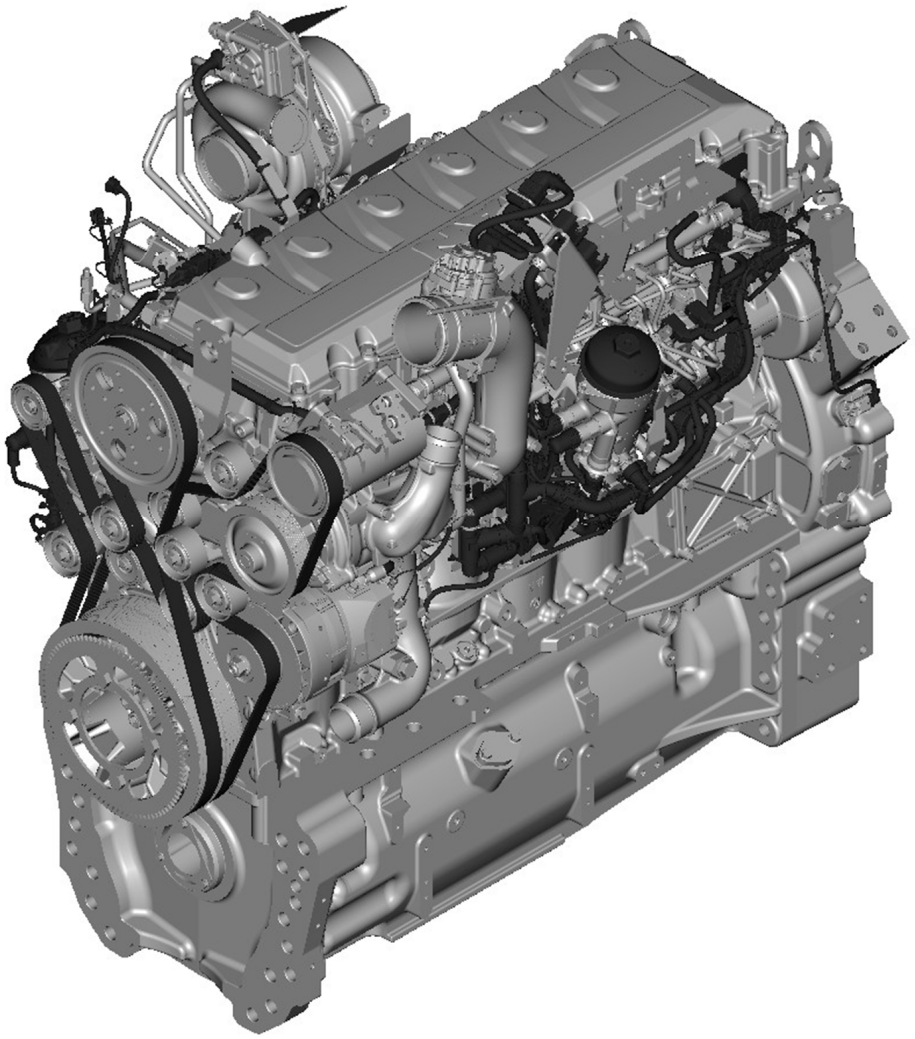

Repair Manual

MAN Industrial Diesel Engines

D1556 LE5XX

MAN Engines

Repair Manual

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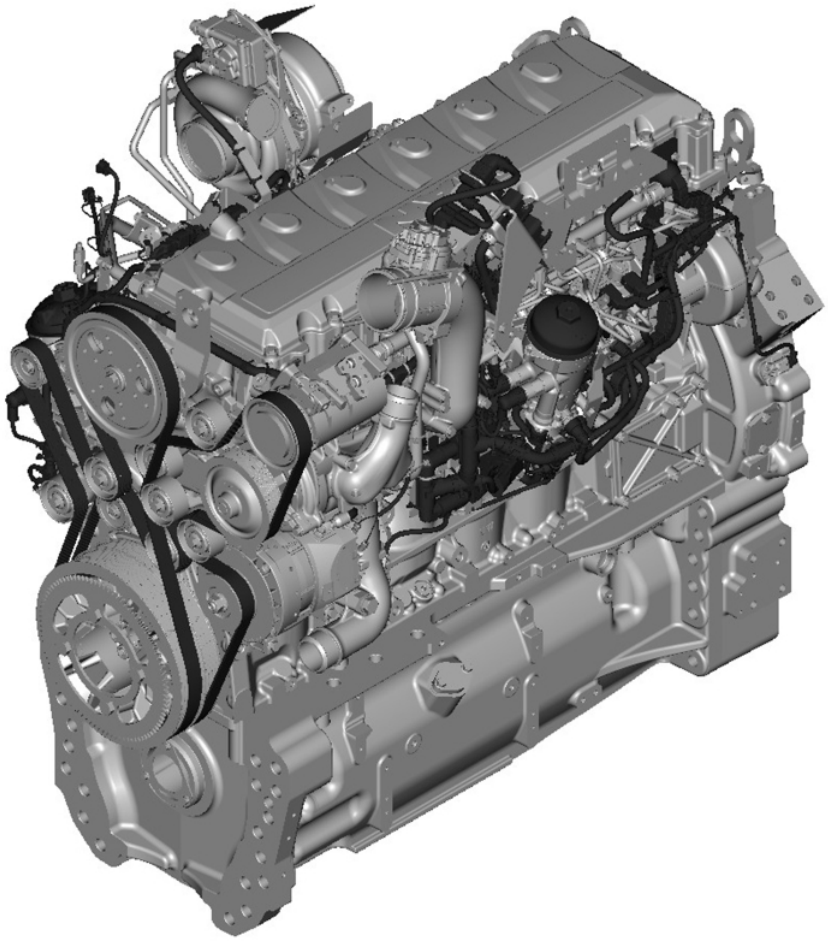

Translation of the original instructions

51.99598-8470

Version 03

TABLE OF CONTENT

1.1 Preface

Preface

This repair manual is intended to provide assistance in performing repairs correctly on vehicles and units. The technical details were correct at the time of going to press.

This publication assumes that persons who use it possess the requisite technical knowledge in handling vehicles and units.

Pictures and the corresponding descriptions are typical snapshots; they do not always correspond to the unit in question or its peripherals, but this does not necessarily mean they are incorrect. In such cases, plan and execute the repair work accordingly.

Repair work on complex attachment units should be entrusted to our customer service or to the customer service of the manufacturing company. These units are mentioned specifically in the text.

The repair jobs are divided up into sections and subsections. Each subsection starts with a page of jobs to do in advance. The jobs to do in advance contain a summary of the main prerequisites for the repair section in question. A detailed description of work can follow the jobs to do in advance.

Important instructions concerning technical safety and the safety of personnel are specifically highlighted, as indicated below.

1.2 Service

MAN Service is at your disposal for technical queries and to provide you with information.

Tip for users

Please mention the engine type, engine number and the order number with all communication.

You can contact us anytime via phone or e-mail, see Imprint.

1.3 Explanation of icons

Warnings

Warnings in this instruction are identified by icons. The information has been introduced with signal words that express the extent of risk or danger.

Follow the instructions in all cases and proceed with care in order to prevent accidents, personal injury and material damage.

