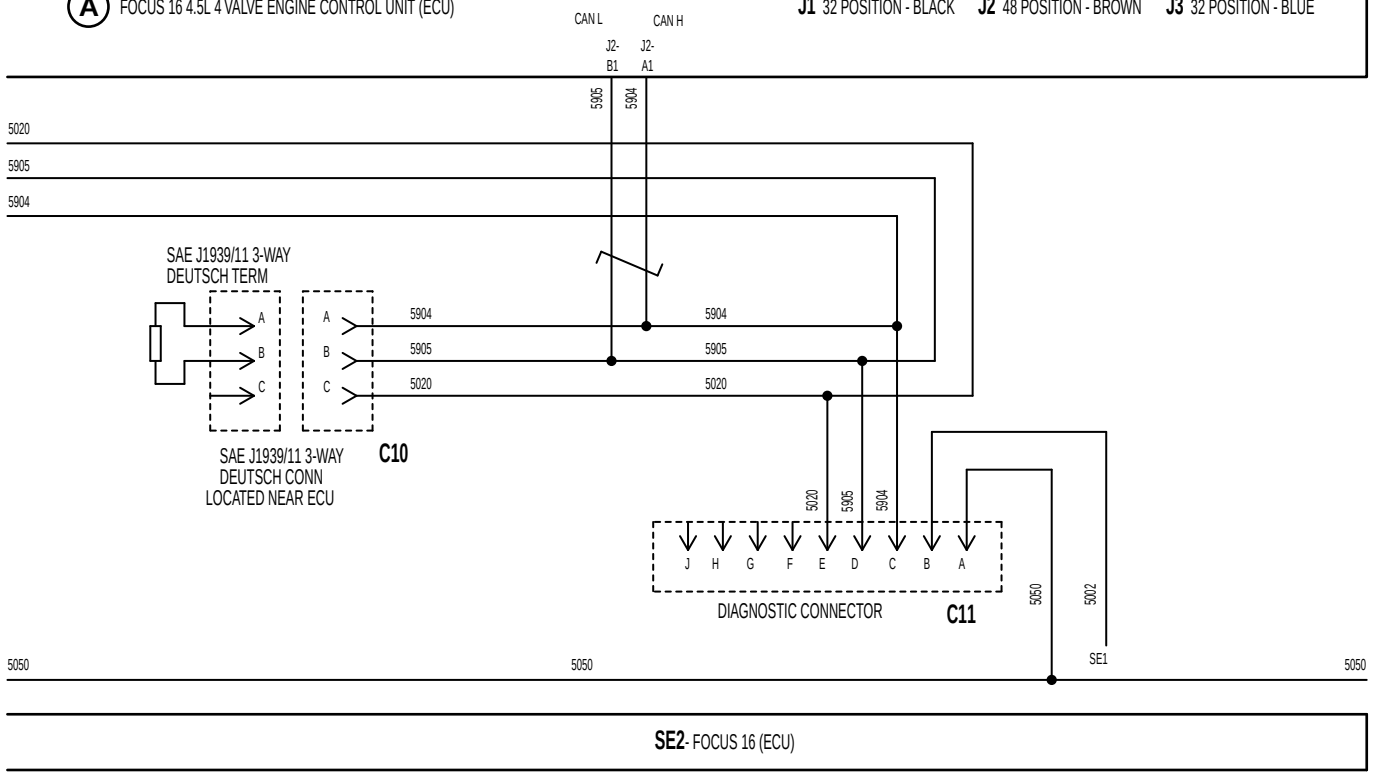
A— Focus 16, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C01— Fuel Injectors
C09-A— Wait To Start
C09-B— Fused Unswitched Power
C09-C— Sensor Return
C09-D— Start
C09-E— Ground
C09-F— CAN Shield
C09-G— Ignition
C09-H— Warning Lamp
C09-J— Accessory
C09-K— Tachometer
C09-L— Analog Throttle
C09-M— Excitation Voltage (+5 V)
C09-N— Override Shutdown
C09-P— Override Shutdown Return
C09-R— Digital Throttle
C09-S— Sensor Return
C09-T— Resume Coast/Bump Down
C09-U— CAN Low
C09-V— CAN High
C09-W— Set Accelerator/Bump Up
C09-X— Bump Enable
J1— 32 Position - Black
J1-C1— Cylinder 2
J1-D1— Cylinder 4
J1-E1— Cylinder 1
J1-F1— Cylinder 3
J1-H1— High Driver
J1-H2— Low Driver
J2— 48 Position - Brown
J3— 32 Position - Blue
SE2— Focus 16 (ECU)
Y01— Pressure Control Valve 1 (12 V/ 24 V)

RG19661,00003ED -19-21FEB13-2/2

4045TFM85 Marine Electronic Control System Wiring Diagram - Cont-d



SE1-ENGINE START COMPONENTS



SE2- FOCUS 16 (ECU)

RG22437 —UN—21FEB13

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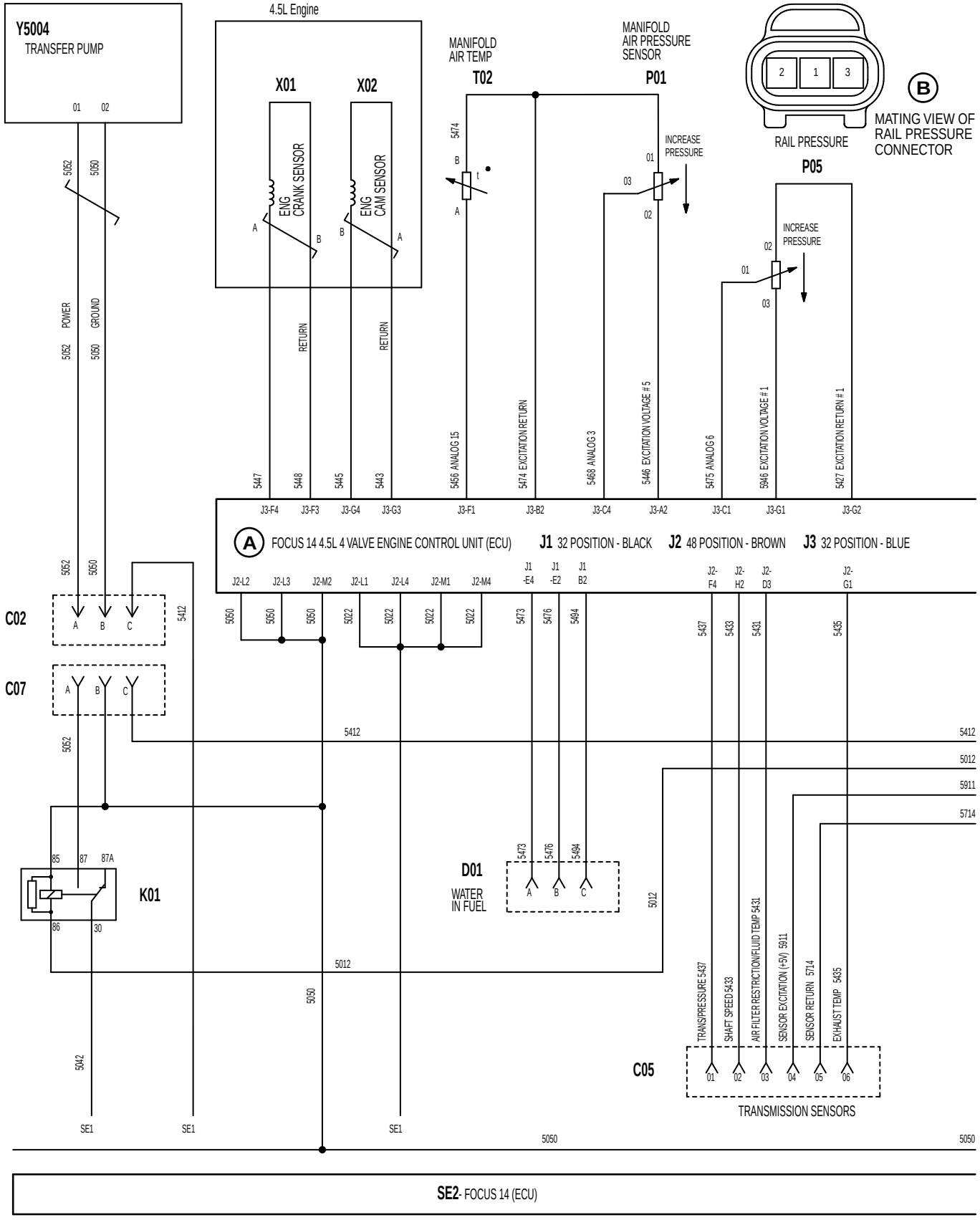
RG19661,00003EE -19-25FEB13-1/2

A— Focus 16, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C06— Wiring Supplied With JD Alternator
C10— SAE J1939/ 11 Way Deutsch Connector, Located Near ECU
C11— Diagnostic Connector
C12— Transient Voltage Protection (12 V or 24 V)
C13— Starter Relay Coil Ground
C14— Starter Relay Coil Power
C15— Remote On/Off
C16— Battery
C17— Single Point Ground
G1— Alternator 12 V
J1— 32 Position - Black
J2— 48 Position - Brown
J3— 32 Position - Blue
J2-A1— CAN High
J2-B1— CAN Low
J3— 32 Position - Blue
M1— Start Motor 12 V
SE1— Engine Start Components
SE2— Focus 16 (ECU)

RG19661,00003EE -19-25FEB13-2/2

4045AFM85 Marine Electronic Control System Wiring Diagram



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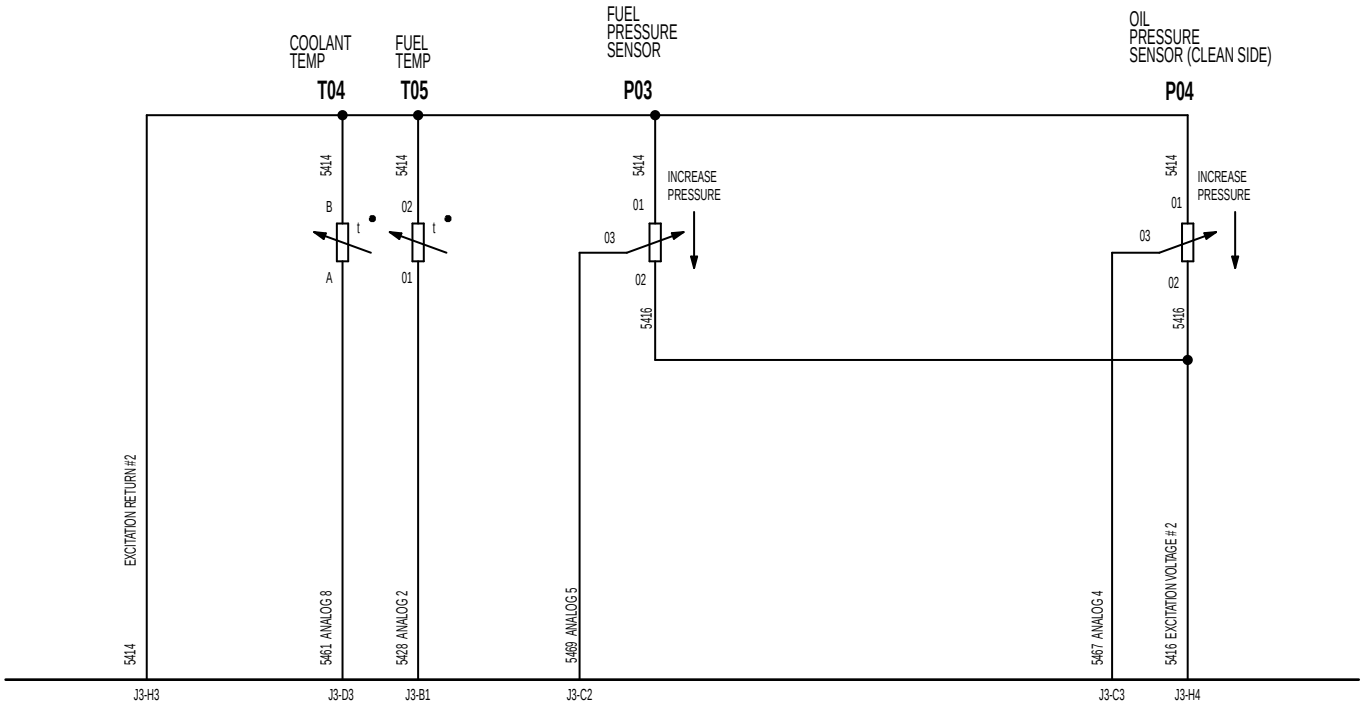
RG19661,00003EB -19-21FEB13-1/2

