YANMAR

OPERATION MANUAL

INDUSTRIAL ENGINES

TNV

3TNV88C
3TNV86CT
4TNV88C
4TNV86CT
4TNV98C
4TNV98CT

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.

California
Proposition 65 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.

Disclaimers:

All information, illustrations and specifications in this manual are based on the latest information available at the time of publishing. The illustrations used in this manual are intended as representative reference views only. Moreover, because of our continuous product improvement policy, we may modify information, illustrations and/or specifications to explain and/or exemplify a product, service or maintenance improvement. We reserve the right to make any change at any time without notice. YANMAR and **YANMAR** are registered trademarks of YANMAR CO., LTD. in Japan, the United States and/or other countries.

All Rights Reserved:

OPERATION MANUAL	Model	TNV Common Rail Series
	Code No.	0ATN4-G00100

YANMAR WARRANTIES

YANMAR LIMITED WARRANTY

What is Covered by this Warranty?

YANMAR warrants to the original retail purchaser that a new YANMAR TNV common rail series industrial engine will be free from defects in material and/or workmanship for the duration of the warranty period.

Note: YANMAR engines may be equipped with external components including, but not limited to: wiring harnesses, electrical devices, control panels, radiators, air filters, fuel filters, and/or exhaust systems that are supplied and/or installed by manufacturers other than YANMAR. For warranty information on such external components, please contact the machine or component manufacturer directly or see your authorized YANMAR dealer or distributor.

This warranty is provided in lieu of all other warranties, express or implied. YANMAR specifically disclaims any implied warranties of merchantability or fitness for a particular purpose, except where such disclaimer is prohibited by law. If such disclaimer is prohibited by law, then implied warranties shall be limited in duration to the life of the express warranty.

How Long is the Warranty Period?

The YANMAR standard limited warranty period runs for a period of **twenty-four (24) months or two-thousand (2000) engine operation hours**, whichever occurs first. An extended limited warranty of thirty-six (36) months or three thousand (3000) engine operating hours, whichever occurs first, is provided for these specific parts only: the cylinder block, cylinder head, crankshaft forging, connecting rods, flywheel, flywheel housing, camshaft, timing gear, and gear case. The warranty period for both the standard limited warranty and the extended limited warranty (by duration or operation hours) begins on the date of delivery to the original retail purchaser and is valid only until the applicable warranted duration has passed or the operation hours are exceeded, whichever comes first.

YANMAR limited warranty - continued

What the Engine Owner must Do:

If you believe your YANMAR engine has experienced a failure due to a defect in material and/or workmanship, you must contact an authorized YANMAR industrial engine dealer or distributor within thirty (30) days of discovering the failure. You must provide proof of ownership of the engine, proof of the date of the engine purchase and delivery, and documentation of the engine operation hours. Acceptable forms of proof of delivery date include, but are not limited to: the original warranty registration or sales receipts or other documents maintained in the ordinary course of business by YANMAR dealers and/or distributors, indicating the date of delivery of the YANMAR product to the original retail purchaser. This information is necessary to establish whether the YANMAR product is still within the warranty period. Thus, YANMAR strongly recommends you register your engine as soon as possible after purchase in order to facilitate any future warranty matters.

You are responsible for the transportation of the engine to and from the repair location as designated by YANMAR.

To Locate an Authorized YANMAR Industrial Engine Dealer or Distributor:

You can locate your nearest authorized YANMAR industrial engine dealer or distributor by visiting the YANMAR Co., Ltd. website at:

http://www.yanmar.co.jp (The Japanese language page will be displayed.) For English language “click” on “English Page.”)

- “Click” on “Network” in the website heading to view the “Yanmar Worldwide Network.”
- Choose and “Click” on the desired product group.
- “Click” on the Icon closest to your region.
- “Click” on the desired country or associate company to locate your nearest authorized YANMAR industrial engine dealer or distributor.

You may also contact YANMAR by clicking on “Inquiry” in the website heading and typing in your question or comment.

What YANMAR will Do:

YANMAR warrants to the original retail purchaser of a new YANMAR engine that YANMAR will make such repairs and/or replacements at YANMAR’s option, of any part(s) of the YANMAR product covered by this warranty found to be defective in material and/or workmanship. Such repairs and/or replacements will be made at a location designated by YANMAR at no cost to the purchaser for parts or labor.

YANMAR limited warranty - continued

What is not Covered by this Warranty?

This warranty does not cover parts affected by or damaged by any reason other than defective materials or workmanship, including, but not limited to, accident, misuse, abuse, "Acts of God," neglect, improper installation, improper maintenance, improper storage, the use of unsuitable attachments or parts, the use of contaminated fuels, the use of fuels, oils, lubricants, or fluids other than those recommended in your YANMAR Operation Manual, unauthorized alterations or modifications, ordinary wear and tear, and rust or corrosion. This warranty does not cover the cost of parts and/or labor required to perform normal/scheduled maintenance on your YANMAR engine. This warranty does not cover consumable parts such as, but not limited to, filters, belts, hoses, fuel injector, lubricants and cleaning fluids. This warranty does not cover the cost of shipping the product to or from the warranty repair facility.

Warranty Limitations:

The foregoing is YANMAR's only obligation to you and your exclusive remedy for breach of warranty. Failure to follow the requirements for submitting a claim under this warranty may result in a waiver of all claims for damages and other relief. **In no event shall YANMAR or any authorized industrial engine dealer or distributor be liable for incidental, special or consequential damages.** Such consequential damages may include, but not be limited to, loss of revenue, loan payments, cost of rental of substitute equipment, insurance coverage, storage, lodging, transportation, fuel, mileage, and telephone costs. The limitations in this warranty apply regardless of whether your claims are based on breach of contract, tort (including negligence and strict liability) or any other theory. Any action arising hereunder must be brought within one (1) year after the cause of action accrues or it shall be barred. Some states and countries do not allow certain limitations on warranties or for breach of warranties. **This warranty gives you specific legal rights, and you may also have other rights which vary from state to state and country to country.** Limitations set forth in this paragraph shall not apply to the extent that they are prohibited by law.

Warranty Modifications:

Except as modified in writing and signed by the parties, this warranty is and shall remain the complete and exclusive agreement between the parties with respect to warranties, superseding all prior agreements, written and oral, and all other communications between the parties relating to warranties. **No person or entity is authorized to give any other warranty or to assume any other obligation on behalf of YANMAR, either orally or in writing.**

Questions:

If you have any questions or concerns regarding this warranty, please call or write to the nearest authorized YANMAR industrial engine dealer or distributor or other authorized facility.

EMISSION SYSTEM WARRANTY

YANMAR CO., LTD. LIMITED EMISSION CONTROL SYSTEM WARRANTY - USA ONLY

Your Warranty Rights and Obligations:

■ California

The California Air Resources Board (CARB), the Environmental Protection Agency (EPA) and YANMAR Co., Ltd. hereafter referred to as YANMAR, are pleased to explain the **emission control system warranty** on your industrial compression-ignition engine. In California, model year 2000 or later off-road compression-ignition engines must be designed, built and equipped to meet the state's stringent anti-smog standards. In all states, 1998 and later non-road compression-ignition engines must be designed, built and equipped to meet the United States EPA emissions standards. YANMAR warrants the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system, the air induction system, the electronic control system, EGR (Exhaust Gas Recirculation) system and Diesel Particulate Filter. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, YANMAR will repair your non-road compression-ignition engine at no charge to you including diagnosis, parts and labor.

Manufacturer's Warranty Period:

The model year 1998 or later certified and labeled non-road compression-ignition engines are warranted for the periods listed below. If any emission-related part on your engine is found to be defective during the applicable warranty period, the part will be replaced by YANMAR.

If your engine is certified as	And its maximum power is	And its rated speed is	Then its warranty period is
Variable speed or constant speed	kW < 19	Any speed	1,500 hours or two (2) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.
Constant speed	19 ≤ kW < 37	3,000 rpm or higher	1,500 hours or two (2) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.
Constant speed	19 ≤ kW < 37	Less than 3,000 rpm	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Variable speed	19 ≤ kW < 37	Any speed	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Variable speed or constant speed	kW ≥ 37	Any speed	3,000 hours or five (5) years whichever comes first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.

Limited emission control system warranty - USA only - continued

Warranty Coverage:

This warranty is transferable to each subsequent purchaser for the duration of the warranty period. Repair or replacement of any warranted part will be performed at an authorized YANMAR industrial engine dealer or distributor.

Warranted parts not scheduled for replacement as required maintenance in the operation manual shall be warranted for the warranty period. Warranted parts scheduled for replacement as required maintenance in the operation manual are warranted for the period of time prior to the first scheduled replacement. Any part repaired or replaced under warranty shall be warranted for the remaining warranty period.

During the warranty period, YANMAR is liable for damages to other engine components caused by the failure of any warranted part during the warranty period.

Any replacement part which is functionally identical to the original equipment part in all respects may be used in the maintenance or repair of your engine, and shall not reduce YANMAR's warranty obligations. Add-on or modified parts that are not exempted may not be used. The use of any non-exempted add-on or modified parts shall be grounds for disallowing a warranty.

Warranted Parts:

This warranty covers engine components that are a part of the emission control system of the engine as delivered by YANMAR to the original retail purchaser. Such components may include the following:

- Fuel injection system
- Electronic control system
- Cold start enrichment system
- Intake manifold
- Turbocharger systems
- Exhaust manifold
- EGR system
- Positive crankcase ventilation system
- Hoses, belts, connectors and assemblies associated with emission control systems
- Exhaust gas after treatment (Diesel Particulate Filter)

Since emissions-related parts may vary slightly between models, certain models may not contain all of these parts and other models may contain the functional equivalents.

Limited emission control system warranty - USA only - continued

Exclusions:

Failures other than those arising from defects in material and/or workmanship are not covered by this warranty. The warranty does not extend to the following: malfunctions caused by abuse, misuse, improper adjustment, modification, alteration, tampering, disconnection, improper or inadequate maintenance or use of non-recommended fuels and lubricating oils; accident-caused damage, and replacement of expendable items made in connection with scheduled maintenance. YANMAR disclaims any responsibility for incidental or consequential damages such as loss of time, inconvenience, loss of use of equipment/engine or commercial loss.

Owner's Warranty Responsibilities:

As the engine owner, you are responsible for the performance of the required maintenance listed in your owner's manual. YANMAR recommends that you retain all documentation, including receipts, covering maintenance on your non-road compression-ignition engine, but YANMAR cannot deny warranty solely for the lack of receipts, or for your failure to ensure the performance of all scheduled maintenance.

YANMAR may deny your warranty coverage of your non-road compression-ignition engine if a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on diesel fuel only. Use of any other fuel may result in your engine no longer operating in compliance with applicable emissions requirements.

You are responsible for initiating the warranty process. You must present your engine to a YANMAR dealer as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible. If you have any questions regarding your warranty rights and responsibilities, or would like information on the nearest YANMAR dealer or authorized service center, you should contact YANMAR America Corporation.

Website: www.yanmar.com
E-mail: CS support@yanmar.com
Toll free telephone number: 1-800-872-2867, 1-855-416-7091

EMISSION-RELATED INSTALLATION INSTRUCTIONS (REF)

Failing to follow these instructions when installing a certified engine in a piece of nonroad equipment violates Federal Law (40 CFR1068.105(B)), subject to fines or other penalties as described in the clean air act.

Installation of Nonroad Engines into Equipment

To ensure engines operate under the certified configurations, YANMAR has established defined application requirements when installing any certified engine into a piece of equipment. The instructions outlined below are included in our certification process and any failure to comply will be considered tampering.

YANMAR certifies engines to operate under variable speed or constant speed conditions. Engines certified as constant speed are prohibited from installation into variable speed applications. The emission control information label will identify an engine certified as constant speed.

Allowable Air Intake Restriction and Exhaust Back Pressure

Resistance to intake airflow and exhaust gas flow is generated in the intake and exhaust systems. Exceeding the limitations will affect the operation of an engine and its certified configuration. Refer to the installation requirements and limitations of the TNV series Application Manual for the engine being equipped with these systems.

Allowable Air Intake Restriction

Engine model	Allowable air intake restriction ≤ kPa (mmAq)	
	Initial upper limit	Upper limit for air cleaner replacement
All TNV models	2.94 (300)	6.23 (635)

Allowable Exhaust Back Pressure

Engine model	Allowable exhaust back pressure ≤ kPa (mmAq)	
	Initial upper limit	Upper limit for exhaust system cleaning
All models	12.7 (1300)	45 (4590)

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INTRODUCTION

Welcome to the world of YANMAR Engines! YANMAR has been the leader in industrial diesel engines for over 90 years. We developed the world's first practical small-sized diesel engine in 1933. Our engineers are continuously developing new technology to keep YANMAR on the leading-edge of the industry. The TNV engine is only one example of the new technology we have developed. We are committed to maintaining our environment, and are proud of our history of innovation, quality and respect for operator safety.

To help you enjoy your YANMAR TNV engine for many years to come, please follow these recommendations:

- Read and understand this Operation Manual before you operate the machine to ensure that you follow safe operating practices and maintenance procedures.
- Keep this Operation Manual in a convenient place for easy access.
- If this Operation Manual is lost or damaged, order a new one from your authorized YANMAR industrial engine dealer or distributor.
- Make sure this manual is transferred to subsequent owners. This manual should be considered a permanent part of the engine and remain with it.
- Constant efforts are made to improve the quality and performance of YANMAR products, so some details included in this Operation Manual may differ slightly from your engine. If you have any questions about these differences, please contact your authorized YANMAR industrial engine dealer or distributor.
- The specifications and components (instrument panel, fuel tank, etc.) described in this manual may differ from ones installed on your machine. Please refer to the manual provided by the manufacturer of these components.

RECORD OF OWNERSHIP

Take a few moments to record the information you need when you contact YANMAR for service, parts or literature.

Engine model: _____

Engine serial No.: _____

Date purchased:_____

Dealer: _____

Dealer phone:_____

SYMBOL EXPLANATION

The following symbols are used throughout this manual to identify specific engine model information

- 3TNV88C
- 3TNV86CT
- 4TNV88C
- 4TNV86CT
- 4TNV98C
- 4TNV98CT

TABLE OF CONTENTS

TABLE OF CONTENTS

SAFETY

SAFETY STATEMENTS

YANMAR is concerned for your safety and your machine's condition. Safety statements are one of the primary ways to call your attention to the potential hazards associated with YANMAR TNV engine operation. Follow the precautions listed throughout the manual before operation, during operation and during periodic maintenance procedures for your safety, the safety of others and to protect the performance of your engine. Keep the labels from becoming dirty or torn and replace them if they are lost or damaged. Also, if you need to replace a part that has a label attached to it, make sure you order the new part and label at the same time.

This safety alert symbol appears with most safety statements. It means attention, become alert, your safety is involved! Please read and abide by the message that follows the safety alert symbol.

⚠ 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.

NOTICE

NOTICE indicates a situation which can cause damage to the machine, personal property and/or the environment or cause the equipment to operate improperly.

SAFETY PRECAUTIONS

Before You Operate

NOTICE

- Never permit anyone to operate the engine or driven machine without proper training.

- Read and understand this Operation Manual before you operate or service the machine to ensure that you follow safe operating practices and maintenance procedures.
- Machine safety signs and labels are additional reminders for safe operating and maintenance techniques.
- See your authorized YANMAR industrial engine dealer or distributor for additional training.

During Operation and Maintenance

⚠ DANGER

High Pressure Hazard!

- **This engine uses a high pressure common rail system. For disassembly of the high pressure parts (e.g. the high pressure pipe) in particular, be sure to wait approximately 10 to 15 minutes before performing disassembly.**
- **Do not loosen the high pressure pipe while the engine is running, even in low idle. This is dangerous because fuel under high pressure will blow out.**
- **Failure to comply will result in death or serious injury.**

⚠ DANGER

Scald Hazard!

- **Never remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.**
- **Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.**
- **Always check the level of the engine coolant by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

⚠ DANGER

Explosion Hazard!

- **Keep the area around the battery well-ventilated. While the engine is running or the battery is charging, hydrogen gas is produced which can be easily ignited.**
- **Keep sparks, open flame and any other form of ignition away while the engine is running or battery is charging.**
- **Never short out the battery terminals, including when checking the remaining battery charge. This will result in a spark and may cause an explosion or fire. Use a hydrometer to check the remaining battery charge.**
- **If the electrolyte is frozen, slowly warm the battery before you recharge it.**
- **Failure to comply will result in death or serious injury.**

⚠ DANGER

Fire and Explosion Hazard!

- Diesel fuel is extremely flammable and explosive under certain conditions.

- When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.
- Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.
- Wipe up any spills immediately.
- Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.
- Only use the key switch to start the engine.
- Never jump-start the engine. Sparks caused by shorting the battery to the starter terminals may cause a fire or explosion.
- If the unit has an electric fuel pump, when you prime the fuel system, turn the key switch to the ON position for 10 to 15 seconds to allow the electric fuel pump to prime the system.
- If the unit has a mechanical fuel pump, when you prime the fuel system, operate the fuel priming lever of the mechanical fuel pump several times until the fuel filter cup is filled with fuel.
- Never open the air vent valve while the fuel system is being primed. The fuel filter has an internal air bleed port.
- Never use diesel fuel as a cleaning agent.
- Never remove the fuel cap with the engine running.
- Only fill the fuel tank with diesel fuel. Filling the fuel tank with gasoline may result in a fire and will damage the engine.
- Never refuel with the engine running.

⚠ DANGER (Continued)

- Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) well away when refueling.
- Never overfill the fuel tank.
- Fill the fuel tank. Store any containers containing fuel in a well-ventilated area, away from any combustibles or sources of ignition.
- Be sure to place the diesel fuel container on the ground when transferring the diesel fuel from the pump to the container. Hold the hose nozzle firmly against the side of the container while filling it. This prevents static electricity buildup which could cause sparks and ignite fuel vapors.
- Never place diesel fuel or other flammable material such as oil, hay or dried grass close to the engine during engine operation or shortly after shutdown.
- Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of engine operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of engine operation, whichever comes first.
- When you prime the fuel system, operate the fuel priming lever of the mechanical fuel pump several times until the fuel filter cup is filled with fuel.
- Failure to comply will result in death or serious injury.

⚠ DANGER

Crush Hazard!

- When you need to transport an engine for repair, have a helper assist you to attach it to a hoist and load it on a truck.
- Never stand under a hoisted engine. If the hoist mechanism fails, the engine will fall on you, causing death or serious injury.
- Failure to comply will result in death or serious injury.

⚠ WARNING

Burn Hazard!

- Batteries contain sulfuric acid. Never allow battery fluid to come in contact with clothing, skin or eyes. Severe burns could result. Always wear safety goggles and protective clothing when servicing the battery. If battery fluid contacts the eyes and/or skin, immediately flush the affected area with a large amount of clean water and obtain prompt medical treatment.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Sever Hazard!

- Keep hands and other body parts away from moving/rotating parts such as the cooling fan, flywheel or PTO shaft.
- Wear tight-fitting clothing and keep your hair short or tie it back while the engine is running.
- Remove all jewelry before you operate or service the machine.
- Never start the engine in gear. Sudden movement of the engine and/or machine could cause death or serious personal injury.
- Never operate the engine without the guards in place.
- Before you start the engine make sure that all bystanders are clear of the area.
- Keep children and pets away while the engine is operating.
- Check before starting the engine that any tools or shop rags used during maintenance have been removed from the area.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Exhaust Hazard!

- Never operate the engine in an enclosed area such as a garage, tunnel, underground room, manhole or ship's hold without proper ventilation.
- Never block windows, vents, or other means of ventilation if the engine is operating in an enclosed area. All internal combustion engines create carbon monoxide gas during operation. Accumulation of this gas within an enclosure could cause illness or even death.
- Make sure that all connections are tightened to specifications after repair is made to the exhaust system.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Alcohol and Drug Hazard!

- Never operate the engine while you are under the influence of alcohol or drugs.
- Never operate the engine when you are feeling ill.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Exposure Hazard!

- Wear personal protective equipment such as gloves, work shoes, eye and hearing protection as required by the task at hand.
- Never wear jewelry, unbuttoned cuffs, ties or loose-fitting clothing when you are working near moving/rotating parts such as the cooling fan, flywheel or PTO shaft.
- Always tie back long hair when you are working near moving/rotating parts such as a cooling fan, flywheel, or PTO shaft.
- Never operate the engine while wearing a headset to listen to music or radio because it will be difficult to hear the alert signals.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Burn Hazard!

- Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.
- If you must drain the engine oil while it is still hot, stay clear of the hot engine oil to avoid being burned.
- Always wear eye protection.
- Keep your hands and other body parts away from hot engine surfaces such as the muffler, exhaust pipe, turbocharger (if equipped) and engine block during operation and shortly after you shut the engine down. These surfaces are extremely hot while the engine is operating and could seriously burn you.
- Failure to comply could result in death or serious injury.

⚠ WARNING

High-Pressure Hazard!

- Avoid skin contact with the high-pressure diesel fuel spray caused by a fuel system leak such as a broken fuel injection line. High-pressure fuel can penetrate your skin and result in serious injury. If you are exposed to high-pressure fuel spray, obtain prompt medical treatment.
- Never check for a fuel leak with your hands. Always use a piece of wood or cardboard. Have your authorized YANMAR industrial engine dealer or distributor repair the damage.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Shock Hazard!

- Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.
- Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. Always keep the connectors and terminals clean.
- Failure to comply could result in death or serious injury.

⚠ WARNING

Entanglement Hazard!

- Stop the engine before you begin to service it.
- Never leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it. This could result in a serious injury.
- If you must service the engine while it is operating, remove all jewelry, tie back long hair, and keep your hands, other body parts and clothing away from moving/rotating parts.
- Failure to comply could result in death or serious injury.

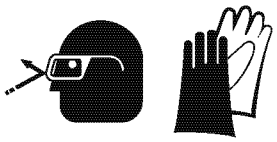
⚠ WARNING

Sudden Movement Hazard!

- Engaging the transmission or PTO at an elevated engine speed could result in unexpected movement of the equipment.
- Failure to comply could result in death or serious injury.

⚠ CAUTION

Coolant Hazard!

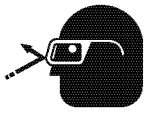


- **Wear eye protection and rubber gloves when you handle long life or extended life engine coolant. If contact with the eyes or skin should occur, flush eyes and wash immediately with clean water.**

- **Failure to comply may result in minor or moderate injury.**

⚠ CAUTION

Flying Object Hazard!



- **Always wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**

- **Failure to comply may result in minor or moderate injury.**

⚠ CAUTION

- **When using a 120 V system only, push the change-over switch to the right (120 V).**
- **The main switch should always be kept in the ON position during operation.**
- **Before starting the engine, always turn the switches on the working instruments (lighting apparatus, motor, etc.) to their OFF position. If the switches are not OFF, the sudden application of load when the engine is started could be very dangerous.**

NOTICE

Never attempt to adjust the low or high idle speed limit screw. This may impair the safety and performance of the machine and shorten its life. If adjustment is ever required, contact your authorized YANMAR industrial engine dealer or distributor.

NOTICE

If any problem is noted during the visual check, the necessary corrective action should be taken before you operate the engine.

NOTICE

- Only use diesel fuels recommended by YANMAR for the best engine performance, to prevent engine damage and to comply with EPA/ARB warranty requirements.
- Only use clean diesel fuel.
- Never remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.

NOTICE

Never hold the key in the START position for longer than 15 seconds or the starter motor will overheat.

NOTICE

Make sure the engine is installed on a level surface. If a continuously running engine is installed at an angle greater than (30°) in any direction or if an engine runs for short periods of time (less than three minutes) at an angle greater than (35°) in any direction, engine oil may enter the combustion chamber causing excessive engine speed and white exhaust smoke. This may cause serious engine damage.

NOTICE

Never attempt to adjust the low or high idle speed limit screw. This may impair the safety and performance of the machine and shorten its life. If the idle speed limit screws require adjustment, see your authorized YANMAR industrial engine dealer or distributor.

NOTICE

Observe the following environmental operating conditions to maintain engine performance and avoid premature engine wear:

- Avoid operating in extremely dusty conditions.
- Avoid operating in the presence of chemical gases or fumes.
- Avoid operating in a corrosive atmosphere such as salt water spray.
- Never install the engine in a floodplain unless proper precautions are taken to avoid being subject to a flood.
- Never expose the engine to the rain.

NOTICE

Observe the following environmental operating conditions to maintain engine performance and avoid premature engine wear:

- The standard range of ambient temperatures for the normal operation of YANMAR engines is from -15 °C (+5 °F) to +45 °C (+113 °F).
- If the ambient temperature exceeds +45 °C (+113 °F) the engine may overheat and cause the engine oil to break down.
- If the ambient temperature is below -15 °C (+5 °F) the engine will be hard to start and the engine oil may not flow easily.
- Contact your authorized YANMAR industrial engine dealer or distributor if the engine will be operated outside of this standard temperature range.

NOTICE

The illustrations and descriptions of optional equipment in this manual, such as the operator's console, are for a typical engine installation. Refer to the documentation supplied by the optional equipment manufacturer for specific operation and maintenance instructions.

NOTICE

If any indicator illuminates during engine operation, stop the engine immediately. Determine the cause and repair the problem before you continue to operate the engine.