⚠ DANGER

Describes an immediate dangerous situation that will lead to severe injuries or death if it is not avoided.

For this reason:

•

⚠ WARNING

Describes a potentially dangerous situation that may lead to severe injuries or death if it is not avoided.

For this reason:

•

⚠ CAUTION

Describes a potentially dangerous situation that may lead to minor or moderate injuries if it is not avoided.

For this reason:

•

NOTICE

Describes a potentially dangerous situation that may lead to damage to property if it is not avoided.

For this reason:

•

Tips and Recommendations

Tip for users

Tips and recommendations as well as information for efficient and trouble-free operation.

ENVIRONMENTAL WARNING

Tips on conduct for environmental protection.

General information

- This symbol indicates a listing at the first level.

►This symbol displays an action or series of actions.

1 This symbol displays the position of a graphic in the text.

[1] This symbol displays the position of a special tool in the text.

2.1 General

Only personnel with the proper training are permitted to perform maintenance or repair work on the engine.

The present manual must be read and understood carefully and completely.

The instructions refer to an engine in a removed[1] and dry[2] condition.

The safety regulations of the overall system must also be observed when working on the installed engine. These are not included in the present manual.

The engine must be located on a suitable device, e.g. the assembly device of MAN Truck & Bus SE.

The assembly device can be obtained from a contact of MAN Truck & Bus SE.

The following sections include **summaries** of important regulations, listed according to major topics. The intention is to provide the knowledge needed to avoid accidents which could lead to injury, damage and environmental pollution. **Please note that these are merely brief extracts taken from various accident prevention regulations and cannot replace them.** Naturally, all other safety regulations must be observed and the appropriate measures taken.