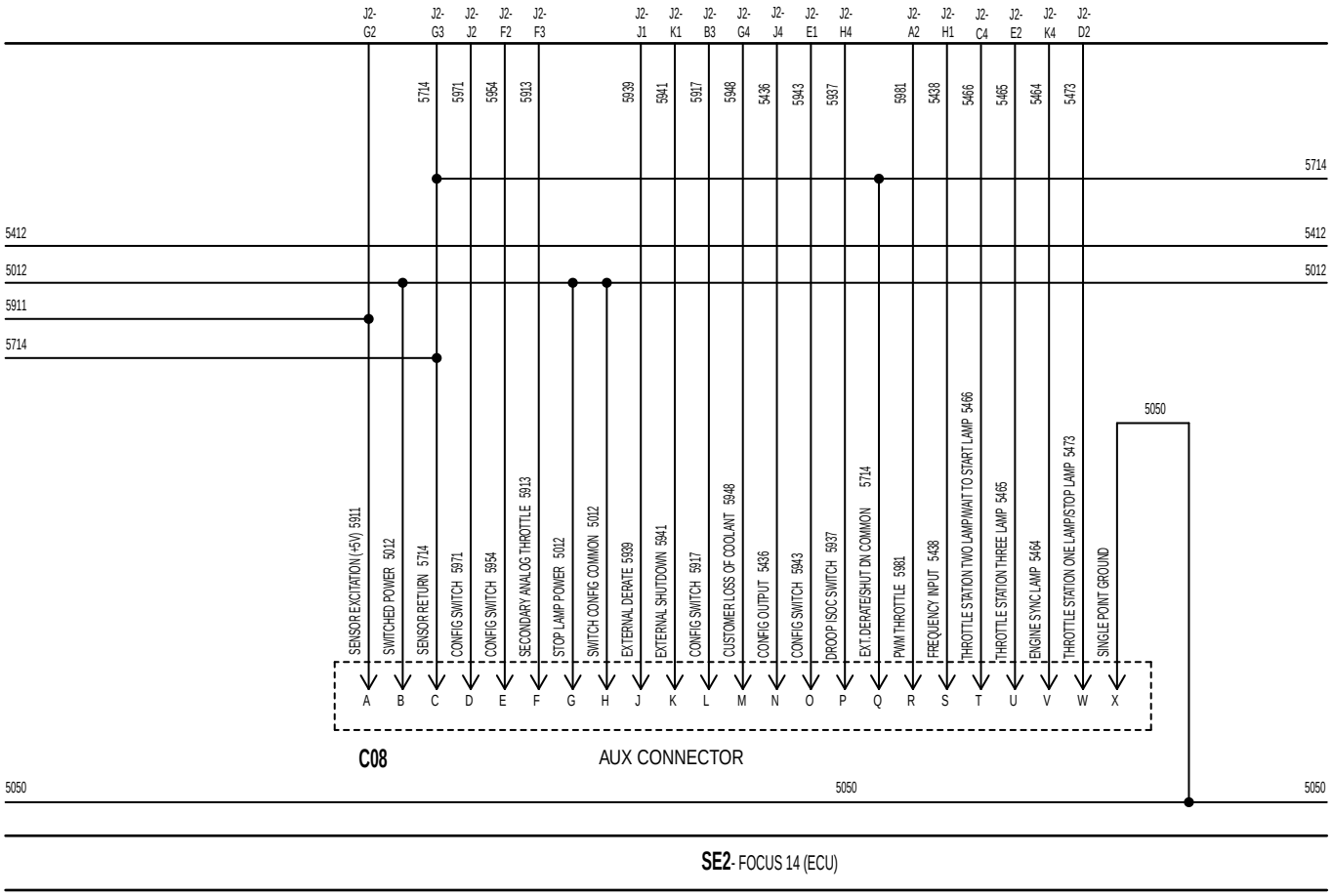
A— Focus 14, 4.5 L, 4 Valve, Engine Control Unit (ECU)
B— Mating View of Rail Pressure Connector
C05— Transmission Sensors
C05-01— Transmission Pressure
C05-02— Shaft Speed
C05-03— Air Filter Restriction Fluid Temperature
C05-04— Sensor Excitation (+5 V)
C05-05— Sensor Return
C05-06— Exhaust Temperature
D01— Water-In-Fuel Sensor
J3-A2— Excitation Voltage #5
J3-B2— Excitation Return
J3-C1— Analog 6
J3-C4— Analog 3
J3-F1— Analog 15
J3-F3— Return
J3-G1— Excitation Voltage #1
J3-G2— Excitation Return #1
J3-G3— Return
P01— Manifold Air Pressure Sensor
P05— Fuel Rail Pressure Sensor
SE2— Focus 14 (ECU)
T02— Manifold Air Temperature Sensor
X01— Crankshaft Position Sensor
X02— Camshaft Position Sensor
Y5004— Low-Pressure Fuel Pump

RG19661,00003EB -19-21FEB13-2/2

4045AFM85 Marine Electronic Control System Wiring Diagram - Cont'd



(A) FOCUS 14 4.5L 4 VALVE ENGINE CONTROL UNIT (ECU) **J1** 32 POSITION - BLACK **J2** 48 POSITION - BROWN **J3** 32 POSITION - BLUE



RG22430 —UN—15FEB13

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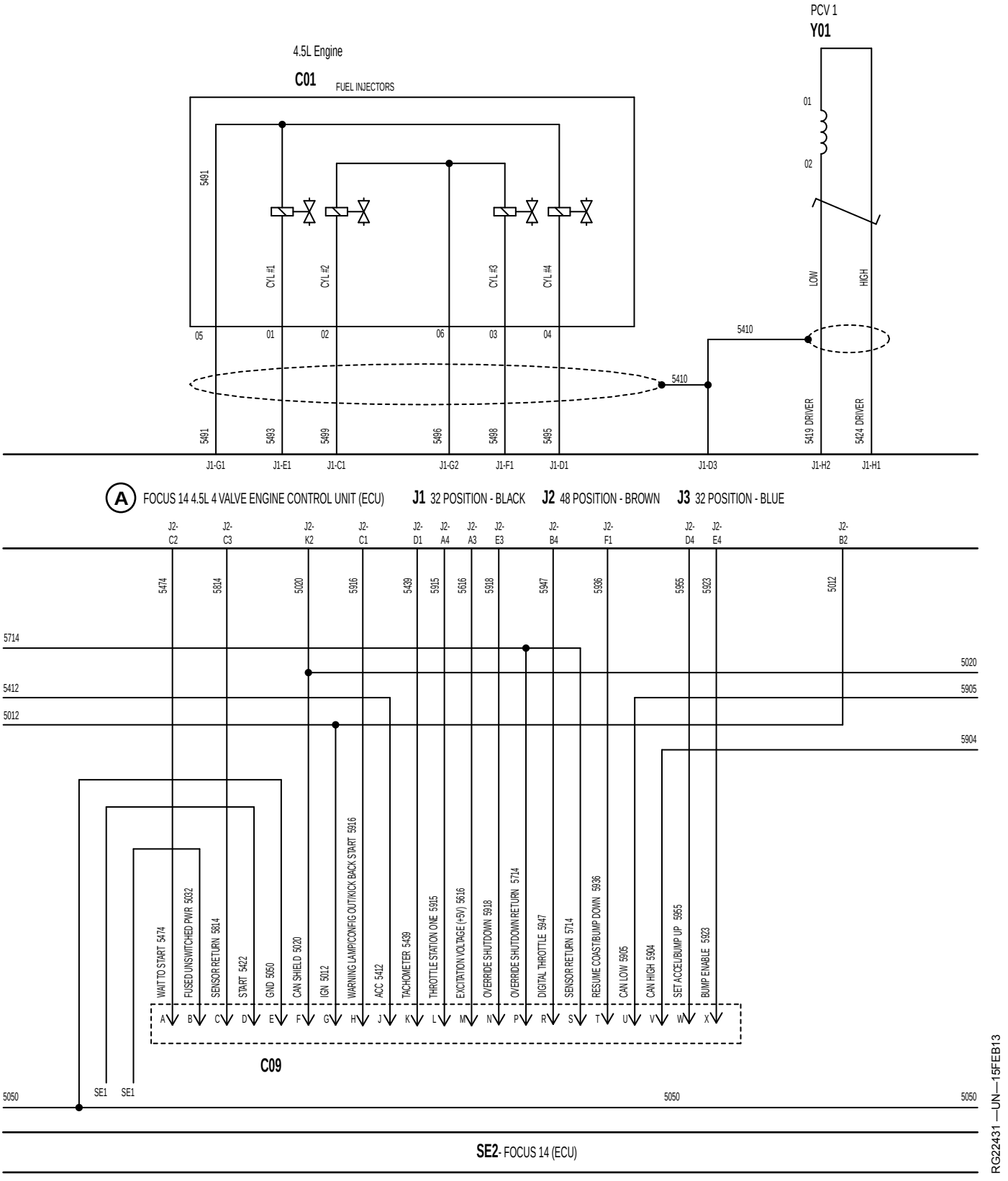
RG19661,00003EF -19-21FEB13-1/2

A— Focus 14, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C08— Auxiliary Connector
C08-A— Sensor Excitation (+5 V)
C08-B— Switched Power
C08-C— Sensor Return
C08-D— Configurable Switch
C08-E— Configurable Switch
C08-F— Secondary Analog Throttle
C08-G— Stop Lamp Power
C08-H— Common Configurable Switch
C08-J— External Derate
C08-K— External Shutdown
C08-L— Configurable Switch
C08-M— Customer Loss of Coolant
C08-N— Configurable Output
C08-O— Configurable Switch
C08-P— Droop Isochronous Switch
C08-Q— External Derate/Shutdown Common
C08-R— PWM Throttle
C08-S— Frequency Input
C08-T— Throttle Station Two Lamp/Wait To Start Lamp
C08-U— Throttle Station Three Lamp
C08-V— Engine Sync Lamp
C08-W— Throttle Station Two Lamp/Stop Lamp
C08-X— Single Point Ground
J1— 32 Position - Black
J2— 48 Position - Brown
J3— 32 Position - Blue
J3-B1— Analog 2
J3-C2— Analog 5
J3-C3— Analog 4
J3-D3— Analog 8
J3-H3— Excitation Return #2
J3-H4— Excitation Voltage #2
P03— Fuel Rail Pressure Sensor
P04— Engine Oil Pressure Sensor (Clean Side)
SE2— Focus 16 (ECU)
T04— Engine Coolant Temperature Sensor
T05— Fuel Temperature Sensor

