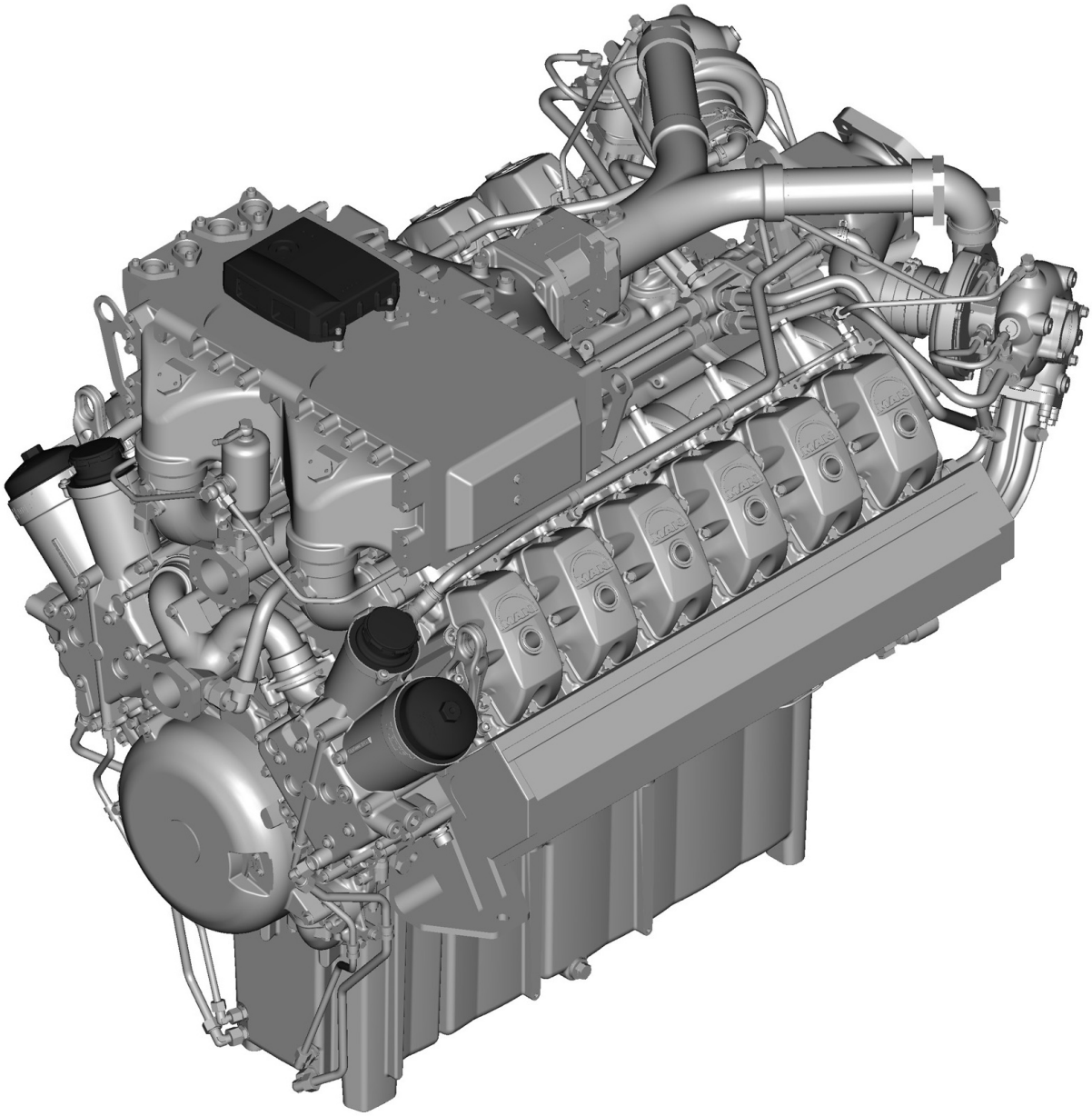


Operating Instruction

MAN Industrial Gas Engines

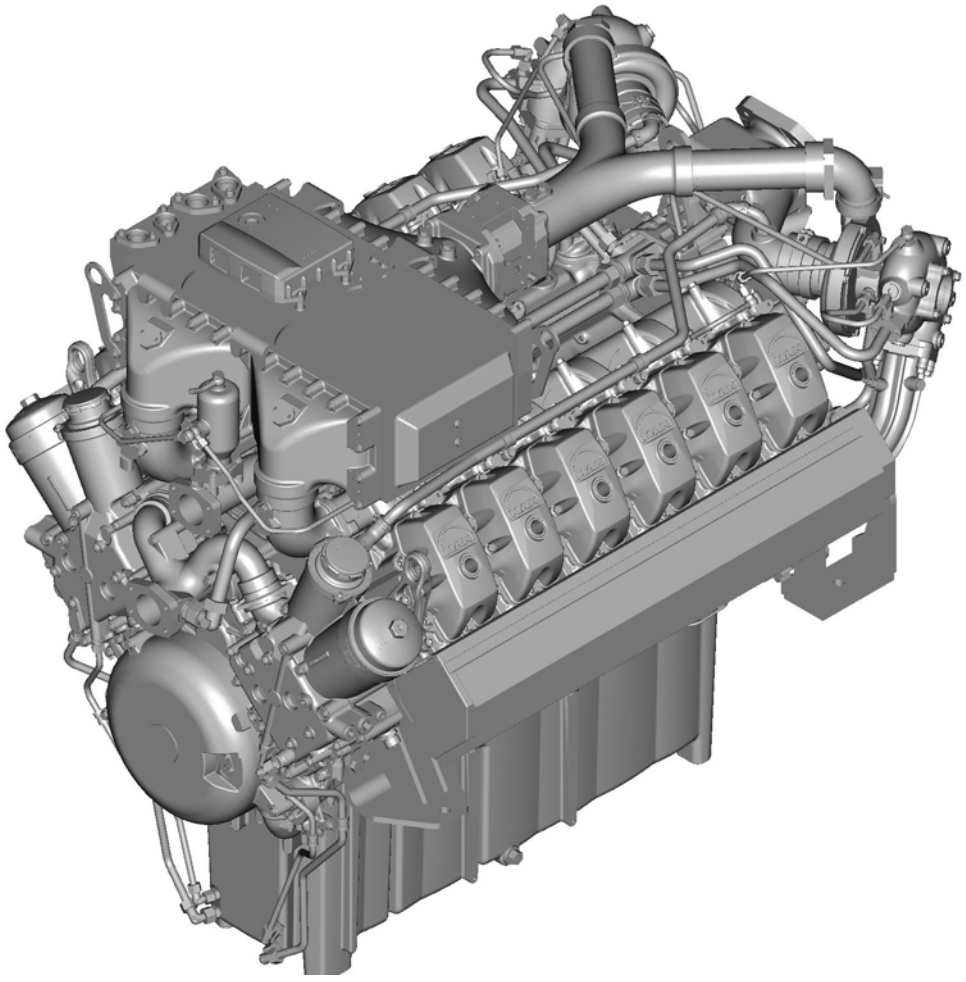
E3268 LE212/222 / E3262 LE202/212

MAN Engines
A Division of MAN Truck & Bus

Operating Instruction

MAN Industrial Gas Engines

E3268 LE212, E3268 LE222
E3262 LE202, E3262 LE212



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Information and Copyright

Subject to change without notice.

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List of contents

1 Foreword

1.1 Information about these instructions

User tip

This provisional version of the instructions reflects the current development state of the engines.
These instructions therefore contain graphic representations of the MAN industrial gas engines on which these instructions are based.

These instructions provide important information on handling engines. Safe working can only be assured if all safety instructions and handling instructions are followed.

In addition to this, the local accident prevention regulations and general safety regulations applicable to the engines' field of application must be followed.

Timely and proper maintenance and care of the engines according to the set maintenance intervals ensure and maintain the operational safety and the reliable application of these engines.

Only use genuine MAN spare parts and accessories or ones that have been approved by MAN.
Only the genuine spare parts approved by us have been tested by us and therefore meet the requirements for use of the engine.

A particular concern of MAN is to improve environmental protection.
This begins with the development and design of our engines. We make sure that no environmentally hazardous materials are used and, for example, that the emissions fulfil the highest requirements.

Economical operation helps to conserve our resources and our environment.

1.1.1 Supplementary publications

These instructions are supplemented by the following publications:
- Fuels, Lubricants and Coolants for MAN Industrial Gas Engines

Both publications are considered "parts of the product" and should always be kept in the immediate vicinity of the engine for the personnel.

Carefully read the Installation and Operating Instructions before starting any work! This is especially valid for the chapter on General Safety Instructions and the safety instructions in each of the chapters.

Failure to follow these instructions and any operating instructions provided by suppliers invalidates the warranty.

1.1.2 Further publications

The following publications supplement these instructions:

- Spare Parts Catalogue (included)

For the service personnel

- Repair Instructions

1.2 Symbol explanation

Warnings

Warnings are indicated by symbols in these instructions. The warnings are preceded by signal words which indicate the extent of the danger.

Always heed these warnings and act prudently to prevent accidents, injuries and property damage.

DANGER

Describes an immediately dangerous situation that will lead to serious injury or death if it is not avoided.

WARNING

Describes a possibly dangerous situation that can lead to serious injury or death if it is not avoided.

CAUTION

Describes a possibly dangerous situation that can lead to minor or moderate injury if it is not avoided.

NOTE

Describes a possibly dangerous situation that can lead to damage if it is not avoided.