Additional direct references to danger are contained in the instructions at points where there is a potential danger.

Accidents may happen in spite of all precautionary measures having been taken. In such an eventuality, obtain immediate medical assistance from a doctor. This is particularly important if the accident involves skin contact with corrosive acid, fuel penetration under the skin, scalding by hot oil, antifreeze spraying into eyes, crushing of limbs, etc.

[1]The engine is located on a suitable assembly device. [2]There are no fluids (e.g. lubricant, coolant) in the engine

2.2 Requirements of personnel

Qualifications

- **each trained person** has been instructed by qualified personnel about the tasks assigned to him/her and the potential dangers of working on an engine.
- **Qualified personnel**, by virtue of their professional training, knowledge and experience, as well as of their knowledge of the relevant provisions, are capable of undertaking the tasks assigned to them.

The personnel must be briefed and trained regularly. The training must be recorded for better tracking of the training.

MAN Truck & Bus SE regularly provides product and application training. These training sessions can provide the necessary expertise.

Contact information for the MAN Engine Academy.

↗ http://www.engines.man.eu/global/de/ueber-man-engines/man-engine-academy/Themen.html

2.3 Regulations to prevent accidents with personal injury

During inspection, adjustment and repair work

- Secure units during their removal.
- Keep assemblies, ladders, steps, walkways and their surrounding areas free of oil and grease. Accidents due to slipping may cause severe injuries.
- **Checking, adjusting and repair measures may only be performed by authorized specialist personnel.**
- The main battery switch must be switched off during installation work.
- When performing maintenance and repair work, ensure that the engine cannot be started inadvertently by unauthorized persons.
- Only authorized personnel are allowed to start and operate the engine.
- Do not use any tools that are not in perfect condition.

Operating the engine

- Only authorized personnel are allowed to start and operate the engine.

- Do not get too close to rotating parts when the engine is running. Wear close-fitting work clothes.
- Ensure that there is adequate ventilation in enclosed spaces.
- Do not touch equipment at operating temperature with bare hands. Risk of burns! Do not work with bare hands, especially when performing an oil change (units at operating temperature).
- Open the coolant circuit only after the engine has cooled.
- The tool must be approved by MAN and in good technical condition.

Suspended loads

- Do not lift heavy parts with physical strength. Use suitable means.

  Procedure:
- Carefully secure single components and component groups to the lifting equipment so that there is no danger.
- Only use suitable and serviceable lifting equipment and lifting gear with a sufficient load rating.
- Only lift the engine from the provided lifting eyes using the crane lifting gear.
- Persons are not allowed to stand below an engine hanging from a crane hook. Keep the lifting gear in order.

Bodies and special bodies

- Comply with the safety instructions and regulations issued by the body manufacturer in question if bodies or special bodies are fitted.

Working on high-pressure lines

- Do not attempt to tighten, loosen or open pipes and hoses (e.g. in the lubrication circuit, coolant circuit and hydraulic oil circuit) whilst they are pressurized:

Risk of injury from escaping liquids!

Work on the electrical system

- Only start units when the batteries are properly connected.
- Do not disconnect batteries whilst the engine is running.
- Only start units when they are completely connected to the electronic control system.
- Do not use a quick-charger to start the unit. Use only separate batteries as a starting aid.
- The battery terminals must be removed to quick-charge the batteries.

  Observe the quick-charger's Operating Instructions.
- For arc welding work, the batteries must be disconnected and both cables (+ and -) firmly connected with each other.
- The connections of the control units may only be disconnected/connected when the electrical system is switched off.
- Reversal of the control-unit supply-voltage polarity (e.g. if batteries are connected with the polarity reversed) can cause irreparable damage to the control units.
- Screw on the connections on the injection system using the prescribed tightening torques.
- At expected temperatures above 80 °C (e.g. in a drying oven), the control units must be removed.
- Use only matching test lines for measurements at plug connectors.
- Telephones and radios that are not connected with an outside aerial can lead to a vehicle electronics malfunction. This represents a threat to the operational safety of the unit.

Important: battery gases are explosive!

- Oxyhydrogen gas may form in enclosed battery boxes. Take particular care after the engine has been running for an extended period or after charging the batteries with a battery charger.
- Avoid short circuits caused by polarity reversal or by placing metal objects (spanners, pliers, etc.) on the battery terminals.
- Disconnect the batteries of disabled engines or recharge them every 4 weeks.
- When the batteries are disconnected, gas may be ignited by sparks produced by other continuously operating consumers that are not shut down. Before disconnecting, ventilate the battery box sufficiently!