RG19661,00003EF -19-21FEB13-2/2

4045AFM85 Marine Electronic Control System Wiring Diagram - Cont'd



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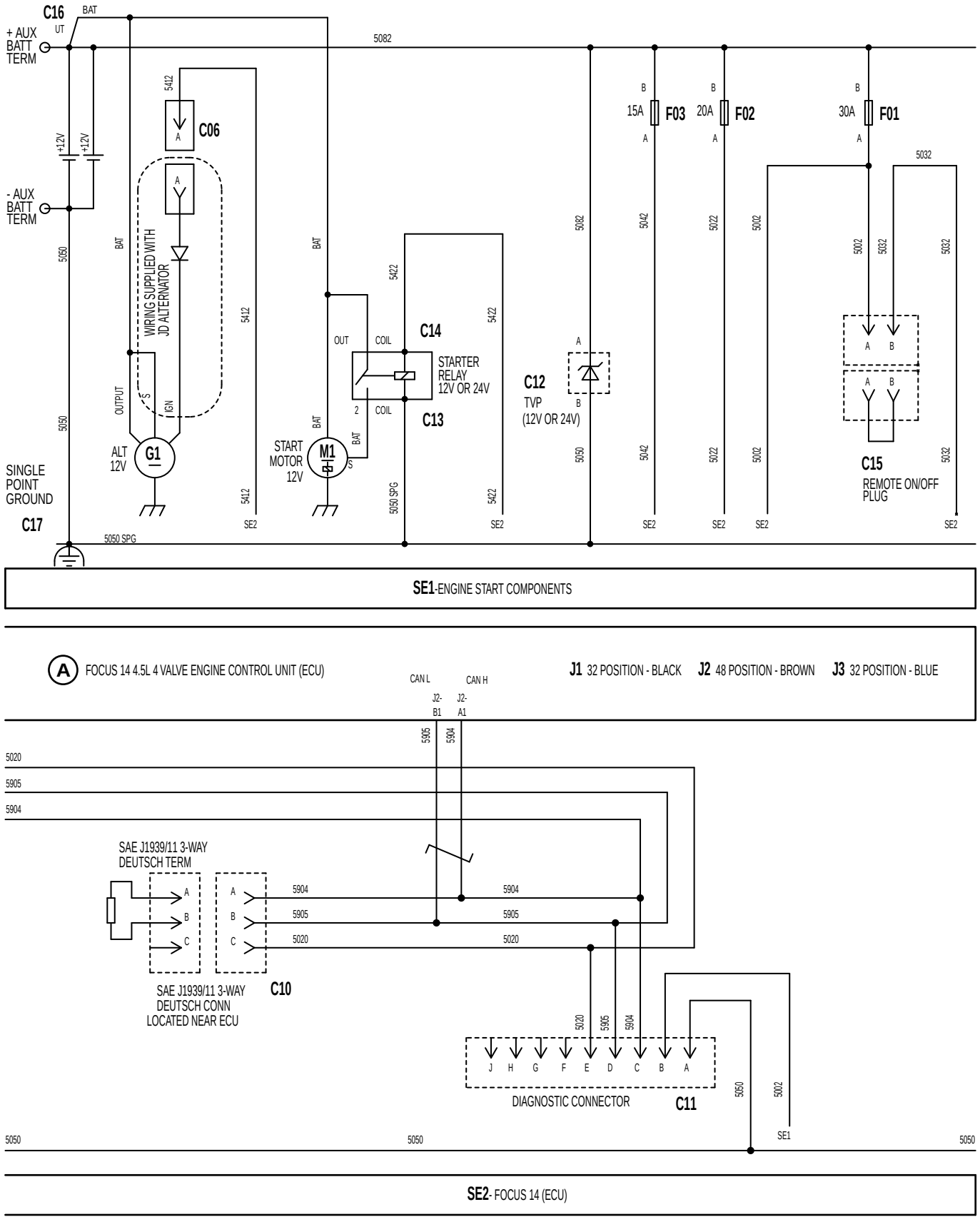
RG19661,00003F0 -19-25FEB13-1/2

A— Focus 14, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C01— Fuel Injectors
C09-A— Wait To Start
C09-B— Fused Unswitched Power
C09-C— Sensor Return
C09-D— Start
C09-E— Ground
C09-F— CAN Shield
C09-G— Ignition
C09-H— Warning Lamp/Configurable Output/Kick Back Start
C09-J— Accessory
C09-K— Tachometer
C09-L— Throttle Station 1
C09-M— Excitation Voltage (+5 V)
C09-N— Override Shutdown
C09-P— Override Shutdown Return
C09-R— Digital Throttle
C09-S— Sensor Return
C09-T— Resume Coast/Bump Down
C09-U— CAN Low
C09-V— CAN High
C09-W— Set Accelerator/Bump Up
C09-X— Bump Enable
J1— 32 Position - Black
J1-C1— Cylinder 2
J1-D1— Cylinder 4
J1-E1— Cylinder 1
J1-F1— Cylinder 3
J1-H1— High Driver
J1-H2— Low Driver
J2— 48 Position - Brown
J3— 32 Position - Blue
SE2— Focus 14 (ECU)
Y01— Pressure Control Valve 1

RG19661,00003F0 -19-25FEB13-2/2

4045AFM85 Marine Electronic Control System Wiring Diagram - Cont'd



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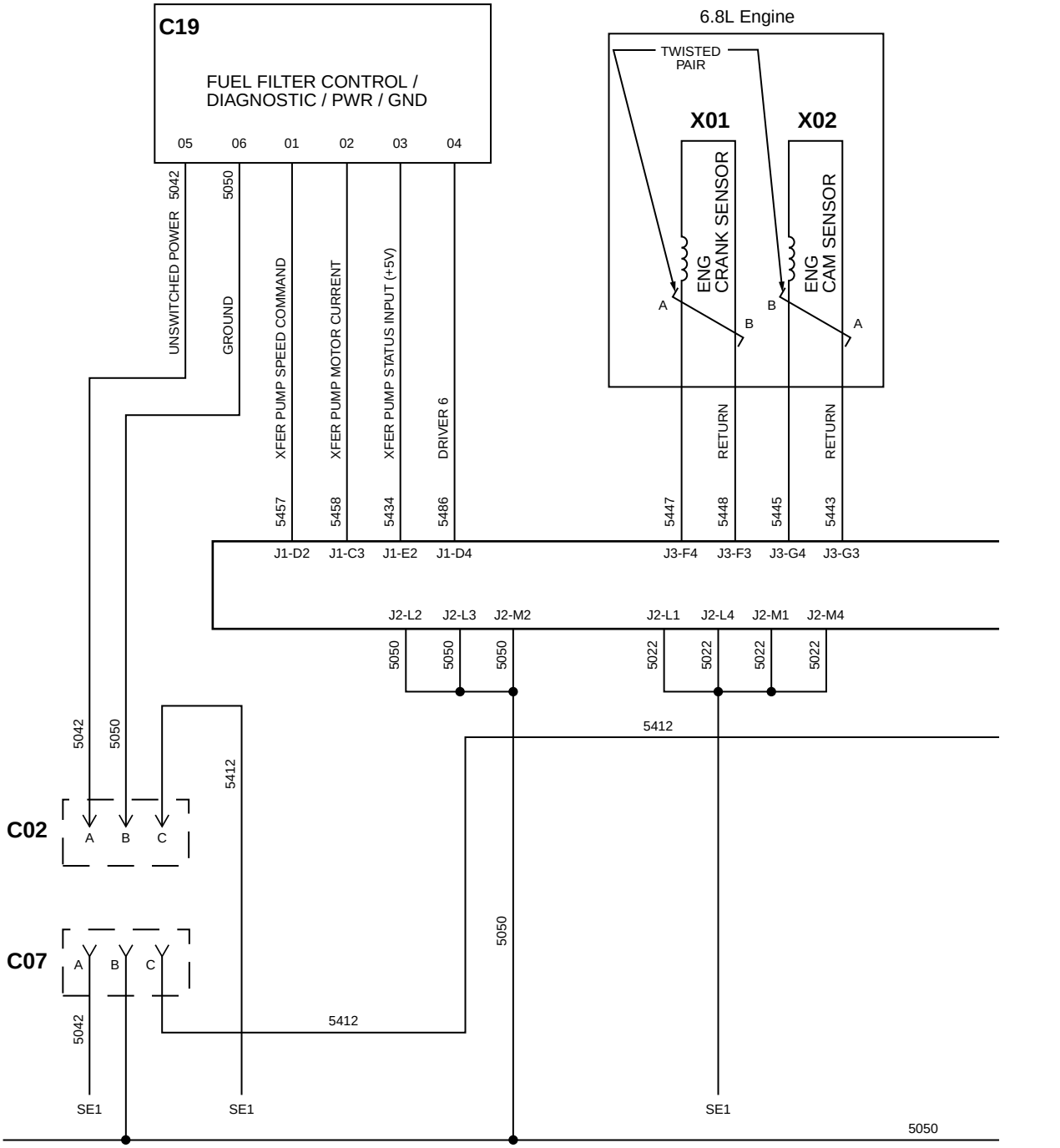
RG19661,00003F1 -19-25FEB13-1/2

A— Focus 14, 4.5 L, 4 Valve, Engine Control Unit (ECU)
C06— Wiring Supplied With JD Alternator
C10— SAE J1939/ 11 Way Deutsch Connector, Located Near ECU
C11— Diagnostic Connector
C12— Transient Voltage Protection (12 V or 24 V)
C13— Starter Relay Coil Ground
C14— Starter Relay Coil Power
C15— Remote On/Off
C16— Battery
C17— Single Point Ground
G1— Alternator 12 V
J1— 32 Position - Black
J2— 48 Position - Brown
J3— 32 Position - Blue
J2-A1— CAN High
J2-B1— CAN Low
J3— 32 Position - Blue
M1— Start Motor 12 V
SE1— Engine Start Components
SE2— Focus 14 (ECU)