Tips and Recommendations

User tip

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

ENVIRONMENTAL NOTE

Tips on how to deal with protection of the environment.

General Information

- This symbol indicates a list at the first level.
- This symbol indicates a list at the second level.

1. This symbol indicates a sequence of actions.

1 This symbol indicates a graphic item in the text.

1.3 Limitation of liability

All of the information in these instructions have been prepared while taking into account the valid standards and regulations, the state of the art, as well as our many years of experience and knowledge.

MAN is not liable for damages resulting from:

- Failure to follow these instructions
- Improper use
- Use of untrained personnel
- Customer conversions
- Technical modifications
- Use of non-approved spare parts and fuels, fluids and lubricants

The actual scope of delivery for special versions, additional ordering options or technical modifications may deviate from what is described and illustrated in these instructions.

Valid are the commitments agreed upon in the delivery contract and the General Terms and Conditions of MAN and the law applicable at the time of contracting arrangements.

1.4 Copyright protection

Treat the Installation and Operating Instructions confidentially. They are aimed solely at persons who deal with the engine.
The instructions may not be passed to third parties without written approval from MAN.

User tip

The information, texts, drawings, illustrations and other depictions are all protected by copyright and are subject to industrial property rights.
Any improper use is punishable by law.

1.5 Applicable documents

Supplier components are installed in the engine. Risk assessments have been carried out on these parts by the suppliers.
The compliance of the design with the existing European and national legislation has been declared by the respective suppliers of the components.

1.6 Spare parts

Only use genuine MAN spare parts and accessories or ones that have been approved by MAN.
Only the spare replacement parts approved by us have been tested by us and therefore meet the requirements for use of the engine.

Spare parts and accessories must either be MAN genuine parts or parts that have been specifically approved by MAN. The reliability, safety and suitability of these parts have been established specifically for the engines. We cannot assess and vouch for other non-MAN products, despite ongoing market observations.

⚠ WARNING

Risk of injury due to incorrect spare parts
Incorrect or faulty spare parts can lead to damage, malfunctions or total failures and interfere with safety.

For this reason:
- Only use MAN genuine spare parts

User tip

Quote the engine type, engine number and order number in all enquiries and communications,
see page 25.

Order spare parts through authorised dealers or directly from MAN.
For address, see page 2.

1.7 Disposal

Dispose in accordance with national regulations.

If no return or disposal agreement has been made, recycle the disassembled components as follows:

- Sort metals before scrapping.
- Recycle the plastic parts.
- Dispose of all other parts according to their material composition.

1.8 Warranty provisions

Valid are the commitments agreed upon in the delivery contract and the General Terms and Conditions of MAN and the law applicable at the time of contracting arrangements.

Failure to follow these instructions and any operating instructions provided by suppliers invalidates the warranty.

The use of non-approved parts leads to the loss of warranty claims.

We recommend to use genuine parts even after the warranty period has expired. This will ensure the continuous performance of the engine.

1.9 Product support

Our MAN product support is available for technical information.

User tip

Quote the engine type, engine number and order number in all enquiries and communications,
see page 25.

Information about contact persons can always be called up by telephone, fax, email or over the Internet.
For addresses see page 2.

Foreword

Carefully read these Operating Instructions before starting any work!
This is especially valid for the chapter on General Safety Instructions
and the safety instructions in each of the chapters.

2 General Safety Instructions

This chapter provides information on residual risks and hazards during proper use of the engine.
The generally valid safety instructions to be observed are listed here. They provide optimum protection for personnel and for the safe and smooth operation of the engine.

In the following, specific, action and situation-related safety information is placed before the corresponding step, or in the chapter described.

Failure to observe the Operating Instructions and Safety Instructions in this document can result in significant hazards.

2.1 Intended use

The engine is built exclusively to drive generators or for the coupling of heat exchangers within the limits of technical data.
Any other use is considered as "non-intended".
MAN is not liable for any damage resulting from non-intended use. The risk is entirely borne by the operator.

Intended use also includes compliance with the country-specific, local environmental regulations.
This in particular concerns the compliance with the applicable legal exhaust emission limits.
Furthermore, the engine operating parameters according to the technical data sheets currently in effect must also be adhered to.
The mixture generating and control system, as well as - if needed - the exhaust aftertreatment system must be prepared by the manufacturer of the complete machine to meet these criteria.

Intended use also includes compliance with the prescribed operating, maintenance and repair work.
The engine may only be used, maintained and repaired by persons who are familiar with the engine and have been informed of the hazards.

Unauthorised modifications to the engine shall void any liability for any resulting property damage and personal injury.
Similarly, tampering with the control system can affect engine performance and emission characteristics.
Compliance with statutory environmental protection requirements is therefore no longer guaranteed.

⚠ DANGER

Danger due to non-intended use
Any use that exceeds the intended use and/or any different use of the engine can lead to dangerous situations which will invalidate the operating permit.

For this reason:
- Use the engine for its intended purpose only.
- Use the engine outside of hazardous areas where there is a risk of explosion.
- Use the engine with an overspeed limiting device installed.

User tip

Observe the following information when operating the engine:
- The safety instructions in these Operating Instructions and the suppliers' instructions.
- The “Technical data" section in these instructions and the suppliers' instructions.
- Country-specific regulations.

2.2 Content of the Installation and Operating Instructions

Any person who is instructed to perform work on or with the engine, must have read and understood these Operating Instructions before starting any work. This also applies if the person has worked with such an engine or a similar engine, or has already been trained by MAN.

Familiarity with these instructions is therefore essential.

2.3 Engine modifications and conversions

In order to avoid hazards and to ensure optimum performance, no modifications or conversions to the engine may be made which are not expressly approved by MAN.

If changes are made without the written consent of MAN, the guarantee or warranty obligation for MAN is no longer valid for damage and defects which are based on these unauthorised changes. Furthermore MAN assumes no liability for any damage caused as a result of unauthorised changes.

2.4 Operator's responsibility

The engine operator is subject to the statutory requirements for workplace safety.

In addition to the Safety Instructions in these Operating Instructions, the safety regulations, accident prevention regulations and environmental protection regulations valid for the application area of this engine must also be observed.

In particular:

- The operator must be knowledgeable about the valid occupational health and safety regulations and be able to assess, in a risk analysis, the dangers that are present in the specific working conditions at the operating site of the engine. He must then implement these safety regulations in the form of operating instructions for the operation of the engine.
- During the entire period of operation of the engine the operator must check whether the operating instructions he created meet the most current standards and regulations and revise them if necessary.
- The operator must clearly define and regulate the responsibilities for installation, operation, maintenance and cleaning of the product.
- The operator must ensure that all staff who deal with the engine have read and understood the Operating Instructions.
  In addition, the operator must periodically train the staff and inform them about hazards.
- The operator must provide the personnel with the necessary protective equipment.
- The operator must limit access to the operating room.
- The operator must ensure proper ventilation of the operating room.
- These operating instructions must be kept in the immediate vicinity of the engine and be readily accessible at any time to those persons working on and with the engine.

The operator is responsible for ensuring that the engine is always operated in perfect working condition and working order.

In particular:

- Perform maintenance work as described in these instructions in full and at the specified intervals or have it performed by a MAN Service workshop/authorised MAN partner.
- The operator must have all safety equipment checked regularly for function and integrity.
- The instructions must be followed in full and without restrictions!

2.5 Personnel requirements

2.5.1 Qualifications

⚠ WARNING

Risk of injury if personnel is not sufficiently qualified
Improper handling can result in significant personal injury and property damage.

For this reason:
- Specific activities must only be performed by those persons who are named in the respective chapters in these Operating Instructions.

The following qualifications are specified for various areas of activity in the instructions:

- **Instructed Persons**
  Have been instructed in a briefing about the possible dangers of improper handling in their tasks.
- **Qualified Personnel**
  Due to their technical training, knowledge and experience and knowledge of the relevant regulations they can properly perform the tasks assigned to them.
- **Electric Specialist**
  Is capable of performing work on electrical systems due to his/her technical education/training, knowledge and experience as well as knowledge of the respective standards and regulations and can recognise and avoid any possible dangers.
  The electric specialist is trained for the specific operating site in which he/she works and knows the relevant standards and regulations.

Only those people who can perform their work reliably should be considered as authorised personnel. Individuals whose responsiveness is influenced, for example, by alcohol or drugs, are not permitted.

- When selecting personnel, observe the regulations regarding age and profession valid at the operating site.

2.5.2 Unauthorised personnel

⚠ WARNING

Danger to unauthorised personnel
Unauthorised persons who do not fulfil the requirements described here do not realise the dangers that exist in the working area.

For this reason:
- Keep unauthorised persons out of the working area.
- In case of doubt, address the person and remove him/her from the working area if necessary.
- Interrupt the work until all unauthorised persons are out of the working area.

2.5.3 Instruction

Personnel must be instructed on regular basis and this should be documented in a log to keep better track of who and when.

2.6 Personal protective equipment

Wearing personal protective equipment is necessary to minimise the health risks when working.

- The required personal protective equipment for the relevant job must always be worn while working.
- All signs pertaining to personal protective equipment in the working area must be followed.

Protective Clothing

Close-fitting clothing with low initial tear strength, with narrow sleeves and with no protruding parts. It is used primarily to protect against injury, weather and dirt.

No rings, bracelets, necklaces and other jewellery are to be worn while working.

Protective Helmet

To protect against falling and flying parts.

Safety Shoes

To protect against heavy falling parts and slipping on slippery surfaces.