NOTICE

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap/dipstick and the surrounding area before you remove the cap.
- Never mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- Never overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

NOTICE

Never use an engine starting aid such as ether. Engine damage will result.

NOTICE

- Only use the engine coolant specified. Other engine coolants may affect warranty coverage, cause an internal buildup of rust and scale and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine coolant. Carefully clean the radiator cap and the surrounding area before you remove the cap.
- Never mix different types of engine coolants. This may adversely affect the properties of the engine coolant.

NOTICE

- Never overfill the engine with engine oil.
- Always keep the oil level between the upper and lower lines on the oil cap/dipstick.

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

NOTICE

Never engage the starter motor while the engine is running. This may damage the starter motor pinion and/or ring gear.

NOTICE

- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

NOTICE

Precautions for handling desiccant

Disposal:

This material is disposable as non-flammable. however, the bag is flammable and if it is necessary, then tear the bag and discard the bag and the contents separately.
It is desirable to bury the contents in the bag under ground.
Dispose in accordance with the disposal standards for industrial waste defined by local laws and regulations.

Handling:

The contents of the bag do not leak out in the normal use.
Take the following emergency measures, however, if the contents leak out.

- If the contents get on the skin, rinse thoroughly with running water.
- If the contents get in the eyes, rinse thoroughly with water. Consult with doctors when any abnormalities are found.
- If the contents get in the mouth, rinse thoroughly with water. Drink water to dilute if the content is swallowed, though a small amount is harmless. Consult with doctors when any abnormalities are found.

Characteristics of materials:

• Calcium Chloride ($CaCl_2$)	Approx. 57 %
• Grain Polysaccharide	Approx. 28 %
• Grain Skins	Approx. 9 %
• Ethylene Polymer (Bag)	Approx. 5 %

Hazard information:

• Explosiveness	None
• Inflammability	Inflammable
• Combustibility	None
• Oxidation	None

NOTICE

Establish a periodic maintenance plan according to the engine application and make sure you perform the required periodic maintenance at intervals indicated. Failure to follow these guidelines will impair the engine's safety and performance characteristics, shorten the engine's life and may affect the warranty coverage on your engine. *See YANMAR limited warranty in the warranty section of this manual.*

Consult your authorized YANMAR industrial engine dealer or distributor for assistance when checking items marked with a ●.

NOTICE

New engine break-in:

- On the initial engine start-up, allow the engine to idle for approximately 15 minutes while you check for proper engine oil pressure, diesel fuel leaks, engine oil leaks, coolant leaks, and for proper operation of the indicators and/or gauges.
- During the first hour of operation, vary the engine speed and the load on the engine. Short periods of maximum engine speed and load are desirable. Avoid prolonged operation at minimum or maximum engine speeds and loads for the next four to five hours.
- During the break-in period, carefully observe the engine oil pressure and engine temperature.
- During the break-in period, check the engine oil and coolant levels frequently.

NOTICE

Protect the air cleaner, turbocharger (if equipped) and electric components from damage when you use steam or high-pressure water to clean the engine.

NOTICE

Never use high-pressure water or compressed air at greater than 28 PSI (193 kPa; 19686 mmAq) or a wire brush to clean the radiator fins. Radiator fins damage easily.

NOTICE

The tightening torque in the *Standard Torque Chart in the Periodic Maintenance Section of this manual* should be applied only to the bolts with a "7" head. (JIS strength classification: 7T)

- Apply 60 % torque to bolts that are not listed.
- Apply 80 % torque when tightened to aluminum alloy.

NOTICE

If any indicator fails to illuminate when the key switch is in the ON position, see your authorized YANMAR industrial engine dealer or distributor for service before operating the engine.

NOTICE

If no water drips when the fuel filter/water separator drain cock is opened, loosen the air vent screw on the top of the fuel filter/water separator by using a screwdriver to turn it counterclockwise 2 - 3 turns.

This may occur if the fuel filter/water separator is positioned higher than the fuel level in the fuel tank. After draining the fuel filter/water separator, be sure to tighten the air vent screw.

NOTICE

- When the engine is operated in dusty conditions, clean the air cleaner element more frequently.
- Never operate the engine with the air cleaner element(s) removed. This may allow foreign material to enter the engine and damage it.

NOTICE

The maximum air intake restriction, in terms of differential pressure measurement, must not exceed 0.90 PSI (6.23 kPa; 635 mmAq). Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

NOTICE

Make it a habit to perform daily checks. *See Daily Checks in the Before You Operate Section of this manual.*

Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

NOTICE

- Never attempt to modify the engine's design or safety features such as defeating the engine speed limit control or the diesel fuel injection quantity control.
- Modifications may impair the engine's safety and performance characteristics and shorten the engine's life. Any alterations to this engine may void its warranty. Be sure to use YANMAR genuine replacement parts.

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PRODUCT OVERVIEW

YANMAR TNV ENGINE FEATURES AND APPLICATIONS

YANMAR's series of TNV engines are environmentally friendly and are designed to:

- Lower the amount of exhaust gas emissions.
- Reduce engine noise and vibration.
- Be easy to start thanks to the specially designed fuel injection pump and combustion system.
- Be economical to run because diesel fuel and engine oil consumption are reduced.
- Be easy to operate due to the minimum amount of required maintenance and their compact design.
- Be durable and reliable due in part to the newly designed fuel injection valve and fuel injection pump.

YANMAR TNV engines are designed to supply power to a wide variety of driven machines including:

- Construction
- Agriculture
- Power generation

We are sure that you will agree these features provide excellent value in an industrial diesel engine.

These engines are designed to deliver power to driven machines by means of a "direct coupled drive" or "belt drive." In direct coupled drive engine applications, the engine's flywheel housing or end plate is coupled directly to the driven machine. In belt drive engine applications, a belt drive is used to power the driven machine. If you have applications that require a belt drive and/or front power take-off (PTO), please contact your authorized YANMAR industrial engine dealer or distributor.

The engine is designed for a wide range of applications. Options, such as fuel tank, control panel, indicators, gauges and alarms, are available to customize the application.

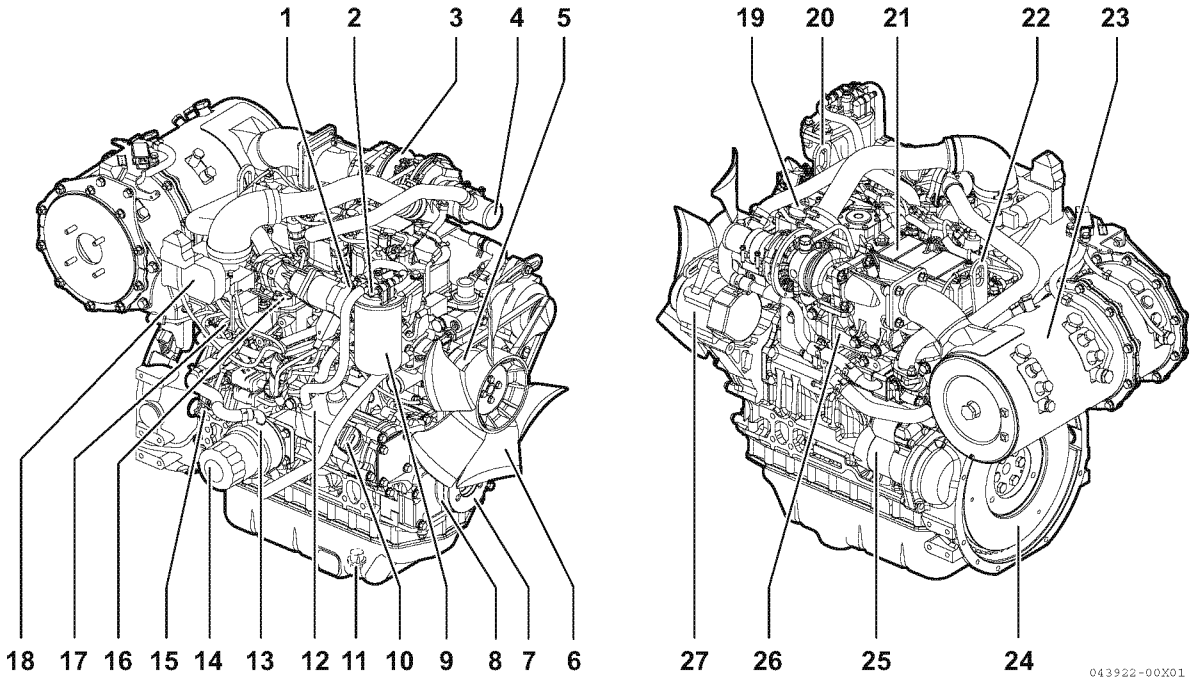
Since designing the application and installing the engine require special knowledge and skill, always consult your authorized YANMAR industrial engine dealer or distributor for these services. They will help you:

- Select optional equipment. Optional equipment should be selected to match the work conditions and environment.
- Maximize engine performance with a minimum amount of downtime and safety related incidents by carefully matching the characteristics of the engine with the driven machine.
- Plan for safe fuel piping, exhaust piping, electrical wiring, ventilation and accurate engine installation.
- Design your applications so they meet requirements of the local authorities.

COMPONENT IDENTIFICATION

■ 3TNV88C, 3TNV86CT, 4TNV88C, 4TNV86CT

Figure 1 shows where major common rail system engine components are located.



1 – Fuel inlet
2 – Fuel return to fuel tank
3 – Turbocharger*1
4 – Air intake port (from air cleaner)
5 – Engine coolant pump
6 – Engine cooling fan
7 – Crankshaft V-pulley
8 – V-belt
9 – Fuel filter
10 – Side filler port (engine oil)
11 – Drain plug (engine oil)*2
12 – Supply pump
13 – Engine oil cooler
14 – Engine oil filter
15 – Dipstick (engine oil)
16 – Intake manifold
17 – Common rail
18 – Intake throttle valve
19 – Top filler port (engine oil)
20 – Lifting eye (engine cooling fan end)
21 – Rocker arm cover
22 – Lifting eye (flywheel end)
23 – Diesel Particulate Filter
24 – Flywheel
25 – Starter motor
26 – Exhaust manifold
27 – Alternator

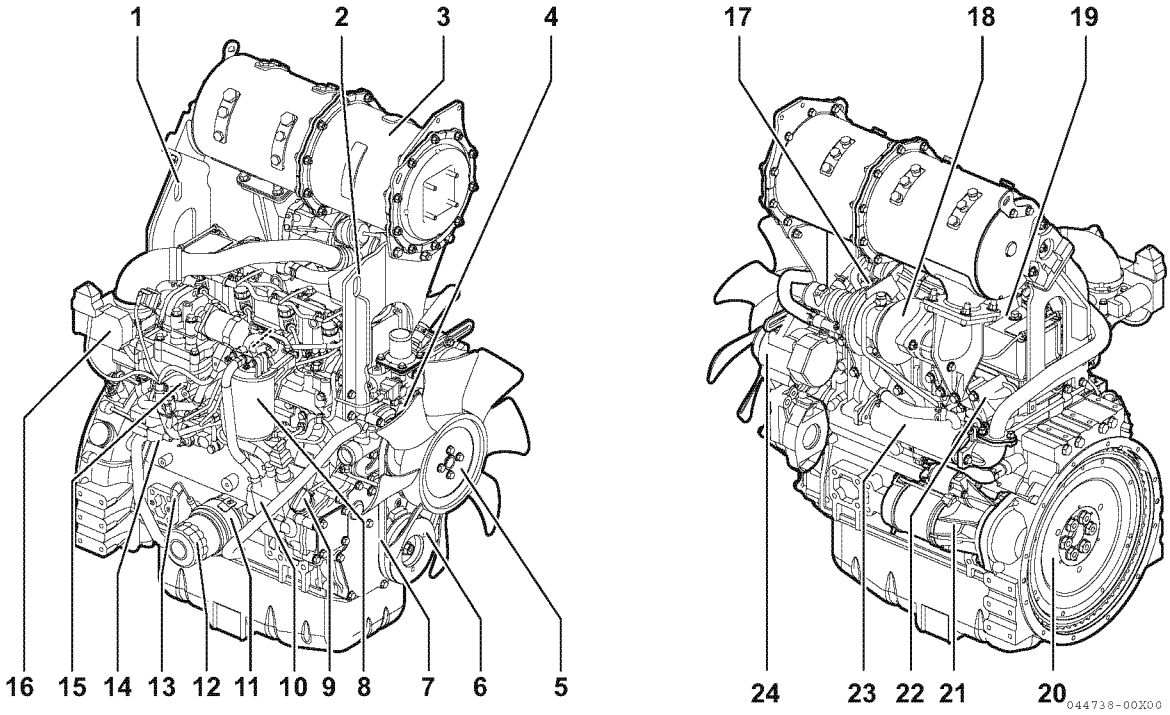
Figure 1

**1 Only applies to 3TNV86CT, 4TNV86CT.*

**2 Engine oil drain plug location may vary based on oil pan options.*

■ 4TNV98C, 4TNV98CT

Figure 2 shows where major common rail system engine components are located.



1 – Lifting eye (flywheel end)
2 – Lifting eye (engine cooling fan end)
3 – Diesel Particulate Filter
4 – Engine coolant pump
5 – Engine cooling fan
6 – Crankshaft V-pulley
7 – V-belt
8 – Fuel filter
9 – Side filler port (engine oil)
10 – Supply pump
11 – Engine oil cooler
12 – Engine oil filter
13 – Dipstick (engine oil)
14 – Drain plug (cooling water)
15 – Dipstick (engine oil)
16 – Intake throttle valve
17 – Top filler port (engine oil)
18 – Turbocharger*1
19 – Rocker arm cover
20 – Flywheel
21 – Starter motor
22 – Exhaust manifold
23 – EGR cooler
24 – Alternator

Figure 2

**1 Only applies to 4TNV98CT, 4TNV94CHT.*
**2 Engine oil drain plug location may vary based on oil pan options.*

LOCATION OF LABELS

Figure 3 shows the location of regulatory and safety labels on YANMAR TNV series engines.

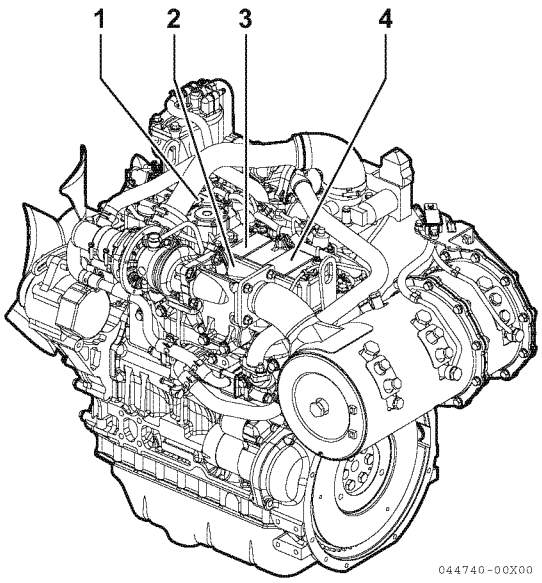
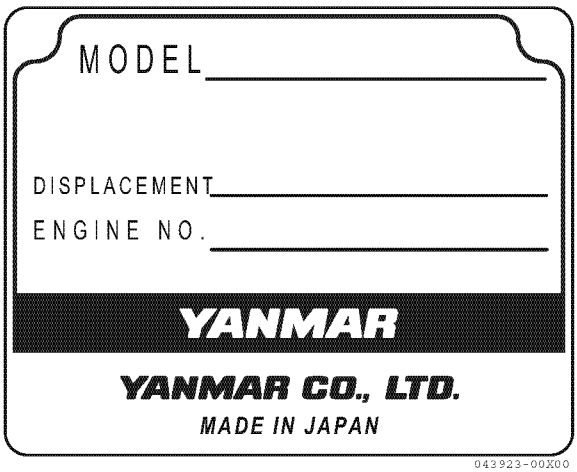


Figure 3

■ Location of labels/nameplates on direct injection model engines

Model	Engine nameplate	EPA/ARB certification label	97/68/EC emission control label
3TNV88C, 3TNV86CT	On the top of the locker arm cover (cooling fan end) **Figure 3, (1)**	On the top of the locker arm cover (flywheel end) **Figure 3, (4)**	On the exhaust side of the locker arm cover (near the flywheel) **Figure 3, (2)**
4TNV88C, 4TNV86CT	On the top of the locker arm cover (cooling fan end) **Figure 3, (1)**	On the top of the locker arm cover (flywheel end) **Figure 3, (4)**	On the top of the locker arm cover (center) **Figure 3, (3)**
4TNV98C, 4TNV98CT	On the top of the locker arm cover (flywheel end) **Figure 3, (4)**	On the top of the locker arm cover (center) **Figure 3, (3)**	On the top of the locker arm cover (fan end) **Figure 3, (1)**

■ Engine nameplate (typical)



EPA/ARB EMISSION CONTROL REGULATIONS - USA ONLY

YANMAR TNV engines meet Environmental Protection Agency (EPA) (U. S. Federal) emission control standards as well as the California Air Resources Board (ARB, California) regulations. Only engines that conform to ARB regulations can be sold in the State of California.

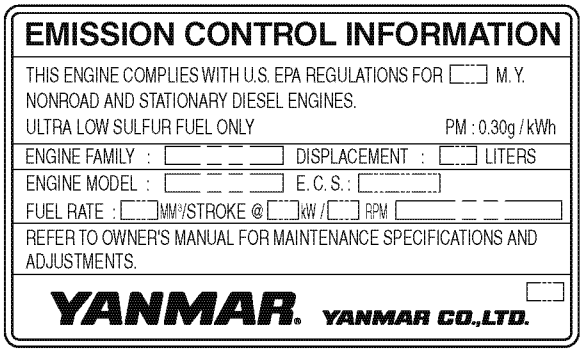
Refer to EPA/ARB Installation Requirements USA Only on page 57 and Required EPA/ARB Maintenance USA Only on page 57 in the Periodic Maintenance section of this manual. Also refer to the YANMAR Co., Ltd. Limited Emission Control System Warranty - USA Only on page iv.

EMISSION CONTROL LABELS

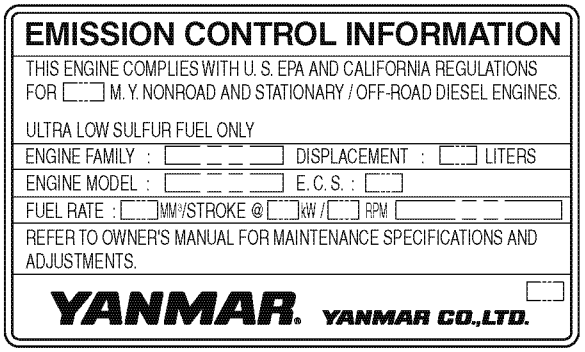
Since emission control regulations are being issued on a global basis, it is necessary to identify which regulations a particular engine complies with. We have listed several different types of labels you might find on your engine.

EPA/CARB Labels (Typical)

■ EPA



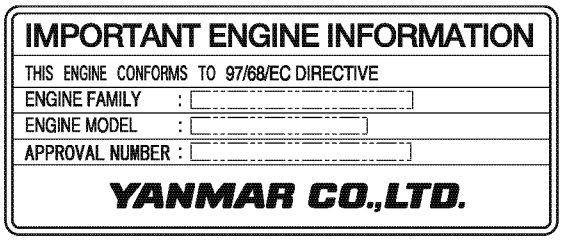
■ EPA & CARB



THE 97/68/EC DIRECTIVE CERTIFIED ENGINES

The engines described in this manual have been certified by the 97/68/EC Directive.

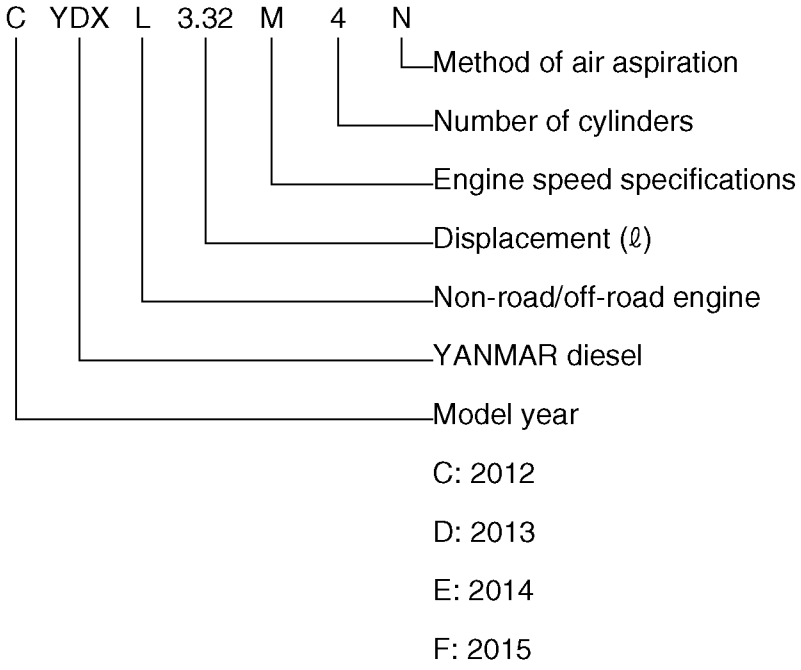
To identify the engines that meet this certification, the 97/68/EC emission control label is affixed on the engines.



(97/68/EC)

ENGINE FAMILY

The EPA/ARB labels and the 97/68/EC label all have an Engine Family field.
The following is an explanation of the Engine Family designation:



FUNCTION OF MAJOR ENGINE COMPONENTS

Components	Functions
Air cleaner	The air cleaner prevents airborne contaminants from entering the engine. Since the air cleaner is application specific, it must be carefully selected by an application engineer. It is not part of the basic engine package as shipped from the YANMAR factory. Periodic replacement of the air cleaner filter element is necessary. *See the Periodic Maintenance Schedule on page 58* for the replacement frequency.
Alternator	The alternator is driven by a V-belt which is powered by the crankshaft V-pulley. The alternator supplies electricity to the engine systems and charges the battery while the engine is running.
Dipstick (engine oil)	The engine oil dipstick is used to determine the amount of engine oil in the crankcase.
Electric fuel pump	The electric fuel pump makes sure there is a constant supply of diesel fuel to the fuel injection pump. The electric fuel pump is electro-magnetic and runs on 12 V DC. An electric fuel pump may be installed as an option or as standard equipment. Standard equipment may vary based on engine model and specification. If an electric fuel pump is installed, turn the key switch to the ON position for 10 to 15 seconds to prime the fuel system.
Engine oil filter	The engine oil filter removes contaminants and sediment from the engine oil. Periodic replacement of the engine oil filter is necessary. *See the Periodic Maintenance Schedule on page 58* for the replacement frequency.
Engine oil cooler (if equipped)	The engine oil cooler helps to keep the engine oil cool. Engine coolant from the cooling system is circulated by the coolant pump through an adapter at the base of the engine to the oil cooler and then to the cylinder block and back to the coolant pump.
Fuel filter	The fuel filter removes contaminants and sediments from the diesel fuel. Periodic replacement of the fuel filter is necessary. *See the Periodic Maintenance Schedule on page 58* for the replacement frequency. ***Please note that the word "diesel" is implied throughout this manual when the word "fuel" is used.***
Fuel filter/water separator	The fuel filter/water separator removes contaminants, sediment and water from diesel fuel going to the fuel filter. This is a required component of the fuel system and is standard equipment with every engine. The separator is installed between the fuel tank and the fuel pump. Periodically drain the water from the fuel filter/water separator using the drain cock at the bottom of the separator.
Fuel tank	The fuel tank is a reservoir that holds diesel fuel. When fuel leaves the fuel tank it goes to the fuel filter/water separator. Next, fuel is pumped to the fuel filter by the electric or mechanical fuel pump. Next the fuel goes to the fuel injection pump. Since fuel is used to keep the fuel injection pump cool and lubricated, more fuel than necessary enters the injection pump. When the injection pump pressure reaches a preset value, a relief valve allows excess fuel to be returned back to the fuel tank. The fuel tank is a required engine component.
Side and top filler port (engine oil)	You can fill the crankcase with engine oil from ***either the side or top filler port*** depending upon which one is most convenient.
Starter motor	The starter motor is powered by the battery. When you turn the key switch in the operator's console to the START position, the starter motor engages with the ring gear installed on the flywheel and starts the flywheel in motion.
Turbocharger (only applies to 3TNV86CT, 4TNV86CT, 4TNV98CT)	The turbocharger pressurizes the air coming into the engine. It is driven by a turbine that is energized by exhaust gases.