RG19661,00003F1 -19-25FEB13-2/2

6068SFM85 / AFM85 Marine Electronic Control System Wiring Diagram

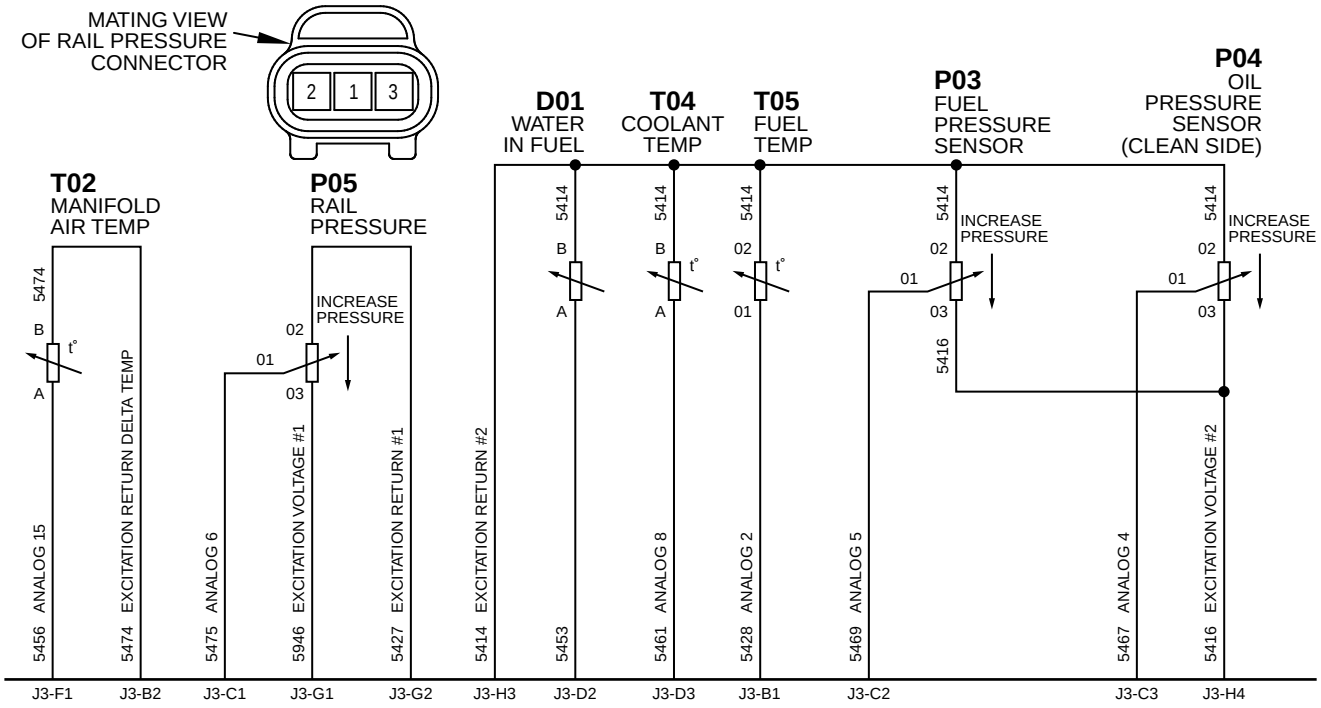


RG15474A —UN—27JAN11

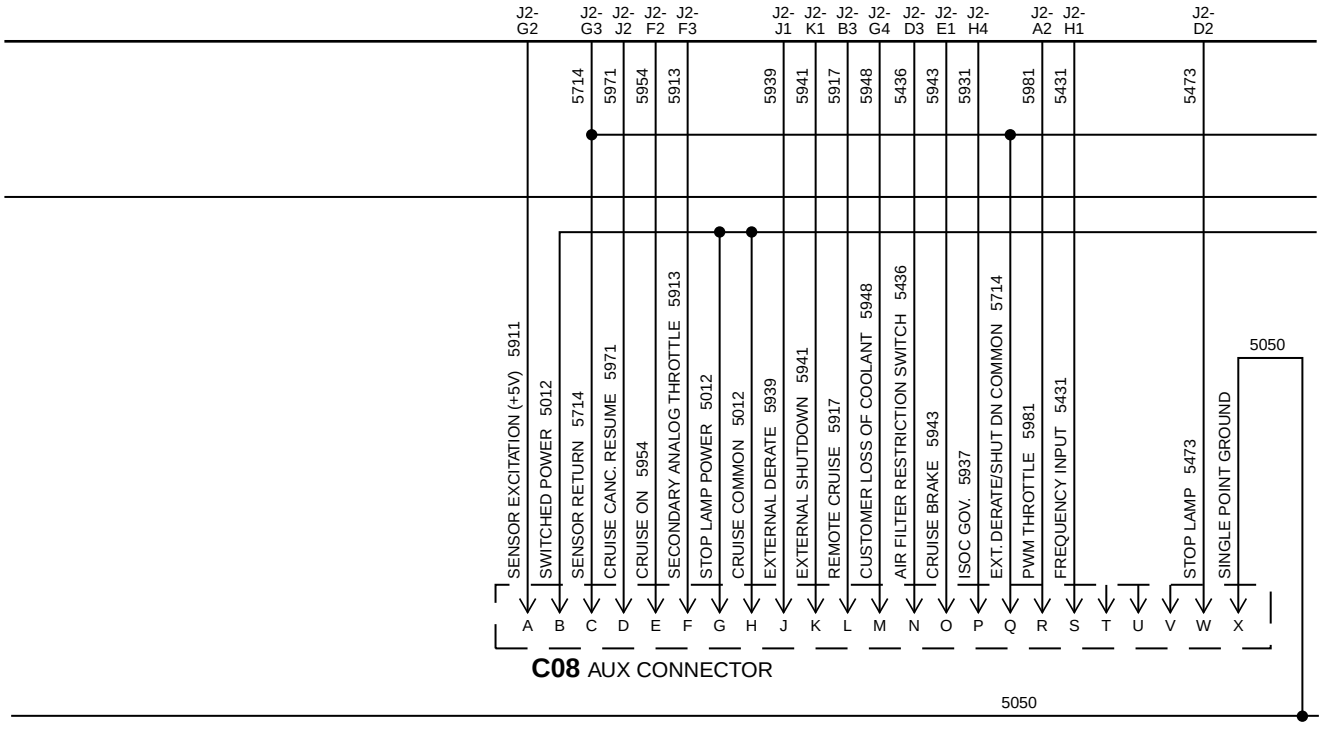
C19— Fuel Filter Control/ Diagnostic/Pwr/Gnd
X01— Engine Crank Sensor
X02— Engine Cam Sensor
5042— Unswitched Power
5050— Ground
5434— Xfer Pump Status Input (+5V)
5443— Return
5448— Return
5457— Xfer Pump Speed Command
5458— Xfer Pump Motor Current
5486— Driver 6

RG19661,00003DF -19-15FEB13-1/1

6068SFM85 / AFM85 Marine Electronic Control System Wiring Diagram - Continued



FOCUS 14 6.8L 4 VALVE ENGINE CONTROL UNIT (ECU)



RG15321A —UN—27JAN11

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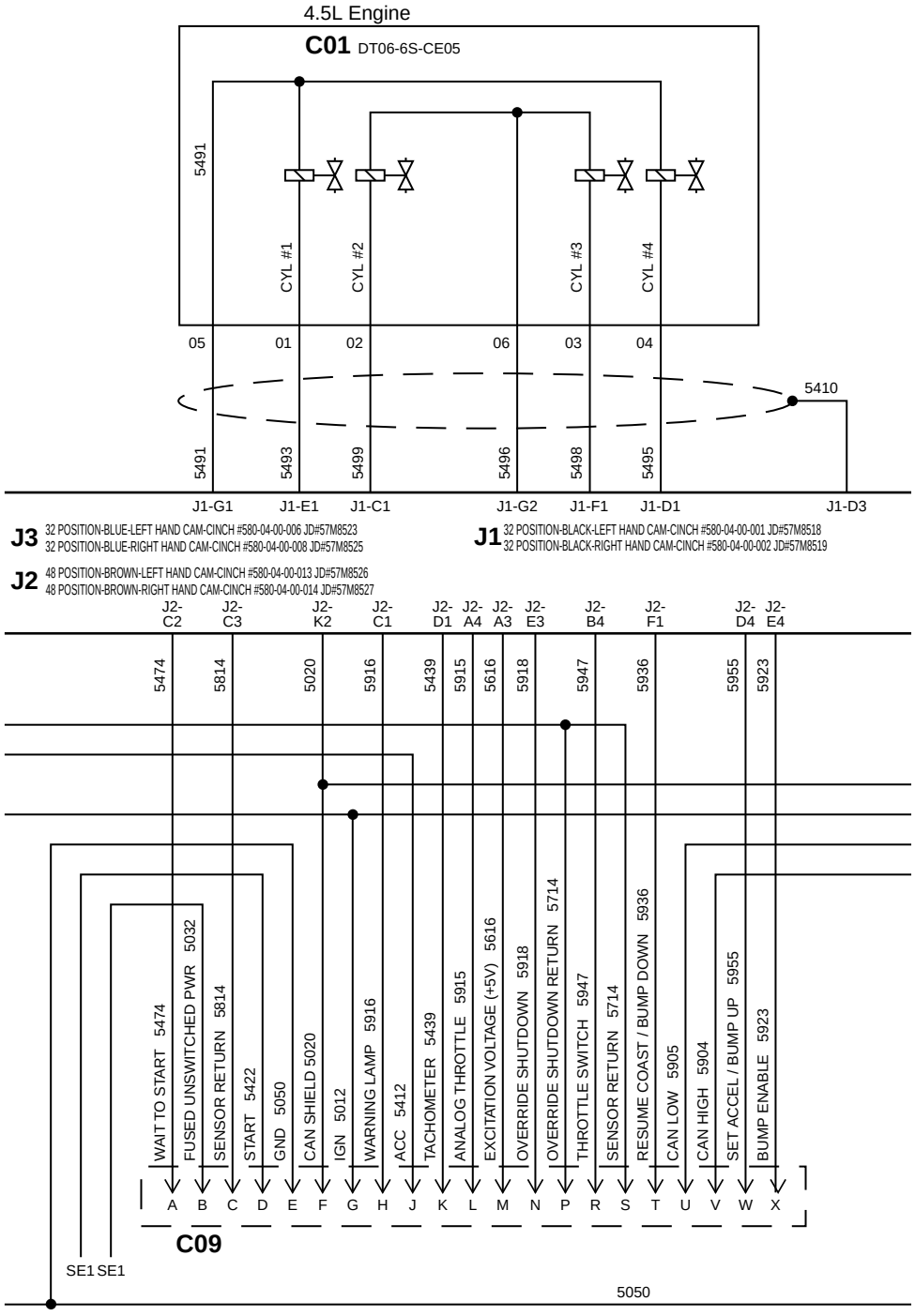
RG19661,00003E0 -19-15FEB13-1/2

C08— Aux Connector
D01— Water in Fuel
P03— Fuel Pressure Sensor
P04— Oil Pressure Sensor (Clean Side)
P05— Rail Pressure
T02— Manifold Air Temp
T04— Coolant Temp
T05— Fuel Temp
5012— Switched Power/Stop Lamp Power/Cruise Common
5050— Single Point Ground
5414— Excitation Return #2
5416— Excitation Voltage #2
5427— Excitation Return #1
5428— Analog 2
5431— Frequency Input
5436— Air Filter Restriction Switch
5456— Analog 15
5461— Analog 8
5467— Analog 4
5469— Analog 5
5473— Stop Lamp
5474— Excitation Return Delta Temp
5475— Analog 6
5714— Sensor Return/Ext. Derate/Shut Dn Common
5911— Sensor Excitation (+5V)
5913— Secondary Analog Throttle
5917— Remote Cruise
5937— Isoc. Gov
5939— External Derate
5941— External Shutdown
5943— Cruise Brake
5946— Excitation Voltage #1
5948— Customer Loss of Coolant
5954— Cruise On
5971— Cruise Canc. Resume
5981— Pwr Throttle

RG19661,00003E0 -19-15FEB13-2/2

6068SFM85 / AFM85 Marine Electronic Control System Wiring Diagram - Continued



5012— IGN
5020— CAN Shield
5032— Fused Unswitched Power
5050— Ground
5412— ACC
5422— Start
5439— Tachometer
5474— Wait to Start
5616— Excitation Voltage (+5V)
5714— Sensor Return/Override Shutdown Return
5814— Sensor Return
5904— CAN High
5905— CAN Low
5915— Analog Throttle
5916— Warning Lamp
5918— Override Shutdown
5923— Bump Enable
5936— Resume Coast/Bump Down
5947— Throttle Switch
5955— Set Accel/Bump Up

