Engine

Section 03-09

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines, which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

Table of Contents

List of Figures

Scope of This Publication, 03-09

Proper fuel selection, maintenance, and storage have great importance in the life of diesel-powered machines. Following these recommendations will help to increase production, reduce maintenance expenses and increase the life of the engine.

Proper maintenance of the cooling system is critical to the service life of diesel-powered machines.

NOTICE

In addition to these general instructions, it is IMPORTANT to refer to the engine manufacturer's recommendations regarding proper fuel, storage, oil and filter change intervals, and general engine maintenance.

Customer Responsibilities and Warranty Advisories

P&H wheel loaders are warranted in accordance with the warranty policy provided with the machine. The recommended operating and maintenance procedures set forth shall be followed to ensure warranty coverage is not jeopardized. Failure to comply with recommended operating and maintenance procedures may void machine warranty.

Any questions or problems relating to warranty policy or administration should be directed to Komatsu Service Center. Include the model and serial number, in-service date of the machine, and hour meter reading. **We especially draw your attention to the following safety advisors.**

This Page Intentionally Left Blank

Safety

This publication contains special instructions that pertain to safety, operation, maintenance, and repair of the machine. Listed below are the signal words and symbols that precede these instructions and their meanings:

⚠ DANGER

- **The danger label indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING

- **The warning label indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION

- **The caution label, used with the safety alert symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury (includes the safety alert symbol ⚠).**

CAUTION

- **The caution label (without safety alert symbol) is used to address practices not related to personal injury – only equipment damage.**

NOTICE

The NOTICE graphic is to indicate areas of importance to the reader that are not related to personal injury or machine damage.

Safety, Warnings and Cautions

⚠ WARNING

INHALATION AND SKIN HAZARDS

- **Inhalation and skin hazards exists if contacting microbes or fungi from a fuel reservoir. When a fuel tank is contaminated and cleaning is necessary, workers must be protected with breathing apparatuses. The most common problem associated with exposure to these microorganisms is dermatitis, which can be very serious. Any exposed skin must be thoroughly washed with warm, soapy water. Avoid eating, drinking and smoking while working with contaminated tanks. Any ingestion of microorganisms or exposure to broken skin must be considered serious. It is recommended that if this happens the worker be taken to a doctor, along with a sample of the microorganisms. Failure to prevent inhalation or skin contact with microbes or fungi can cause inhalation and skin hazards resulting in serious injury or death.**

INHALATION AND EXPLOSION HAZARDS

- **Inhalation and explosion hazards exist inside the cab if spraying ether-starting aid into the air intake of the Komatsu Cartridge Filtration System (KLENZ™ system). The KLENZ system provides fresh air to the cab (and other components). Inhalation of ether fumes is dangerous and can**

render a person unconscious or cause death. Ether fumes are extremely flammable. They can build up inside the cab and cause an explosion. Never use ether starting aid to start the engine. The use of ether is NOT recommended by Komatsu as an engine starting aid. Using ether starting aid in the engine intake can cause an inhalation and explosion hazard resulting in serious injury or death.

INHALATION AND SKIN HAZARDS

- **Inhalation and skin hazards exist if contacting microbes or fungi from a fuel reservoir. When a fuel tank is contaminated and cleaning is necessary, workers must be protected with breathing apparatuses. The most common problem associated with exposure to these microorganisms is dermatitis, which can be very serious. Any exposed skin must be thoroughly washed with warm, soapy water. Avoid eating, drinking and smoking while working with contaminated tanks. Any ingestion of microorganisms or exposure to broken skin must be considered serious. It is recommended that if this happens the worker be taken to a doctor, along with a sample of the microorganisms. Failure to prevent inhalation or skin contact with microbes or fungi can cause inhalation and skin hazards resulting in serious injury or death.**

CRUSH HAZARD

- **Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.**

BURN HAZARD

- **Burn hazard exists when working on or around hot cooling systems. Liquid cooling systems build up pressure, as the engine gets hot. Before removing the radiator cap, stop the engine and let the system cool. Remove the radiator cap or surge tank cap only after the coolant is cold. Failure to allow the coolant to cool can result in serious burns.**
- **Burn hazard exists if removing the radiator cap on a hot radiator. Wait for the coolant to cool before removing an engine radiator cap or engine coolant surge reservoir cap. Serious injury may result from escaping steam and hot coolant. On machines that utilize surge reservoirs, turn the ball valve to release the pressure before removing surge reservoir cap. Failure to wait for the coolant to cool can cause burn hazards resulting in serious burn injury.**

EXPLOSION HAZARD

- **Explosion hazards exist if blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel. Never mix these chemicals together. This practice creates an extreme fire hazard and under certain conditions an explosive hazard. Blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel can cause a fire or explosion hazard resulting in serious injury or death.**
- **Explosion hazards exist if spraying ether-starting aid into the air intake of the Komatsu Cartridge Filtration System (KLENZ™ system). Ether fumes are extremely flammable. Never use ether starting aid to start the engine. The use of ether is NOT recommended by Komatsu as an engine starting aid. The KLENZ system provides air to the engine turbos, generator, motors, and cab. Using ether starting aid in the engine intake can cause an explosion hazard resulting in serious injury or death.**

INHALATION HAZARD

- **Inhalation hazard exists when working around engine exhaust. Always have proper ventilation when working around engine exhaust. Failure to use proper ventilation can cause inhalation hazard resulting in serious injury or death.**

WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel.

⚠ CAUTION

FIRE HAZARD

- **Fire hazard exists if the fuel reservoir is filled all the way to the top. Fuel expands as it gets warm and may overflow. Stop fueling the reservoir before the level reaches the top of the filler neck. Filling the fuel reservoir to the top can cause a fire hazard resulting in personal injury.**

BURN HAZARD

- **Burn hazard exists if unwrapping the engine exhaust piping or muffler while hot. Wait for the engine exhaust to cool off before unwrapping the exhaust pipes for inspection. Failure to wait for the exhaust to cool off can cause burn hazards resulting in personal injury.**

BURNS AND FALL HAZARDS

- **Burns and fall hazards exist if working around the engine exhaust stacks while they are hot. The ends of the stacks extend outside the guard assembly and can be physically touched. Touching the stacks while hot can produce severe burns. Personal injury from burns, or reacting to burns and falling, is possible. Always wear personal protective equipment (PPE) to prevent burns. Failure to avoid touching the stacks can cause burn and fall hazards resulting in injury.**

STRUCK-BY HAZARDS

Struck-by hazards exist when around hydraulic fluid, air, fuel, or grease that is under pressure. Hoses under pressure can blow out or come loose from connections, causing a struck-by hazard with deadly force. DO NOT tighten or loosen hydraulic, air, fuel, or grease lines without first relieving the pressure. DO NOT make adjustments to any fluid pressures while the machine is running. Shut down the machine, make the adjustment, then restart the machine to check the adjustment. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly pressurized liquids or air. Failure to use proper PPE or to shut down the machine before making adjustments can cause a struck-by hazard resulting in serious injury or death.

BURN HAZARDS

Burn hazards exist when around hot hydraulic fluid that is under pressure. Hoses under pressure can blow out or come loose from connections, causing a burn hazard from leaks or spraying. DO NOT tighten or loosen hydraulic fluid hoses without first relieving the pressure. DO NOT make adjustments to any fluid pressures or flow while the machine is running. Shut down the machine, make the adjustment, then restart the machine to check the adjustment. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly hot pressurized liquids. Failure to use proper PPE or to shut down the machine before making adjustments can cause a burn hazard resulting in serious injury or death.

SKIN INJECTION HAZARD

Skin injection hazard exists when around diesel fuel, air, hydraulic fluid, or grease that is under pressure. Fluids under pressure can penetrate the skin and cause serious personal injury, blindness, or death. If any fluid is injected into the skin, it must be removed as soon as possible by a doctor familiar with treating this type of injury. Fluid or air leaks under pressure may not be visible. When searching for leaks, NEVER use your hand; use a piece of metal. Wear work gloves and keep your hand well away from the possible source of leakage. DO NOT tighten or loosen fuel, hydraulic, air, or grease lines without first relieving the pressure. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly pressurized liquids or air. Failure to use proper PPE can cause a skin injection hazard resulting in serious injury or death.

Environmental Precautions

NOTICE

Some environmental hazards can exist during the performance of a maintenance, repair, or adjustment procedure. Komatsu cannot anticipate all hazards present during a specific procedure. The following suggestions/requirements are provided to help avoid hazards that may have been identified during some procedures.

- **Be prepared to catch/contain and properly dispose of all fluids to prevent environmental spills and contamination. Some examples include:**
  - **Engine radiator coolant**
  - **Engine oil**
  - **Battery acid**
  - **Engine fuel (diesel)**

Theory of Operation

P&H wheel loaders use a diesel engine to rotate a generator to power the electric motors and turn a hydraulic pump drive (HPD). The engine is operated at set throttle speeds. The fuel system is critical to proper operation of the engine. The engine is water cooled by pumping the coolant (Tier 4 engines require RP-329A 50/50 coolant) through a radiator that has a thermostatically controlled fan.

This Page Intentionally Left Blank

Component Description

Engine

Applicable engine service, repair, PM, and parts information related to your specific engine is no longer provided to Komatsu by the engine manufacturers. This information is only available from your local Cummins or Detroit engine dealer.

Please provide your engine serial number to your local engine distributor to determine their options for online access or paper copies.

The serial number is typically located on the engines as shown below.

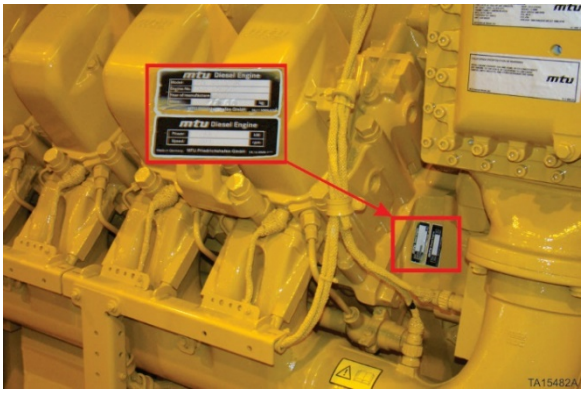
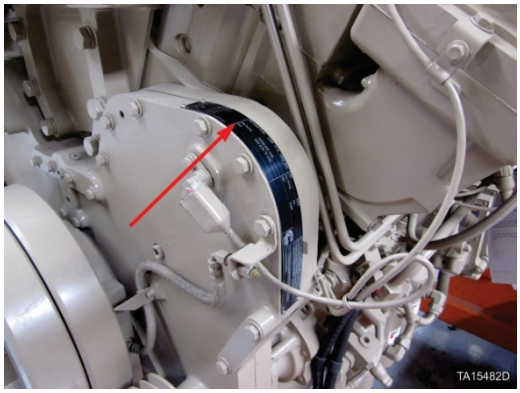
Detroit Diesel engine: The serial number is typically located on the left side of the engine on the generator end as shown below.	**Cummins engine:** The serial number is typically located on the left side of the engine on the engine fan end as shown below.
	
Typical location of tag on Detroit Diesel engine	**Typical location of tag on Cummins engine**

Figure 1. Engine serial number location

Komatsu will also have the SERIAL NUMBER available after installation of the new engine into the machine.

⚠ WARNING

Inhalation hazard exists when working around engine exhaust. Always have proper ventilation when working around engine exhaust. Failure to use proper ventilation can cause inhalation hazard resulting in serious injury or death.

WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel.

Fuel and Fuel System

NOTICE

Disposal of diesel fuel, used oil, hydraulic fluid, and engine coolant is subject to country, state, and local environmental regulations. Dispose of these items properly through approved reclamation facilities per applicable regulations. DO NOT flush or pour these items into streams or sewer systems. Improper disposal can cause an environmental impact.

Fuel Grade Selection

Diesel engines burn a wide variety of fuels. Use of clean fuel is imperative and selection of the right type is important. The two major grades of diesel fuel are 1-D and 2-D.

Grade 1-D

Grade 1-D is more volatile and is recommended for modern high-speed engines, with variable loads and speeds, as well as for operation in extremely cold weather, or at altitudes above 5000 ft.

Grade 2-D

Grade 2-D is recommended for high-speed engines, with relatively high loads and more uniform speeds, as well as for engines, not requiring the higher volatility of 1-D. Grade 2-D is generally less expensive than 1-D and more widely used.

Fuel Quality Selection Criteria

When evaluating diesel fuel for use in a machine, consider the following items and any others that may be noted in engine manufacturers' manuals or service bulletins.

Some fuels will give better performance, higher efficiency, improved reliability, or lower maintenance costs than others. Fuel must be selected based on overall operating costs, not just the price per gallon.

Most engine manufacturers' specifications refer to the tests done by The American Society for Testing and Materials (ASTM). Their test results are published in their Annual Book of Standards. It is IMPORTANT to verify the tests referred to by the manufacturer for various rating criteria are comparable to the test data on the fuel supplied by your fuel vendor.

Insist that the fuel vendor periodically supply the proper documentation to be sure the fuel meets the manufacturer's recommendations and the needs of your specific application. Fuel quality can change with each bulk delivery.

Cetane Rating

Ignition qualities of diesel fuels are measured by the cetane number, which is roughly comparable to the octane rating of gasoline. Cetane ratings are mistakenly used to indicate fuel quality. A high cetane number should not be considered alone when evaluating fuel quality. Cetane ratings vary from 33 to 64. High-cetane fuels permit engines to be started at lower air temperatures and higher altitudes, provide faster engine warm-up without misfiring, reduce varnish and carbon deposits, and help eliminate knock caused by slow ignition. Fuel with too high cetane rating can cause incomplete combustion, which can rapidly dilute and contaminate engine oil.

Fuel Sulfur Content

Fuels with high sulfur content cause rapid deterioration of the engine lubricating oils that protect and cool engine parts, necessitating more frequent oil changes. Engine manufacturers provide their recommendations for allowable fuel sulfur content and normal oil change intervals in their operator's manuals and service manuals. These intervals may vary in length depending on engine operation, fuel quality, and lubricant quality. The proper oil change interval for a specific application may be established by recommendations of an on-going oil analysis program provided by the manufacturer. As an oil analysis program indicates the condition of the engine, it should not be used to extend oil change intervals. The oil should be changed if any contamination is present in concentrations exceeding manufacturer's recommendations. The choice of fuel should be changed to stay within these guidelines if the analysis program indicates it is a source of contamination.

Fuel Operating Temperature and Viscosity

Diesel fuel provides cooling for the injection system. The temperature of the fuel may vary considerably due to the ambient temperature, engine temperature, and the amount of fuel remaining in the tank. As fuel temperature increases, the fuel viscosity, and therefore the lubrication capabilities of the fuel diminish. Maintaining proper fuel temperatures in combination with the selection of fuels with the viscosity ranges recommended by the manufacturer will assure proper injection system functioning. Some systems have an external fuel cooling system.

Distillation

The boiling range is very important in consideration of diesel fuel quality. Many specifications contain a partial listing of the distillation test results, i.e. Distillation Temperature at 90% Recovered etc. Many diesel fuels are blended products that may contain constituents with boiling ranges much different than the majority of the fuel composition. The full boiling range as recommended by the engine manufacturer in the operator's manual or service manual should be closely followed.

Final Boiling Point

Fuel can be burned in an engine only after it has been completely vaporized. The temperature at which the fuel is completely vaporized is described as the End Point Temperature. This temperature must be low enough to permit complete vaporization at combustion chamber temperatures. The combustion chamber temperature depends on ambient temperature, engine speed, and load. Poor vaporization is more likely to occur during severe cold weather, prolonged idling, and light operation. Engines operating under these conditions should use fuels with lower distillation end point temperatures.

Other Selection Criteria

There are several other items to consider in the selection of fuel, which are listed in most engine manufacturer's requirements. These include:

Water and sediment: The amount of water and solid debris in the fuel is generally classified as water and sediment. It is good practice to filter fuel while it is being put into the tank.

More water vapor condenses in partially filled tanks due to breathing caused by temperature changes. Filter elements, fuel screens in the fuel pump, and fuel inlet connections on injectors must be cleaned or replaced whenever they become dirty. These screens and filters, in performing their intended function, will become clogged when using a poor or dirty fuel and will need to be changed more often.

Density: Gravity is an indication of the high-density energy content of the fuel. A fuel with a high density (low API gravity) contains more BTUs per gallon than a fuel with a low density (higher API gravity).

Carbon Residue: The tendency of a diesel fuel to form carbon deposits in an engine can be estimated by determining the Ramsbottom or Conradson carbon residue of the fuel after 90 percent of the fuel has been evaporated.

Cloud Point: The cloud point of the fuel is the temperature at which crystals of paraffin wax first appear. Crystals can be detected by a cloudiness of the fuel. These crystals will cause filters to clog.

Ash: The small amount of non-combustible metallic material found in almost all petroleum products is commonly called ash.

Acid Number: Using fuel with higher acid numbers can lead to higher than desirable levels of wear.

Emergency Fuels

Most manufacturers provide specifications and tolerances for fuel that must be used in an emergency situation where the recommended fuel is not available. Use of these fuels can have an adverse effect on engine performance and durability. They are meant to be used for short periods of time when no other fuels are available. Refer to the engine manufacturer's manuals, technical service bulletins, authorized distributors, and fuel supplier for information on emergency fuels.

Fuel Blending

CAUTION

Refer to the engine manufacturer's manuals and technical bulletins and consult with authorized distributors and your fuel supplier before blending any fuel for use in the machine.

Three common practices of fuel blending are:

The first is the blending of heavier fuels with lighter fuels to lower the wax content, cloud point, and pour point, and thus improve cold weather operation.

The second is the blending of NEW engine lubricating oil with fuel to increase the viscosity.

The third is the blending of USED engine lubricating oil to reduce fuel costs and to aid in disposing of used engine oil.

CAUTION

Some manufacturers specifically DO NOT recommend blending USED lubrication oil with diesel fuel and others have allowable specifications. Refer to the engine manufacturer's manuals and technical bulletins or consult with authorized distributors before blending used lubricating oil with diesel fuel for use in the machine.

⚠ WARNING

Explosion hazards exist if blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel. Never mix these chemicals together. This practice creates an extreme fire hazard and under certain conditions an explosive hazard. Blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel can cause a fire or explosion hazard resulting in serious injury or death.

Winter Fuel Problems

The two major winter fuel problems encountered by owners and operators of diesel-powered equipment are wax and ice. There is no solution to either of these problems, which is ideal for all situations. The following troubleshooting information should help with these problems.

Loss of Engine Power

Determining whether a low power complaint is due to a fuel filter-plugging problem is somewhat simple. Replace the fuel filter with a new one. If this allows the machine to operate normally, even for a short time period, then obviously something in the fuel is plugging the filter and causing the problem.

A simple way to determine whether the filter plugging is caused by wax or ice is to bring the plugged filter into a warm shop, drain out the liquid fuel, place the filter upside down on a piece of paper or in a shallow pan, and allow the filter to warm to room temperature. If ice is the problem, it will melt and run out of the filter and the water on the paper or in the pan will be obvious. Most petroleum wax will not melt at room temperature. To speed the process, the filter can be cut open and spread out. Once the cause of the problem is determined, then a logical solution can be chosen.

Fuel Wax (Cloud Point)

All diesel fuel contains paraffin wax. This paraffin occurs naturally in the crude oil from which diesel fuel is distilled. The wax content of diesel fuel varies depending on the crude from which it was produced and in its processing. Because of the strong relationship between temperature and solubility of wax, wax separation is a problem in handling and using diesel fuel during cold weather.

As fuel cools, a temperature is reached at which the fuel becomes saturated with wax; and any further cooling will cause wax to separate out of solution. The temperature at which the solution is saturated is the cloud point. If fuel is cooled below the cloud point, the fuel becomes so thick it will no longer flow. This temperature is the Pour Point. At the Pour Point, most of the fuel is still liquid although it is very thick or viscous and trapped in a honeycomb-like network of wax crystals.

Wax in the fuel will deposit in any restriction or sharp bend in the fuel plumbing system. If fuel starvation occurs during cold weather operation and plugged fuel filters do not seem to be the problem, look for plugging of tank pickup screens, sharp bends in the fuel lines, fittings, etc.

Water Contamination

Free water (non-dissolved) in the fuel can freeze at low temperatures and the resulting ice crystals can plug fuel filters causing fuel starvation.

Water can get into a diesel engine's fuel system in two ways:

1. Water can be in the storage tank and be entrained when filling the machine's fuel tank. Care must be taken to keep fuel storage tanks free of condensate.

2. Water, or moisture, in the air above the fuel can condense on the walls of the fuel tank. Condensation in the machine's fuel tank occurs when the air in the tank cools down during a shutoff period.

NOTICE

Refer to FUEL STORAGE and FUEL ADDITIVES, located within this section, for IMPORTANT information concerning proper fuel storage, fuel additives and fueling procedures that relate to water contamination.

Engine Idling

Avoid unnecessary engine idling. During long engine idling periods (10 minutes or more), the engine coolant temperature will fall below the normal operating range. The incomplete combustion of fuel in a cold engine will cause crankcase dilution; formation of lacquer or gummy deposits on the valves, pistons, and rings and rapid accumulation of sludge in the engine.

Fuel Storage

CAUTION

Proper fuel storage is extremely important. Many diesel engine difficulties can be traced to dirty or contaminated fuel or fuel that has been in storage too long.

Water Contamination in Storage

Diesel fuel oxidizes in the presence of air and water. The oxidation of fuel can result in the formation of undesirable gums and sediment. Such undesirable deposits can cause filter plugging, combustion chamber deposit formation and gumming or lacquering of injection system components with resultant sticking or wear.

Storage Reservoir Maintenance

Storage reservoirs and stored fuel should be inspected regularly for dirt, water, scale, sludge, and other foreign matter; and cleaned if necessary. Drain and flush storage reservoirs periodically. Water will condense in partially filled reservoirs.

NOTICE

Fuel storage reservoirs should be tested often with water detecting paste (usually obtainable from fuel vendors) to be sure they are dry. If water is detected, it must be pumped out and what remains must be treated with anhydrous isopropyl alcohol or methoxy ethanol to prevent freezing. It is IMPORTANT to refer to engine manufacturer's manuals, technical bulletins, or consult with authorized distributors to determine the correct approach before treating the fuel with these additives.

Storage Tank Construction

Diesel storage reservoirs can be constructed of aluminum, monel, stainless steel, black iron, welded steel, or reinforced (non-reactive) plastic. The storage reservoirs should have provision for draining water that settles in their bottoms.

CAUTION

A galvanized steel tank should NEVER be used for fuel storage because the fuel reacts chemically with the zinc coating to form powdery flakes which can quickly clog the fuel strainer and filter and damage the fuel pump and injectors.

NOTICE

If keeping water out of bulk storage tanks is a persistent problem, a drier (fuel/water separator) should be installed on the bulk fuel dispensing system.

Microbial Contamination of Fuel

Microbial contamination of the fuel occurs primarily in bulk storage facilities. Typically, it is passed into the fuel system of machines during the fueling process. These microorganisms, primarily bacteria and fungi, exist rather harmlessly in moisture-free fuel, passing through fuel systems without causing any problems. However, in the presence of water, these microorganisms begin to grow and reproduce. The rate of growth depends on how well the environment suits the particular organism's needs. An improperly maintained fuel tank on a machine is an ideal place for these microorganisms to flourish.

Microbial contamination of a fuel system can cause several problems.

The first and usually most obvious is fuel filter plugging with a greenish-black or brown slime, frequently accompanied by a foul odor. This slimy, string-like colony can also plug sharp bends in fuel lines, fuel meters, and other restrictions.

The second problem these microorganisms cause is corrosion due to the acid by-products some of them produce.

The third problem is that if the microorganisms pass through the fuel filter, they will form deposits and cause damage in the fuel pump and injectors.

The best way to verify the presence of microbial contamination is to use a commercially available test kit, on a routine basis. These test kits can detect microorganisms before there is any evidence of a problem.

CAUTION

There are several micro biocide additives commercially available and it is IMPORTANT to refer to the manufacturer's manuals and technical bulletins and consult with authorized distributors and your fuel supplier before treating your fuel for microbial contamination.

⚠ WARNING

Inhalation and skin hazards exist if contacting microbes or fungi from a fuel reservoir. When a fuel tank is contaminated and cleaning is necessary, workers must be protected with breathing apparatuses. The most common problem associated with exposure to these microorganisms is dermatitis, which can be very serious. Any exposed skin must be thoroughly washed with warm, soapy water. Avoid eating, drinking and smoking while working with contaminated tanks. Any ingestion of microorganisms or exposure to broken skin must be considered serious. It is recommended that if this happens the worker be taken to a doctor, along with a sample of the microorganisms. Failure to prevent inhalation or skin contact with microbes or fungi can cause inhalation and skin hazards resulting in serious injury or death.

NOTICE

Environmental hazards exist if placing removed contaminants into sewer systems. The contaminants such as microorganisms can kill bacteria used in sewage treatment. NEVER place these contaminants in storm sewers or surface water streams as they can kill fish and other aquatic animals. Follow all local rules, regulations, and laws to dispose of contaminants. Some laws may require expensive fines or imprisonment. Failure to follow all local rules, regulations, and laws to dispose of contaminants can cause an environmental hazard resulting in environmental damage.

Fuel Additives

Great care must be exercised in the choice and use of additives. Some fuel additives can be harmful to the engine. Most legitimate fuel additives perform only one function. Multi-functional fuel additives are mixtures of several additives. All fuel additives perform differently in different fuels; therefore, the additive used must be one to which the fuel will respond.

NOTICE

There are no known additives that can increase power or improve the efficiency of a properly maintained engine.

CAUTION

Fuel additives should NOT be used unless specifically recommended by the engine manufacturer.

Some fuel additives provide temporary benefits but do not replace good fuel handling practices. Such additives are helpful when water or microbial contamination is suspected:

Isopropyl alcohol and methoxy ethanol is designed for treatment of water contamination and prevention of ice crystal formation. Refer to the engine manufacturer's guidelines for the amount to be mixed with the fuel. Refer to "Fuel Storage", within this section, for additional information on the use of these additives.

Microbiocide additives - for treatment of microbe growth or black "slime". Follow the manufacturer's instructions for treatment. Refer to "Microbial Contamination of Fuel", within this section, for additional information concerning the use of micro biocide additives.

⚠ WARNING

Explosion hazards exist if blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel. Never mix these chemicals together. This practice creates an extreme fire hazard and under certain conditions an explosive hazard. Blending gasoline, gasohol, or alcohol (ethanol or methanol) with diesel fuel can cause a fire or explosion hazard resulting in serious injury or death.

NOTICE

Refer to FUEL BLENDING, within this section, for additional information and cautions concerning blending of diesel fuel.

⚠ WARNING

Explosion hazards exist if spraying ether-starting aid into the air intake of the Komatsu Cartridge Filtration System (KLENZ™ system). Ether fumes are extremely flammable. Never use ether starting aid to start the engine. The use of ether is NOT recommended by Komatsu as an engine starting aid. The KLENZ system provides air to the engine turbos, generator, motors, and cab. Using ether starting aid in the engine intake can cause an explosion hazard resulting in serious injury or death.

⚠ WARNING

Inhalation hazard exists inside the cab if spraying ether-starting aid into the air intake of the Komatsu Cartridge Filtration System (KLENZ™ system). The KLENZ system provides fresh air to the cab (and other components). Inhalation of ether fumes is dangerous and can render a person unconscious or cause death. Ether fumes are extremely flammable. Never use ether starting aid to start the engine. The use of ether is NOT recommended by Komatsu as an engine starting aid. Using ether starting aid in the engine intake can cause an inhalation hazard resulting in serious injury or death.

Safety in Fueling Operations

These guidelines should be followed in the routine fueling of the machine to ensure safe operations:

Fuel leaks and spills are a fire hazard. They should be noted and reported during routine inspections. Should a leak or spill be discovered, correct the problem and clean the affected area before operating the machine.

a. NEVER smoke while checking the fuel level or refueling. Unguarded trouble lights, flames, or spark producing devices should be kept at a safe distance while fueling.

b. NEVER use an open flame to check fuel level or for a leak on the machine. Use an ignition proof light source.

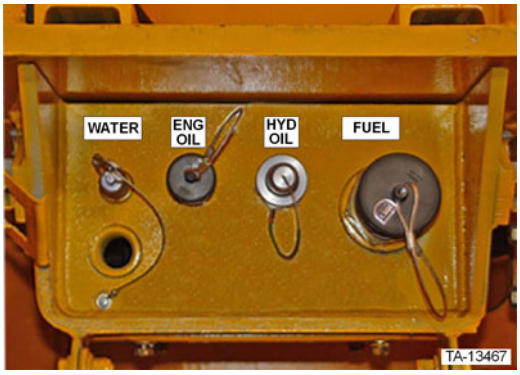
c. ALWAYS stop the engine while fueling the machine.

d. The fueling facility should be in a well-ventilated and well-lighted location.

e. Learn the location and operation of the fire extinguisher closest to the fueling facility.

1) Fuel Filler Neck (Standard), **2)** Central Service System

Figure 2. Typical fuel filler location



(left side of rear frame)

Figure 3. Typical central service system (optional)

Fueling the Machine

The machine has a fuel filler neck located at the left side the rear frame. An optional central service system is available, which provides a quick connect fitting for fueling the machine. The central service system is also located at the left side of rear frame.

CAUTION

The best fuel, if contaminated by dirt or water, can damage an engine. Refer to text "Fuel Storage", within this section, for additional information concerning contamination of diesel fuel.

a. Fueling should never take place in a locale where dust, dirt, or water can enter an open fuel reservoir.

b. Dust, dirt, and water should be wiped away from the machine's fuel reservoir and cap before opening.

c. The machine's fuel reservoir should be drained periodically to eliminate water which condensates in the reservoir and settles in the bottom.

NOTICE

The machine should be refueled after each shift to prevent condensate from accumulating in the reservoir and contaminating the fuel.

⚠ CAUTION

Fire hazard exists if the fuel reservoir is filled all the way to the top. Fuel expands as it gets warm and may overflow. Stop fueling the reservoir before the level reaches the top of the filler neck. Filling the fuel reservoir to the top can cause a fire hazard resulting in personal injury.

Fuel Cooler - Cummins Engines Only

Machines equipped with Cummins engines have a fuel cooler that cools the fuel being returned to the fuel tank. The cooler core is mounted behind the engine radiator (refer to illustration “FUEL COOLER CORE – CUMMINS ENGINE ONLY”). When the fuel’s viscosity level indicates the need for cooling, the fuel is routed through the cooling core via a 4-psi check valve and then to the fuel tank. Check fuel cooler frequently for a buildup of dust and dirt. Clean with a high-pressure washer or steam cleaner as required.

Figure 4. Fuel cooler core - Cummins engine only

Fuel Tank Check Valve

The machine is equipped with a fuel line check valve(s), located on the fuel tank, at the right rear of the machine. Detroit Diesel equipped machines have one check valve and Cummins engine equipped machines have two check valves. Every 1000 hours of operation, remove, inspect, and clean the valve(s) as required.

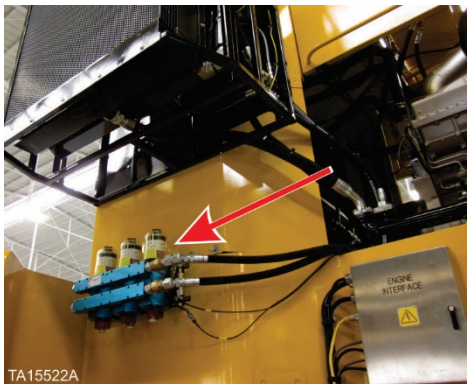
Fuel Filter

It is essential to replace the fuel filters per the engine manufacturer's recommendations outlined in the engine owner's manual. The location of fuel filters varies with the engine manufacturer. The engine owner's manual is available on the manufacturer's website.

Some machines can be optionally equipped with a fuel filter system that consists of a permanently mounted, replaceable filter. The unit is mounted on the right side of the rear frame in most applications (refer to illustration "Typical fuel filter" below). The filter must be replaced every 500 hours of operation. Instructions for replacing the filter are included in the manufacturer's product information.

NOTICE

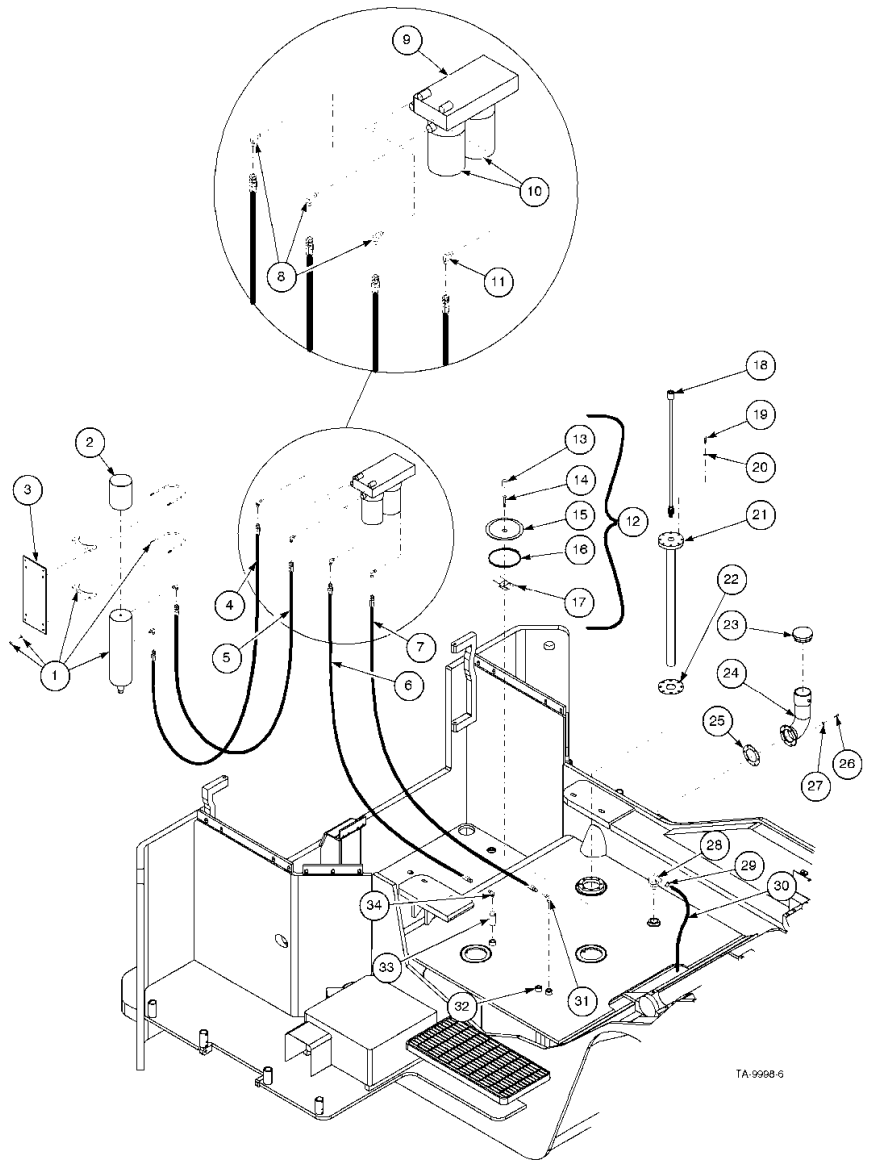
The Cummins filter system has an indicator zone that indicates when the filter should be changed.



(typically mounted right rear side of the machine)

Detroit Tier Ii engines only

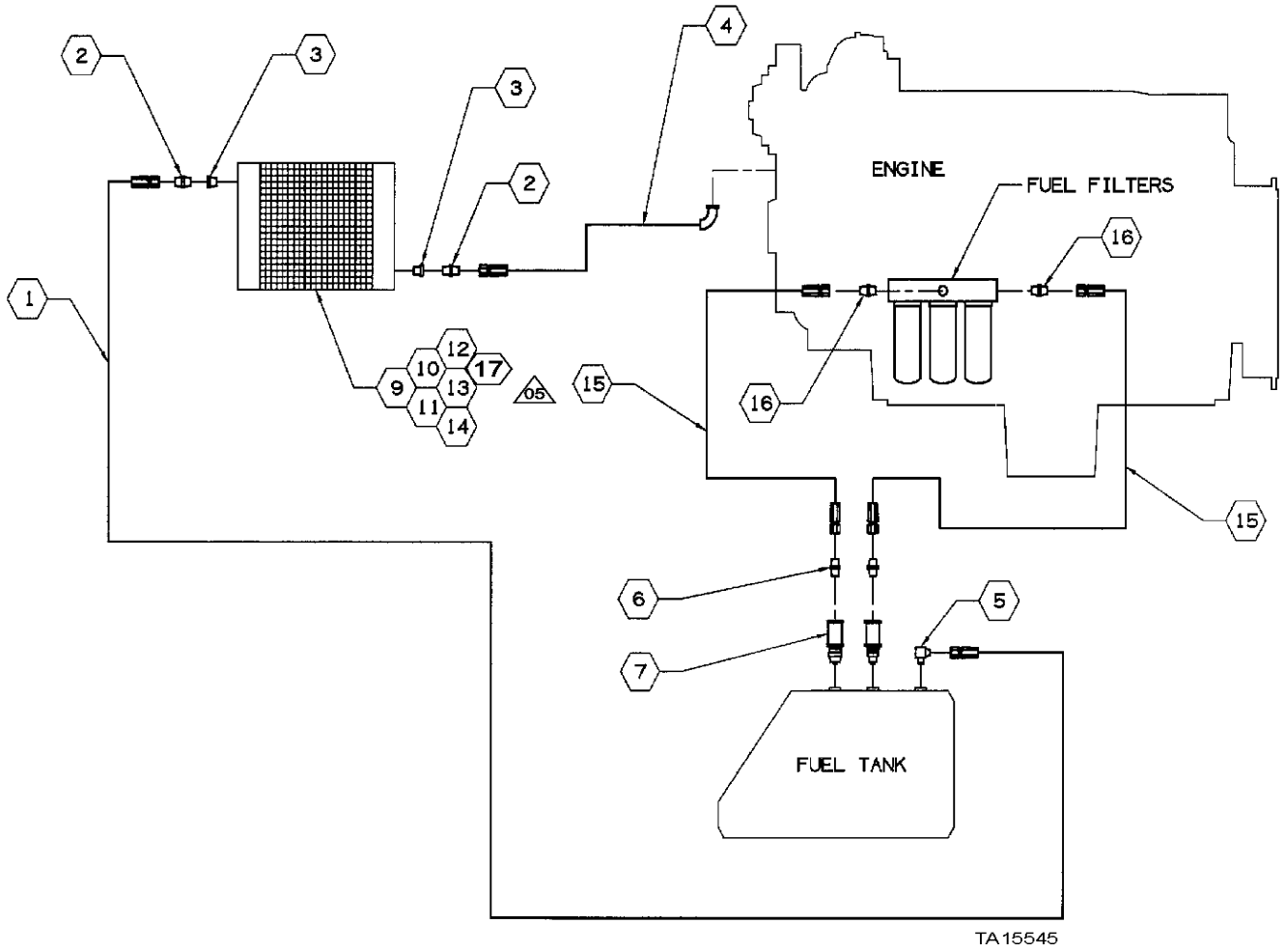
Figure 5. Typical fuel filter



1. Filter Assembly	**12.** Cover Assembly	**23.** Filler Neck
2. Fuel Filter	**13.** Pipe Plug	**24.** Gasket
3. Mount Plate	**14.** Capscrew	**25.** Bolt
4. Hose Assembly	**15.** Cover Structure	**26.** Lockwasher
5. Hose Assembly	**16.** O-Ring	**27.** Vent Assembly
6. Hose Assembly	**17.** Clamp Structure	**28.** Clamp
7. Hose Assembly	**18.** Sending Unit, Fuel Level	**29.** Hose
8. Elbow	**19.** Bolt	**30.** Elbow
9. Filter Mount	**20.** Flatwasher	**31.** Pipe Plug
10. Fuel Filter	**21.** Mount Structure	**32.** Check Valve
11. Elbow	**22.** Gasket	**33.** Elbow

Figure 6. L-1350 typical fuel system installation (Detroit Diesel)

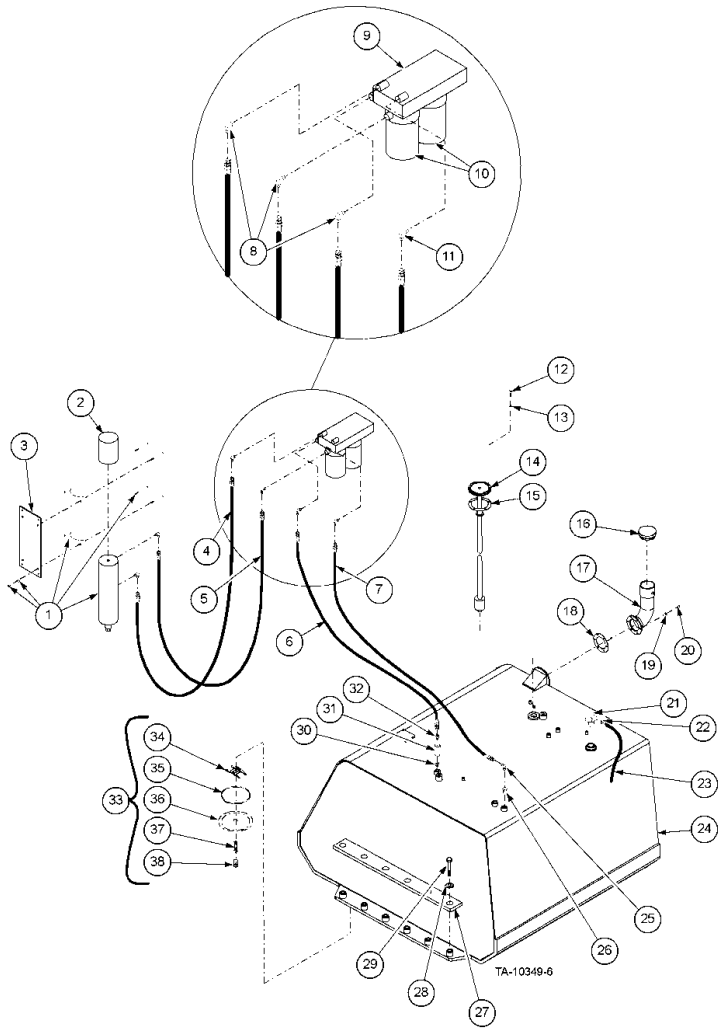
On the model L-1350 loader, the fuel tank is an integral part of the rear frame



1) Hose, **2)** Hydraulic Fitting, **3)** Hydraulic Fitting, **4)** Hose, **5)** Hydraulic Fitting, **6)** Hydraulic Fitting, **7)** Fuel Check Valve Kit, **9)** Fuel Cooler, **10)** Oil Cooler Brace Bar, **11)** Hex Bolt, **12)** Flatwasher, **13)** Lockwasher, **14)** Hex Nut, **15)** Hose, **16)** Hydraulic Fitting, **17)** Oil Cooler Mount Bar

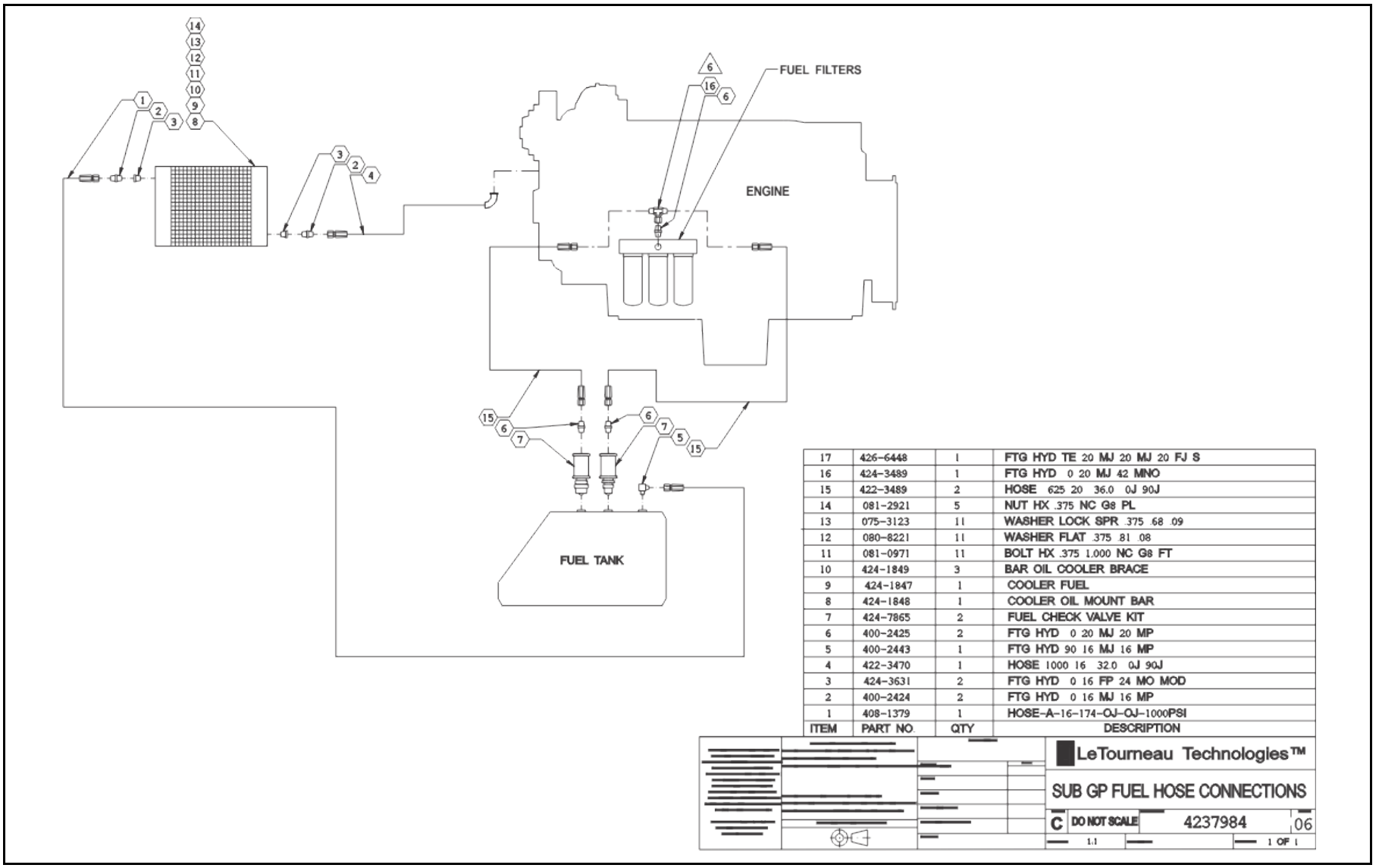
Figure 7. L-1350 typical fuel system installation (Cummins)

On the model L-1350 loader, the fuel tank is an integral part of the rear frame



1. Filter Assembly, DAVCO
2. Filter, Fuel
3. Mount Plate, Filter Assembly
4. Hose Assembly
5. Hose Assembly
6. Hose Assembly
7. Hose Assembly
8. Elbow - Swivel
9. Filter Mount
10. Filter, Fuel
11. Elbow - Swivel
12. Screw
13. Lockwasher
14. Sending Unit, Fuel Level
15. Gasket, Fuel Sending Unit
16. Cap Assembly, Fuel
17. Filler Neck Structure, Fuel Tank
18. Gasket, Filler Neck
19. Lockwasher
20. Bolt
21. Vent Assembly
22. Clamp, Hose - Worm
23. Hose
24. Tank Structure, Fuel
25. Elbow
26. Bushing
27. Spacer Bar, Fuel Tank Mount
28. Lockwasher
29. Bolt
30. Nipple, Pipe
31. Valve Kit, Check - Fuel
32. Adapter
33. Cover Assembly, Access - Fuel Tank
34. Clamp Structure
35. O-Ring
36. Cover Structure
37. Capscrew
38. Plug, Pipe, Hex Csk.