Caution! Battery acid is poisonous and corrosive.

- Please observe the manufacturer's specifications.

- Wear suitable protective clothing (gloves) when handling batteries. Do not tip or tilt batteries as acid may emerge.
- Only measure voltage with suitable measuring devices! The input resistance of the measurement device must be at least 10 MΩ.
- Disconnect or connect the cable harness connectors of electronic control units only when the ignition is switched off.

Electric welding

- Please observe the welding instructions.
- Connect the “ANTIZAP SERVICE SENTRY” protection device (MAN part number 80.78010.0002) as described in the instructions accompanying the device
- If this device is not available, disconnect the batteries and firmly connect the positive lead to the negative lead so that a conductive circuit is created.
- Always place the ground of the welding equipment as close as possible to the welding location. Do not lay welding equipment cable in parallel to the electrical cables in the vehicle.
- When carrying out welding tasks in the immediate vicinity of control units, the plug connectors must be disconnected. In doing so, observe the instructions and regulations contained in the section EDC Control Units.

Painting

- If paint spraying is to be carried out, do not expose the electronic components to high temperatures (max. 95 °C) for more than brief periods; a time of up to 2 hours is permissible at a maximum of 85 °C.
- Disconnect the batteries.
- Remove sensitive electrical components.
- Painting of bolt connections in the high-pressure section of the injection system is **not** permitted. Risk of dirt ingress in the event of repairs

Work on plastic tubes – risk of damage and fire

- Plastic tubes must not be subject to mechanical or thermal load.

2.4 Regulations for avoiding injury and environmental contamination

Preventative measures to protect your health

- Avoid extended, excessive or repeated skin contact with service products, process materials, diluting agents and solvents.
- Protect the skin using a suitable skin protection agent or protective gloves.
- Do not use service products, auxiliary substances, thinners or solvents to clean the skin.
- Wash contaminated skin thoroughly with soap and water.
- Special cleaning agents make it easier to clean dirty hands.
- Apply a greasy skin cream after cleaning skin.
- Change out of clothing or shoes which have become soaked with oil.
- Never put oil-soaked rags into your clothing pockets.

Coolant

Treat undiluted antifreeze as hazardous waste. Follow the instructions issued by the relevant local authority when disposing of used coolant (mixture of antifreeze and water).

Cleaning the cooling circuit

Do not pour cleaning fluids and rinsing water down the drain when this practice is restricted by specific local regulations. However, the cleaning fluid and rinsing water must, in all cases, be passed through an oil separator with a sludge trap.

Cleaning the filter insert

When blowing compressed air through the filter insert, make sure the filter dust is collected by an extractor system, or is blown into a dust collection bag. Otherwise, use a respiratory protection mask. Wear suitable rubber gloves or use a skin barrier cream when washing out the element, because cleaning agents have aggressive grease-dissolving characteristics.

Engine oil, transmission oil, filter cartridges, inserts and box-type filters, desiccant cartridges

Filter inserts, cartridges and box-type filters (oil and fuel filters, desiccant cartridges for the air dryer) are classified as hazardous waste materials. Please observe instructions issued by the relevant local authority on the disposal of the parts mentioned above.

Used engine oil and transmission oil

Lengthy or repeated skin contact with any type of engine oil or transmission oil removes grease from the skin. This can cause dry skin, irritation or skin inflammation. In addition to these hazards, used engine oil contains dangerous materials which can trigger dangerous skin diseases. It is particularly important to wear gloves during an oil change.

2.5 Liability limitations for replacement parts and accessories

General

All information and instructions in this manual have been compiled taking into consideration the applicable standards and regulations, the state-of-the-art technology as well as our knowledge and experience acquired over a period of several years.

MAN does not assume any liability for damage caused as a result of:

- Non-observance of this manual
- Use that is not in accordance with specifications
- Use of untrained personnel
- Unauthorized alterations
- Technical changes
- Use of non-approved spare parts and service products

In case of special designs, the actual scope of supply, the use of additional ordering options or on account of the latest technical modifications may vary from the explanations and illustrations described here.

The obligations agreed upon in the delivery agreement and the General Terms and Conditions of Business of MAN Truck & Bus shall apply in addition to the statutory regulations valid at the time of the conclusion of the contract.