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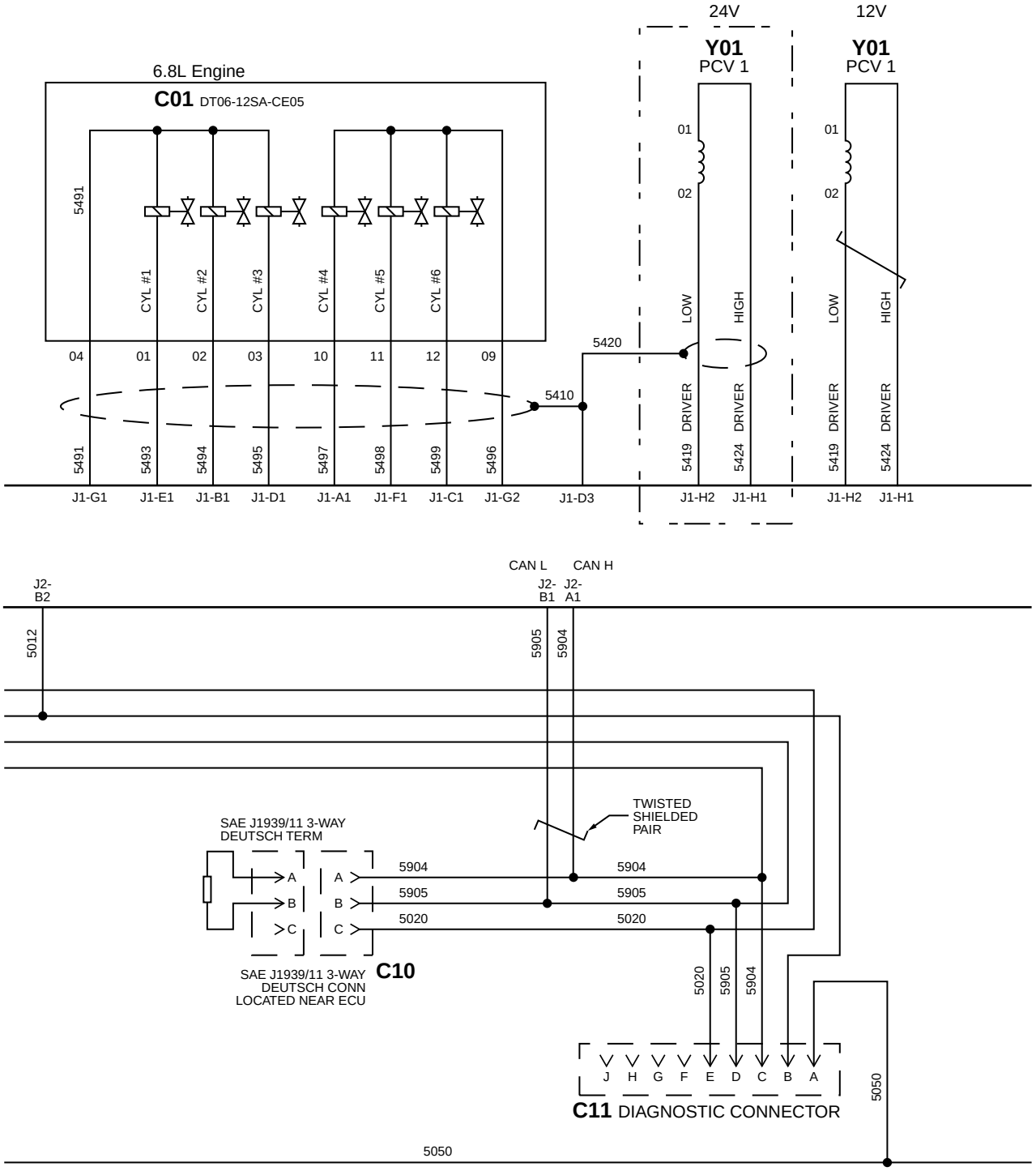
RG19661,00003E1 -19-11FEB13-1/2



C10— Deutsch Conn. Located Near ECU

C11— Diagnostic Connector

5419— Driver Low

5424— Driver High

RG19661,00003E1 -19-11FEB13-2/2

Engine Troubleshooting

NOTE: If using BIODIESEL blends above B20, the possibility of some of the symptoms listed below, such as power loss, could increase.

NOTE: Before troubleshooting the engine, first retrieve any fault codes on the diagnostic gauge display and perform the corrective actions. (See information later in this section.) If any problems remain, use the following charts to solve engine problems.

Symptom	Problem	Solution
Engine cranks but will not start	Incorrect starting procedure.	Verify correct starting procedure.
	No fuel.	Check fuel in tank and manual shut-off valve.
	Exhaust restricted.	Check and correct exhaust restriction.
	Fuel filter plugged or full of water.	Replace fuel filter or drain water from filter.
	Injection pump not getting fuel or air in fuel system.	Check fuel flow at supply pump or bleed fuel system.
	Faulty injection pump or nozzles.	Consult authorized diesel repair station for repair or replacement.
Engine hard to start or will not start	Engine starting under load.	Disengage PTO (if equipped).
	Improper starting procedure.	Review starting procedure.
	No fuel.	Check fuel tank.
	Air in fuel line.	Bleed fuel line.
	Cold weather.	Use cold weather starting aids.
	Slow starter speed.	See “Starter Cranks Slowly”.
	Crankcase oil too heavy.	Use oil of proper viscosity.
	Improper type of fuel.	Consult fuel supplier; use proper type fuel for operating conditions.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Clogged fuel filter.	Replace filter element.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
	Electronic fuel system problem	See your authorized servicing dealer
	Injection pump shut-off not reset.	Turn key switch to “OFF” then to “ON”.
Engine knocks	Low engine oil level.	Add oil to engine crankcase.

Continued on next page

Symptom	Problem	Solution
	Injection pump out of time.	See your authorized servicing dealer or engine distributor.
	Low coolant temperature.	Remove and check thermostat.
	Engine overheating.	See “Engine Overheats”.
Engine runs irregularly or stalls frequently	Low coolant temperature.	Remove and check thermostat.
	Clogged fuel filter.	Replace fuel filter element.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Poor quality fuel.	Change to better quality fuel.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
	Electronic fuel system problem	See your authorized servicing dealer
Below normal engine temperature	Defective thermostat.	Remove and check thermostat.
	Defective temperature gauge or sender.	Check gauge, sender, and connections.
Lack of power	Engine overloaded.	Reduce load.
	Intake air restriction.	Service air cleaner.
	Clogged fuel filter.	Replace filter elements.
	Improper type of fuel.	Use proper fuel.
	Overheated engine.	See “Engine Overheats”.
	Below normal engine temperature.	Remove and check thermostat.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
	Injector tip deposits	Use Northern Lights approved biodiesel fuel conditioners containing detergents.
	Injection pump out of time.	See your authorized servicing dealer or engine distributor.
	Turbocharger not functioning. (Turbocharger engines only.)	See your authorized servicing dealer or engine distributor.

Continued on next page

Symptom	Problem	Solution
	Leaking exhaust manifold gasket.	See your authorized servicing dealer or engine distributor.
	Defective aneroid control line.	See your authorized servicing dealer or engine distributor.
	Restricted fuel hose.	Clean or replace fuel hose.
	Low fast idle speed.	See your authorized servicing dealer or engine distributor.
	Damaged propeller	Have propeller checked.
	Marine growth	Clean hull.
Low oil pressure	Low oil level.	Add oil.
	Improper type of oil.	Drain, fill crankcase with oil of proper viscosity and quality.
High oil consumption	Crankcase oil too light.	Use proper viscosity oil.
	Oil leaks.	Check for leaks in lines, gaskets, and drain plug.
	Restricted crankcase vent tube.	Clean vent tube.
	Defective turbocharger (if equipped).	See your authorized servicing dealer or engine distributor.
Engine emits white smoke	Improper type of fuel.	Use proper fuel.
	Low engine temperature.	Warm up engine to normal operating temperature.
	Defective thermostat.	Remove and check thermostat.
	Defective injection nozzles.	See your authorized servicing dealer or engine distributor.
	Engine out of time.	See your authorized servicing dealer or engine distributor.
Engine emits black or gray exhaust smoke	Improper type of fuel.	Use proper fuel.
	Clogged or dirty air cleaner.	Service air cleaner.
	Engine overloaded.	Reduce load.

Continued on next page

Symptom	Problem	Solution
	Fuel injectors dirty.	Use Northern Lights approved biodiesel or diesel fuel conditioners containing detergents. If no improvement is seen, see your authorized servicing dealer or engine distributor.
	Engine out of time.	See your authorized servicing dealer or engine distributor.
	Turbocharger not functioning.	See your authorized servicing dealer or engine distributor.
	Electronic fuel system problem	See your authorized servicing dealer
Engine overheats	Engine overloaded.	Reduce load.
	Low coolant level.	Fill coolant tank to proper level, check coolant tank and hoses for loose connections or leaks.
	Faulty coolant tank cap.	Have serviceman check.
	Stretched poly-vee belt or defective belt tensioner.	Check automatic belt tensioner and check belts for stretching. Replace as required.
	Faulty sea (raw) water pump.	Check/replace impeller/pump.
	Low engine oil level.	Check oil level. Add oil as required.
	Cooling system needs flushing.	Flush cooling system.
	Defective thermostat.	Remove and check thermostat.
	Defective temperature gauge or sender.	Check water temperature with thermometer and replace, if necessary.
	Electronic fuel system problem	See your authorized servicing dealer
	Incorrect grade of fuel.	Use correct grade of fuel.
	Plugged heat exchanger.	Clean heat exchanger and core.
	Plugged keel cooler.	Flush and clean keel cooler. Check for marine growth on O.D. of keel cooler tubes.
	Trash or debris in engine compartment.	Clean engine compartment.
High fuel consumption	Improper type of fuel.	Use proper type of fuel.
	Clogged or dirty air cleaner.	Service air cleaner.

Continued on next page

Symptom	Problem	Solution
	Engine overloaded.	Reduce load.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
	Injection nozzles dirty.	See your authorized servicing dealer or engine distributor.
	Injector tip deposits	Use Northern Lights approved biodiesel fuel conditioners containing detergents.
	Engine out of time.	See your authorized servicing dealer or engine distributor.
	Defective turbocharger.	See your authorized servicing dealer or engine distributor.
	Low engine temperature.	Check thermostat.

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Electrical Troubleshooting

Symptom	Problem	Solution
Undercharged electrical system	Excessive electrical load from added accessories.	Remove accessories or install higher output alternator.
	Excessive engine idling.	Increase engine rpm when heavy electrical load is used.
	Poor electrical connections on battery, ground strap, starter, or alternator.	Inspect and clean as necessary.
	Defective battery.	Test battery.
	Defective alternator.	Test charging system.
Battery uses too much water	Cracked battery case.	Check for moisture and replace as necessary.
	Defective battery.	Test battery.
	Battery charging rate too high.	Test charging system.
Batteries will not charge	Loose or corroded connections.	Clean and tighten connections.
	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Stretched poly-vee belt or defective belt tensioner.	Adjust belt tension or replace belt.
Starter will not crank	PTO engaged (if equipped).	Disengage PTO.
	Marine gear control engaged.	Disengage marine gear.
	Loose or corroded connections.	Clean and tighten loose connections.
	Low battery output voltage.	See your authorized servicing dealer or engine distributor.
	Faulty start circuit relay.	See your authorized servicing dealer or engine distributor.
	Blown main system fuse.	Replace fuse.
Starter cranks slowly	Low battery output.	See your authorized servicing dealer or engine distributor.
	Crankcase oil too heavy.	Use proper viscosity oil.
	Loose or corroded connections.	Clean and tighten loose connections.
Starter and hour meter functions; rest of electrical system does not function	Blown fuse on magnetic switch.	Replace fuse.

Continued on next page

Symptom	Problem	Solution
Entire electrical system does not function	Faulty battery connection.	Clean and tighten connections.
	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Blown main system fuse.	Replace fuse.