FUNCTION OF COOLING SYSTEM COMPONENTS

Components	Functions
Cooling system	The TNV engine is liquid-cooled by means of a cooling system. The cooling system consists of a radiator, radiator cap, engine cooling fan, engine coolant pump, thermostat, and reserve tank. ***Note that all cooling system components are required for proper engine operation. Since some of the components are application specific, they must be carefully selected by an application engineer. The application specific items are not part of the basic engine package as shipped from the YANMAR factory.***
• Engine cooling fan	The engine cooling fan is driven by a V-belt which is powered by the crankshaft V-pulley. The purpose of the engine cooling fan is to circulate air through the radiator.
• Engine coolant pump	The engine coolant pump circulates the engine coolant through the cylinder block and cylinder head and returns the engine coolant to the radiator.
• Radiator	The radiator acts as a heat exchanger. As the engine coolant circulates through the cylinder block it absorbs heat. The heat in the engine coolant is dissipated in the radiator. As the engine cooling fan circulates air through the radiator, the heat is transferred to the air.
• Radiator cap	The radiator cap controls the cooling system pressure. The cooling system is pressurized to raise the boiling point of the engine coolant. As the engine coolant temperature rises, the system pressure and the coolant volume increases. When the pressure reaches a preset value, the release valve in the radiator cap opens and the excess engine coolant flows into the reserve tank. As the engine coolant temperature is reduced, the system pressure and volume is reduced and the vacuum valve in the radiator cap opens allowing engine coolant to flow from the reserve tank back into the radiator.
• Reserve tank	The reserve tank contains the overflow of engine coolant from the radiator. If you need to add engine coolant to the system, add it to the reserve tank, not the radiator.
• Thermostat	A thermostat is placed in the cooling system to prevent engine coolant from circulating into the radiator until the engine coolant temperature reaches a preset temperature. When the engine is cold, no engine coolant flows through the radiator. Once the engine reaches its operating temperature the thermostat opens and allows engine coolant to flow through the radiator. By letting the engine warm up as quickly as possible, the thermostat reduces engine wear, deposits and emissions.

ELECTRONIC CONTROL SYSTEM

⚠ WARNING

- The TNV series engines use a high pressure common rail system.
- The fuel is injected at extremely high pressure.
- Never disassemble the fuel system parts.
- Failure to comply may result in death or serious injury.
- If a malfunction occurs, contact your nearest YANMAR dealer or distributor.

⚠ WARNING

- Never use the E-ECU for other purposes than intended or in other ways than specified by YANMAR. Doing so could result in the violation of emission control regulations and will void the product warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

⚠ WARNING

- Be sure to use the E-ECU in conjunction with the engines whose models or serial numbers are specified by YANMAR.
  Other E-ECU/engine combinations than specified will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

⚠ WARNING

- Replacing the fuel injector involves rewriting the fuel injection data in the E-ECU. Be sure to contact your local YANMAR dealer before replacing the fuel injector. Failure to rewrite the fuel injection data before replacing the fuel injector will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

⚠ WARNING

- Replacing the E-ECU involves migrating the fuel injection data to the existing E-ECU to the new unit. Be sure to contact your local YANMAR dealer before replacing the E-ECU. Failure to migrate the fuel injection data before replacing the E-ECU will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

NOTICE

Shut down the engine if the fault indicator comes on.

Continuing running the engine with the fault indicator being on may result in a serious malfunction of or damage to the engine, and will void the engine warranty.

NOTICE

Do not energize the starter for a period of longer than 15 seconds.

Take a pause of at least 30 seconds between energization of the starter.

Otherwise the starter could suffer damage.

NOTICE

- High-pressure washing not recommended.
- Avoid using high-pressure washing for electronic or electric devices installed in, on or around the engine, including the E-ECU, relays and harness couplers.

Otherwise such devices may suffer malfunction due to water ingress into them.

NOTICE

- Do not plug or unplug the E-ECU for a period of at least 6 seconds after power to the unit has been turned on or off.
- Do not touch connector pins of the E-ECU with bare hands.
  Doing so may result in corrosion of the connector pins and/or damage to the internal circuits of the E-ECU due to static electricity.
- Do not force a measuring probe into the female coupler.
  Doing so may cause contact failure of the connector pins, resulting in malfunction of the E-ECU.
- Take care to prevent water from entering the couplers when plugging or unplugging the connector.
  Water inside the couplers may cause corrosion, resulting in malfunction of the E-ECU.
- Take care to prevent water from entering the couplers when plugging or unplugging the connector. Water inside the couplers may cause corrosion, resulting in malfunction of the E-ECU.
- Avoid plugging/unplugging the connector more than approx. 10 times.
  Frequent plugging/unplugging of the connector may cause contact failure of the connector pins, resulting in malfunction of the E-ECU.
- Do not use the E-ECU that has ever suffered drop impact.

NOTICE

Always check the battery for proper charge.

Otherwise the electronically controlled engines may fail to start.

MAIN ELECTRONIC CONTROL COMPONENTS AND FEATURES

Component/feature	Description
Controller	By controlling the fuel injection timing, injection volume, injection pressure, and number of injection in accordance with the target speed indication entered from the accelerator sensor, the controller adjusts the engine speed and power. Depending on the above-mentioned speed and power, the controller controls the EGR opening. Also, the controller acts as the key station of the application function.
Fuel pump (supply pump)	The fuel pump supplies fuel to the common rail.
Common rail	The common rail stores the compressed high-pressure fuel from the supply pump and distributes fuel to the injector in each cylinder.
Fuel Injector	The Fuel Injectors the high-pressure fuel from the rail to the engine combustion room after receiving a signal from the ECU in the most appropriate injection timing, injection volume, injection ratio, number of injection and spray condition.
EGR valve	Controls the exhaust gas recirculation flow rate depending on the engine speed/load signals from the E-ECU. It is installed on the top of the exhaust manifold.
Diesel Particulate Filter (DPF)	The Diesel Particulate Filter (DPF) consists of the diesel oxidation catalyst (DOC) and the soot filter (SF). It is a device to prevent the discharge of particulate matter (PM) by breaking down the hazardous constituent with the DOC and collecting the PM in the exhaust gas with the SF.
Intake throttle valve	The intake throttle adjusts the amount of intake air in the engine and controls the exhaust temperature to assist the DPF regeneration.
Accelerator sensor	Unlike mechanical governors, the Eco-governor has no governor lever. The accelerator sensor serves as the governor lever to provide the speed command signal (voltage signal) to the E-ECU for engine speed control. It is installed in the operator cabin of the driven machine. Constant speed engines for e.g. generator use do not require accelerator sensors because the engine speed can be shifted via a switch on the operator's console.
Optional	CAN communication capability is available as an option.
Fault indicator	Is installed on the operator's console. If a fault occurs in the E-ECU or Eco-governor, the fault indicator flashes alerting the operator to a fault. The number of flashes and/or the flashing pattern vary depending on the type or source of the fault, enabling quick-fix.
Optional	

Component/feature		Description
Engine diagnosis tool		Allows the operator to troubleshoot the cause of a problem based on detailed information regarding the problem occurring in the E-ECU. This tool can also be used for data maintenance tasks including programming and mapping. *See Troubleshooting on page 79*
	Option for service	
Engine coolant temperature sensor		Allows the fuel injection volume and ERG to be controlled in engine cold-start conditions.
Glow plugs	Optional	When the key switch is turned to the ON position, the glow plugs/air heater are/is energized for up to 15 seconds (glow plugs). The duration of energization depends on the engine coolant temperature. The HEAT indicator is on during energization. When the indicator goes out, turn the key switch to the START position to start the engine.
Droop control	Standard with VM series	Reduces the engine speed by a certain percentage from no load to full (rated) load in steady state operation. The same percentage droop is maintained even when the load increases at any no-load speed.
Isochronous control	Standard with CL series Optional with VM series	Offers a constant engine speed from no load to full load. The engine speed does not decrease even when the load increases at any no-load speed.
Low-idling speed up		Increases the low-idling speed to up to 1000 min^{-1} (rpm) depending on the engine coolant temperature. When the coolant temperature reaches a predetermined value, this feature returns the engine speed to the normal low idle setting, thus reducing the warm-up time.
High-idling speed down	Optional	Decreases the high-idling speed depending on the engine coolant temperature. When the coolant temperature falls to a predetermined value, this feature returns the engine speed to the normal high idle setting, thus minimizing the emission of white smoke at low temperatures.
Auto deceleration	Optional	Brings the running engine in low idle mode automatically when the accelerator pedal is not operated for a predetermined period of time. When the pedal is operated, i.e., the accelerator sensor is activated, the low idle mode is cancelled.

All of engines come with the Exhaust Gas Recirculation (EGR) system to conform to the engine emission regulations (EPA 2012 and 2013 rules).
The EGR system and common rail fuel injection system constitute an electronic engine control system.

The electronic engine control system regulates the exhaust gas recirculation flow rate and the fuel injection volume depending on the engine load and speed signals from the engine controller (E-ECU), so that the exhaust gas is kept clean according to the emission control regulations. **Figure 4** illustrates the electronic engine control system.

Features of the electronic engine control system include:

- Engine speed control schemes
  Droop control/Low-idling speed up/Auto deceleration/High-idling speed down/Black smoke suppression
- Starting aid
  Auto preheating/After heating
- Engine failure detection
- CAN communication with the control system of the driven machine
- Diesel Particulate Filter (DPF) regeneration control

The above features are detailed in the table on the next pages.

Consult the operation manual for the driven machine for applicability of the features that depends on the machine.

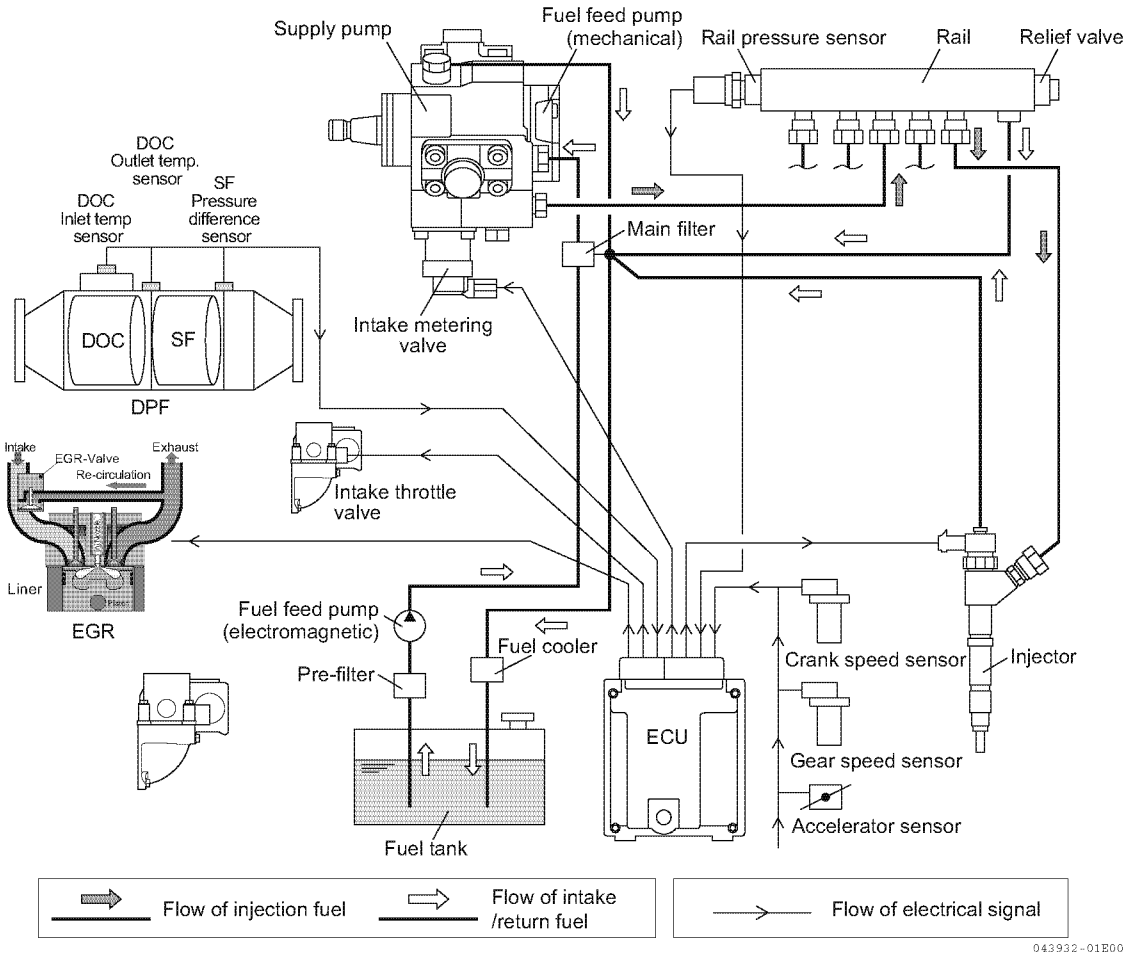


Figure 4

GAUGES AND INDICATORS

The operator's console provides you with the means to start and stop the unit and a series of gauges and indicators that inform you about the current status of the engine. This is a required engine component. Since the operator's console is application specific, it must be carefully selected by an application engineer. It is not part of the basic engine package as shipped from the YANMAR factory.

NOTICE

The illustrations and descriptions of optional equipment in this manual, such as the operator's console, are for a typical engine installation. Refer to the documentation supplied by the optional equipment manufacturer for specific operation and maintenance instructions.

Gauges

The following gauges are located on a typical operator's console. Some operator's consoles may not have the gauges described here or may have different gauges.

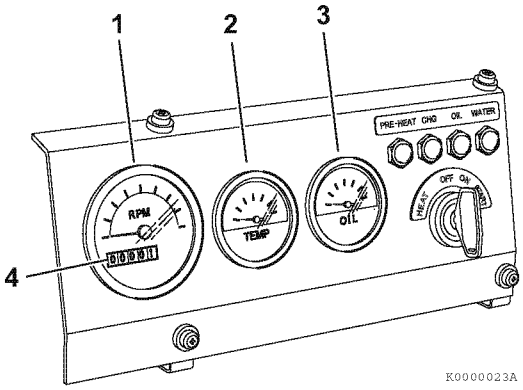


Figure 5

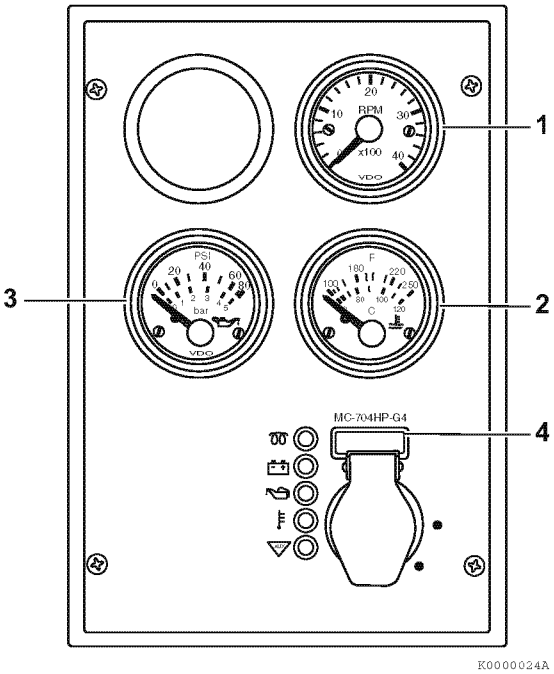


Figure 6

Tachometer - The tachometer display **(Figure 5, (1))** or **(Figure 6, (1))** shows the engine speed in revolutions per minute (RPM).

Engine coolant temperature - The engine coolant temperature display **(Figure 5, (2))** or **(Figure 6, (2))** shows the temperature of the engine coolant.

Engine oil pressure - The engine oil pressure display **(Figure 5, (3))** or **(Figure 6, (3))** shows the pressure of the engine oil.

Hour meter - The hour meter display **(Figure 5, (4))** or **(Figure 6, (4))** shows the total number of hours the engine has run. This is useful for planning the *Periodic Maintenance Procedures on page 60.*

Indicators

The following indicators are located on a typical operator's console.

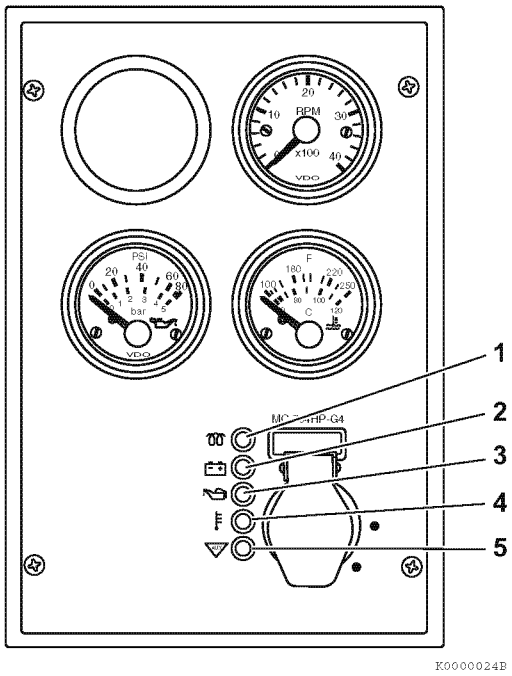


Figure 7

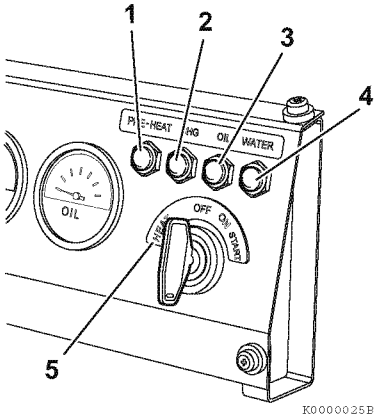


Figure 8

HEAT indicator (Figure 7, (1)) - The pre-heat function is automatically activated when the key switch is turned to the ON position. The indicator flashes for several seconds (4 sec.) and when it goes out you can turn the key switch to START.

Some electronically controlled engines have the optional capability of controlling the glow plug/air heater energization time via the key switch. For details, consult the operation manual for the driven machine.

HEAT indicator (Figure 8, (1)) - Note that on this type of panel you must turn the key to the HEAT position **(Figure 8, (5))** to activate the inlet air heater or glow plugs. The indicator will flash for several seconds (4 sec.) when you turn the key to HEAT and when it goes out, you can turn the key switch to START.

Battery charge (Figure 7, (2)) or **(Figure 8, (2))** - This indicator will come on if there is a problem in the charging system. This indicator does not indicate if the battery is discharged. *See Troubleshooting Chart on page 80.*

Engine oil pressure (Figure 7, (3)) or **(Figure 8, (3))** - This indicator will come on if the engine oil pressure is below or exceeds normal limits. *See Troubleshooting Chart on page 80.*

Engine coolant temperature (Figure 7, (4)) or **(Figure 8, (4))** - This indicator will come on if the engine coolant temperature exceeds normal limits. *See Troubleshooting Chart on page 80.*

Auxiliary (Figure 7, (5)) - Used for special applications.

GAUGES AND INDICATORS

Gauges

The following gauges are located on a typical operator's console. Some operator's consoles may not have the gauges described here or may have different gauges.

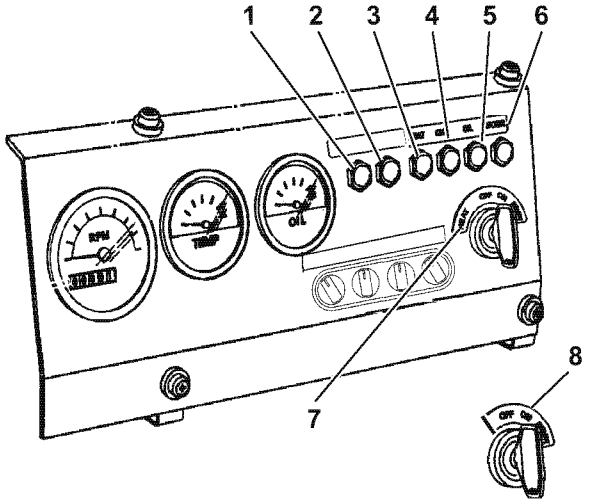
NOTICE

The illustrations and descriptions of optional equipment in this manual, such as the operator's console, are for a typical engine installation. Refer to the documentation supplied by the optional equipment manufacturer for specific operation and maintenance instructions.

Indicators

The following indicators are located on a typical operator's console.

See the Gauges and Indicators section for description of indicators that are not described below.



Optional key switch: Turning it to ON energizes the glow plugs automatically.

Figure 9

Figure 9 Typical operator's console

Fault (Figure 9, (1)) (optional) - This indicator will flash if a fault occurs in the E-ECU. The number of flashes and/or the flashing pattern vary depending on the type or source of the fault. *See Troubleshooting Chart on page 80.*

Auxiliary (Figure 9, (2)) - Reserved as an optional fault indicator.

HEAT (Figure 9, (3)) - This indicator will come on when the key switch is turned to the HEAT position **(Figure 9, (7))** and stay on as long as the glow plugs are/is energized (15 sec. for models with glow plugs) during engine cold start. When the indicator goes out, you can turn the key switch to START.

Turning the optional key switch **(Figure 9, (8))** to ON allows you to energize the glow plugs for up to 15 sec. depending on the engine coolant temperature.

When an optional after heater is installed, it is energized for up to 80 sec. after the engine has started, during which, however, the indicator is not on.

Others (optional) - Other optional indicators including those for indicating the air cleaner is clogged or the water separator is filled with water can also be installed on the console. See the operation manual for the driven machine for details.

Machine events including alarms and faults are all stored in memory of the E-ECU and can be loaded into the service tool.

CONTROLS

Key Switch

The key switch for the operator's console illustrated in **Figure 10** has three positions - OFF, ON and START.

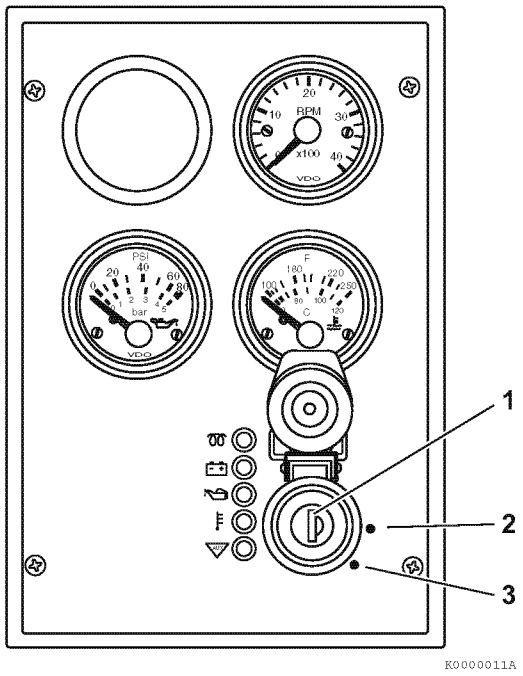


Figure 10

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

OFF (key straight up and down) **(Figure 10, (1))** and **(Figure 11, (1))** - When you turn the key to this position the engine shuts down. Electric current to the gauges and indicators is shut off. You can insert and remove the key in this position.

ON (Figure 10, (2)) and **(Figure 11, (2))** - This is the position the key will be in when the engine is running. When the engine is not running, use this position to energize the gauges, indicators, electric fuel pump and auxiliary devices.

NOTICE

Never hold the key in the START position for longer than 15 seconds or the starter motor will overheat.

START (Figure 10, (3)) and **(Figure 11, (3))** - Turn the key to this position to start the engine. As soon as the engine starts, release the key and it will automatically return to the ON position. Some key switches may be equipped with a feature that prevents you from turning the key to the START position while the engine is running. When operating a key switch with this feature, you cannot turn the key to the START position without first returning the key to the OFF position.

The key switch for the operator's console illustrated in **Figure 11** has four positions - OFF, ON, START, and HEAT.

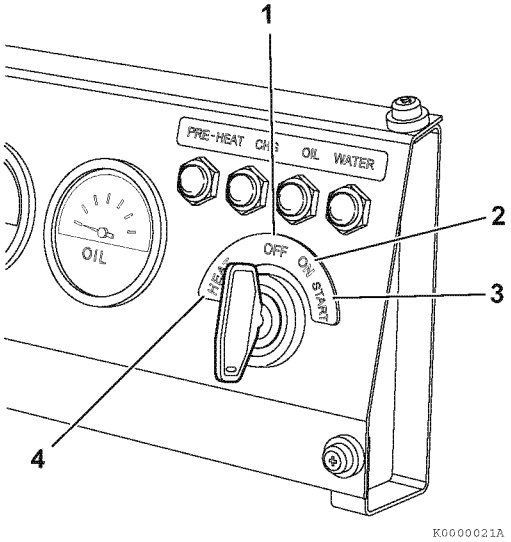


Figure 11

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

NOTICE

Never hold the key in the START position for longer than 15 seconds or the starter motor will overheat.

HEAT (Figure 11, (4)) - You must turn the key to the HEAT position to activate the inlet air heater. The indicator will flash for several seconds when you turn the key to HEAT. You can turn the key to START when the indicator goes out.

Glow Plugs

Glow plugs help make the engine easy to start at cold temperatures. During the engine starting sequence, the glow plugs are activated for approximately 4 seconds. After the pre-heat indicator goes out, the engine can be started.

These plugs are installed in the combustion chambers.

Speed Control

The electronically controlled engines have no governor lever. For these engines, the position signal of the throttle lever or accelerator pedal of the driven machine is converted into an electric signal by the accelerator sensor **Figure 12**, which is then delivered to the fuel injector through the E-ECU **Figure 13**, allowing the engine speed to be controlled.