Figure 8. L-1850/L-2350 typical fuel system layout (Detroit Diesel)



ITEM	PART NO.	QTY	DESCRIPTION
17	426-6448	1	FTG HYD TE 20 MJ 20 MJ 20 FJ S
16	424-3489	1	FTG HYD 0 20 MJ 42 MNO
15	422-3489	2	HOSE .625 20 36.0 0J 90J
14	081-2921	5	NUT HX .375 NC G8 PL
13	075-3123	11	WASHER LOCK SPR .375 .68 .09
12	080-8221	11	WASHER FLAT .375 .81 .08
11	081-0971	11	BOLT HX .375 1.000 NC G8 FT
10	424-1849	3	BAR OIL COOLER BRACE
9	424-1847	1	COOLER FUEL
8	424-1848	1	COOLER OIL MOUNT BAR
7	424-7865	2	FUEL CHECK VALVE KIT
6	400-2425	2	FTG HYD 0 20 MJ 20 MP
5	400-2443	1	FTG HYD 90 16 MJ 16 MP
4	422-3470	1	HOSE 1000 16 32.0 0J 90J
3	424-3631	2	FTG HYD 0 16 FP 24 MO MOD
2	400-2424	2	FTG HYD 0 16 MJ 16 MP
1	408-1379	1	HOSE-A-16-174-OJ-OJ-1000PSI

Figure 9. L-1850/L-2350 typical fuel system layout (Cummins)

This Page Intentionally Left Blank

Cooling System

NOTICE

In addition to these general instructions, it is ESSENTIAL to refer to the engine and radiator manufacturers' recommendations regarding proper maintenance of the cooling system and any special instructions they may provide in their operator manuals or service manuals.

Safety in Cooling System Maintenance

The following guidelines should be followed to ensure safety when performing service or repair operations to cooling systems:

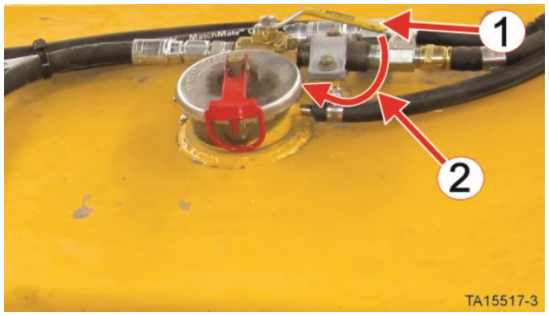
⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

a. Wear a hard hat, protective glasses, and other protective equipment as required by job conditions.

⚠ WARNING

Burn hazard exists when working on or around hot cooling systems. Liquid cooling systems build up pressure, as the engine gets hot. Before removing the radiator cap, stop the engine and let the system cool. Remove the radiator cap or surge tank cap only after the coolant is cold. Failure to allow the coolant to cool can result in serious burns.



1) Shown in open position

2) To close

(located on top of rear frame)

Figure 10. Surge tank release ball valve

NOTICE

Turn ball valve to release pressure before removing the surge tank cap.

f. Hot coolant and components can cause personal injury. Do not allow hot coolant or components to contact the skin.

g. Be sure all guards and protective covers are in place and secure.

h. DO NOT work on the machine with the engine running unless specifically instructed to do so by the engine manufacturer's operator's manual or service manual for the specific repair or maintenance that is to be completed.

Engine Exhaust Wrap

While running, and for some time after shutdown, the engine exhaust piping and muffler are hot enough to cause serious burns. Some machines are equipped with an engine exhaust wrap. The piping and muffler are wrapped with a material intended to help prevent burns. The wrapping should be checked daily to ensure it is secured properly.

⚠ CAUTION

Burn hazard exists if unwrapping the engine exhaust piping or muffler while hot. Wait for the engine exhaust to cool off before unwrapping the exhaust pipes for inspection. Failure to wait for the exhaust to cool off can cause burn hazards resulting in personal injury.

Troubleshooting

Cooling System

Overheating is the most common problem in cooling systems and can be avoided with proper maintenance. The most common causes of overheating are clogged systems, low coolant level, and defective water pumps and thermostats.

The most serious effect of overheating is the breakdown of engine lubrication. Engine overheating causes accelerated breakdown of the lubricating properties of the oil and causes formation of varnish. Warping and cracking of major engine components such as the cylinder head(s) and block is common in overheated engines and is made worse when followed by rapid cooling.

Corrosion

Restricted coolant flow as the result of the radiator becoming clogged with rust and scale is the most common cause of overheating. This problem can be prevented by regular rust proofing and cleaning when necessary.

As rust and scale forms on the walls of the engine water jacket and other metal parts, it flakes off and settles in the passages within the water jacket and in the tubes of the radiator. This cuts down on heat transfer and the result is engine overheating. Continual overheating causes the formation of more rust in the system that eventually results in the radiator becoming totally clogged.

Rust, scale, and grease can be removed by the use of double-action cleaners, which will not harm the system if used according to instructions. If rust and grease are not completely neutralized and flushed out, they can destroy the corrosion inhibitors in later fills of antifreeze and anti-rust solutions.

CAUTION

DO NOT use caustic cleaners in aluminum radiators, as the heat transfer surfaces will be damaged. BE SURE to verify that any cleaning solutions used are approved by both the engine and radiator manufacturer.

The entire system should be drained at least once a year. If the coolant has rust-colored appearance, a cooling system cleaning solution should be used. If no rust buildup is noticed, a radiator flushing solution or plain water should be used to thoroughly flush the entire system, including the block. Corrosion inhibitors will not clean out rust and scale already formed. Refill with a solution of antifreeze containing rust inhibitors sufficient to protect the system for the lowest possible temperatures expected.

CAUTION

Handling and disposal of used coolant may be subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities for disposal of used coolant. DO NOT flush into municipal sewer systems or streams.

Coolant, Antifreeze and Rust Inhibitors

Minerals contained in the water from most public water systems are not desirable in engine cooling systems. Distilled water is recommended for most engines (Tier 4F engines see NOTICE below) but will still cause rust if used without a rust inhibitor.

NOTICE

Tier 4F engines require RP-329A 50/50 coolant.

Most radiators have an expansion volume built in and can be filled to the bottom of the filler neck. Refer to engine and radiator manufacturer's manuals for capacity and filling recommendations. A sight glass is provided on the surge tank, to monitor the coolant level.

Low silicate ethylene glycol based antifreeze is recommended as most diesel engines develop temperatures in excess of the boiling point of alcohol. Rust inhibitor should be added if the antifreeze does not already contain it.

NOTICE

A refractometer MUST be used to accurately measure the freeze point of coolant. DO NOT use a ball hydrometer. Floating ball hydrometers will give incorrect readings.

NOTICE

It is ESSENTIAL to use only as much antifreeze as is needed to protect the system from the lowest temperatures expected because with ethylene glycol-based antifreeze a mixture that is too strong can actually reduce the protection against freezing. Pure, undiluted antifreeze content or mixture will freeze at -10ºF (-23ºC). Beyond 70% antifreeze content or mixture, the freeze point reverts to the undiluted water freezing point.

CAUTION

NEVER pour hot water into a cold engine or cold water into a hot engine. This could crack the head or block.

Repair radiator and other cooling system leaks before adding antifreeze coolant.

CAUTION

DO NOT use radiator-sealing solutions to repair minor leaks without first confirming that they are approved by the engine and radiator manufacturer for use in the system. These solutions may not be compatible with water filters and alloys used in the components of the engine, radiator, and other parts. They can result in cooling system plugging and inadequate coolant flow that will cause overheating.

Supplemental Coolant Additives (SCA or DCA)

Heavy-duty diesel engines require a “heavy-duty coolant. Heavy-duty coolant is defined as a correct mixture of good quality water, low silicate antifreeze, and supplemental coolant additives (SCA or DCA). Supplemental coolant additives (or equivalent) are required to protect the cooling system from fouling, solder blooming, and general corrosion. A cooling system filter is required to protect the coolant system from abrasive materials, debris, and precipitated coolant additives. Engine manufacturers provide detailed instructions in their operators’ manuals on testing, concentrations, mixing, filters, and replacement cycles required for SCA or DCA. Some filters contain SCA or DCA in a unit number specified by the engine manufacturer. These additives completely dissolve in the coolant after two hours of operation. It is ESSENTIAL to refer to engine manufacturers’ manuals or authorized distributors and to follow their instructions.

NOTICE

A quick-connect fitting is optionally provided on the side of the engine for collecting coolant samples to verify DCA or SCA levels.

CAUTION

Insufficient concentration of the coolant additives will result in cylinder liner pitting and engine failure.

CAUTION

DO NOT use soluble oils in cooling systems. The use of soluble oils will cause cylinder pitting, corrode brass and copper materials, and damage heat transfer surfaces, seals, and hoses.

Radiator Inspection and Exterior Cleaning

The entire cooling system should be checked before any maintenance operations are begun.

- Check the radiator, water pump, hoses, drain cocks, block, and cylinder head(s) for leaks. Special attention should be given to checking the radiator for bent fins and tubes with cracks, kinks, dents, and split seams.
- The exterior of the radiator and hydraulic oil cooler should be inspected for an accumulation of dust and dirt as part of the operator’s daily walk-around inspection. The radiator and oil cooler should be cleaned with a hot-water high-pressure washer as required. Failure to keep the radiator and oil cooler coils clean could result in engine and hydraulic system overheating.
- The radiator should be periodically pressure tested per the manufacturer’s specifications. Any measurable drop in pressure may indicate an external or internal leak and should be thoroughly investigated and corrected.

NOTICE

Only experienced radiator repair technicians should make repairs to the radiator.

Radiator Cap

⚠ WARNING

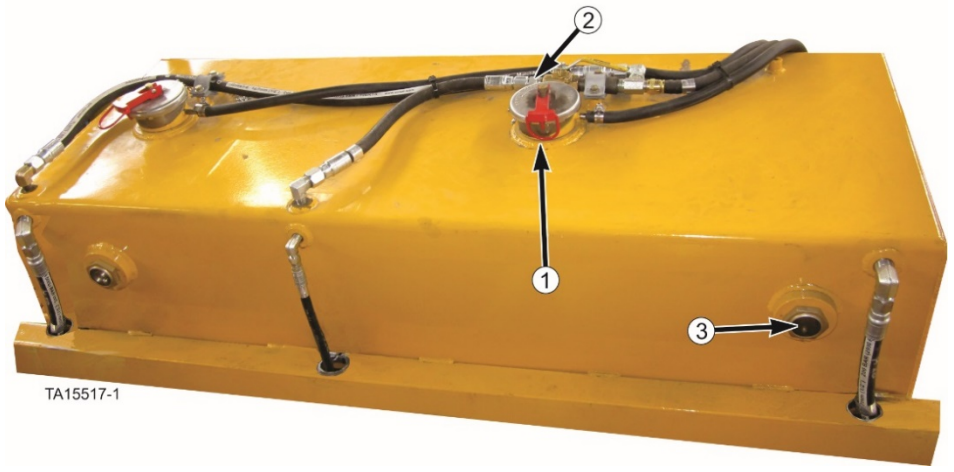
Burn hazard exists if removing the radiator cap on a hot radiator. Wait for the coolant to cool before removing an engine radiator cap or engine coolant surge reservoir cap. Serious injury may result from escaping steam and hot coolant. On machines that utilize surge reservoirs, turn the ball valve to release the pressure before removing surge reservoir cap. Failure to wait for the coolant to cool can cause burn hazards resulting in serious burn injury.

Most radiator caps have a pressure valve to vent coolant or steam if pressure reaches a certain point, and a vacuum valve that opens to prevent vacuum in the cooling system. The radiator cap should be checked periodically with a pressure tester to be sure both valves are opening properly and at the pressures intended by the manufacturer. If either valve malfunctions, the cap should be replaced.

Leaks and Contamination

There are two kinds of leaks, external and internal. They can both cause engine overheating and contamination of the lubricating and cooling system resulting in costly repairs and downtime. It is essential to check the radiator coolant level and appearance during the operator's daily walk-around inspection. This is done by checking the sight glass on the top tank of the radiator or surge tank, as applicable. The surge tank cap should not be removed to check the coolant level.

External leaks: Most radiator leakage is the result of mechanical failure of soldered joints caused by cooling system pressure or engine or frame vibration. Other common locations for external leaks are hoses and hose connections, expansion or "freeze" plugs, gaskets, bolts, and capscrews. The cylinder block should be checked for coolant leakage both before and after it gets hot and while the engine is running.



1) Radiator Cap, **2)** Pressure Relief Valve, **3)** Fluid Level Sight Glass

Figure 11. Radiator surge tank (typical view)

Testing the system with a pressure tester is a good method to locate an external leak.

Internal coolant leaks: Internal leaks have several reasons why they occur. Common internal leaks occur because of a loose cylinder head(s) or sleeve joint, defective gaskets, a cracked casting, or a malfunction in the pushrod compartment. Water or antifreeze will form sludge when mixed with engine oil. This will cause

lubrication failure, sticking piston rings and pins, sticking valves and valve lifters, and extensive engine damage. A milky appearance of the crankcase oil indicates an internal coolant leak.

NOTICE

Anytime an engine has overheated, it is recommended that the cooling system be pressure tested for leaks.

If an internal coolant leak is detected, the engine will have to be disassembled and the leak repaired properly before returning the machine to service. If replacing the cylinder head gaskets, be sure the head and block are checked for cracks and the mating surfaces are true, clean, and smooth. Follow the manufacturer's torque specifications and sequence for tightening cylinder head bolts.

Internal oil leaks: Contamination of the cooling system from an internal oil leak is also possible. One possible cause of such contamination is a cracked oil cooler core in some engines.

NOTICE

It is ESSENTIAL to follow engine manufacturer's instructions (available on manufacturer's website) regarding flushing of the cooling system to eliminate contamination resulting from an internal coolant or oil leak.

Thermostats

Faulty or improper thermostats can cause engines to warm up too slowly or to operate at the wrong temperatures.

CAUTION

ALWAYS use the thermostat recommended by the engine manufacturer. NEVER run an engine without thermostat protection (some engines have two or more).

Discard broken, faulty, or corroded thermostats. Do not use bellow-type thermostats in high-pressure cooling systems.

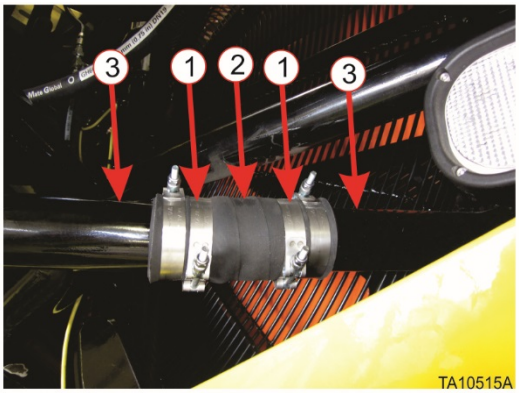
To check a thermostat, suspend it and a thermometer in a container of water and, while stirring, heat the water gradually. The thermostat should begin to open at the temperature stamped on it, plus or minus 10º, and should be fully open at 22º above the specified temperature. After removing the thermostat from the hot water, observe its closing action.

When installing a thermostat, clean the gasket surfaces and use a new gasket. Position the thermostat with the expansion element toward the engine (the frame should not block water flow).

Hoses

All hoses on the machine should be checked every 500 hours of operation for hardening, cracking, softening, and swelling. If hoses must be removed, check any inside reinforcing springs for corrosion.

Replace hoses often enough to be sure they are always pliable and able to pass coolant without leaking or shedding small particles of rubber, which could clog the radiator. Use only the best available hoses and coat connections with non-hardening sealing compound when installing. Tighten hose clamps securely. A pressurized cooling system can blow off an improperly installed hose.



1) Clamp, **2)** Hose, **3)** Radiator Piping

Typical hose installation in radiator piping

Figure 12. Radiator piping hose installation (typical)

NOTICE

The photographs in illustration above show typical hose installations in the radiator piping. These hose installations appear at multiple locations. It is essential to inspect the hose installations every 500 hours of operation for hardening, swelling, cracking, or softening. Inspect clamps to ensure they are secure and properly positioned. An illustration of the radiator piping for specific machines is provided in the PARTS MANUAL.

Water Pump

Overheating can quickly occur if the water pump malfunctions. Pump malfunctions may be caused by leaks in the housing, broken or bent vanes on the impeller, and damaged seals or bearings.

NOTICE

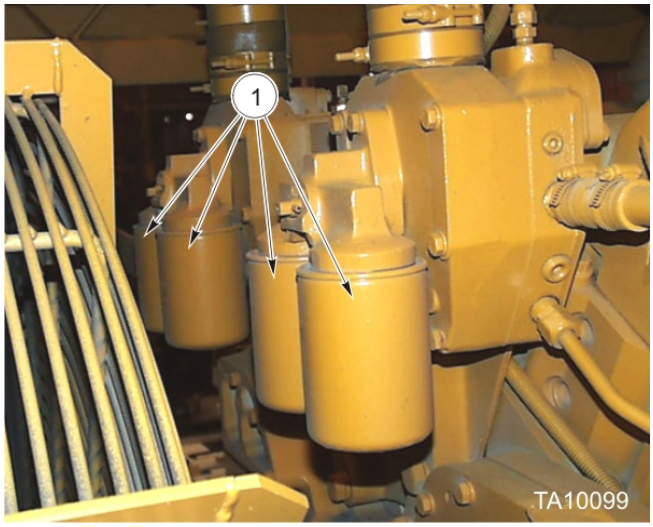
If a pump must be removed and disassembled for inspection, replace all damaged or worn parts and use new seals and gaskets when reassembling. Follow the manufacturer's instruction.

Filters

Some engines have filters in the cooling system. The filter element and resistor plates may contain chemicals that remove or neutralize corrosives. These chemicals alkalinize the coolant enough to prevent corrosion of metal parts and to form rustproof films on metal surfaces.

NOTICE

If the engine is equipped with a coolant filtration system, it is ESSENTIAL to follow manufacturer's instructions for replacing the water filter and draining water from the lower sump of the filtration system.



1) Coolant Conditioning Filters

(Mounted at top – front of engine - Cummins engine shown)

Figure 13. Typical coolant conditioning filters

Accessory Drive Belts and Fan Service

The drive belts should be periodically checked for signs of early failure, i.e. cracks, splits, excessive stretching, and fraying. Replace belts when these signs are present. Adjust belt tension as specified by the engine manufacturer. Too much tension causes premature failure of the belt and bearings. Too little tension permits belt slippage and causes insufficient cooling and excessive belt wear. Worn pulleys should be replaced when manufacturer's limits are reached.

Fan service usually consists of making sure the blades are straight and far enough from the radiator so they will not strike the core.

Aeration

Aeration is caused by air inside a cooling system mixing with the coolant. It can accelerate the formation of rust and corrosion and it can cause foaming, overheating, and loss of coolant through the overflow pipe. Aeration may result from a leak in the system, turbulence in the top tank, and too low coolant level.

Use the following steps to check for aeration in the cooling system:

a. Adjust coolant to proper level.

b. Replace pressure cap with plain but airtight cap.

c. Attach rubber tube to lower end of overflow pipe.

d. With machine parked, run engine at high throttle until temperature gauge stops rising and stabilizes.

e. Without changing engine speed or temperature, place the end of the rubber tube in a container of water.

f. A continuous stream of bubbles from the tube will show that air is being drawn into the cooling system.

NOTICE

All Komatsu installed power units are approved for proper de-aeration capabilities. Flange and hose routing should never be altered without factory approval.

Exhaust Gas Leakage

Exhaust gas can enter the cooling system through a crack in the cylinder head or a loose cylinder head joint even though the joint may be tight enough to keep liquid from leaking into a cylinder. Exhaust gases dissolved in the coolant will destroy the rust inhibitors and form acids that cause corrosion, rust and clogging. The cylinder head(s) gasket(s) may burn or corrode because of the gases and excess pressure may force coolant out of the overflow pipe.

Exhaust gas leakage can cause the coolant to be rusty or cause severe rust clogging, corrosion, or overflow losses. A chemical tester is available to detect the presence of exhaust gas in the cooling system. It should only be used by experienced personnel, as its use requires opening the radiator.

Flushing the Cooling System

The cooling system should be flushed and thoroughly checked at least once a year and always before installing new antifreeze. Incomplete flushing, such as hosing out the radiator, will close the thermostat and prevent thorough back flushing of the block.

Flushing Procedures

NOTICE

Always contain and properly dispose of all liquids being used when flushing. Failure to contain and dispose of liquids in a manner required by any local or national governmental authorities can result in an environmental impact.

a. Drain the coolant from the radiator and engine.

b. Refill with soft, clean water. If rust is present, the use of a chemical cleaning solution may be required to achieve the desired results. Refer to engine and radiator manufacturer owner's manuals for recommended cleaning solutions. If the engine is hot, fill slowly to prevent rapid cooling and distortion of engine castings.

c. Start the engine and operate it for fifteen minutes to circulate the water thoroughly.

d. After thoroughly flushing the system, open all drain points to drain the system.

e. Clean out the overflow pipe; remove insects, dirt, and any other foreign matter from the radiator passages, radiator grille, and screens.

f. Check the thermostat, radiator pressure cap, and the cap seat for dirt and corrosion.

g. Refill with the proper mixture of coolant to protect the system down to the lowest possible temperature expected.

CAUTION

Filling the radiator at over 5 U.S. gallons (20 liters) per minute can cause air pockets to form in the cooling system.

NOTICE

Refilling the cooling system can be best accomplished by using the optional (refer to illustration "Central service system (opt.)," below.

Figure 14. Central service system (opt.)

h. After draining and refilling the cooling system, ALWAYS operate the engine with the radiator cap removed until the coolant level stabilizes.

i. Recheck the coolant level and add coolant as necessary to fill the system. The system should be filled to a point midway between the radiator core and the bottom of the filler neck to allow for expansion.

Cooling systems can also be pressure flushed and reverse flushed. Refer to the engine manufacturer's operator's manual and service manual for recommendations and instructions on performing these procedures.

If the radiator cannot be satisfactorily cleaned by normal flushing with the aid of chemical cleaners, reverse or pressure flushing, it may be necessary to remove the upper tank and rod out the radiator tubes. Only qualified and experienced personnel should perform this operation.

Cooling System External Monitoring

The cooling system is monitored by the LINCS computer system. Should the engine overheat, the RED alarm light will illuminate, an audible alarm will sound and an ALARM screen indicating engine overheating will appear on the computer monitor. Traction will be inhibited and the machine will go into dynamic braking, which will stop the machine. **Should an alarm situation occur, SHUT THE ENGINE DOWN IMMEDIATELY. Serious engine damage could occur during an alarm situation if the engine is not shut down immediately.**

The operator can silence the audible alarm and remove the ALARM message from the computer monitor; however, the RED alarm light will continue to illuminate and the fault will be logged into the VIEW ACTIVE ALARMS option of the Maintenance Menu. The light can be turned off and the fault removed from the log, only by maintenance personnel who have access to the service function of the LINCS computer system.

Engine Air Restriction Gauges

The engine safety filters are monitored by two “Engine Air Restriction Indicators”. They are located inside a box assembly, mounted above the generator/below the KLENZ™ box.

These indicator restriction gauges provide both a visual monitoring point and an indication of restriction signal for the machine’s onboard monitoring/control system (LINCS). The indicator restriction gauge visually shows an indication of restriction in inches of water.

After new filters are installed, a clean filter reading of approximately 12” (304 mm) H2O for Detroit engine and 15” (381 mm) H2O for Cummins engine is typical. If the engine filters restriction reaches 20” (508 mm) H2O, the restriction gauge has an internal switch that actuates, causing LINCS to generate a Red Alarm and send the engine into a timed shutdown sequence. A reset button is located on the bottom of each restriction gauge.

Some machines have two and some have four restriction gauges, depending on engine manufacturer

Figure 15. Engine filter restriction gauges

Figure 16. Engine filter restriction gauge location

The air restriction gauges must be reset after the filters are replaced. Press the reset button to cause the indicator to return to original position.

NOTICE

KLENZ™ filters should NEVER be cleaned and reused. Always replace filters with the correct Komatsu replacement filters.

Figure 17. Reset button located on bottom of restriction gauge

Engine Safety Adapter

The safety adapter is located between the restriction gauge intake hose and the KLENZ™ box structure engine intake tubing flange (typically threaded into the engine intake tubing flange). One restriction adapter is located on each engine filter turbo tube flange. Restriction of the adapter can prevent the engine safety filter alarm from alarming.

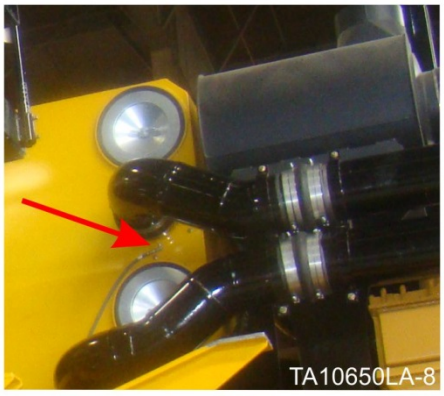


Figure 18. Engine filter safety adapter location

Engine Exhaust Stacks Guard Assembly

The engine exhaust stacks may have an optional guard assembly surrounding them, to help prevent burns when working in close proximity while they are hot.

⚠ CAUTION

Burs and fall hazards exist if working around the engine exhaust stacks while they are hot. The ends of the stacks extend outside the guard assembly and can be physically touched. Touching the stacks while hot can produce severe burns. Personal injury from burns, or reacting to burns and falling, is possible. Always wear personal protective equipment (PPE) to prevent burns. Failure to avoid touching the stacks can cause burn and fall hazards resulting in injury.

Figure 19. Engine exhaust stacks guard assembly

Vendor Literature

VL124 – L&M Mesabi Service Manual for Oil Cooler

VL125 – L&M Mesabi Service Manual for Radiator

VL132 – Mesabi Service Manual for Copper Tube

VL139 – MTU Fluids and Lubricants Specifications

This Page Intentionally Left Blank

SERVICE MANUAL

MESABI®

HIGH EFFICIENCY COPPER TUBE AIR-TO-OIL & AIR-TO-AIR COOLERS

MAXIMUM 150 PSI (1034 KPA)

Please read and follow instructions carefully before proceeding with any service work and/or repairs. Consult factory before proceeding with any possible warranty claims.

MARCH 2010

CONTENTS

MESABI® High Efficiency Copper Tube Air-to-Oil and Air-to-Air Cooler

This service manual is available to print online at www.MESABI.com. A service video is also available for viewing online, or request a DVD from L&M Radiator. The service video does not replace the information contained in this service manual.

CONTACT L&M'S CUSTOMER SERVICE DEPARTMENT PRIOR TO REPAIRS WHERE WARRANTY CLAIM IS A POSSIBILITY. FAILURE TO DO SO MAY VOID WARRANTY.

L&M RADIATOR GENERAL WARRANTY

Consult L&M before proceeding with warranty claims or repairs. Failure to do so may void this limited warranty. This limited warranty allocates the risk of failure of the product(s) between the buyer and L&M and is reflected in the purchase price.

L&M warrants that MESABI® products will conform to L&M's written quotation specifications and drawings. MESABI® framework components are warranted for 18 months from the date of invoice against defects in materials and workmanship during normal usage. L&M warranty against seal leakage during normal operation is stated in individual product literature.

L&M's liability is limited to the rework or replacement (at L&M's sole option) of products or parts manufactured by L&M that are determined by L&M to be defective in workmanship or material or do not meet L&M's quoted specifications.

L&M product warranty does not apply if the product has been subjected to abnormal use or conditions, unauthorized modifications or repair, corrosion, misuse, neglect, abuse, accident, improper installation, or other acts which are not the fault of L&M, including damage caused by shipping.

L&M does not warranty products incorporated into L&M products that are not manufactured by L&M. Buyer's sole recourse with respect to such products will be subject to the warranty of the individual manufacturer.

OTHER THAN AS STATED HEREIN, L&M MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER MATTERS WITH RESPECT TO THE SALE OF L&M PRODUCT(S) AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. IN NO EVENT WILL L&M'S LIABILITY INCLUDE ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, EVEN IF L&M KNEW OF THE LIKELIHOOD OF SUCH DAMAGES.

Any action or lawsuit for breach of the limited warranty in these L&M terms and conditions must be commenced in Minnesota. This warranty supersedes all previously published warranties.

MESABI® PRODUCT SPECIFIC WARRANTY COPPER TUBE AIR-TO-OIL AND AIR-TO-AIR COOLER

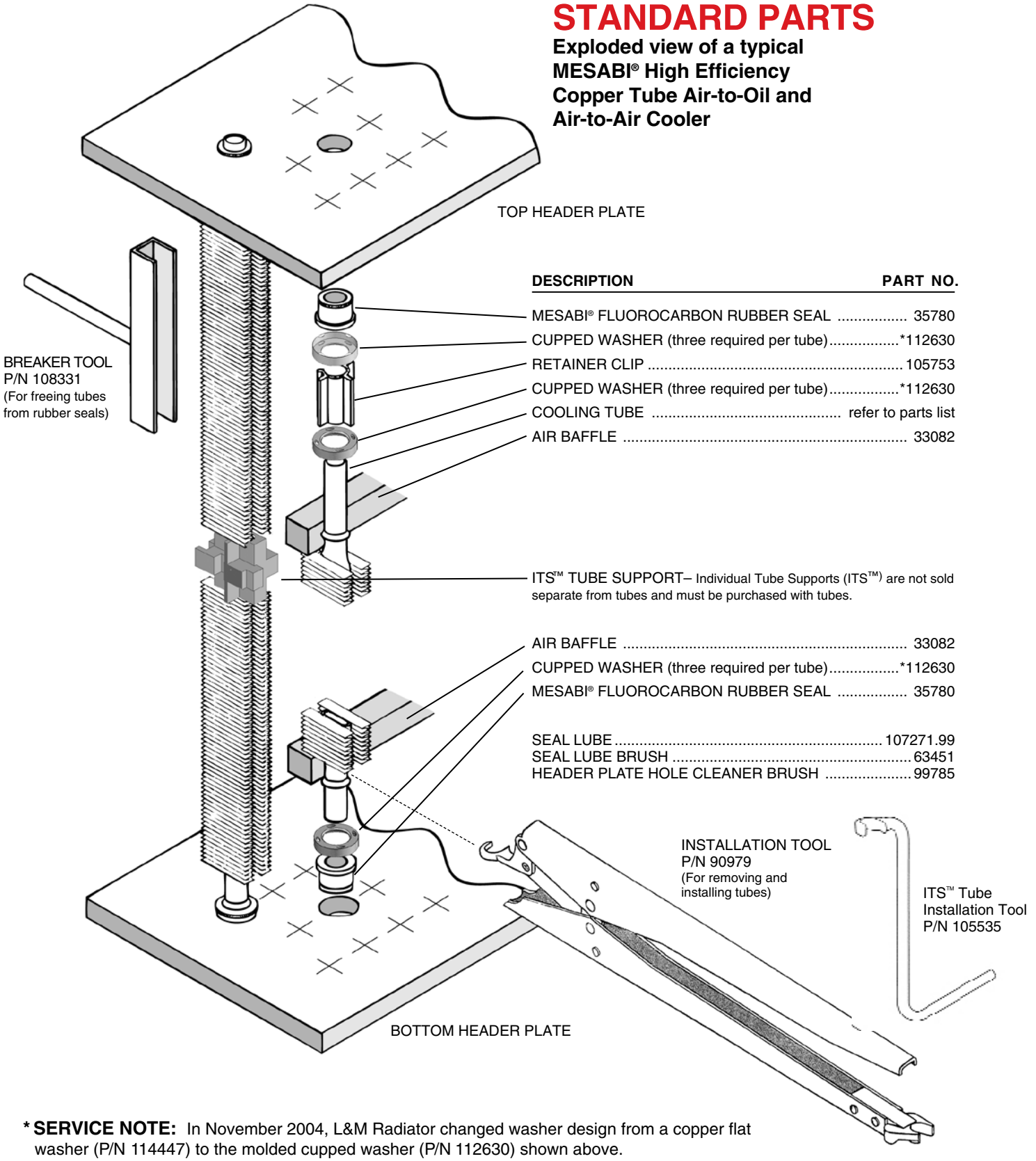
MESABI® Copper Tube Coolers are covered by the L&M General Warranty along with the following Product Specific Warranty:

L&M Radiator warrants MESABI® Copper Tube Coolers against seal leakage during normal operation for 48 months from date of invoice on new coolers.

MESABI® High Efficiency Copper Tube Air-to-Oil and Air-to-Air Cooler

STANDARD PARTS

Exploded view of a typical MESABI® High Efficiency Copper Tube Air-to-Oil and Air-to-Air Cooler



DESCRIPTION	PART NO.
MESABI® FLUOROCARBON RUBBER SEAL	35780
CUPPED WASHER (three required per tube)	*112630
RETAINER CLIP	105753
CUPPED WASHER (three required per tube)	*112630
COOLING TUBE	refer to parts list
AIR BAFFLE	33082
ITS™ TUBE SUPPORT– Individual Tube Supports (ITS™) are not sold separate from tubes and must be purchased with tubes.	
AIR BAFFLE	33082
CUPPED WASHER (three required per tube)	*112630
MESABI® FLUOROCARBON RUBBER SEAL	35780
SEAL LUBE	107271.99
SEAL LUBE BRUSH	63451
HEADER PLATE HOLE CLEANER BRUSH	99785

* **SERVICE NOTE:** In November 2004, L&M Radiator changed washer design from a copper flat washer (P/N 114447) to the molded cupped washer (P/N 112630) shown above. These parts are completely interchangeable. PART NO. 114447 MAY STILL BE USED IN HIGH TEMPERATURE APPLICATIONS. CONTACT L&M FOR DETAILS.

Cleaning

Standard External Cleaning

To assure maximum life of a MESABI® Core, reasonable care must be taken when cleaning.

Most radiator shops use a hot alkaline soap, caustic soda or chemical additives in their boil-out tanks, which attacks solders. If a MESABI® tube is soaked in such a solution, the solder bond between the finning and tube will be adversely affected. It must be known that the solution used is not harmful to solder so that it will not attack the solder used on the MESABI® tube. Be sure to completely rinse the cleaned tube/core in clean water after removing from the boil-out tank.

In most cases, it may be best to blow out any dry dirt with a high-pressure air gun prior to washing core with the high-pressure, hot-water washer.

For general external cleaning, a high-pressure, hot-water washer (with or without soap) can be used at pressures up to 1200 psi (8268 kPa). **(CAUTION! To prevent fin damage, stay a few inches away from the core and you must spray straight into the core – not at an angle.)**

If the cooler is still in the machine, you may have to use an offset angled nozzle so that you can spray straight into the core. If there is any doubt, try your cleaning method on a small portion of the core first.) It is important to start on the air exit side. Work from the top to the bottom. Concentrate on small areas and work slowly. Wash until the water exiting the opposite side is free from dirt and debris. Complete this side and then repeat the process from the other side.

Epoxy-Coated Core External Cleaning

Epoxy-coated cores must be cleaned with care to ensure the coating is not damaged.

1. A high-pressure, hot-water washer can normally be used. Use a "fresh" water supply. Water temperature should not exceed 180° F (82.2° C). Do not steam clean. The nozzle should be kept approximately 12 inches (30.48 cm) away from the core.

   CAUTION: We do not recommend a pressure rating because as epoxy ages the coating becomes brittle and might be damaged at higher pressures. We recommend that you try your cleaning method on a portion of a single tube first.
2. Wash the core thoroughly and methodically, starting at the top and working towards the bottom. Do not wash in one area for extended periods. The core will be clean when the water exiting the core is clean.
3. Blow off excess water with air. Epoxy coatings are not meant for submerged duty. L&M Radiator does not warrant against corrosion, but this coating, properly cared for, will help increase the service life and efficiency of your cooling system.

Internal Cleaning

The MESABI® copper tube coolers have an internal stainless steel turbulator that **CANNOT** be removed from the tube. In cases where it is necessary to clean the inside of the cooler, before removing any tubes or pumping any chemicals through the cooler, contact L&M Customer Service. See back page for contact information.

Tube Removal

HELPFUL HINTS:

- If all tubes are to be removed, pull out the air baffle prior to washing the core.
- Clean the core prior to removing tubes.
- To avoid bending or kinking tube ends, reduce the angle of the tube as it is being pulled from the top seal.
- If the core has a center tank, remove the top core tubes and seals first.
- If the core has an ITS™ (Individual Tube Support) system, mark the bars front and back before removing to ease re-assembly. Also note the position of the front tabs on the ITS™ – tubes support relative to the face of the cooler.
- To assist in the removal process, spray light oil on the top end of the tubes.
- If tubes are difficult to remove, try using the breaker tool and removal tool simultaneously.

Fig. 1

STEP 1.
Use a pair of pliers to remove the retainer clip from the top of the tube, as shown in **Fig. 1**.

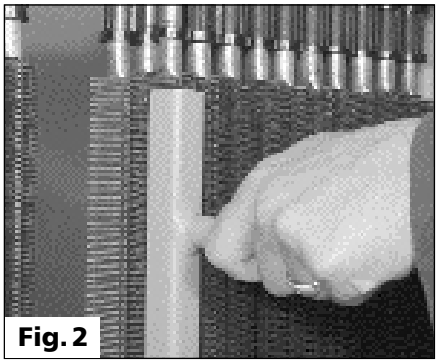


Fig. 2

STEP 2.
Loosen the tube by using Breaker Tool L&M P/N 108331, as shown in **Fig. 2**. The Breaker Tool should be placed at top or bottom, not at middle, when freeing tube from seal. Lightly twist the tube back and forth, to loosen tube from seals.

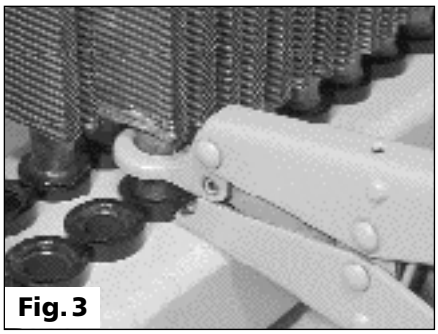


Fig. 3

STEP 3.
After tube is free, place upper jaw of Installation Tool, L&M P/N 90979, around the round portion at the bottom end of tube. Place lower jaw so that it rests on the header plate, just in front of the rubber seal, as shown in **Fig.3**. **DO NOT allow the lower jaw to rest on the washer.**
Squeeze handles of tool together and raise tube up as far as possible.

Tube Removal (continued)

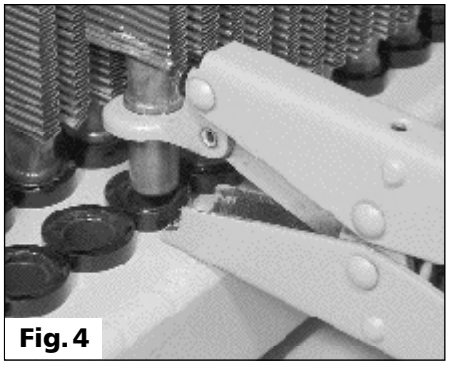


Fig. 4

STEP 4.
Reposition tool, so the upper jaw is between the upset on the tube and the cupped washer as shown in **Fig. 4**. Raise tube until bottom end clears the washer and seal.

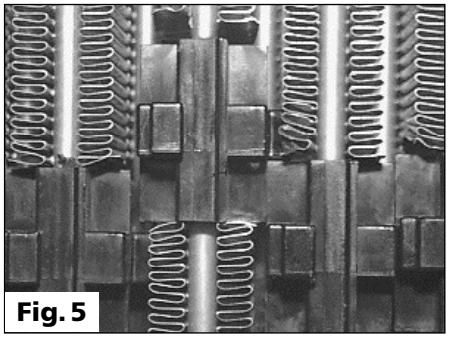


Fig. 5

If you are working with an ITS™ core, the tube should be raised high enough so that the interlocking tab clears the adjacent dovetail groove as shown in **Fig. 5**. **Raising a second tube will help the removal process on simple repairs.**

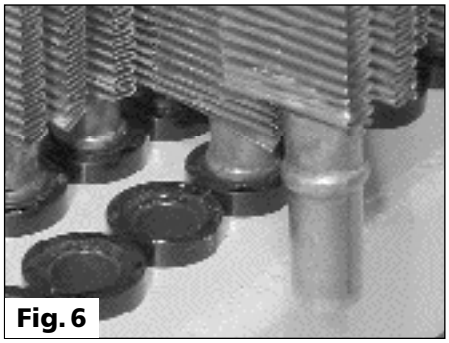


Fig. 6

STEP 5.
Use a minimum of angle to swing the tube out, just far enough to allow it to be pulled down and out of its top seal, as shown in **Fig. 6**.