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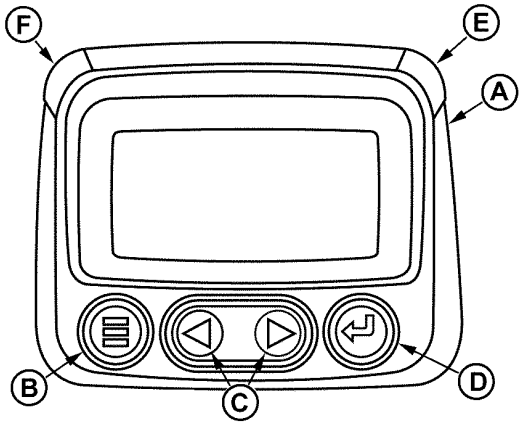
Instrument Panel Method for Retrieving Diagnostic Trouble Codes

IMPORTANT: Care should be used during diagnostic procedures to avoid damaging the terminals of connectors, sensors, and actuators. Probes should not be poked into or around the terminals or damage will result. Probes should only be touched against the terminals to make measurements.

Diagnosis of the electronic control system should be performed according to the following procedure:

1. Make sure all engine mechanical and other systems not related to the electronic control system are operating properly.
2. Read and record diagnostic trouble codes (DTCs) displayed on the diagnostic gauge (A). To access trouble codes on diagnostic gauge (A), see Page 24 of this manual.
3. Go to the LISTING OF DIAGNOSTIC TROUBLE CODES (DTCs) later in this section, to interpret the DTCs present.



Diagnostic Gauge

A—Diagnostic Gauge

4. Contact your nearest engine distributor or servicing dealer with a list of DTC codes that are displayed so necessary repairs can be made.

Listing Of Diagnostic Trouble Codes (DTC)

The Diagnostic Trouble Codes (DTCs) are output on the diagnostic gauge according to the J1939 standard as a two-part code. The first part is a two to four-digit Suspect Parameter Number (SPN) followed by a one or two-digit Failure Mode Identifier (FMI) code.

Following is a list of SPNs, FMIs, Blink Codes and description of the diagnostic trouble codes that can occur in the various engine systems. Not all of these codes will be present in all engine applications.

When trouble codes appear on the diagnostic gauge, see your engine dealer for repairs as soon as possible.

Listing Of Diagnostic Trouble Codes—Continued

SPN	FMI	Blink Code	Description of Fault	Corrective Action
28	03	03	Throttle #3 Signal Out of Range High	Check Sensor and Wiring
28	04	14	Throttle #3 Signal Out of Range Low	Check Sensor and Wiring
29	03	15	Throttle #2 Signal Out of Range High	Check Sensor and Wiring
29	04	16	Throttle #2 Signal Out of Range Low	Check Sensor and Wiring
84	02	91	Vehicle Speed Mismatch	Contact Servicing Dealer
91	03	11	Throttle #1 Signal Out of Range High	Check Switch and Wiring
91	04	12	Throttle #1 Signal Out of Range Low	Check Switch and Wiring
91	09	·····	Throttle #1 Communication Signal Erratic	Check Sensor and Wiring
94	01	58	Low Pressure Fuel Signal Extremely Low	Contact Servicing Dealer
94	03	27	Low Pressure Fuel Signal Out of Range High	Check Sensor and Wiring
94	04	28	Low Pressure Fuel Signal Out of Range Low	Check Sensor and Wiring
94	10	86	Low Pressure Fuel Rate of Change Abnormal	Contact Servicing Dealer
94	13	·····	Low Pressure Fuel Out of Calibration	Contact Servicing Dealer
94	17	85	High Pressure Fuel System- Pressure Slightly Low	Contact Servicing Dealer
94	18	57	Fuel Supply Pressure Moderately Low	Contact Servicing Dealer
97	00	·····	Water-in-Fuel Signal Continuously Detected	Contact Servicing Dealer
97	03	·····	Water-in-Fuel Signal Out of Range High	Check Sensor and Wiring
97	04	·····	Water-in-Fuel Signal Out of Range Low	Check Sensor and Wiring
97	16	·····	Water in Fuel Detected	Stop and Drain Water Separator
100	01	75	Engine Oil Pressure Signal Extremely Low	Check Oil Level
100	03	23	Engine Oil Pressure Signal Out of Range High	Check Sensor and Wiring
100	04	24	Engine Oil Pressure Signal Out of Range Low	Check Sensor and Wiring
100	16	·····	Engine Oil Pressure Signal Moderately High	Check Sensor and Wiring
100	18	74	Engine Oil Pressure Signal Moderately Low	Check Oil Level
105	00	·····	Intake Manifold Air Temperature Signal Extremely High	Check Air Cleaner, Aftercooler, or Room Temperature
105	03	·····	Intake Manifold Air Temperature Signal Out of Range High	Check Sensor and Wiring
105	04	·····	Intake Manifold Air Temperature Signal Out of Range Low	Check Sensor and Wiring
105	15	·····	Manifold Air Temperature Slightly High	Check Air Cleaner, Aftercooler, or Room Temperature
105	16	·····	Intake Manifold Air Temperature Signal Moderately High	Check Air Cleaner, Aftercooler, or Room Temperature
107	00	·····	Air Filter Pressure Differential Extremely High	Contact Servicing Dealer
110	00	63	Engine Coolant Temperature Signal Extremely High	Check Cooling System, Reduce Power
110	03	18	Engine Coolant Temperature Signal Out of Range High	Check Sensor and Wiring
110	04	19	Engine Coolant Temperature Signal Out of Range Low	Check Sensor and Wiring
110	15	62	Engine Coolant Temperature Signal Slightly High	Check Cooling System, Reduce Power
110	16	63	Engine Coolant Temperature Signal Moderately High	Check Cooling System, Reduce Power
111	01	61	Engine Coolant Level Low	Check Operator's Manual
157	03	·····	Fuel Rail Pressure Signal Out of Range High	Check Sensor and Wiring
157	04	·····	Fuel Rail Pressure Signal Out of Range Low	Check Sensor and Wiring
157	10	·····	Fuel Rail Pressure Loss Detected	Contact Servicing Dealer

Continued on next page

SPN	FMI	Blink Code	Description of Fault	Corrective Action
158…	17…..	54 …..	ECU Power Down Error (Internal ECU Problem) ……	Contact Servicing Dealer
174…	00…..	67 …..	Fuel Temperature Signal Extremely High ……	Add Fuel or Switch Fuel Tanks
174…	03…..	…….	Fuel Temperature Signal Out of Range High ……	Check Sensor and Wiring
174…	04…..	…….	Fuel Temperature Signal Out of Range Low……	Check Sensor and Wiring
174…	15…..	33/53 …….	Fuel Temperature Slightly High……	Contact Servicing Dealer
174…	16…..	71 …..	Fuel Temperature Signal Moderately High ……	Add Fuel or Switch Fuel Tanks
174…	31…..	98 …..	Fuel Temperature Sensor Faulty ……	Contact Servicing Dealer
189…	00…..	…….	Engine Speed Derate Condition Exists ……	Check Fault Codes or Contact Servicing Dealer
189…	31…..	48 …..	Engine Speed Derate……	Contact Servicing Dealer
190…	00…..	42 …..	Engine Speed Extremely High……	Reduce Engine Speed
190…	01…..	…….	Engine Speed Extremely Low ……	Contact Servicing Dealer
190…	16…..	42 …..	Engine Speed Moderately High ……	Reduce Engine Speed
190…	18…..	…….	Engine Speed Moderately Low ……	Contact Servicing Dealer
611…	03…..	…….	Injector Shorted to Power……	Check Wiring
611…	04…..	…….	Injector Shorted to Ground ……	Check Wiring
620…	03…..	…….	Sensor Supply Voltage High ……	Check Wiring
620…	04…..	…….	Sensor Supply Voltage Low ……	Check Wiring
627…	01…..	…….	All Injector Circuits Have High Resistance	Contact Servicing Dealer
627…	04…..	76 …..	ECU Unswitched, Power Missing ……	Contact Service Dealer
627…	18…..	…….	Injector Power Supply Voltage Out of Range Low	Contact Servicing Dealer
629…	12…..	…….	ECU EEPROM Error	Contact Servicing Dealer
629…	13…..	…….	ECU Programming Error……	Contact Service Dealer
629…	19…..	34 …..	ECU to Pump Communication Error……	Contact Service Dealer
632…	02…..	37 …..	Fuel Shutoff Error ……	Contact Service Dealer
632…	05…..	86 …..	Fuel Shutoff Not Functioning……	Contact Service Dealer
636…	02…..	44 …..	Engine Position Sensor Signal Unreliable……	Check Sensor and Wiring
636…	05…..	…….	Camshaft Position Circuit Has High Resistance	Check Sensor and Wiring
636…	06…..	…….	Camshaft Position Circuit Has Low Resistance	Check Sensor and Wiring
636…	08…..	43 …..	Engine Position Sensor Signal Missing……	Check Sensor and Wiring
636…	10…..	44 …..	Engine Position Sensor Signal Rate of Change Abnormal..	Check Sensor and Wiring
637…	02…..	39 …..	Engine Timing Sensor Signal Unreliable ……	Check Sensor and Wiring
637…	05…..	…….	Crankshaft Position Circuit Has High Resistance……	Check Sensor and Wiring
637…	06…..	…….	Crankshaft Position Circuit Has Low Resistance ……	Check Sensor and Wiring
637…	07…..	…….	Engine Timing and Position Signals Mismatch……	Check Sensor and Wiring
637…	08…..	38 …..	Engine Timing Sensor Signal Missing……	Check Sensor and Wiring
637…	10…..	39 …..	Engine Timing Signal Rate of Change Abnormal ……	Check Sensor and Wiring
639…	13…..	…….	CAN Bus Error ……	Contact Servicing Dealer
644…	02…..	…….	Speed Input Erratic ……	Contact Servicing Dealer
651…	05…..	…….	Injector Number 1 Circuit Has High Resistance……	Check Injector Wiring or Injector Solenoid
651…	05…..	…….	Injector Number 1 Circuit Has High Resistance……	Check Injector Wiring or Injector Solenoid
651…	02…..	…….	– Injector Number 1 Part Number Data Invalid……	Contact Servicing Dealer
651…	05…..	…….	Injector Number 1 Circuit Has High Resistance……	Check Injector Wiring or Injector Solenoid
651…	06…..	…….	Injector Number 1 Circuit Has Low Resistance ……	Check Injector Wiring or Injector Solenoid
651…	07…..	…….	Injector Number 1 Not Responding……	Injector Failed or Flow Limiter Closed
651…	13…..	…….	Injector Number 1 Part Number Calibration Fault ……	Contact Servicing Dealer
652…	02…..	…….	Injector Number 2 Part Number Data Invalid ……	Contact Servicing Dealer
652…	05…..	…….	Injector Number 2 Circuit Has High Resistance……	Check Injector Wiring or Injector Solenoid
652…	06…..	…….	Injector Number 2 Circuit Has Low Resistance ……	Check Injector Wiring or Injector Solenoid
652…	07…..	…….	Injector Number 2 Not Responding……	Injector Failed or Flow Limiter Closed