Safety Gloves

To protect the hands from friction, scraping, punctures or deep injuries and to protect from hot or caustic parts or fluids

To be worn when performing specific types of work

When performing certain types of work, special protective equipment is required. This will be specifically mentioned in the relevant chapters.

Safety Glasses

To protect the eyes against flying parts and sprayed fluids.

Hearing Protection

To protect the ears from damage by loud noises.

2.7 Particular dangers

The following section describes residual risks which have been identified.

- Observe the safety instructions listed here and the warnings in the other chapters of these instructions in order to reduce health hazards and avoid dangerous situations.

Electrical Current

DANGER

Danger to life due to electrical voltage
Touching live parts endangers life.
Damaged insulation of components endanger life.

For this reason:
- If the insulation is damaged, immediately switch off the power supply and get the insulation repaired.
- Any work performed on the electrical system may only be made by a qualified electrician.
- When working on the electrical system the power supply must be switched off and then properly checked to ensure no electrical current is present.
- Before starting any maintenance, cleaning or repair work the power supply must be switched off and secured from being accidentally switched back on.
- Do not bridge or bypass any fuses. When replacing fuses, ensure to use the correct amperage.
- Keep moisture clear of parts conducting electrical current. This could cause a short-circuit.

Moving Parts

WARNING

Risk of injury due to moving parts
Rotating and/or linear-moving components can cause injuries.

For this reason:
- Do not touch or handle moving parts during operation.
- Do not open the covers during operation.
- Only perform checking and maintenance jobs when the engine is at a standstill.
- Observe the run-on time: before opening any covers ensure that no parts are still moving.
- Wear close-fitting clothing in the hazard area.

Flying components in the event of sudden engine damage

WARNING

Risk of injury due to running engines
In the event of engine damage, components can fly through the engine room at high speed and injure people in the immediate vicinity.

For this reason:
- Do not remain in the engine room when the engine is running.

Exhaust gases

⚠ WARNING

Health risk due to leaking exhaust system
Exhaust gases can damage health.

For this reason:
- Immediately stop and repair machines with leaking exhaust systems.
- Ensure sufficient ventilation.

Highly Flammable Substances - Gaseous Fuels, Oils and Grease

⚠ WARNING

Risk of injury due to highly inflammable materials
Highly inflammable materials, liquids or gases catch fire easily.

For this reason:
- Smoking, naked flames and sources of ignition are prohibited in the danger zone and immediate surroundings.
- Keep fire extinguishers at hand.
- Immediately report any suspicious substances, fluids or gases to the person in charge.
- Repair any leaks.
- In the case of fire, immediately stop working. Leave hazard area until the danger is over.

Coolants - Antifreeze, Anticorrosion Agents

⚠ WARNING

Risk of injury caused by coolants that are hazardous to health
Coolant contains substances that are hazardous to health.

For this reason:
- Observe the safety sheets from the manufacturer.
- Always wear protective clothing, chemical-resistant protective gloves and safety glasses.
- Avoid spilling or spraying these substances.

Hot Fluids and Lubricants

⚠ WARNING

Risk of burns due to hot fuels, lubricants and coolants
Fuels, lubricants and coolants get hot during operation and cause burns if touched.

For this reason:
- Before handling any fluids and lubricants, check whether they are hot. If necessary, let them cool down first.

Hot Surfaces

⚠ CAUTION

Risk of burns due to hot surfaces
Touching hot components causes burns.

For this reason:
- When performing any work in the vicinity of hot components always wear protective clothing and protective gloves.
- Before starting any work ensure that all components have cooled down to ambient temperature.

Noise

⚠ WARNING

Hearing damage due to noise
The noise level in the working area can cause serious hearing damage.

For this reason:
- Always wear hearing protection when working.
- Do not unnecessarily remain in the hazard area. Leave hazard area when work is finished.

Sharp Edges and Corners

⚠ CAUTION

Risk of injury on edges and corners
Sharp edges and corners can cause skin grazes and cuts.

For this reason:
- Always work carefully and with caution in the vicinity of sharp edges and corners.
- In cases of doubt, wear protective gloves.

Dirt and Objects

⚠ CAUTION

Risk of tripping due to dirt and discarded objects
Dirt and discarded objects represent a tripping and slipping hazard and can cause serious injuries.

For this reason:
- Always keep the work area clean.
- Remove any objects that are no longer necessary.
- Mark areas where there is a danger of tripping with yellow and black striped tape.

2.8 Safety equipment

The operator must have the following safety equipment in place:

Before the engine is placed into operation, install the emergency-off equipment and connect it into the safety chain of the system.

Connect the emergency-off equipment so that dangerous situations to people and property are avoided in case the its power supply is interrupted or is turned back on after an interruption.

The emergency-off equipment must always be freely accessible.

⚠ WARNING

Danger to life due to non-functioning safety equipment

For this reason:

- Before commencing work, check that all safety equipment is functioning and correctly installed.
- Before starting the engine, check that all safety equipment is functioning and correctly installed.

2.9 Response to danger and accidents

Preventative Measures

- Always be prepared for an accident!
- Keep first aid equipment (first aid kit, blankets, etc.) and fire extinguishers at hand.
- Regularly check first-aid equipment and fire extinguishers for completeness and correct functioning.
- Familiarise the personnel with the emergency, first aid and rescue equipment.
- Instruct the personnel on safety on a regular basis.
- Always keep access lanes for rescue vehicles free of any obstructions.

In the case of an accident: Act accordingly

- Remain calm.
- Immediately shut down engine using the emergency-off button.
- Start first-aid measures.
- Alert rescue services and/or fire department.
- Move people out of the danger zone.
- Clear access lanes for rescue vehicles.
- Inform the person in charge.

⚠ CAUTION

Accidents despite preventative measures
Should an accident occur despite all preventative measures, e.g. due to one of the reasons listed below,

call a doctor immediately:

- Contact with caustic acids.
- Penetration of fuel into the skin.
- Scalding by hot oil or coolant.
- Antifreeze sprayed into the eyes, etc..

2.10 Signs

⚠ WARNING

Risk of injury due to illegible symbols
Labels and symbols get dirty over time, rendering them illegible.

For this reason:
- Always keep the safety, warning and operational signs in good legible condition.
- Clean or replace illegible safety, warning and operational signs.

The following symbols should be installed in the immediate vicinity of the hazard area.

Access forbidden

Areas displaying this sign must not be entered.

Electric Voltage

Spaces marked with this symbol may only be accessed by qualified electricians.

Unauthorised persons may not enter these spaces.

Hot Surfaces

Hot surfaces such as hot engines and hot fluids may not always be recognisable. Do not touch these surfaces without protective gloves.

Danger to life due to suspended loads
During lifting operations, loads can swing out and fall down. This can cause serious injury and even death.

Risk of injury
Failure to follow the instructions poses a risk of injury.

2.11 Weight data E3268 LE212/LE222

Ensure that suitable lifting gear is used for handling the engine and the engine parts listed in the table.

Part	Weight (kg)
Oil pan 95l	27
Crankcase	459
Crankshaft	131
Flywheel housing	30
Flywheel	66
Exhaust turbocharger 1500 rpm	38
Charge mixture cooler E3268	88
Engine carriage	107

2.12 Environmental protection

ENVIRONMENTAL NOTE

Risk of environmental pollution due to incorrect handling of service products
Serious environmental damage can result.

For this reason:
- Follow the safety instructions.
- Take suitable measures immediately if environmentally hazardous substances escape into the environment.
- Inform the relevant local authorities of the damage.

The following environmentally hazardous substances are used:

Lubricants

Lubricants such as grease and oils contain poisons and environmentally hazardous substances. They must not be allowed to be released into the environment. Disposal must be performed by a qualified disposal company.

Coolants

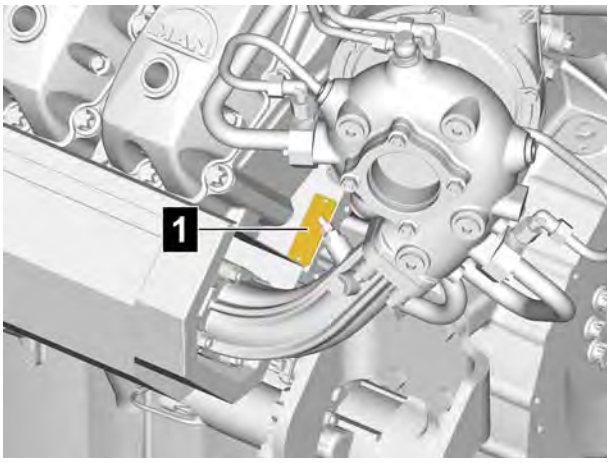
Coolants can contain poisons and environmentally hazardous substances. They must not be allowed to be released into the environment. Disposal must be performed by a qualified disposal company.

3 Engine model plate

Always quote the engine type 3, engine number 4 and factory number/order number 5 in all enquiries and communications.

Before the engine is first commissioned, you should therefore check the relevant data on the engine model plates and enter it below.

The engine model plates 1 and 2 are attached to the crankcase.



Model 3

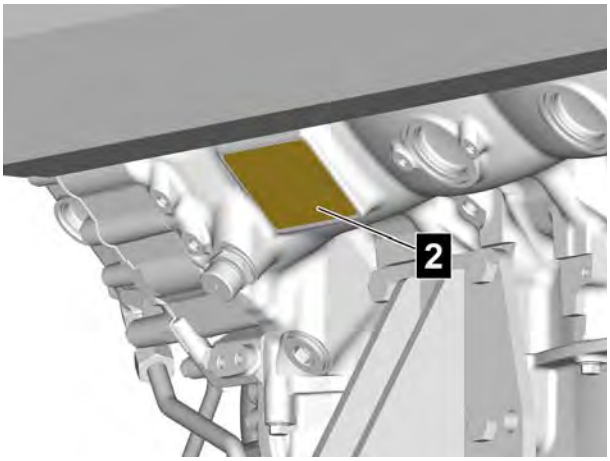
.....