Cleaning Tube Ends

Before the original tubes are reinstalled, the tube ends must be clean of foreign material. L&M recommends polishing the tube ends with a polishing wheel (Grainger #5A725 – use Qty. 5 together) and a copper polishing compound (Grainger #3W769).

If the debris cannot be removed by polishing, L&M recommends using a piece of fine grit emery cloth or steel wool. If there is a lot of debris on the tube ends, use a 6 in. or 8 in. (15.24 cm or 20.32 cm) diameter wire wheel brush with a wire size of .006 in. or .008 in. (.152 mm or .203 mm). Larger diameter wire sizes could damage the tube ends. Try installing a tube. If it does not slide easily into the top and bottom seals, try polishing the tube ends as per above.

Seal Installation

HELPFUL HINTS:

- L&M recommends installing new MESABI® seals any time tubes are removed.
- After removing the old seals, clean the plate holes of any foreign debris. We recommend using L&M P/N 99785 header plate hole cleaning brush in an electric or air drill.
- Clean inside of tanks and blow out plate holes with air.
- **Install new seals in clean, dry holes.**
- If the core has a center tank, do not install seals at the bottom of the top core until all the tubes are installed in the bottom core.

With your thumb start the new MESABI® seals into the holes and push them part way in. Care must be taken not to install seals too far into the header plate.

The use of a hammer directly on the seal can easily cause seals to be installed too far into the header plate. L&M recommends the use of a flat plate, 3/8 in. x 3 in. x 6 in. (9.53 mm x 76.20 mm 152.40 mm), placed over the seals and hitting with a rubber mallet will allow the seals to be properly installed.

A properly installed seal has a crowned or convex top surface, and the tube hole is slightly flared at the opening. A seal that is installed too far into the header has a concave top surface and the tube hole is noticeably smaller in diameter as shown in **Fig. 7**. **Seals installed too far will make tube installation more difficult and are much more likely to be damaged during tube installation.**

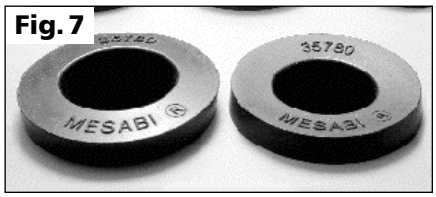


Fig. 7

CORRECT INCORRECT

ON THE LEFT:
Properly installed P/N 35780 seal.

RIGHT:
P/N 35780 seal installed too far into header (concave).

Cupped Washer Installation – After the seals have been installed, place the cupped washers P/N 112630 over the seals. The washers should be pressed firmly onto the seal so that they encompass the seal flange. **If you are servicing with the old style flat copper washers see service note, page 3.**

Seal Lubrication – After all the cupped washers are in place, lubricate all the seals. Use L&M lube brush P/N 63451 and assembly lube P/N 107271.99.

Tube End Lubrication – It is important to visually inspect both ends of each tube for damage prior to lubrication. Correct any problems or replace tubes. Lubricate both ends of each tube using the 63451 lube brush and 107271.99 lubricant.

Tube Installation

HELPFUL HINTS:

- If you are working with a center tank core, the bottom core must be assembled before the top core. **DO NOT install seals at the bottom of the top core (top side of the center tank).**
- Minimize the angle of the tube as it's being installed into the top seal.
- Make sure the tube is centered in the bottom seal before any force is applied to pull or push into place.

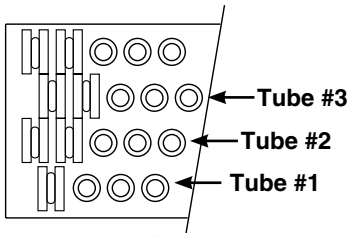
A vertical cooler position with the bottom header of the section being worked on at a comfortable height for the assembler is recommended.

CAUTION! If a tube seems difficult to install into a seal, STOP and figure out WHY! One of the following reasons could be the answer.

1. A tube or seal has inadequate lubrication.
2. Seal improperly installed (may be pushed too far into the header plate hole).
3. Damaged tube end.
4. Trying to insert the tube into the seal at too steep of an angle.
5. Tube is not centered in seal.

NOTE: If for any of the above reasons a tube is difficult to install, the seal should be removed and inspected for any scuffing marks, tears or cuts. If there is any doubt, replace the seal.

Recommended Tube Installation Pattern:

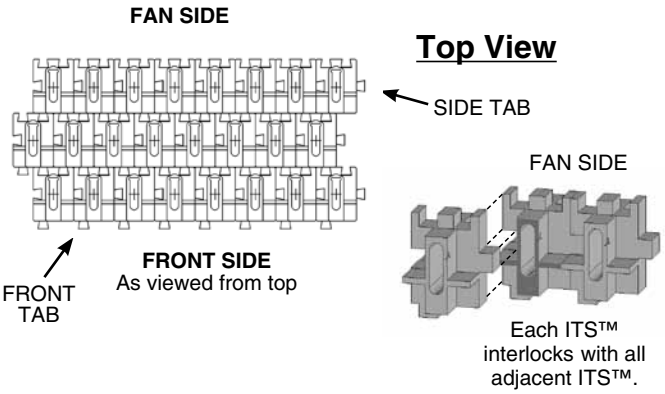


- It is recommended that tubes be installed outwardly from each side member or tension tie across all rows in a "diagonal pattern" as indicated in the sketch. This pattern will provide better control of the tube and allows a 100% view of the seal during tube installation and seal inspection.
- The diagonal pattern should be continued until there is not enough room at which point the centermost row should then be completed, followed by the remaining rows.
- The diagonal pattern can slope right or left, but each tube installed should be the outermost tube compared to adjacent rows to allow for the best grip on the tube and maximum visibility of the washers and seals.

Air baffles can be pulled into place using a heavy string or a wire after final pressure testing. Air baffles are not required behind gussets. Before the last tube is installed in the outside row adjacent the air baffle, a wire or heavy string can be installed where the air baffle is required.

ITS™ – Individual Tube Support Installation

Make sure the tabs on the ITS™ tube supports are facing to the front and to the right.



STEP 1. Before installing tubes, place one cupped washer P/N 112630 on the top end of each tube making sure that the flat face of the washer faces upward towards the top of the tube. This will allow the retainer clip P/N 105753 to slide into position properly. (see page 3).

STEP 2. Installing the tube in the top seal:
Carefully insert the tube into the top seal. The cupped washer will help keep the tube centered in the top seal. Keeping the tube at a minimum angle, with a slight twisting forward motion, push the tube into the seal far enough to clear the bottom washer/seal. To minimize installation angle, tubes in any given row should be installed from the closest header edge.

STEP 3. Installing the tube in the bottom seal:
Hold the tube with one hand near the center of the tube (above the ITS™ if there is one present) and the other hand near the bottom end of the tube.

- Holding the tube at the center allows you to easily deflect the tube sideways enough to allow a full grip on the tube with your upper hand and eliminate any interference when ITS™ systems are used.
- Holding the tube close to the bottom provides the best control of the tube end and lowest force on both hands.

Looking below your lower hand to see the washer/seal, slowly insert the tube about 1/4 to 3/8 inch (6.35 mm to 9.53 mm) into the bottom seal.

NOTE: When ITS™ systems are present, there is no need to worry about engaging the ITS™ until the tube is 1/4 to 3/8 of an inch (6.35 mm to 9.53 mm) into the bottom seal.

STEP 4. Fully seat the tube into the bottom seal, engaging the ITS™ when present. Tool P/N 105535 can be used at this point to help pull the tube into the bottom plate. Tool is positioned at top of tube as shown in **Fig. 8**.

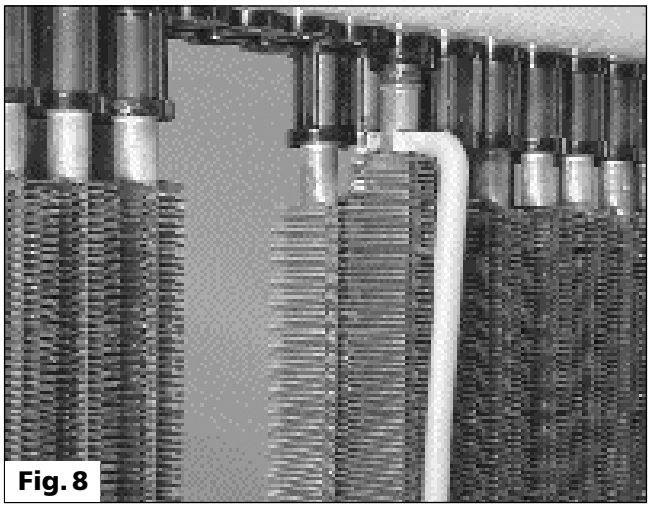


Fig. 8

STEP 5. Using a pair of pliers, reinstall the tube retainer clips P/N 105753 on the inner rows of tubes positioning the center tab towards the front of the cooler. The retainers on the outermost (front) row of tubes can be installed after all the tubes are in place. **See Fig. 9** for proper positioning of the retainer clips.

NOTE: The tabs on our older style retainer clips, P/N 33567 are wider and must be rotated slightly so that they overlap.

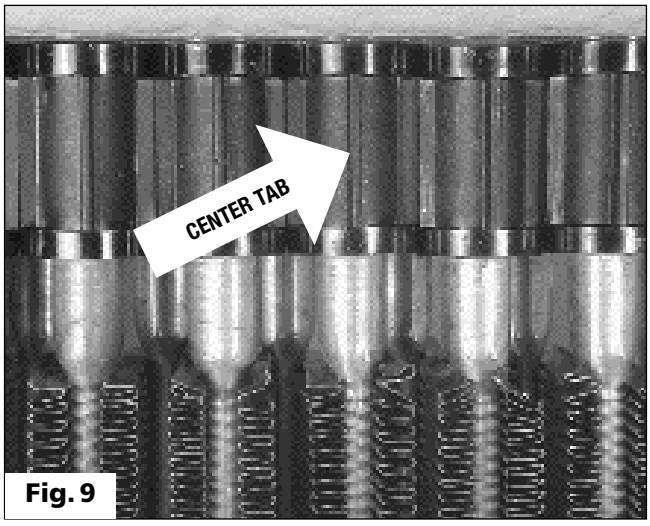


Fig. 9

Picture shows retainer clips in place with center tabs facing outwards towards the front of the cooler.

STEP 6. Repeat the previous steps for the subsequent diagonal groups of tubes.

STEP 7. (If applicable)
If you are working with the ITS™ support system, install the appropriate support bar as shown in **Fig. 10**.

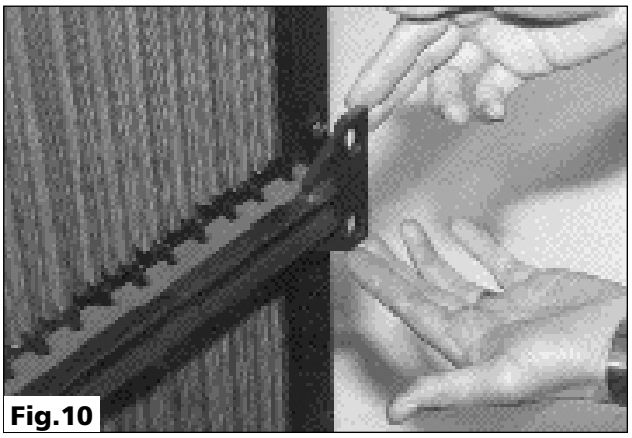


Fig.10

The support bar part number has been stamped on the outside face. Use the L&M Radiator Assembly Drawing and Parts List (on page 3) for proper installation. Using a rubber mallet, gently tap the bar into place and secure to the side member with bolts.

STEP 8. The air baffles can be installed after pressure testing as indicated earlier.

Pressure Testing

Pressure testing procedure that follows recommends testing to 150 psi (1034 kPa). You should test to pressure rating specified on tag attached to your cooler. If there is no pressure rating specified, please contact L&M Customer Service with the part number of your cooler.

Caution: Always bring pressure up slowly and use personal protection gear. Tube retainer and support bars (if applicable), must be installed prior to testing.

1. Install fittings or cover plates in or over all ports. One port to have an air supply connector.
2. Pressurize with line pressure not exceeding 150 psi (1034 kPa) and submerge in water. Repair or tighten fittings to eliminate leaking. Note that air bubbles from trapped air in exterior pockets could appear for 10 to 15 minutes. This is normal. Repeat as needed until no leaks are detected.
3. After successful pre-testing to find and repair major leaks, cycle testing can begin. Pressurize with compressed air or nitrogen to 150 psi (1034 kPa) and hold submerged for 15 minutes. Repair any leaks that occur and repeat until you have reached a 15 minute time period successfully. Then cycle to 0 psi and pressure back to 150 psi (1034 kPa) and hold for 1 minute. Repeat this process three more times and hold the last cycle for 5 minutes. After any repairs in this stage, start the cycling testing over from the beginning until you have a successful test.

MESABI® heat exchangers are the world standard for heat exchanger reliability

L&M RADIATOR FACTORY-DIRECT SALES AND SERVICE

Because so many of our radiators and heat exchangers are a custom design, all sales are on a factory-direct basis. This assures that our customers receive a product that meets their cooling / heating requirements, offered to them at the least possible price.

We ship most parts within 24 hours. On-site technical and engineering assistance is available almost anywhere in the world within a few days notice.

L&M QUALITY POLICY

"The Quality Policy of L&M Radiator is to produce a quality engineered, quality manufactured product through continuous improvement that we deliver to the customer's satisfaction."

Manufactured and distributed by:

L AND M Radiator

Toll Free: 800-346-3500 (U.S.A. and Canada)
Web Site: MESABI.com **Email: cool@MESABI.com**

WORLD HEADQUARTERS

L&M Radiator, Inc.
1414 East 37th Street
Hibbing, Minnesota 55746 U.S.A.
Telephone: (218) 263-8993
Fax: (218) 263-8234

ISO 9001:2008 CERTIFIED

UNITED STATES

L&M Radiator, Inc.
Hibbing, Minnesota U.S.A.

L&M Radiator, Inc.
Independence, Iowa U.S.A.

L&M Radiator, Inc.
El Paso, Texas U.S.A.

L&M Radiator, Inc.
Yankton, South Dakota U.S.A.

MEXICO

L y M de Mexico S.A. de C.V.
Calle De La Plata y Los Nogales
Parque Industrial
Hermosillo, Sonora, Mexico
Telephone: 011-52-662-251-0480
Fax: 011-52-662-251-0638
Email: ventas@lym.com.mx

AUSTRALIA

L&M Radiator Pty. Ltd.
Cnr. Kew & Kathleen Streets
Welshpool, Western Australia 6016
Telephone: +61-8-93616855
Fax: +61-8-94703075
Email: cool@mesabi.com.au

SERVICE MANUAL

MESABI®

COPPER TUBE

- RADIATORS
- CORES
- AIR-TO-AIR COOLERS
- LOW PRESSURE OIL COOLERS & FUEL COOLERS (MAXIMUM 50 PSI/345 KPA)

Please read and follow instructions carefully before proceeding with any service work and/or repairs. Consult factory before proceeding with any possible warranty claims.

MAY 2009

CONTENTS

MESABI® Radiator Cores

CONTACT L&M'S CUSTOMER SERVICE DEPARTMENT PRIOR TO REPAIRS WHERE WARRANTY CLAIM IS A POSSIBILITY. FAILURE TO DO SO MAY VOID WARRANTY.

MESABI® GENERAL WARRANTY

Consult L&M before proceeding with warranty claims or repairs. Failure to do so may void this limited warranty. This limited warranty allocates the risk of failure of the product(s) between the buyer and L&M and is reflected in the purchase price.

L&M warrants that MESABI® products will conform to L&M's written quotation specifications and drawings. MESABI® framework components are warranted for 18 months from the date of invoice against defects in materials and workmanship during normal usage. L&M warranty against seal leakage during normal operation is stated in individual product literature.

L&M's liability is limited to the rework or replacement (at L&M's sole option) of products or parts manufactured by L&M that are determined by L&M to be defective in workmanship or material or do not meet L&M's quoted specifications.

L&M product warranty does not apply if the product has been subjected to abnormal use or conditions, unauthorized modifications or repair, corrosion, misuse, neglect, abuse, accident, improper installation, or other acts which are not the fault of L&M, including damage caused by shipping.

L&M does not warranty products incorporated into L&M products that are not manufactured by L&M. Buyer's sole recourse with respect to such products will be subject to the warranty of the individual manufacturer.

OTHER THAN AS STATED HEREIN, L&M MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER MATTERS WITH RESPECT TO THE SALE OF L&M PRODUCT(S) AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. IN NO EVENT WILL L&M'S LIABILITY INCLUDE ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, EVEN IF L&M KNEW OF THE LIKELIHOOD OF SUCH DAMAGES.

Any action or lawsuit for breach of the limited warranty in these L&M terms and conditions must be commenced in Minnesota. This warranty supersedes all previously published warranties.

MESABI® PRODUCT SPECIFIC WARRANTY

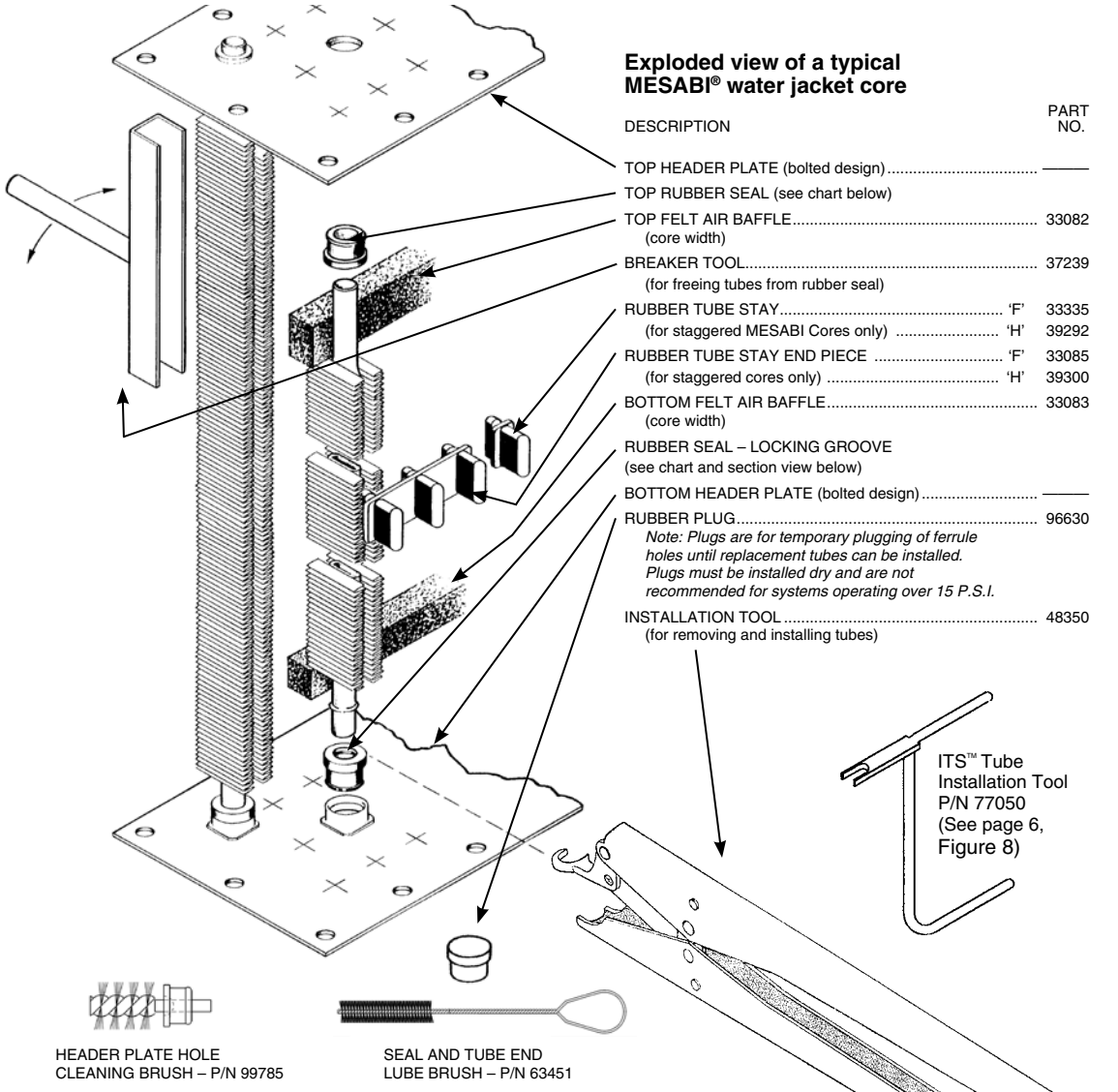
Covers:

- Radiators
- Cores
- Air-To-Air Coolers
- Low Pressure Oil Coolers & Fuel Coolers
  (maximum 50 psi/345 kPa)

In addition to the MESABI® General Warranty, L&M Radiator further warrants the MESABI® heat exchangers listed above against seal leakage during normal operation for 48 months from date of invoice.

Standard Parts of a Typical MESABI® Radiator Core

SINGLE UPSET TUBE



Exploded view of a typical MESABI® water jacket core

DESCRIPTION		PART NO.
TOP HEADER PLATE (bolted design)		———
TOP RUBBER SEAL (see chart below)		
TOP FELT AIR BAFFLE (core width)		33082
BREAKER TOOL (for freeing tubes from rubber seal)		37239
RUBBER TUBE STAY	'F'	33335
(for staggered MESABI Cores only)	'H'	39292
RUBBER TUBE STAY END PIECE	'F'	33085
(for staggered cores only)	'H'	39300
BOTTOM FELT AIR BAFFLE (core width)		33083
RUBBER SEAL – LOCKING GROOVE (see chart and section view below)		
BOTTOM HEADER PLATE (bolted design)		———
RUBBER PLUG		96630
Note: Plugs are for temporary plugging of ferrule holes until replacement tubes can be installed. Plugs must be installed dry and are not recommended for systems operating over 15 P.S.I.		
INSTALLATION TOOL (for removing and installing tubes)		48350

ITS™ Tube Installation Tool P/N 77050 (See page 6, Figure 8)

HEADER PLATE HOLE CLEANING BRUSH – P/N 99785

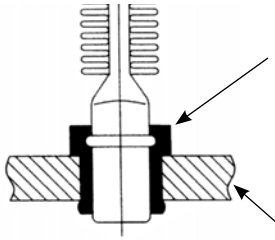
SEAL AND TUBE END LUBE BRUSH – P/N 63451

SEAL & LUBE CHART

If you are not sure of your core style, contact L&M Customer Service.

Core Style	Top Seal	Bottom Seal	Lube P/N
F (coolant)	WT	WB	113230.99
H (coolant)	WT	WB	113230.99
L (coolant)	WT	WB	113230.99
M (coolant)	WT	WB	113230.99
V (coolant)	WT	WB	113230.99
Locomotive*	35780	87530	113230.99
Air-to-Air*	35780	87530	107271.99
Oil Cooler*	35780	87530	107271.99

*Air-to-Air, Oil Cooler and Locomotive can be any style of core above (F, H, L, M, V)



LOCKING GROOVE SEAL (P/N 87530 or P/N WB) must be used at the bottom. The tube bead will seat in the seal inner groove.

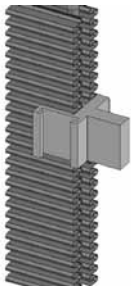
Tube Locking design

Bottom Plate

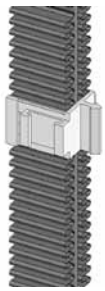
Additional Tube Styles

(Sold As Assemblies Only)

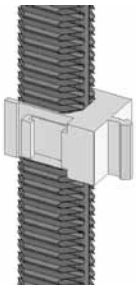
ITS™ (Individual Tube Support) Used on H, L, and V style cores



STAY Used on "L" style cores



STAY Used on "M" style cores



STAY Used on "V" style cores

Cleaning

STANDARD EXTERNAL CLEANING

To maintain efficiency and assure maximum life of a MESABI® Core, reasonable care must be taken when cleaning.

Most radiator shops use a hot alkaline soap, caustic soda or chemical additives in their boil-out tanks, which attacks solders. If a MESABI® tube is soaked in such a solution, the solder bond between the finning and tube will be adversely affected. If it is known that the particular solution used is not harmful to solder, then it will not hurt the solder used on the MESABI® tube. Be sure to completely rinse the cleaned tube/core in clean water after removing from the boil-out tank.

In most cases, it may be best to blow out any dry dirt with a high pressure air gun prior to washing the core with a high pressure hot water washer.

For general external cleaning, a high pressure, hot water washer (with or without soap) can be used at pressures up to 1200 psi (8274 KPa). (**CAUTION! To prevent fin deformation, you must stay a few inches away from the core and spray straight into the core not at an angle. If the cooler is still in the machine, you may have to use an offset angled nozzle so that you can spray straight into the core. If there is any doubt, try your cleaning method on a small portion of the core first.)** It is important to start on the air exit side. Work from the top to the bottom. Concentrate on small areas and work slowly. Wash until the water exiting the opposite side is free from dirt and debris. Complete this side and then repeat the process from the other side.

EPOXY-COATED CORES

Epoxy-coated cores must be cleaned with care to assure the coating is not damaged.

1. A high pressure hot water washer can normally be used. Use a “fresh” water supply. Water temperature should not exceed 180^{0}F. Do not steam clean. The nozzle should be kept approximately 12 inches away from the core.

CAUTION! We do not recommend a pressure rating because as epoxy ages the coating does become brittle and might be damaged at higher pressures. We recommend that you try your cleaning method on a portion of a single tube first.

2. Wash the core thoroughly and methodically, starting at the top and working towards the bottom. Do not wash in one area for extended periods. The core will be clean when the water exiting the core is clean.
3. Blow off excess water with air.

Epoxy coatings are not meant for submergent duty. L&M Radiator does not warrant against corrosion, but this coating, properly cared for, will help increase the service life and efficiency of your cooling system.

INTERNAL CLEANING

In most cases just flushing the inside of the tubes with a high pressure hot water washer, with soap, will do the job. Rinse thoroughly with clean water.

Tube Removal

HELPFUL HINTS:

- Clean the core prior to removing tubes.
- To avoid bending or kinking tube ends, reduce the angle of the tube as it’s being pulled from the top seal.
- If the core has a center tank, remove the top core tubes and seals first.
- If the core has an ITS™ (Individual Tube Support) or stay system with support bars, mark the bars front and back before removing, to ease reassembly.
- To assist in the removal process, spray WD-40 on the top end of tubes.
- If tubes are difficult to remove, try using the breaker tool and removal tool simultaneously.

STEP 1.

Loosen the tube by using Breaker Tool, L&M P/N 37239, as shown in **Fig. 1**. The Breaker Tool should be placed at top or bottom, not at middle when freeing tube from seal. Lightly twist the tube back and forth, to loosen tube from seals.

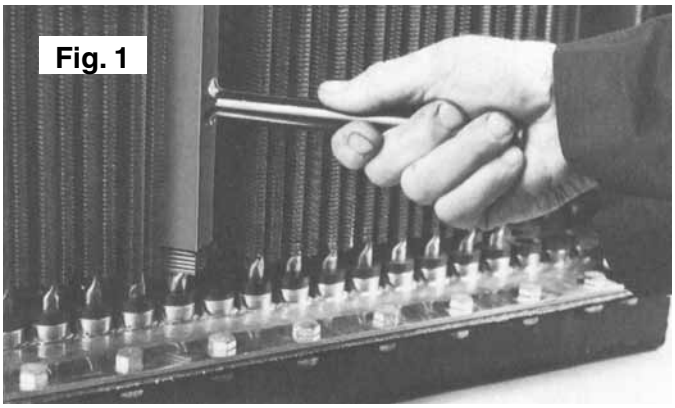


Fig. 1

STEP 2.

After tube is free, place upper jaw of Installation Tool P/N 48350 around the round portion of tube, just below the flattened portion. Place lower jaw on top of bottom seal, see **Fig. 2**. Squeeze handles of tool together and raise tube only enough to clear bottom seal.

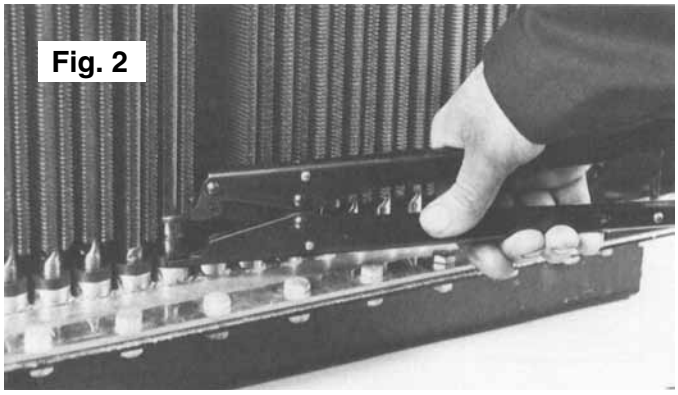


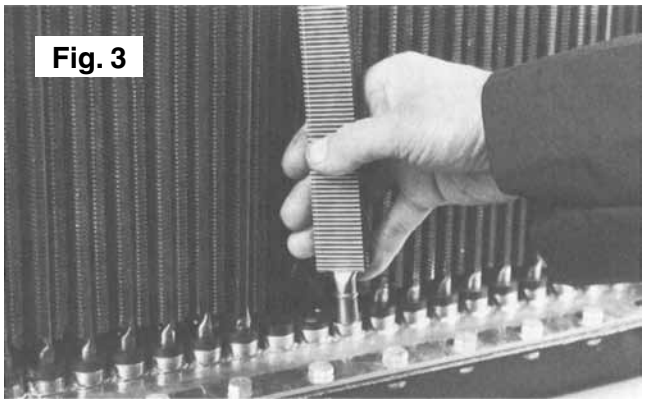
Fig. 2

Tube Removal (continued)

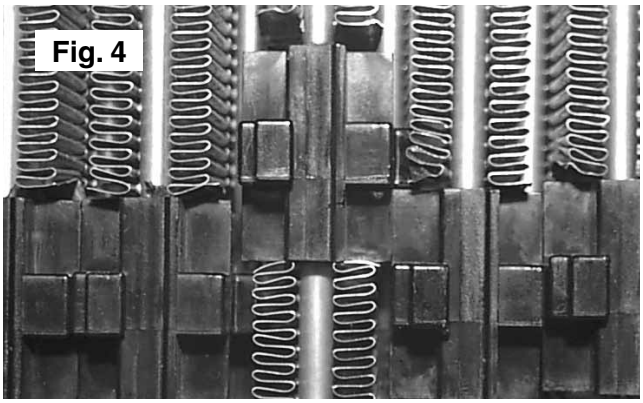
STEP 3.

Put down tool and swing tube out just far enough to allow it to be pulled down and out of its top seal, as shown in **Fig. 3**.

Remove all tubes in the row, repeating the above procedure.



If you are working with any of L&M's ITS™ or stay systems with interlocking tabs, the tube must be raised high enough so that the interlocking tab clears the adjacent groove, as shown in **Fig. 4**.



Cleaning Tube Ends

Before the original tubes are reinstalled, the tube ends must be clean of foreign material. L&M recommends polishing the tube ends with a polishing wheel (Grainger #5A725 – use Qty. 5 together) and a copper polishing compound (Grainger #3W769).

If the debris cannot be removed by polishing, L&M recommends using a piece of fine grit emery cloth or steel wool. If there is a lot of debris on the tube ends, use a 6" or 8" diameter wire wheel brush with a wire size of .006 or .008. Larger diameter wire sizes could damage the tube ends. Try installing a tube.

If it does not slide easily into the top and bottom seals, try polishing the tube ends as per above.

Seal Installation

HELPFUL HINTS:

- L&M recommends installing new MESABI® seals when tubes are removed.
- After removing the old seals, clean the plate holes of any foreign debris with L&M P/N 99785 header plate hole cleaning brush placed in an electric or air drill.
- Clean out inside of tanks and blow out plate holes with air.
- Install new seals in clean dry holes. **Do not apply any lubricant to header plate holes.**
- If the core has a center tank, do not install seals at the bottom of the top core until all the tubes are installed in the bottom core.
- For ease of seal installation, soak seals in hot water just prior to installing.
- Make sure you use proper seal part number (see Seal & Lube Chart on page 3).

With your thumb, start the new MESABI® seals into the holes and push them part way in. Care must be taken not to install seals too far into the header plate. A properly installed seal has a crowned or convex top surface, and the tube hole is slightly flared at the opening. A seal that is installed too far into the header has a concave top surface and the tube hole is noticeably smaller in diameter as shown in **Fig.5**. Over-installed seals will make tube installation more difficult and are much more likely to be damaged during tube installation.

The use of a hammer directly on the seal can easily cause seals to be installed too far into the header plate. L&M recommends the use of a flat plate 3/8" x 3"x 6" placed over the seals. Hitting with a rubber mallet will allow the seals to be properly installed.

CORRECT INCORRECT

Fig. 5

ON THE LEFT:
Properly installed seal.

RIGHT:
Seal installed too far into header.

Lubricating Seals and Tube Ends

For ease of tube installation and to minimize the chance of scuffing or tearing rubber seals during tube installation, both top and bottom seals and both tube ends must be thoroughly lubricated, using L&M lube (see Seal & Lube Chart on page 3 for proper lube part number). Using a 1/2" diameter brush (L&M P/N 63451) and a minimal amount of lubricant, apply a thin film into each seal hole and onto each tube end.

Tube Installation

CAUTION! If a tube seems difficult to install into a seal, STOP and figure out WHY! One of the following reasons could be the answer.

1. A tube or seal with inadequate lubrication.
2. Improperly installed seal that could be pushed too far into the header plate hole.
3. Damaged tube end.
4. Trying to insert the tube into the seal at too steep of an angle.
5. Tube is not centered in seal.

NOTE: *If, for any of the above reasons, a tube is difficult to install, the seal should be removed and inspected for any scuffing marks, tears, or cuts. If there is any doubt, replace the seal.*

HELPFUL HINTS:

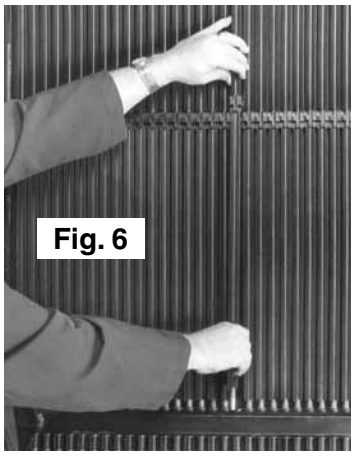
- If you are working with a center tank core, the bottom core must be assembled before the top core.
- Minimize the angle of the tube as it's being installed into the top seal.
- Make sure the tube is centered in the bottom seal before any force is applied to pull or push into place.
- For ease of tube installation, install the tubes behind the side member gussets in each row first. Install the tubes behind the left side gussets, working towards the core center. Then, going to the far right hole, in the same row, install the tubes working towards the core center.
- Individual rubber tube stays and, in some cases, tube stay ends are necessary to interlock the tubes. For part numbers see page 3. If more detailed information is required for proper assembly of cores using tube stays and tube stay ends, contact one of the L&M manufacturing facilities listed on back page.
- If your core style includes plastic tube supports, see page 7 for ITS™ or stay orientation prior to starting.

STEP 1.

To minimize installation angle, tubes in any given row must be installed from the closest header plate edge.

Use a minimum of angle and a slight twisting, pushing motion, to push the top end of the tube into the top seal. Push it far enough in so the bottom of the tube clears the top of the bottom seal.

If you are working with any of L&M's ITS™ or stay systems, you will need to insert the tube far enough into the top seal to allow clearance for the tabs to be aligned with the grooves when the tube is pulled down into the bottom seal (see **Figs. 4. and 6.**). Please note that when ITS™ or stays with interlocking tabs and grooves are present, the bottom end of the tube should be centered in the seal and then pulled down slightly into the seal so that the tabs engage the adjacent grooves.

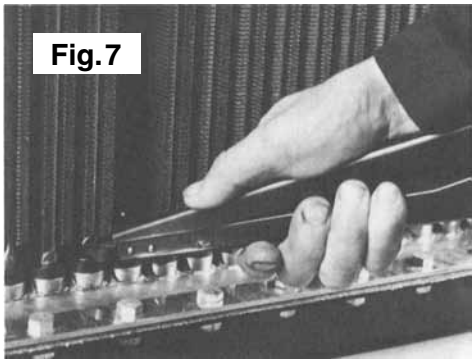


NOTE: *See page 7 for ITS™ or stay orientation in the core.*

STEP 2.

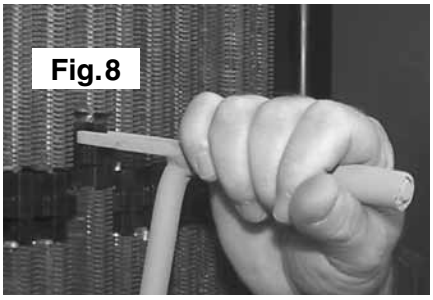
Center bottom end of tube into respective seal in the bottom header plate. Then, push tube down and into seal until the formed bead is seated into the locking groove of the bottom seal.

This may be done by grasping tubes by hand and pulling the tube downward until seated, or by using Installation Tool, L&M P/N 48350. This tool has a semicircular form on the end of the handle. Place this end on the formed bead of the tube and push downward until seated, as shown in **Fig. 7**.



Now, complete the row of tubes. Precaution should be taken to make sure formed bead is seated into bottom seal, and that the tubes are straight and aligned to assure maximum air flow.

If you are working with an ITS™ system (refer to page 3 and page 7, **Fig. 9,** for identification), use L&M tube installation tool P/N 77050 to pull the tube into the bottom seal. (See **Fig. 8**.) Hook the slotted end of the tool behind the front tab on the ITS™ tube support. Using the tool and your free hand, center the bottom end of the tube into the bottom seal. At the same time guide the dovetail slots into the tabs on the ITS™ tube support. Once in place, and with the tool P/N 77050 still hooked onto the ITS™ tube support, pull the tube into the bottom seal until the formed bead is seated into the locking groove of the bottom seal. Push the remaining tubes in this row. Use the same procedure on all remaining rows except the front side row.



Tube Installation (continued)

STEP 2. (CONTINUED)

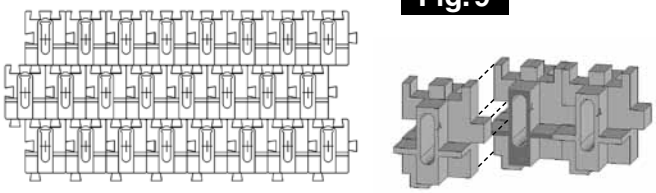
Tube Support Orientation

All illustrations front side as viewed from top.

A. ITS™ (can be used on H, L, or V style cores)

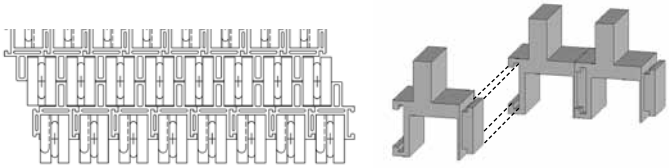
Make sure the tabs on the ITS tube supports are facing to the front and to the right.

Fig. 9



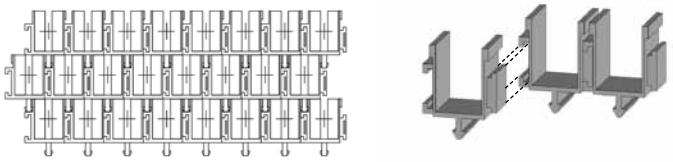
FRONT

B. "L" Stay



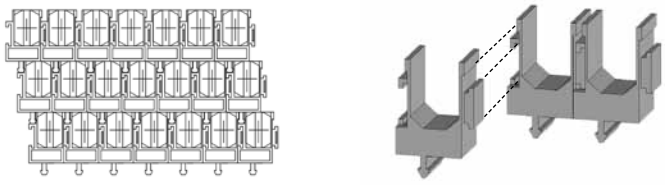
FRONT

C. "M" Stay



FRONT

D. "V" Stay



FRONT

NOTE: *If you are working with an older stay style that has rubber tube stays (see Exploded View page 3) and need assembly assistance, please contact L&M Customer Service.*

STEP 3.

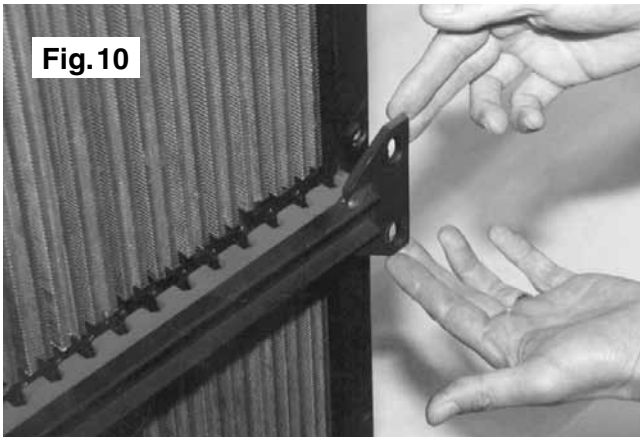
Before you install the front side row, install the felt air baffles.

Caution! To prevent seal leaks, do not allow the felt baffles to be pushed (top) or pulled (bottom) into the seal hole when installing the front row of tubes.

STEP 4. (If applicable)

If you are working with the ITS™ or stay support system, install the appropriate support bar as shown in **Fig. 10**.

Fig. 10



The support bar part number has been stamped on the outside face. Use the L&M Radiator Technical Drawing and Parts List for proper installation. Using a rubber mallet, gently tap the bar into place and secure to the side member.

PRESSURE TESTING

Pressure testing procedure that follows recommends testing to 15 psi (103 kPa). You should test to pressure rating specified on tag attached to your cooler. If there is no pressure rating specified, please contact L&M customer service with the part number of your cooler.

(Caution: Always bring air pressure up slowly and always wear protective gear)

1. Pressurize with compressed air to 15 psi (103 kPa) and submerge in water.
2. Seal any leaks at the test fittings and/or cover plates.
3. Repair any other leaks as needed.
4. Cycle test after successful initial test. Hold pressure at 15 psi (103 kPa) for 15 minutes. Note that the time starts after all leaks are fixed and air bubbles have subsided. Cycle to zero psi and pressure back up to 15 psi (103 kPa). Hold at 15 psi (103 kPa) for one minute. Repeat three more times and then hold the last cycle pressure at 15 psi (103 kPa) for five minutes. Should any leaks appear, fix them, and start the cycle test over.

If you have any questions regarding the procedures described in this Service Manual, please contact L&M Radiator and ask for Customer Service. See back page for contact information.

MESABI® is the world standard for heat exchanger reliability

L&M RADIATOR FACTORY-DIRECT SALES AND SERVICE

Because so many of our radiators and heat exchangers are a custom design, all sales are on a factory-direct basis. This assures that our customers receive a product that meets their cooling / heating requirements, offered to them at the least possible price.

We ship most parts within 24-hours. On-site technical and engineering assistance is available almost anywhere in the world within a few days notice.

L&M QUALITY POLICY

"The Quality Policy of L&M Radiator is to produce a quality engineered, quality manufactured product through continuous improvement that we deliver to the customer's satisfaction."

Manufactured and distributed by:

L&M Radiator

Toll Free: 800-346-3500 (U.S.A. and Canada)
Web Site: www.mesabi.com **Email: cool@mesabi.com**

WORLD HEADQUARTERS

L&M Radiator, Inc.
1414 East 37th Street
Hibbing, Minnesota 55746 U.S.A.
Telephone: (218) 263-8993
Fax: (218) 263-8234

ISO 9001:2008 CERTIFIED

UNITED STATES

L&M Radiator, Inc.
Hibbing, Minnesota U.S.A.

L&M Radiator, Inc.
Independence, Iowa U.S.A.

L&M Radiator, Inc.
El Paso, Texas U.S.A.

L&M Radiator, Inc.
Yankton, South Dakota U.S.A.