Continued on next page

SPN	FMI	Blink Code	Description of Fault	Corrective Action
652...	13.....	.....	Injector Number 2 Part Number Calibration Fault	Contact Servicing Dealer
653...	02.....	.....	Injector Number 3 Part Number Data Invalid	Contact Servicing Dealer
653...	05.....	.....	Injector Number 3 Circuit Has High Resistance.....	Check Injector Wiring or Injector Solenoid
653...	06.....	.....	Injector Number 3 Circuit Has Low Resistance	Check Injector Wiring or Injector Solenoid
653...	07.....	.....	Injector Number 3 Not Responding.....	Injector Failed or Flow Limiter Closed
653...	13.....	.....	Injector Number 3 Part Number Calibration Fault	Contact Servicing Dealer
654...	02.....	.....	Injector Number 4 Part Number Data Invalid	Contact Servicing Dealer
654...	05.....	.....	Injector Number 4 Circuit Has High Resistance.....	Check Injector Wiring or Injector Solenoid
654...	06.....	.....	Injector Number 4 Circuit Has Low Resistance	Check Injector Wiring or Injector Solenoid
654...	07.....	.....	Injector Number 4 Not Responding.....	Injector Failed or Flow Limiter Closed
654...	13.....	.....	Injector Number 4 Part Number Calibration Fault	Contact Servicing Dealer
655...	02.....	.....	Injector Number 5 Part Number Data Invalid	Contact Servicing Dealer
655...	05.....	.....	Injector Number 5 Circuit Has High Resistance.....	Check Injector Wiring or Injector Solenoid
655...	06.....	.....	Injector Number 5 Circuit Has Low Resistance	Check Injector Wiring or Injector Solenoid
655...	07.....	.....	Injector Number 5 Not Responding.....	Injector Failed or Flow Limiter Closed
655...	13.....	.....	Injector Number 5 Part Number Calibration Fault	Contact Servicing Dealer
656...	02.....	.....	Injector Number 6 Part Number Data Invalid	Contact Servicing Dealer
656...	05.....	.....	Injector Number 6 Circuit Has High Resistance.....	Check Injector Wiring or Injector Solenoid
656...	06.....	.....	Injector Number 6 Circuit Has Low Resistance	Check Injector Wiring or Injector Solenoid
656...	13.....	.....	Injector Number 6 Part Number Calibration Fault	Contact Servicing Dealer
656...	07.....	.....	Injector Number 6 Not Responding.....	Injector Failed or Flow Limiter Closed
676...	03.....	.....	Glow Plug Signal Received When Not Expected	Check Relay and Wiring
676...	05.....	.....	Glow Plug Signal Not Received When Expected	Check Relay and Wiring
729...	03.....	.....	Inlet Air Heater Signal High	Contact Servicing Dealer
729...	05.....	.....	Inlet Air Heater Signal Low	Contact Servicing Dealer
810...	02.....	92	Calculated Vehicle Speed Input Noise	Contact Servicing Dealer
898...	09.....	77	Vehicle Speed or Torque Message Not Valid	Contact Servicing Dealer
970...	02.....	.....	Auxiliary Engine Shutdown Switch Signal Invalid.....	Contact Servicing Dealer
970...	31.....	.....	External Shutdown Commanded.....	Non Engine Fault. Check Other Shutdown Devices
971...	31.....	.....	External Fuel Derate Switch Active.....	Non Engine Fault. Check Other Shutdown Devices
1075.....	05.....	.....	Low Pressure Fuel Pump Circuit Has High Resistance	Check Pump and Wiring
1075.....	06.....	.....	Low Pressure Fuel Pump Circuit Has Low Resistance.....	Check Pump and Wiring
1075.....	12.....	.....	Low Pressure Fuel Pump Status Error.....	Check Pump and Wiring
1076.....	02.....	66	Injection Pump Detected Defect.....	Contact Servicing Dealer
1077.....	07.....	35	Attempting to Fuel Without Command	Contact Servicing Dealer
1077.....	11.....	68	Pump Supply Voltage Out of Range.....	Contact Servicing Dealer
1077.....	12.....	97	Pump Self Test Error.....	Contact Servicing Dealer
1077.....	19.....	96	Pump Detected Communication Error	Contact Servicing Dealer
1077.....	31.....	36	Pump Initiated Engine Protection	Contact Servicing Dealer
1078.....	07.....	95	ECU/Pump Timing Moderately Mismatched	Contact Servicing Dealer
1078.....	11.....	87	ECU/Pump Speed Mismatched	Contact Servicing Dealer
1078.....	31.....	94	ECU/Pump Timing Extremely Mismatched	Contact Servicing Dealer

Continued on next page

SPN	FMI	Blink Code	Description of Fault	Corrective Action
1079	03	21	Sensor Supply 1 Voltage High	Check Wiring
1079	04	22	Sensor Supply 1 Voltage Low	Check Wiring
1080	03	31	Sensor Supply 2 Voltage High	Check Wiring
1080	04	32	Sensor Supply 2 Voltage Low	Check Wiring
1109	31	·····	Engine Protection Shutdown Warning	Check Fault Codes
1110	31	·····	Engine Protection Shutdown	Check Fault Codes
1136	00	·····	ECU Temperature Signal Extremely High	Contact Servicing Dealer
1136	16	·····	ECU Temperature Signal Moderately High	Contact Servicing Dealer
1347	03	79	High Pressure Fuel Pump Control Valve Signal Out of Range High	Contact Servicing Dealer
1347	05	77	High Pressure Fuel Pump Solenoid Number 1 Circuit Has High Resistance	Check Pump Wiring
1347	07	78	High Pressure Fuel Pump Not Able to Meet Required Rail Pressure	Check Fuel Filter and Lines
1485	02	89	Pump Power Relay Fault	Contact Servicing Dealer
1568	02	·····	Requested Torque Curve Signal Unreliable	Contact Servicing Dealer
1569	31	47	Engine in Derate Condition	Check Fault Codes
2000	13	·····	Security Violation	Contact Servicing Dealer
3509	03	·····	Sensor Supply Number 1 Voltage Out of Range High	Contact Servicing Dealer
3509	04	·····	Sensor Supply Number 1 Voltage Out of Range Low	Contact Servicing Dealer
3510	03	·····	Sensor Supply Number 2 Voltage Out of Range High	Contact Servicing Dealer
3510	04	·····	Sensor Supply Number 2 Voltage Out of Range Low	Contact Servicing Dealer
3511	03	·····	Sensor Supply Number 3 Voltage Out of Range High	Contact Servicing Dealer
3511	04	·····	Sensor Supply Number 3 Voltage Out of Range Low	Contact Servicing Dealer
3512	03	·····	Sensor Supply Number 4 Voltage Out of Range High	Contact Servicing Dealer
3512	04	·····	Sensor Supply Number 4 Voltage Out of Range Low	Contact Servicing Dealer
3513	03	·····	Sensor Supply Number 5 Voltage Out of Range High	Contact Servicing Dealer
3513	04	·····	Sensor Supply Number 5 Voltage Out of Range Low	Contact Servicing Dealer

NOTE: Diagnostic gauge on instrument panel may also display text for communication faults, such as “CAN BUS FAILURE”. Contact you servicing dealer.

OURGP12,00001FC -19-08APR10-4/4

Intermittent Fault Diagnostics

Intermittent faults are problems that periodically “go away”. A problem such as a terminal that intermittently doesn't make contact can cause an intermittent fault. Other intermittent faults may be set only under certain operating conditions such as heavy load, extended idle etc. When diagnosing intermittent faults, take special note of the condition of wiring and connectors since a high percentage of intermittent problems originate here. Check for loose, dirty or disconnected connectors. Inspect the wiring routing looking for possible shorts caused by contact with external parts (for example, rubbing against sharp sheet metal edges). Inspect the connector vicinity looking for wires that have pulled out of connector terminals, damaged connectors, poorly positioned terminals, and corroded or damaged terminals. Look for broken wires, damaged splices, and wire-to-wire shorts. Use good judgement if component replacement is thought to be required.

NOTE: The Engine Control Unit (ECU) is the component LEAST likely to fail.

Suggestions for diagnosing intermittent faults:

If the problem is intermittent, try to reproduce the operating conditions that were present when the Diagnostic Trouble Code (DTC) set.

If a faulty connection or wire is suspected to be the cause of the intermittent problem: clear DTCs, then check the connection or wire by wiggling it while watching the diagnostic gauge to see if the fault resets.

Possible Causes of Intermittent Faults:

1. Faulty connection between sensor or actuator and harness.
2. Faulty contact between terminals in connector.
3. Faulty terminal/wire connection.

Electromagnetic interference (EMI) from an improperly installed 2-way radio, etc. can cause faulty signals to be sent to the ECU.

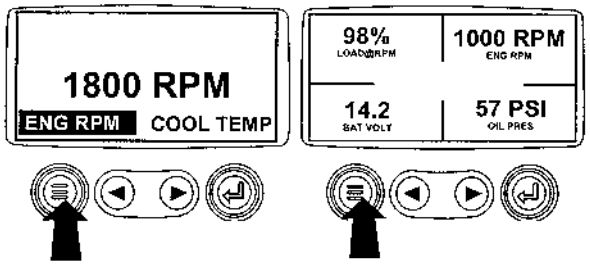
NOTE: Refer to wiring diagram foldouts earlier in this section as a guide to connections and wires.

OURGP11,0000206 -19-07OCT03-1/1

Displaying Diagnostic Gauge Software

NOTE: The following steps can be used to display the software version of the diagnostic gauge if needed by your dealer for troubleshooting. This is a read only function.

1. Starting at the single or four engine parameter display, press the "Menu" key.

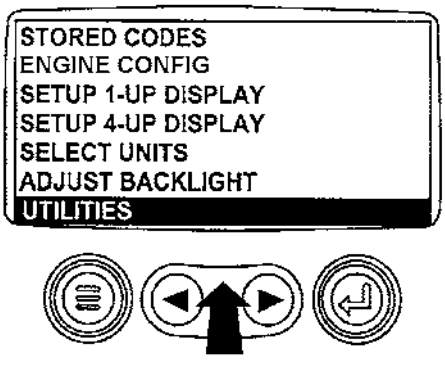


RG13159 —UN—26SEP03

Menu Key

OURGP11,00000E3 -19-29SEP03-1/4

2. The main menu will be displayed. Use the "Arrow" key to scroll through the menu until "Utilities" is highlighted.



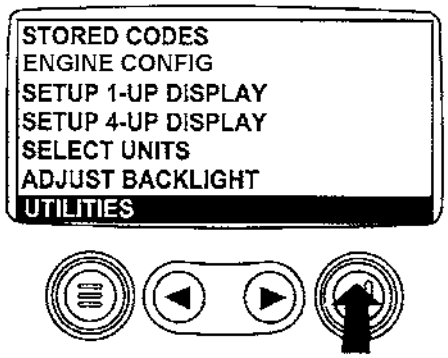
RG13234 —UN—22OCT03

Select Utilities

Continued on next page

OURGP11,00000E3 -19-29SEP03-2/4

3. Once "Utilities" is highlighted, press "Enter" to activate the utilities function.

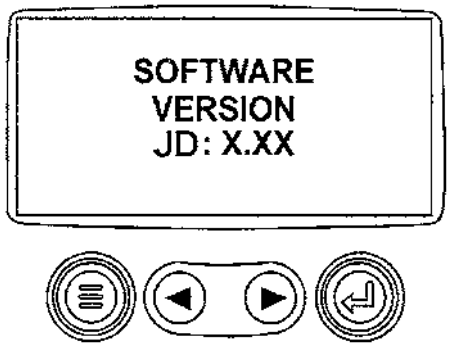


RG13237 —UN—22OCT03

Select Utilities

OURGP11,00000E3 -19-29SEP03-3/4

4. Scroll to the "Software Version". Press "Enter" to view the software version. Press the menu button twice to return to the main menu.