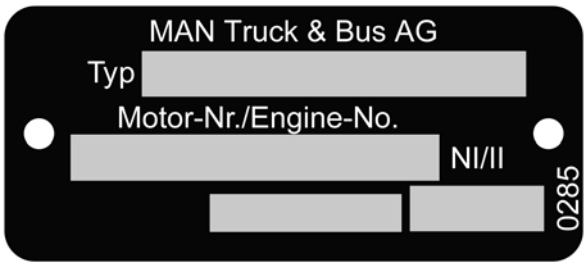
Engine number 4

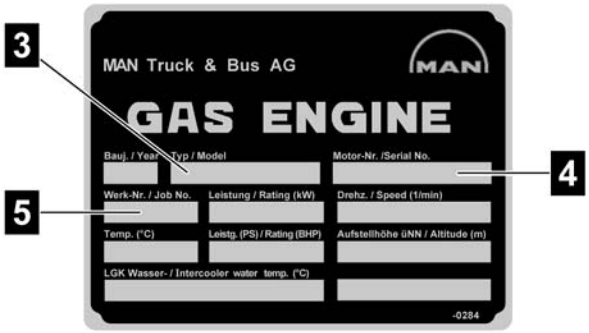
.....

Factory number/order number 5

.....







3.1 Explanation of Motor-Nr./Engine No. (engine identification number)

Class identifier (assignment)	1	2	3	4
Motor-Nr./Engine No.	XXX	XXXX	XXX	XXXX
1 Model number after model code				
2 Day of assembly (determined internally at factory)				
3 Assembly sequence (consecutive number on day of assembly)				
4 Production- and equipment-specific data				

3.2 Explanation of model designation

Model designation	Explanation	Example
E	Fuel type	Natural gas/biogas
32	Figure + 100	132 mm bore
6	Stroke figure (rounded)	157 mm stroke
8 / 2	Number of cylinders	8, 12 cylinders
L	Charging	with charging and charge mixture cooling
E	Engine installation	Installation engine
202/212/222	Model designation identification	Development number

4 Design and function

4.1 Engine application fields

The 8- and 12-cylinder engines described here are liquid-cooled 4-stroke petrol engines with exhaust gas turbocharger and mixture cooling.

4.2 Engine design and engine equipment

Engines E3268 LE212, E3268LE222 and E3262 LE202, E3262 LE212 are 8- or 12-cylinder gas engines with turbocharger and mixture cooling.

Split crankcase, wet cylinder liners made of highly wear-resistant special centrifugal casting, aluminium piston with cooling duct for piston cooling. Single cylinder heads with shrink-fitted valve seats and pressed-in valve guides. 4 valves per cylinder. Valve control via central camshaft, roller tappets, tappet push rods and rocker arms (OHV).

Charge mixture system

The charge mixture system consists of the charge mixture cooler, the charge mixture manifolds, the throttle valve and the air distributor pipes.

Gas supply line

The gas supply line - consisting of ball cock, gas filter, solenoid valves, gas pressure regulator, gas mixer and air filter - is not supplied by MAN.

Engine Lubrication

Force-feed lubrication with two lubrication oil pumps for crankshaft, conrod and camshaft bearings as well as piston pin sockets, roller tappet and rocker arm.

Oil filtration through oil modules with integrated oil cooler and crankcase breather in main flow. Auxiliary units such as turbocharger are connected to the engine lubrication oil circuit.

Intake and Exhaust System

Dry exhaust pipes.
For E3268, one exhaust turbocharger; for E3262, two exhaust turbochargers.
The exhaust turbochargers are lubricated via the engine's main flow oil circuit.

The intake air flows through the air filter to the gas mixer and then to the turbocharger(s). The now precompressed air/gas mixtures are supplied to the engine after mixture cooling.

Flywheel housing and flywheel

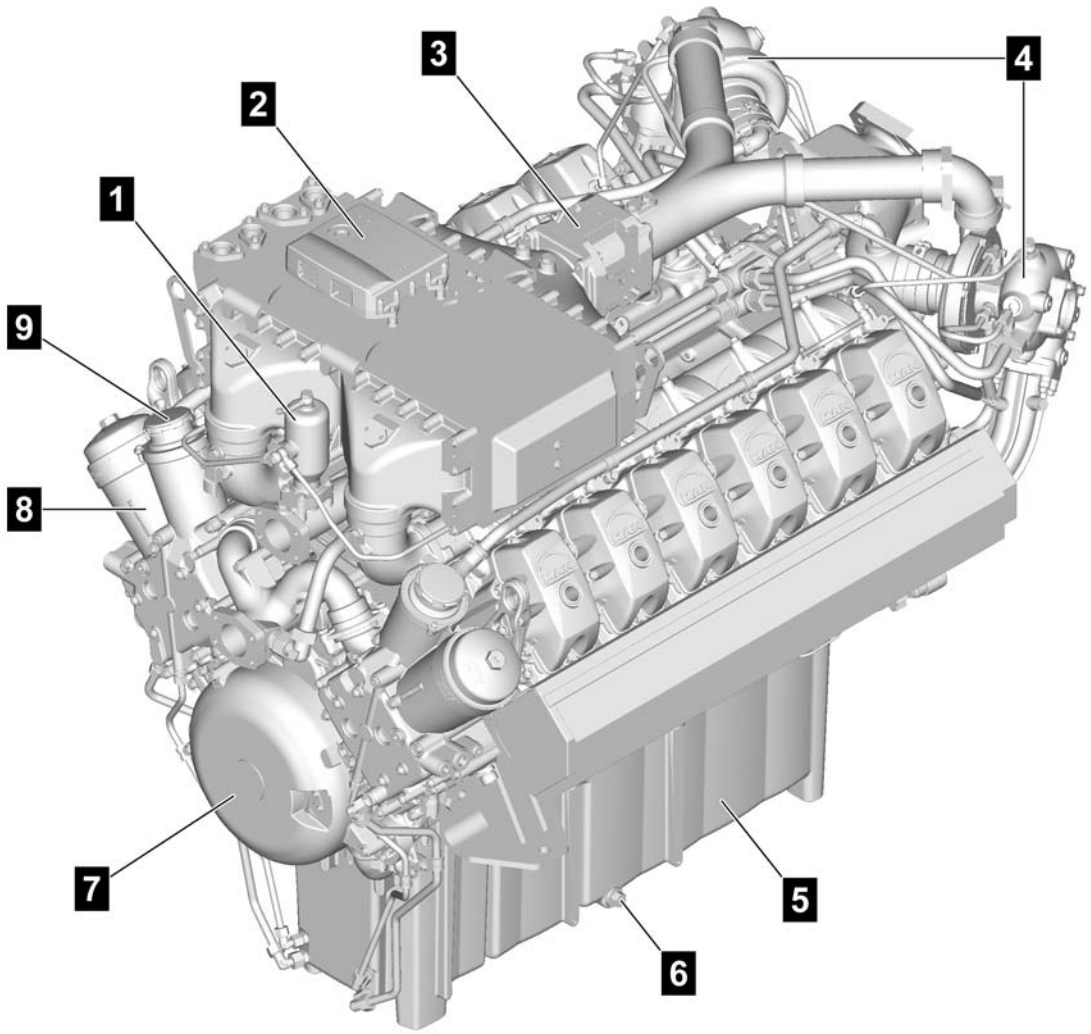
The flywheel housing as a connection to SAE1.
Different flywheel versions can be supplied, depending on the type of application.

Starter

The electric starter is of two-pin, insulated design. The starter can be mounted on the left or right of the engine.