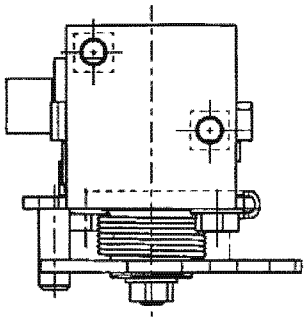


Figure 12

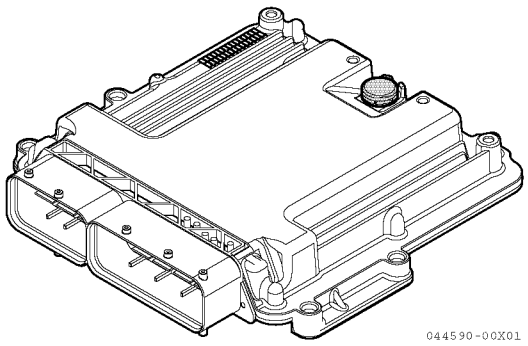


Figure 13

Electronic Engine Speed Control

■ Engine speed curves

Figure 14 shows typical engine speed curves that outline the relationship between engine speed and load.

Droop control

The VM series engines for general use are designed so that the engine speed is reduced by a certain percentage from 30 % load to full rated load. See curves (1) in **Figure 14** below. The same percentage droop is maintained at any no-load speed.

Isochronous control

The CL series consists of isochronous design engines, the speed of which is kept constant from no load to full rated load. See curves (2) in **Figure 14** below.

Some VM series engines for general use may be custom-engineered and have the isochronous capability. Consult the operation manual for the driven machine for application details of such engines.

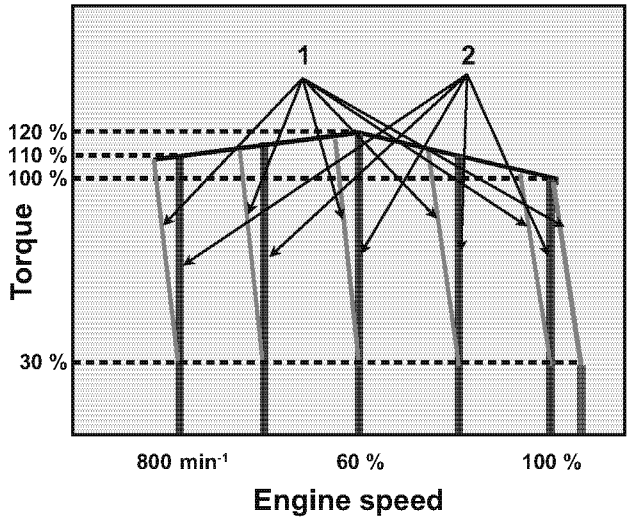


Figure 14

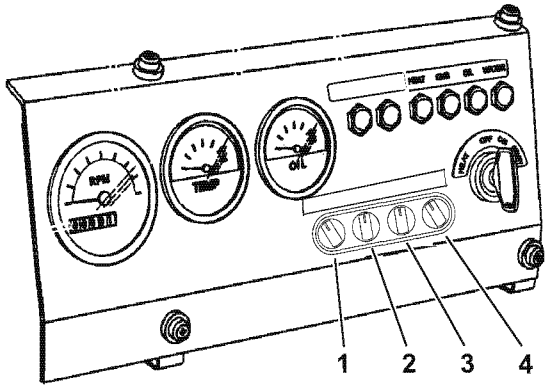


Figure 15

Figure 15 Typical operator's console and switch arrangement

Low-idling speed up

This feature increases the low-idling speed to some extent depending on the engine coolant temperature. When the coolant temperature reaches a predetermined value, this feature returns the engine speed to the normal low idle setting, thus reducing the warm-up time.

Auto deceleration (optional)

This feature brings the running engine in low idle mode automatically when the accelerator pedal is not operated for a predetermined period of time. When the pedal is operated, i.e., the accelerator sensor is activated, the low idle mode is cancelled.

A certain ON/OFF combination of switches (1) - (4) on the operator's console **Figure 15** will implement this optional feature. For details, see the operation manual for the driven machine.

High-idling speed down (optional)

This feature decreases the high-idling speed depending on the engine coolant temperature. When the coolant temperature falls to a predetermined value, this feature returns the engine speed to the normal high idle setting, thus minimizing the emission of white smoke at low temperatures.

A certain ON/OFF combination of switches (1) - (4) on the operator's console **Figure 15** will implement this optional feature. For details, see the operation manual for the driven machine.

Others

Other optional features can be provided by selecting certain ON/OFF combinations of switches (1) - (4) on the operator's console **Figure 15** will implement this optional feature. For details, see the operation manual for the driven machine.

Diesel Particulate Filter (DPF)

The DPF consists of the diesel oxidation catalyst (DOC) and the SF, held by a case that sends the exhaust gas to the DOC and the SF. The role of the DPF is to prevent the discharge of PM by breaking down the hazardous constituents with the DOC and collecting the PM with the SF. The PM clogs the SF if left there and the engine performance decreases, so a means of regeneration is required. YANMAR engines use a continuous regeneration method. While continuing the operation, the DPF collects the PM and is regenerated at the same time. To perform the regeneration, the PM collected in the SF is combusted with NO_2 generated in the DOC and O_2 in the exhaust gas. At the same time, the DOC purifies the exhaust gas elements such as HC and CO into H_2O and CO_2.

Apart from the PM, ash also collects in the SF. This comes mostly from metallic components in the additives to the lubricating oil. Part of the lubricating oil is burnt in the high temperature combustion chamber and exhausted along with the combustion gas. In that case, metallic components are collected together with the PM in the SF. However, because the amount of ash is very little compared to the PM, it does not clog the SF immediately. Because ash is a metallic component, it cannot be combusted in the DPF for treatment like the PM. Therefore, ash is over-accumulated in the SF over a long period of time. This increases the pressure loss and has adverse effects on the engine. In this case, maintenance must be performed to remove the SF with the accumulated ash from the DPF. Yanmar recommends to do this maintenance once every 3,000 operating hours.

Be sure to use the specified fuel and lubricating oil so that the DPF can fulfill its function. For fuel, use diesel fuel (ultra-low sulfur) with a sulfur mass of 15 ppm or lower. If you use a fuel other than the specified, performance of the catalyst contained in the DOC deteriorates rapidly due to sulfur. Because of this, the DPF cannot develop its regeneration capabilities and PM accumulates easier. This leads to increased fuel consumption and a deterioration of general engine receptiveness caused by decreased engine performance and frequent switching to the regeneration mode.

For lubricating oil, use low ash oil. If you use any other than the specified lubricating oil, a large amount of ash is vented through the exhaust and the DPF will clog within a short period of time. This will not only cause the engine output to decrease and the fuel costs to increase, but also makes earlier maintenance of the SF necessary.

■ Overview of DPF regeneration control

Electrical components such as the DPF differential pressure sensor, temperature sensor, and intake throttle are installed in the DPF. If the DPF cannot perform continuous regeneration due to low load operation, the ECU uses these electrical components to control assisted DPF regeneration (DPF regeneration control) automatically to prevent PM from over-accumulating.

■ Self-regeneration

Regeneration without the use of regeneration assistance devices (normal)

During the operation at high speed or high load, the exhaust temperature rises and PM is continuously combusted and eliminated.

■ Assisted regeneration

Regeneration with the use of assistance devices (e.g. the intake throttle)

When the differential pressure in the SF inlet/outlet in the DPF rises, the differential pressure sensor installed to the DPF detects the increase. The ECU commands the intake throttle to open the throttle according to the detected differential pressure to adjust the amount of engine intake air. The ECU also controls the regeneration by performing after-injection to increase the exhaust temperature. At this time, the EGR valve is closed.

■ Reset regeneration

Regeneration with the combined use of assisted regeneration and post-injection

Approximately every 100 hours of operation, the assisted regeneration and post-injection are automatically used together to control regeneration by increasing the exhaust temperature to burn off and remove PM.

These automatic regenerations can be performed during operation. No special operation is required for the operator. The following conditions may occur due to the characteristics of the DPF system, but they are not malfunctions.

- The engine sound may change during the idling operation at no load.
- White smoke may be discharged from the exhaust pipe right after starting a cold engine or during acceleration.
  This is due to discharge of water vapor. When the exhaust temperature increases, the white smoke disappears.
- The exhaust gas is purified through the catalyst installed in the DPF, so the smell of the exhaust gas is different from the exhaust gas of a conventional diesel engine.

⚠ CAUTION

- **During reset regeneration, post-injection is used and fuel is burned directly inside the DPF (burned by chemical reaction inside the DOC). Through this heat, regeneration occurs inside the SF, but the combustion increases the temperature of the exhaust gas to close to 600 °C (1112 °F). Be careful that neither people nor flammable materials are near the exhaust gas outlet.**
- **Post-injection can cause the fuel consumption to increase by a small amount.**
- **Through this genuine YANMAR regeneration method, the dilution of the lubricating oil with fuel caused by the post-injection is kept to a minimum, but some dilution is possible for low-load operation (low temperature exhaust gas) of fork lifters or similar machines. Make sure that you do a daily check of the oil level.**

■ Stationary regeneration

Although the DPF performs the regeneration control, if the operation conditions with idling at no load and low speed/low load operation are frequently repeated, the PM may not be regenerated. If the ECU determines that performing the stationary regeneration is required at this time, the DPF regeneration request lamp lights up.

If the DPF regeneration request lamp is lit, immediately conduct the stationary regeneration by performing the following operation.

If the operation is continued with the DPF regeneration request lamp lit up, an excessive amount of PM will accumulate. Abnormal combustion of PM may cause fire and damage to the DPF.

Operation procedures of stationary regeneration

1. Move to a well-ventilated and safe location.
2. Move the accelerator lever to the lowest position and operate the engine in idling.

   Note: If the DPF regeneration prohibition switch is installed, turn the DPF regeneration prohibition switch to "Regeneration Permitted".

3. Operate the interlock mechanism including the parking brake and activate the interlock function.

   Note: When the ECU verifies that the interlock mechanism is enabled with the regeneration interlock switch, the DPF regeneration approval lamp starts blinking.

4. Press the DPF regeneration request switch for 1 second or longer to start the stationary regeneration.
   - When the stationary regeneration starts, the engine speed increases gradually to high idle speed. Then the reset regeneration is performed at that operation condition.
   - When the stationary regeneration starts, the DPF regeneration request lamp turns off, the DPF regeneration approval lamp switches from blinking to continuously lit, and the exhaust temperature warning lamp lights up.
   - The stationary regeneration is complete after approximately 25 to 30 minutes.
   - If you want to interrupt the stationary regeneration, perform one of the following operations.
     - Turn the interlock switch to "Regeneration Disabled".
     - Turn the DPF regeneration prohibition switch to "Regeneration Prohibited".
     - Raise the accelerator lever above the lowest position.
     - Turn off the power switch.
5. When the above-mentioned time has elapsed, the engine speed decreases to low idling, the regeneration approval lamp and the exhaust temperature warning lamp turn off, and the stationary regeneration is complete.

■ Outline of Diesel Particulate Filter (DPF)

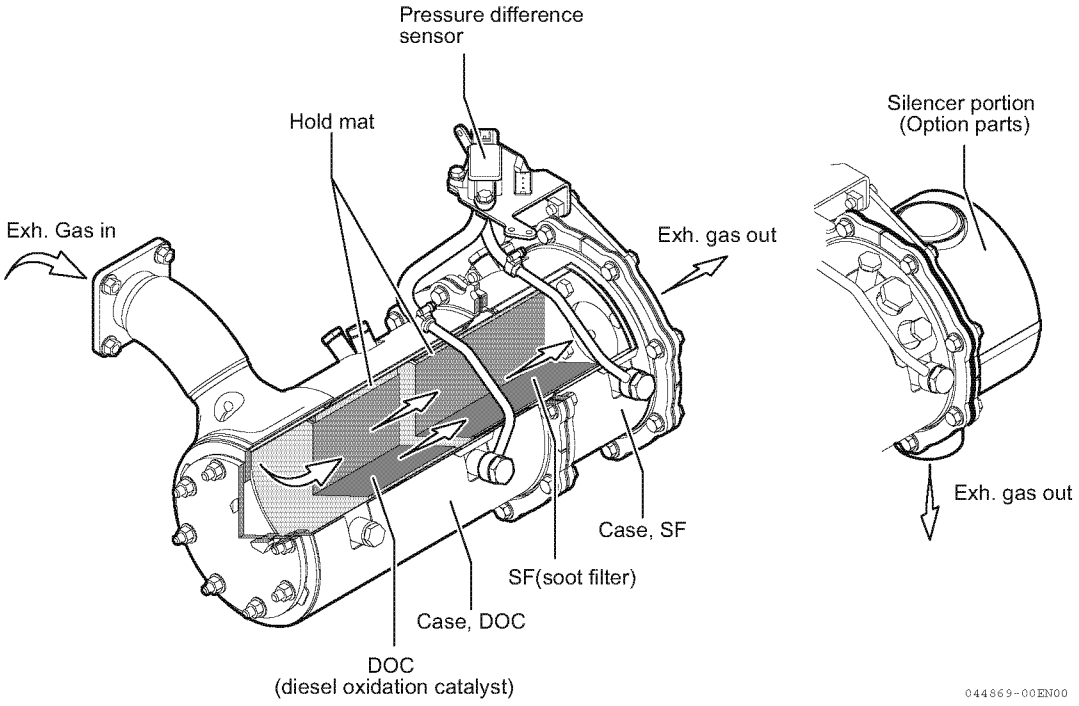


Figure 16

■ DPF service

DOC: Maintenance-free parts
Replacement only, every 9000 hrs of operation

SF: Maintenance is required parts
Perform the cleaning every 3000 hrs of operation

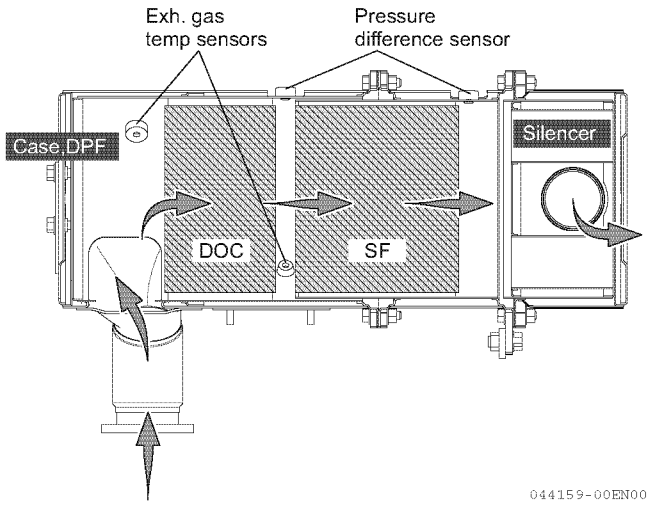


Figure 17

Item	Engine type	Emission warranty (Useful life)	Periodic maintenance interval	
			Replacement	Clean
DOC	19 - 37 kW	5000 hrs or 7 years, whichever comes first.	Every 9000 hrs of operation	N/A
	≥ 37 kW	8000 hrs or 10 years, whichever comes first		
SF	19 - 37 kW	5000 hrs or 7 years, whichever comes first	Every 9000 hrs of operation	Every 3000 hrs of operation
	≥ 37 kW	8000 hrs or 10 years, whichever comes first		

Intake Throttle

The intake throttle is a device that controls the amount of the engine air intake. The TNV series engines use it for the combustion of soot collected inside the DPF. The intake throttle is driven by the DC motor. The ECU controls the appropriate degree of opening of the throttle depending on the engine speed and load conditions. Accordingly, the engine takes in the minimum required amount of air to increase the exhaust temperature and burn soot inside the DPF.

Precautions for handling the intake throttle

- Do not use a throttle after you have dropped it. Even if it appears okay on the outside, it may have internal damage.
- Do not apply excessive impact or load to the throttle.
- Do not touch the stop screw part, as it has already been adjusted.
- Prevent any foreign matter including oil, dust, and water droplets from entering the air passage part.
- Do not remove the sensor cover installation rivet.
- Consider static electricity and prevent static electric charge of the human body when handling the throttle.
- Do not touch the sensor cover terminal directly.
- Do not touch the throttle valve with your hands when the throttle is energized.
  Your hands may get pinched in the valve and get injured.
- Do not check operation with the installation surface of the throttle unit pointing down, as the valve protrudes from the installation surface.
- Prevent water and foreign matter from entering the connector connection part.

Installation Position of Sensors

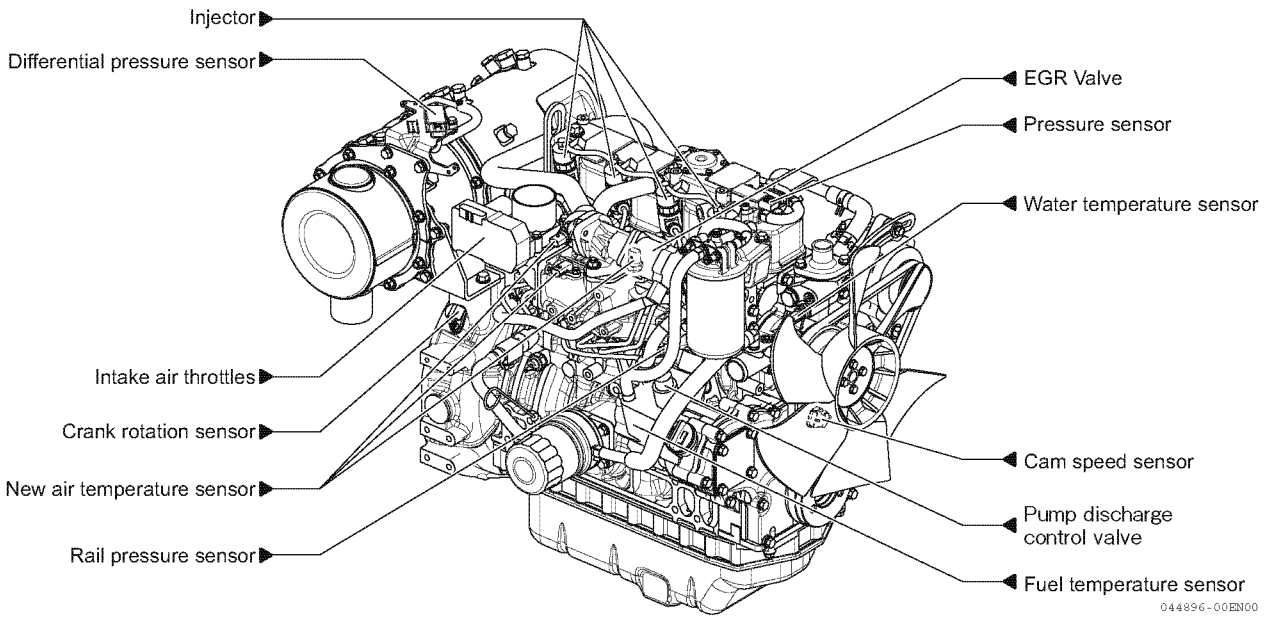


Figure 18

BEFORE YOU OPERATE

This section of the Operation Manual describes the diesel fuel, engine oil, and engine coolant specifications and how to replenish them. It also describes the daily engine checkout.

DIESEL FUEL

Diesel Fuel Specifications

Diesel fuel should comply with the following specifications. The table lists several worldwide specifications for diesel fuels.

Diesel fuel specification	Location
ASTM D975 No. 1D S15 No. 2D S15	USA
EN590:96	European Union
ISO 8217 DMX	International
BS 2869-A1 or A2	United Kingdom
JIS K2204 Grade No. 2	Japan
KSM-2610	Korea
GB252	China

■ Additional technical fuel requirements

- The fuel cetane number should be equal to 45 or higher.
- The sulfur content must not exceed 15 ppm by volume. A higher sulfur content fuel may cause sulfuric acid corrosion in the cylinders of the engines. Especially in U.S.A. and Canada, Ultra Low Sulfur fuel must be used.
- Bio-diesel fuels. *See Bio-diesel fuels on page 39.*
- Never mix kerosene, used engine oil, or residual fuels with the diesel fuel.
- Water and sediment in the fuel should not exceed 0.05 % by volume.
- Keep the fuel tank and fuel-handling equipment clean at all times.
- Poor quality fuel can reduce engine performance and/or cause engine damage.
- Fuel additives are not recommended. Some fuel additives may cause poor engine performance. Consult your YANMAR representative for more information.
- Ash content not to exceed 0.01 % by volume.
- Carbon residue content not to exceed 0.35 % by volume. Less than 0.1 % is preferred.
- Total aromatics content should not exceed 35 % by volume. Less than 30 % is preferred.
- PAH (Polycyclic Aromatic Hydrocarbons) content should be below 10 % by volume.
- Metal content of Na, Mg, Si, and Al should be equal to or lower than 1 mass ppm. (Test analysis method JPI-5S-44-95)
- Lubricity: Wear mark of WS1.4 should be Max. 0.018 in. (460 µm) at HFRR test.

■ Bio-diesel fuels

In Europe and in the United States, as well as some other countries, non-mineral oil based fuel resources such as RME (Rapeseed Methyl Ester) and SOME (Soybean Methyl Ester), collectively known as FAME (Fatty Acid Methyl Esters), are being used as extenders for mineral oil derived diesel fuels.

YANMAR approves the use of bio-diesel fuels that do not exceed a blend of 7 % (by volume) of FAME with 93 % (by volume) of approved mineral oil derived diesel fuel. Such bio-diesel fuels are known in the marketplace as B5 diesel fuels.

These B7 diesel fuels must meet certain requirements.

1. The bio-fuels must meet the minimum specifications for the country in which they are used.
   - In Europe, bio-diesel fuels must comply with the European Standard for both EN14214 and EN590 (for Oxidation stability).
   - In the United States, bio-diesel fuels must comply with the American Standard for both ASTM D-6751 and ASTM D-7467 (for Oxidation stability).
2. Bio-fuels should be purchased only from recognized and authorized diesel fuel suppliers.

Precautions and concerns regarding the use of bio-fuels:

1. Free methanol in FAME may result in corrosion of aluminum and zinc FIE components.
2. Free water in FAME may result in plugging of fuel filters and increased bacterial growth.
3. High viscosity at low temperatures may result in fuel delivery problems, supply pump seizures, and poor injection nozzle spray atomization.
4. FAME may have adverse effects on some elastomers (seal materials) and may result in fuel leakage and dilution of the engine lubricating oil.
5. Even bio-diesel fuels that comply with a suitable standard as delivered, will require additional care and attention to maintain the quality of the fuel in the equipment or other fuel tanks. It is important to maintain a supply of clean, fresh fuel. Regular flushing of the fuel system, and/or fuel storage containers, may be necessary.
6. Use bio diesel fuel within 2 months after filling it to the fuel tank, or within 3 months after its production at the manufacturer.
   The use of bio-diesel fuels that do not comply with the standards as agreed to by the diesel engine manufacturers and the diesel fuel injection equipment manufacturers, or biodiesel fuels that have degraded as per the precautions and concerns above, may affect the warranty coverage of your engine. *YANMAR Limited Warranty on page i.*

Filling the Fuel Tank

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**

- **Only fill the fuel tank with diesel fuel. Filling the fuel tank with gasoline may result in a fire and will damage the engine.**
- **Never refuel with the engine running.**
- **Wipe up all spills immediately.**
- **Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) well away when refueling.**
- **Never overfill the fuel tank.**
- **Fill the fuel tank. Store any containers containing fuel in a well-ventilated area, away from any combustibles or sources of ignition.**
- **Be sure to place the diesel fuel container on the ground when transferring the diesel fuel from the pump to the container. Hold the hose nozzle firmly against the side of the container while filling it. This prevents static electricity buildup which could cause sparks and ignite fuel vapors.**
- **Never place diesel fuel or other flammable material such as oil, hay or dried grass close to the engine during engine operation or shortly after shutdown.**
- **Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of engine operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of engine operation, whichever comes first.**
- **Failure to comply will result in death or serious injury.**

NOTICE

- Only use diesel fuels recommended by YANMAR for the best engine performance, to prevent engine damage and to comply with EPA/ARB warranty requirements.
- Only use clean diesel fuel.
- Never remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.

Note that a typical fuel tank is shown. The fuel tank on your equipment may be different.

1. Clean the area around the fuel cap **(Figure 1, (1))**.
2. Remove the fuel cap from the fuel tank **(Figure 1, (2))**.
3. Observe the fuel level sight gauge **(Figure 1, (3))** and stop filling when gauge shows fuel tank is full. Never overfill the fuel tank.
4. Replace the fuel cap **(Figure 1, (1))**, hand tighten. Over tightening the fuel cap will damage it.

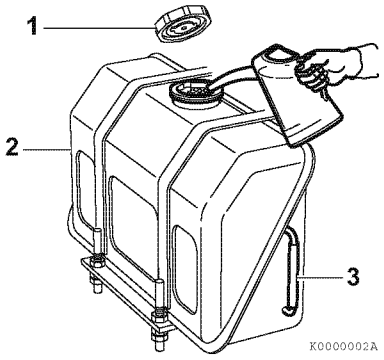


Figure 1

NOTICE

Check the fuel level gauge in the fuel tank daily and ensure that the engine does not run out of fuel.Seizure to the supply pump may occur.

Priming the Fuel System

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**

- **If the unit has an electric fuel pump, when you prime the fuel system, turn the key switch to the ON position for 10 to 15 seconds to allow the electric fuel pump to prime the system.**
- **Failure to comply will result in death or serious injury.**

The fuel system needs to be primed under certain conditions:

- Before starting the engine for the first time
- After running out of fuel and fuel has been added to the fuel tank
- After fuel system maintenance such as changing the fuel filter and draining the fuel filter/water separator, or replacing a fuel system component.