2.6 Guidelines for preventing damage and premature wear on the engine

General

- The engine is built exclusively for the application corresponding to the scope of supply -*as defined by the equipment manufacturer*- (designated use).
- The intended use also includes compliance with the operating and maintenance conditions defined by the manufacturer. The engine must only be used, maintained and repaired by personnel who are acquainted with it and have been instructed about any potential dangers.
- The manufacturer does not assume any liability for damage resulting from unauthorised modifications to the engine.

  Manipulation of the injection and control system may also affect the performance and exhaust-gas values of the unit. Compliance with legal environmental regulations would then no longer be guaranteed.
- If malfunctions occur, determine the cause and remedy the problem immediately so that no serious damage occurs.
- Clean the engine thoroughly before repairing. Ensure that no dirt, sand or foreign objects get into the unit during repair work.
- Only use original spare parts. Installation of parts of by other manufacturers can sometimes cause major damage, for which the workshop carrying out the repair bears the responsibility. Follow the instructions in the section on Limitation on Liability for Accessories and Parts.
- Never run an engine dry, i.e. always make sure that it has been filled with lubricating oil before running it.
- Never run engines that have not been filled with coolant beforehand.
- Use a suitable information sign to clearly indicate units that are not ready to be operated.
- Use service products only in accordance with MAN regulations; otherwise the manufacturer's warranty is rendered void.

For basic information concerning service products, see the publication "Service Products for MAN Diesel Engines".

You can find approved products on the Internet at:

↗ https://my.man-mn.com/portal/irj/asp

- Do not replenish engine oil/transmission oil above the max. mark. Do not exceed the maximum permitted operational tilt.
- Non-observance can result in serious damage to the engine.

2.7 Limp-home program for engines with an electronic control unit

General information

Engines have an electronic control system that monitors the engine as well as itself (self-diagnosis).

As soon as there is a malfunction, the malfunction is evaluated and one of the following measures is initiated:

- Output of a fault message with a diagnostic memory entry.
- Changeover to suitable, yet limited operation. Have malfunctions rectified immediately by MAN Customer Service.
- If MAN-cats® is used, the diagnostic memory entry is output directly.

2.8 Information for working on the common rail system

General

- A jet of fuel can penetrate the skin. Atomised fuel represents a fire hazard.
- Never loosen the bolt connection on the fuel high-pressure side of the common rail system when the engine is running (high-pressure line from the high-pressure pump to the rail, at the rail and on the cylinder head to the fuel injector). Whilst the engine is running, the lines are constantly carrying fuel under a pressure of 1600 bar or more. Wait for at least one minute before undoing bolt connections to allow the pressure to drop. MAN-cats® must be used to check that the system is depressurized at the rail.
- Do not remain in the vicinity of the engine when it is running.

Information for individuals with pacemakers

- Any changes made to the original engine cabling can result in the limit values specified in pacemaker safety regulations being exceeded, e.g. non-twisted injector cables or installing the test box (bushing box).
- There is no danger to the driver or any passengers with pacemakers, in approved operation.
- Vehicle operators with heart pacemakers are not at risk from systems with MAN Common Rail engines, in approved operation.
- The product, in its original condition, complies with all the currently known limit values for heart pacemakers.

Special information for people with pacemakers

- Any changes made to the original engine cabling can result in the limit values specified in pacemaker safety regulations being exceeded, e.g. non-twisted injector cables or installing the test box (bushing box).
- Wearers of pacemakers must remain a minimum of 20 cm from the running engine.

Risk of damage due to ingress of dirt

- The components of the diesel fuel-injection system consist of high-precision parts that are subjected to extreme loads. Owing to this high level of precision engineering, **strict rules of cleanliness** must be followed when working on the fuel system.
- Even particles of dirt as small as **0.002 mm** can cause component failure.
- The engine and engine compartment must be cleaned (steam cleaned) before work is performed on the clean side of the fuel system. The fuel system must be closed when cleaning takes place.
- Perform a visual inspection for leaks or damage to the fuel system.
- Do not aim jet of steam cleaner at electrical components, or fit covers to protect them.
- Place the engine in a clean area of the workshop where none of the work causes dust to be swirled up (sanding, welding, brake repairs, brake checks, performance tests etc.).