MEXICO

L y M de Mexico S.A. de C.V.
Calle De La Plata y Los Nogales
Parque Industrial
Hermosillo, Sonora, Mexico
Telephone: 011-52-662-251-0480
Fax: 011-52-662-251-0638
Email: ventas@lym.com.mx

AUSTRALIA

L&M Radiator Pty. Ltd.
Cnr. Kew & Kathleen Streets
Welshpool, Western Australia 6016
Telephone: +61-8-93616855
Fax: +61-8-94703075
Email: cool@mesabi.com.au

SERVICE MANUAL

MESABI®

COPPER TUBE

- RADIATORS
- CORES
- AIR-TO-AIR COOLERS
- LOW PRESSURE OIL COOLERS & FUEL COOLERS (MAXIMUM 50 PSI/345 KPA)

Please read and follow instructions carefully before proceeding with any service work and/or repairs. Consult factory before proceeding with any possible warranty claims.

MAY 2009

CONTENTS

MESABI® Radiator Cores

CONTACT L&M'S CUSTOMER SERVICE DEPARTMENT PRIOR TO REPAIRS WHERE WARRANTY CLAIM IS A POSSIBILITY. FAILURE TO DO SO MAY VOID WARRANTY.

MESABI® GENERAL WARRANTY

Consult L&M before proceeding with warranty claims or repairs. Failure to do so may void this limited warranty. This limited warranty allocates the risk of failure of the product(s) between the buyer and L&M and is reflected in the purchase price.

L&M warrants that MESABI® products will conform to L&M's written quotation specifications and drawings. MESABI® framework components are warranted for 18 months from the date of invoice against defects in materials and workmanship during normal usage. L&M warranty against seal leakage during normal operation is stated in individual product literature.

L&M's liability is limited to the rework or replacement (at L&M's sole option) of products or parts manufactured by L&M that are determined by L&M to be defective in workmanship or material or do not meet L&M's quoted specifications.

L&M product warranty does not apply if the product has been subjected to abnormal use or conditions, unauthorized modifications or repair, corrosion, misuse, neglect, abuse, accident, improper installation, or other acts which are not the fault of L&M, including damage caused by shipping.

L&M does not warranty products incorporated into L&M products that are not manufactured by L&M. Buyer's sole recourse with respect to such products will be subject to the warranty of the individual manufacturer.

OTHER THAN AS STATED HEREIN, L&M MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER MATTERS WITH RESPECT TO THE SALE OF L&M PRODUCT(S) AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. IN NO EVENT WILL L&M'S LIABILITY INCLUDE ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES, EVEN IF L&M KNEW OF THE LIKELIHOOD OF SUCH DAMAGES.

Any action or lawsuit for breach of the limited warranty in these L&M terms and conditions must be commenced in Minnesota. This warranty supersedes all previously published warranties.

MESABI® PRODUCT SPECIFIC WARRANTY

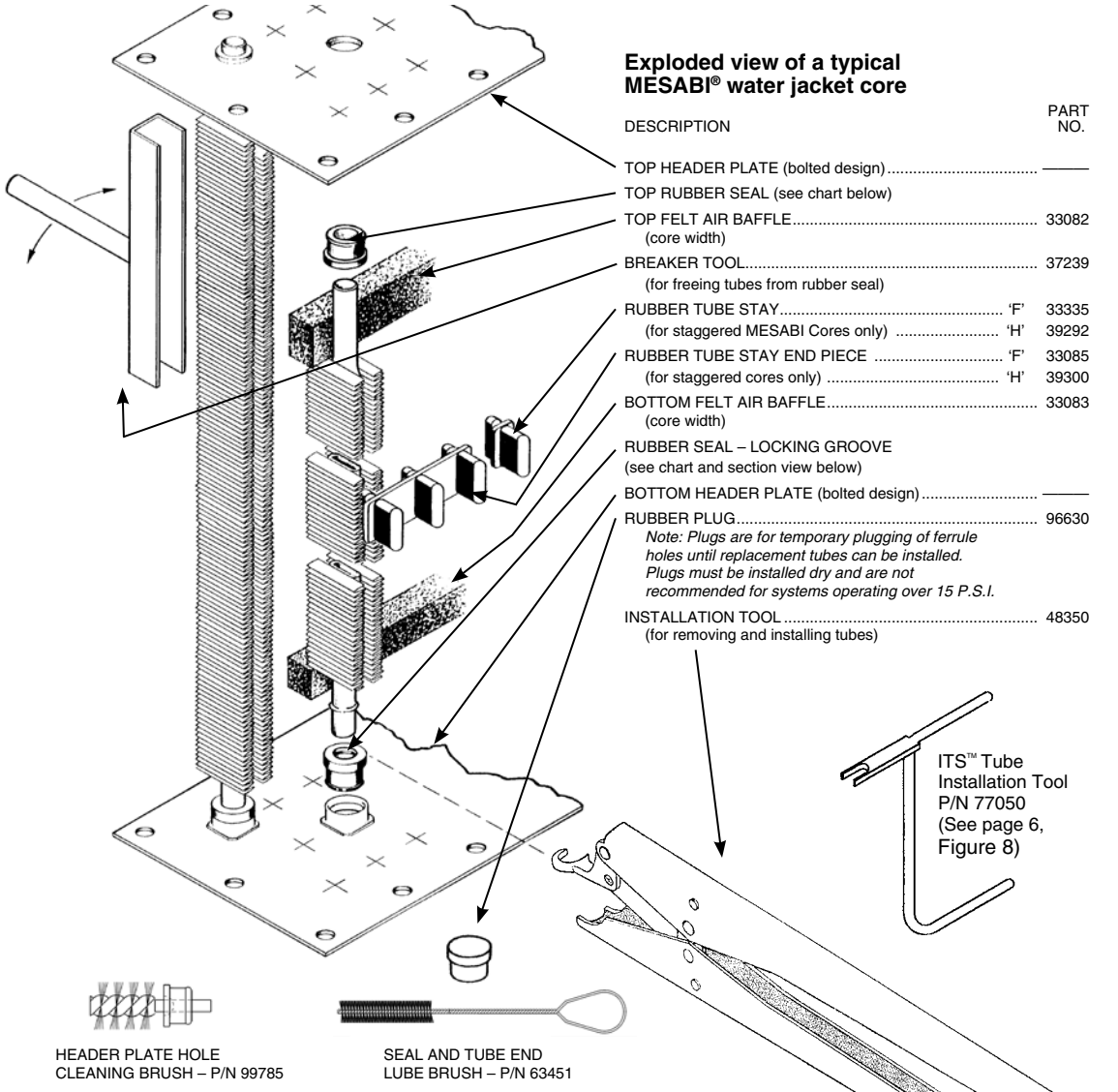
Covers:

- Radiators
- Cores
- Air-To-Air Coolers
- Low Pressure Oil Coolers & Fuel Coolers
  (maximum 50 psi/345 kPa)

In addition to the MESABI® General Warranty, L&M Radiator further warrants the MESABI® heat exchangers listed above against seal leakage during normal operation for 48 months from date of invoice.

Standard Parts of a Typical MESABI® Radiator Core

SINGLE UPSET TUBE



Exploded view of a typical MESABI® water jacket core

DESCRIPTION		PART NO.
TOP HEADER PLATE (bolted design)		———
TOP RUBBER SEAL (see chart below)		
TOP FELT AIR BAFFLE (core width)		33082
BREAKER TOOL (for freeing tubes from rubber seal)		37239
RUBBER TUBE STAY	'F'	33335
(for staggered MESABI Cores only)	'H'	39292
RUBBER TUBE STAY END PIECE	'F'	33085
(for staggered cores only)	'H'	39300
BOTTOM FELT AIR BAFFLE (core width)		33083
RUBBER SEAL – LOCKING GROOVE (see chart and section view below)		
BOTTOM HEADER PLATE (bolted design)		———
RUBBER PLUG		96630
Note: Plugs are for temporary plugging of ferrule holes until replacement tubes can be installed. Plugs must be installed dry and are not recommended for systems operating over 15 P.S.I.		
INSTALLATION TOOL (for removing and installing tubes)		48350

ITS™ Tube Installation Tool P/N 77050 (See page 6, Figure 8)

HEADER PLATE HOLE CLEANING BRUSH – P/N 99785

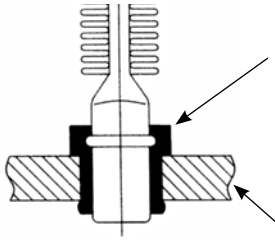
SEAL AND TUBE END LUBE BRUSH – P/N 63451

SEAL & LUBE CHART

If you are not sure of your core style, contact L&M Customer Service.

Core Style	Top Seal	Bottom Seal	Lube P/N
F (coolant)	WT	WB	113230.99
H (coolant)	WT	WB	113230.99
L (coolant)	WT	WB	113230.99
M (coolant)	WT	WB	113230.99
V (coolant)	WT	WB	113230.99
Locomotive*	35780	87530	113230.99
Air-to-Air*	35780	87530	107271.99
Oil Cooler*	35780	87530	107271.99

*Air-to-Air, Oil Cooler and Locomotive can be any style of core above (F, H, L, M, V)



LOCKING GROOVE SEAL (P/N 87530 or P/N WB) must be used at the bottom. The tube bead will seat in the seal inner groove.

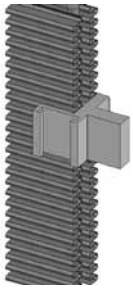
Tube Locking design

Bottom Plate

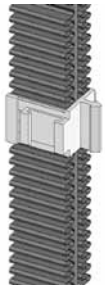
Additional Tube Styles

(Sold As Assemblies Only)

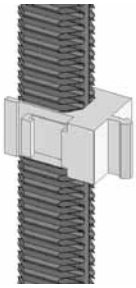
ITS™ (Individual Tube Support) Used on H, L, and V style cores



STAY Used on "L" style cores



STAY Used on "M" style cores



STAY Used on "V" style cores

Cleaning

STANDARD EXTERNAL CLEANING

To maintain efficiency and assure maximum life of a MESABI® Core, reasonable care must be taken when cleaning.

Most radiator shops use a hot alkaline soap, caustic soda or chemical additives in their boil-out tanks, which attacks solders. If a MESABI® tube is soaked in such a solution, the solder bond between the finning and tube will be adversely affected. If it is known that the particular solution used is not harmful to solder, then it will not hurt the solder used on the MESABI® tube. Be sure to completely rinse the cleaned tube/core in clean water after removing from the boil-out tank.

In most cases, it may be best to blow out any dry dirt with a high pressure air gun prior to washing the core with a high pressure hot water washer.

For general external cleaning, a high pressure, hot water washer (with or without soap) can be used at pressures up to 1200 psi (8274 KPa). (**CAUTION! To prevent fin deformation, you must stay a few inches away from the core and spray straight into the core not at an angle. If the cooler is still in the machine, you may have to use an offset angled nozzle so that you can spray straight into the core. If there is any doubt, try your cleaning method on a small portion of the core first.)** It is important to start on the air exit side. Work from the top to the bottom. Concentrate on small areas and work slowly. Wash until the water exiting the opposite side is free from dirt and debris. Complete this side and then repeat the process from the other side.

EPOXY-COATED CORES

Epoxy-coated cores must be cleaned with care to assure the coating is not damaged.

1. A high pressure hot water washer can normally be used. Use a “fresh” water supply. Water temperature should not exceed 180^{0}F. Do not steam clean. The nozzle should be kept approximately 12 inches away from the core.

CAUTION! We do not recommend a pressure rating because as epoxy ages the coating does become brittle and might be damaged at higher pressures. We recommend that you try your cleaning method on a portion of a single tube first.

2. Wash the core thoroughly and methodically, starting at the top and working towards the bottom. Do not wash in one area for extended periods. The core will be clean when the water exiting the core is clean.
3. Blow off excess water with air.

Epoxy coatings are not meant for submergent duty. L&M Radiator does not warrant against corrosion, but this coating, properly cared for, will help increase the service life and efficiency of your cooling system.

INTERNAL CLEANING

In most cases just flushing the inside of the tubes with a high pressure hot water washer, with soap, will do the job. Rinse thoroughly with clean water.

Tube Removal

HELPFUL HINTS:

- Clean the core prior to removing tubes.
- To avoid bending or kinking tube ends, reduce the angle of the tube as it’s being pulled from the top seal.
- If the core has a center tank, remove the top core tubes and seals first.
- If the core has an ITS™ (Individual Tube Support) or stay system with support bars, mark the bars front and back before removing, to ease reassembly.
- To assist in the removal process, spray WD-40 on the top end of tubes.
- If tubes are difficult to remove, try using the breaker tool and removal tool simultaneously.

STEP 1.

Loosen the tube by using Breaker Tool, L&M P/N 37239, as shown in **Fig. 1**. The Breaker Tool should be placed at top or bottom, not at middle when freeing tube from seal. Lightly twist the tube back and forth, to loosen tube from seals.

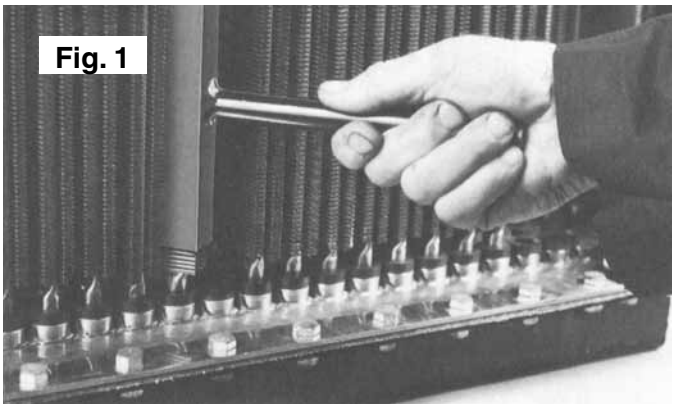


Fig. 1

STEP 2.

After tube is free, place upper jaw of Installation Tool P/N 48350 around the round portion of tube, just below the flattened portion. Place lower jaw on top of bottom seal, see **Fig. 2**. Squeeze handles of tool together and raise tube only enough to clear bottom seal.

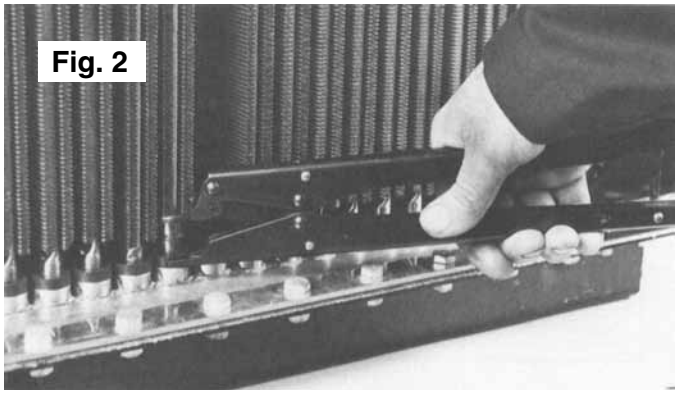


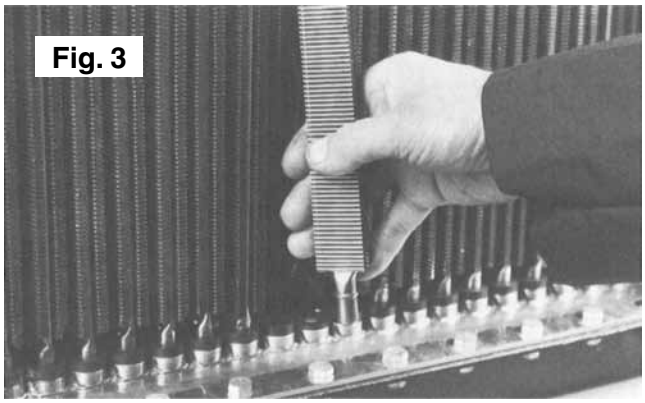
Fig. 2

Tube Removal (continued)

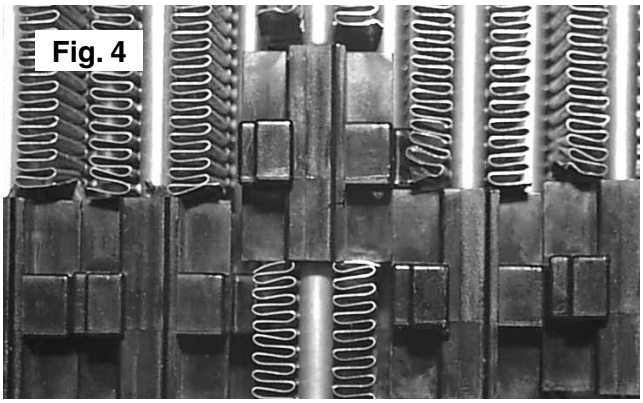
STEP 3.

Put down tool and swing tube out just far enough to allow it to be pulled down and out of its top seal, as shown in **Fig. 3**.

Remove all tubes in the row, repeating the above procedure.



If you are working with any of L&M's ITS™ or stay systems with interlocking tabs, the tube must be raised high enough so that the interlocking tab clears the adjacent groove, as shown in **Fig. 4**.



Cleaning Tube Ends

Before the original tubes are reinstalled, the tube ends must be clean of foreign material. L&M recommends polishing the tube ends with a polishing wheel (Grainger #5A725 – use Qty. 5 together) and a copper polishing compound (Grainger #3W769).

If the debris cannot be removed by polishing, L&M recommends using a piece of fine grit emery cloth or steel wool. If there is a lot of debris on the tube ends, use a 6" or 8" diameter wire wheel brush with a wire size of .006 or .008. Larger diameter wire sizes could damage the tube ends. Try installing a tube.

If it does not slide easily into the top and bottom seals, try polishing the tube ends as per above.

Seal Installation

HELPFUL HINTS:

- L&M recommends installing new MESABI® seals when tubes are removed.
- After removing the old seals, clean the plate holes of any foreign debris with L&M P/N 99785 header plate hole cleaning brush placed in an electric or air drill.
- Clean out inside of tanks and blow out plate holes with air.
- Install new seals in clean dry holes. **Do not apply any lubricant to header plate holes.**
- If the core has a center tank, do not install seals at the bottom of the top core until all the tubes are installed in the bottom core.
- For ease of seal installation, soak seals in hot water just prior to installing.
- Make sure you use proper seal part number (see Seal & Lube Chart on page 3).

With your thumb, start the new MESABI® seals into the holes and push them part way in. Care must be taken not to install seals too far into the header plate. A properly installed seal has a crowned or convex top surface, and the tube hole is slightly flared at the opening. A seal that is installed too far into the header has a concave top surface and the tube hole is noticeably smaller in diameter as shown in **Fig.5**. Over-installed seals will make tube installation more difficult and are much more likely to be damaged during tube installation.

The use of a hammer directly on the seal can easily cause seals to be installed too far into the header plate. L&M recommends the use of a flat plate 3/8" x 3"x 6" placed over the seals. Hitting with a rubber mallet will allow the seals to be properly installed.

CORRECT INCORRECT

Fig. 5

ON THE LEFT:
Properly installed seal.

RIGHT:
Seal installed too far into header.

Lubricating Seals and Tube Ends

For ease of tube installation and to minimize the chance of scuffing or tearing rubber seals during tube installation, both top and bottom seals and both tube ends must be thoroughly lubricated, using L&M lube (see Seal & Lube Chart on page 3 for proper lube part number). Using a 1/2" diameter brush (L&M P/N 63451) and a minimal amount of lubricant, apply a thin film into each seal hole and onto each tube end.

Tube Installation

CAUTION! If a tube seems difficult to install into a seal, STOP and figure out WHY! One of the following reasons could be the answer.

1. A tube or seal with inadequate lubrication.
2. Improperly installed seal that could be pushed too far into the header plate hole.
3. Damaged tube end.
4. Trying to insert the tube into the seal at too steep of an angle.
5. Tube is not centered in seal.

NOTE: *If, for any of the above reasons, a tube is difficult to install, the seal should be removed and inspected for any scuffing marks, tears, or cuts. If there is any doubt, replace the seal.*

HELPFUL HINTS:

- If you are working with a center tank core, the bottom core must be assembled before the top core.
- Minimize the angle of the tube as it's being installed into the top seal.
- Make sure the tube is centered in the bottom seal before any force is applied to pull or push into place.
- For ease of tube installation, install the tubes behind the side member gussets in each row first. Install the tubes behind the left side gussets, working towards the core center. Then, going to the far right hole, in the same row, install the tubes working towards the core center.
- Individual rubber tube stays and, in some cases, tube stay ends are necessary to interlock the tubes. For part numbers see page 3. If more detailed information is required for proper assembly of cores using tube stays and tube stay ends, contact one of the L&M manufacturing facilities listed on back page.
- If your core style includes plastic tube supports, see page 7 for ITS™ or stay orientation prior to starting.

STEP 1.

To minimize installation angle, tubes in any given row must be installed from the closest header plate edge.

Use a minimum of angle and a slight twisting, pushing motion, to push the top end of the tube into the top seal. Push it far enough in so the bottom of the tube clears the top of the bottom seal.

If you are working with any of L&M's ITS™ or stay systems, you will need to insert the tube far enough into the top seal to allow clearance for the tabs to be aligned with the grooves when the tube is pulled down into the bottom seal (see **Figs. 4. and 6.**). Please note that when ITS™ or stays with interlocking tabs and grooves are present, the bottom end of the tube should be centered in the seal and then pulled down slightly into the seal so that the tabs engage the adjacent grooves.

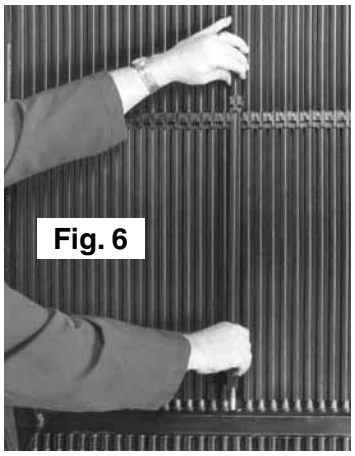


Fig. 6

NOTE: *See page 7 for ITS™ or stay orientation in the core.*

STEP 2.

Center bottom end of tube into respective seal in the bottom header plate. Then, push tube down and into seal until the formed bead is seated into the locking groove of the bottom seal.

This may be done by grasping tubes by hand and pulling the tube downward until seated, or by using Installation Tool, L&M P/N 48350. This tool has a semicircular form on the end of the handle. Place this end on the formed bead of the tube and push downward until seated, as shown in **Fig. 7**.

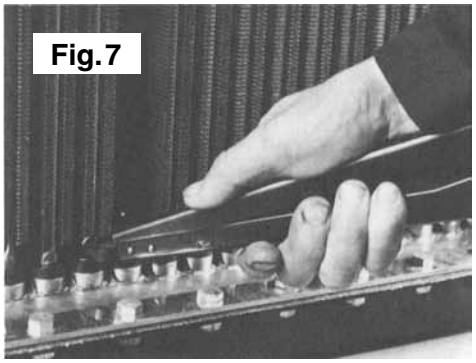


Fig. 7

Now, complete the row of tubes. Precaution should be taken to make sure formed bead is seated into bottom seal, and that the tubes are straight and aligned to assure maximum air flow.

If you are working with an ITS™ system (refer to page 3 and page 7, **Fig. 9,** for identification), use L&M tube installation tool P/N 77050 to pull the tube into the bottom seal. (See **Fig. 8**.) Hook the slotted end of the tool behind the front tab on the ITS™ tube support. Using the tool and your free hand, center the bottom end of the tube into the bottom seal. At the same time guide the dovetail slots into the tabs on the ITS™ tube support. Once in place, and with the tool P/N 77050 still hooked onto the ITS™ tube support, pull the tube into the bottom seal until the formed bead is seated into the locking groove of the bottom seal. Push the remaining tubes in this row. Use the same procedure on all remaining rows except the front side row.

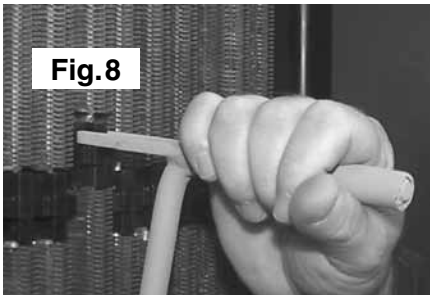


Fig. 8

Tube Installation (continued)

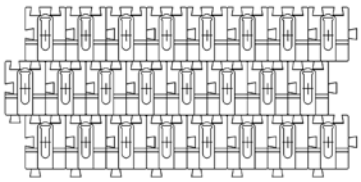
STEP 2. (CONTINUED)

Tube Support Orientation

All illustrations front side as viewed from top.

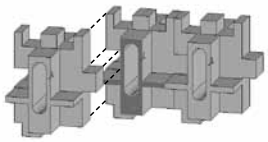
A. ITS™ (can be used on H, L, or V style cores)

Make sure the tabs on the ITS tube supports are facing to the front and to the right.

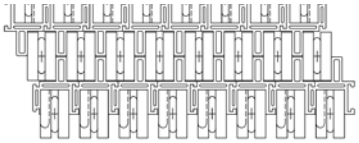


FRONT

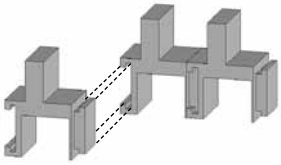
Fig. 9



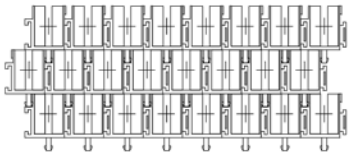
B. "L" Stay



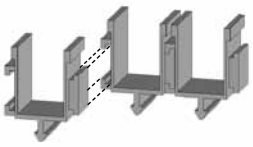
FRONT



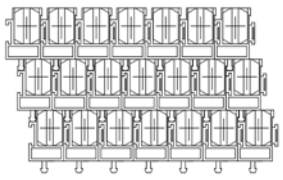
C. "M" Stay



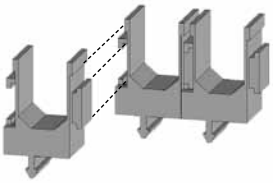
FRONT



D. "V" Stay



FRONT



NOTE: *If you are working with an older stay style that has rubber tube stays (see Exploded View page 3) and need assembly assistance, please contact L&M Customer Service.*

STEP 3.

Before you install the front side row, install the felt air baffles.

Caution! To prevent seal leaks, do not allow the felt baffles to be pushed (top) or pulled (bottom) into the seal hole when installing the front row of tubes.

STEP 4. (If applicable)

If you are working with the ITS™ or stay support system, install the appropriate support bar as shown in **Fig. 10**.

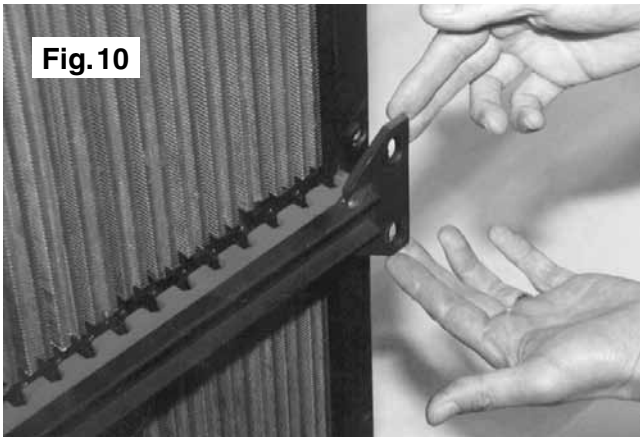


Fig. 10

The support bar part number has been stamped on the outside face. Use the L&M Radiator Technical Drawing and Parts List for proper installation. Using a rubber mallet, gently tap the bar into place and secure to the side member.

PRESSURE TESTING

Pressure testing procedure that follows recommends testing to 15 psi (103 kPa). You should test to pressure rating specified on tag attached to your cooler. If there is no pressure rating specified, please contact L&M customer service with the part number of your cooler.

(Caution: Always bring air pressure up slowly and always wear protective gear)

1. Pressurize with compressed air to 15 psi (103 kPa) and submerge in water.
2. Seal any leaks at the test fittings and/or cover plates.
3. Repair any other leaks as needed.
4. Cycle test after successful initial test. Hold pressure at 15 psi (103 kPa) for 15 minutes. Note that the time starts after all leaks are fixed and air bubbles have subsided. Cycle to zero psi and pressure back up to 15 psi (103 kPa). Hold at 15 psi (103 kPa) for one minute. Repeat three more times and then hold the last cycle pressure at 15 psi (103 kPa) for five minutes. Should any leaks appear, fix them, and start the cycle test over.

If you have any questions regarding the procedures described in this Service Manual, please contact L&M Radiator and ask for Customer Service. See back page for contact information.

MESABI® is the world standard for heat exchanger reliability

L&M RADIATOR FACTORY-DIRECT SALES AND SERVICE

Because so many of our radiators and heat exchangers are a custom design, all sales are on a factory-direct basis. This assures that our customers receive a product that meets their cooling / heating requirements, offered to them at the least possible price.

We ship most parts within 24-hours. On-site technical and engineering assistance is available almost anywhere in the world within a few days notice.

L&M QUALITY POLICY

"The Quality Policy of L&M Radiator is to produce a quality engineered, quality manufactured product through continuous improvement that we deliver to the customer's satisfaction."

Manufactured and distributed by:

L&M Radiator

Toll Free: 800-346-3500 (U.S.A. and Canada)
Web Site: www.mesabi.com **Email: cool@mesabi.com**

WORLD HEADQUARTERS

L&M Radiator, Inc.
1414 East 37th Street
Hibbing, Minnesota 55746 U.S.A.
Telephone: (218) 263-8993
Fax: (218) 263-8234

ISO 9001:2008 CERTIFIED

UNITED STATES

L&M Radiator, Inc.
Hibbing, Minnesota U.S.A.

L&M Radiator, Inc.
Independence, Iowa U.S.A.

L&M Radiator, Inc.
El Paso, Texas U.S.A.

L&M Radiator, Inc.
Yankton, South Dakota U.S.A.

MEXICO

L y M de Mexico S.A. de C.V.
Calle De La Plata y Los Nogales
Parque Industrial
Hermosillo, Sonora, Mexico
Telephone: 011-52-662-251-0480
Fax: 011-52-662-251-0638
Email: ventas@lym.com.mx

AUSTRALIA

L&M Radiator Pty. Ltd.
Cnr. Kew & Kathleen Streets
Welshpool, Western Australia 6016
Telephone: +61-8-93616855
Fax: +61-8-94703075
Email: cool@mesabi.com.au

Fluids and Lubricants Specifications

All commercial MTU series
(except Series 1000 - 1600, 1800), DDC S60 Off-Highway
and two-cycle engines

A001061/37E

Power. Passion. Partnership.

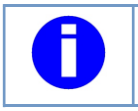
Table of Contents

1 Preface

1.1 General information

Used symbols and means of representation

The following instructions are highlighted in the text and must be observed:



This symbol indicates instructions, tasks and operations that must be followed to avoid hazards to persons as well as damage to or destruction of material.

Note:

A note provides special instructions that must be observed when performing a task.

Fluids and lubricants

The service life, operational reliability and function of the drive systems are largely dependent on the fluids and lubricants employed. The correct selection and treatment of these fluids and lubricants are therefore extremely important. This publication specifies which fluids and lubricants are to be used.

Test standard	Designation
DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum
DVGW	German Gas and Water Industry Association

Table 1: Test standards for fluids and lubricants

Applicability of this publication

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to use, ensure that the most recent version is available. The most recent version can be called up under:

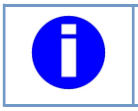
http://www.mtu-online.com/mtu/technische-info/betriebsstoffvorschriften/index.de.html

If you have further queries, please contact your MTU representative.

Warranty

Use of the approved fluids and lubricants, either under the brand name or in accordance with the specifications given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the worldwide standard quality of the named products.



Fluids and lubricants for drive systems may be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, such as product-specific safety data sheets, statutory regulations and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

Preservation

All information on preservation, represervation and depreservation including the approved preservatives is available in the MTU Preservation and Represervation Specifications (publication number A001070/...). The most recent version can be called up under:

http://www.mtu-online.com/mtu/technische-info/konservierungs-und-nachkonservierungsvorschrift/index.de.html

2 Lubricants for Four-Cycle Engines

2.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Requirements of the engine oils for MTU approval

The MTU requirements for approval of engine oils for diesel engines are contained in the MTU Factory Standards MTL 5044 and MTL 5051 for first-use oils and corrosion-inhibiting oils. For gas engines, oil approval requirements are contained in MTU Factory Standard MTL 5074 and for two-cycle engines in MTL 5111. These standards can be ordered under these reference numbers.

Manufacturers of engine oils are notified in writing if their product is approved.

Approved diesel engine oils are divided into the following MTU Quality Categories:
- Oil category 1: Standard quality / Single and multigrade oils
- Oil category 2: Higher quality / Single and multigrade oils
- Oil category 2.1: Multi-grade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality / Multi-grade oils
- Oil category 3.1: Multi-grade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphor content and an ash-forming additive content of ≤1%.

They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. When using diesel particle filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

Selection of a suitable engine oil is based on fuel quality, projected oil drain interval and on-site climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

The use of engine oils not approved by MTU can mean that statutory emission limits can no longer be observed. This can be a punishable offense.

Mixing different engine oils is strictly prohibited!
Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.
This procedure also applies to MTU's own engine oils in the regions Europe, Middle East, Africa, America and Asia.

When changing to an engine oil in Category 3, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits).
It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Special features

MTU diesel engine oils

At MTU, the following single and multigrade oils are available in the individual regions:

Manufacturer & sales region	Product name	SAE grade	Oil category	Material number
MTU Friedrichshafen Europe Middle East Africa	Diesel Engine Oil DEO SAE 15W-40	15W-40	2	20 l canister: X00070830 210 l barrel: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
	Power Guard® DEO SAE 40	40	2	20 l canister: X00062816 210 l barrel: X00062817 IBC: X00064829
MTU America Americas	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135
	Power Guard® SAE 40 Off Highway Heavy Duty	40	2	5 gallons: 23532941 55 gallons: 23532942
MTU Asia Asia	Diesel Engine Oil DEO SAE 15-W40	15W-40	2	18 l canister: 64247/P 200 l barrel: 65151/D
MTU Asia China	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO 10W-40	10W-40	2	20 l canister: 60606/P
	Diesel Engine Oil - DEO 5W-30	5W-30	3	20 l canister: 60808/P
MTU Asia Indonesia	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
MTU India Pvt. Ltd. India	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 63333/P 205 l barrel: 65151/P
	Diesel Engine Oil - DEO 40	40	2	20 l canister: 73333/P 205 l barrel: 75151/D

Table 2:

Restrictions for applications in Series 2000 and 4000

Series 2000: Cx6, Gx6, Gx7, Mx6, M84, M94, Sx6

Series 4000: M73-M93L, N43 and N83, 4000-03 Genset (application group 3F, 3G, 3H), 4000-04 C&I, 4000-05 C&I, 4000-04 Marine, 4000-04 Rail, 4000-05 Genset, 4000-04 Oil&Gas, 4000-05 Oil&Gas

Oils in oil category 1 must not be used!

Restrictions for applications in Series 2000 M72

Mobil Delvac 1630/1640 and Power Guard® SAE 40 Off-Highway Heavy Duty must not be used!

Restrictions on Series 4000 C, R, T application

In engines in Series 4000 C64, T94 and T94L, only engine oils of oil category 3 or 3.1 of SAE grades 5W-40 or 10W-40 must be used!
Exceptions:

- For Series 4000 T, Chevron Delo 400 LE SAE 15W-40 (oil category 2.1) can also be used.
- For Series 4000 T, Fleet Supreme EC SAE 15W-40 (oil category 2.1) can also be used.

In engines in Series 4000 R64, R74 and R84, only engine oils of oil category 3.1 of SAE grades 5W-40 or 10W-40 must be used!

The maximum oil service life is 1000 operating hours with observance of the analytical limit values for used oils!

Restrictions on Series 8000 applications

Only the following engine oils may be used:

- Castrol HLX SAE 30 / SAE 40
- Chevron Delo 400 SAE 30 / SAE 40
- Exxon Mobil Delvac 1630 SAE 30
- Exxon Mobil Delvac 1640 SAE 40
- PowerGuard® SAE 40 Off-Highway Heavy Duty (material number: 5 gallons 23532941; 55 gallons 23532942)
- Shell Sirius X SAE 30 / SAE 40

SAE grade 40 engine oils may only be used in combination with preheating and oil priming ($T_{oil\ >30\ °C}$).

Restrictions for Series S60 applications

Only multigrade oils of SAE grade 15W-40 marked with index [2)] must be used.
The maximum oil service life is 250 operating hours or 1 year.

Restrictions when using low SAPS oils

Oil Categories 2.1 and 3.1 may be used if the sulfur content in the fuel does not exceed 50 mg/kg.

Restrictions for applications in Series 595 and 1163

Category 2 or Category 3 oils are normally stipulated for fast commercial ferries using Series 595 and Series 1163 engines.

Restrictions for applications in Series 956 TB31 / TB32 / TB33 / TB34 and 1163 TB32

Engine oils of oil categories 1, 2.1 and 3.1 are generally not approved!

Only the following engine oils are currently approved for Series 956 TB 31, TB 32, TB 33, TB 34 engines for nuclear power station applications and for Series 1163-02 TB32 engines.

Series	Oil category 2, single-grade oil	Oil category 2, multi-grade oil	Oil category 3
956 TB 31	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1630 Mobil Delvac 1640	No approval	Shell Rimula R6 MS SAE 10W-40
956 TB 32	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640	No approval	Shell Rimula R6 MS SAE 10W-40
956 TB 33 Ɛ = 9	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640	No approval	Shell Rimula R6 MS SAE 10W-40
956 TB 33 Ɛ = 12	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640 Shell Sirius X 30	Lukoil Avantgarde Ultra NP 15W40	Shell Rimula R6 MS SAE 10W-40
956 TB 34	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640 Shell Sirius X 30	Lukoil Avantgarde Ultra NP 15W40	Shell Rimula R6 MS SAE 10W-40
1163-02 TB 32 Emergency power, gen-set	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640 Shell Sirius X 30	No approval	Shell Rimula R6 MS SAE 10W-40

Table 3:

Engine oil approvals upon customer request for applications in Series 956 TB 31, TB32, TB33, TB34

The engine oil must have valid MTU approval as per MTL 5044 and a quality level of oil category 2 or 3.

For customer certification, an engine test run under the following conditions is required: Individual cylinder test run 50 hours; with positive findings the engine test run has to be carried out as follows:

- Engine runtime with specific oil: min. 50 hours (30 hours of which at min. 100% power)
- Then endoscopic examination of combustion chambers.
- Disassembly of 4 pistons (2 on engine A-side and 2 on engine B-side) for detailed results.

Engine oils for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the oils used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following oils can be used.

Exhaust gas technology	Approval for oil category				
	1	2	2.1	3	3.1
Oxidation catalyst without particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with vanadium catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with zeolith catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes

Exhaust gas technology	Approval for oil category				
Closed particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
Combination system SCR+ particulate filter	no[1)]	no[1)]	yes	no[1)]	yes

Table 4:

[1)] = individual test possible for optional and retrofitted exhaust aftertreatment systems

The use of engine oils of categories 1, 2 and 3 (with ash content >1%) on plants with exhaust aftertreatment results in a significantly reduced service life of the exhaust aftertreatment system and, with particulate filters, increased back pressure.

For EPA Tier 4i or Tier 4 and EU IIIb-certified engines with exhaust aftertreatment, only low-ash engine oils of category 2.1 or 3.1 are permitted.

Any possible restrictions related to engine requirements must also be observed.

Selection of viscosity grades

Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed the engines can be operated both with single grade and multigrade oils, depending on the application. Standard values for the temperature limits in each viscosity grade are shown in (→ Figure 1).

If the prevailing temperature is too low, the engine oil must be preheated.

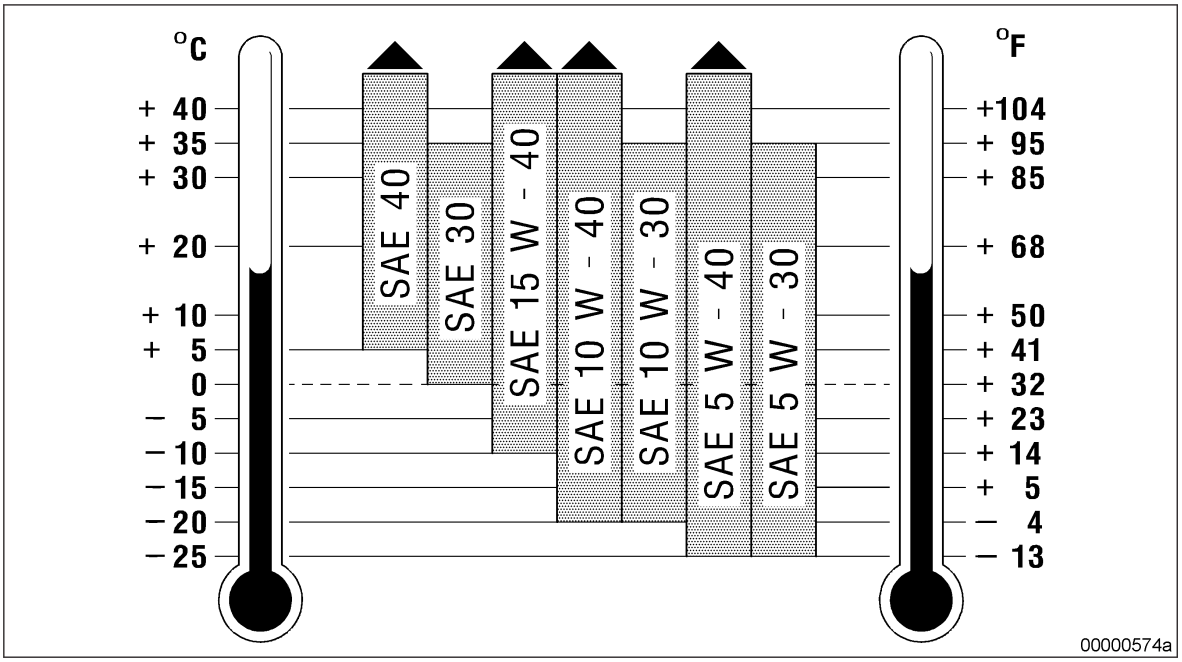


Figure 1: Viscosity grade chart

Oil drain intervals for diesel engines

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

The intervals quoted (Table) are guidelines based on operational experience and are valid for applications with a standard load profile.

Transmission fluid change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter or by-pass oil filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1[1)]	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1[1)]	750 operating hours	1500 operating hours

Table 5:

[1)] = To be used in conjunction with fuels with max. 50 mg/kg sulfur content

The oil drain intervals in the table are recommended guidelines when using diesel fuels with < 0.5% sulfur content. The defined limit values for the used oil (→ Table 6) must be observed. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:
- Extreme climatic conditions
- High engine start-up frequency
- Frequent and prolonged idling or low-load operation
- High fuel sulfur content of 0.5 to 1.5% by weight (see "Use of High-Sulfur Fuel")

For applications involving low runtimes, the engine oil must be changed every two years at the latest irrespective of its category.

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use (→ Page 97), a change must be carried out every 3 years at the latest.

In individual cases the service life of the engine oil can be optimized by regular laboratory analysis and appropriate engine inspections in consultation with the MTU service point responsible:

The first oil sample should be taken from the engine as a “basic sample” after the engine has run for approximately 1 hour after being filled with fresh oil.

Further samples are to be analyzed at specific intervals (see "Laboratory Analysis").

The appropriate engine inspections are to be carried out before and after the oil analyses.
After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.
Oil samples must always be taken under the same conditions and at the point provided for that purpose (see Operating Instructions).

Special additives

Engine oils approved have been specially developed for diesel engines and have all necessary properties. Further additives are therefore superfluous and may even be harmful.

Laboratory analysis

Spectrometric oil analysis

Analysis of the engine oil's additive-metal content is carried out by the MTU laboratory to determine the brand of oil.

MTU does not generally analyze the oil's wear-metal contents in order to determine the degree of engine wear. These content levels are very much dependent on the following factors, among others:

- Individual engine equipment status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

Unambiguous conclusions as to the wear status of the engine components involved are therefore not possible. This means that no limit values can be given for wear-metal contents.

Used-oil analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling / analysis should take place more frequently.

The specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 6) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate investigation and remedy of the abnormality.

The limit values relate to individual oil samples. When these limit values are reached or exceeded, an immediate oil change is necessary. The results of the oil analysis do not necessarily give an indication of the wear status of particular components.

In addition to the analytical limit values, the engine condition, its operating condition and any operational faults are decisive factors with regard to oil changes.

Some of the signs of oil deterioration are:

- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal oil filters or separators, especially in comparison with the previous analysis.
- Abnormal discoloration of components.

Analytical limit values for used diesel engine oils

	Test Method	Limit values	
Viscosity at 100 °C max. mm²/s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
min. mm²/s		SAE 30 SAE 5W-30 SAE 10W-30	9.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	10.5
Flash point °C (COC)	ASTM D92 DIN EN ISO 2592	Min. 190	
Flash point °C (PM)	ASTM D93 DIN EN ISO 2219	Min. 140	

	Test Method	Limit values
Soot content (by weight %)	DIN 51452 CEC-L-82-A-97	Max. 3.0 (Oil category 1) Max. 3.5 (Oil category 2, 2.1, 3 and 3.1)
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of new-oil value
Proportion of water (vol. %)	ASTM D6304 EN 12937 ISO 6296	Max. 0.2
Oxidation (A/cm)[1)]	DIN 51453[1)]	Max. 25
Ethylene glycol (mg/kg)	ASTM D2982	Max. 100

Table 6:

[1)] = only possible if there are no ester compounds

Use of high-sulfur diesel fuel

The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:
- Use of an engine oil with a total base number (TBN) of more than 8 mgKOH/g
- Shorten the oil-change intervals (see Oil change intervals).

Chart (→ Figure 2) (Total Base Numbers) lists the recommended minimum total base numbers for new and used oils depending on the sulfur content of the diesel fuel.

The total base numbers for the approved engine oils are listed in chapter Approved engine oils (→ Page 97).

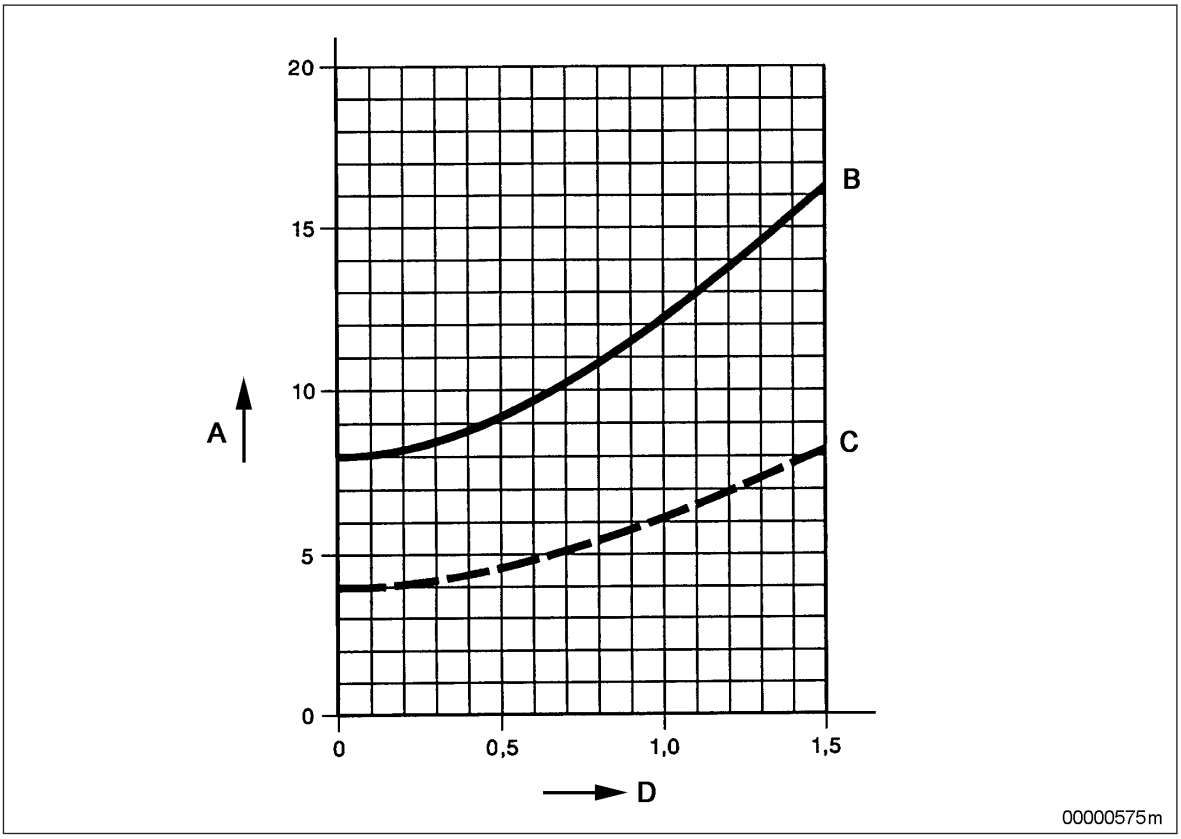


Figure 2: Total base number for engine oil depending on sulfur content of the diesel fuel

A Total base number in mgKOH/g, ISO 3771
B Recommended min. total base number for fresh oil
C Min. total base number for used oil
D Sulfur content of fuel in % weight

Use of low-sulfur diesel fuel

The use of diesel fuels with low sulfur content (< 0.5%) does not influence the oil drain intervals.

Minimum requirements for operational checks

Oil analyses can be carried out using the MTU Test Kit. The Test Kit contains all the equipment required as well as instructions for use.

The following checks can be performed:
- Determination of oil dispersing capacity (spot test)
- Determination of diesel fuel content in oil
- Determination of water content in oil

2.2 Fluorescent dyestuffs for detecting leaks in the lube oil circuit

The fluorescent dyestuffs listed below are approved for detection of leaks in the lube oil circuit.

Manufacturer	Product name	Concentration for use	Part No.	Container size	Storage stability[1)]
Chromatech Europe B.V.	D51000A Chromatint Fluorescent Yellow 175	0.04 % - 0.07 %	X00067084	16 kg	2 years
Cimcool, Cincinnati	Producto YFD-100	0.5% - 1.0 %		5 gallons (canister) 55 gallons (barrel)	6 months

Table 7:

[1)] = ex works delivery, based on original and hermetically sealed containers in frost-free storage (> 5 °C).

The fluorescence (light-yellow color tone) of both dyestuffs is made visible with a UV lamp (365 nm).

2.3 Lubricating greases

Requirements

The MTU conditions for lubricating-grease approval are specified in the MTU Factory Standard MTL 5050, which can be ordered under this reference number.

Grease manufacturers are notified in writing if their product is approved by MTU.

Lubricating greases for general applications

Lithium-saponified greases are to be used for all lubrication points with the exception of:
- Emergency-air shutoff flaps fitted between turbocharger and intercooler (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency-air shutoff flaps located between turbocharger and intercooler:
- Aero Shell Grease 15
- Optimol Inertox Medium

General purpose greases suffice for emergency-air shutoff flaps located before the turbocharger or after the intercooler.

Greases for internal centerings of couplings

Greases for internal centerings:
- Esso Unirex N3 (stable up to approx. 160 °C)

Special-purpose lubricants

Oil for turbochargers

Exhaust turbochargers with integrated oil supply are generally connected to the engine oil system.

For ABB turbochargers which are not connected to the engine lube oil system, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Lubricating greases for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth couplings:
- - Klüber: Structovis BHD MF (highly viscous lubricating oil)
- - Klüber: Klüberplex GE11–680 (adhesive transmission lubricant)

Guidelines on use and service life are contained in the relevant Operating Instructions and Maintenance Schedules.

3 Lubricants for Gas Engines

3.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.

Mixing different engine oils is strictly prohibited!
Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.

Engine oil requirements for gas engines

Viscosity grade SAE 40 is stipulated for gas engines!
Multigrade oils are not permitted!

The selection of a suitable engine oil for gas engines depends primarily on the composition of the fuel used to power the engine. The gas engine must only be operated with approved lube oil. The engine oils to be used must be taken from the table (→ Page 127). Another significant factor is the quality of the gas regarding its purity. This requires that the operator regularly carries out gas checks. The gas engine oils to be used are characterized by the lowest possible ash content. This prevents increased ash deposits which can lead to reduced catalytic converter performance or combustion knocking.

Oil drain intervals for gas engines Series 4000

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

For this reason, an oil sample must be taken every 250 operating hours and the oil analysis must be compared to the limit values (→ Table 7). The oil samples must always be taken under the same site conditions (engine at operation temperature) and at the designated point (extraction nozzle on oil filter housing). When the limit values (→ Table 7) are reached or exceeded, an immediate oil change is necessary. When using increased oil volumes, the limit values for wear elements must be reduced inversely proportionally to the volume increase (see following example).

Double oil volume = halved limit value of the wear element (e.g. iron (Fe) –> 15 mg/kg).

The maximum permissible reduction of limit value for the wear elements is 50% of the limit value (→ Table 7).

The results of the oil analyses must be archived and the last respective oil sample must be stored for any necessary follow-up examinations.

If the limit values are not achieved, an oil change must be carried out after one year at the latest.

Special gas

During operation with gases containing silicium, take particular note of the increased silicium content in the oil. For this purpose, the silicium operational value Si_B must be calculated with the help of the formula below. The limit value for the silicium operational value is 0.01. If this value is exceeded, the engine is being operated outside the fuel specifications and the warranty becomes void. More details can be obtained in the chapter "Fluids and lubricants for gas engines" (→ Page 86). The comprehensive observance of Si_B must be verified by the operating company with the help of oil analyses $Si_{(n)}$.

$$Si_B = \text{Delta Si (ppm) oil analysis } (Si_{(n)} - Si_{(n-1)}) \times \frac{[\text{Oil filling quantity + refilling quantity (liter)}]}{\text{Generated electric work (kWh)}}$$

TIM-ID: 0000034889 - 003

If the permissible limit values for chlorine, fluorine, sulfur and silicium compounds in the fuel are exceeded, this can result in corrosive wear, combustion chamber deposits and accelerated reduction of the alkaline lube oil reserve.

In this case, gas conditioning is absolutely necessary.

Oil drain intervals for gas engines Series 4000

See Maintenance Schedule

Analytical limit value for used gas engine oils SAE 40

	Test Method	Limit values
Viscosity at 100 °C (mm²/s)	ASTM D445 DIN 51562	max. 17.5 min. 11.5
Total base number TBN (mgKOH/g)	ASTM D2896 ISO 3771	min. 3 and TBN > TAN
Acid number, TAN (mgKOH/g)	ASTM D664	New oil value + 2.5
iph value		min. 4.5
Water (% by vol.)	ASTM D6304 EN 12937 ISO 6296	max. 0.2
Glycol (mg/kg)	ASTM D2982	max. 100
Oxidation (A/cm)	DIN 51453	max. 20
Nitration (A/cm)	IR method	max. 20
Wear elements (mg/kg) Iron (Fe) Lead (Pb) Aluminum (Al) Copper (Cu) Tin (Sn) Silicon (Si)	RFA, ICP	 max. 30 max. 20 max. 10 max. 20 max. 5 max. 15 *

- * The limit value for the wear element Si only refers to natural gas operation

4 Lubricants for Two-Cycle Engines

4.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the fuel tank!

Engine oil requirements for two-cycle engines of Series 53/71/92 and 149

Specification	Test method		SAE grade	
			40	50
API CF-2	ASTM	ISO	Limit values	Limit values
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	12.5 - 16.3	16.3 - 21.9
Viscosity at 40 °C (mm^2/s)	D445	EN 3104	130 - 150	200 - 300
Pour point (°C)	D97	3016	Max. -15	Max. -10
Flashpoint (°C)	D92	2592	Min. 225	Min. 230
Sulfated ash (by weight %)	D874	DIN 51575	Max. 1.0	Max. 0.8
Total base number (mgKOH/g)	D2896	3771	7.0 - 10.0	Min. 7.0
Calcium (mg/kg)		14596	No limit value	Max. 500
Phosphor mg/kg		DIN 51363-2/3	Min. 700	Max. 100
Zinc (mg/kg)		DIN 51391-3	Min. 700	Max. 100

Table 8:

Special features

The following listed two-cycle engine oils are available at MTU America:

MTU engine oils for two-cycle engines

Manufacturer & sales region	Product name	SAE grade	Specification	Comments / material number
MTU America Americas	PowerGuard® Heavy Duty Engine Oil for Detroit Diesel 2-Cycle (4x1G) SAE 40	40	API CF-2	4x1 gallons: 23512701
	PowerGuard® Heavy Duty Engine Oil for Detroit Diesel 2-Cycle SAE 40	40	API CF-2	5 gallons: 23512734 55 gallons: 23512702 IBC: 23512739

Table 9:

TIM-ID: 0000018567 - 002

Restrictions for Series 53/71/92 applications - all applications except marine

Start failures may occur at ambient temperatures < 0 °C when the engine is operated with SAE grade 40 oils.
If no start aids are available, oils of SAE grade 30 may be used as a short-term solution.
At lower temperatures (-18 to -32 °C) oils of SAE grade 15W-40 may also be used. These oils must, however, comply with the specification API CF-2 and have a high-temperature viscosity of min. 3.7 cP at 150 °C.
The oil grade must be changed back to SAE 40 as soon as the temperatures allow to do so.

Restrictions for Series 53/71/92 marine applications

No single-grade oils of SAE grade 30 or multigrade oils must be used!

Restrictions for Series 53/71/92 applications

For applications with coolant outlet temperatures > 94 °C, oils of SAE grade 50 must be used!
If fuels with low-sulfur content of 0.5 to 1.0% are used, the oil service life is shortened.

Restrictions for Series 149 applications

For applications with ambient temperatures > 35 °C, oils of SAE grade 50 must be used!
Oil of SAE grade 50 can no longer be recommended at ambient temperatures <7 °C.
If starting speed is no longer reached with the use of SAE grade 50 oils, oil from SAE grade 40 can also be used.
No single-grade oils of SAE grade 30 or multigrade oils must be used!
If fuel with a sulfur content of between 0.5 and 1% are used, oils with a base number of at least 10 mg/KOH/g and with zinc and phosphor contents of max. 100 mg/kg must be used!

Analytical limit values for used diesel two-cycle engine oils

	ASTM	ISO	Limit value SAE 40	Limit value SAE 50
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	Min. 12.5 Max. 16.3	Min. 16.0 Max. 22.0
Soot content (by weight %)		DIN 51452	Max. 0.8	Max. 0.8
Water (% by vol.)	D1744	EN 12937	Max. 0.3	Max. 0.3
Ethylene glycol	D2982	DIN 51375	Negative	Negative
Iron (mg/kg)	ASTM D5185		Max. 150	max. 35
Aluminum, silicium, copper (mg/kg)	ASTM D5185		Max. 25	Max. 25
Lead (mg/kg)	ASTM D5185		Max. 10	Max. 10

Table 10:

Oil change intervals with use of fuels with sulfur content < 0.5%

Application	Series	Oil change interval
C&I, Marine	S 53/71/92	150 h or 1 year
C&I, Marine	S 149	300 h or 1 year

Application	Series	Oil change interval
Generator - emergency power	S 53/71/92/149	150 h or 6 months
Generator - continuous operation	S 53/71/92/149	150 h or 3 months

Table 11:

5 Coolants

5.1 General information

Coolant definition

Coolant	= coolant additive (concentrate) + freshwater to predefined mixing ratio ready for use in engine.

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled. The only exception is Oil 9156, which maintains its corrosion-inhibiting character even when the coolant was drained due to oil-film formation in the circuit.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium was drained. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. For the preservation procedure, refer to the MTU Preservation and Represervation Specifications A001070/.. of the engine.

Coolants must be prepared from suitable fresh water and an MTU-approved coolant additive. Conditioning of the coolant takes place outside the engine.

Mixtures of various coolant additives and supplementary additives (also in coolant filters and filters downstream of plant components) are not permitted!

The conditions for the approval of coolant additives are specified in the following MTU works standards (MTL):

- MTL 5047: Emulsifiable corrosion-inhibiting oils
- MTL 5048: Corrosion-inhibiting antifreeze
- MTL 5049: Water-soluble corrosion inhibitors

Coolant manufacturers are informed in writing if their product is approved by MTU.

To prevent cooling system damage:

- When topping up (following loss of coolant) it must be ensured that not only water but also concentrate is added. The specified antifreeze and/or corrosion inhibitor concentration must be maintained.
- The corrosion inhibitor concentration must not exceed 55 % by volume (max. antifreeze protection). Concentrations in excess of this reduce antifreeze protection and heat dissipation. Only exception: BASF G206 (special application)
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The majority of corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that the engine is stored safe from frost, because a certain amount of coolant remains in the engine after draining.
- A coolant circuit can not usually be drained completely, i.e. residual quantities of used coolant or freshwater from a flushing procedure remain in the engine. These residual quantities can result in the dilution of a coolant to be filled (mixed from a concentrate or use of a ready mixture). This dilution effect is higher the more add-on components there are on the engine. Check the coolant concentration in the coolant circuit and adapt it if necessary.

All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit of MTU engines. In the case of complete propulsion plants, the operating fluids approvals of the component manufacturer must be observed!

For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approve corrosion inhibitor!

Special features

MTU coolants

The following coolant additives are available from MTU:

Manufacturer & sales region	Product name	Material number
MTU Friedrichshafen, MTU Asia Europe Middle East Africa Asia	**Antifreeze**	
	Coolant AH 100 Antifreeze Concentrate	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l)
	Coolant AH 50/50 Antifreeze Premix	X00070528 (20 l) X00070530 (210 l) X00700527 (1000 l) (sales region: England)
	Coolant AH 40/60 Antifreeze Premix	X00070533 (20 l) X00070531 (210 l) X00700532 (1000 l) (sales region: England, Spain)
	Coolant AH 35/65 Antifreeze Premix	X00069382 (20 l) X00069383 (210 l) X0006938 (1000 l) (sales region: Italy)
	Coolant without antifreeze	
	Coolant CS 100 Corrosion Inhibitor Concentrate	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l)
	Coolant CS 10/90 Corrosion Inhibitor Premix	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)
MTU America America	**Antifreeze**	
	Power Cool® Off-Highway Coolant 50/50 Premix	23533531 (5 gallons) 23533532 (55 gallons)
	Power Cool®Universal 50/50 mix	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool®Universal 35/65 mix	800085 (5 gallons) 800086 (55 gallons)
	Power Cool®3149 Concentrate	23528572 (55 gallons) 23528571 (1000 l)
	Coolant without antifreeze	
	Power Cool®Plus 6000 Concentrate	23533526 (1 gallon) 23533527 (5 gallons) colored green

Table 12:

Note:

For ready mixtures, the proportion of coolant additive (concentrate) is always named first. Example:

- Coolant AH 40/60 Antifreeze Premix = 40% by vol. coolant additive / 60% by vol. freshwater

5.2 Unsuitable materials in the coolant circuit

Components made of copper, zinc and brass materials

Unless various preconditions are observed, components made of copper, zinc and brass materials in the coolant circuit can cause an electrochemical reaction in conjunction with base metals (e.g. aluminum). As a result, components made of base metals are subject to corrosion or even corrosive pitting. The coolant circuit becomes leaky at these points.

Requirements

Based on current knowledge, the following materials and coatings must not be used in an engine coolant circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- no galvanized surfaces
  The entire cooling system must be free of zinc components. This also applies to coolant supply and drain lines as well as to storage containers.
- No copper-based alloys as material with the use of coolant containing nitrite, with the exception of the following to alloys:
  - CuNi10Fe1Mn corresponds to CW-352-H
  - CuNi30Mn1Fe corresponds to CW-354-H
- Do not use components containing brass in the coolant circuit (e.g. coolers made of CuZn30) if exposed to ammoniacal solutions (e.g. amines, ammonium, ...) and solutions containing nitrite or sulfide. Stress-corrosion cracking is possible in the presence of tensile stress and a critical potential area. "Solutions" refer to cleaning agents, coolants and similar substances.

Non-metallic materials

- Do not use EPDM and no silicon elastomers when using emulsifiable corrosion inhibitor oils or other types of oil introduced to the coolant circuit.

Coolant filter / filter downstream of plant components

- When using such filters, only products that do not contain additives must be used.
  Supplementary additives such as silicates, nitrites etc. can diminish the protective effect or service life of a coolant and, possibly, attack the materials installed in the coolant circuit.

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuits, consultation with the respective MTU specialist department must be held.

5.3 Freshwater requirements

Only clean, clear water with values in accordance with those in the following table must be used for preparing the coolant. If the limit values for the water are exceeded, hardness or mineral content can be decreased by adding demineralized water.

For preparation of coolant without antifreeze protection:

Item	Minimum	Maximum
Total earth alkalines[1)] (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH value at 20 °C	5.5	8.0
Chloride ions		100 mg/l
Sulfate ions		100 mg/l
Total chloride + sulfate ions		200 mg/l
Bacteria		10^3CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

Table 13:

[1)] = Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$
- 1°d = 17.9 mg/kg $CaCO_3$, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

For preparation of emulsifiable corrosion inhibitors:

Item	Minimum	Maximum
Total earth alkalines[1)] (Water hardness)	0.36 mmol/l 2°d	1.8 mmol/l 10°d
pH value at 20 °C	7.0	8.0
Chloride ions		100 mg/l
Sulfate ions		100 mg/l
Total chloride + sulfate ions		200 mg/l
Bacteria		10^3CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

Table 14:

[1)] = Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$
- 1°d = 17.9 mg/kg $CaCO_3$, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

If the water is too soft, this can result in foam formation and the water has to be hardened before application by adding hard water. If the water is too hard, this impairs the emulsion stability. This causes increased oil separation and the formation of deposits in the system. Excessively hard water must therefore be softened by blending with soft water.

5.4 Emulsifiable corrosion-inhibiting oils

Emulsifiable corrosion-inhibiting oils

Emulsions of MTU-approved corrosion-inhibiting oils (1.0 – 2.0% by volume) and suitable freshwater (→ Page 26) provide adequate corrosion protection.

However, they do not provide antifreeze protection.

A 2% by volume concentration must be used for initial filling.

The required quantity of corrosion-inhibiting oil is best mixed in advance in a container with 4 to 5 times the amount of freshwater and then added to the coolant when the engine is running at operating temperature.

In maintenance stations or multi-engine installations the complete amount of coolant required should be prepared in a separate container, it can then be used for initial filling or replenishment as required.

Under unfavorable conditions, individual cases of bacterial attack may occur in the emulsifiable corrosion-inhibiting oils. Treat the coolant emulsion with biocide in this case! Refer to chapter "Flushing and cleaning specifications for engine cooling circuits" (→ Page 172).

Note:

Slight precipitation may occur where coolant emulsions are used. This is shown by a layer on the surface of the coolant in the expansion tank. This is of no significance provided that the emulsion concentration remains within the specified limit values. Change the coolant in the event of a sudden drop in coolant additive concentration or if the additive is no longer absorbed. If necessary, the engine coolant chambers are to be cleaned, see the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 172).

Emulsifiable corrosion-inhibiting oils must not be used in engines of the following series:

- Series 099
- Series 183
- Series 2000
- Series 396
- Series 4000
- Series S60
- Two-cycle engines

The series with application approval for emulsifiable corrosion inhibitor oils are listed in the chapter "Approved coolants" (→ Page 132).

For the following listed serial numbers of the Series 20V956TB33 up to year of manufacture end of 2008 (as per identification plate), only emulsifiable corrosion-inhibiting oil must be used:

Serial number	Serial number	Serial number	Serial number	Serial number
5870001	5870002	5870003	5870004	5870005
5870006	5870007	5870008	5870009	5870010
5870011	5870012	5870013	5870014	5870015
5870016	5870017	5870018	5870019	

Table 15:

Special approvals presently in effect remain valid.

The emulsifiable corrosion-inhibiting oil must never be used for coolant temperatures >90 °C!

Flushing with water is required after every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 172).

5.5 Antifreeze

The predecessor version of the MTU Fluids and Lubricants Specifications used the term "Corrosion inhibiting antifreeze". For clarity purposes, this publication uses the term "Antifreeze" will be used.

Antifreeze is necessary for engines without heating facilities and for operation in areas where below-freezing temperatures may occur.

The product BASF G206 is available for use at arctic temperatures (< -40 °C).

Most of the antifreezes approved at MTU are based on ethylene glycol.

Exceptions:
- Ready mixture of Fleetguard PG XL based on propylene glycol (→ Page 171)
- Concentrate BASF G206 as a mixture of ethylene glycol and propylene glycol

Provided that they are used in approved concentrations, antifreezes approved by MTU provide effective protection against corrosion, see Operational monitoring (→ Page 31).

The antifreeze concentration must be determined not only in accordance with the minimum anticipated temperatures but also with the corrosion protection requirements.

For approved coolant additives for the individual engine series, refer to chapter "Approved coolants" (→ Page 132).

Special approvals presently in effect remain valid.

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Marine engines are subject to the following limitations when using antifreezes:

- Series 538, 595 and 8000:
  The use of antifreezes is not allowed for these engines.
- Series 956-01, 956-02, 1163-02, 1163-03, 1163-04:
  These engines are fitted with heating units. Because of their cooler capacity, antifreezes must not be used.
- Series 099, 183, 396:
  Antifreezes may be used with these engines at seawater temperatures up to a maximum of 20 °C max.
- Series 2000 and 4000:
  On these engines with installed heat exchanger, antifreezes may be used at seawater temperatures up to a maximum of 25 °C. The use of antifreezes is generally not allowed on engines with no installed heat exchanger. Ensure that the heat exchanger not installed on the engine is sufficiently dimensioned.
  The specified maximum values for the seawater temperatures apply to all engines on a vessel that are cooled with seawater, e.g. drive motor and onboard power generator.

The possibility of using antifreezes for the above-mentioned series for other applications (e.g. genset, rail) is described in the overview in the chapter "Approved coolants"(→ Page 132).

Note:

Propylene glycol-based antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This results in a higher temperature level in the engine.

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 172).

5.6 Coolant without antifreeze

The predecessor version of the MTU Fluids and Lubricants Specifications used the term "water-soluble corrosion inhibitors". For clarity purposes, this publication uses the term "Coolant without antifreeze". Emulsifiable corrosion inhibitor oils are not covered in this chapter. See the chapter "Emulsifiable corrosion inhibitor oils" (→ Page 27)

Coolant without antifreeze is required for higher coolant temperatures and large temperature drops in heat exchangers, e.g. in TB systems (with plate-core heat exchanger) and TE systems in Series 099, 183, 2000, 396 and 4000 engines.

Provided that they are used in adequate concentration, coolants without antifreeze approved by MTU provide effective corrosion protection. The relevant concentration range for use is listed in the section on operational monitoring.

For approved coolant additives for the individual engine series, refer to chapter "Approved coolants" (→ Page 132).

Special arrangements presently in effect remain valid.

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 172).

5.7 Operational checks

Inspection of the fresh water and continuous monitoring of the coolant are essential for trouble-free engine operation. Freshwater and coolant should be inspected at least once per year and with each fill-up. Inspections can be carried out using the MTU Test Kit which contains the necessary equipment, chemicals and instructions for use.

The following tests can be conducted with the MTU Test Kit:
- Determination of total hardness (°d)
- pH value
- Chloride content of fresh water
- Corrosion-inhibiting oil content
- Determination of antifreeze content
- Determination of the concentration of coolant without antifreeze

Orders for freshwater and coolant analysis may be placed with MTU. Samples of min. 0.25 l must be supplied.

As an additional exhaust gas cooler is installed in the Series 4000-04 and the cooling system is more sensitive, a regular check of the coolant is very important for trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is filled.
The concentration, pH value and silicium content (only with coolant that contain Si) must be within the values specified in the MTU Fluids and Lubricants Specifications.

Permissible concentrations

	Minimum				Maximum
Emulsifiable corrosion inhibitor oils without antifreeze	1% by volume	–	–	–	2% by volume
Antifreeze on ethylene glycol basis	35% by volume	40% by volume	45% by volume	50% by volume	55% by volume
with antifreeze protection up to*	-20 °C	-25 °C	-31 °C	-37 °C	-45 °C
Antifreeze on propylene glycol-basis	35% by volume	–	–	–	50% by volume
with antifreeze protection up to*	-18 °C	–	–	–	-32 °C
BASF G206	65% by volume for application at outside temperatures of up to -65 °C in arctic regions				

* = antifreeze specifications determined as per ASTM D 1177

Operational monitoring for permissible concentrations, coolant without antifreeze

Permissible concentration range	Manufacturer	Brand name	Reading on hand refractometer) at 20 °C (= degrees Brix)					
		% by vol.	7	8	9	10	11	12
9 to 11% by volume	MTU Friedrichshafen	Coolant CS 100 Corrosion Inhibitor Concentrate	3.5	4.0	4.5	5.0	5.5	6.0
		Coolant CS 10/90 Corrosion Inhibitor Premix	3.5	4.0	4.5	5.0	5.5	6.0
	MTU America	Power Cool® Plus 6000	3.5	4.0	4.5	5.0	5.5	6.0
	Arteco	Freecor NBI	Please use test kit of manufacturer					
	BASF SE	Glysacorr G93-94	3.5	4.0	4.5	5.0	5.5	6.0
	BP Lubricants	Castrol Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Manufacturing IL Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	Chevron	Texcool A -200	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool Plus 6000	4.9	5.6	6.3	7.0	7.7	8.4
	Drew Marine	Drewgard XTA	3.5	4.0	4.5	5.0	5.5	6.0
	ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	Ginouves	York 719	3.5	4.0	4.5	5.0	5.5	6.0
	Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	4.9	5.6	6.3	7.0	7.7	8.4
	Valvoline	Zerex G-93	3.5	4.0	4.5	5.0	5.5	6.0
7 to 11% by volume	Arteco	Havoline Extended Life Corrosion Inhibitor XLI [EU 32765]	2.6	3.0	3.4	3.7	4.1	4.4
	Nalco	Alfloc (Maxitreat) 3443	1.75	2.0	2.25	2.5	2.75	3.0
		Alfloc (Maxitreat) 3477	1.75	2.0	2.25	2.5	2.75	3.0
	Total	WT Supra	2.6	3.0	3.4	3.7	4.1	4.4
5 to 6% by volume	Fleetguard	DCA-4L	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool 3000						
	Penray	Pencool 3000						

TIM-ID: 0000018575 - 003

Permissible concentration range	Manufacturer	Brand name % by vol.	Reading on hand refractometer[1] at 20 °C (= degrees Brix) 7 | 8 | 9 | 10 | 11 | 12
3 to 4% by volume	Detroit Diesel Corporation	Power Cool 2000	Please use test kit of manufacturer
	Nalco	Alfloc 2000	
		Nalco 2000	
		Nalcool 2000	
		Trac 102	
	Penray	Pencool 2000	

Table 16:

[1] = concentration determination by means of suitable hand refractometer

Calibrate the hand refractometer with clean water at coolant temperature. The coolant temperature should be 20 °C. Observe the specifications of the manufacturer.

Operational monitoring of permissible concentrations, antifreeze on ethylene glycol basis

The concentration is determined using a suitable glycol refractometer and direct reading of the scale value in % by vol.

Calibration table for antifreeze for special applications

Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol antifreeze	II. BASF G206	
26.3	24.8	35% by volume
26.9	25.5	36% by volume
27.5	26.1	37% by volume
28.2	26.7	38% by volume
28.8	27.4	39% by volume
29.5	28.0	40% by volume
30.1	28.6	41% by volume
30.8	29.2	42% by volume
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume
33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume

Reading on hand refractometer at 20 °C (= degrees Brix)		
I. Propylene glycol antifreeze	II. BASF G206	Corresponds to a concentration of
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Table 17:

5.8 Limit values for coolants

pH value when using:		
– Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5
– Antifreeze	Min. 7.0	Max. 9.0
– Coolant without antifreeze for engines containing light metal	Min. 7.0	Max. 9.0
– Coolant without antifreeze for engines free of light metal	Min. 7.0	Max. 11.0
Silicon (valid for coolants containing Si)	Min. 25 mg/l	

Table 18:

The coolant must be changed in case of non-compliance with the above specifications.

Note:

For a holistic appraisal of a coolant function, apart from the above-mentioned limit values the respective coolant-specific characteristic data and the freshwater quality used must be taken into consideration.

5.9 Storage capability of coolant concentrates

The storage stability specification is based on an original sealed and airtight container at a storage temperature of up to max. 30 °C.

Coolant concentrate	Limit value	Brand name / Comments
Emulsifiable corrosion-inhibiting oil	6 months	
Antifreeze	Approx. 3 years	Observe manufacturer's specifications.
Products containing propylene glycol	3 years	BASF G206
Coolant without antifreeze	6 months	Nalco Trac 102
	1 year	Detroit Diesel Corp. Power Cool 3000 Penray Pencool 3000
	2 years	Arteco Freecor NBI Chevron Texcool A-200 – Nalco Alfloc 2000 Nalco Nalcool 2000 Nalco Nalco 2000 Detroit Diesel Corp. Power Cool 2000 Penray Pencool 2000
	3 years	BASF Glysacorr G93–94 Drew Marine Drewgard XTA Ginouves York 719 MTU Friedrichshafen Coolant C150 MTU America Power Cool® Plus 6000 Nalco Alfloc (Maxitreat) 3477 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] BP Castrol Extended Life Corrosion Inhibitor CCI Corporation A216 CCI Manufacturing IL A216 Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] Detroit Diesel Corp. Power Cool Plus 6000 ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor Fleetguard DCA-4L Old World Industries Final Charge Extended Life Corrosion Inhibitor (A216) Total WT Supra

Table 19:

Note:

For reasons of corrosion protection, do not store in galvanized containers. Take this requirement into account when coolant must be transferred.

Containers must be hermetically sealed and stored in a cool, dry place. Frost protection must be provided in winter.

Further information can be obtained from the product and safety data sheets for the individual coolants.

5.10 Color additives for detection of leaks in the coolant circuit

The following listed fluorescent dyes are approved as additives for coolant without antifreeze for the detection of leaks.

Manufacturer	Product name	Material number	Container size	Storage stability[1)]
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years

Table 20: Approved color additives

[1)] = based on original and hermetically sealed containers in frost-free storage (> 5 °C)

Application:

Approx. 40 g dye must be added to 180 l coolant.

This dye quantity is already very generous and must not be exceeded.

The fluorescence (yellow color tone) is easily recognizable in daylight. In dark rooms, UV light can be used with a wave length of 365 nm.

6 Fuels

6.1 Diesel fuels - General

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Selection of a suitable diesel fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels.

Diesel fuels are not available worldwide in the required (→ Table 21)quality.
The fuel properties depend on many factors, in particular, region, time of year and storage.

Unsuitable fuel usually leads to a reduced service life of engine components and can also cause engine damage.

Further details on fuel qualities, tank care and filtration are available in the publication "Useful information on fuels, tank systems and filtration" (publication number A060631/..).

Fuel specifications to be complied with

		Test Method		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorous compounds.
Total contamination (= fuel-insoluble ingredients)	max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	min.	D1298 D4052	EN ISO 3675 EN ISO 12185	0.820 g/ml
	max.			0.860 g/ml
API gravity at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm²/s
	max.			4.5 mm²/s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C (60 °C for SOLAS)[1)]
Boiling curve:		D86	EN ISO 3405	
– Initial boiling point				160 to 220 °C
– Volume share at 250 °C	max.			65% by volume
Recovery at 350 °C	min.			85% by volume
– Residue and loss	max.			3% by volume
Fatty acid methyl ester content (FAME) ("Biodiesel")	max.		EN 14078 Internal MTU procedure	7.0% by volume
Proportion of water: (absolute, no free water)	max.	D6304	EN ISO 12937	200 mg/kg

TIM-ID: 0000018622 - 003

		Test Method		Limit values
		ASTM		
Carbon residue from 10% distillation residue	max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:[2)]		D482	EN ISO 6245	
– Engines without exhaust aftertreatment and DOC-/SCR system	max.			0.01% by weight (100 mg/kg)
– Engines with exhaust aftertreatment	max.			0.001 % by weight (10 mg/kg)
Sulfur content:[2)]		D5453, D2622	EN ISO 20846 EN ISO 20884	
– Engines without exhaust gas aftertreatment / recirculation	max.			0.5% by weight (5000 mg/kg)
– Engines with exhaust aftertreatment	max.			0.0015% by weight (15 mg/kg)
– Series 2000Cx6 / Sx6	max.			0.0015% by weight (15 mg/kg)
– Series 4000R64 / R74 / R84 / T94 / T94L	max.			0.0015% by weight (15 mg/kg)
Cetane number	min.	D613	EN ISO 5165, EN ISO 15195	45
Cetane index	min.	D976	EN ISO 4264	42
Copper corrosion 3 hrs. at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability (Rancimat)	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m³
Lubricity at 60 °C (HFRR value)	max.	D6079	EN ISO 12156-1	520 µm
Filter plugging point (CFPP)		D6371	DIN EN 116	See Note [3)]
Cloud point		D2500	DIN EN 23015	See Note [4)]
Neutralization number	max.	D974		0.2 mgKOH/g

Table 21:

[1)] For marine applications, a min. flashpoint of 60 °C (SOLAS = Safety of life at sea) applies.

[2)] see series-specific injection / and exhaust aftertreatment systems (→ Page 41) for the Definition as to whether an exhaust aftertreatment system is installed.

[3)] Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).

[4)] The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.

It is the fuel supplier's responsibility to provide a fuel that will assure correct engine operation at the expected minimum temperatures and under the given geographical and other local conditions.

The operating company must ensure that there is always sufficient fuel to meet the corresponding climatic requirements.

Note: 1 by weight % = 10000 mg/kg = 10000 ppm

Note:

For safe and efficient engine operation, the limit values specified in (→ Table 21), in particular for water, total contamination, must be observed for all permissible fuel grades at the interface marked in Fig. 4 item 5 at the latest.

In addition to the limit values named in (→ Table 21), a particle distribution in the fuel according to ISO 4406 must be observed:

Particle distribution	Test method		Limit values	
	ASTM		Common rail	conventional injection
Particle distribution for fuel between last tank and prefilter (see Fig. 4 item 5)	D7619	Coding of number of particles as per ISO 4406	max. ISO Code 18/17/14 for 4/6/14 µm particle size	max. ISO Code 21/20/17 for 4/6/14 µm particle size

Table 22:

The limit values named in (→ Table 22) must already be observed in the feed between the last tank before the engine and the prefilter (if necessary, with water separator).

For plants without a prefilter, this refers to the feed between the last tank and the MTU equipment. For the analysis of the fuel quality, an interface (sample extraction cock) must be provided for sample extraction during operation.

For existing plants without an accessible feed, a sample extraction point in the last tank before the MTU equipment is permissible.

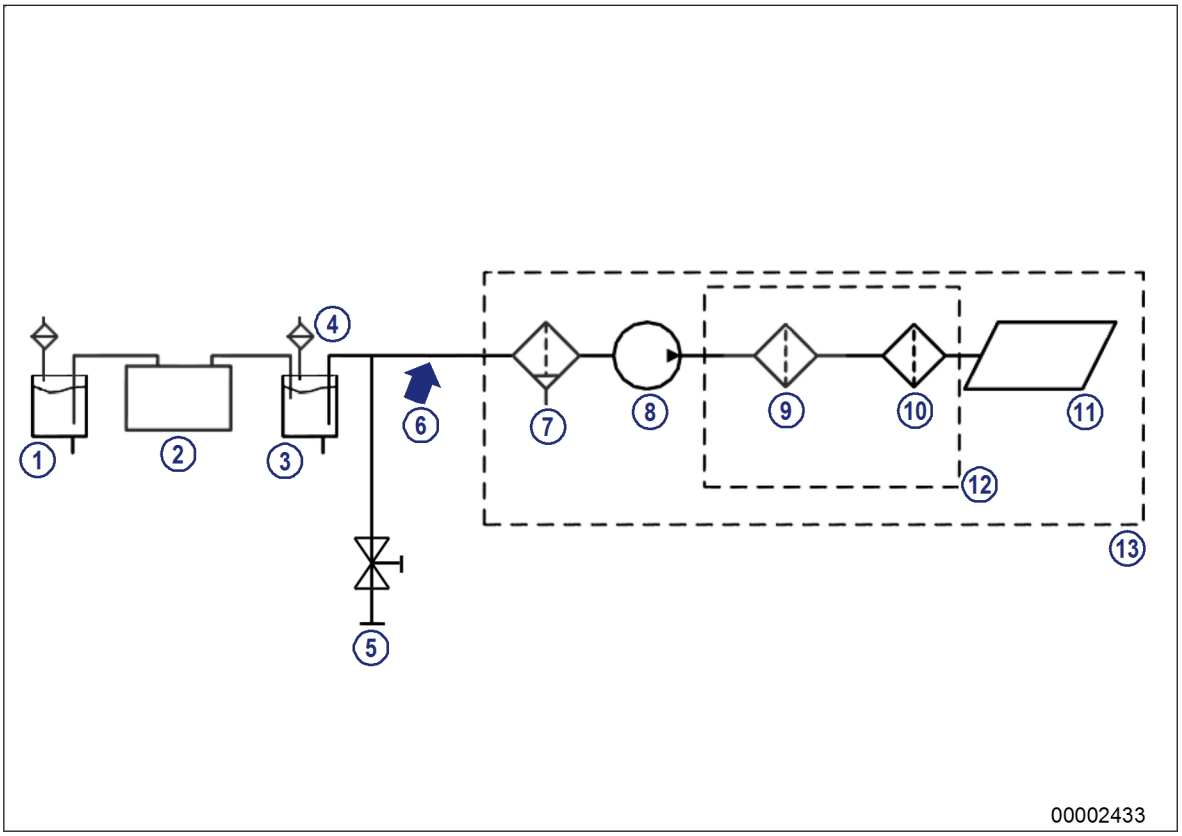


Figure 3:

1 Fuel tank
2 Fuel conditioning (option)
3 Last tank before engine
4 Tank ventilation filter
5 Sample extraction
6 Interface for fuel specification
7 Fuel prefilter with water separator (option)
8 Fuel low-pressure pump
9 Intermediate filter (option)
10 Main filter
11 Injection system
12 Engine filter
13 Engine scope

Note:

With poorer particle distribution, it is necessary to integrate further / more-optimized filter stages in the fuel system to achieve the operational life of fuel filters and components of the injection system.

For the limit values named for the interface, it has been validated that MTU-approved prefilters provide sufficient filtration.

Damage and disadvantages to engine caused by the use of non-MTU-approved fuel qualities in accordance with (→ Table 21) and (→ Table 22) and chapter 6.2 (→ Page 43) or prefilters are not deficiencies that are covered by the warranty from MTU-Friedrichshafen GmbH.

Series-related injection / and exhaust aftertreatment systems

Series	Diesel accumulator injection system (Common rail)	Conventional injection systems	Exhaust aftertreatment system	Exhaust gas recirculation (EGR)
S60		yes	no	
099		yes	no	no
183		yes	no	no

Series	Diesel accumulator injection system (Common rail)	Conventional injection systems	Exhaust aftertreatment system	Exhaust gas recirculation (EGR)
396 C&I, Genset, Marine, Rail, Submarine		yes	no	no
538 Marine		yes	no	no
595 Marine		yes	no	no
956-01, -02, -03, -04		yes	no	no
1163-01, -02, -03		yes	no	no
1163-04	yes		no	no
2000Cx0, Cx1, Cx2, Gx3, Gx5, Mx0, Mx1, Px2, Sx0, Sx1, Sx2		yes	no	no
2000Cx6, Gx6, Gx7, Mx2, Mx3, Mx4, Mx6, Sx6	yes		only Series 2000Gx7 / Mx6	only Series 2000Cx6 / Sx6
4000-00, -01, -02, -03, -04, -05	yes		only Series 4000Rx4, Gx5	only Series 4000Cx4 / Cx5 / Rx4 / T94 / T95
8000	yes		no	no
Two-cycle engines		yes	no	no

Table 23:

Emission certification

For EPA Tier4i, Tier4 and/or Tier3 (Marine and Rail) engines and EU IIIb-certified engines with exhaust aftertreatment, fuels in accordance with DIN EN 590:2014-04 and ASTM D 975-14a Grade1-D S15 and Grade 2-D S15 are permitted.