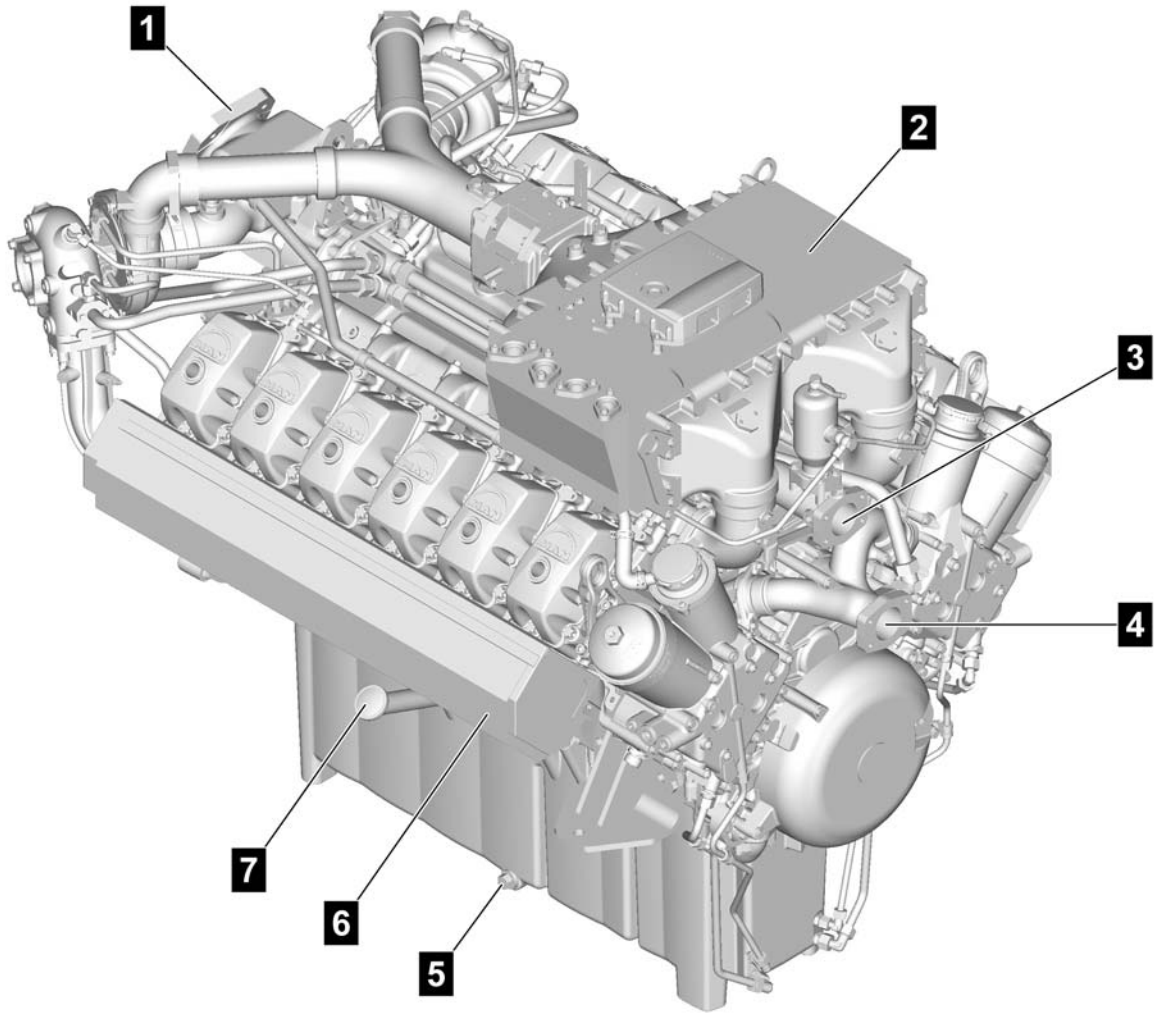
4.3 Engine views E3262 LE202

4.3.1 Front left view



1 Vent housing for coolant
2 Data acquisition
3 Throttle valve
4 Exhaust turbocharger
5 Oil pan
6 Oil drain plug
7 Protective cover for crankshaft and vibration damper
8 Oil filter
9 Oil separator

4.3.2 Front right view



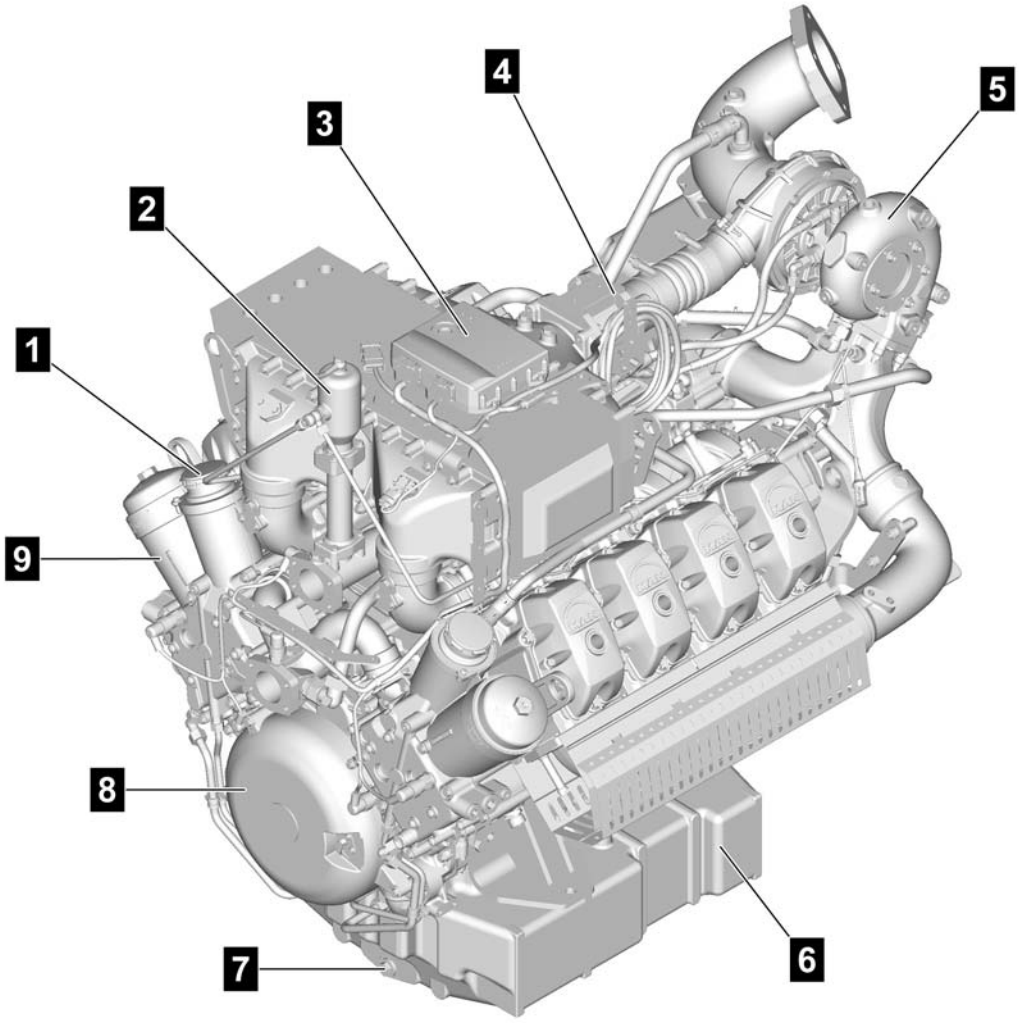
1 Intake manifold
2 Charge mixture cooler
3 Coolant outlet
4 Coolant inlet
5 Oil drain plug
6 Heat protection cover
7 Oil filler neck

User tip

The gas supply line - consisting of ball cock, gas filter, solenoid valves, gas pressure regulator, gas mixer and air filter - is not supplied by MAN.

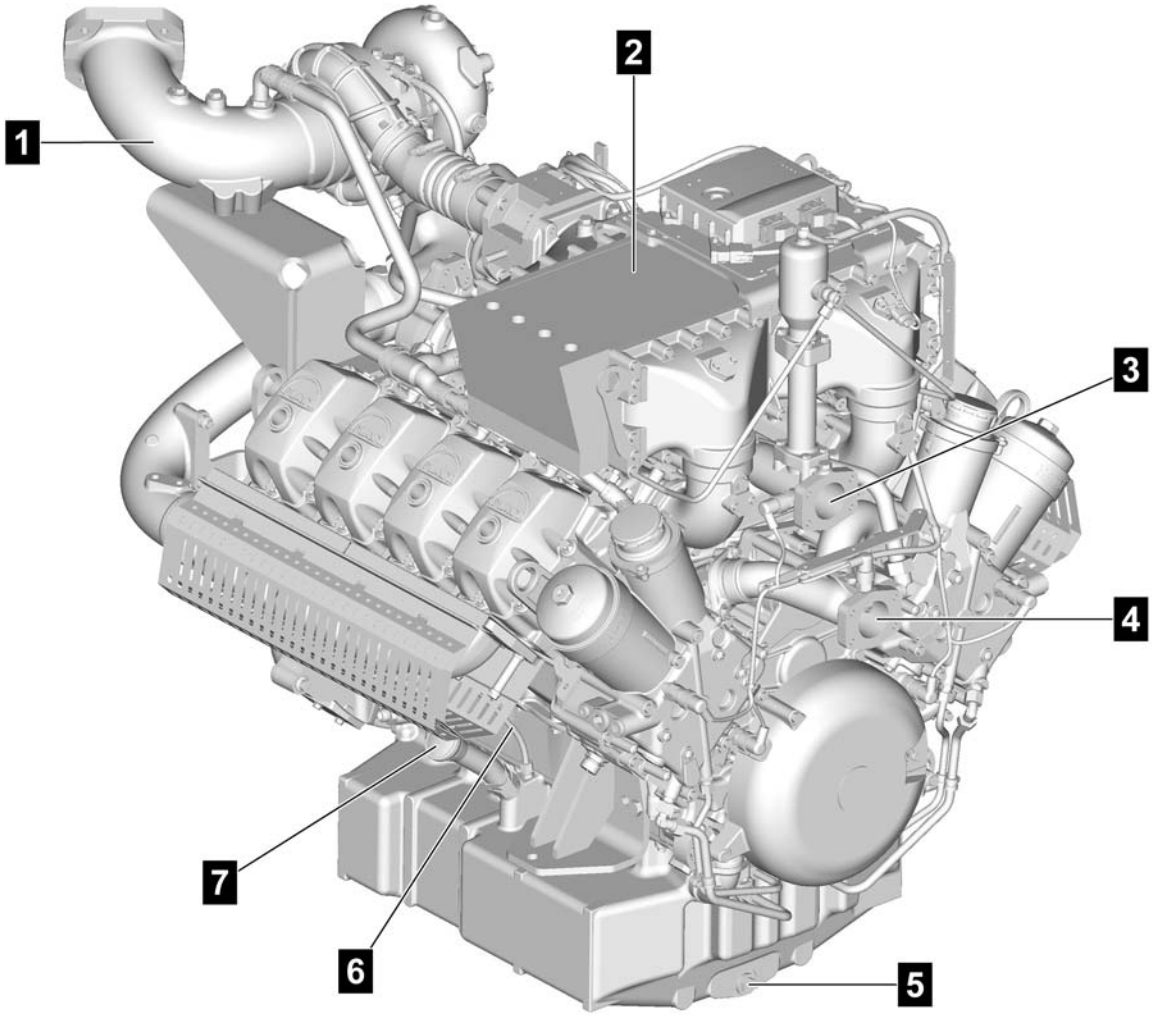
4.4 Engine views E3268 LE212

4.4.1 Front left view



1 Oil separator
2 Vent housing for coolant
3 Data acquisition
4 Throttle valve
5 Exhaust turbocharger
6 Oil pan
7 Oil drain plug
8 Protective cover for crankshaft and vibration damper
9 Oil filter

4.4.2 Front right view



1 Intake manifold
2 Charge mixture cooler
3 Coolant outlet
4 Coolant inlet
5 Oil drain plug
6 Oil dipstick
7 Oil filler neck

User tip

The gas supply line - consisting of ball cock, gas filter, solenoid valves, gas pressure regulator, gas mixer and air filter - is not supplied by MAN.