To prime the fuel system:

1. Turn the key to the ON position for 10 to 15 seconds. This will allow the electric fuel pump to prime the fuel system.
2. Never use the starter motor to crank the engine in order to prime the fuel system. This may cause the starter motor to overheat and damage the coils, pinion and/or ring gear.

ENGINE OIL

NOTICE

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap/dipstick and the surrounding area before you remove the cap.
- Never mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- Never overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

Engine Oil Specifications

Use an engine oil that meets or exceeds the following guidelines and classifications:

■ Service categories

- API service categories CJ-4
- ACEA service categories E6
- JASO service category DH-2

■ Definitions

- API classification (American Petroleum Institute)
- ACEA classification (Association des Constructeurs Européens d'Automobilies)
- JASO (Japanese Automobile Standards Organization)

Note:

- *Be sure the engine oil, engine oil storage containers, and engine oil filling equipment are free of sediments and water.*
- *Change the engine oil after the first 50 hours of operation and then at every 250 hours thereafter.*
- *Select the oil viscosity based on the ambient temperature where the engine is being operated. See the SAE service grade viscosity chart* ***(Figure 2)****.*
- *YANMAR does not recommend the use of engine oil "additives."*

■ Additional technical engine oil requirements:

The engine oil must be changed when the Total Base Number (TBN) has been reduced to 1.0 mgKOH/g. TBN (mgKOH/g) test method; JIS K-201-5.2-2 (HCl), ASTM D4739 (HCl).

Engine Oil Viscosity

Select the appropriate engine oil viscosity based on the ambient temperature and use the SAE service grade viscosity chart in **Figure 2**.

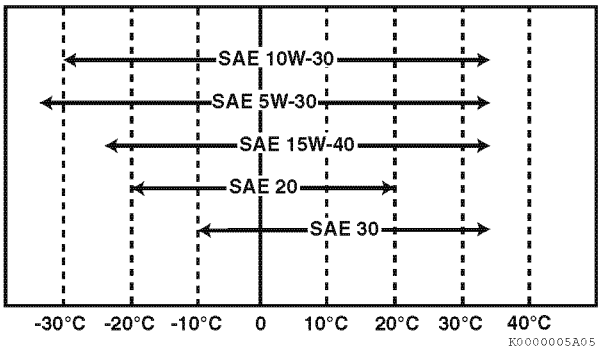


Figure 2

Checking Engine Oil

1. Make sure engine is level.
2. Remove dipstick **(Figure 3, (1))** and wipe with clean cloth.
3. Fully reinsert dipstick.
4. Remove dipstick. The oil level should be between upper **(Figure 3, (2))** and lower **(Figure 3, (3))** lines on the dipstick.
5. Fully reinsert dipstick.

Adding Engine Oil

1. Make sure engine is level.
2. Remove oil cap **(Figure 3, (4))**.
3. Add indicated amount of engine oil at the top or side engine oil filler port **(Figure 3, (5))**.
4. Wait three minutes and check oil level.
5. Add more oil if necessary.
6. Reinstall oil cap **(Figure 3, (4))** and hand-tighten. Over-tightening may damage the cap.

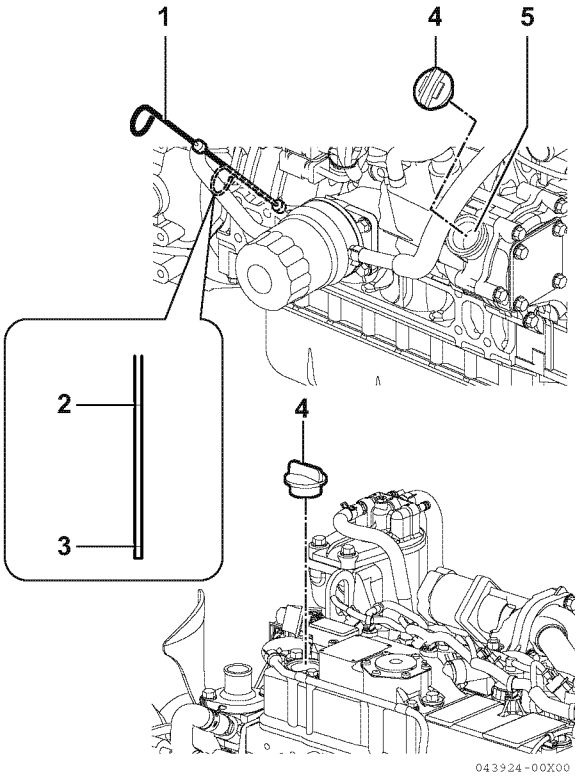


Figure 3

Engine Oil Capacity (Typical)

Note: These are the engine oil capacities associated with a "Deep Standard" oil pan. Oil capacity will vary dependent upon which optional oil pan is used. Refer to the operation manual provided by the driven machine manufacturer for the actual engine oil capacity of your machine.

The following are the engine oil capacities for various YANMAR TNV engines.

Engine model	Dipstick upper limit/lower limit
3TNV88C, 3TNV86CT	7.1/4.1 qt (6.7/3.9 ℓ)
4TNV88C, 4TNV86CT	7.8/4.2 qt (7.4/4.0 ℓ)
4TNV98C, 4TNV98CT	11.1/6.3 qt (10.5/6.0 ℓ)

ENGINE COOLANT

⚠ DANGER

Scald Hazard!

- **Never remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.**
- **Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.**
- **Always check the level of the engine coolant by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

⚠ WARNING

Burn Hazard!

- **Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.**
- **Failure to comply could result in death or serious injury.**

NOTICE

- Only use the engine coolant specified. Other engine coolants may affect warranty coverage, cause an internal buildup of rust and scale and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine coolant. Carefully clean the radiator cap and the surrounding area before you remove the cap.
- Never mix different types of engine coolants. This may adversely affect the properties of the engine coolant.

Engine Coolant Specifications

Use a Long Life Coolant (LLC) or an Extended Life Coolant (ELC) that meets or exceeds the following guidelines and specifications.

■ Alternative engine coolant

If an Extended or Long Life Coolant is not available, alternatively, you may use an ethylene glycol or propylene glycol based conventional coolant (green).

Note:

- *Always use a mix of coolant and water. Never use water only.*
- *Mix coolant and water per the mixing instructions on the coolant container.*
- *Water quality is important to coolant performance. YANMAR recommends that soft, distilled or demineralized water be used to mix with coolants.*
- *Never mix extended or long life coolants and conventional (green) coolants.*
- *Never mix different types and/or colors of extended life coolants.*
- *Replace the coolant every 1000 engine hours or once a year.*

■ Additional technical coolant specifications:

- ASTM D6210, D4985 (US)
- JIS K-2234 (Japan)
- SAE J814C, J1941, J1034 or J2036 (International)

Filling Radiator with Engine Coolant

Fill the radiator and reserve tank as follows. This procedure is for filling the radiator for the first time or refilling it after it is flushed. Note that a typical radiator is illustrated.

1. Check to be sure the radiator drain plug is installed and tightened or the drain cock **(Figure 4, (1))** is closed. Also make sure the coolant hoses **(Figure 5, (1))** are installed at the oil cooler.

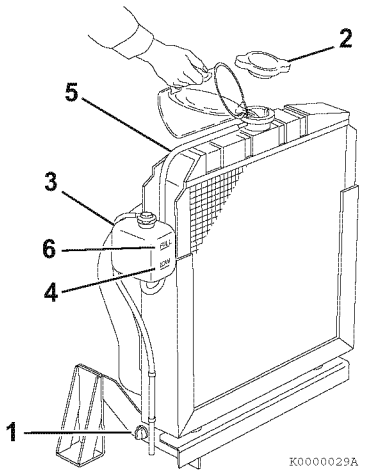


Figure 4

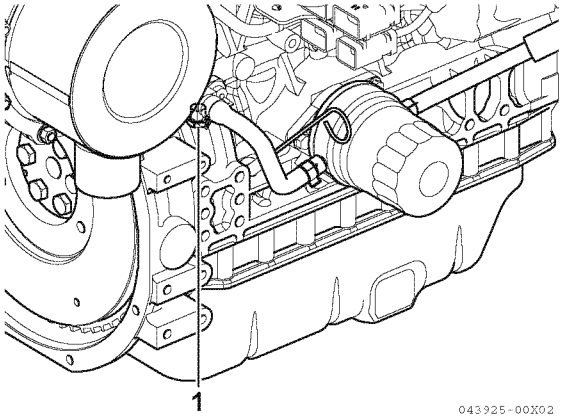


Figure 5

2. Remove the radiator cap **(Figure 4, (2))** by turning it counterclockwise about 1/3 of a turn.
3. Pour the engine coolant slowly into the radiator until it is even with the lip of the engine coolant filler port. Make sure that air bubbles do not develop as you fill the radiator.
4. Reinstall the radiator cap **(Figure 4, (2))**. Align the tabs on the back side of the radiator cap with the notches on the engine coolant filler port. Press down and turn the cap clockwise about 1/3 of a turn.
5. Remove the cap of the reserve tank **(Figure 4, (3))**, and fill it to the LOW (COLD) mark **(Figure 4, (4))** with engine coolant. Reinstall the cap.
6. Check the hose **(Figure 4, (5))** that connects the reserve tank **(Figure 4, (3))** to the radiator. Be sure it is securely connected and there are no cracks or damage. If the hose is damaged, engine coolant will leak out instead of going into the reserve tank.
7. Run the engine until it reaches operating temperature. Check the level of engine coolant in the reserve tank When the engine is running and the engine coolant is at normal temperature, the coolant level in the reserve tank should be at or neat the FULL (HOT) mark **(Figure 4, (6))**. If the coolant is not at the FULL (HOT) mark, add coolant to the reserve tank to bring the coolant level to the FULL (HOT) mark.

Daily Check of the Cooling System

1. Check the level of engine coolant in the reserve tank. When the engine is cold, the coolant level in the tank should be at or slightly above the LOW (COLD) mark **(Figure 4, (4))** on the coolant reserve tank.

   If the coolant level is at the FULL (HOT) mark **(Figure 4,** (6)) when the engine is cold, the coolant will expand when it becomes hot and possibly spray out of the overflow hose.
2. Add additional engine coolant to the reserve tank if necessary.
3. Check the radiator hoses for cracks, abrasions, cuts or other damage. Replace as necessary.

Engine Coolant Capacity (Typical)

Note: Capacities listed are for the engine only without a radiator. Refer to the operation manual provided by the driven machine manufacturer for actual engine coolant capacity on your machine.

The following are the engine coolant capacities for various YANMAR TNV engines.

Engine model	Engine coolant capacity
3TNV88C, TNV86CT	2.1 qt (2.0 ℓ)
4TNV88C, 4TNV86CT	2.9 qt (2.7 ℓ)
4TNV98C, 4TNV98CT	4.4 qt (4.2 ℓ)

DAILY CHECKS

Before you begin any job, make sure the YANMAR TNV engine is in good operating condition. Make sure you check the following items before you start your shift and have any repairs completed before you start work.

⚠ WARNING

High-Pressure Hazard!

- **Avoid skin contact with the high-pressure diesel fuel spray caused by a fuel system leak such as a broken fuel injection line. High-pressure fuel can penetrate your skin and result in serious injury. If you are exposed to high-pressure fuel spray, obtain prompt medical treatment.**
- **Never check for a fuel leak with your hands. Always use a piece of wood or cardboard. Have your authorized YANMAR industrial engine dealer or distributor repair the damage.**
- **Failure to comply could result in death or serious injury.**

NOTICE

Make it a habit to perform daily checks. *See Daily Checks in the Before You Operate Section of this manual.*

Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

Visual Checks

1. Check for engine oil leaks.
2. Check for fuel leaks.
3. Check for engine coolant leaks.
4. Check for damaged or missing parts.
5. Check for loose, missing or damaged fasteners.
6. Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors.
7. Check hoses for cracks, abrasions, and damaged, loose or corroded clamps.
8. Check and clean radiator fins as necessary. *See Check and clean radiator fins on page 68.*
9. Check the fuel filter/water separator for presence of water and contaminants. If you find any water or contaminants, drain the fuel filter/water separator. *See Drain fuel filter/separator on page 64.* If you have to drain the fuel filter/water separator frequently, drain the fuel tank and check for the presence of water in your fuel supply. *See Drain fuel tank on page 66.*

NOTICE

- If any problem is noted during the visual check, the necessary corrective action should be taken before you operate the engine.
- Be sure to check water in the fuel filter/water separator daily. The fuel system in the common rail system is extremely high-pressured. If water is mixed to the supplied fuel in the supply pump, seizure to the supply pump and the injector may result.

Check Diesel Fuel, Engine Oil and Engine Coolant Levels

Follow the procedures in *Diesel Fuel on page 38*, *Engine Oil on page 41* and *Engine Coolant on page 43* to check these levels.

Check Engine Speed Control

Check the engine speed control for smooth operation.

Check Operator's Console

Before you operate the engine you should make sure that all of the indicators are functioning properly.

Check Indicators

YANMAR TNV engines are available with various operator's consoles. Two typical operator's consoles are shown **(Figure 6)** or **(Figure 7)**.

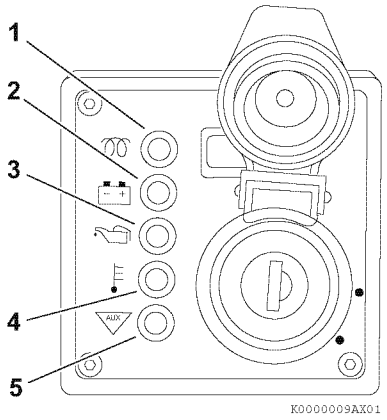


Figure 6

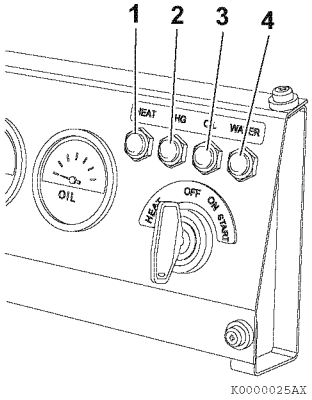


Figure 7

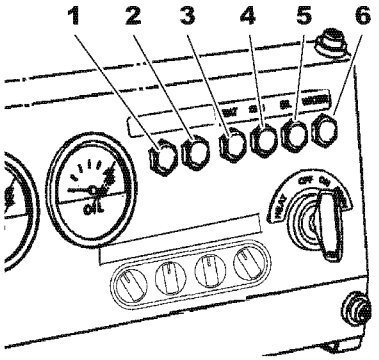


Figure 8

HEAT (Figure 6, (1)) or (Figure 7, (1)) or (Figure 8, (1)) - **Figure 7** shows a typical indicator arrangement on the operator's console. When the key switch is turned to the HEAT position, the HEAT indicator comes on indicating the glow plugs are energized, and stays on for 4 sec. When it goes out, turn the key switch to the START position to start the engine.

Figure 6 shows a typical operator's console having the optional key switch. When the optional key switch is turned to the ON position, the indicator comes on indicating the glow plugs are energized, and stays on for 4 sec. When it goes out, turn the key switch to the START position to start the engine.

Battery charge (Figure 6, (2)) or **(Figure 7, (2)) or (Figure 8, (4))** - Stays on until the engine is running and the alternator is supplying charging current. This indicator does not indicate whether the battery is discharged.

Engine oil pressure (Figure 6, (3)) or **(Figure 7, (3)) or (Figure 8, (5))** - Stays on until the engine is running and the oil pressure is within normal limits.

Engine coolant temperature (Figure 6, (4)) or **(Figure 7, (4)) or (Figure 8, (6))** - Stays on momentarily. Comes back on if engine overheats.

Auxiliary (Figure 6, (5)) or (Figure 8, (2)) - Stays on momentarily. Used for special applications.

Here is a summary of how these indicators function. The table shows what happens when you turn the key in a certain direction (e.g., OFF to ON).

Fault indicator (Figure 8, (1)) (optional) - Illuminates for approx. 2 sec. when the key switch is turned to ON, and stays off while the engine is running. If a fault occurs during energization of the E-ECU, this indicator will flash in a certain pattern to indicate what fault has occurred. See the troubleshooting section for details.

Indicator			OFF to HEAT	OFF to ON	ON to OFF
HEAT **Figure 6, (1)** **Figure 7, (1)** **Figure 8, (3)**	ON-glow ON-air heat type	Glow	NA	Lights for several seconds (4 sec.) then goes.	OFF
				Lights for several 15 seconds then goes out.Lights for 1 - 23 sec. for electronically controlled engines depending on the coolant temperature.	OFF
	HEAT position available on key switch	Glow	Lights for several seconds (4 sec.) then goes out.	OFF	OFF
Battery charge **Figure 6, (2)** **Figure 7, (2)** **Figure 8, (4)**			NA	ON	OFF (Stays on until alternator is supplying charging current. Remains on if there is a problem in the charging system. This indicator does not indicate whether the battery is discharged.)
Engine oil pressure **Figure 6, (3)** **Figure 7, (3)** **Figure 8, (5)**			NA	ON	OFF (Stays on until oil pressure reaches normal operating pressure. Remains on, or comes back on, if there is a problem in the lubrication system.)
Engine coolant temperature **Figure 6, (4)** **Figure 7, (4)** **Figure 8, (6)**			NA	ON	OFF (Stays on momentarily. Comes back on if there is a problem in the cooling system.)
Auxiliary **Figure 6, (5)** **Figure 8, (2)**			NA	ON	OFF
Fault (optional) **Figure 8, (1)**			NA	Lights for 2 sec. only.	OFF (Flashes or intermittently lights if a fault occurs in the E-ECU.)

ENGINE OPERATION

This section of the Operation Manual describes the procedures for starting the engine, checking engine performance during operation, and shutting the engine down.

STARTING ENGINE

⚠ WARNING

Sudden Movement Hazard!

- **Engaging the transmission or PTO at an elevated engine speed could result in unexpected movement of the equipment.**
- **Failure to comply could result in death or serious injury.**

Use the following procedure to start the engine. Note that two typical operator's consoles are shown for illustrative purposes only.

1. Make sure you follow the procedures stated in the *Daily Checks on page 46*.
2. Make sure the fuel filter/water separator fuel cock **(Figure 1, (1))** is in the ON position **(Figure 1, (2))**.

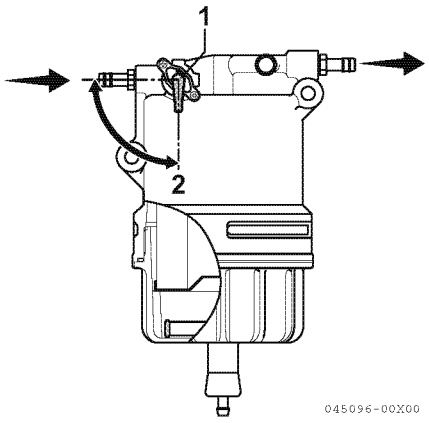


Figure 1

3. Set the transmission (if equipped) in the NEUTRAL position.
4. Disengage the PTO (if equipped).
5. Set the engine speed control to the mid-position.

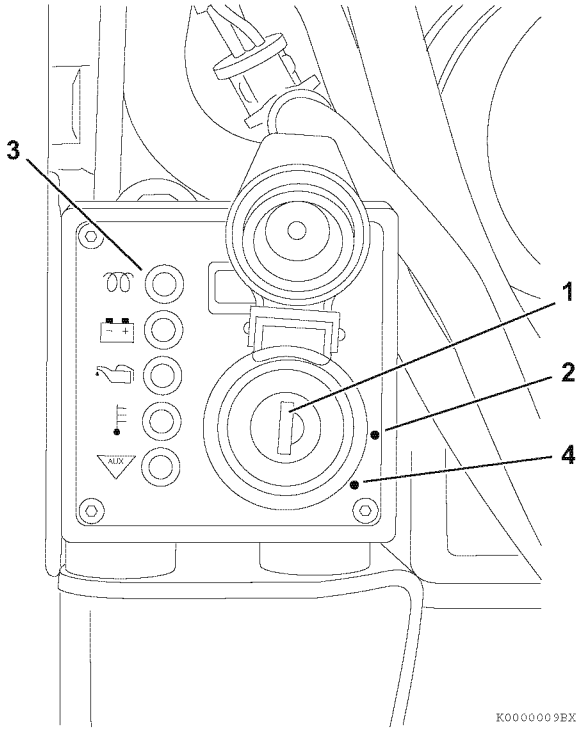


Figure 2

NOTICE

- Never use an engine starting aid such as ether. Engine damage will result.
- Be sure to perform priming the engine before starting. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

---

6. Insert the key into the key switch **(Figure 2, (1))** or **(Figure 3, (1))**.

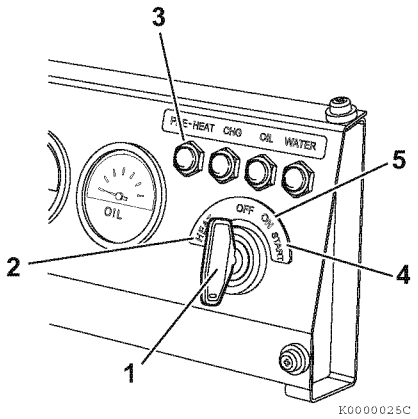


Figure 3

7. Turn the key to the ON position **(Figure 2, (2))** or the HEAT position **(Figure 3, (2))**. The pre-heat indicator **(Figure 2, (3))** flashes for several seconds and then goes out. After the pre-heat indicator goes out you can start the engine.

   Note: The glow plugs are used to assist starting in cold weather conditions. If you are operating your engine in normal or warm weather conditions, you may bypass the Pre-Heat/Heat functions and go directly to Start.

NOTICE

Never hold the key in the START position for longer than 15 seconds or the starter motor will overheat.

8. Turn the key clockwise to the START position **(Figure 2, (4))** or **(Figure 3, (4))**. Release the key as soon as the engine starts. It will return to the ON position **(Figure 2, (2))** or **(Figure 3, (5))**.
9. If the engine fails to start:
   1- Wait until the engine comes to a complete stop before you attempt to start it again. Engaging the starter while the engine is still rotating will result in damage to the starter and flywheel.

   Note: Some key switches are equipped with an interlock that will not allow you to re-engage the starter without first turning the key to the OFF position.

   2- Wait at least 30 seconds before you attempt to start the engine again. This procedure will allow the battery voltage to recover and prevent damage to the starter motor due to the low battery voltage.

CHECKING THE ENGINE DURING OPERATION

⚠ WARNING

High-Pressure Hazard!

- **Avoid skin contact with the high-pressure diesel fuel spray caused by a fuel system leak such as a broken fuel injection line. High-pressure fuel can penetrate your skin and result in serious injury. If you are exposed to high-pressure fuel spray, obtain prompt medical treatment.**
- **Never check for a fuel leak with your hands. Always use a piece of wood or cardboard. Have your authorized YANMAR industrial engine dealer or distributor repair the damage.**
- **Failure to comply could result in death or serious injury.**

NOTICE

Make sure the engine is installed on a level surface. If a continuously running engine is installed at an angle greater than 30° in any direction or if an engine runs for short periods of time (less than three minutes) at an angle greater than 35° in any direction, engine oil may enter the combustion chamber causing excessive engine speed and white exhaust smoke. This may cause serious engine damage.

NOTICE

New engine break-in:

- On the initial engine start-up, allow the engine to idle for approximately 15 minutes while you check for proper engine oil pressure, diesel fuel leaks, engine oil leaks, coolant leaks, and for proper operation of the indicators and/or gauges.
- During the first hour of operation, vary the engine speed and the load on the engine. Short periods of maximum engine speed and load are desirable. Avoid prolonged operation at minimum or maximum engine speeds and loads for the next four to five hours.
- During the break-in period, carefully observe the engine oil pressure and engine temperature.
- During the break-in period, check the engine oil and coolant levels frequently.

NOTICE

Never engage the starter motor while the engine is running. This may damage the starter motor pinion and/or ring gear.

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1. While the engine is running, check the gauges for normal indications. The gauges shown in **Figure 5** and **Figure 4** are provided for illustrative purposes only.