Laboratory analysis

An order for fuel analysis can be placed with MTU.

The following data is required:
- Fuel specifications
- Sampling point
- Serial number of engine from which fuel sample was taken

Submit the following:
- 0.5 liters of fuel
- 1.5 liters of fuel (with additional determination of cetane number)

6.2 Series-dependent approval of fuel grades for MTU engines

6.2.1 Distillate fuels as per DIN EN590 and ASTM D975

Commercially available diesel fuels meeting the following specifications are approved for use:

New series

Fuel specifications	DIN EN 590: 2014-04 Summer and winter quality	ASTM D975-16 Grade 1-D S 15, S 500, S 5000	ASTM D975-16 Grade 2-D S 15, S 500, S 5000
Restrictions	- SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	- SOLAS: Flashpoint min. 60 °C - Density: 0.820 to 0.860 g/ml* * = deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power readjustment, it is possible that the engine operational values change - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	
Series			
S60	Approved	Approved	Approved
2000Cx0, Cx1, Cx2 without exh. aftertreatment	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 500 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 500 mg/kg
2000Gx5, Gx6 without exh. aftertreatment	Approved		
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6 without exh. aftertreatment	Approved		
2000Px2 without exh. aftertreatment	Approved		
2000Cx6	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg
2000Sx6	Approved		
2000Mx6 with exh. aftertreatment	Approved		
2000Gx7 with exh. aftertreatment	Approved		

Fuel specifications Restrictions	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-16 Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Density: 0.820 to 0.860 g/ml* * = deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power readjustment, it is possible that the engine operational values change - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-16 Grade 2-D S 15, S 500, S 5000
Series			
4000-00	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01	Approved		
4000-02	Approved		
4000-03 C, G, P, R, S	Approved		
4000M23F, M23S	Approved		
4000M33F, M33S	Approved		
4000M53, M53R	Approved		
4000M63, M63L	Approved		
4000M53B, M73 - M93L, N43S, N83	Approved		
4000-04 G, M	Approved		
4000-05 G	Approved		
4000C64	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg
4000R54, R64, R74, R84	Approved		
4000T94, T94L	Approved		
4000C45, C55, C65	Approved	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000T95, T95L, T95R	Approved		
8000	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 24:

Classic series

Fuel specifications Restrictions	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Density: 0.820 to 0.860 g/ml* * = deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power readjustment, it is possible that the engine operational values change - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
Series			
099	Approved	Approved	Approved
183	Approved	Approved	Approved
396 C&I, Genset, Marine, Rail, Submarine	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - cetane number min. 45 or - cetane index min. 42
538 Marine 595 Marine	Approved Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	Approved Anti-wear additive necessary	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg
956-01 Marine / Rail 956-02 Marine	Approved Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163TB32 Genset	Approved Anti-wear additive necessary	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg

Fuel specifications Restrictions Series	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Density: 0.820 to 0.860 g/ml* * = deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power readjustment, it is possible that the engine operational values change - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
1163-02 Marine 1163-03 Marine	Approved Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163-04 Marine	Approved	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42

Table 25:

Two-cycle engines

Fuel specifications	DIN EN 590: 2014-04 Summer and winter quality	ASTM D975-14a Grade 1-D S 15, S 500, S 5000	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
Restrictions	- SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	- SOLAS: Flashpoint min. 60 °C - Density: 0.820 to 0.860 g/ml* * = deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power readjustment, it is possible that the engine operational values change - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	
Series			
S53, S71, S92, S149	Approved	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 26:

6.2.2 British Standard

New series

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: Max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
S60	Approved	Approved
2000Cx0, Cx1, Cx2, Cx6	No approval	No approval
2000Gx5, Gx6, Gx7		
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6		
2000Px2		
2000Sx0, Sx1, Sx2, Sx6		
4000-00	Approved	Approved
4000-01		
4000-02		
4000-03 C, G, P, R, S		
4000M23F, M23S		
4000M33F, M33S		
4000M53, M53R		
4000M63,M63L		
4000M53B, M73 - 93L, N43S, N83		
4000-04 M		
4000C64	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000R54, R64, R74, R84		
4000T94, T94L		
4000C45, C55, C65		
4000 95, T95L, T95R		
8000	Approved	Approval issued if: - sulfur content max. 50 mg/kg

Table 27:

Classic series

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: Max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
099	Approved	Approved
183	Approved	Approved
396 C&I, Genset, Marine, Rail, Submarine	Approved	Approved
538 Marine 595 Marine	Approved Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	No approval	No approval
956-01 Marine / Rail 956-02 Marine	Approved Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
1163-02TB32 Genset	No approval	No approval
1163-02 Marine 1163-03 Marine	Approved Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
1163-04 Marine	Approved	Approved

Table 28:

Two-cycle engines

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: Max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
S53, S71, S92, S149	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 29:

6.2.3 Heating oil

Commercially available diesel fuels meeting the following specifications are approved for use:

New series

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- SOLAS: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S60	Approved	Approved	No approval
2000Cx0, Cx1, Cx2 without exh. aftertreatment	Approval issued if: - density at 15 °C min. 0.820g/ml - sulfur content max. 500 mg/kg	Approved	No approval
2000Gx5 without exh. aftertreatment			
2000Mx0, Mx1 without exh. aftertreatment			
2000Px2 without exh. aftertreatment			
2000Sx0, Sx1, Sx2 without exh. aftertreatment			
2000Gx6 without exh. aftertreatment	No approval	Approval issued if: - sulfur content max. 500 mg/kg	No approval
2000Mx2, Mx3, Mx4, Mx6 without exh. aftertreatment			
2000Cx6	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
2000Gx7 with exh. aftertreatment			
2000Mx6 with exh. aftertreatment			
2000Sx6			
4000-00	Approved	Approved	No approval
4000-01	Approved	Approved	No approval
4000-02	Approved	Approved	No approval
4000-03 C, G, P, R, S	Approved	Approved	No approval
4000M23F, M23S	Approved	Approved	No approval
4000M33F, M33S			
4000M53, M53R			
4000M63, M63L			

TIM-ID: 0000071307 - 001

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- SOLAS: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
4000M53B, M73 - 93L, N43S, N83	Approved	Approved	No approval
4000-04 M	Approved	Approved	No approval
4000C64	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
4000R54, R64, R74, R84			
4000T94, T94L			
4000C45, C55, C65			
4000T95, T95L, T95R			
8000	Approved	Approved	No approval

Table 30:

Classic series

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- SOLAS: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
099	Approved	Approved	No approval
183	Approved	Approved	No approval
396 C&I, Genset, Marine, Rail, Submarine	Approved	Approved	No approval
538 Marine	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary	No approval
595 Marine			

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- SOLAS: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	Approval issued if: Heating oils EL standard and low-sulfur according to DIN 51603-1 must only be used if all requirements in acc. with Heating oil EL (→ Page 82) have been met.		No approval
956-01 Marine / Rail	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary	No approval
956-02 Marine			
1163-02TB32 Genset	Approval issued if: Heating oils EL standard and low-sulfur according to DIN 51603-1 must only be used if all requirements in acc. with Heating oil EL (→ Page 82) have been met.		No approval
1163-02 Marine	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary	No approval
1163-03 Marine			
1163-04 Marine	Approved	Approved	No approval

Table 31:

Two-cycle engines

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- SOLAS: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S53, S71, S92, S149	No approval	No approval	No approval

Table 32:

6.2.4 Marine distillate fuels in accordance with ISO 8217:2013-12

Commercially available diesel fuels meeting the following specifications are approved for use:

New series

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
S60	Approved	No approval	No approval	No approval
2000 Cx0, Cx1, Cx2, Cx6	No approval	No approval	No approval	No approval
2000Gx5, Gx6, Gx7				
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6				
2000Px2				
2000Sx0, Sx1, Sx2, Sx6				
4000-01	Approval issued if: Viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42		No approval
4000-02				
4000-03 C, G, P, R, S				
4000M23F, M23S	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - suitable filter system is used Except for area of application of EPA Tier 2		No approval
4000M33F, M33S				
4000M53, M53R				
4000M63, M63L				

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
4000M53B, M73-M93L, N43S, N83	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - suitable filter system is used - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 Except for area of application of EPA Tier 2		No approval
4000-04 M	No approval	No approval	No approval	No approval
4000C64	No approval	No approval	No approval	No approval
4000R54, R64, R74, R84				
4000T94, T94L				
4000C45, C55, C65				
4000T95, T95L, T95R				
8000	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required - sulfur content max. 50 mg/kg	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42		No approval

Table 33:

Classic series

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
099	Approved	upon request	upon request	No approval
183	Approved	upon request	upon request	No approval
396 C&I, Genset, Marine, Rail, Sub-marine	Approval issued if: - sulfur content max. 0.5 % (5000 mg/kg)	upon request	upon request	No approval
538 Marine	Approval issued if: - sulfur content max. 0.5 % (5000 mg/kg)	upon request	upon request	No approval
595 Marine	Approval issued if: - sulfur content max. 0.5 % (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	No approval	No approval	No approval	No approval
956-01 Marine / Rail 956-02 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
1163-02 TB32 Genset	No approval	No approval	No approval	No approval

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
1163-02 Marine 1163-03 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
1163-04 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with MTU is possible, e.g. through limitation of the temperature range or preheating - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - suitable filter system is used - sulfur content max. 0.5%		No approval

Table 34:

Two-cycle engines

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Series				
S53, S71, S92, S149	No approval	No approval	No approval	No approval

Table 35:

6.2.5 Aviation turbine fuel

Commercially available diesel fuels meeting the following specifications are approved for use:

Aviation turbine fuel

New series

Fuel specifications Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
S60	Generally not approved, approval upon request		
2000Cx0, Cx1, Cx2, Cx6	Generally not approved, approval upon request		
2000Gx5, Gx6, Gx7	Generally not approved, approval upon request		
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6	Generally not approved, approval upon request		
2000Px2	Generally not approved, approval upon request		
2000Sx0, Sx1, Sx2, Sx6	Generally not approved, approval upon request		
4000-01	Generally not approved, approval upon request		
4000-02	Generally not approved, approval upon request		
4000-03 C, G, P, R, S	Generally not approved, approval upon request		Approval issued for: 4000-03 G
4000M23F, M23S	Generally not approved, approval upon request		
4000M33F, M33S	Generally not approved, approval upon request		
4000M53, M53R	Generally not approved, approval upon request		
4000M63, M63L	Generally not approved, approval upon request		
4000M53B, M73 - M93L	Generally not approved, approval upon request		
4000-04 M	Generally not approved, approval upon request		
4000C64	Generally not approved, approval upon request		
4000R54, R64, R74, R84	Generally not approved, approval upon request		
4000T94, T94L	Generally not approved, approval upon request		
4000C45, C55, C65	Generally not approved, approval upon request		
4000T95, T95L, T95R	Generally not approved, approval upon request		
8000	Generally not approved		

Classic series

Fuel specifications Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
099	Generally not approved, approval upon request		
183	Generally not approved, approval upon request		

Fuel specifications Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
396 C&I, Genset, Marine, Rail, Submarine	Generally not approved, approval upon request		
538 Marine	Generally not approved, approval upon request		
595 Marine			
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	Generally not approved		
956-01 Marine / Rail	Generally not approved, approval upon request		
956-02 Marine			
1163-02 TB32 Genset	Generally not approved		
1163-02 Marine	Generally not approved, approval upon request		Approved
1163-03 Marine			
1163-04 Marine	Generally not approved, approval upon request		Approved

Table 36:

Two-cycle engines

Fuel specifications Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
S53, S71, S92, S149	Generally not approved		

Table 37:

6.2.6 NATO diesel fuels

Commercially available diesel fuels meeting the following specifications are approved for use:

Diesel fuel NATO Code F-54

New series

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S60	Approved	Approved
2000Cx0, Cx1,Cx2	Approval issued if: - sulfur content max. 500 mg/kg	Approval issued if: - sulfur content max. 500 mg/kg
2000Gx5, Gx6		
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6		
2000Px2		
2000Sx0, Sx1, Sx2		
2000Cx6	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
2000Gx7 with exh. aftertreatment		
2000Mx6 with SCR/exh. after-treatment		
2000Sx6		
4000-00	Approved	Approved
4000-01		
4000-02		
4000-03 C, G, P, R, S		
4000M23F, M23S	Approved	Approved
4000M33F, M33S		
4000M53, M53R		
4000M63, M63L		
4000M53B, M73 - 93L, N43S, N83	Approved	Approved
4000-04 M	Approved	Approved

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
4000C64	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000R54, R64, R74, R84		
4000T94, T94L		
4000C45, C55, C65		
4000T95, T95L, T95R		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approved

Table 38:

Diesel fuel NATO Code F-75

New series

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0% → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S60	No approval	No approval
2000Cx0, Cx1, Cx2, Cx6	No approval	No approval
2000Gx5, Gx6, Gx7		
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6		
2000Px2		
2000Sx0, Sx1, Sx2, Sx6		
4000-00	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01		
4000-02		
4000-03 C, G, P, R, S		
4000M23F, M23S	Approved	Approved
4000M33F, M33S		
4000M53, M53R		
4000M63, M63L		
4000M53B, M73 - 93L, N43S, N83	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-04 M	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0% → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
4000C64	No approval	No approval
4000R54, R64, R74, R84		
4000T94, T94L		
4000C45, C55, C65		
4000 95, T95L, T95R		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 39:

Diesel fuel NATO Code F-76

New series

Fuel specifications Restrictions Series	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
S60	Approved	Approval issued if: - density 0.820 to 0.860 g/ml	Approved
2000Cx0, Cx1, Cx2, Cx6	Generally not approved, approval upon request	Generally not approved, approval upon request	Generally not approved, approval upon request
2000Gx5, Gx6, Gx7			
2000Mx0, Mx1, Mx2, Mx3, Mx4, Mx6			
2000Px2			
2000Sx0, Sx1, Sx2, Sx6			

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
4000-00	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01			
4000-02			
4000-03 C, G, P, R, S			
4000M23F, M23S	Approved	Approved	Approved
4000M33F, M33S			
4000M53, M53R			
4000M63, M63L			
4000M53B, M73 - M93L, N43S, N83	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-04 M	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approved	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000C64	No approval	No approval	No approval
4000R54, R64, R74, R84			
4000T94, T94L			
4000C45, C55, C65			
4000T95, T95L, T95R			
8000	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 40:

TIM-ID: 0000071310 - 001

NATO diesel fuels

Diesel fuels Nato Code F-54

Classic series

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
099	Approved	Approved
183	Approved	Approved
396 C&I, Genset, Marine, Rail, Submarine	Approved	Approved
538 Marine 595 Marine	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary
956TB 31, TB32, TB33 956TB34 Nuclear power station, emergency power	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary
956-01 Marine / Rail 956-02 Marine	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary
1163-02TB32 Genset	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary
1163-02 Marine 1163-03 Marine	Approved Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approved Anti-wear additive necessary
1163-04 Marine	Approved	Approved

Table 41:

Diesel fuel NATO Code F-75

Classic series

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0% → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
099	Approved	upon request
183	Approved	upon request
396 C&I, Genset, Marine, Rail, Submarine	Approved	upon request
538 Marine	Approved	upon request
595 Marine	Approved	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% and min. 0.05%
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	No approval	No approval
956-01 Marine / Rail	Approved	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% and min. 0.05%
956-02 Marine		
1163-02 TB32 Genset	No approval	No approval

TIM-ID: 0000071310 - 001

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0% → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
1163-02 Marine	Approved	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% and min. 0.05%
1163-03 Marine		
1163-04 Marine	Approved	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%

Table 42:

Diesel fuel NATO Code F-76

Classic series

Fuel specifications Restrictions Series	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
099	Approved	Approval issued if: - density 0.820 to 0.860 g/ml	Approved
183	Approved	Approval issued if: - density 0.820 to 0.860 g/ml	Approved
396 C&I, Genset, Marine, Rail, Submarine	upon request	Approval issued if: - density 0.820 to 0.860 g/ml	upon request
538 Marine	upon request	Approved	upon request

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
595 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
956TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	No approval	No approval	No approval
956-01 Marine / Rail 956-02 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163-02 TB32 Genset	No approval	No approval	No approval
1163-02 Marine 1163-03 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5% and min. 0.05%
1163-04 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42

Table 43:

– Other qualities on request

NATO diesel fuels

Diesel fuel NATO Code F-54

Two-cycle engines

Fuel specifications	NATO Code F-54 in accordance with TL 9140-0001 Edition 8	NATO Code F-54 in accordance with STANAG 7090 Edition 4
Restrictions	Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: Min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: Max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
Series		
S53, S71, S92, S149	Approval issued if lubricity max. 460 µm	

Table 44:

Diesel fuel NATO Code F-75

Two-cycle engines

Fuel specifications	NATO Code F 75 TL 9140-0003	NATO Code F 75 STANAG 1385
Comments	- Reduced power possible due to min. density of 0.815 g/ml	- Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0% → Adapt oil and oil change interval
Restrictions	- With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
Series		
S53, S71, S92, S149	No approval	No approval

Table 45:

Diesel fuel NATO Code F-76

Two-cycle engines

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S53, S71, S92, S149	No approval	No approval	No approval

Table 46:

– Other qualities on request

6.2.7 Paraffinic diesel fuel according to DIN EN 15940

Selected paraffinic diesel fuels according to DIN EN 15940 are currently in the qualification phase.

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

6.2.8 B20 diesel fuel

B20 diesel fuel is a diesel fuel with a biodiesel share of 20%.

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

The following section provides additional information on B20 diesel fuel.

Use of B20 diesel fuels

Biodiesel mixtures consist of fuels which are obtained from biological raw materials and mixed with conventional diesel fuel. For instance, B20 denotes a mixture comprising 20% biodiesel and 80% fuel based on crude oil/mineral oil. MTU engines were not specially designed to be operated with biodiesel mixtures. For this reason, the use of biodiesel mixtures may have negative effects in terms of engine power, service and maintenance requirements, emissions and service life.

Operators of MTU engines therefore need to be clear about the effects that biodiesel may have on their engines, and must take all of the necessary measures to ensure the reliability and safety of their engines. This letter provides MTU customers with important information on the use of biodiesel mixtures in MTU engines, and explains the potential impact these fuels may have on the MTU warranty. Please read this information carefully before using biodiesel mixtures in MTU engines.

1. Regarding the use of approved biodiesel mixtures

At present, only biodiesel mixtures with up to 7% biodiesel (in accordance with DIN EN 590) or 5% biodiesel (in accordance with ASTM D 975) are approved for use in the MTU Fluids and Lubricants Specifications.

Although biodiesel mixtures with up to 20% biodiesel (B20) are not yet approved in the MTU Fluids and Lubricants Specifications at present, they can be used in the engines listed below in section 6, AS LONG AS the following requirements are met:

- The biodiesel complies with DIN EN 14214 or ASTM D 6751.
- The distilled diesel fuel added to the biodiesel is approved in the latest version of the MTU Fluids and Lubricants Specifications.
- The operator complies with the operating requirements given in section 2 and the additional maintenance recommendations from section 5.

Important information

The provisions with regard to requirements placed on fuel may differ depending on legislation and application of the engine. The operator is responsible for ensuring that only fuels which comply with the applicable provisions are used in the engines.

2. Operating requirements for the use of B20

The following operating requirements must be met when biodiesel mixtures are used in MTU engines:

a For engines used in emergency generators, an additive must be used to improve the oxidation stability of the biodiesel.

b All engines used in fire pumps, fire-extinguishing equipment or police equipment must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications each time they are operated with a biodiesel mixture. Furthermore, an additive must be used in these engines to improve the oxidation stability of the biodiesel.

c All engines which are only used seasonally or which are not operated for extended periods between uses must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications before they are decommissioned.

d Biodiesel mixtures cannot be used in engines equipped with an exhaust gas after-treatment system (e.g. catalytic converters, particle filters (DPF) and/or systems for reducing NOx emissions, e.g. SCR systems).

3. Impact on the MTU warranty

The manufacturer shall not be responsible for breakdowns which can be attributed to the use of fuels not approved in the MTU Fluids and Lubricants Specifications and such breakdowns shall therefore not be covered by the MTU warranty. MTU shall reject all warranty claims connected to the use of biodiesel mixtures with a biodiesel content of more than 7% (in accordance with DIN EN 590) or 5% (in accordance with ASTM D 975) if the operator is unable to prove that the operating requirements and recommendations contained in this letter were met and strictly followed. Regardless of this, MTU shall on no account be liable for providing compensation for costs arising from the effects described below in section 4.

Important information

All properties guaranteed by MTU in terms of engine power and/or availability in operation only apply to the cases in which fuels approved by MTU are used and the engine demonstrates no defects or damage arising from operation with fuels not approved in the MTU Fluids and Lubricants Specifications.

4. Effects of biodiesel on engines/exclusion of liability

The biodiesel contained in biodiesel mixtures is a natural product and therefore undergoes natural aging processes. These may have a negative effect on the engines in which the biodiesel mixtures are used. The effects that biodiesel may have on engines are explained below.

Important: THESE EFFECTS ARE NOT FAULTS CAUSED BY THE ENGINE MANUFACTURER. THEY ARE THEREFORE EXCLUDED FROM THE MTU WARRANTY. MTU SHALL NOT ASSUME ANY LIABILITY FOR COSTS ARISING FROM THE EFFECTS DESCRIBED BELOW.

- The formation of deposits may cause components to become "sticky", which potentially restricts their movement. On engines with long downtimes, this can result in a situation where the engine can no longer be started. This is why additives for improving the oxidation stability of the biodiesel must be employed when biodiesel mixtures are used in emergency generators. MTU SHALL ACCEPT NO LIABILITY IN THE EVENT THAT THE ENGINE IN AN EMERGENCY GENERATOR CANNOT BE STARTED AS A RESULT OF THE FORMATION OF DEPOSITS.
- The formation of deposits may have an adverse effect on the interaction of components inside the unit. This results in an increased risk of components failing, and even the breakdown of entire cylinders. The high operating temperatures in the surroundings encourage the formation of mineral deposits, other deposits and encrustations which may render the valve unable to correctly regulate the fuel supply. This means that it is not longer possible for the quantity of fuel required at full load to be injected into the engine, thereby reducing the maximum engine power.
- The viscosity properties of biodiesel are less favorable at low temperatures. The use of biodiesel at low temperatures may therefore cause the fuel filter to become blocked.
- On all engines, lubricating the piston skirts with oil leads to a small amount of fuel entering the engine oil. This is generally of little importance with conventional diesel fuels in accordance with the MTU Fluids and Lubricants Specifications since the fuel evaporates quickly upon reaching the operating temperature. On the other hand, biodiesel evaporates much less effectively, with the result that more biodiesel accumulates in the oil. Aging of the biodiesel can therefore cause residues to form, filters to become clogged and ultimately cause the engine to come to a stop, resulting in significantly shorter oil change intervals.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a lower energy density. Operating the engine with B20 results in a power reduction of approximately 2% and an increase in fuel consumption of around 3%.
- Biodiesel contains chemical components which can interact with the sensors in the exhaust gas recirculation system in such a way that incorrect data is reported to the engine control system. This can have consequences such as engine operation being adapted to the wrong values and emissions therefore no longer complying with the applicable provisions. This is why biodiesel must not be used in engines which feature exhaust gas recirculation (EGR) and/or exhaust gas after-treatment systems.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a higher water solubility, meaning that a higher proportion of water should be expected depending on the fuel temperature. This can lead to increased corrosion and faster microbe growth in the fuel system. Due to the higher proportion of water in biodiesel, reduced water separator performance must be expected.
- Biodiesel is a solvent. After switching over to a biodiesel mixture, impurities and certain deposits may become loose in the tank and lines, causing the fuel filter to be subjected to an increased accumulation of these. Biodiesel mixtures may also strip paint when they come into contact with painted surfaces.
- On engines with exhaust gas after-treatment systems, the functioning of the catalytic converter may be impaired, as biodiesel mixtures can contain a higher proportion of trace elements (e.g. calcium, magnesium, sodium, potassium and phosphorus) than conventional diesel fuels according to the MTU Fluids and Lubricants Specifications. This means that the legally prescribed emission limits are not complied with and the operating license becomes invalid. Furthermore, legally prescribed technologies for checking emissions on these engines (e.g. NOx monitoring diagnostics) lead to a significant decrease in engine power. The aforementioned trace elements may also result in excess ash formation and accumulations in the soot filters and catalytic converters. Excess ash formation results in a constantly rising exhaust back pressure and can therefore cause a slow reduction in engine power.

The aforementioned points do not constitute a complete risk assessment. MTU is unable to assess all biodiesel variants and their long-term effects on MTU products.

5. Additional maintenance recommendations

The following requirements must be met to ensure the quality and availability of your engine:

- Only purchase biodiesel from manufacturers with BQ9000 certification.
- Select the highest possible content of distilled fuel. Only use fuels approved in the MTU Fluids and Lubricants Specifications.
- After switching over to a biodiesel mixture, replace the fuel filters after 50 operating hours at the latest (in order to remove the impurities which become loose from the tank and lines).
- Install a fuel preheating system if the engine is operated at temperatures below 0 °C (32 °F). This can reduce the negative effect on the fuel supply.
- Follow the recommendations below with regard to engine oil and maintenance:
  - If biodiesel mixtures are used, the change intervals for engine oil and filters must be halved in comparison to the intervals stated in the MTU Fluids and Lubricants Specifications.
  - In addition to changing the oil and filters on time, the engine oil and filters must be analyzed regularly in order to ensure that the oil quality is correct. Interval: Every 100 operating hours or every three months, depending on which comes first. A decision must be made to either further reduce or extend the change intervals on the basis of the results.
  - The oil and oil filter must be replaced before biodiesel is used.
  - High-quality engine oil must be used. Operating the engine without high-quality category 3 oil leads to a deterioration in oil quality. The MTU Fluids and Lubricants Specifications contain a list of approved oil types.
- Use a suitable tank and line system:
  - Do not use any components which contain zinc, copper or NBR seals.
  - Ensure that the system can be filled up to the fill line.
  - Minimize the entry of atmospheric oxygen through the tank vent in the event of temperature fluctuations, etc. (e.g. by installing a pressure relief valve and filter; contact your tank supplier to do this).
- For systems without a water separator: Retrofit a water separator to reduce the risk of microbe growth and corrosion in the fuel system.
- Avoid relatively long engine downtimes and temporary decommissioning (more than one month). If downtimes cannot be avoided, you must use a suitable additive to improve oxidation stability. In Q4/2013, MTU approved an additive specially certified for MTU diesel engines. When this additive is used, B20 can be stored for up to four months, depending on the storage conditions and quality of the biodiesel. Prior to this point, we provided an additive on request.
- For engines used seasonally, we strongly recommend rinsing the fuel system, including the fuel tank, with pure, high-quality distilled diesel fuel in accordance with the MTU Fluids and Lubricants Specifications before the engine is decommissioned for a relatively long period (more than three months).
- Prevent biodiesel from coming into contact with painted surfaces to avoid damaging and stripping the paint.
- You must also always comply with the latest version of the MTU Fluids and Lubricants Specifications.

More extensive preventative measures are additionally required for some applications. Our Customer Service department is available to answer any questions you may have on this topic.

6. Affected engines

This customer information applies to the following engine series:

Series	Remarks
S1600G00	All years of manufacture
S2000G02 S2000G03 S2000G04 S2000G05	All years of manufacture With metal low-pressure fuel lines All years of manufacture All years of manufacture
S4000G01 S4000G02 S4000G03	With metal low-pressure fuel lines All years of manufacture All years of manufacture

Table 47:

TIM-ID: 0000072504 - 001

Should you have any questions about this customer information, please contact your on-site MTU representative.

TIM-ID: 0000072504 - 001

6.3 Diesel fuels for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the fuels used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following fuels can be used.

Exhaust gas technology	Technical approval for					
	DIN EN 590:2014-04	ASTM D975-14a Grade 1-D	ASTM D975-14a Grade 2-D	DMX in accordance with DIN ISO 8217:2013-12	DMA in accordance with DIN ISO 8217:2013-12	Heating oil in accordance with DIN 51603-6:2011-09 EL low-sulfur
Restrictions:						
Oxidation catalyst DOC (without particulate filter)	No restriction	S15	S15	No approval	No approval	No approval
Particle oxidation catalyst (POC)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	No approval	No approval	No approval
SCR system with vanadium catalysts (no particulate filter)	No restriction	S15 S<500 mg/kg with individual case approval	S15 S<500 mg/kg with individual case approval	Individual case approval		
SCR system with zeolith catalysts (no particulate filter)	No restriction	S15	S15	No approval	No approval	No approval
Diesel particulate filter (DPF)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval
Combination system SCR+ particulate filter	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval

Table 48: Diesel fuels for engines with exhaust aftertreatment

If the specifications from the tables are not observed, the prescribed TBO can not be guaranteed.

Warranty claim cases that result from the use of an impermissible fuel quality shall be rejected.

If a fuel is present that does not comply with MTU specifications, in certain circumstances MTU can assist in the selection of corresponding improvement measures.

Any possible restrictions related to engine requirements must also be observed.

Diesel fuel with a proportion of biodiesel (FAME, fatty acid methyl ester) of max. 7% in accordance with DIN EN 590:2014-04 may be used. The use of fuels with an increased proportion of biodiesel is not permitted for plants with exhaust aftertreatment because trace elements they may contain can act as catalyst poisons and lead to filter obstructions.

	Commercially available diesel fuels normally contain considerably less ash-forming agents that those certified by the relevant standards (typical ash content max. 0.001 % = 10 mg/kg). The particulate filters are designed for these low loads accordingly because the exhaust system would otherwise be completely overdimensioned. The maximum ash content in fuel specified by MTU has been defined to ensure that the particulate filter reaches the assured service life without the back pressure of the filter becoming too high for the engine.

	The use of fuel additives for minimizing wear is not permitted on plants with exhaust aftertreatment!

Use of fuel additives for lowering soot regeneration temperature on plants with particulate filters

Fuel additives for lowering the soot regeneration temperature (FBC, fuel borne catalyst) are generally not approved. The exhaust aftertreatment systems from MTU are designed such that soot regeneration takes place without additives.

TIM-ID: 0000057608 - 002

6.4 Biodiesel – Biodiesel admixture

The standardized general term "FAME" (fatty acid methyl ester) is used here to designate biodiesel fuels.

General information

- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Any contact with paint, for example, must therefore be avoided.
- The characteristic smell of FAME exhaust, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by an oxidation catalyst which may be installed by the vehicle / equipment manufacturers at their own risk.

Our company accepts no responsibility for and provides no warranty in respect of any fault or damage connected in any way with the use of FAME of a lower quality or resulting from non-compliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

Use of B20 fuels

Information on the use of B20 fuels is available in chapter (→ Page 72).

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2014-06.

Approved/non-approved engines for operation with 100% FAME

Series	Approved / Not approved	Conversion necessary
SUN	No approval	
700	No approval	
750	No approval	
OM 457 LA	From series introduction	no
460	From series introduction	no
900	From series introduction	no
500	From series introduction	no
S40	No approval	
S50	No approval	
S60	No approval	
183	No approval	
2000	No approval	
396	No approval	
4000	No approval	
538	No approval	
595	No approval	
956	No approval	
1163	No approval	
8000	No approval	

Table 49:

Diesel fuel with a FAME content of max. 7% in compliance with DIN EN 590:2014-04 may be used. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

Fuel

- The fuel must comply with DIN EN 14214:2014-06. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel may be used. The various mixtures of FAME and normal diesel fuel which may occur in the fuel tank as a result, present no problems.

Engine oil and servicing

- For operation using 100% FAME, engine oils are to be preferred which comply with MB Fluids and Lubricants Specifications, Sheet 228.5 or Oil Category 3 in accordance with MTU Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per MTU Fluids and Lubricants Specifications may also be used provided that oil drain intervals are reduced.
- A certain amount of fuel always finds its way into the engine oil via the pistons and cylinders. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Under certain conditions chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- For this reason, engine oil and filter change intervals must be shortened for operation both with pure FAME and with FAME-diesel mixtures.
- For Series 457, 460, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME (→ Table 50). This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

Effects on the engine oil change interval with operation with 100% FAME

Engine version	Engine oil change interval
Engines not fitted with special equipment for operation with FAME	Reduction of engine oil change interval to 30% of the standard interval required for operation with fossil diesel fuels
Engines fitted with special equipment Code MK21 and Code MK04	Reduction of engine oil change interval to 50% of the standard interval required for operation with fossil diesel fuels

Table 50:

The relevant engine oil change intervals must be complied with without fail!
Exceeding the engine oil change intervals can cause engine damage!

- Operation with 100% FAME requires shortened fuel filter change intervals. A new fuel filter must be fitted each time the engine oil is changed.
- The fuel filter and engine oil must be changed approximately 25 operating hours after conversion to FAME due to the danger of blockage caused by loosened deposits (FAME has a pronounced cleaning effect).
- Over longer periods, fuel filter service life may be reduced as a result of old residues being carried into the filter from the fuel system. A special, approved fuel prefilter can be installed as an improvement. This fuel prefilter with heated water separator is already installed on engines fitted with special equipment Code MK04.

Engine power and engine standstill

- Due to its calorific value, operation with 100% FAME involves a reduction of approx.8% to 10% in engine power. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Prior to any extended period out of operation, the fuel system must be flushed out in order to prevent congestion. For flushing, the engine must be operated for at least 30 minutes on FAME-free diesel fuel.

Vegetable oils as an alternative to diesel fuel

The use of pure vegetable oils as an alternative to diesel fuel or FAME is strictly prohibited due to the absence of standardization and to negative experience (engine damage caused by coking, deposits in the combustion chambers and oil sludge)!

Diesel fuels in winter operation

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate on account of paraffin precipitation.

In order to prevent operational problems (e.g. clogged filters) during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible during transitional periods and in individual countries.

6.5 Heating oil EL

Heating oil differs from diesel fuel mainly because of the following non-specified characteristics:

– Cetane number

– Sulfur content

– Oxidation stability

– Corrosion effect on copper

– Lubricity

– Low temperature behavior

If the heating requirements comply with the specifications of the diesel fuel DIN EN 590:2014-04 (summer and winter quality), there are no technical reasons why it can not be used in the diesel engine

6.6 Supplementary fuel additives

Supplementary fuel additives

The engines are designed such that satisfactory operation with normal, commercially available fuels is ensured. Many of these fuels already contain performance-enhancing additives.

The additives are added by the supplier as the agent responsible for product quality.

The anti-wear additives and biocides represent an exception(→ Page 83).

Attention is drawn to the fact that the use of diesel fuels or additives other than those stipulated in the MTU Fluids and Lubricants Specifications is always the responsibility of the operator.

Diesel fuels with sulfur content < 500 mg/kg

On Series 362, 396, 538, 652, 595, 956, 1163-02 and 03 engines with cylinder heads not fitted with valve seat inserts, the use of low-sulfur fuel (< 500 mg/kg) can lead to increased valve seat wear. This wear can be reduced by the addition of anti-wear additives. The approved supplementary additives must be mixed with the fuel in the predefined concentration. The additive must be filled before every refueling.

Microorganisms in fuel

Bacterial attack and sludge formation may occur in the fuel under unfavorable conditions. In such cases, the fuel must be treated with biocides in accordance with the manufacturer's specifications. Overconcentration must always be avoided.

The biocides approved at MTU are listed in table (→ Table 52).

Approved anti-wear additives

Manufacturer	Brand name	Concentration for use
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. 01 440-943-4200	ADX 766 M	250 to 350 mg/kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0) 8171 1600-0 Fax. +49 (0) 8171 1600-91	Tunadd PS	250 to 350 mg/kg

Table 51:

The use of anti-wear additives is not permitted on engines/plants with exhaust aftertreatment!

Approved biocides

Biocides should have a pure hydrocarbon structure, i.e. should only consist of the following components:

- Carbon
- Hydrogen
- Oxygen
- Nitrogen

They must not contain inorganic substances because they can cause damage to the engine. The use of halogenated biocides is prohibited due to their effects on the engine system and the environment.

A release for biocides that meet the above requirements is possible upon request.

Manufacturer	Brand name	Concentration for use
ISP Biochema Schwaben GmbH Ashland Specialty Ingredients Luitpoldstrasse 32 87700 Memmingen Tel. +49 (0)8331 9580 0 Fax. +49 (0)8331 9580 51	Bakzid	100 ml / 100 l
Maintenance Technologies Paddy's Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Dieselcure Fuel Decontainment	1 : 1200 (833 mg/kg)
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0) 7940 15-2248	Dieselcure Fuel Decontainment	1 : 1200 (833 mg/kg)
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40 52100-00 Fax. +49 (0) 40 52100-244	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton
Supafuel Marketing CC PO Box 1167 Allens Nek 1737 Johannesburg South Africa Tel. +27 83 6010 846 Fax. +27 86 6357 577	Dieselfix / Supafuel	1:1200 (833 mg/kg)
Wilhelmsen Ships Service AS Willem Barentszstraat 50 3165 AB Rotterdam-Albrtandswaard Tel. +31 10 487 7777 Fax. +31 10 487 7888 Netherlands	DieselPower MAR 71 (Biocontrol MAR 71)	333 ml / ton

Table 52:

Flow improvers

Flow improvers can not prevent paraffin precipitation but they do influence the size of the crystals and thus allow the diesel fuel to pass through the filter.

The effectiveness of the flow improvers is not guaranteed for every fuel.

Certainty is only assured after laboratory testing of the filtering capability.

Required quantities and mixing procedures must be carried out according to the manufacturer's instructions.

6.7 Unsuitable materials in the diesel fuel circuit

Components made of copper and zinc materials

The use of components made of copper and zinc materials in the fuel circuit is prohibited. They can cause chemical reactions in the fuel and thus lead to formation of a coating in the fuel system.

Requirements

Based on current knowledge, the following materials and coatings must not be used in a diesel fuel circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- Zinc, also as surface protection
- Zinc-based alloys
- Copper
- Copper-based alloys with the exception of CuNi10 and CuNi30 (seawater cooler)
- Tin, also as surface protection
- Magnesium-aluminum alloy

Non-metallic materials

- Elastomers: Nitrile rubber, natural rubber, chloroprene rubber, butyl rubber, EPDM
- Silicon elastomer
- Fluorosilicone elastomer
- Polyurethane
- Polyvinyl

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuit, consultation with the respective MTU specialist department must be held.

6.8 Fuel for gas engines

Gas engines must be operated exclusively with gases which have been specifically approved for the type of gas engine in use. The suitability for use of approved gas types must be checked regularly, but at least every six months, by means of a gas analysis in order to detect changes in the gas composition and changes to harmful components in the gas and to take appropriate action. In the entire application and operating range of the engine, the use of fuels is restricted to purely gaseous fuels. Liquid fuels are not permissible and not specified.

Components that may be used for gas engines are listed in the following tables. Generally valid limits for the main ingredients are specified in (→ Table 53) and (→ Table 54). Examples of typical natural gas compositions are shown in (→ Table 55) and (→ Table 56). The typical properties of fuel gases with a biogenic origin are shown in (→ Table 57). The listed components are relevant to gas engines. Components other than those listed below are not permitted for gas engines. They provide a reference value for the most gas compositions used today. Limit values for the individual components, unless they are explicitly restricted, are based on the general requirements of freedom from fluid elements, the exclusion of condensate and hydrocarbons and the global parameters of gas mixing (→ Table 58).