5 Transport, packaging and storage

It is absolutely necessary to observe the “Installation Instructions” for the installation and commissioning of a new or reconditioned engine.

User tip

Installation and commissioning is only to be performed by the employees of the manufacturer of the entire system or by manufacturer authorised personnel.

5.1 Requirements

Before starting any work read and observe the General Safety Instructions and the safety information in this chapter.
Strictly observe these instructions and act prudently to avoid accidents, personal injury and property damage.

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Protective Helmet
- Safety Shoes
- Safety Gloves

5.2 Safety instructions

Heavy Suspended Loads

WARNING

Danger to life due to suspended loads
During lifting, loads can swing out and drop.

For this reason:
- Do not stand under or remain in the swivel range of the suspended load.
- Only move the load under supervision.
- Only use approved lifting equipment and accessories with sufficient load capacity.
- Never use torn or scuffed lifting equipment such as ropes or straps.
- Do not let lifting equipment such as rope or straps come into contact with sharp edges and corners and do not twist or knot them.
- Before leaving the work area, lower load to ground.

Off-Centre Point of Gravity

⚠ WARNING

Danger to life due to incorrect handling of transported item
Transported item can swing out, tilt and/or drop.

For this reason:
- Use the crane hook lugs solely for transporting the engine without attachments (without alternator).
- Observe the information and markings on the package concerning centre of gravity.
- When transporting with a crane, the hook must be placed so that it is directly above the package's centre of gravity.
- Carefully raise the package and observe its movement. If necessary, change the position of the lifting equipment.
- Handle transported items carefully and note the symbols and instructions on the packaging.
- Use lifting gear. Diagonal pull not permitted.

Swingout of Packages being Transported

⚠ WARNING

Risk of injury due to transported item swinging out
Transported item can cause injury and damage

For this reason:
- Ensure that during the transport of packages, no persons, objects or obstacles are in the swivel range of the packages being transported.

Unauthorised Transport

NOTE

Risk of damage due to untrained personnel

For this reason:
- Only trained personnel are allowed to unload the transported items.
- Unauthorised transport or attachment/removal of transport aids is not permitted.
- No unauthorised removal of packaging permitted.

Improper Transport

NOTE

Damage due to improper transport
Improper transport can cause packages to fall or tip over. This could cause considerable property damage.

For this reason:
- Carefully handle the packages when unloading during delivery and when transporting them within the company. Observe the symbols and instructions on the packages.
- Only use the prescribed lifting points.

5.3 Transport inspection

Check the delivery for missing items and for damage from transport.

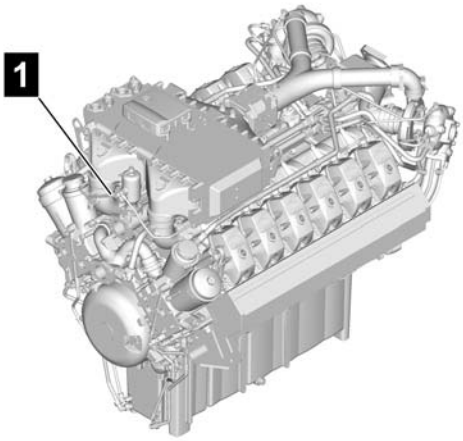
If external signs of transport damage are apparent:

- Do not accept delivery or only accept under written protest.
- List scope of damage on the transport documents or on the transportation company's packaging slip.
- Initiate a claims process.

User tip

Make sure to claim each damage case as soon as it is discovered. Damage claims can only be claimed within the applicable time limits.

During work on the engine, the engine **1** must not be accessed!



5.4 Transport

DANGER

Falling loads (weight 2000kg!) can lead to serious accidents

For this reason:

- Use sufficiently dimensioned crane lifting gear for lifting an engine!
  Ropes and chains must exert vertical tension (tolerance 5°) on the crane hooks.
  Crane lifting gear, ropes and chains must be in perfect condition.

WARNING

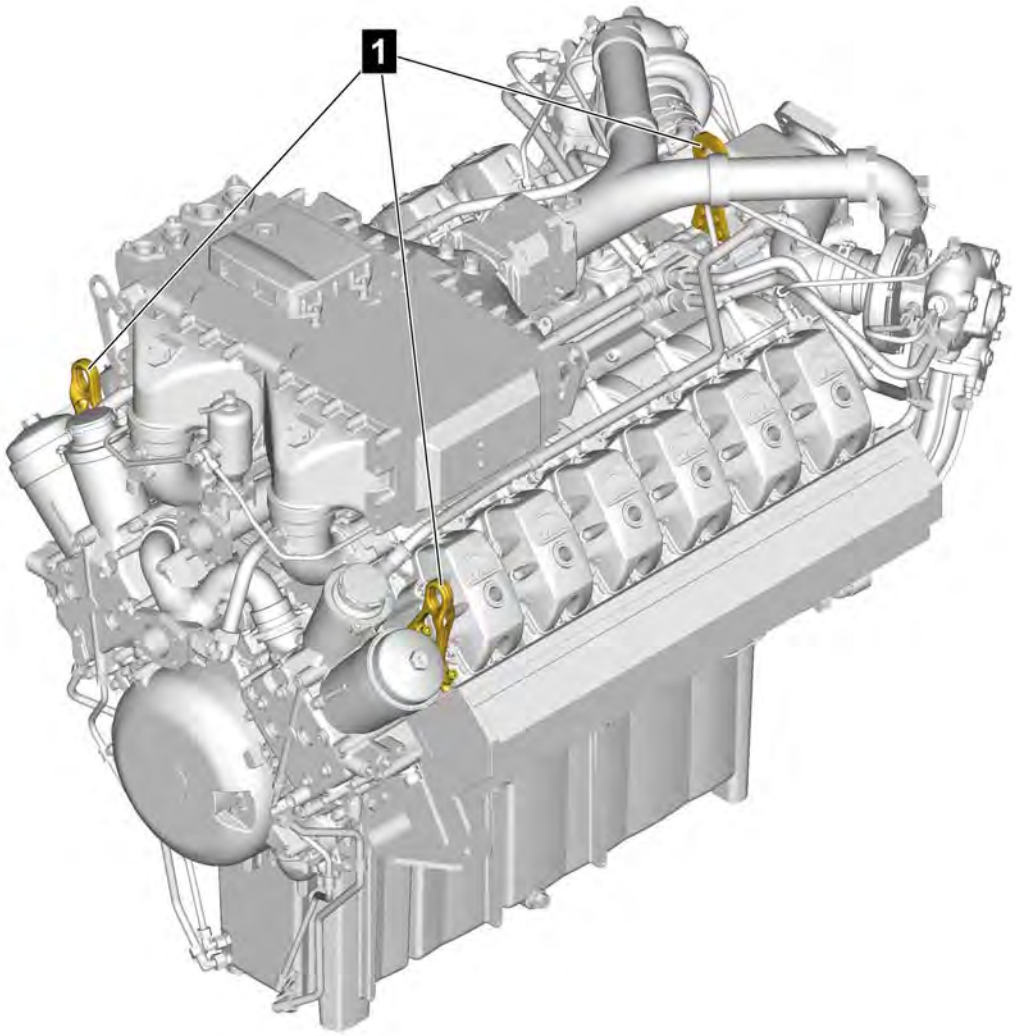
Danger to life due to incorrect handling of transported item

Transported item can swing out, tilt and/or drop.