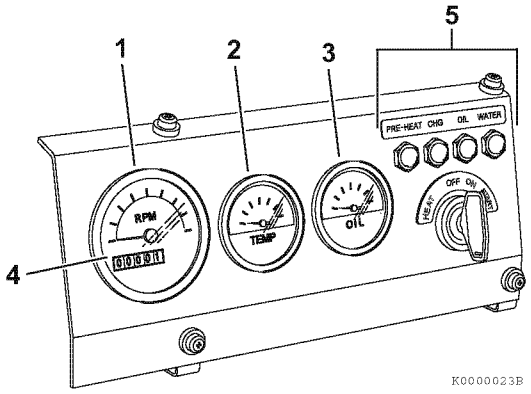


Figure 4

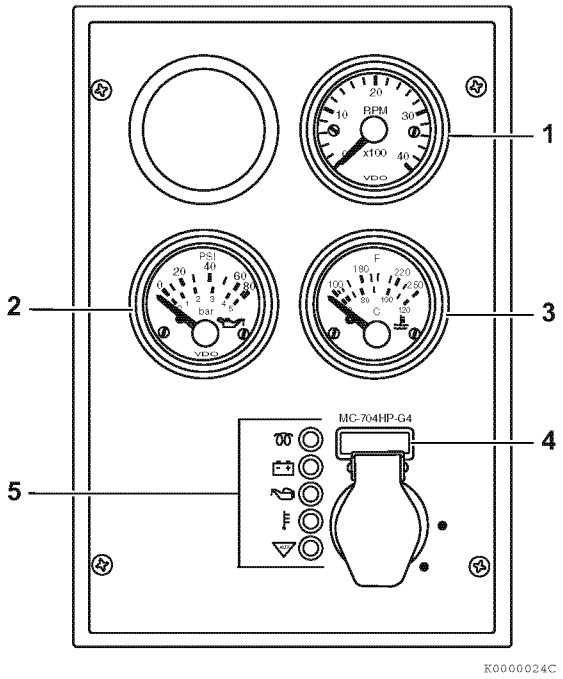


Figure 5

- **Tachometer (Figure 5, (1))** or **(Figure 4, (1))** -Make sure the engine speed is within normal limits.
- **Engine oil pressure (Figure 5, (2))** or **(Figure 4, (3))** - Make sure the engine oil pressure is within normal limits. *See Principal Engine Specifications on page 93.*
- **Engine coolant temperature (Figure 5, (3))** or **(Figure 4, (2))** - Make sure the engine coolant temperature is within normal limits.
- **Hour meter** - The hour meter display **(Figure 5, (4))** or **(Figure 4, (4))** shows the total number of hours the engine has run. This is useful for planning periodic maintenance operations. *See Periodic Maintenance Schedule on page 58.*
- If any of the gauges shows an out of normal limits condition, shut down the engine and have the necessary repairs performed.

2. After the engine has reached operating temperature, all of the indicators **(Figure 5, (5))** or **(Figure 4, (5))** should be off. If any of the indicators are on, shut down the engine and have the necessary repairs performed.
3. Check for white or black smoke from the exhaust system. A small amount of white exhaust smoke is normal on start-up of a cold engine. Black exhaust smoke could mean the engine is overloaded or is being over-fueled. If either of these conditions persists, contact your authorized YANMAR industrial engine dealer or distributor.
4. Check for abnormal sounds or vibration. In some applications the engine and its mounting may start to resonate and cause unusual vibrations at certain engine speeds. Avoid running the engine at these speeds. If the abnormal sounds or vibration cannot be resolved, shut down the engine and have the necessary repairs performed. Contact your authorized YANMAR industrial engine dealer or distributor.
5. Check for any fuel, engine coolant or engine oil leaks. If any leaks are found shut down the engine and have the necessary repairs performed.
6. Check the fuel level during operation. If the fuel level runs low, stop the engine and refuel.

SHUTTING DOWN THE ENGINE

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

Follow these steps to shut down the engine:

1. Disengage the PTO and/or set the transmission to NEUTRAL (if equipped).
2. Set the engine speed control to its lowest setting.
3. Run the engine at low idle speed for at least five minutes before you shut it down.

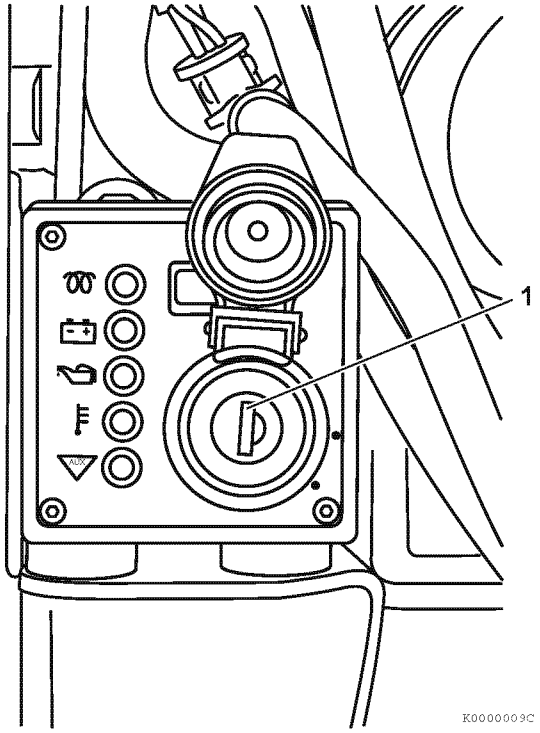


Figure 6

4. Turn the key to the OFF position **(Figure 6, (1))** or **(Figure 7, (1))** and remove it from the key switch.

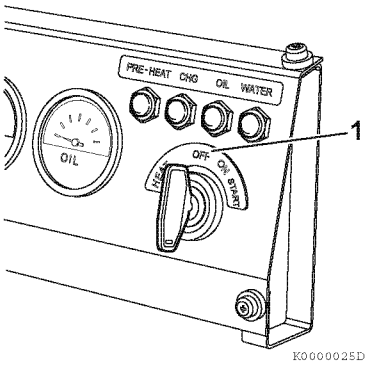


Figure 7

5. If the engine will not be used for six months or longer, follow the additional instructions in *Long-Term Storage on page 87*.

PERIODIC MAINTENANCE

This section of the Operation Manual describes the procedures for proper care and maintenance of the engine.

PRECAUTIONS

The Importance of Periodic Maintenance

Engine deterioration and wear occurs in proportion to length of time the engine has been in service and the conditions the engine is subject to during operation. Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

Performing Periodic Maintenance

⚠ WARNING

Exhaust Hazard!

- **Never operate the engine in an enclosed area such as a garage, tunnel, underground room, manhole or ship's hold without proper ventilation.**
- **Never block windows, vents, or other means of ventilation if the engine is operating in an enclosed area. All internal combustion engines create carbon monoxide gas during operation. Accumulation of this gas within an enclosure could cause illness or even death.**
- **Make sure that all connections are tightened to specifications after repair is made to the exhaust system.**
- **Failure to comply could result in death or serious injury.**

Perform periodic maintenance procedures in an open, level area free from traffic. If possible, perform the procedures indoors to prevent environmental conditions, such as rain, wind, or snow, from damaging the machine.

The Importance of Daily Checks

Periodic Maintenance Schedules assume that the daily checks are performed on a regular basis. Make it a habit of performing daily checks before the start of each shift. *See Daily Checks on page 46.*

Keep a Log of Engine Hours and Daily Checks

Keep a log of the number of hours the engine is run each day and a log of the daily checks performed. Also note the date, type of repair (e.g., replaced alternator), and parts needed for any service needed between the periodic maintenance intervals. Periodic maintenance intervals are every 50, 250, 500, 1000, 1500, 2000 and 3000 engine hours. Failure to perform periodic maintenance will shorten the life of the engine.

YANMAR Replacement Parts

YANMAR recommends that you use genuine YANMAR parts when replacement parts are needed. Genuine replacement parts help ensure long engine life.

Tools Required

Before you start any periodic maintenance procedure make sure you have the tools you need to perform all of the required tasks.

Ask Your Authorized YANMAR Industrial Engine Dealer or Distributor For Help

Our professional service technicians have the expertise and skills to help you with any maintenance or service related procedures you need help with.

Required EPA/ARB Maintenance USA Only

To maintain optimum engine performance and compliance with the Environmental Protection Agency (EPA) Regulations Non-Road Engines and the California Air Resources Board (ARB, California), it is essential that you follow the *Periodic Maintenance Schedule on page 58* and *Periodic Maintenance Procedures on page 60*.

EPA/ARB Installation Requirements USA Only

The following are the installation requirements for the EPA/ARB. Unless these requirements are met, the exhaust gas emissions will not be within the limits specified by the EPA and ARB.

Therefore, periodically perform the maintenance and cleaning of air cleaner and muffler.

Maximum Exhaust Gas Restriction shall be:

Initial upper limit	12.7 kPa (1300 mmAq)
Cleaning upper limit	45 kPa (4590 mmAq)

Maximum air intake restriction shall be 0.90 PSI (6.23 kPa; 635 mmAq) or less. Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

Tightening Fasteners

Use the correct amount of torque when you tighten fasteners on the machine. Applying excessive torque may damage the fastener or component and not enough torque may cause a leak or component failure.

NOTICE

The tightening torque in the *Standard Torque Chart in the Periodic Maintenance Section of this manual* should be applied only to the bolts with a "7" head. (JIS strength classification: 7T)

- Apply 60 % torque to bolts that are not listed.
- Apply 80 % torque when tightened to aluminum alloy.

STANDARD TORQUE CHART

Thread size × pitch mm		M6 × 1.0	M8 × 1.25	M10 × 1.5	M12 × 1.75	M14 × 1.5	M16 × 1.5
Tightening torque	in.-lb	96.0 ± 9.0	–	–	–	–	–
	ft-lb	–	19.0 ± 2.0	36.0 ± 4.0	65.0 ± 7.0	101.0 ± 7.0	167.0 ± 7.0
	N·m	10.8 ± 1.0	25.5 ± 2.9	49.0 ± 4.9	88.3 ± 9.8	137.0 ± 9.8	226.0 ± 9.8
	kgf/m	1.1 ± 0.1	2.6 ± 0.3	5.0 ± 0.5	9.0 ± 1.0	14.0 ± 1.5	23.0 ± 2.0

Note: Torque values shown in this manual are for clean, non-lubricated fasteners unless otherwise specified.

PERIODIC MAINTENANCE SCHEDULE

Daily and periodic maintenance is important to keep the engine in good operating condition. The following is a summary of maintenance items by periodic maintenance intervals. Periodic maintenance intervals vary depending on engine application, loads, diesel fuel and engine oil used and are hard to establish definitively. The following should be treated only as a general guideline.

NOTICE

Establish a periodic maintenance plan according to the engine application and make sure you perform the required periodic maintenance at intervals indicated. Failure to follow these guidelines will impair the engine's safety and performance characteristics, shorten the engine's life and may affect the warranty coverage on your engine. *See YANMAR Limited Warranty in the Warranty Section of this manual.*

It is recommended to perform water-bleeding of the oil/water separator in particular daily. Protect the supply pump and the injector from seizure.

The TNV series engines may inject fuel after general combustion for the purpose of self-regeneration of the DPF. This fuel may enter the oil pan through the cylinder and dilute the engine oil. Check the oil level daily. If it is above the upper limit of the dipstick, change the oil regardless of the replacement intervals.

Consult your authorized YANMAR industrial engine dealer or distributor for assistance when checking items marked with a ●.

Periodic Maintenance Chart

○: Check ◇: Replace ●: Contact your authorized YANMAR industrial engine dealer or distributor

System	Check item	Daily	Periodic maintenance interval						
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 1500 hours	Every 2000 hours	Every 3000 hours
Cooling system	Check and refill engine coolant	○							
	Check and clean radiator fins			○					
	Check and adjust cooling fan V-belt		○ 1st time	○ 2nd and after					
	Drain, flush and refill cooling system with new coolant					◇ or every 1 year whichever comes first			
Cylinder head	Adjust intake/exhaust valve clearance					●			
	Lap intake/exhaust valve seats (if required)							●	
Electrical equipment	Check indicators	○							
	Check battery		○						

○: Check ◇: Replace ●: Contact your authorized YANMAR industrial engine dealer or distributor

System	Check item	Daily	Periodic maintenance interval						
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 1500 hours	Every 2000 hours	Every 3000 hours
Engine oil	Check engine oil level	○							
	Drain and fill engine oil		◇ 1st time	◇ 2nd and after					
	Replace engine oil filter								
Emission control warranty	Inspect turbocharger (blower wash as necessary)								●
	Inspect, clean and test EGR valve								●
	Clean EGR lead valve								●
	Clean EGR cooler (clean to blow water/air passages)						●		
	Inspect crankcase breather system						●		
	Soot filter cleaning								●
	Check and function test intake throttle								○
Fuel	Check and refill fuel tank level	○							
	Drain fuel tank			○					
	Drain fuel filter/water separator	○							
	Check fuel filter/water separator	○							
	Replace filter of fuel filter/water separator				○				
	Check and clean injector								○
	Replace fuel filter				◇				
Hoses	Replace fuel system and cooling system hoses							◇ or every 2 years	
Intake and exhaust	Clean or replace air cleaner element			○	◇				
Complete engine	Overall visual check daily	○							

Note: These procedures are considered normal maintenance and are performed at the owner's expense.

PERIODIC MAINTENANCE PROCEDURES

After Initial 50 Hours of Operation

Perform the following maintenance after the initial 50 hours of operation.

- **Replace engine oil and engine oil filter**
- **Check and adjust cooling fan V-belt**

■ Replace engine oil and engine oil filter

⚠ WARNING

Burn Hazard!

- **If you must drain the engine oil while it is still hot, stay clear of the hot engine oil to avoid being burned.**
- **Always wear eye protection.**
- **Failure to comply could result in death or serious injury.**

⚠ WARNING

Sudden Movement Hazard!

- **Engaging the transmission or PTO at an elevated engine speed could result in unexpected movement of the equipment.**
- **Failure to comply could result in death or serious injury.**

NOTICE

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap/dipstick and the surrounding area before you remove the cap.
- Never mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- Never overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

NOTICE

- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

The engine oil on a new engine becomes contaminated from the initial break-in of internal parts. It is very important that the initial oil change is performed as scheduled.

Note: The oil drain plug may be in another location if an optional oil pan is used.

Drain the engine oil as follows:

1. Make sure the engine is level.
2. Start the engine and bring it up to operating temperature.
3. Stop the engine.
4. Remove one of the oil filler caps **(Figure 1, (1))** to vent the engine crankcase and allow the engine oil to drain more easily.
5. Position a container under the engine to collect waste oil.

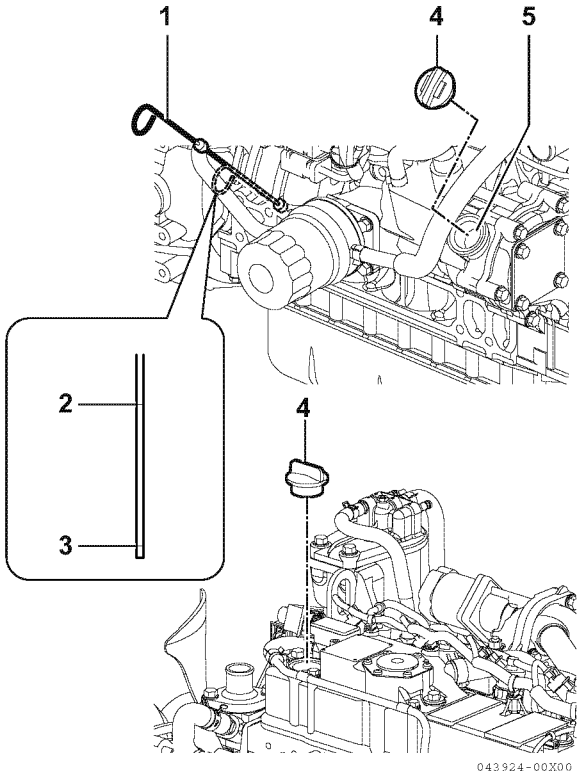


Figure 1

6. Remove the oil drain plug **(Figure 2, (1))** from the engine oil pan. Allow oil to drain.
7. After all oil has been drained from the engine, reinstall the oil drain plug **(Figure 2, (1))** and tighten to 40 - 47 ft-lb (53.9 - 63.7 N·m, 5.5 - 6.5 kgf/m).
8. Dispose of used oil properly.

Remove the engine oil filter as follows:

1. Turn the engine oil filter **(Figure 2, (2))** counterclockwise **(Figure 2, (3))** using an oil filter wrench.
2. Clean the engine oil filter mounting face.
3. Lightly coat the gasket on the new oil filter with engine oil. Install the new engine oil filter manually by turning it clockwise **(Figure 2, (4))** until it contacts the mounting surface. Tighten to 14 - 17 ft-lb (19.6 - 23.5 N·m, 2.0 - 2.4 kgf/m) or one additional turn using the oil filter wrench.

Engine oil filter Part No.		
	Standard	**Dust proof***
3TNV88C, 3TNV86CT, 4TNV88C, 4TNV86CT	129150-35153	119005-35151
4TNV98C, 4TNV98CT	119005-35151	

** Consult the operation manual for the driven machine for applicability of the dust proof filter.*

4. Add new engine oil to the engine through either of the oil filler ports as specified in *Adding Engine Oil on page 42*.

NOTICE

- Never overfill the engine with engine oil.
- Always keep the oil level between the upper and lower lines on the oil cap/dipstick.

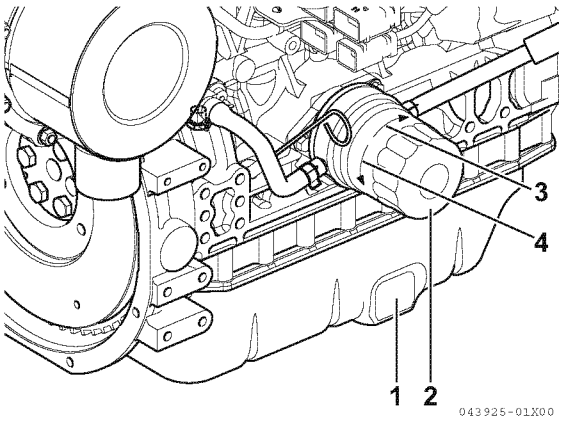


Figure 2

5. Warm up the engine by running it for 5 minutes and check for any engine oil leaks.
6. After engine is warm, shut it off and let it sit for 10 minutes.
7. Recheck the engine oil level.
8. Add engine oil to engine oil filler port **(Figure 3, (5))** as needed until the level is between the upper **(Figure 3, (2))** and lower lines **(Figure 3, (3))** shown on the dipstick **(Figure 3, (1))**.
9. Reinstall the oil filler cap **(Figure 3, (4))**. If any engine oil is spilled, wipe it away with a clean cloth.

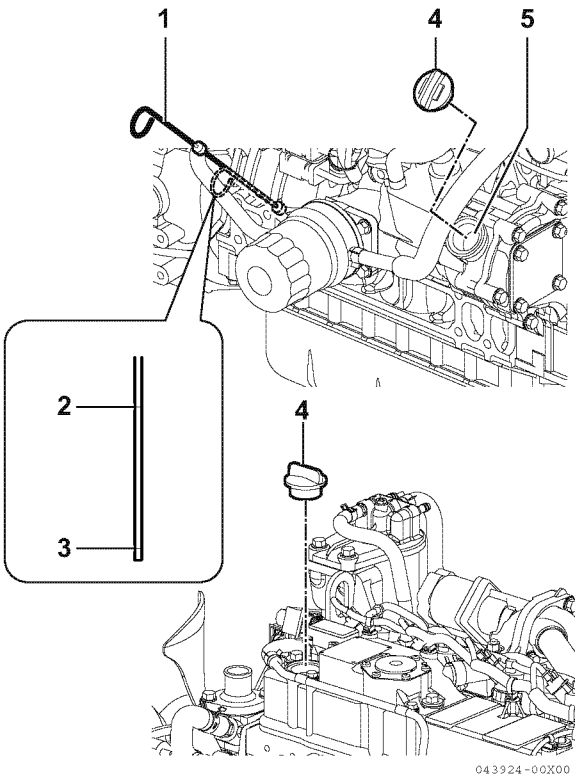


Figure 3

■ Check and adjust cooling fan V-belt

The V-belt will slip if it does not have the proper tension. This will prevent the alternator from generating sufficient power. Also, the engine will overheat due to the engine coolant pump pulley slipping.

Check and adjust the V-belt tension (deflection) as follows:

1. Press the V-belt down with your thumb with a force of approximately 22 ft-lb (98 N·m, 10 kgf/m) to check the deflection.

   There are three positions to check for V-belt tension **(Figure 4, (A), (B) and (C))**. You can check the tension at whichever position is the most accessible. The proper deflection of a used V-belt at each position is:

Used V-belt tension		
A	**B**	**C**
3/8 - 1/2 in. (10 - 14 mm)	1/4 - 3/8 in. (7 - 10 mm)	5/16 - 1/2 in. (9 - 13 mm)

Note: A "Used V-Belt" refers to a V-belt which has been used on a running engine for five minutes or more.

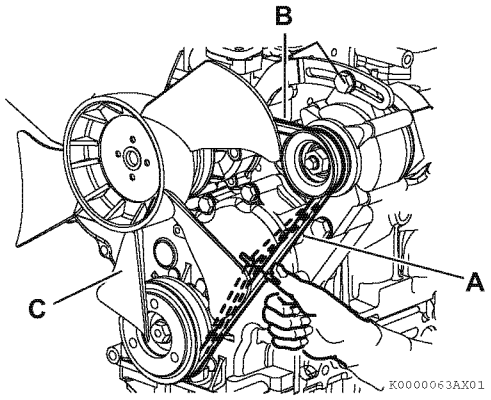


Figure 4

2. If necessary, adjust the V-belt tension. Loosen the adjusting bolt **(Figure 5, (1))** and related bolts and/or nuts, then move the alternator **(Figure 5, (2))** with a pry bar **(Figure 5, (3))** to tighten the V-belt to the desired tension. Then tighten the adjusting bolts and/or nuts.

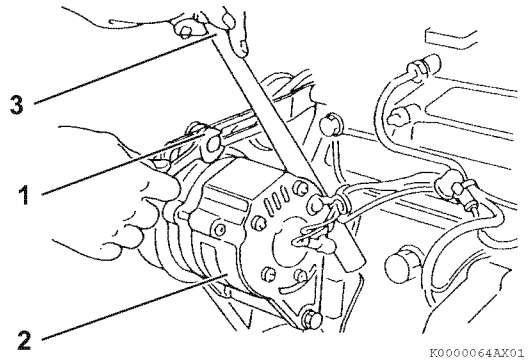


Figure 5

3. Tighten the V-belt to the proper tension. There must be clearance **(Figure 6, (1))** between the V-belt and the bottom of the pulley groove. If there is no clearance **(Figure 6, (2))** between the V-belt and the bottom of the pulley groove, replace the V-belt.

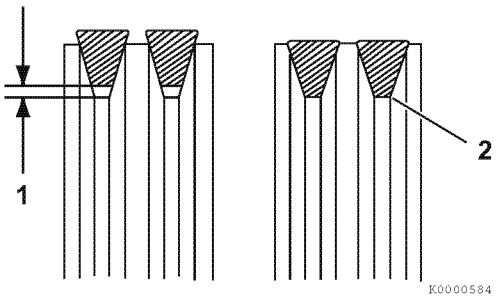


Figure 6

4. Check the V-belt for cracks, oil or wear. If any of these conditions exist, replace the V-belt.
5. Install the new V-belt. Refer to the table for proper tension.

New V-belt tension		
A	**B**	**C**
5/16 - 7/16 in. (8 - 12 mm)	3/16 - 5/16 in. (5 - 8 mm)	1/4 - 7/16 in. (7 - 11 mm)

6. After adjusting, run the engine for 5 minutes or more. Check the tension again using the specifications for a used V-belt.

Used V-belt tension		
A	**B**	**C**
3/8 - 1/2 in. (10 - 14 mm)	1/4 - 3/8 in. (7 - 10 mm)	5/16 - 1/2 in. (9 - 13 mm)

Every 50 Hours of Operation

After you complete the initial 50 hour maintenance procedures, perform the following procedures every 50 hours thereafter.

- **Drain fuel filter/water separator**
- **Check battery**

■ Drain fuel filter/separator

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

NOTICE

If no water drips when the fuel filter/water separator drain cock is opened, loosen the air vent screw on the top of the fuel filter/water separator by using a screwdriver to turn it counterclockwise 2 - 3 turns.

This may occur if the fuel filter/water separator is positioned higher than the fuel level in the fuel tank. After draining the fuel filter/water separator, be sure to tighten the air vent screw.

NOTICE

- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Drain the fuel filter/water separator whenever there are contaminants, such as water, collected in the bottom of the cup. Never wait until the scheduled periodic maintenance if contaminants are discovered.

The separator cup is made from semi-transparent material. In the cup is a red-colored float ring. The float ring will rise to the surface of the water to show how much needs to be drained. Also, some optional fuel filter/water separators are equipped with a sensor to detect the amount of contaminants. This sensor sends a signal to an indicator to alert the operator.

Drain the fuel filter/water separator as follows:

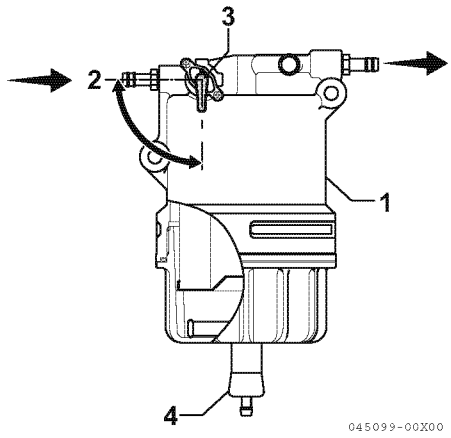


Figure 7

1. Position an approved container under the fuel filter/water separator **(Figure 7, (1))** to collect the contaminants.
2. Close **(Figure 7, (2))** the fuel cock **(Figure 7, (3))**.
3. Loosen the drain cock **(Figure 7, (4))** at the bottom of the fuel filter/water separator. Drain any water collected inside.
4. Hand-tighten the drain cock (tightening torque 1 - 2 N·m (0.1 - 0.2 kgf·m).
5. Open the fuel cock **(Figure 7, (3))**.
6. Be sure to prime the diesel fuel system when you are done. *See Priming the Fuel System on page 41.*
7. Check for fuel leaks.

■ Check battery

⚠ DANGER

Explosion Hazard!