RG13236 —UN—13OCT03

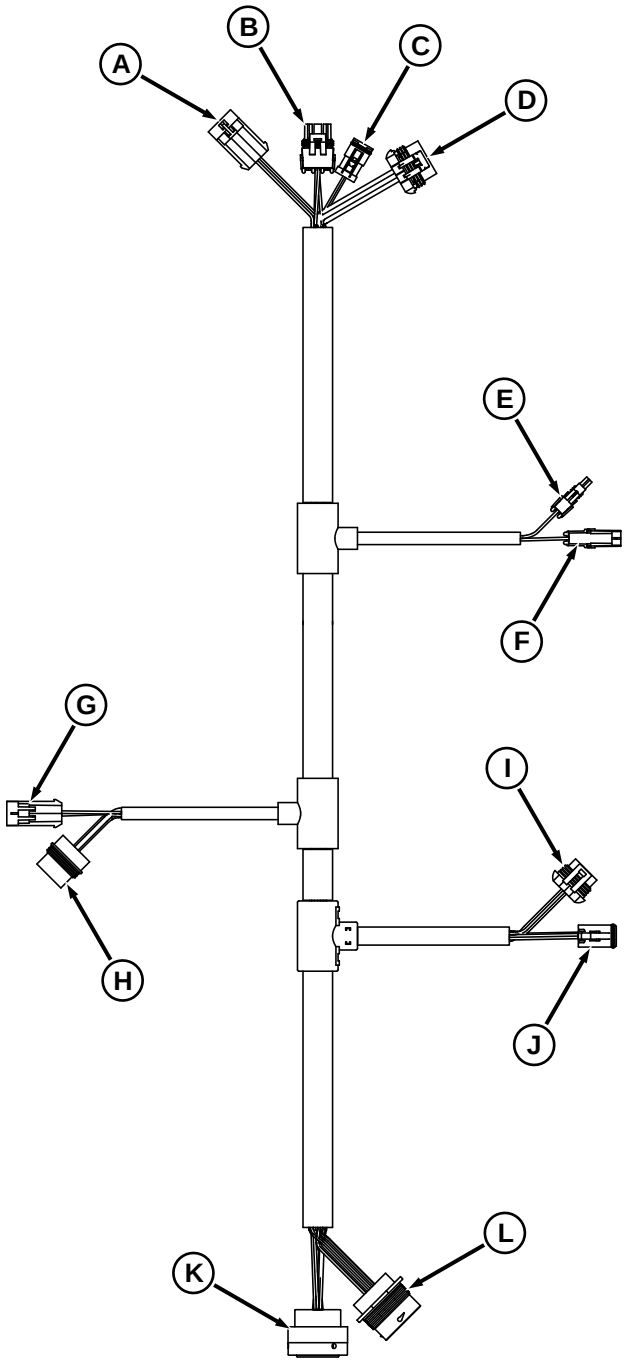
Software Version

OURGP11,00000E3 -19-29SEP03-4/4

Transition Harness

The marine transition harness connects the engine wiring harness and the main instrument panel. The engine end of the transition harness contains connections for the 21- and 23-pin connectors, the starter cutout relay, an external shutdown connection, station select and an auxiliary analog throttle input. The instrument panel end of the harness contains connectors for station select/engine sync, engine sync in and out, power and starting circuit wiring for the instrument panel, wheelhouse analog throttle and CAN bus connection.

A— Wheelhouse Station Speed Input
B— Wheelhouse Throttle Input
C— CAN Connector (to marine instrument panel)
D— Battery (+), Ground (—)
E— Engine Sync Input
F— Engine Sync Output
G— External Shutdown Conector
H— Starter Cutout Relay
I— Auxiliary Throttle Input
J— Auxiliary Station Select Input
K— 23-Pin Connector (engine wiring harness)
L— 21-Pin Connector (engine wiring harness)



Transition Harness

RG19661,00003DD -19-11FEB13-1/1

Engine Storage Guidelines

1. Northern Lights engines can be stored outside for up to three (3) months with no long term preparation IF COVERED BY WATERPROOF COVERING. No outside storage is recommended without a waterproof covering.
2. Northern Lights engines can be stored in a standard overseas shipping container for up to three (3) months with no long term preparation.
3. Northern Lights engines can be stored inside for up to six (6) months with no long term preparation.
4. Northern Lights engines expected to be stored more than six (6) months MUST have long term storage preparation. (See PREPARING ENGINE FOR LONG TERM STORAGE, later in this section.)
5. Long term storage includes the use of a stabilized rust preventive oil to protect internal metal components of the engine. This oil should be an SAE 10 oil with 1-4 percent morpholine or equivalent vapor corrosion inhibitor. These rust preventive oils are available from area distributors.

IMPORTANT: DO NOT USE BIODIESEL DURING MACHINE STORAGE. When using biodiesel blends, switch to petroleum diesel for long term storage. Before storage, operate engine on at least one complete tank of petroleum diesel fuel to purge the fuel system. Follow normal storage procedures once the fuel system has been purged.

OUOD006,0000114 -19-16OCT07-1/1

Preparing Engine for Long Term Storage

The following storage preparations are used for long term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

IMPORTANT: Any time your engine will not be used for over six (6) months, the following recommendations for storing it and removing it from storage will help to minimize corrosion and deterioration.

IMPORTANT: DO NOT USE BIODIESEL DURING MACHINE STORAGE. When using biodiesel blends, switch to petroleum diesel for long term storage. Before storage, operate engine on at least one complete tank of petroleum diesel fuel to purge the fuel system. Follow normal storage procedures once the fuel system has been purged.

1. Change engine oil and replace filter. (See CHANGE ENGINE OIL AND FILTER in Lubrication and Maintenance/500 Hour Section.) Used oil will not give adequate protection. Add one (1) ounce of rust preventive oil to the engine crankcase for every quart of oil. This rust preventive oil should be an SAE 10 oil with 1-4 percent morpholine or equivalent vapor corrosion inhibitor.
2. Ensure the machine fuel tank is filled with high quality petroleum diesel fuel. Filling the tank completely will ensure that water does not build up due to condensation. For storage of more than one year, use Northern Lights PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.
3. Service air cleaner. (See REPLACING AIR CLEANER FILTER ELEMENTS in Service As Required Section.)
4. Draining and flushing of cooling system is not necessary if engine is to be stored only for several months. However, for extended storage periods of a year or longer, it is recommended that the cooling system be drained, flushed, and refilled. Refill with appropriate coolant. (See RECOMMENDED ENGINE COOLANT in Fuels, Lubricants, and Coolant Section and ADDING COOLANT in Service As Required Section.)
5. Prepare a tank with a solution of diesel fuel and rust preventive oil, at ten (10) ounces of rust preventive oil per gallon of diesel fuel.
6. Remove existing lines/plugs as required, and run a temporary line from the tank to the engine fuel intake, and another temporary line from the fuel return manifold to the tank, so rust preventive oil solution is circulated through the injection system during cranking.
7. Crank the engine several revolutions with starter (do not allow the engine to start). This will allow rust preventive oil solution to circulate.
8. Remove temporary lines installed in Step 6 above, and replace any lines/plugs previously removed.

NOTE: One gallon of fuel/oil solution can be used to treat 100 engines; two gallons to treat 200 engines, etc. The oil could then be replenished by adding an additional five (5) ounces of rust preventive oil per gallon of solution. However, starting over with a new solution is recommended to dispose of any water or other impurities.

9. Loosen, or remove and store, fan/alternator poly-vee belt.
10. Remove and clean batteries. Store them in a cool, dry place and keep them fully charged.
11. Disengage the clutch for any driveline.
12. Clean the exterior of the engine with salt-free water and touch up any scratched or chipped painted surfaces with a good quality paint.
13. Coat all exposed (machined) metal surfaces with grease or corrosion inhibitor if not feasible to paint.
14. Seal all openings on engine with plastic bags and tape.
15. Store the engine in a dry protected place. If engine must be stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

OUOD006,00000FC -19-26FEB10-1/1

Removing Engine from Long-Term Storage

Refer to the appropriate section for detailed services listed below or have your authorized servicing dealer or engine distributor perform services that you may not be familiar with.

1. Remove all protective coverings from engine. Unseal all openings in engine and remove covering from electrical systems.
2. Remove the batteries from storage. Install batteries (fully charged) and connect the terminals.
3. Install alternator poly-vee belt if removed. Adjust belt tension. (See CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR in Lubrication and Maintenance/500 Hour/12 Month Section.) Install belt guard.
4. Perform all appropriate prestarting checks. (See DAILY PRESTARTING CHECKS in Lubrication and Maintenance/Daily Section.)
5. Open sea water valve and prime the sea water system.
6. Open fuel valve, fill fuel filter/water separator with clean fuel and bleed the fuel system. (See BLEEDING THE FUEL SYSTEM in Service as Required Section.)

IMPORTANT: DO NOT operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.

7. Crank engine for 20 seconds with starter (do not allow the engine to start). Wait 2 minutes and crank engine an additional 20 seconds to assure bearing surfaces are adequately lubricated.
8. Start engine and run at low idle and no load for several minutes. Warm up carefully and check all gauges before placing engine under load.
9. On the first day of operation after storage, check overall engine for leaks and check all gauges for correct operation.

NOTE: If using BIODIESEL blends after long term storage, frequency of fuel filter plugging may increase initially.

OUOD006,0000115 -19-16OCT07-1/1

General Marine Engine Specifications - 4.5L

ITEM	UNIT OF MEASURE	ENGINE MODEL M50C13 - M65C13	ENGINE MODEL M80A13 - M99C13
General Data			
Engine Type		In-line, 4 cycle diesel	In-line, 4 cycle diesel
Aspiration		Turbocharged	Turbocharged and coolant after cooled
Number of Cylinders		4	4
Bore	mm (in.)	106 (4.17)	106 (4.17)
Stroke	mm (in.)	127 (5.00)	127 (5.00)
Displacement	L (cu in.)	4.5 (275)	4.5 (275)
Combustion System		Direct Injection	Direct Injection
Compression Ratio		16.0:1	16.7:1
Physical Dimensions:			
Width	mm (in.)	715 (28.1)	770 (30.3)
Height	mm (in.)	912 (35.9)	964 (31.0)
Length	mm (in.)	1007 (39.6)	1105 (43.5)
Basic Dry Weight (approximate)	kg (lb)	n/a	510 (1125)
Lubrication System (Propulsion Applications)			
Oil Pressure at Rated rpm (±35%)	kPa (psi)	—	436 (63)
Oil Pressure at Low Idle (800 rpm)	kPa (psi)	—	213 (31)
Lubrication System (Generator Applications)			
Oil Pressure at Rated rpm (±35%)	kPa (psi)	290 (42)	378 (55)
Oil Fill Capacity	L (qt)	15 (16)	18 (19)
Cooling System (Liquid, pressurized with centrifugal pump)			
Recommended Pressure Cap	kPa (psi)	110 (16)	110 (16)
Coolant Temperature Operating Range	°C (°F)	82-94 (180-202) 110 (230)	82-94 (180-202) 110 (230)
Coolant Temperature (Maximum)	°C (°F)		
Coolant Capacity	L (qt)	17 (18)	17 (18)
Valve Actuation			
Valve Clearance (Cold)			
Intake	mm (in.)	0.35 (0.014)	0.35 (0.014)
Exhaust	mm (in.)	0.45 (0.018)	0.45 (0.018)
Fuel System			
ECU Description		L16	L16
Fuel Injection Type		HPCR	HPCR
Governor Type		Electronic	Electronic
Primary Fuel Filter		10 micron	10 micron
Secondary Fuel Filter		2 micron	2 micron
Electrical System			
Battery Capacity (Minimum)- 12 Volt System	CCA	625	925
Battery Capacity (Minimum)- 24 Volt System	CCA	500	625
Air System			
Maximum Air Intake Restriction	in. H_2O	25	25
	(kPa)	(6.25)	(6.25)
	(psi)	(1.0)	(1.0)

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4420 14th Ave. NW., Seattle WA 98107
Tel: (206) 789-3880 • 1-800-762-0165 • www.northern-lights.com