Main components of natural gases

Name	Components	Unit	Value range
Natural gas	CO	% by vol.	<2
	CO_2	% by vol.	<10
	CH_4	% by vol.	80-100
	C_2H_6	% by vol.	<12
	C_3H_8	% by vol.	<9
	C_4H_{10}	% by vol.	<1
	N_2	% by vol.	< 20
	O_2	% by vol.	< 3

Table 53:

Main ingredients of fuel gases of biogenic origin, mainly from fermentation processes

Name	Components	Unit	Value range
Fuel gases of biogenic origin	CO	% by vol.	unnamed
	CO_2	% by vol.	15 - 50
	CH_4	% by vol.	40 - 85
	C_2H_6	% by vol.	unnamed
	C_3H_8	% by vol.	unnamed
	C_4H_{10}	% by vol.	unnamed
	N_2	% by vol.	remainder
	O_2	% by vol.	remainder

Table 54:

Examples for natural gases

Typical natural gas compositions, natural gas H (according to DVGW worksheet G260)

		Russia	North Sea I	North Sea II	Network gas
CO	% by vol.	0.0000	0.0000	0.0000	0.0000
CO_2	% by vol.	0.1000	0.0000	0.3000	1.4000

		Russia	North Sea I	North Sea II	Network gas
CH_4	% by vol.	98.3000	88.6000	83.0000	88.6000
C_2H_4	% by vol.	0.0000	0.0000	0.0000	0.0000
C_2H_6	% by vol.	0.5000	8.4000	11.6000	5.3000
C_3H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_3H_8	% by vol.	0.2000	1.7000	3.1000	1.4000
C_4H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_8	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.1000	0.7000	0.5000	0.6000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000	0.0000
C_XH_Y	% by vol.	0.0000	0.0000	0.0000	0.0000
N_2	% by vol.	0.8000	0.6000	1.5000	2.7000
O_2	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2O	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2S	% by vol.	0.0000	0.0000	0.0000	0.0000
SO_2	% by vol.	0.0000	0.0000	0.0000	0.0000
Ar	% by vol.	0.0000	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000	100.000
Ho	kWh/m^3_N	11.1	12.2	12.5	11.5
Hu	kWh/m^3_N	10.0	11.0	11.3	10.3
Density	kg/m^3_N	0.731	0.810	0.853	0.814
rel. density	– –	0.56	0.62	0.66	0.63
Ws,n	kWh/m^3_N	14.7	15.4	15.4	14.5
Methane number	Methane no. (±2)	89	72	68	78

Table 55:

Typical natural gas compositions, natural gas L (according to DVGW worksheet G260)

		Holland I	Holland II	Osthannover (East Hanover)
CO	% by vol.	0.0000	0.0000	0.0000
CO_2	% by vol.	1.0000	1.3000	0.7000
CH_4	% by vol.	81.3000	82.9000	79.5000
C_2H_4	% by vol.	0.0000	0.0000	0.0000
C_2H_6	% by vol.	2.8000	3.7000	1.1000
C_3H_6	% by vol.	0.0000	0.0000	0.0000
C_3H_8	% by vol.	0.4000	0.7000	0.1000
C_4H_6	% by vol.	0.0000	0.0000	0.0000

		Holland I	Holland II	Osthannover (East Hanover)
C_4H_8	% by vol.	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.3000	0.3000	0.0000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000
C_XH_Y	% by vol.	0.0000	0.0000	0.0000
N_2	% by vol.	14.2000	11.1000	18.6000
O_2	% by vol.	0.0000	0.0000	0.0000
H_2	% by vol.	0.0000	0.0000	0.0000
H_2O	% by vol.	0.0000	0.0000	0.0000
H_2S	% by vol.	0.0000	0.0000	0.0000
SO_2	% by vol.	0.0000	0.0000	0.0000
Ar	% by vol.	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000
Ho	kWh/m^3_N	9.76	10.20	9.04
Hu	kWh/m^3_N	8.81	9.21	8.15
Density	kg/m^3_N	0.836	0.832	0.835
rel. density	– –	0.64	0.64	0.64
Ws,n	kWh/m^3_N	12.2	12.7	11.3
Methane number	Methane no. (±2)	90	86	101

Table 56:

Typical characteristics of fuel gases of biogenic origin from fermentation processes (according to DVGW worksheet G262)

		Biogas plants	Reference biogas plant in Northern Germany	Sewage gas plant	Landfill gas plant
CO	% by vol.	0	0	0	0
CO_2	% by vol.	15 - 50 (50*)	45*	20 - 35 (35*)	20 - 40 (40*)
CH_4	% by vol.	50 - 85 (50*)	52*	65 - 70 (65*)	65 - 70 (40*)
C_2H_4	% by vol.	0	0	0	0
C_2H_6	% by vol.	0	0	0	0
C_3H_6	% by vol.	0	0	0	0
C_3H_8	% by vol.	0	0	0	0
C_4H_6	% by vol.	0	0	0	0
C_4H_8	% by vol.	0	0	0	0
C_4H_{10}	% by vol.	0	0	0	0
C_5H_{12}	% by vol.	0	0	0	0
C_XH_Y	% by vol.	0	0	0	0
N_2	% by vol.	5 - 10 (0*)	2.4*	5 - 10 (0*)	10 - 20 (20*)

		Biogas plants	Reference biogas plant in Northern Germany	Sewage gas plant	Landfill gas plant
O_2	% by vol.	0 - 2.5 (0*)	0.6*	0 - 0.6 (0*)	0 - 2.7 (0*)
H_2	% by vol.	0	0	0	0
H_2O	% by vol.	*, **	*	*	*
H_2S	% by vol.	≤0.66 (0*)	≤0.005*	≤0.66 (0*)	≤0.66 (0*)
SO_2	% by vol.	0	0	0	0
Ar	% by vol.	0	0	0	0
Σ	% by vol.	100.000	100.000	100.000	100.000
The values marked with an asterisk * are used for calculating the following gas properties.					
Ho	kWh/m^3_N	5.53	5.75	7.19	4.42
Hu	kWh/m^3_N	4.98	5.18	6.48	3.99
Density	kg/m^3_N	1.347	1.301	1.158	1.323
rel. density	– –	1.042	1.006	0.896	1.027
Ws,n n = 0 °C, 101.32 kPa	kWh/m^3_N	5.42	5.73	7.6	4.37
Methane number	Methane no. (±2)	>140	146	133.8	>150

Table 57:

** = steam saturation corresponding to gas temperature

Requirements for gaseous fuel

Requirements and site conditions for natural gas fuel and the corresponding fuel supply

Designation	Unit	Limit value	Note
Type of gas		natural gas	Applies to natural gas H and L, other gases are currently not approved
Minimum methane number MN min.	–	≥70	Depending on the model type, power and fuel consumption adaptations may be necessary. Operating Instructions (Techn. data) must be observed Consultation with manufacturer and gas analysis required in case of lower values.
Nominal methane number	–	70	Engine type/model type Series 4000L62
	–	80	Series 4000L62 epsilon reduced
	–	80	Series 4000L63
	–	80	Series 4000L32
	–	80	Series 4000L33
	–	80	Series 4000L64
Methane number change	-/min	5	linear constant change with a frequency of maximum 1/h

Designation	Unit	Limit value	Note
Calorific power Hu	kWh/m^3_N	8.0< Hu <11.0	Consult the manufacturer in case of lower or higher values
Calorific value deviation from the setting value	%	± 5	Consultation with manufacturer required for higher values
Permissible change speed of calorific value in relation to setting value	%/min.	1.0	Linear constant change necessary with a frequency of maximum 1/h
Density of gas	kg/m^3_N	0.73-0.84	The density of the gas can fluctuate in accordance with the composition; it is constant for a certain type of gas. When using gas from different gas supply areas, the density may vary. When changing the gas supplier, a gas analysis is necessary; an adaptation of the mixture control may be necessary.
Setting value for gas pressure, gas control valve inlet	mbar	80-200	Observe the specifications for the gas train corresponding to the project
Gas pressure deviation from the setting value	%	± 5	
Permissible change speed of gas pressure	mbar/min.	1	Constant change required
Gas temperature, natural gas from public gas supply network	°C	5< T <45	If there is a danger of undershooting the dew point, the gas temperature must be increased. In case of deviating temperatures, there is a danger of thermal aging of NBR materials (gaskets, diaphragms) and impairment of the elasticity behavior.
Natural gas from LNG evaporator plants	°C	15< T <45	On plants with LNG operation, the permissible temperature range must be coordinated project-specifically. The gas evaporation system design must be analyzed on the part of MTU for this purpose.
Gas temperature deviation from the setting value	°C	± 9	
Permissible change speed of gas temperature	K/min.	0.3	

TIM-ID: 0000018625 - 003

Designation	Unit	Limit value	Note
Relative gas humidity in the gas in the permissible temperature and pressure range, however maximum	% g/kg	< 80 20	No water vapor condensation in the pressure and temperature range. No condensation admissible in lines and tanks carrying fuel gas and fuel gas-air mixtures. Gas drying must be provided at higher values or if there is a risk of condensation in the pressure and temperature operating ranges.
Oil vapors (HC with carbon number >5)	mg/m^3_N	< 0.4	No condensation in lines carrying fuel gas and fuel gas-air mixture, nor formation of condensable oil mists
HC solvent vapors	mg/m^3_N	0	Consultation with manufacturer and analysis necessary
Organically fixed silicium (e.g. hydrosilicons, siloxanes, silicons)	mg/m^3_N	< 1.0	Consultation with manufacturer and analysis necessary
Inorganically fixed silicon	$mg/m^3_N CH_4$	< 5	With Si >5 mg/m^3_N based on 100% CH_4 gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Dust 3- 10 µm	mg/m^3N	5	Dust must be removed such as to ensure trouble-free operation of gas devices and technical equipment which conform with standards or widely accepted engineering design.
Dust <3 µm	mg/m^3N	technically free	dust <3 µm must be assessed by a technical analysis, corresponding special filters may need to be used.
Total sulfur	mg/m^3N	30	DVGW worksheet G260
Mercaptan sulfur	mg/m^3N	6	DVGW worksheet G260
Hydrogen sulphide H_2S	mg/m^3N	5	DVGW worksheet G260
Chlorine	mg/m^3N	10*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine	mg/m^3N	5*	With higher values, consultation with manufacturer and analysis are necessary
Chlorine + fluorine	mg/m^3N	10*	With higher values, consultation with manufacturer and analysis are necessary
NH_3	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

Table 58:

* = Lower limit values may apply to engines with exhaust aftertreatment and/or exhaust gas heat recovery systems .

The limit values are based on a calorific value of 10 kWh/m^3_N. This corresponds to a reference to fuels with 100% by vol. methane or, if there are other combustible elements in the fuel, an equal energy equivalent and thus an equal input of pollutants.

Example:

Russian natural gas with a calorific value of 10 kWh/m^3_N (→ Table 55) is used. The permissible value for total sulfur in the gas thus corresponds exactly to the limit value specified in (→ Table 58).

When using gas from Osthannover, for example, with Hu = 8.15 kWh/m^3_N (→ Table 56), the permissible max. value of total sulfur is calculated thus:

permissible total sulfur content = 30 mg/m^3_N ∗ (8.15 kWh/m^3_N : 10.0 kWh/m^3_N) = 24.5 mg/m^3_N

No warranty is given in respect of impairment and / or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was unknown and agreed upon on conclusion of contract.

Requirements and site conditions for fuel from biogenic gases from fermentation processes and the corresponding fuel supply

Designation	Unit	Limit value	Note
Type of gas		Biogenic gases from fermentation processes	
Methane number	–	≥115	Below this limit there is a danger of combustion knock; gas analysis and consultation with manufacturer are required
Calorific power Hu	kWh/m^3N	4.5< Hu < 8.0	Consult the manufacturer in case of lower or higher values
Calorific value deviation from the setting value	%	±20	Consultation with manufacturer required for higher values
Maximum change speed of calorific value in relation to setting value	%/min.	1.0	For starting procedures, changes to the calorific power <10%/min. with a frequency of 1/h are permissible.
Density of gas	kg/m^3_N	0.93 - 1.40	The gas density can fluctuate according to the composition. If there are changes to the main substrate and/or significant changes in the mixing ratio of the substrates, a gas analysis or, if necessary, an adaptation of the mixture control is necessary.
Setting value for gas pressure before gas control valve	mbar	30 - 60	Project-specific features must be noted when designing the gas train.
Gas pressure fluctuation in relation to setting value	%	±10	This applies to the gas inlet at the gas control valve on the engine side
Permissible change speed of calorific value	mbar/min.	1	This applies to the gas inlet at the gas control valve on the engine side

Designation	Unit	Limit value	Note
Gas temperature at the gas inlet on the engine-side gas control valve	°C	5<t<45	Phase transitions in the fuel gas-air mixture during engine operation are not permissible. In the case of undershooting the dew point, the gas temperature must be increased. In case of deviating temperatures, there is a danger of thermal aging of NBR materials (gaskets, diaphragms) and impairment of the elasticity behavior.
Gas temperature fluctuation in relation to setting value	°C	±15	This applies to the gas inlet at the gas control valve on the engine side
Permissible change speed of gas temperature	K/min.	0.3	This applies to the gas inlet at the gas control valve on the engine side
Relative gas humidity in the gas in the permissible temperature and pressure range, however maximum	% g/kg	< 80 28	No water vapor condensation in the temperature and pressure range. No condensation admissible in lines and tanks carrying fuel gas and fuel gas-air mixtures. At higher values or if there is a danger of condensation in the operating range of pressure and temperature, gas drying must be provided.
Oil vapors (HC with carbon number >5)	mg/m^3_N	< 0.4	No condensation in lines carrying fuel gas and fuel gas-air mixture, nor formation of condensable oil mists.
HC solvent vapors	mg/m^3_N	0	
Organically fixed silicium (e.g. hydrosilicons, siloxanes, silicons)	mg/m^3_N	< 4*	With Si >5 mg/m^3_Nbased on 100% CH_4, gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Inorganically fixed silicium	mg/m^3_N	< 2*	With Si >5 mg/m^3_Nbased on 100% CH_4, gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Dust 3 - 10 µm	mg/m^3N	5	Dust must be removed such as to ensure trouble-free operation of gas devices and technical equipment which conform with standards or widely accepted engineering design.
Dust <3 µm	mg/m^3N	technically free	Dust <3 µm must be assessed by a technical analysis, corresponding special filters may need to be used.
Silicium of organic (e.g. silicons) and inorganic compounds (e.g. hydrosilicons, siloxanes)	mg/m^3N	6*	
Total sulfur	mg/m^3N	800*	
Mercaptan sulfur	mg/m^3N	4*	

Designation	Unit	Limit value	Note
Hydrogen sulphide H_2S	mg/m³N	850*	
Total of all chlorine and fluorine compounds	mg/m³N	≤ 40*	
Chlorine	mg/m³N	≤ 40*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine		≤ 20*	With higher values, consultation with manufacturer and analysis are necessary
NH_3	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

Table 59:

* = Lower limit values may apply to engines with exhaust aftertreatment and/or exhaust gas heat recovery systems .

The limit values are based on a calorific value of 10 kWh/m^3_N. This corresponds to a reference to fuels with 100% by vol. methane or, if there are other combustible elements in the fuel, an equal energy equivalent and thus an equal input of pollutants.

No warranty is given in respect of impairment and / or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was unknown and agreed upon on conclusion of contract.

7 NOx Reducing Agent AUS 32 for SCR Exhaust Gas Aftertreatment Systems

7.1 General information

SCR (Selective Catalytic Reduction) catalysts can be used for NO_x emission reduction. The reducing agent (urea solution with an urea concentration of 32.5%) in such catalysts reduces the nitrogen oxide emissions.

To ensure efficient operation of the exhaust gas aftertreatment system, compliance of the reducing agent with the quality requirements stipulated in DIN 70070 / ISO 222 41-1 is mandatory.

In Europe, this reducing agent is often offered under the brand name “AdBlue”.

The test methods to determine the quality and characteristics of the reducing agent are specified in the standards DIN 70071 / ISO 222 41-2. The following table (→ Table 60) shows the quality characteristics of the reducing agent together with the associated test methods (extract from ISO 222 41-1).

SCR systems from MTU are usually designed for a concentration of 32.5% urea. The use of NOx reducing agent with other urea concentrations (AUS 40, AUS 48) requires a different design of the dosing systems. Systems with the corresponding design must be run with the appropriately adapted concentration.
The purity requirements of the reducing agent then comply with the standards for AUS 32

The use of antifreeze additives for AUS 32, or winter urea, is generally not approved.

Quality features and test procedures for the reducing agent

	Unit	Test method ISO	Limit values
Urea content	by weight %	22241–2 Annex B	31.8 - 33.2
Spec. grav. at 20 °C	kg/m^3	3675 12185	1087.0 - 1092.0
Refractive index at 20 °C		22241–2 Annex C	1.3817 - 1.3840
Alkalinity as NH_3	by weight %	22241–2 Annex D	Max. 0.2
Biuret content	by weight %	22241–2 Annex E	Max. 0.3
Aldehyde content	mg/kg	22241–2 Annex F	Max. 5
Non-soluble constituents	mg/kg	22241–2 Annex G	Max. 20
Phosphate content as PO_4	mg/kg	22241–2 Annex B	Max. 0.5
Metal contents		22241–2 Annex I	
Calcium	mg/kg		Max. 0.5
Iron	mg/kg		Max. 0.5
Copper	mg/kg		Max. 0.2

	Unit	Test method ISO	Limit values
Zinc	mg/kg		Max. 0.2
Chrome	mg/kg		Max. 0.2
Nickel	mg/kg		Max. 0.2
Aluminum	mg/kg		Max. 0.5
Magnesium	mg/kg		Max. 0.5
Sodium	mg/kg		Max. 0.5
Potassium	mg/kg		Max. 0.5
Identity			Identical with the reference sample

Table 60:

Storage of reducing agent

For instructions on storage, packing, transport and suitable/unsuitable materials, refer to the standard ISO 222 41-3. The instructions of the manufacturer must be observed.

The reducing agent crystallizes at -11 °C.

Avoid direct sunlight because it promotes the occurrence of microorganisms and the decomposition of the reducing agent.

8 Approved Engine Oils and Lubricating Greases

8.1 Engine Oils for Four-Cycle Engines

8.1.1 Series-based usability of engine oils in MTU oil category 1

Series	Oil category 1	Oil category 1	Remarks
	Single-grade oils SAE30/40	Multigrade oils	
S60	no	no	
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes	yes	not for fast commercial vessels
956	no	no	all application
1163-01 Marine	yes	yes	not for fast commercial vessels
1163-02 Marine	no	no	not for fast commercial vessels
1163-02 TB32 emergency power, genset	no	no	
1163-03 Marine	yes	yes	
1163-04 Marine	no	no	
2000Mx2 / Mx3	yes	yes	
2000Mx4	no	no	
2000Cx6 / Gx6 / Gx7 / Mx6 / Sx6	no	no	
2000Cx0 / Cx1 /Cx2	yes	yes	
2000Gx5	yes	yes	
2000Mx0 / Mx1	yes	yes	
2000Px2	yes	yes	
2000Sx0 / Sx1 / Sx2	yes	yes	
4000-00	yes	yes	
4000-01	yes	yes	
4000-02	yes	yes	
4000-03G / S/ P / C / R	yes	yes	
4000-03Gx3F / Gx3G / Gx3H / R63x	no	no	
4000M23F - M63L	yes	yes	
4000M23S	yes	yes	

Series	Oil category 1	Oil category 1	Remarks
4000-03M53B / M73-M93L / N43 / N83	no	no	
4000-04C	no	no	
4000-04G	yes	yes	
4000-04M	no	no	
4000-04R	no	no	
4000-04T	no	no	
4000-05G / T / C	no	no	
8000	no	no	

Table 61:

yes = approval issued

no = no approval

8.1.2 Single-grade oils - Category 1, SAE grades 30 and 40 for diesel engines

Single-grade engine oils

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Aegean Oil SA	Vigor Super D	40	X			
Avia	Avia Special HDC	30, 40	X			
Castrol Ltd.	Castrol MLC	30, 40		X		
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30	X			Increased corrosion protection
Cyclon Hellas	Cyclon D Prime	30, 40	X			
Gulf Oil International	Gulf Superfleet	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Serie 3	30, 40		X		
	Repsol Marino 3	30		X		
	Repsol Marino 3 SAE 40	40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Rekord	30, 40		X		
Shell International Petroleum Company	Shell Gadinia	30, 40		X		
	Shell Rimula R3	30, 40	X			
	Shell Rimula R3+	30	X			
	Sirius	30	X			
	Shell Sirius Monograde	30, 40	X			
SK Lubricants	SD 5000	40	X			
Total	Fina Delta Super	30, 40		X		
	Total Caprano TD 30	30		X		
	Total Caprano TD 40	40		X		
	Total Rubia S	30, 40		X		
United Oil	XD 7000 Extra Duty-3U		X			
	XD 7000 Extra Duty-4U		X			

Table 62:

8.1.3 Multigrade oils - Category 1, SAE grades 10W-40 and 15W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

[1] = These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.

[2] = Engine oils marked [2] are also permitted for the "Series 60"

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Advanced Lubrication Specialties	Translub 15W40 CI-4	15W-40		X		
BP p.l.c.	BP Vanellus Multi	15W-40	X			
ENI S.p.A	eni i-Sigma universal DL	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac Super 1400E	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac XHP	15W-40	X			
Gulf Oil International	Gulf Superfleet	15W-40	X			
Lubrication Specialties Company	TOP 1 Oil Products Co. / Transport SAE 15W-40	15W-40		X		
Manufacture Zavod imeni Shaumyana	M5z/14D$_2$CE	15W-40			X	
OPET Petrolcülük	Omega Turbo Power SHPD	15W-40		X		[1] and oil change interval 500 operating hours
Petróleos de Portugal, Petrogal S.A.	Galp Galaxia Super 15W-40	15W-40	X			
Singapore Petroleum Company Limited	SPC SDM 801	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Total	Fina Kappa Turbo DI	15W-40	X			
	Total Caprano TD	15W-40	X			
Unil Opal	Intercooler 400	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

Table 63:

8.1.4 Series-based usability of engine oils in MTU oil category 2 and 2.1 (low SAPS)

Series	Oil category 2 Single-grade oils	Oil category 2 Multigrade oils	Oil category 2.1 (low SAPS) Multigrade oils	Remarks
S60	no	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	yes	
183	yes	yes	yes	
396	yes	yes	yes	
538	yes	yes	yes	
595 with carbon scraper ring	yes	yes	yes	
595 without carbon scraper ring	yes	yes	yes	
956	yes	yes	yes	
956-01 Marine, Rail	yes	yes	no	
956-02 Marine, Rail	yes	yes	no	
956TB31 Nuclear power station, emergency power	Mobil Delvac 1630 Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty	no	no	
956TB32 Nuclear power station, emergency power	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty	no	no	
956TB33 Nuclear power station, emergency power Ɛ = 9	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty	no	no	
956TB33 Nuclear power station, emergency power Ɛ = 12	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty Sirius X 30	Lukoil Avantgarde Ultra NP 15W40	no	
956TB34 Nuclear power station, emergency power	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty Sirius X 30	Lukoil Avantgarde Ultra NP 15W40	no	
1163-01 Marine	yes	yes	yes	
1163-02 Marine	yes	yes	yes	
1163-02 TB32 nuclear power station, emergency power	Sirius X 30	no	no	
1163-03 Marine	yes	yes	no	

Series	Oil category 2 Single-grade oils	Oil category 2 Multigrade oils	Oil category 2.1 (low SAPS) Multigrade oils	Remarks
1163-04 Marine	yes	yes	yes	
2000Mx3 / Mx4	yes	yes	yes	
2000 M72	yes[3)]	yes	yes	[3)] = except for Mobil Delvac 1630/1640 & Power Guard® SAE 40 Heavy Duty
2000Cx6 / Gx6 / Gx7 / Mx6 / Sx6	yes	yes	yes	
2000Cx0 / Cx1 / Cx2	yes	yes	yes	
2000Gx5	yes	yes	yes	
2000Mx0 / Mx1	yes	yes	yes	
2000Px2	yes	yes	yes	
2000Sx0 / Sx1 / Sx2	yes	yes	yes	
4000-00	yes	yes	yes	
4000-01	yes	yes	yes	
4000-02	yes	yes	yes	
4000-03G / S / P / C / R	yes	yes	yes	
4000-03Gx3F / Gx3G / Gx3H	yes	yes	yes	
4000M23F - M63L	yes	yes	yes	
4000M53 / M73-M93L / N43 / N83	yes	yes	yes	
4000-04C	no	no	only Fleet Supreme EC 15W-40	
4000-04G	yes	yes	yes	
4000-04M	yes	yes	yes	
4000-04R	no	no	no	
4000-04T	no	no	only Chevron Delo 400 LE 15W-40	
4000-05G	no	no	yes	
4000-05T / C	no	no	no	
8000	restricted [4)]	no	no	[4)]= only named engine oils Reapproval only after engine test in Series 8000

Table 64:

yes = approval issued

no = no approval

8.1.5 Single-grade oils - Category 2, SAE-grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU single-grade engine oils

	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Power Guard® DEO SAE 40	40	X			20 l container: X00062816 210 l container X00062817 IBC: X00064829
MTU America	Power Guard® SAE 40 Off-Highway Heavy Duty	40		X		5 gallons: 23532941 55 gallons: 23532942 Approved for Series 8000 (→ Table 65) available through MTU America Not approved for Series 2000 M72
MTU India Pvt Ltd.	Diesel Engine Oil DEO SAE 40	40		X		20 l container: 73333/P 205 l container: 75151/D Sale of Indian oil only intended in Indian market

Table 65:

Note:

For Series 8000 engines, the approved SAE-40 engine oils may only be used in combination with preheating and oil priming (T_{oil}> 30 °C).

Further single-grade engine oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol	Addinol Turbo Diesel MD 407	40	X			
Adnoc Distribution	ADNOC Voyager Plus 40 CF/SL	40	X			
Atak Madeni Yag Lubricants	Protector MX 30	30			X	
	Protector MX 40	40			X	
BayWa AG	Tectrol HD 30	30		X		
	Tectrol HD 40	40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Belgin Madeni Yaglar	Lubex Marine M	30		X		
	Lubex Marine M	40		X		
	Lubex Marine LTM-30	30		X		
	Lubex Marine LTM-40	40		X		
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500 h, Series 595, 1163
Cepsa Lubricants	Cepsa Petrel HDL 40	40			X	
Chevron Lubricants (Texaco)	Ursa Super TD	30, 40		X		
	Ursa Premium TDX	40		X		
	Delo 400	30, 40		X		
	Delo Gold	40		X		
Chevron – Lyteca – (Texaco)	Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
ENOC Marketing L.L.C.	ENOC Strata Super Duty	40		X		
Exxon Mobil Corporation	Mobil Delvac 1630	30		X		Not approved for Series 2000 M72
	Mobil Delvac 1640	40		X		Not approved for Series 2000 M72
Fuchs Europe Schmierstoffe GmbH	Titan Universal HD	30, 40	X			
	Titan Universal HD 30 MTU	30	X			Increased corrosion protection
Gulf Oil International	Gulf Superfleet Plus	40	X			
Gulf Western Oil, Australia	Turboil	40			X	
GS Caltex Corporation	Kixx D1 40	40	X			
Hyrax Oil Sdn Bhd	Hyrax Top Deo	40	X			
Koçak Petrol Ürünleri San. ve. TIC. Ltd.	Speedol Ultra HDX 30 TBN 12	30		X		
	Speedol Ultra HDX 40 TBN 12	40		X		
	Speedol Deniz Dizel Motor Yağî	30, 40		X		
	Speedol Ultra HDX	30, 40	X			
Kuwait Petroleum	Q8 T 750	30, 40	X			
Manufacture Zavod imeni Shaumyana Ltd.	M-14D2CE	40			X	
Motor Oil, Hellas	EMO SHPD Plus	30, 40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
OOO Lukoil International	Lukoil Avantgarde M 40	40	X			
Oryx Energies	Supreme RR	40			X	
Panolin AG	Panolin Extra Diesel	40	X			
Paz Lubricants & Chemicals	Pazl Marine S 40	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310-AP	30		X		
	Marbrax CCD-410-AP	40		X		
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia 40	40		X		
Prista Oil Holding EAD	Prista SHPD 40	40			X	
PTT Public Comp.	PTT Navita MTU Type 2	40		X		
	Navita Plus, SAE 40	40		X		
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Serie 3 MT	40			X	
Shell International Petroleum Company	Shell Sirius X	30			X	
	Shell Sirius X	40			X	
Singapore Petroleum Company Limited	SPC SDM 900, SAE30	30		X		
	SPC SDM 900, SAE40	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Increased corrosion protection
Statoil Lubricants	PowerWay 30	30		X		
	PowerWay 40	40		X		
Total	Total Caprano MT 30	30			X	
	Total Caprano MT 40	40			X	
	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
	Total Rubia MT 30	30			X	
	Total Rubia MT 40	40			X	
Viva Energy Australia	Penske Power Systems Premium	40			X	

Table 66:

8.1.6 Multigrade oils – Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

MTU multi-grade engine oils

Manufacturer	Brand name	SAE viscosity class	TBN 8 to 10 mgKOH/g	TBN 10 to 12 mgKOH/g	TBN >12 mgKOH/g	Remarks
MTU Friedrichshafen GmbH	Diesel Engine Oil DEO SAE 15W-40	15W-40		X		20 l container: X00070830 210 l container: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
MTU Asia	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l container: 64247/P 200 l container: 65151/D
MTU Asia China	Diesel Engine Oil - DEO SAE 15W-40	15W-40		X		20 l canister: X00064242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO SAE 10W-40	10W-40		X		20 l canister: 60606/P
MTU India Pvt. Ltd.	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l canister: 63333/P[2] 205 l barrel: 65151/D Sale only intended in Indian market

Table 67:

Further multi-grade engine oils

Manufacturer	Brand name	SAE viscosity class	TBN 8 to 10 mgKOH/g	TBN 10 to 12 mgKOH/g	TBN > 12 gKOH/g	Remarks
Adnoc Distribution	Adnoc Voyager Plus	15W-40		X		[2]
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			[2]
Addinol Lube Oil	Addinol Super Longlife MD1047	10W-40		X		[2]
	Addinol Diesel Longlife MD1548	15W-40		X		[2]

TIM-ID: 0000019001 - 004

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Anomina Petroli Italiana	IP Tarus	15W-40	X			
	IP Tarus Turbo	15W-40	X			
	IP Tarus Turbo Plus	15W-40	X			2)
Arabi Enertech KSC	Burgan Ultra Diesel CH-4	15W-40		X		2)
Aral AG	Aral Turboral	10W-40		X		
Atak Madeni Yag Lubricants	Alpet Turbot Fleetmax 1540	15W-40		X		2)
Auto-Teile-Ring GmbH	Cartechnic Motorenöl SAE 15W-40	15W-40	X			
Avista Oil Refining & Trading Deutschland GmbH	Pennasol Turbo Super	15W-40		X		2)
	MOTOR GOLD Turbotec	15W-40		X		2)
Bahrain Petroleum Company B.S.C.	Frontier Megatek	10W-40	X			
	Frontier Super Plus	15W-40		X		2)
	Frontier Turbo	15W-40		X		
	Frontier Turbo LD	10W-40		X		
BayWa AG	Tectrol Turbo 4000	10W-40		X		
Belgin Madeni Yaglar	Lubex Marine M	15W-40		X		
BP p.l.c.	BP Vanellus C6 Global Plus	10W-40		X		
	BP Vanellus Multi-Fleet	15W-40			X	2)
	BP Multi Mine	15W-40	X			2)
	BP Vanellus Longdrain	15W-40		X		2)
	BP Vanellus Multi A	10W-40		X		2)
	BP Vanellus Agri	10W-40		X		2)
	BP Vanellus Multi A	15W-40	X			2)
	BP Vanellus Agri	15W-40	X			2)
	BP Vanellus Max Extra	15W-40			X	2)
Bucher AG Langenthal	Motorex Universal	10W-40		X		
Castrol Ltd.	Castrol CRB Turbo 15W-40 CH-4/E7	15W-40	X			2)
	Castrol Rivermax RX+ 15W-40	15W-40	X			2)
	Castrol Vecton 15W-40 DH-1	15W-40			X	2)
	Castrol RX Diesel	15W-40	X			2)
	Castrol Vecton	10W-40		X		
Cepsa	Cepsa Euromax SHPD	15W-40		X		2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Chevron Lubricants (Caltex)	Delo SHP Multigrade	15W-40		X		
	Delo Gold Multigrade	15W-40	X			
	Delo Gold Ultra	15W-40		X		
	Delo 400 Multigrade	15W-40			X	
	Delo 400 Multigrade	15W-40			X	2)
	Delo Gold Multigrade	15W-40	X			
	Ursa Premium TDX Plus	15W-40		X		2)
	Ursa Super Plus	15W-40		X		2)
	Delo Gold Multigrade	15W-40	X			
	OEC SAE 15W-40	15W-40		X		
Chevron Lubricants (Texaco)	Ursa Super Plus	15W-40		X		2)
	Ursa Super TD	15W-40		X		2)
	Ursa Super TDS	10W-40		X		2)
	Ursa Premium TD	10W-40	X			
	Ursa Premium TD	15W-40		X		
	Ursa Premium TDX	15W-40		X		2)
	Ursa Premium TDX Plus	15W-40		X		2)
	Ursa Ultra MG	15W-40		X		2)
	Ursa Heavy Duty	15W-40	X			
	Ursa Premium TD 10W-40	10W-40		X		
	Ursa Premium TD	15W-40	X			2)
	Ursa Premium TDX	15W-40	X			
CPC Corporation, Taiwan	CPC Superfleet CG4 Motor Oil	15W-40	X			
Cubalub	Cubalub Extra Diesel MX	15W-40			X	2)
	Cubalub Extra Diesel	15W-40	X			
Cyclon Hellas	Cyclon D Super	15W-40	X			2)
Delek	Delkol Super Diesel	15W-40	X			
Delek Industries Ltd.	Super Diesel	15W-40		X		
EKO A.B.E.E.	Eko Forza plus	15W-40	X			
Engen Petroleum Ltd.	Engen Dieselube 600 Super	15W-40	X			2)
eni S.p.A.	Agip Blitum T	15W-40	X			
	eni i-Sigma super fleet	15W-40		X		
	eni i-Sigma performance E3	15W-40	X			
	eni i-Sigma performance E7	15W-40		X		2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
	Taurus Extreme HST	15W-40		X		2)
Exxon Mobil Corporation	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500 h
	Mobil Delvac Super 1400	15W-40	X			
	Mobil Delvac MX	15W-40		X		
	Mobil Delvac MX Extra	15W-40		X		
	Mobil Delvac Advanced City Logistics	15W-40	X			
Finke Mineralölwerk GmbH	AVIATICON Turbo Super Plus	15W-40	X			2)
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Truck Plus	15W-40		X		2)
	Titan Unimax Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Fuchs Titan Truck	15W-40	X			2)
	Titan Unimax Plus MC	10W-40		X		
	Fuchs Titan Universal HD	15W-40	X			
Fuchs Lubrifiants France	Cofran Plura Super	15W-40		X		2)
Gazpromneft Lubricants Ltd.	Belaz G-Profi Mining	15W-40		X		2)
	Belaz G-Profi Mining FF	15W-40		X		2)
	G-Profi MSI 10W-40	10W-40		X		
	G-Profi MSI 15W-40	15W-40		X		
	G-Profi MSH 15W-40	15W-40	X			
	G-Profi MSI Plus	15W-40		X		2)
	Gazpromneft Diesel Premium	15W-40	X			
German Mirror Lubricants and Greases Co. FZE	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 10W-40	10W-40		X		
	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 15W-40	15W-40	X			2)
	Mirr Turbo Diesel Engine Oil API CH-4 SAE 15W-40	15W-40	X			2)
Ginouves Georges SAS	York 849	15W-40		X		2)
GS Caltex India Private Limited	Kixx Dynamic Gold	15W-40		X		2)
GS Caltex Corporation	Kixx HD 1	10W-40		X		
	Kixx HD 1	15W-40		X		2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Gulf Oil International	Gulf Super Duty VLE	15W-40	X			
	Gulf Superfleet LE	10W-40		X		
	Gulf Superfleet LE	15W-40	X			2)
	Gulf Superfleet Supreme	10W-40		X		
	Gulf Superfleet Supreme	15W-40		X		2)
	Gulf Superfleet Plus	15W-40	X			
Gulf Western Oil, Australia	TOP DOG XDO	15W-40	X			2)
HAFA France	Stradex 1800	10W-40		X		
Hessol Lubrication GmbH	Hessol Turbo Diesel	15W-40		X		2)
High Industrial Lubricants & Liquids Corporation (HILL)	Fastroil Force F300 Diesel	15W-40		X		2)
	Fastroil Force F500 Diesel	15W-40		X		2)
	Fastroil Force F700 Diesel Pro	10W-40		X		
Hitachi Construction Machinery CO., Ltd.	Hitachi Premium Orange	15-W40	X			
Huiles Berliet S.A.	RTO Maxima RD	15W-40	X			2)
	RTO Maxima RLD	15W-40		X		2)
Hyrax Oil Sdn Bhd	Hyrax Admiral 15W-40	15W-40	X			2)
INA Maziva Ltd.	INA Super Max	15W-40		X		2)
Indian Oil Corporation	Servo Premium (N)	15W-40		X		
Ipiranga Produtos des Petróleo S.A.	Ipiranga Brutus Alta Performance	15W-40		X		2)
Kuwait National Lube Oil MfgCo (KNLOC)	Burgan Ultra Diesel CH-4	15W-40		X		2)
Kuwait Petroleum	Q8 T 750	15W-40	X			2)
	Q8 T 800	10W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tirot 15W-40	15W-40		X		
Liqui Moly	Liqui Moly Marine 4T Motor Oil	15W-40		X		2)
	Liqui Moly Touring High Tech SHPD	15W-40	X			
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
Lubricantes de América	Generac Aceite	15W-40		X		
	Lubral Nano Diesel	15W-40		X		
Lubrisa	Gulf Superfleet Supreme	15W-40		X		2)
Lukoil Lubricants Europe Oy	Teboil Power Plus	15W-40	X			
	Tepoil Super HPD	15W-40		X		
Mega Lube Marketers cc.	Megalube Diesel Engine Oil	15W-40		X		
Meguin GmbH	megol Motorenoel SHPD	15W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
MOL-LUB Kft..	MOLDynamic MK9	15W-40		X		
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
	Mol Dynamic Transit	10W-40		X		2)
	MOL Super Diesel	15W-40	X			
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
NSL OilChem Trading Pte Ltd	Liquid Gold D-Flo X4	15W-40		X		2)
Orlen Oil	Mogul Diesel DTT Extra	15W-40			X	2)
	Platinum Ultor	15W-40	X			2)
	Platinum Ultor Plus	15W-40			X	2)
OOO “LLK-International”	BELAZ CI-4	15W-40	X			
	Lukoil Avantgarde Extra	15W-40	X			
	Lukoil Avantgarde Ultra	15W-40		X		
	Lukoil Avantgarde NP	15W-40		X		
	Lukoil Avantgarde Ultra Plus	10W-40		X		
Oryx Energies	Enduro 600	15W-40		X		
Panolin AG	Panolin Universal SFE	10W-40		X		
	Panolin Diesel Synth	10W-40		X		
PDVSA CA	PDV Ultradiesel	15W-40		X		2)
Pertamina	Meditran SX Plus	15W-40		X		2)
Petrobras Colombia Combustibles	Petrobras Top Turbo T2	15W-40	X			
Petrobras Distribuidora S.A.	Lubrax Nautica Diesel	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL	15W-40		X		2)
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia LD star	15W-40		X		
Petron Corporation	Petron Rev-x Premium Multi Grade	15W-40		X		2)
Petronas Lubricants International	Petronas Urania LD7	15W-40		X		
	Petronas Urania LD 7	10W-40	X			
	Petronas Urania Supremo CI-4	10W-40	X			2)
	Petronas Urania Supremo CI-4	15W-40	X			2)
Petromin Corporation	Petromin Turbomaster XD	15W-40		X		2)
Phillips 66 Lubricants	Conoco Hydroclear Power D	15W-40			X	
Prista Oil AD	Prista Turbo Diesel	15W-40	X			
PTT Public Limited	Navita Plus SAE 15W-40	15W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			
Raloy Lubricantes, S.S. de C.V.	Raloy Diesel Power	15W-40		X		2)
Raj Petro Specialities P Ltd.	Zoomol Rforce 3100 RF 1	15W-40	X			2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Mineralöl Turbo Plus SHPD	15W-40	X			2)
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Super Turbo SHPD	15W-40	X			2)
	Repsol Neptuno S-Turbomar	15W-40	X			
RN-Lubricants	Rosneft Revolux D5	15W-40		X		
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40		X		2)
S.A.E.L.	Gulf Gulfleet Long Road	15W-40	X			
Shell International Petroleum Company	Shell Rimula MV	15W-40	X			
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		2)
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula R4 X	15W-40		X		2)
	Shell Rimula RT4	15W-40		X		2)
	Shell Rimula RT4 X	15W-40		X		2)
	Shell Rimula T4	15W-40		X		2)
	Shell Rimula X	15W-40		X		
	Shell Rotella T2	15W-40		X		
	Shell Rotella T Multigrade	15W-40		X		2)
	Shell Sirius	15W-40		X		2)
	Eicher Premium Plus Diesel Engine Oil	15W-40		X		2)
Shanghai HIRI Lubricants R & D Centre	HIRI	15W-40	X			
Singapore Petroleum Company Limited	SDM 900 SAE 15W40	15W-40		X		
Sinopec Lubricant Co., Ltd.	Sinopec Tulux T500	15W-40		X		2)
SK Lubricants Co. Ltd.	ZIC X5000 10W-40	10W-40		X		
	ZIC X5000	15W-40	X			2)
	ZIC X7000 CI-4 10W-40	10W-40		X		
	ZIC X7000 CI-4	15W-40	X			2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Motorenöl O-236	15W-40	X			[2] enhanced corrosion protection
	SRS Multi-Rekord top	15W-40		X		[2]
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X			[2]
	SRS Cargolub TFX	10W-40		X		
Statoil Fuel & Retail Lubricants Sweden AB	MaxWay	10W-30		X		
	MaxWay	10W-40		X		
	MaxWay	15W-40		X		[2]
Tesla Technoproducts FZE	Denebola Saheli Ultra XS 1120	15W-40		X		[2]
Total Lubrifiants	Antar Milantar PH	15W-40	X			[2]
	Antar Milantar PX	15W-40	X			[2]
	Fina Kappa Optima	15W-40		X		[2]
	Fina Kappa Extra Plus	15W-40	X			[2]
	Total Caprano Energy FE	15W-30		X		
	Total Caprano TDH	15W-40		X		[2]
	Total Caprano TDI	15W-40		X		[2]
	Total Disola SGS	15W-30		X		
	Total Disola W	15W-40		X		
	Total Genlub TDX	15W-40	X			
	Total Rubia Works 1000	15W-40		X		[2]
	Hitachi Genuine Engine Oil 15W40 DH-1	15W-40		X		[2]
Unil Opal	Medos 700	15W-40	X			[2]
Valvoline EMEA	All-Fleet Extra SAE 15W-40	15W-40	X			[2]
	All-Fleet Plus	15W-40	X			[2]
	NextGen All-Fleet extra	15W-40		X		[2]
	Premium Blue Classic	15W-40		X		[2]
	Premium Blue 7800	15W-40		X		[2]
Viscolube	Revivoil - Re Refined High-Tech HD Motoroil	15W-40	X			[2]
Viva Energy Australia	Penske Power Systems Premium	15W-40	X			[2]
Wunsch Öle GmbH	Wunsch Rekord TLM-TU 10W-40	10W-40		X		

Table 68:

TIM-ID: 0000019001 - 004

8.1.7 Multigrade oils - Category 2.1 (low SAPS oils)

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

MTU multi-grade oils category 2.1

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU America	Power Guard® SAE 15W-40 Off-Highway Heavy Duty	15W-40	X			5 gallons: 800133 55 gallons: 800134 IBC: 800135 available through MTU America [2]

Table 69:

Further multigrade oils category 2.1

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Bucher AG Langenthal	Motorex Focus CF	15W-40	X			[2]
BP p.l.c.	BP Vanellus Eco	15W-40	X			[2]
Castrol Ltd.	Castrol CRB Mining 15W-40	15W-40	X			[2]
	Castrol CRB Turbo G4 15W-40	15W-40	X			[2]
	Castrol Hypuron	10W-30		X		
Chevron Lubricants (Caltex)	Delo 400 LE	15W-40	X			[2]
Chevron Lubricants (Chevron)	Delo 400 LE	15W-40	X			[2] also approved for Series 4000-04 T
	Delo 400 MGX	15W-40	X			[2]
	Delo 400 XLE Synblend	10W-30	X			
Chevron Lubricants (Texaco)	Ursa Ultra LE	15W-40	X			[2]
ExxonMobil Corporation	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Delvac 1300 Super F2	15W-40	X			
	Mobil Fleet	15W-40	X			[2]
eni S.P.A.	eni i-Sigma top MS	15W-40	X			[2]

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			2)
Fuchs Petrolub SE	Fuchs Titan Cargo	15W-40	X			2)
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			2)
	Gulf Supreme Duty XLE	10W-30	X			
Kuwait Petroleum	Q8 T 760	10W-30	X			
Lotos Oil	Turdus Powertec 1100	15W-40	X			2)
Morris Lubricants	Versimax HD6	15W-40	X			2)
OOO "LLK-International"	Lukoil Avantgarde Professional LA	10W-30	X			
	Lukoil Avantgarde Professional LA	10W-40	X			
	Lukoil Avantgarde Professional LA	15W-40	X			2)
Panolin AG	Panolin Universal LA-X	15W-40	X			2)
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		2)
Petro-Canada	Duron -E	15W-40	X			2)
Phillips 66 Lubricants	Fleet Supreme EC	15W-40	X			2) also approved for Series 4000-04 C
	Guardol ECT	15W-40	X			2)
	Kenndall Super-D XA	15W-40	X			2)
Prolube Lubricants	Prolube Ultraplus	15W-40	X			2)
Repsol Lubricantes Y Especialidades, S.A.	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			2)
Shell International Petroleum Company	Shell Rimula Super	15W-40		X		2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T5	10W-30	X			
	Shell Rotella T5	10W-40	X			
	Shell Rotella T6	5W-40		X		
	Shell Rimula R5 LE	10W-30	X			
	Shell Rimula R5 LE	10W-40	X			
	Shell Rotella T Triple Protection	15W-40		X		
	Shell Rimula R4 MV	15W-40	X			2)
	Shell Rimula R4 L	15W-40	X			2)
SK energy	ZIC XQ 5000	15W-40	X			2)
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			2)
	SRS Turbo Rekord plus FE	10W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Statoil Lubricants	MaxWay E9 15W-40	15W-40	X			2)
Total Lubrifiants	Total Rubia TIR 7900	15W-40	X			
	Total Rubia Works 2000	10W-40	X			
	Total Max Star FE	10W-30	X			
	Hitachi Genuine Engine Oil 10W-40 DH-2	10W-40	X			
	Total Rubia Works 2000 FE 10W-30	10W-30	X			
Trinidad & Tobago National Petroleum Marketing Company Ltd. (NPMC)	Ultra Duty 15W-40 Engine Oil	15W-40	X			2)
Valvoline EMEA	Valvoline All Fleet Extra LE SAE 15W-40	15W-40	X			2)
	All-Fleet Extra LE NTI	15W-40	X			2)
	Premium Blue 8100 15!-40	15W-40	X			2)
Valvoline USA	All Fleet Plus	15W-40	X			2)
Verco International	April Superpro RXL 1 Gold Plus	15W-40	X			2)

Table 70:

8.1.8 Series-based usability of engine oils in MTU oil category 3 and 3.1 (low SAPS)

Series	Oil category 3	Oil category 3.1 (low SAPS)	Remarks
	Multigrade oils	Multigrade oils	
S60	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes	yes	
956	yes	yes	
956TB31/ 32 Nuclear power station, emergency power	Shell Rimula R6MS 10W-40	no	
956TB33 Nuclear power station, emergency power (Ɛ=12)	Shell Rimula R6MS 10W-40		
956TB34 Nuclear power station, emergency power	Shell Rimula R6MS 10W-40		
1163-01 Marine	yes	yes	
1163-02 Marine	yes	yes	
1163-02TB32/ Nuclear power station, emergency power	no	no	
1163-03 Marine	yes	yes	
1163-04 Marine	yes	yes	
2000 Mx2 / Mx3 / Mx4	yes	yes	
2000Cx6 / Gx6 / Gx7 / Mx6 / Sx6	yes	yes	
2000Cx0 / Cx1 / Cx2	yes	yes	
2000Gx5	yes	yes	
2000Mx0 / Mx1	yes	yes	
2000Px2	yes	yes	
2000Sx0 / Sx1 / Sx2	yes	yes	
4000-00	yes	yes	
4000-01	yes	yes	
4000-02	yes	yes	
4000-03G / S / P / C / R	yes	yes	