- Avoid air movements (possible swirling up of dust due to starting of engines, the workshop heating / ventilation system, due to draughts etc.).
- The area of the still closed fuel system must be cleaned and dried by means of compressed air.
- Use a suitable extractor unit (industrial extractor unit) to remove loose dirt particles such as paint chippings and insulating material.
- Use a new and clean cover in areas of the engine compartment where dirt particles can become loose.
- Before starting disassembly, wash your hands and put on a clean working overall.
- After the clean-side fuel system has been opened, it is not permitted to use compressed air for cleaning.
- Only lint-free cleaning cloths are allowed to be used on the fuel system.
- Clean tools and working equipment before starting work.
- Only tools that show no sign of damage (e.g. cracked chromium plating) must be used.
- Materials such as cloths, cardboard or wood must not be used when removing and fitting components, as particles and fibres may become detached from such materials.
- If paint flakes should be produced when loosening connections (e.g. due to painting over the connections), these must be carefully removed before the bolt connection is finally undone.
- All removed components on the clean side of the fuel system must be plugged **immediately** at their connection openings using suitable caps.
- These sealing parts must remain packaged dust-tight until use and must be disposed of after being used once.
- The components must then be stored carefully in a clean, closed container.
- **Never** expose these components to used cleaning or testing fluids.
- New parts must only be taken out of the original packaging immediately before use.
- Work on removed components must be performed only at a work place equipped for this purpose.
- If removed parts are shipped, always use the original packaging of the new part.

2.9 Handling DEF

DEF is a 32.5% urea solution that is used for NO_x reduction in the SCR catalytic converter. The DEF used must conform with standard ISO 22241. Observe the DEF safety data sheets.

In the event of contact with DEF, immediately take suitable measures:

- **Eye contact:** Immediately rinse the entire eye with clean water continuously for at least 15 minutes. Prior to that, the eye should be checked for contact lenses. If the eye has a contact lens, please remove it first. Seek medical attention immediately in the event of physical symptoms.
- **Skin contact:** Wash areas concerned thoroughly with soap and water. Seek medical attention immediately in the event of physical symptoms.
- **If swallowed:** Do not induce vomiting. Seek immediate medical assistance.
- **Contaminated clothing:** Immediately change clothes and wash any areas on skin that have come into contact thoroughly with soap and water.

When **opening components containing DEF**, small amounts of ammonia fumes can escape. Do not inhale the ammonia fumes. Ammonia fumes are especially irritating to the eyes, mucous membranes and skin. The working area should be **well-ventilated**.

DEF has a **corrosive effect**

on many materials. Clean components concerned thoroughly

with water or a suitable cleaning agent.

Unintended release of DEF:

- **Small amounts:** Absorb with liquid-binding material. Dispose of binding agent in the correct manner.
- Prevent **large amounts** from entering water drain facilities or the ground. If large amounts cannot be intercepted, the local authorities must be notified.

The **storage temperature** of DEF should not exceed 25°C. Storage should take place in well-ventilated and liquid-tight locations.

2.10 Engine overhaul

General information on performing an engine overhaul

A range of very different factors affect the engine service life. It is therefore not possible to indicate the exact number of operating hours before a major overhaul is due.

We are of the opinion that opening an engine or performing a general overhaul is not required, as long as the engine has good compression values and the following operating values do not deviate considerably from those determined at start-up.

- Charging pressure
- Exhaust gas temperature
- Coolant and lubricating oil temperatures
- Oil pressure and oil consumption
- Smoke behavior

The following criteria have considerable influence on the engine's service life:

- Correct performance setting according to deployment
- Correct installation
- Approval of the installation by authorised personnel
- Regular maintenance according to the maintenance schedule
- For the selection and quality of lubricating oil, fuel and coolant, please see the publication "Service products for MAN diesel engines"

2.11 Assembly information

Assembly information

Fitting nuts and bolts

- Lightly lubricate nuts and bolts on the threading and the contact surface of the bolt head.
- Refer to the reference values in works standard M 3059 for screw connections without specially prescribed tightening torques

Installation of micro-encapsulated bolts

- Comply with the application guidelines in works standard MAN 222 when using micro-encapsulated bolts.

Reuse of bolts and nuts

- Check bolt heads, threads and nuts for wear and ease of movement, replace if necessary
- Only reuse bolts and nuts if they are not worn!

Installing pipe assemblies

Danger: Pipes of all kinds may not be bent! - Danger of breakage!

Mounting gaskets

- Only use MAN genuine gaskets
- Make sure that the areas to be sealed are undamaged and clean.
- Do not use adhesives or sealing compounds. If necessary, to facilitate installation, use a little grease to stick the gasket to the part to be mounted.
- Tighten bolts evenly to prescribed tightening torque.

Mounting O-rings

- Only use MAN genuine O-rings.
- Make sure that the areas to be sealed are undamaged and clean.
- Generally apply engine oil on O-rings as per MAN Standard 3277 for installation.