For this reason:

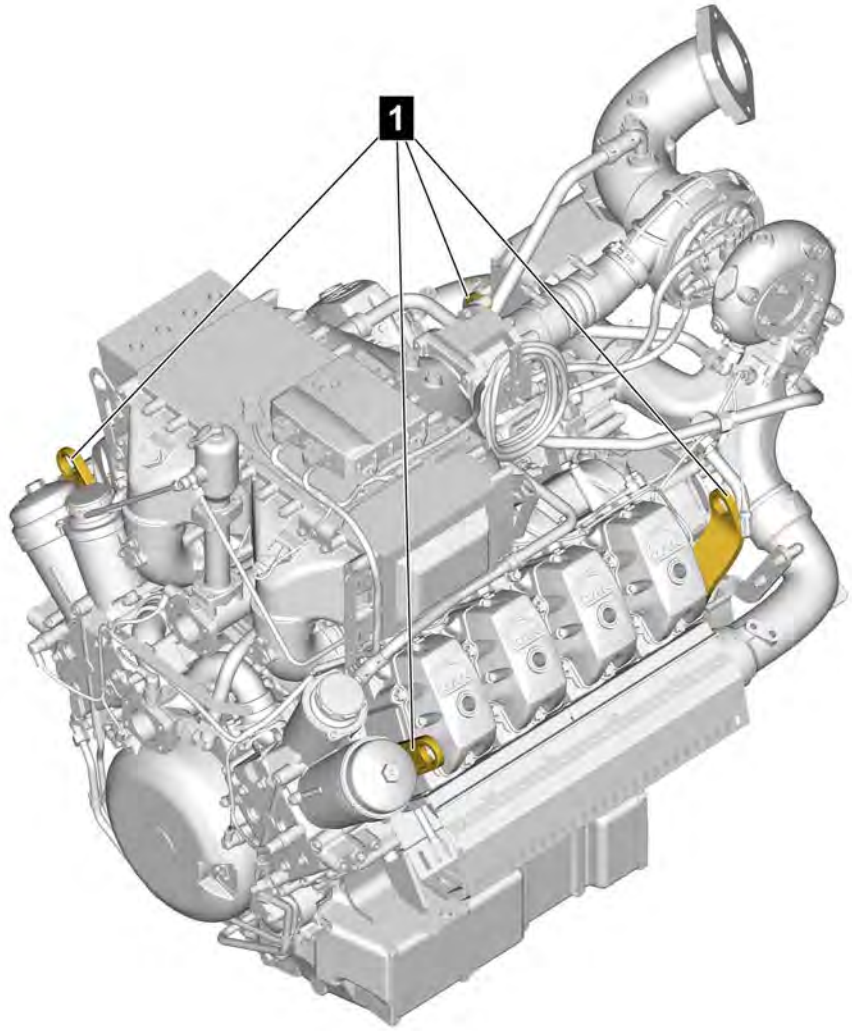
- Use the crane hook lugs solely for transporting the engine with gearbox.
- Observe the information and markings on the package concerning centre of gravity.
- When transporting with a crane, the hook must be placed so that it is directly above the package's centre of gravity.
- Carefully raise the package and observe its movement. If necessary, change the position of the lifting equipment.
- Handle transported items carefully and note the symbols and instructions on the packaging.
- Use lifting gear. Diagonal pull not permitted.

Attachment points E3262 LE202, E3262 LE212



For lifting the engine, 3 crane hook lugs 1 are attached to the engine.

Attachment points E3268 LE212, E3268 LE222



For lifting the engine, 3 crane hook lugs 1 are attached to the engine.

Transport with Crane

The engine can be transported with a crane under the following conditions.

- The crane and the lifting equipment must be designed for the weight of the engine.
- Ropes and chains must not exert diagonal pull on the crane hooks.
- The operator must be qualified for operating the crane.

1. Attach the ropes, straps or multipoint lifting equipment according to the picture.
2. Ensure that the package is hanging straight or compensate for the off-centre point of gravity.
3. Start the transport.

Transport with Forklift

The engine can be transported with a forklift under the following conditions.

- The forklift must be designed for the weight of the engine.
- The engine must be securely mounted on the pallet.
- The pallet must not be damaged.
- The forklift operator must be qualified and authorised to operate the forklift.

1. Insert the fork of the forklift between or under the pallet's struts.
2. The fork must be inserted into the pallet until it protrudes from the other side.
3. Ensure that the pallet cannot tip over if the centre of gravity of off-centre.
4, Lift the pallet and transport it to the desired location.

5.5 Packaging

Packaging

The individual packages are packed in accordance with the expected conditions of transport.

The purpose of the packaging is to protect the components from transport damage, corrosion and other damage. For this reason do not unpack components until shortly before they are to be assembled.

Handling Packing Material

Dispose of packing material according to the valid local and statutory regulations.

ENVIRONMENTAL NOTE

Incorrect disposal of packaging materials poses an environmental hazard

- Dispose of packing materials in an environmentally friendly manner.
- Observe the valid local regulations. If necessary, contact a professional disposal company.

5.6 Storage

Storage of packages

Store packages under the following conditions:

- Do not store in the open.
- Store in a dry and dust-free environment.
- Do not expose to damaging chemicals.
- Protect from sunlight.
- Avoid any physical shocks.
- Storage temperature: 15 to 35 °C.
- Relative air humidity: max. 60%.
- If stored for more than 3 months, regularly check the condition of the packaging. If necessary, renew or replace the preservation.

User tip

Some of the packages may have information printed on them regarding their proper storage. Please observe this information.

6 Installation and commissioning

6.1 Notes regarding installation and commissioning

6.1.1 Requirements

Before starting any work read and observe the General Safety Instructions and the safety information in this chapter.
Strictly observe these instructions and act prudently to avoid accidents, personal injury and property damage.

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Safety Shoes
- Safety Gloves

6.2 Safety instructions

Personnel

- The installation and commissioning may only be performed by MAN employees or by MAN-trained qualified personnel.

⚠ WARNING

Danger caused by faulty installation and commissioning!
Installation and commissioning require trained qualified personnel with sufficient experience. Faulty installation can cause life threatening situations and considerable property damage.

For this reason:
- Installation and commissioning may only be performed by expert personnel trained by MAN.

Ground Rules

⚠ WARNING

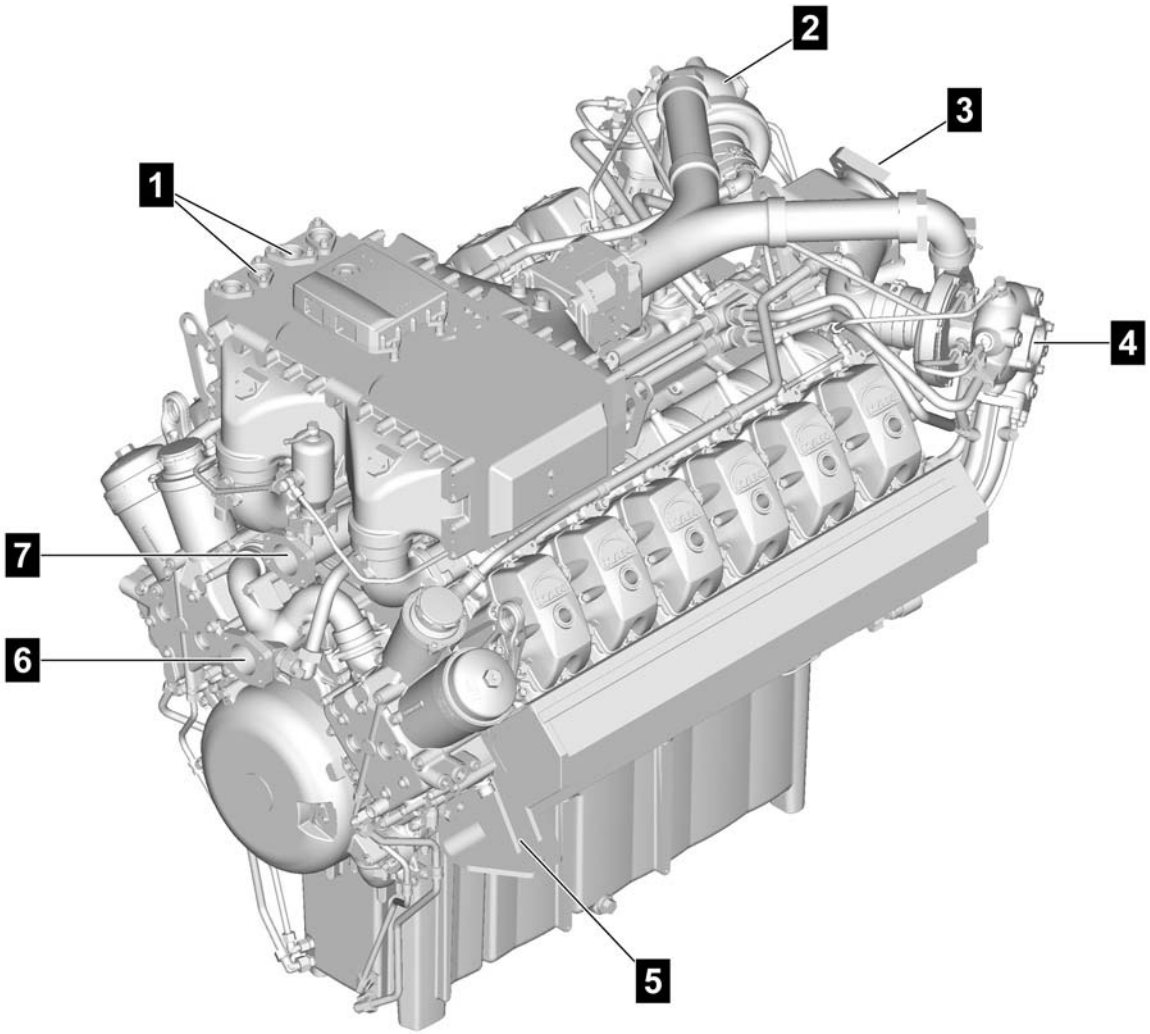
Risk of injury due to improper installation and commissioning
Improper installation and commissioning can cause serious personal injury or considerable property damage.

For this reason:
- Ensure adequate work space before starting any work.
- Be careful when working with exposed parts with sharp edges.
- Make sure work space is kept clean and orderly!
- Install components in a correct manner.
- Observe the prescribed tightening torques.
- Secure components so that they do not fall or tip over.