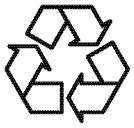
- **Never short out the battery terminals, including when checking the remaining battery charge. This will result in a spark and may cause an explosion or fire. Use a hydrometer to check the remaining battery charge.**
- **If the electrolyte is frozen, slowly warm the battery before you recharge it.**
- **Failure to comply will result in death or serious injury.**

⚠ WARNING

Burn Hazard!

- **Batteries contain sulfuric acid. Never allow battery fluid to come in contact with clothing, skin or eyes. Severe burns could result. Always wear safety goggles and protective clothing when servicing the battery. If battery fluid contacts the eyes and/or skin, immediately flush the affected area with a large amount of clean water and obtain prompt medical treatment.**
- **Failure to comply could result in death or serious injury.**

NOTICE



- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

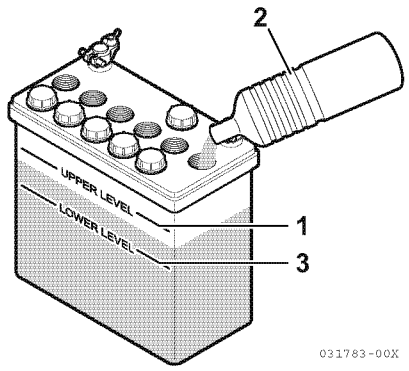


Figure 8

- When the amount of fluid nears the lower limit **(Figure 8, (1))**, fill with distilled water **(Figure 8, (2))** so it is at the upper limit **(Figure 8, (3))**. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode. During the summer, check the fluid level more often than specified.
- If the engine cranking speed is so slow that the engine does not start, recharge the battery.
- If the engine still will not start after charging, have your authorized YANMAR industrial engine dealer or distributor check the battery and the engine's starting system.
- If operating the machine where the ambient temperature could drop to -15 °C (5 °F) or less, remove the battery from the machine at the end of the day. Store the battery in a warm place until the next use. This will help start the engine easily at low ambient temperatures.

Every 250 Hours of Operation

Perform the following maintenance every 250 hours of operation.

- **Drain fuel tank**
- **Replace engine oil and engine oil filter**
- **Check and clean radiator fins**
- **Check and adjust cooling fan V-belt**
- **Clean air cleaner element**

■ Drain fuel tank

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

NOTICE

- Always be environmentally responsible.

- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Note that a typical fuel tank is illustrated.

1. Position an approved container under the diesel fuel tank **(Figure 9, (1))** to collect the contaminants.

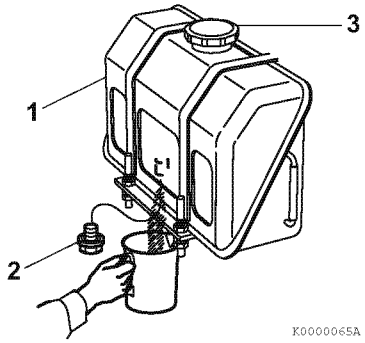


Figure 9

2. Remove the fuel cap **(Figure 9, (3))**.
3. Remove the drain plug **(Figure 9, (2))** to drain the contaminants (water, dirt, etc.) from the bottom of the tank.
4. Drain the tank until clean diesel fuel with no water or dirt flows out. Reinstall and tighten the drain plug firmly.
5. Reinstall the fuel cap.
6. Check for leaks.

NOTICE

Be sure to perform priming. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

■ Replace engine oil and engine oil filter

NOTICE

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and/or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap/dipstick and the surrounding area before you remove the cap.
- Never mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- Never overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

NOTICE

- Always be environmentally responsible.

- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

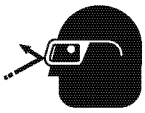
Change the engine oil every 250 hours of operation after the initial change at 50 hours. Replace the engine oil filter at the same time.

See Replace engine oil and engine oil filter on page 60.

■ Check and clean radiator fins

⚠ CAUTION

Flying Object Hazard!



- **Always wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**

- **Failure to comply may result in minor or moderate injury.**

Dirt and dust adhering to the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

Note that a typical radiator is shown in **Figure 10** for illustrative purposes only.

- Blow off dirt and dust from fins and radiator with 28 PSI (0.19 MPa, 2 kgf/cm^2) or less of compressed air **(Figure 10, (1))**. Be careful not to damage the fins with the compressed air.

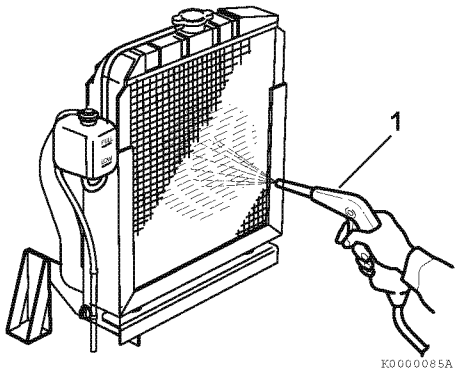


Figure 10

- If there is a large amount of contamination on the fins, apply detergent, thoroughly clean and rinse with tap water.

NOTICE

Never use high-pressure water or compressed air at greater than 28 PSI (193 kPa; 19686 mmAq) or a wire brush to clean the radiator fins. Radiator fins damage easily.

■ Check and adjust cooling fan V-belt

Check and adjust the cooling fan V-belt every 250 hours of operation after the initial 50 hour V-belt maintenance. *See Check and adjust cooling fan V-belt on page 63.*

■ Clean air cleaner element

⚠ CAUTION

Flying Object Hazard!

- **Always wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**

- **Failure to comply may result in minor or moderate injury.**

Note that a typical air cleaner is shown in **Figure 11** and **Figure 12** for illustrative purposes only.

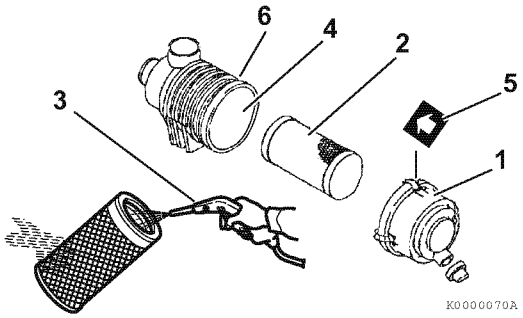


Figure 11

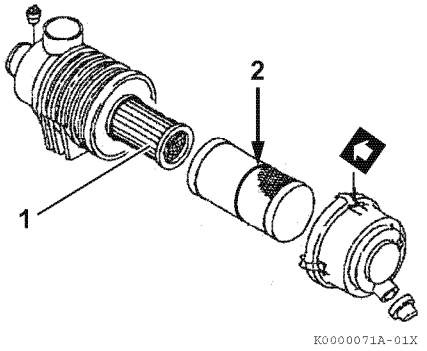


Figure 12

The engine performance is adversely affected when the air cleaner element is clogged with dust. Be sure to clean the air filter element periodically.

1. Unlatch and remove the air cleaner cover **(Figure 11, (1))**.
2. Remove the element **(Figure 11, (2))** (outer element if equipped with two elements).
3. Blow air **(Figure 11, (3))** through the element from the inside out using 42 - 71 PSI (0.29 - 0.49 MPa, 3.0 - 5.0 kgf/cm^2) compressed air to remove the particulates. Use the lowest possible air pressure to remove the dust without damaging the element.
4. If the air cleaner is equipped with a double element, only remove and replace the inner element **(Figure 12, (1))** if the engine lacks power or the dust indicator actuates (if equipped).

   Note: The inner element should not be removed when cleaning or replacing the outer element. The inner element is used to prevent dust from entering the engine while servicing the outer element.
5. Replace the element with a new one if the element is damaged, excessively dirty or oily.
6. Clean inside of the air cleaner cover.
7. Reinstall the element into the air cleaner case **(Figure 11, (4))**.

   *Note: If there is a red line **(Figure 12, (2))** in the outer element, reinsert the element until the overlap position of red line and end face of the air cleaner case.*
8. Reinstall the air cleaner cover making sure you match the arrow **(Figure 11, (5))** on the cover with the arrow on the case **(Figure 11, (6))**.
9. Latch the air cleaner cover to the case.

NOTICE

- When the engine is operated in dusty conditions, clean the air cleaner element more frequently.
- Never operate the engine with the air cleaner element(s) removed. This may allow foreign material to enter the engine and damage it.

Every 500 Hours of Operation

Perform the following maintenance every 500 hours of operation.

- **Replace air cleaner element**
- **Replace fuel filter**
- **Replace filter of fuel filter/water separator**

■ Replace air cleaner element

NOTICE

The maximum air intake restriction, in terms of differential pressure measurement, must not exceed 0.90 PSI (6.23 kPa; 635 mmAq). Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

Replace the air cleaner element **(Figure 11, (2))** every 500 hours even if it is not damaged or dirty.

When replacing the element, clean the inside of the air cleaner case **(Figure 11, (4))**.

If the air cleaner is equipped with a double element, *only remove and replace the inner element* **(Figure 12, (1))** *if the engine lacks power or the dust indicator actuates (if equipped).* This is in addition to replacing the outer element.

■ Replace fuel filter

⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

NOTICE

For maximum engine life, YANMAR recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

NOTICE

- Always be environmentally responsible.

- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Replace the fuel filter at specified intervals to prevent contaminants from adversely affecting the diesel fuel flow.

1. Stop the engine and allow it to cool.
2. Close the fuel cock of the fuel filter/water separator.
3. Remove the fuel filter using a filter wrench to turn it to the left **(Figure 13, (1))**. When removing the fuel filter, carefully hold it to prevent the fuel from spilling. Wipe up all spilled fuel.

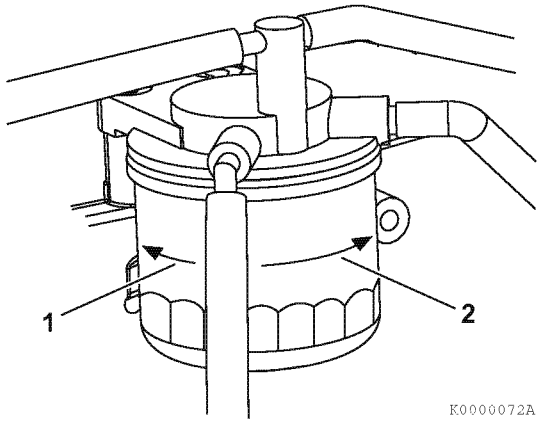


Figure 13

4. Clean the filter mounting surface and apply a small amount of diesel fuel to the gasket of the new fuel filter.
5. Install the new fuel filter. Hand-tighten it to the right **(Figure 13, (2))** until it comes in contact with the mounting surface. Use a filter wrench and tighten to 14 - 17 ft-lb (19.6 - 23.5 N·m, 2.0 - 2.4 kgf/m) or one additional turn using the filter wrench.

Fuel filter Part No.
129A00-55800

6. Open the fuel cock of the fuel filter/water separator.
7. Prime the fuel system. *See Priming the Fuel System on page 41.*
8. Check for fuel leaks.

NOTICE

Be sure to perform priming the engine before starting. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

■ Replace filter of fuel filter/water separator

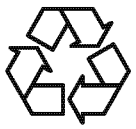
⚠ DANGER

Fire and Explosion Hazard!

- **Diesel fuel is flammable and explosive under certain conditions.**

- **Never use diesel fuel as a cleaning agent.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **Never use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

NOTICE



- Always be environmentally responsible.

- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Periodically clean the fuel filter/water separator element and inside the cup.

1. Position an approved container under the cup **(Figure 14, (1))** of the fuel filter/water separator to collect the contaminants.
2. Close **(Figure 14, (2))** the fuel cock **(Figure 14, (3))**.
3. Loosen the drain cock **(Figure 14, (4))** and drain the fuel.
4. Turn the cup **(Figure 14, (1))** to the left **(Figure 14, (10))** and remove the cup **(Figure 14, (1))**. If equipped, disconnect the sensor wire from the cup before removing the cup.
5. Carefully hold the cup to prevent fuel from spilling. If you spill any fuel, clean up the spill completely.

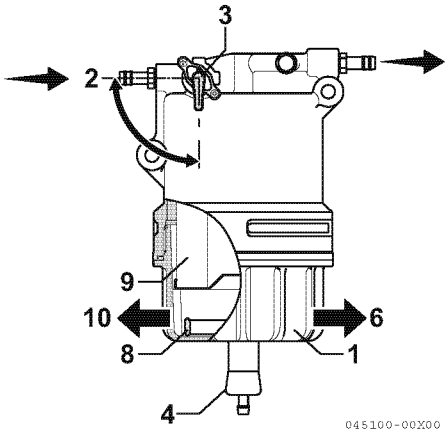


Figure 14

6. Remove the float ring **(Figure 14, (8))** from the cup. Pour the contaminants into the container and dispose of it properly.
7. Clean the inside cup.

Applicable element Part No.	
All models	129A00-55730

8. Install the new element into the body.
9. Position the float ring in the cup.
10. Check the condition of the O-ring. Replace if necessary.

11. Install the cup to the bracket by tightening the retaining ring to the right **(Figure 14, (6))** to 27 - 33 N·m (2.8 - 3.4 kgf·m).
12. Close the drain cock. Reconnect the sensor wire if equipped (tightening torque for cock: 1.0 - 2.0 N·m (0.1 - 0.2 kgf·m).
13. Open the fuel cock **(Figure 14, (3))**.
14. Prime the fuel system. *See Priming the Fuel System on page 41.*
15. Check for leaks.

Every 1000 Hours of Operation

Perform the following maintenance every 1000 hours of operation.

- **Drain, flush and refill cooling system with new coolant**
- **Adjust intake/exhaust valve clearance if required**

■ Drain, flush and refill cooling system with new coolant

⚠ DANGER

Scald Hazard!

- **Never remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.**
- **Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.**
- **Always check the level of the engine coolant by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

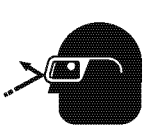
⚠ WARNING

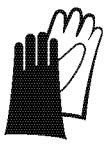
Burn Hazard!

- **Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.**
- **Failure to comply could result in death or serious injury.**

⚠ CAUTION

Coolant Hazard!





- **Wear eye protection and rubber gloves when you handle long life or extended life engine coolant. If contact with the eyes or skin should occur, flush eyes and wash immediately with clean water.**
- **Failure to comply may result in minor or moderate injury.**

NOTICE

- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Engine coolant contaminated with rust or water scale reduces the cooling effect. Even when extended life engine coolant is properly mixed, the engine coolant gets contaminated as its ingredients deteriorate. Drain, flush and refill the cooling system with new coolant every 1000 hours or once a year, whichever comes first.

1. Allow engine and coolant to cool.
2. Remove the radiator cap **(Figure 15, (1))**.
3. Remove the drain plug or open the drain cock **(Figure 15, (2))** at the bottom of the radiator and drain the engine coolant.

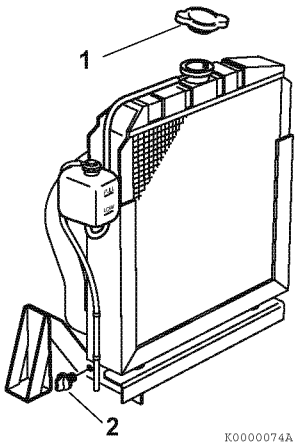


Figure 15

4. Drain the coolant from the engine block.

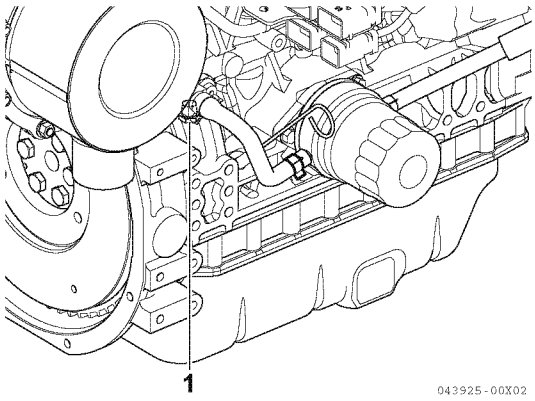


Figure 16

5. After draining the engine coolant, flush the radiator and engine block to remove any rust, scale and contaminants. Then reinstall and tighten the drain plug or close the drain cock in the radiator. Reinstall and tighten the engine block drain plug or reconnect the coolant hose at the oil cooler.
6. Fill radiator and engine with engine coolant. *See Filling Radiator with Engine Coolant on page 44.*

■ Adjust intake/exhaust valve clearance

Proper adjustment is necessary to maintain the correct timing for opening and closing the valves. Improper adjustment will cause the engine to run noisily, resulting in poor engine performance and engine damage. See your authorized YANMAR industrial engine dealer or distributor to adjust the intake/exhaust valve clearance.

Every 1500 Hours of Operation

Perform the following maintenance every 1500 hours of operation.

- **Inspect, clean and test fuel injectors, if necessary**
- **Clean EGR cooler**
- **Inspect crankcase breather system**

■ Inspect, clean and test fuel injectors

⚠ WARNING

High-Pressure Hazard!

- **Avoid skin contact with the high-pressure diesel fuel spray caused by a fuel system leak such as a broken fuel injection line. High-pressure fuel can penetrate your skin and result in serious injury. If you are exposed to high-pressure fuel spray, obtain prompt medical treatment.**
- **Never check for a fuel leak with your hands. Always use a piece of wood or cardboard. Have your authorized YANMAR industrial engine dealer or distributor repair the damage.**
- **Failure to comply could result in death or serious injury.**

Proper operation of the fuel injectors is required to obtain the optimum injection pattern for full engine performance. The EPA/ARB requires that you have the injectors inspected, cleaned and tested every 1500 hours. See your authorized YANMAR industrial engine dealer or distributor for this service.

This procedure is considered normal maintenance and is performed at the owner's expense. This procedures is not covered by the YANMAR Limited Warranty.

■ Clean EGR cooler

The EGR cooler is apt to be contaminated with rust and scale that deteriorate the cooling performance. Carbon accumulation in the exhaust gas passage of the cooler hinders circulation of exhaust gas, resulting in deterioration in exhaust gas cleanup performance.

To prevent such a problem, clean the cooler at least every 1500 hours.

Consult your local YANMAR dealer for this service.

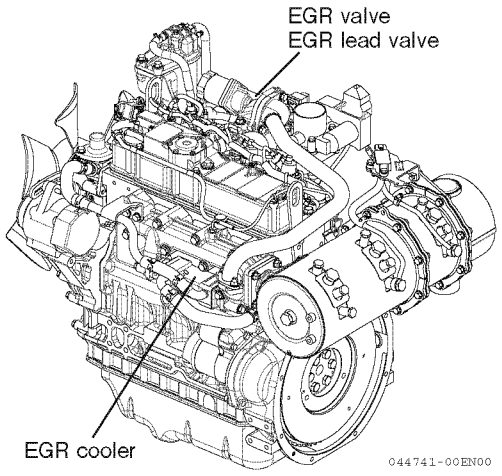


Figure 17

■ Inspect crankcase breather system

Proper operation of the crankcase breather system is required to maintain the emission requirements of the engine. The EPA/ARB requires that you have the crankcase breather system inspected every 1500 hours. See your authorized YANMAR industrial engine dealer or distributor for this service.

Every 2000 Hours of Operation

Perform the following maintenance every 2000 hours of operation.

- **Check and replace fuel hoses and engine coolant hoses**
- **Lap the intake and exhaust valves**

■ Check and replace fuel hoses and engine coolant hoses

NOTICE

- Always be environmentally responsible.
- Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.
- Never dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.
- Failure to follow these procedures may seriously harm the environment.

Regularly check the fuel system and engine coolant system hoses. If they are cracked or degraded, replace them. Replace the hoses at least every two years. See your authorized YANMAR industrial engine dealer or distributor to replace fuel hoses and engine coolant system hoses.

■ Lap the intake and exhaust valves

Adjustment is necessary to maintain proper contact of the valves and seats. See your authorized YANMAR industrial engine dealer or distributor to lap the valve seats.

Every 3000 Hours of Operation

Perform the following maintenance every 3000 hours of operation.

- **Inspect turbocharger (blower wash as necessary)**
  3TNV86CT, 4TNV86CT, 4TNV98CT
- **Inspect, clean and test EGR valve**
- **Check and clean injector**
- **Inspect and clean EGR lead valve**
- **Inspect and clean soot filter of DPF**
- **Check and test intake throttle valve operation**

■ Inspect turbocharger (blower wash as necessary)

3TNV86CT, 4TNV86CT, 4TNV98CT

Turbocharger service is required by the EPA/ARB every 3000 hours. Your authorized YANMAR industrial engine dealer or distributor will inspect and blower wash the unit if necessary. If you notice that the engine seems sluggish or the exhaust color is abnormal never wait until the next periodic interval. Have your authorized YANMAR industrial engine dealer or distributor service the turbocharger soon.

■ Inspect, clean and test EGR valve

The EGR valve is a key component for cleaning exhaust gas.

To prevent the valve from deteriorating in exhaust gas recirculation performance due to carbon accumulation, inspect, clean and test the valve at least every 3000 hours.

Consult your local YANMAR dealer for this service.

■ Check and clean injector

Check the injector tip. Clean the injector tip with a soft brush or replace it if necessary.

■ Inspect and clean EGR lead valve

The EGR lead valve is located in the passage of recirculated gas.

To prevent carbon accumulation in or clogging of the lead valve, inspect and clean the lead valve at regular intervals.

Consult your local YANMAR dealer for this service.

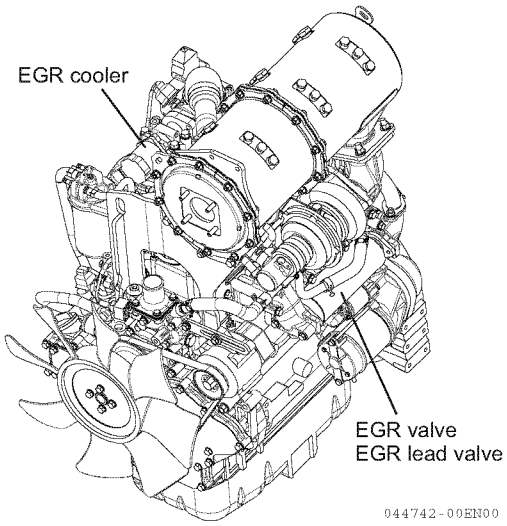


Figure 18

■ Inspect and clean soot filter

See your authorized YANMAR distributor to clean the soot filter.

■ Intake throttle

The intake throttle is a device that controls the amount of the engine air intake. The TNV series engines use it for the combustion of soot collected inside the DPF. The intake throttle is driven by the DC motor. The ECU controls the appropriate degree of opening of the throttle depending on the engine speed and load conditions. Accordingly, the engine takes in the minimum required amount of air to increase the exhaust temperature and burn soot inside the DPF.

Precautions for handling the intake throttle

- Do not use a throttle after you have dropped it. Even if it appears okay on the outside, it may have internal damage.
- Do not apply excessive impact or load to the throttle.
- Do not touch the stop screw part, as it has already been adjusted.
- Prevent any foreign matter including oil, dust, and water droplets from entering the air passage part.
- Do not remove the sensor cover installation rivet.
- Consider static electricity and prevent static electric charge of the human body when handling the throttle.
- Do not touch the sensor cover terminal directly.
- Do not touch the throttle valve with your hands when the throttle is energized.
  Your hands may get pinched in the valve and get injured.
- Do not check operation with the installation surface of the throttle unit pointing down, as the valve protrudes from the installation surface.
- Prevent water and foreign matter from entering the connector connection part.

Characteristics of the intake throttle

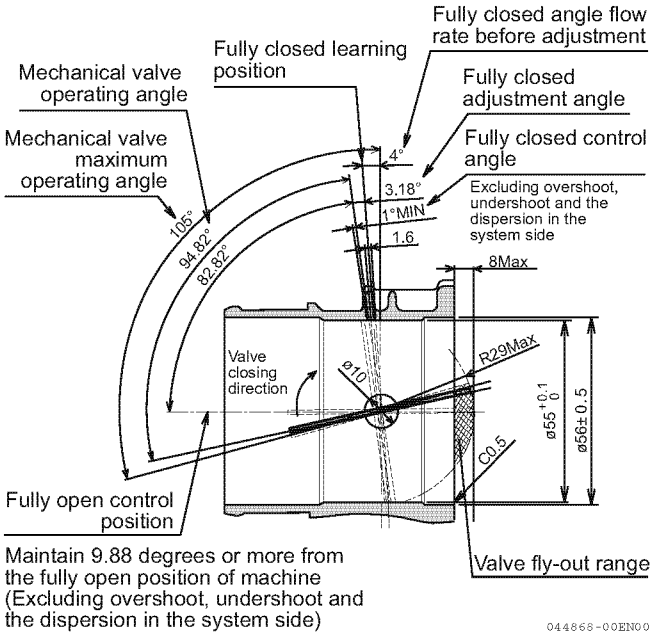


Figure 19

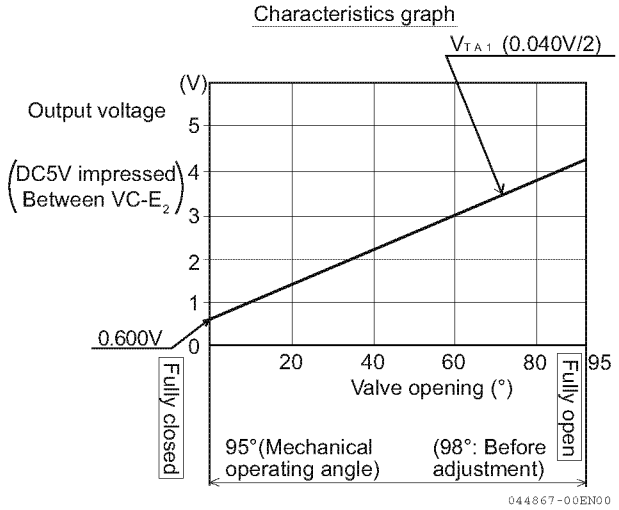


Figure 20

For details, contact your nearest YANMAR dealer or distributor.