Series	Oil category 3	Oil category 3.1 (low SAPS)	Remarks
4000-03Gx3F / Gx3G / Gx3H	ka	yes	
4000M23F - M63L	yes	yes	
4000-03M53B / M73-M93L / N43S / N83	yes	yes	
4000-04 /- 05C	yes	yes	only 5W-40, 10W-40
4000-04G	yes	yes	
4000-04M	yes	yes	
4000-04R	no	yes	only 5W-40, 10W-40
4000-04 / -05T	yes	yes	only 5W-40, 10W-40
4000-05G	no	yes	
8000	restricted [3)]	restricted [3)]	[3)]= only named engine oils

Table 71:

yes = approval issued

no = no approval

8.1.9 Multigrade oils – Category 3, SAE grades 5W-30, 5W-40, and 10W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU multigrade oils category 3

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
MTU Asia China	Diesel Engine Oil - DEO 5W-30	5W-30			X	20 l canister: 60808/P available through MTU Suzhou

Table 72:

Further multigrade oils category 3

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Ultra Truck MD 0538	5W-30			X	
	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Mega Turboral	10W-40			X	
	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-E	10W-40			X	
	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530	5W-30			X	
	Tectrol Super Truck 1040	10W-40		X		
BP p.l.c.	BP Energol IC-MT 10W-40	10W-40			X	
	BP Vanellus Max	5W-30			X	
Castrol Ltd.	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion HD	5W-30			X	
	Castrol Vectron Long Drain	10W-40			X	
	Castrol Vectron Long Drain E7 10W-40	10W-40			X	
	Castrol Vectron 5W-30 Arctic	5W-30			X	
	Castrol Vectron Fuel Saver 5W-30	5W-30			X	
	Castrol Vectron Fuel Saver E7	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		
Chevron Lubricants (Caltex)	Delo XLD Multigrade	10W-40			X	
	Delo XLD Multigrade	10W-40			X	
Chevron Lubricants (Texaco)	Ursa HD	10W-40			X	
	Ursa Premium FE	5W-30			X	
	Ursa Super	10W-40		X		
	Ursa Super TDX	10W-40			X	
	Ursa TDX	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO HC PT Diesel	10W-40			X	
eni S.P.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40			X	
	eni i-Sigma top	10W-40			X	
Enoc	Enoc Vulcan 770 SLD	10W-40		X		
Exxon Mobil Corporation	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac XHP Ultra 5W-30	5W-30			X	
	Mobil Delvac 1 SHC 5W-40	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Fabrika Maziva, FAM AD	Fenix Ultra Sint	10W-40			X	
Finke Mineralölwerk GmbH	AVIATICON Finko Truck LD	10W-40			X	
Fuchs Europe Schmierstoffe GmbH	Titan Cargo SL	5W-30			X	
	Titan Cargo MC	10W-40			X	
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	
	Gulf Superfleet ELD	10W-40			X	
	Gulf Superfleet XLD	10W-40			X	
	Gulf Superfleet Synth ELD	10W-40			X	
High Industrial Lubricants & Liquids Corporation	Fastroil Force Ultra High Performance Diesel (UHPD)	10W-40			X	
Huiles Berliet S.A.	RTO Extensia RXD ECO	5W-30			X	
Iranol Oil Co.	Iranol D40000-EIII	10W-40			X	
Kuwait Petroleum	Q8 T 860	10W-40		X		
	Q8 T 860 D	10W-40			X	
	Q8 T 860 S	10W-40			X	
	Q8 T 905	10W-40	X			
Lotos Oil	Turdus Powertec 3000	10W-40			X	
	Turdus Powertec Synthetic	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Lukoil Lubricants Europe Oy	Teboil Super XLD-2	5W-30			X	
Meguin	Megol Motorenöl Super LL Dimo Premium	10W-40			X	
MOL-LUB Kft	MOL Synt Diesel	10W-40		X		
	MOL Dynamic Synt Diesel E4	10W-40			X	
Orlen Oil Sp.o.o.	Platinum Ultor Max	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional	5W-30			X	
	Lukoil Avantgarde Professional M5	10W-40			X	
	Lukoil Avantgarde Professional M6	10W-40			X	
	Lukoil Avantgarde Ultra M3	15W-40			X	
Panolin	Panolin Diesel HTE	10W-40			X	
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia Extreme	5W-30		X		
	Galp Galaxia Ultra XHP	10W-40			X	
Petromin Corporation	Petromin Turbo Master LD	10W-40			X	
Petronas Lubricants International	Petronas Akros Synt Gold	10W-40			X	
	Arexons HD-Truck E7	10W-40			X	
	Urania Maximo	10W-40			X	
	Petronas Urania Optimo	10W-40			X	
	Urania 100 K	10W-40			X	
	Urania FE	5W-30			X	
	Petronas Urania Maximo	5W-30			X	
PHI OIL GmbH	Motordor Silver 10W40	10W-40			X	
Raj Petro Specialities P Ltd.	Zoomol Rforce 8200 RF1	10W-40			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Super Performance Truck	5W-30			X	
	RAVENOL Performance Truck	10W-40			X	
Repsol Lubricantes y Especialidades S.A.	Repsol Turbo UHPD	10W-40			X	
	Repsol Diesel Turbo VHPD	5W-30			X	
	Repsol Diesel Turbo UHPD Urban	10W-40			X	
RN-Lubricants, LLC	Rosneft Revolux D4	10W-40			X	
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40			X	
SCT Vertriebs GmbH	Fanfaro TRD E4 UHPD	10W-40		X		
	Mannol TS-6 UHPD Eco	10W-40		X		
	Pemco Diesel G-6 Eco UHPD	10W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
	Shell Rimula R6 MS	10W-40			X	
SK Lubricants Co.	ZIC X7000	5W-30			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF	10W-40			X	
	SRS Cargolub TFL	5W-30			X	
	SRS Cargolub TFG	10W-40			X	
	SRS Cargolub TFG plus	10W-40			X	
Statoil Lubricants	MaxWay Ultra 5W-30	5W-30			X	
	MaxWay Ultra E4 10W-40	10W-40			X	
Tedex SA	Tedex Diesel Truck UHPD (S) Motor Oil	10W-40			X	
Total	Antar Maxolia	10W-40		X		
	Fina Kappa Syn FE	5W-30			X	
	Gulf Gulfleet Highway 10W-40	10W-40			X	
	Total Rubia TIR 8600	10W-40			X	
	Total Rubia TIR 9200 FE	5W-30			X	
Transnational Blenders B. V.	Engine Oil Super EHPD	10W-40			X	
Unil Opal	Unil Opal LCM 800	10W-40			X	
Valvoline EMEA	All Fleet Superior	10W-40			X	
	Profleet	10W-40			X	
	Valvoline All-Fleet Extreme NTI	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Vitaltech 10W40 Ultra	10W-40			X	
	Champion New Energy 10W40 Ultra	10W-40			X	
Yacco SAS	Yacco Transpro 45	10W-40			X	

Table 73:

8.1.10 Multigrade oils - Category 3.1 (low SAPS oils)

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40	X			
	Aral Super Turboral LA	5W-30	X			
BayWa AG	Tectrol Super Truck Plus XL 1040	10W-40	X			
Bucher AG Langenthal	Motorex Focus QTM	10W-40	X			
	Motorex Nexus FE SAE 5W-30	5W-30	X			
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40			X	
	BP Vanellus Max Eco 10W-40	10W-40			X	
BVG Vertriebsgesellschaft AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Castrol Ltd.	Castrol Vecton Long Drain 10W-30 E6/E9	10W-30	X			
	Castrol Vecton Long Drain 10W-40 E6/E9	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			
Cepsa Comercial Petroleo, SA	Cepsa Eurotech LS 10W40 Plus	10W-40			X	
Chevron Lubricants (Caltex)	Delo XLE Multigrade	10W-40	X			
	Delo 400 XLE Synthetic	5W-30	X			
Chevron Lubricants (Chevron)	Delo 400 LE Synthetic	5W-30	X			
Chevron Lubricants (Texaco)	Ursa Premium TDX (E4)	10W-40			X	
	Ursa Ultra	10W-40	X			
	Ursa Ultra X	10W-30		X		
	Ursa Ultra X	10W-40	X			
	Ursa Ultra XLE	5W-30			X	
CONDAT Lubrifiants	Vicam Planet 10W40	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO Universal UHPD	10W-40				
De Oliebron B.V.	Tor Turbosynth LSP Plus 10W40	10W-40			X	
eni S.p.a.	eni i-Sigma top MS	10W-40	X			
Enoc International Sales L.L.C.	Vulkan green	10W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Exxon Mobil Corporation	Mobil Delvac 1 LE	5W-30	X			
	Mobil Delvac HD	10W-40		X		
	Mobil Delvac XHP LE	10W-40			X	55 gallons: 800141
	Mobil Delvac XHP Ultra LE	5W-30		X		
Finke Mineralölwerk GmbH	AVIATICON Finko Super Truck LA Plus	10W-40		X		
Fuchs Petrolub SE	Titan Cargo Maxx	5W-30			X	
	Titan Cargo Maxx	10W-40			X	
	Fuchs Titan Cargo EU6	5W-30	X			
Fuchs Schmierstoffe GmbH	Fuchs Titan Cargo LA	5W-30	X			
Gulf Oil International	Gulf Superfleet Synth ULE	5W-30	X			
	Gulf Superfleet XLE	10W-40	X			
	Gulf Superfleet Synth XLE	10W-30		X		
	Gulf Superfleet Synth XLE	10W-40		X		
Helios Lubeoil	Helios Premium KMXX 10W-40	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	PRO 200 X	10W-40	X			
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
INA Rfinerija nafte Rjeka	INA Super 9000	10W-40			X	
Kuwait Petroleum R&T	Q8 905	10W-40	X			
	Q8 T 904	10W-40		X		
	Q8 T 904 FE	10W-30	X			
	Q8 T 905	10W-40	X			
	Q8 T 910	5W-30	X			
	Q8 Formula Truck 8500 FE	10W-30	X			
	Q8 Formula Truck 8700 FE	5W-30	X			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Morris Lubricants	Ring Free Ultra	10W-40		X		
	Fendt Power Grade 10W-40	10W-40		X		
Oel-Brack AG	Midland maxtra	10W-40		X		
OMV Petrol Ofisi A.Ş	Maximus HD-E	5W-30	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
OOO LLK International	Lukoil Avantgarde CNG	10W-40	X			
	Lukoil Avantgarde Professional LE	5W-30			X	
	Lukoil Avantgarde Professional LS	5W-30	X			
	Lukoil Avantgarde Professional LS	10W-40			X	
	Lukoil Avantgarde Professional LS5	5W-30	X			
	Lukoil Avantgarde Professional LS5	10W-40	X			
Orlen Oil	Platinum Ultor Progress	10W-40		X		
	Mogul Diesel L-SAPS	10W-40		X		
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
	Panolin Ecomot	5W-30		X		
Petro-Canada Lubricants Inc.	Duron UHP 5W30	5W-30	X			
	Duron UHP E6 10W40	10W-40	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Petronas Lubricants International	Petronas Urania FE LS	5W-30			X	
	Petronas Urania Ecotech	10W-40			X	
PHI OIL GmbH	Motodor LSP Gold 5W30	5W-30			X	
Prista Oil Ad	Prista UHPD	10W-40	X			
Ravensberger Schmierölvertrieb GmbH	Ravenol Euro VI Truck	10W-40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
	Repsol DieselTurbo VHPD Mid Saps	5W-30		X		
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		
Shell International Petroleum Company	Shell Rimula R6 LM	10W-40	X			Increased corrosion protection
	Shell Rimula R6 LME	5W-30		X		
	Shell Rimula Ultra	5W-30			X	
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLS	5W-30			X	
	SRS Cargolub TLS plus	5W-30		X		
	SRS Turbo Diesel LA	10W-40	X			
	SRS Cargolub low-friction engine oil LA	10W-40		X		
	SRS Antikorrol MLA	10W-40		X		Increased corrosion protection
Statoil Lubricants	MaxWay Ultra E6 10W-40	10W-40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Total	Total Rubia TIR 8900	10W-40	X			
	Total Rubia Works 2500	10W-40	X			
Transnational Blenders B. V.	Engine Oil Synthetic UHPD E6	10W-30		X		
	Engine Oil Synthetic UHPD E6	10W-40		X		
	Motor oil SCR	10W-40	X			
Valvoline EMEA	Valvoline ProFleet LS	5W-30			X	
	Valvoline ProFleet LS	10W-40	X			
	ProFleet LS NTI	10W-40	X			
Wibo Schmierstoffe GmbH	Wibokraft Ultra AF 10W40	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 Ultra MS	10W-40		X		
	Champion OEM Specifica 10W40 Ultra MS	10W-40		X		
Yacco SAS	Yacco Transpo 65	10W-40			X	

Table 74:

8.2 Engine Oils for Gas Engines

8.2.1 Series-based usability of engine oils in SAE grade 40

For details and special features, see chapter on “Lubricants” (→ Page 7)

MTU engine oils for gas engines

Manufacturer	Brand name	SAE viscosity class	Approve model types				Comments / material number
			4000L61 / L62 / L63	4000L32FB / L62FB	4000L32 / L33	4000L64	
MTU Friedrichshafen GmbH	GEO BG "Power B2L"	40		yes			20 l container: X00072870 205 l container: X00072871 IBC: X00072872
	GEO NG "Power X2L"	40	yes				20 l barrel: X00072874 205 l container: X00072875 IBC: X00072876
	GEO NG "Power X3L"	40	yes		yes	yes	20 l container: X00072877 205 l container: X00072878 IBC: X00072879

Table 75:

Further engine oils for gas engines

Manufacturer	Brand name	SAE viscosity class	Model type approval			
			4000L61 / L62 / L63	4000L32FB / L62 FB	4000L32 / L33	4000L64
Addinol	MG 40 Extra LA	40		yes		
	MG 40 Extra Plus	40		yes		
BayWa AG	Tectrol MethaFlexx HC Premium	40		yes		
Castrol Ltd.	Castrol Duratec L	40	yes		yes[1)]	

Manufacturer	Brand name	SAE viscosity class	Model type approval			
			4000L61 / L62 / L63	4000L32FB / L62 FB	4000L32 / L33	4000L64
Chevron (Texaco)	Geotex LA 40	40	yes		yes[1)]	
	HDAX 7200	40	yes		yes	yes
Exxon Mobil Corporation	Mobil Pegasus 705	40	yes		yes[1)]	
	Mobil Pegasus 805 55 gallons: 23538056	40	yes		yes[1)]	
	Mobil Pegasus 1005	40	yes			yes
Fuchs Europe Schmierstoffe GmbH	Titan Ganymet Ultra	40		yes		
	Titan Ganymet LA	40	yes			
NILS S.p.A.	NILS Burian	40		yes		
Shell International Petroleum Company	Shell Mysella S3 N 40	40	yes		yes[1)]	
	Shell Mysella S5 N 40	40	yes		yes	yes
SRS Schmierstoff Vertrieb GmbH	SRS Mihagrun LA 40	40	yes		yes[1)]	
Total	Nateria MH 40	40	yes		yes[1)]	
	Nateria MJ 40	40		yes		
	Nateria MP 40	40	yes	yes	yes	yes
Pedro-Canada	Sentron CG 40	40		yes		
	Sentron LD 5000	40	yes			
	Sentron LD 8000	40	yes		yes	yes

Table 76:

[1)] = The use of these engine oils shortens the service life!

8.3 Engine Oils for Two-Cycle Engines

8.3.1 Series-based usability for two-cycle engine oils

Series	Two-cycle engine oil API CF-2			Comments
	Single-grade oils SAE 40	Single-grade oils SAE 50	Multigrade oils 15W-40	
S 53	yes	restricted[1]	restricted[1]	[1]only short term at low temperatures [2]at coolant outlet temp. > 94 °C
S 71	yes	restricted[1]	restricted[2]	
S 92	yes	restricted[1]	restricted[2]	
S 149	yes[2]	yes	no	

Table 77:

8.3.2 Engine oils for two-cycle engines

If the engine oils listed here are not available, two-cycle engine oils may be used, provided they comply with the requirements listed in the table (Engine oil requirements for two-cycle engines, (→ Page 20)).

MTU two-cycle engine oil

Manufacturer & sales region	Product name	SAE grade & oil category	Comments / material number
MTU America America	Power Guard® Heavy-duty Diesel Engine Oil for Detroit Diesel 2-Cycle (4X1G) SAE 40	40, API CF-2	4X1 gallons: 23512701
	Power Guard® Heavy-duty Diesel Engine Oil for Detroit Diesel 2-Cycle SAE 40	40, API CF-2	5 gallons: 23512734 55 gallons: 23512702 IBC: 23512739

Table 78:

Further two-cycle engine oils

Manufacturer	Product name	SAE grade & oil category	Comments / material number
Bucher AG Langenthal	Motorex Extra SAE 40	40	
Chevron	Ursa Extra Duty SAE 40	40	
	Ursa Extra Duty SAE 50	50	
ExxonMobil	Exxon XD-3 Monogrades SAE 40	40	
	Mobile Delvac 1240	40	
	Mobile Delvac 1250	50	
Lukoil Marine Lubricants	Lukoil Navigo DD40	40	
	Lukoil Navigo DD40 Ultra	40	
Panolin	Extra Diesel DD SAE 40	40	
Shell International Petroleum Company	Shell Rotella DD+40	40	

Table 79:

8.4 Lubricating Greases

8.4.1 Lubricating greases for general applications

For details and special features, see chapter "Lubricating greases"(→ Page 17)

Manufacturer	Brand name	Remarks
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell Deutschland GmbH	Shell Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 80:

9 Approved Coolants

9.1 Series- and application-based usability of coolant additives

All details are based on the coolant circuit on the engine side, no allowance is made for external add-on components.

For details and special features, see "General" (→ Page 23) and "Unsuitable materials in the coolant circuit" (→ Page 25) in the chapter "Coolants".

In the case of an engine coolant circuit with no light metal elements but with add-on components containing light metal (e.g. external cooling system), the coolant approvals for cooling systems containing light metal shall apply. If you have any doubts about a coolant application, consult your contact person at MTU.

Any deviating special agreements between the customer and MTU-Friedrichshafen shall remain valid.

MTU four-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
099	Marine	yes	–	X	–	X[1)]	–	–	–	[1)] not permitted at seawater temperature > 20 °C !
183	Marine	yes	–	X	–	X[2)]	–	–	–	[2)] not permitted at seawater temperature > 20 °C !
183	Rail		–	X	–	X	–	–	–	
396	Marine	yes	–	X	–	X3[)]	–	–	–	[3)] not permitted at seawater temperature > 20 °C !
396TB	Marine	yes	–	X	–	X	–	–	–	
	Genset	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	

TIM-ID: 0000034439 - 003

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
396TC	Marine	yes	–	X	–	X[4)]	–	–	–	[4)] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	–	–	
	C&I	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	
396TE	Marine	yes	–	X	–	X[5)]	–	–	–	[5)] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	–	–	
	C&I	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	
538	Marine	yes	X	–	–	–	–	–	–	
595	Marine	yes	X	–	–	–	–	–	–	
956-01/ 956-02	Marine	yes	X	X	–	–	–	–	–	Heat retention system
	Genset	yes	X	X	–	X	–	–	–	
20V 956TB33	Genset[6)]	yes	X	–	–	–	–	–	–	[6)] up to year of manufacture end of 2008, in acc. with identification plate
	Genset[7)]	yes	X	X	–	X	–	–	–	[7)] from year of manufacture 2009, in acc. with identification plate
12V/16V 956TB33	Genset	yes	X	X	–	X	–	–	–	
956TB34	Genset	yes	X	X	–	X	–	–	–	
1163-02	Marine	yes	X	X	–	–	–	–	–	
	Genset	yes	X	X	–	X	–	–	–	

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
1163-03	Marine	yes	X	X[8)]	–	–	–	–	–	When recommissioning / returning to operation, only water-soluble corrosion inhibitor is permitted with approval as per chap. 9.3 [8)]for products, see information in chap. 9.3
1163-04	Marine	yes	X	X[8)]	–	–	–	–	–	When recommissioning / returning to operation, only water-soluble corrosion inhibitor is permitted with approval as per chap. 9.3 [8)]for products, see information in chap. 9.3

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
2000 (incl. model type 06)	Marine	yes	–	X	–	X[9)]	–	X[9)]	–	[9)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine
	Genset	yes	–	X	–	X	–	X	–	
	C&I	no	–	–	X	–	X	X	X	
	Oil&Gas (S-engines)	no	–	–	X	–	X	X	–	
	Oil&Gas (P-engines)	yes	–	X	–	X	–	X	–	
2000-07	Genset	yes	–	X	–	X	–	X	–	
4000-00/ 4000-01	Marine	yes	–	X	–	X[10)]	–	–	–	[10)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine
4000-01/ 4000-02/ 4000-03/ 4000-04/ 4000-05	Genset	no	–	–	X	–	X	–	X	
4000-01/ 4000-02/ 4000-03	C&I	no	–	–	X	–	X	–	X	

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000-01/ 4000-02/ 4000-03	Rail	no	–	–	X	–	X	–	X	In the case of engines with no light metal components but with an external cooling system containing light metal, the coolant approvals for cooling systems containing light metal shall apply.
4000-01	Oil&Gas	Yes: P11, P61, P81, P91	–	X	–	X	–	–	–	
4000-02/ 4000-03	Oil&Gas	no	–	–	X	–	X	–	X	
4000-00	Rail	yes	–	X	–	X	–	–	–	
4000-03	Marine	no	–	–	X	–	X[11)]	–	X	[11)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter			Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000-04	Marine	no	–	–	X	–	X[12,13)]	–	–	[12)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine [13)] for products, see information in chapter 9.6
	Rail	no	–	–	–	–	X[14)]	–	–	In the case of engines with no light metal components but with an external cooling system containing light metal, the coolant approvals for cooling systems containing light metal shall apply. [14)] for products, see information in chapter 9.6
	Oil & Gas	no	–	–	–	–	X[15)]	–	–	[15)] for products, see information in chapter 9.6
	C&I	no	–	–	–	–	X[16)]	–	–	[16)] for products, see information in chapter 9.6

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000	Gas engine	yes	–	X	–	X	–	X	–	
8000	Marine	yes	X	X	–	–	–	–	–	

Table 81:

Detroit Diesel four-cycle and two-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions See chapter	Coolant without antifreeze See chapter		Antifreeze See chapter		Remarks
			9.2	9.7.3/ 9.7.4	9.8.3/ 9.8.4	9.7.1/ 9.7.2	9.8.1/ 9.8.2	
S60	Marine		–	X	–	X	–	Four-cycle engines
S53	Marine C&I Genset	no	–	–	X	–	X	Two-cycle engines
S71		no	–	–	X	–	X	Two-cycle engines
S92		no	–	–	X	–	X	Two-cycle engines
S149		no	–	–	X	–	X	Two-cycle engines

Table 82:

9.2 Emulsifiable corrosion-inhibiting oils

For details and special features, see chapter on “Coolants”(→ Page 23)

Emulsifiable corrosion-inhibiting oils

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Houghton Deutschland GmbH	Oil 9156	6000 / 1	X00056748 (barrel) X00056749 (canister)

Table 83:

9.3 Coolants without antifreeze for cooling systems containing light metal

9.3.1 Coolant without antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

For the marine engine Series 1163-03 and 1163-04, only coolants marked with an asterisk * can be used!

Coolant without concentrates, antifreeze

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate*		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate*		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
BASF SE	Glysacorr G93-94*		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA*		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
YORK SAS	York 719*		X				6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Valvoline	ZEREX G-93*		X				6000 / 2	

Table 84:

9.3.2 Coolant without antifreeze – Ready mixtures for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS10/90 Corrosion Inhibitor Premix*		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Table 85:

9.4 Coolants without antifreeze for cooling systems free of light metal

9.4.1 Coolants without antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without concentrates, antifreeze

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	X					6000 / 2	
BASF SE	Glysacorr G93-94		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 2000		X	X			6000 / 2	
	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Fleetguard	DCA-4L		X	X	X		2000 / 1	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Nalco	Alfloc (Maxitreat) 3477	X					6000 / 2	
	Alfloc 2000		X	X			6000 / 2	
	Nalco 2000		X	X			6000 / 2	
	Nalcool 2000		X	X			6000 / 2	
	Trac 102		X	X			6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
Total	Total WT Supra	X					6000 / 2	
Valvoline	Zerex G-93		X				6000 / 2	
YORK SAS	York 719		X				6000 / 2	

Table 86:

9.4.2 Coolant without antifreeze – Ready mixtures for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)
Nalco	Alfloc (Maxitreat) 3443 (7 %)	X					6000 / 2	

Table 87:

9.5 Antifreezes for cooling systems containing light metal

9.5.1 Antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Anti-freeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
Clariant	Genantin Super		X	X			9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Krafft S.L.U.	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
Müller Mineralöle GmbH &Co KG	Glycostar®ST48	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500 Coolant Concentrate	X	X				9000 / 3	
Recochem Inc.	R542	X	X				9000 / 3	
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G-30	X					9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
YORK SAS	York 716	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K	X					9000 / 3	

Table 88:

9.5.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 23)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C)

Table 89:

9.5.3 Antifreeze – Ready mixtures for cooling systems containing light metals

For details and special features, see chapter on “Coolants” (→ Page 23)

Ready mixtures for cooling systems containing light metals

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Anti-freeze Premix	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Anti-freeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Anti-freeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
MTU America Inc.	Power Cool®Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool®Universal 50/50 mix	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Bantleon	Avilub Antifreeze Mix (50 %)	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000	X					9000 / 3	Antifreeze protection up to -24 °C
BP Lubricants	Castrol Heavy Duty Extend-ed Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Radicool NF Pre-mix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/ Antifreeze (50/50)	X				X	9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glysantin Alu Protect Plus G48 Ready Mix	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)	X					9000 / 3	

Table 90:

9.6 Antifreezes for cooling systems free of light metal

9.6.1 Antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 23)

For the Series 4000-04, only coolants marked with an asterisk * can be used!

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100* Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Arteco NV	Havoline Extended Life Coolant XLC [EU Code 30379]	X					9000 / 3	
Avia Mineralöl AG	Antifreeze APN*	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48*	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30*	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect*	X	X				9000 / 5	
BP Lubricants	ARAL Antifreeze Extra*	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	X					9000 / 3	
Castrol	Castrol Radicool NF*	X	X				9000 / 5	
CCI Corporation	L415*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C521*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	X					9000 / 3	
Clariant	Genantin Super		X	X			9000 / 3	
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48*	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Comma Oil & Chemicals Ltd.	Comma Xstream® G30®* Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48®* Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant*	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant*	X				X	9000 / 3	
	Mobil Antifreeze Advanced*	X					9000 / 3	
	Mobil Antifreeze Extra*	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced*	X					9000 / 3	
	Esso Antifreeze Extra*	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin*	X	X				9000 / 5	
	Maintain Fricofin G12 Plus*	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
	Maintain Fricofin HDD [Oilcode T-AF3-1]		X	X		X	9000 / 3	
Gazpromneft - Lubricants Ltd.	G - Energy Antifreeze SNF	X					9000 / 3	
Krafft S.L.U	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler	Kuttenkeuler Antifreeze ANF KK48*	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz Al Super*	X	X				9000 / 5	
MOL-Lub Kft.	EVOX Premium concentrate	X					9000 / 3	
Müller Mineralöle GmbH & Co KG	Glycostar® ST48*	X	X				9000 / 5	
Nalco	Nalcool 4070	X	X	X			9000 / 3	
	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C*	X	X				9000 / 5	
OAO Technoform	Cool Stream Premium C	X					9000 / 3	

TIM-ID: 0000019158 - 003

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze*	X				X	9000 / 3	
OMV	OMV Coolant Plus*	X	X				9000 / 5	
	OMV Coolant SF*	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325*	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500	X	X				9000 / 3	
	Power Cool - HB800	X	X	X			9000 / 3	
Recochem Inc.	R542	X	X				9000 / 3	
	R824M	X	X	X			9000 / 3	
Shell	Shell HD Premium N		X	X			9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate*	X	X				9000 / 5	
Total	Glacelf Auto Supra	X					9000 / 3	
	Glacelf MDX*	X	X				9000 / 5	
	Glacelf Supra	X					9000 / 3	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48*	X	X				9000 / 3	
	Zerex G-30*	X					9000 / 5	
YORK SAS	York 716*	X					9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K*	X					9000 / 3	

Table 91:

9.6.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 23)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C) No approval for Series 4000-04

Table 92:

9.6.3 Antifreeze – Ready mixtures for cooling systems free of light metals

For details and special features, see chapter on “Coolants” (→ Page 23)

For the Series 4000-04, only coolants marked with an asterisk * can be used!

Antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Anti-freeze Premix*	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Anti-freeze Premix*	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Anti-freeze Premix*	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
MTU America Inc.	Power Cool® Universal 35/65 mix*	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix*	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Arteco NV	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50 %)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40 %)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35 %)	X					9000 / 3	
Bantleon	Avilub Antifreeze Mix (50 %)*	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000*	X					9000 / 3	Antifreeze protection up to -24 °C

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [AP Code 510609] (50 %)	X					9000 / 3	
Castrol	Castrol Radicool NF Premix (45 %)*	X	X				9000 / 5	
CCI Corporation	L 415 (50 %)*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50 %)*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Predilluted 50/50 Antifreeze Coolant [US Code 227995]	X					9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)*	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Fuchs Petrolub SE	Maintain Fricofin HDD Premix 50/50 [Oilcode T-AF3-2]		X	X		X	9000 / 3	
Nalco	Nalcool 4100 (50 %)	X	X	X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Final Charge Global Extended Life Predilluted Coolant / Antifreeze (50/50)*	X				X	9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
	Power Cool - HB800 Premix 50/50	X	X	X			9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44 %)*	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)*	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Total	Coolelf MDX (40%)*	X	X				9000 / 5	
	Coolelf Supra (40%)	X					9000 / 3	
	Coolelf GF NP (50%)	X					9000 / 3	
Tosol-Sinzez	Glysantin Alu Protect/G30 Ready Mix*	X					9000 / 3	
	Glysantin Protect Plus/G48 Ready Mix*	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready*	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)*	X					9000 / 3	

Table 93:

9.7 Coolant Additives for Series 60 Engines

9.7.1 Antifreeze – Concentrates for Series 60 engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G48	X	X				9000 / 5	X00058054 X00058053
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G 12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK 48	X	X				9000 / 5	
Müller Mineralöle GmbH & Co KG	Glycostar®ST 48	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA pre-charged heavy duty coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant/Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325	X	X				9000 / 5	
Penske Power Systems	Power - Cool HB500	X	X				9000 / 3	
Recochem Inc.	R 542	X	X				9000 / 3	
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G 05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G 30	X					9000 / 3	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K	X					9000 / 3	

Table 94:

9.7.2 Antifreeze – Ready mixtures for Series 60 engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Anti-freeze Premix	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Anti-freeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Anti-freeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X0007527 (1000 l) (sales region: England)
MTU America Inc.	Power Cool® Universal (35/65)	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal (50/50)	X	X				9000 / 5	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off Highway 50/50		X	X			9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
Bantleon	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000	X					9000 / 3	Antifreeze protection up to -24 °C
BP Lubricants	Castrol Heavy Duty Extend-ed Life Prediluted Coolant (50/50	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/ Antifreeze (50/50)	X				X	9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glysantin Alu Protect G48 Ready Mix	X	X				9000 /5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)	X					9000 / 5	

Table 95:

9.7.3 Coolant without antifreeze – Concentrates for Series 60 engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without concentrates, antifreeze

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
BASF SE	Glysacorr G93-94		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
Drew Marine	Drewgard XTA		X				6000 / 2	
Valvoline	ZEREX G-93		X				6000 / 2	
YORK SAS	York 719		X				6000 / 2	

Table 96:

9.7.4 Coolant without antifreeze – Ready mixtures for Series 60 engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	X00069385 (20 l) X00069385 (210 l) X00069385 (1000 l) sales region: Italy

Table 97:

9.8 Coolant Additives for Two-Cycle Engines

9.8.1 Antifreeze – Concentrates for two-cycle engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®3149	X		X			9000 / 5	23528572 23528571
MTU Detroit Diesel Australia	Power Cool - HB500	X	X				9000 / 3	
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G48	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK 48	X	X				9000 / 5	
Müller Mineralöle GmbH & Co KG	Glycostar®ST 48	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA pre-charged heavy duty coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant/Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500	X	X				9000 / 3	
Recochem Inc.	R 542	X	X				9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-30	X					9000 / 3	
	Zerex G-48	X	X				9000 / 5	
YORK SAS	York 716	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K	X					9000 / 3	

Table 98:

9.8.2 Antifreeze – Ready mixtures for two-cycle engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen	Coolant AH 35/65 Antifreeze Premix	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH40/60 Antifreeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Antifreeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
MTU America Inc.	Power Cool®Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool®Universal 50/50 mix	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
Bantleon	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000	X					9000 / 3	Antifreeze protection up to -24 °C
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Detroit Diesel Corp.	Power Cool Antifreeze premix 50/50		X	X			9000 / 3	
	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X	9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Tosol-Sintez	Glysantin Alu Protect/G30 Ready Mix	X					9000 / 3	
	Glysantin Protect Plus/G48 Ready Mix	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)	X					9000 / 3	

Table 99:

9.8.3 Coolant without antifreeze – Concentrates for two-cycle engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without concentrates, antifreeze

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®Plus 6000 Concentrate		X				6000 / 2	colored green 23533527 (1 gallon) 23533526 (5 gallons)
Arteco NV	Freeco NBI		X				6000 / 2	
BASF SE	Glysacorr G93-94		X				6000 / 2	X00058062 (canister) X00054105 (barrel)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	9000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
	Power Cool 2000		X	X			6000 / 2	
	Power Cool 3000		X	X	X		4000 / 2	
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
	Pencool 3000		X	X	X		4000 / 2	
Valvoline	ZEREX G-93		X				6000 / 2	
YORK SAS	York 719		X				6000 / 2	

Table 100:

TIM-ID: 0000019161 - 003

9.8.4 Coolant without antifreeze – Ready mixtures for two-cycle engines

For details and special features, see chapter on “Coolants” (→ Page 23)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Table 101:

9.9 Coolant Additives with Limited Series Approval

9.9.1 Antifreeze – Concentrates on ethylene-glycol basis for series with and without light metal

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	Glysantin®G40 (concentrate)	X	X				9000 / 3	X00066724 (20 l) X00066725 (210 l) Concentration for use: 40 to 50% by volume
Valvoline	ZEREX G40 (concentrate)	X	X				9000 / 3	Concentration for use: 40 to 50% by volume

Table 102:

9.9.2 Antifreeze – Ready mixtures based on propylene glycol for series free of light metal

Antifreeze, ready mixture

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Fleetguard	PG XL (40%) ready mixture		X	X	X		9000 / 3	

Table 103:

10 Flushing and Cleaning Specifications for Engine Coolant Circuits

10.1 General information

These cleaning specifications are for the engine coolant circuits in MTU diesel engines and gas engines.

In the course of time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight-glasses can result.

Below-standard water quality or incorrect coolant preparation can also heavily contaminate the system.

If such conditions occur, the coolant circuit is to be flushed out with fresh water, repeatedly if necessary.

If these flushing sequences are insufficient or if the system is too heavily contaminated, the coolant circuit and all affected parts must be cleaned.

Only clean, fresh water (no river or sea water) must be used for flushing.

Only MTU-approved or corresponding products at the specified concentrations may be used for cleaning. The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the coolant circuits with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications A001061/.. (→ Page 132). Otherwise there is a danger of corrosion!

Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.
These regulations are contained in the manufacturer's instructions, legal requirements and technical guidelines valid in the individual countries. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.
Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants / cleaning agents which it has approved.

Scrap oil heat exchangers from engines with bearing or piston seizures or friction damage!

Test equipment, auxiliary materials and fluids and lubricants

MTU test kit or electric pH-value measuring instrument
- Fresh water
- Prepared engine coolant
- Superheated steam
- Compressed air

10.2 Approved cleaning products

Manufacturer	Product name	Concentration for use		Order No.
For coolant systems:				
Kluthe	Hakutex 111 [1, 5]	2% by volume	Liquid	X00065751
	Hakupur 50-706-3 [10]	2% by volume	Liquid	X00055629
Wilhelmsen Ships Service	Commissioning Cleaner [8]	10% by volume	Liquid	X00072820[7]
For subassemblies:				
Henkel	Bonderite C-AK FD [2]	1 to 10% by weight	Powder	[7]
	Bonderite C-MC 11120 [3]	2 to 10% by weight	Powder	[7]
Kluthe	Hakutex 60 MTU	100% by volume	Liquid	X00070585 (25 kg)
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Schülke & Mayr GmbH	Grotan WS Plus [5]	0.15% by volume	Liquid	X00065326 (10 kg)
	Grotanol SR2 [6]	0.5 vol. -%	Liquid	X00069827 (10 kg)
For external cooler on air side:				
Kluthe	Hakupur 50K [9]	0.5 to 5% by volume	Liquid	X00070940[7]
For painted, contaminated surfaces:				
Kluthe	Hakupur 449 [9]	1% by volume	Liquid	X00071179[7]

The technical data sheets and safety data sheets of the product must be observed!

[1] For light lime deposits, light corrosion

[2] For greasy lime deposits

[3] Preferred for heavy lime deposits

[4] For heavy lime deposits

[5] Bacteria contamination up to 10^4

[6] Bacteria contamination up to > 10^4, contamination with fungi and yeast

[7] Not stocked by MTU

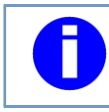
[8] With serious corrosion; not permitted for aluminum materials

[9] Cleaning agent for cleaning with high-pressure cleaning device (parameter: Pressure: 15 bar, gentle spray jet, cleaning agent temperature: 80 °C)

[10] Not suitable for galvanized surfaces

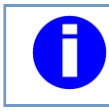
10.3 Engine coolant circuits – Flushing

1. Drain engine coolant.
2. Measure pH-value of the fresh water (MTU test kit or electric pH-value measuring device).
3. Fill coolant circuit with fresh water.



Never pour cold water into a hot engine!

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Take flush-water sample (engine-coolant-sample extraction cock).
7. Shut down engine.
8. Drain flush water.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference < 1: Fill system with treated coolant and start engine.
   b) pH value difference > 1: Fill system with fresh flush water and repeat flushing process.
   c) If the pH value difference is still > 1 after 4 to 5 flushing operations: The coolant circuit must be cleaned, see (→ Page 175). The assemblies may also have to be cleaned, see (→ Page 176).



Refer to the engine operating instructions for additional information.

10.4 Engine coolant circuits – Cleaning

1. Cleaning agents for coolant circuits are prepared in warm, freshwater as a concentrated solution, see (→ Page 173).
2. In the case of powdered products, stir until the cleaning agent is completely dissolved and without sediment.
3. Pour solution together with freshwater into coolant circuit.
4. Start engine and run until warm.
5. Select temperature and duration of residence time according to the specifications of the technical data sheets of the manufacturer.
6. Shut down engine.
7. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
8. Take flush-water sample (engine-coolant-sample extraction cock).
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference < 1: Fill system with treated coolant and start engine.
   b) pH value difference > 1: Clean assemblies, see (→ Page 176).

	Refer to the engine operating instructions for additional information.

10.5 Assemblies - Cleaning

1. Remove, disassemble and clean assemblies that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, charge-air cooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. If greasy lime deposits are found, first degrease the water side.
4. Deposits in charge-air coolers caused by oil mist can be removed using Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Observe the manufacturer's specifications and use only approved detergents in the permissible concentration, see (→ Page 173)

	Deposits on the oil side can also be dissolved in a kerosene bath. The dwell time in the cleaning bath depends on the type and degree of contamination, as well as the temperature and activity of the bath.

7. Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements with superheated steam, a nylon brush (soft) and a powerful water jet.

	In order to avoid damage: Do not use hard or sharp-edged tools (steel brushes, scrapers, etc.) (oxide protective layer). Do not set the pressure of the water jet too high (may damage cooler fins, for example).

8. After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil. This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.
11. After installing all assemblies, flush engine coolant circuit once, see (→ Page 174).
12. Check coolant system for leaks during initial operation of engine.

	For further information, see the Maintenance Manual for the engine in question.

10.6 Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

The system cleaner must flow a sufficiently long time through the complete cooling system to ensure effective cleaning and disinfection.

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system, see (→ Page 173). Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours or max. 48 hours.

Flushing

After draining the coolant/system cleaner mixture, the coolant circuit must be flushed with fresh water as long as visible contamination can be detected and until the flush water has the pH-value of the fresh water (maximum deviation of the pH-values: < 1).

Refill

Before refilling the circuit, make sure the system is free of contaminants.

Refill must be performed directly after flushing to avoid the risk of corrosion!

11 Revision Overview

11.1 Revision overview from version A001061/36 to A001061/37

Seq. No.	Page	Chapter	Subsection	Action	Supplement/ comments
1	(→ Page 5)	Preface		Revised	internet address
2	(→ Page 7)	Lubricants for four-stroke engines	Engine oils	Revised	complete subsection
3	(→ Page 23)	Coolant	General information	Revised	
4	(→ Page 25)		Unsuitable materials in the coolant circuit	Revised	coolant filter added
5	(→ Page 26)		Fresh water requirements	Revised	complete subsection
6	(→ Page 27)		Emulsifiable corrosion-inhibiting oils	Revised	complete subsection
7	(→ Page 29)		Antifreeze	Revised	complete subsection
8	(→ Page 30)		Coolant without antifreeze	Revised	complete subsection
9	(→ Page 31)		Operational checks	Revised	complete subsection
10	(→ Page 35)		Limit values for coolants	Revised	complete subsection
11	(→ Page 36)		Storage capability of coolant concentrates	Revised	table
12	(→ Page 37)		Color additives for detection of leaks in the coolant circuit	Revised	complete subsection
13	(→ Page 38)	Fuels	Diesel fuels	Revised, new structure	Complete chapter
14	(→ Page 43)		Series-dependent approval of fuel grades for MTU engines	Revised	complete subsection
15	(→ Page 79)		Biodiesel - biodiesel admixture	Revised	complete subsection
16	(→ Page 83)		Supplementary fuel additives	Revised	complete subsection
17	(→ Page 86)		Fuel for gas engines	Revised	complete subsection

Seq. No.	Page	Chapter	Subsection	Action	Supplement/ comments
18	(→ Page 95)	NOx reducing agent AUS 32 for SCR exhaust gas aftertreatment systems	General information	Revised	complete subsection
19	(→ Page 97)	Approved engine oils and lubricating greases	Engine oils for four-cycle engines	Revised	complete subsection (8.1.1 to 8.1.10)
20	(→ Page 127)		Engine oils for gas engines	Revised	only 1 subsection (8.2.1)
21	(→ Page 130)		Engine oils for two-cycle engines	Revised	complete subsection (8.3.2)
22	(→ Page 132)	Approved coolants	Series- and application-based usability of coolant additives	Revised	complete subsection (9.1)
23	(→ Page 140)		Coolants without antifreeze for cooling systems containing light metal	Revised	complete subsection (9.3.1 to 9.3.2)
24	(→ Page 142)		Coolants without antifreeze for cooling systems containing light metal	Revised	complete subsection (9.4.1 to 9.4.2)
25	(→ Page 145)		Antifreezes for cooling systems containing light metal	Revised	complete subsection (9.5.1 to 9.5.3)
26	(→ Page 151)		Antifreezes for cooling systems free of light metal	Revised	complete subsection (9.6.1 to 9.6.3)
27	(→ Page 158)		Coolant additives for Series 60 engines	Revised	complete subsection (9.7.1 to 9.7.4)
28	(→ Page 164)		Coolant additives for two-cycle engines	Revised	complete subsection (9.8.1 to 9.8.4)
29	(→ Page 170)		Coolant additives with limited series release	Revised	complete subsection (9.9.1 to 9.9.2)

Seq. No.	Page	Chapter	Subsection	Action	Supplement/ comments
31	(→ Page 173)		Flushing and Cleaning Specifications for Engine Coolant Systems	Revised	subsection (10.2)
32	(→ Page 178)	Revision – Overview	Revision overview from version A001061/36 to A001061/37	Revised	complete chapter

12 Appendix A

12.1 Index