TROUBLESHOOTING

If a problem occurs, stop the engine immediately. Refer to the SYMPTOM column in the Troubleshooting Chart to identify the problem.

NOTICE

If any indicator fails to illuminate when the key switch is in the ON position, see your authorized YANMAR industrial engine dealer or distributor for service before operating the engine.

If any indicator illuminates during engine operation, stop the engine immediately. Determine the cause and repair the problem before you continue to operate the engine.

TROUBLESHOOTING CHART

Symptom	Probable cause	Action	Refer to
Indicator turns ON - engine running			
Engine oil pressure indicator	Low level of engine oil	Check and adjust oil level as necessary	*Checking Engine Oil on page 42*
	Too high an oil level		
	Clogged engine oil filter	Replace engine oil filter	*Replace engine oil and engine oil filter on page 60*
Engine coolant indicator	Low engine coolant level	Add engine coolant	*Filling Radiator with Engine Coolant on page 44*
	Dirty radiator fins	Clean the radiator fins	*Check and clean radiator fins on page 68*
	Engine coolant leaking	See authorized YANMAR industrial engine dealer or distributor	–
	V-belt loose or damaged	Adjust V-belt or replace	*Check and adjust cooling fan V-belt on page 63*
	Contaminated engine coolant	See authorized YANMAR industrial engine dealer or distributor	–
	Faulty engine coolant pump		–
Battery Indicator	V-belt loose or damaged	Adjust V-belt or replace	*Check and adjust cooling fan V-belt on page 63*
	Battery failure	Check battery condition	*Check battery on page 65*
	Faulty alternator	See authorized YANMAR industrial engine dealer or distributor	–
Indicator does not turn ON - key switch is turned to ON (OFF → ON) - engine not running			
	Faulty electrical wiring or faulty indicator	See authorized YANMAR industrial engine dealer or distributor	–
Indicator stays ON - key switch is turned from START to ON (START → ON) - engine not running			
Battery indicator stays ON	Faulty alternator	See authorized YANMAR industrial engine dealer or distributor	–
Engine oil pressure indicator stays ON	Faulty engine oil pressure switch		–
	No or low level of engine oil	Check and adjust oil level as necessary	*Checking Engine Oil on page 42*
	Clogged engine oil filter	Replace engine oil filter	*Replace engine oil and engine oil filter on page 60*

Symptom	Probable cause	Action	Refer to
Engine does not start			
Starter motor operates but engine does not start	No diesel fuel	Refuel and prime fuel system	*Filling the Fuel Tank on page 40*
	Air in fuel system	Prime fuel system	*Priming the Fuel System on page 41*
	Improper diesel fuel	Replace with recommended diesel fuel	*Diesel Fuel Specifications on page 38*
	Clogged fuel filter	Replace fuel filter	*Replace fuel filter on page 70*
	Poor fuel injection	See authorized YANMAR industrial engine dealer or distributor	–
	Compressed air leakage from intake/exhaust valves		–
	Faulty engine stop solenoid		–
Starter motor does not operate or rotates too slowly (engine can be turned manually)	Battery needs charging	Check electrolyte, recharge	*Check battery on page 65*
	Faulty cable connection at battery terminals	Clean terminals, retighten	–
	Faulty starter switch	See authorized YANMAR industrial engine dealer or distributor	–
	Faulty starter motor		–
Engine cannot be manually turned	Inner parts seized or damaged		–
White or black exhaust smoke			
Black exhaust smoke	Engine overloaded	Reduce load	–
	Clogged air cleaner element	Clean element or replace	*Clean air cleaner element on page 68*
	Improper diesel fuel	Replace with recommended diesel fuel	*Diesel Fuel Specifications on page 38*
	Faulty spraying of fuel injection	See authorized YANMAR industrial engine dealer or distributor	–
	Excessive intake/exhaust valve clearance		–
	Faulty EGR valve		–
White exhaust smoke	Improper diesel fuel	Replace with recommended diesel fuel	*Diesel Fuel Specifications on page 38*
	Faulty spray pattern of fuel injection	See authorized YANMAR industrial engine dealer or distributor	–
	Fuel injection timing delay		–
	Engine burning oil		–

TROUBLESHOOTING OF ELECTRONIC CONTROL SYSTEM

⚠ WARNING

- **Never use the E-ECU for other purposes than intended or in other ways than specified by YANMAR. Doing so could result in the violation of emission control regulations and will void the product warranty.**
- **Replacing the fuel injection pump involves rewriting the fuel injection data in the E-ECU. Be sure to contact your local YANMAR dealer before replacing the fuel injection pump. Failure to rewrite the fuel injection data before replacing the fuel injection pump will void the engine warranty.**
- **Replacing the E-ECU involves migrating the fuel injection data to the existing E-ECU to the new unit. Be sure to contact your local YANMAR dealer before replacing the E-ECU. Failure to migrate the fuel injection data before replacing the E-ECU will void the engine warranty.**
- **Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.**

Fault Detection Capability

The E-ECU has a fault detection capability. *See Troubleshooting for Electronic Control System on page 86.*

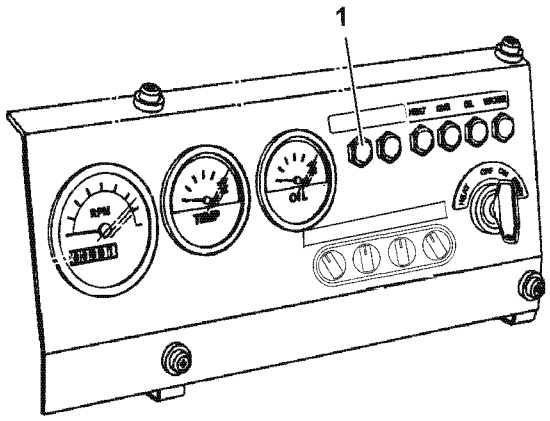
A fault indicator (optional) is located on the operator's console as shown in **Figure 1**.

This indicator comes on at power up of the E-ECU and goes out after 2 sec.

Once a fault is detected, then the indicator flashes in certain patterns, providing fault information to the operator.

NOTICE

Shut down the engine if the fault indicator comes on. Continuing running the engine with the fault indicator being on may result in a serious malfunction of or damage to the engine, and will void the engine warranty.



1 – Fault indicator

Figure 1

Figure 1 Typical operator's console

Figure 2 exemplifies flashing patterns that represent an accelerator fault (5 flashes) or EGR valve fault (1 to 3 flashes) occurring at power up. If multiple faults occur simultaneously, the indicator indicates all the faults in order of smaller to larger number of flashes.

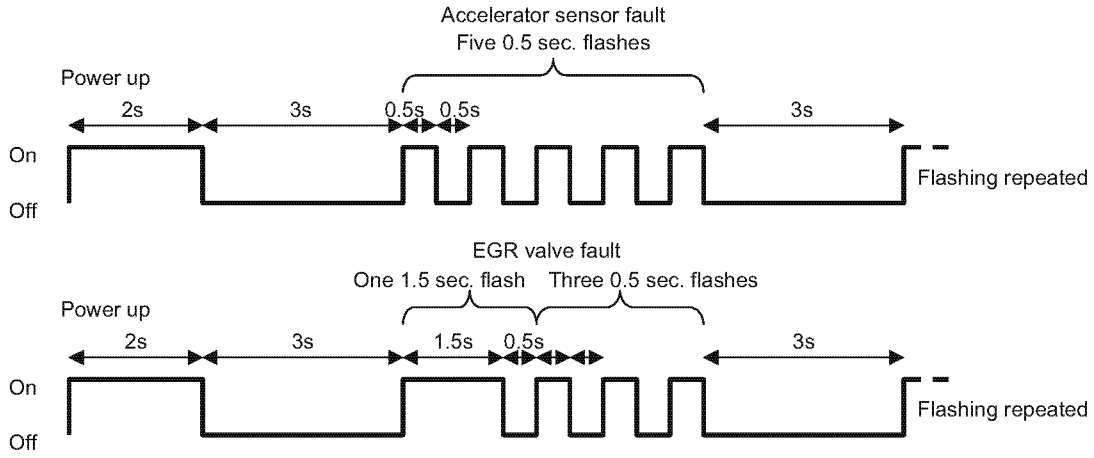


Figure 2

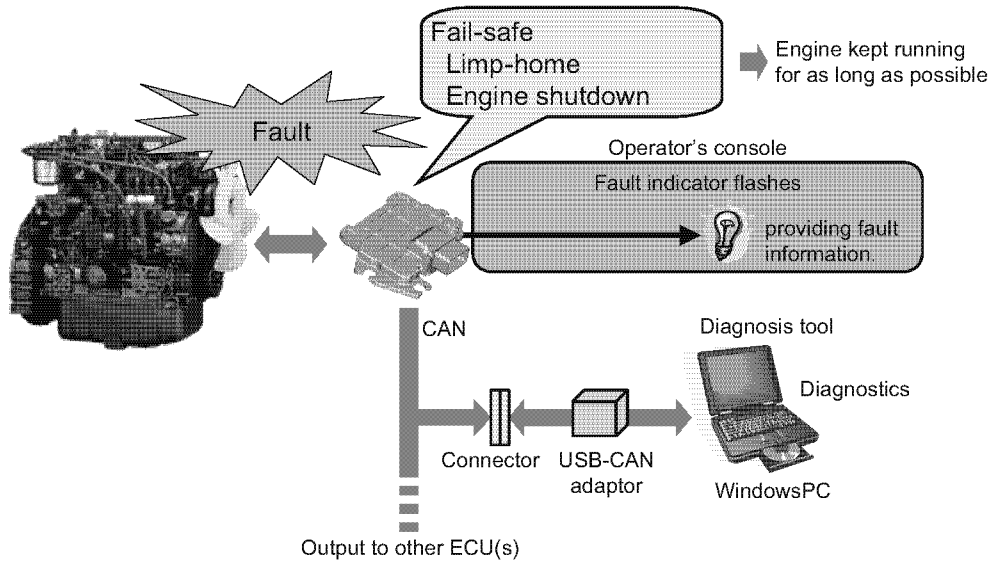


Figure 3

NOTICE

If the fault indicator comes on, check and note the flashing pattern, shut down the engine without delay and contact your local YANMAR dealer.

The YANMAR genuine diagnosis tool allows reviewing detailed fault information, historical fault/alarm logs and freeze frame data, monitoring the engine status and carrying out the fault diagnosis. See **Figure 3**.

Events in the fault/alarm logs can be time stamped.

Diagnosis Tool

A connector is provided at an end of the harness of the driven machine so that the YANMAR genuine diagnosis tool can be loaded with data from the E-ECU. See **Figure 4** and **Figure 5**.

When the fuel injection pump is replaced, data in the E-ECU must also be replaced for accommodating the new pump. When the E-ECU is replaced, the fuel injection data in the existing unit must be migrated to the new unit. The diagnosis tool can be used for the data replacement or migration. Contact your local YANMAR dealer for replacement of the fuel injection pump or E-ECU.

For operation of the diagnosis tool, see the manual for the tool.

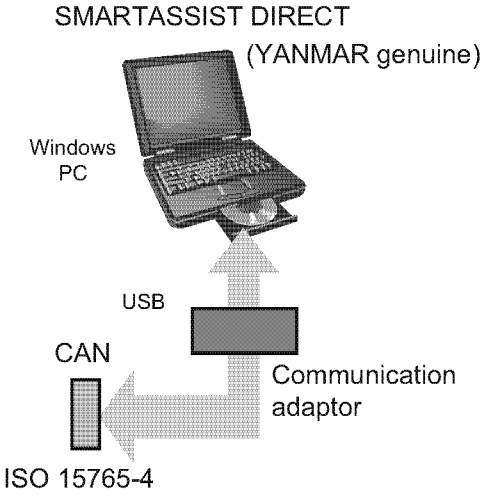


Figure 4

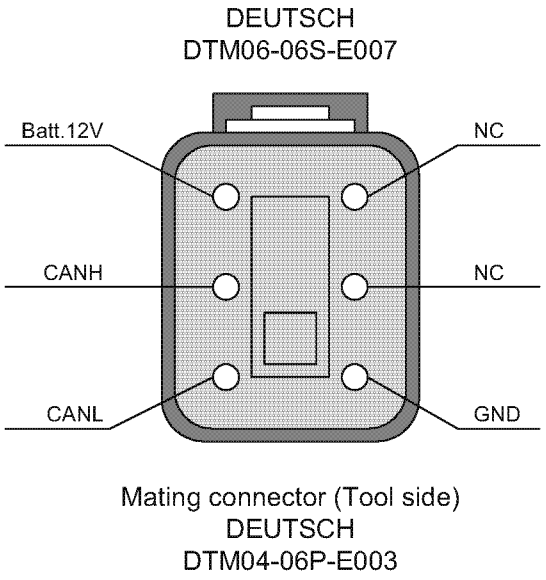


Figure 5

TROUBLESHOOTING INFORMATION

If your engine does not operate properly, refer to the troubleshooting chart or consult your authorized YANMAR industrial engine dealer or distributor.

Supply the authorized YANMAR industrial engine dealer or distributor with the following information:

- Model name and serial number of your engine
- The driven machine type (tractor, generator, skid steer loader), manufacturer's name, model and serial number
- How long the engine has been in service (the number of engine hours or the number of calendar months)
- Operating conditions when problem occurs:
  - Engine RPM
  - Color of exhaust smoke
  - Type of diesel fuel
  - Type of engine oil
  - Flashing patterns of indicators
  - Any abnormal noises or vibration
- Operating environment such as high altitude or extreme ambient temperatures, etc.
- Engine maintenance history and previous problems
- Other factors that contribute to the problem

TROUBLESHOOTING FOR ELECTRONIC CONTROL SYSTEM

See ECU Troubleshooting Manual for detail.

LONG-TERM STORAGE

This section of the Operation Manual describes the procedures necessary to place the engine into long-term storage (six months or longer) and how to place it back into operation.

BEFORE YOU PLACE THE ENGINE IN LONG-TERM STORAGE

⚠ DANGER

Explosion Hazard!

- **Never short out the battery terminals, including when checking the remaining battery charge. This will result in a spark and may cause an explosion or fire. Use a hydrometer to check the remaining battery charge.**
- **If the electrolyte is frozen, slowly warm the battery before you recharge it.**
- **Failure to comply will result in death or serious injury.**

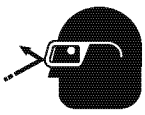
⚠ WARNING

Burn Hazard!

- **Batteries contain sulfuric acid. Never allow battery fluid to come in contact with clothing, skin or eyes. Severe burns could result. Always wear safety goggles and protective clothing when servicing the battery. If battery fluid contacts the eyes and/or skin, immediately flush the affected area with a large amount of clean water and obtain prompt medical treatment.**
- **Failure to comply could result in death or serious injury.**

⚠ CAUTION

Flying Object Hazard!



- **Always wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**
- **Failure to comply may result in minor or moderate injury.**

NOTICE

Protect the air cleaner, turbocharger (if equipped) and electric components from damage when you use steam or high-pressure water to clean the engine.

Perform the next Preventive Maintenance procedure. For example, if there are 10 hours remaining before the 250 hour maintenance, you should do the maintenance before you place the engine in storage.

See Periodic Maintenance Schedule on page 58.

1. Flush the radiator and refill with Long Life Engine Coolant. *See Engine Coolant Specifications on page 44* for engine coolant specifications and *See Filling Radiator with Engine Coolant on page 44* for the procedure for draining and refilling the cooling system.
2. Clean the exterior of the engine so it is free of grease and oil.
3. Drain the fuel tank or make sure it is completely full. *See Filling the Fuel Tank on page 40.*
4. Lubricate exposed parts of the engine speed control system.
5. Protect the air cleaner, muffler and electrical components (alternator, starter motor, switches, EGR valve, controller) from water and dust.
6. Disconnect the negative (-) battery cable to prevent the battery from discharging.
7. Check the battery fluid and add distilled water as required. *See Check battery on page 65.*
8. Charge the battery once a month during storage.
9. Rotate the engine without starting, every four to six months.

RETURNING THE ENGINE TO SERVICE

1. Perform the *Daily Checks on page 46*.
2. The engine should be pre-oiled before startup. Crank the engine, leaving the fuel system shut off so the engine will not start, for 15 seconds. Then pause for 30 seconds. Repeat the procedure until you have cranked the engine for a total of one minute. This will circulate the oil in the engine's lubrication system.
3. Prime the fuel system. *See Priming the Fuel System on page 41*.
4. Start the engine. Allow the engine to idle for approximately 15 minutes while you check for:
   - Proper oil pressure
   - Fuel, engine oil, or coolant leaks
   - Proper operation of the indicators and/or gauges.
5. Avoid prolonged operation at minimum or maximum engine speeds and loads for the remainder of the first hour of operation.

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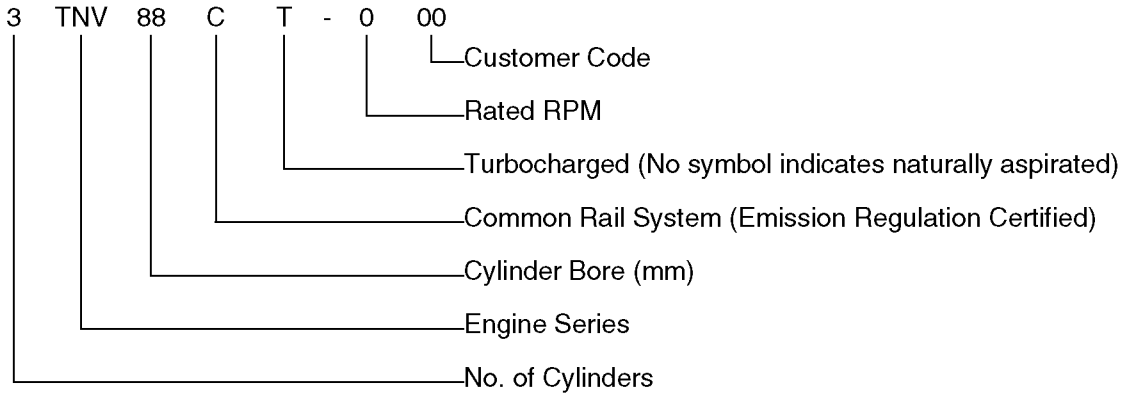
SPECIFICATIONS

GENERAL



Engine General Specifications

Type	Vertical in-line, water cooled, 4-cycle diesel engine
Combustion system	Direct Injection with common rail injection system
Starting system	Electric starting
Cooling system	Radiator
Lubricating system	Forced lubrication with trochoid pump
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end

Note:

- *The information described in Principal Engine Specifications is for a "standard" engine. To obtain the information for the engine installed in your driven machine, please refer to the manual provided by the driven machine manufacturer.*
- *Engine rating conditions are as follows (SAE J1349, ISO 3046/1):*
  - *Atmospheric condition: Room temperature 25 °C (77 °F), atmospheric pressure 29.53 in. Hg (100 kPa, 750 mm Hg), relative humidity 30 %*
  - *Fuel temperature at fuel injector pump inlet: 40 °C (104 °F)*
  - *Fuel feeding pressure: 20 ± 10 kPa (net) after engine break-in has been performed with the cooling fan, air cleaner and muffler installed to the engine.*
  - *With cooling fan, air cleaner, muffler: YANMAR standard*
  - *After the engine break-in period. Output allowable deviation: ± 3 %*
  - *1 PS = 0.7355 kW*
  - *1 hp SAE (Society of Automotive Engineers) = 0.7457 kW*

PRINCIPAL ENGINE SPECIFICATIONS

■ 3TNV88C

Engine model	3TNV88C
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Naturally aspiration
No. of cylinders	3
Bore × stroke	88 × 90 mm
Displacement	1.642 ℓ
Max. rated output (gross)	3000 min^{-1}
	27.5 kW
	37.4 PS
High idling	3150 ± 25 min^{-1}
Engine weight (dry)	188 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.34 - 0.54 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 1.7 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 413CCA
Dimensions (L × W × H)	depend on DPF layout
Engine oil pan capacity	6.7/3.9 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	2.0 ℓ (Engine only)
Standard cooling fan	ø335 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø110/ø110 mm
Top clearance	0.73 ± 0.06 mm

SPECIFICATIONS

■ 3TNV86CT

Engine model	3TNV86CT
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Turbocharged
No. of cylinders	3
Bore x stroke	86 x 90 mm
Displacement	1.568 ℓ
Max. rated output (gross)	3000 min^{-1}
	31.0 kW
	42.1 PS
High idling	3150 ± 25 min^{-1}
Engine weight (dry)	200 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.34 - 0.54 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 1.7 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 413CCA
Dimensions (L x W x H)	depend on DPF layout
Engine oil pan capacity	6.7/3.9 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	2.0 ℓ (Engine only)
Standard cooling fan	ø350 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø110/ø110 mm
Top clearance	0.73 ± 0.06 mm

■ 4TNV88C

Engine model	4TNV88C
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Naturally aspiration
No. of cylinders	4
Bore x stroke	88 x 90 mm
Displacement	2.189 ℓ
Max. rated output (gross)	3000 min^{-1}
	35.5 kW
	48.3 PS
High idling	3150 ± 25 min^{-1}
Engine weight (dry)	220 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.32 - 0.47 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 1.7 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 622CCA
Dimensions (L x W x H)	depend on DPF layout
Engine oil pan capacity	7.4/4.0 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	2.7 ℓ (Engine only)
Standard cooling fan	ø370 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø110/ø110 mm
Top clearance	0.73 ± 0.06 mm

■ 4TNV86CT

Engine model	4TNV86CT
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Turbocharged
No. of cylinders	4
Bore x stroke	86 x 90 mm
Displacement	2.090 ℓ
Max. rated output (gross)	3000 min^{-1}
	44.0 kW
	59.8 PS
High idling	3150 ± 25 min^{-1}
Engine weight (dry)	225 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.36 - 0.51 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 1.7 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 622CCA
Dimensions (L x W x H)	depend on DPF layout
Engine oil pan capacity	7.4/4.0 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	2.7 ℓ (Engine only)
Standard cooling fan	ø370 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø110/ø110 mm
Top clearance	0.73 ± 0.06 mm

■ 4TNV98C

Engine model	4TNV98C
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Naturally aspiration
No. of cylinders	4
Bore x stroke	98 x 110 mm
Displacement	3.319 ℓ
Max. rated output (gross)	2500 min^{-1}
	51.7 kW
	70.3 PS
High idling	2650 ± 25 min^{-1}
Engine weight (dry)	280 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.29 - 0.39 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 3.0 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 799CCA
Dimensions (L x W x H)	depend on DPF layout
Engine oil pan capacity	10.5/6.0 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	4.2 ℓ (Engine only)
Standard cooling fan	ø430 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø130/ø130 mm
Top clearance	0.793 ± 0.063 mm

■ 4TNV98CT

Engine model	4TNV98CT
Version	VM
Type	Vertical in-line diesel engine (common rail system)
Combustion system	Direct injection
Aspiration	Turbocharged
No. of cylinders	4
Bore x stroke	94 x 110 mm
Displacement	3.053 ℓ
Max. rated output (gross)	2500 min^{-1}
	53.7 kW
	73.0 PS
High idling	2650 ± 25 min^{-1}
Engine weight (dry)	291 kg
PTO position	Flywheel end
Direction of rotation	Counterclockwise viewed from flywheel end
Cooling system	Liquid-cooled with radiator
Lubricating system	Forced lubrication with trochoid pump
Normal oil pressure at rated engine speed	0.29 - 0.39 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (starter motor: DC12 V - 3.0 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 799CCA
Dimensions (L x W x H)	depend on DPF layout
Engine oil pan capacity	10.5/6.0 ℓ Dipstick upper limit/lower Limit
Engine coolant capacity	4.2 ℓ (Engine only)
Standard cooling fan	ø430 Pusher
Crank V-pulley dia./Fan V-pulley dia.	ø130/ø130 mm
Top clearance	0.793 ± 0.071 mm

■ Setting output list by rotation

Model	Displacement	Gross output (kW)									
		2000	2100	2200	2300	2400	2500	2600	2700	2800	3000
3TNV88C	1.642	–	–	–	–	21.8	22.8	23.7	24.6	25.5	27.5
3TNV86CT	1.568	–	–	–	–	–	27.4	28.5	–	31.0	32.4
4TNV88C	2.189	24.2	25.4	26.7	27.9	29.1	30.5	31.7	33.0	34.3	35.5
4TNV86CT	2.091	–	–	–	–	35.5	36.6	37.9	39.5	41.1	44.0
4TNV98C	3.318	42.4	44.3	46.2	48.1	49.9	51.7	–	–	–	–
4TNV98CT	3.318	51.6	53.7	53.7	53.7	53.7	53.7	–	–	–	–

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