- Before commissioning the engine, carefully read the Operating Instructions and familiarise yourself with the “critical” subjects.
- It is absolutely necessary to observe the “Assembly Instructions” for the installation and commissioning of a new or reconditioned engine.
- For safety reasons we recommend placing an off limits sign on the door to the engine room and to instruct the operating personnel that they are responsible for the safety of people who enter the engine room.

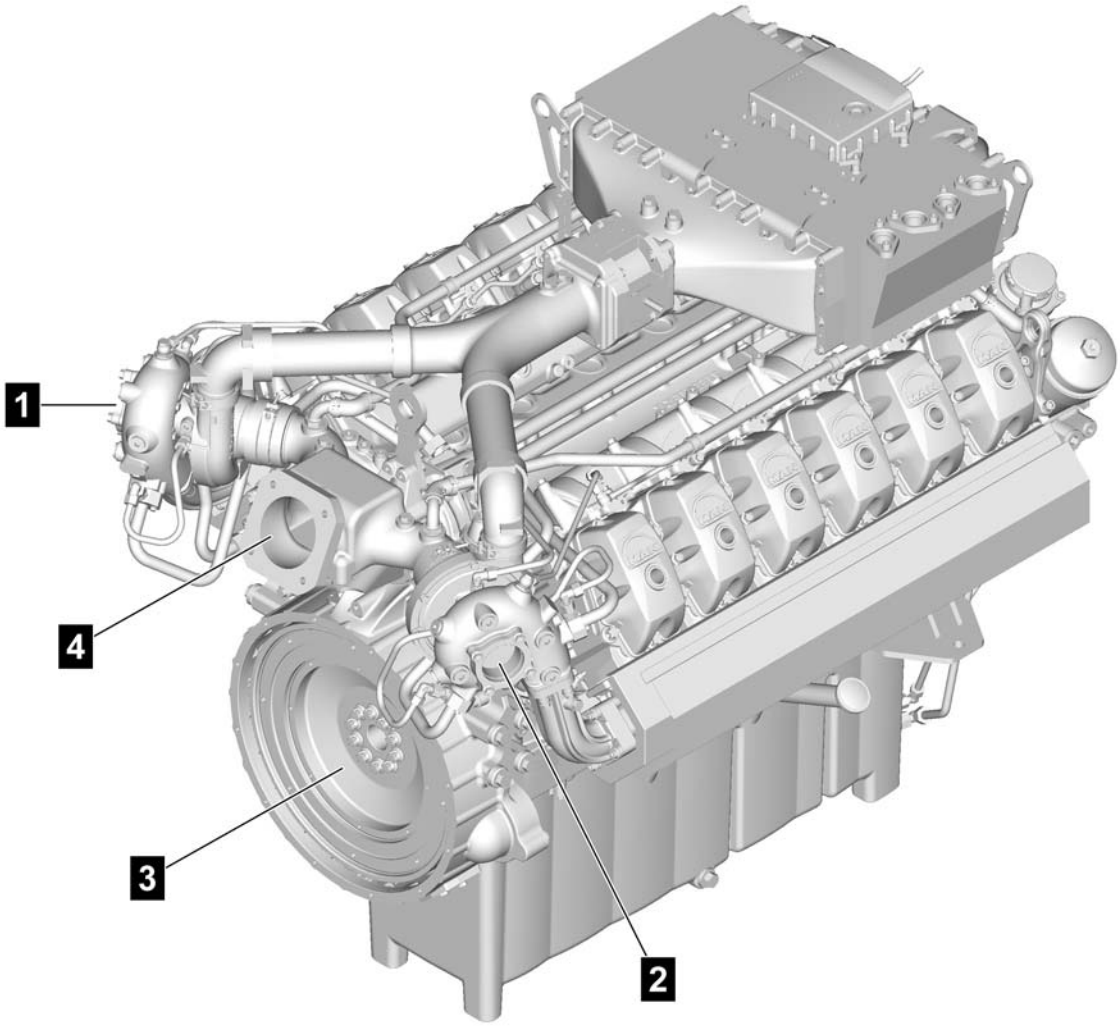
6.3 Engine installation

6.3.1 Interfaces between engine and plant



1 Coolant connections on charge mixture cooler
2 Exhaust turbocharger
3 Intake manifold
4 Exhaust turbocharger
5 Engine mounting
6 Coolant inlet
7 Coolant outlet

2 and 4 Mount exhaust system, see page 49
3 Mount gas inlet, see page 48
6 and 7 Connect cooling system, see page 47



1 Exhaust turbocharger
2 Exhaust turbocharger
3 Flywheel
4 Gas inlet

When installing the engine, perform the following assembly work on the interfaces between engine and plant:

1 and 2 Mount exhaust system, see Installation Instructions
3 Mount alternator, see page 45
4 Connect gas inlet, see page 48

6.3.2 Installation Instructions

Only general engine installation instructions can be given in this chapter.
More detailed information can be found in the “Installation Instructions for MAN Industrial Gas Engines”.
These instructions can be obtained from MAN, see page 2 for contact address.

6.3.3 Installation drawing

The installation drawing provides information about the type of connections and the connection dimensions. Depending on the scope of delivery, wiring diagrams, layout diagrams for the resilient engine mounts etc. may be required. These can be obtained from MAN, see page 2 for contact address.

NOTE

Engine installation is based on the installation instructions and the installation drawing.

For this reason:
- Observe these sources of information for each of the assembly jobs listed hereafter.

6.3.4 Screw and bolt connections

Always tighten screw and bolt connections using a torque wrench.
The assembly tightening torques for all common screw and bolt connections are listed on page 52.

NOTE

Risk of damage due to incorrectly tightened screw and bolt connections
Components get damaged.

For this reason:
- Use impact wrench for pretightening to max. 50% of the specified final torque.
- Always use a torque wrench for final tightening.

6.4 Completion of the engine and assembly of the drive system

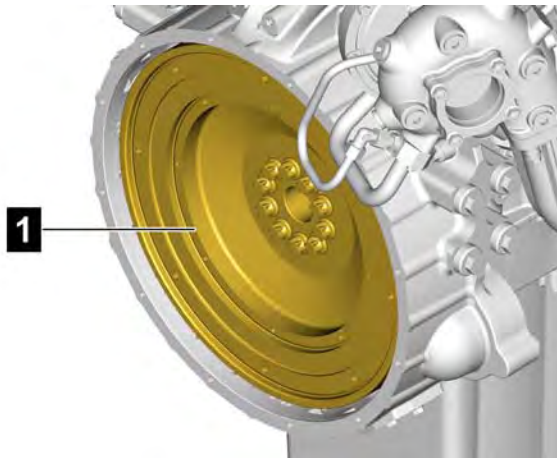
When installing the engine, ensure that there is enough space to perform the regular maintenance work specified in the maintenance schedule.

6.4.1 Mounting an alternator on the flywheel housing

Flywheel

The connection dimensions of the flywheel 1 are indicated on the installation drawing.

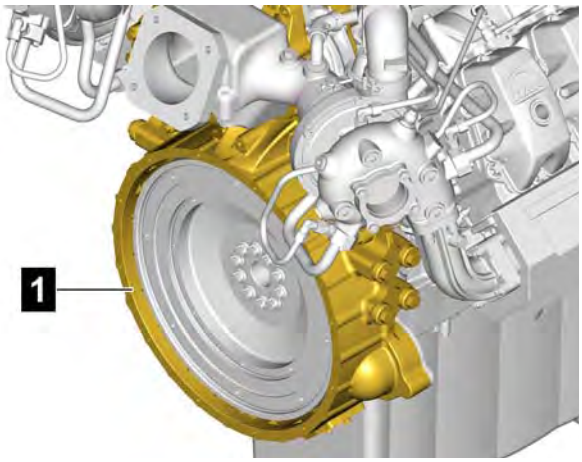
- Remove oil, grease and preservative from the flywheel.



Flywheel housing

> **User tip**
>
> For screw and bolt tightening torques, see page 52.

Information regarding the dimensions of the flywheel housing 1 and the type of screw and bolt connections for mounting the alternator can be found on the installation drawing.



6.4.2 Checking crankshaft axial clearance

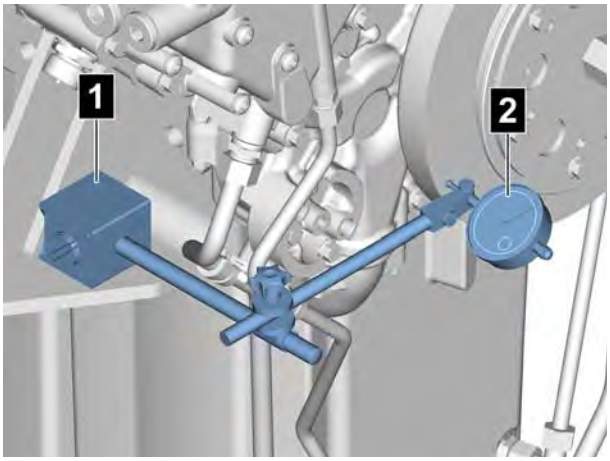
NOTE

The engines' crankshaft axial clearance specified in the design must not be reduced under any circumstances as a result of mounting clutches or other attachments.

For this reason:

- It is essential to determine the crankshaft axial clearance using a dial gauge held on a magnetic stand before **and after** flange-mounting any attachments.

- Remove V-belt protection.
- Position the dial gauge holder 1 with dial gauge 2 on the engine mounting so that the dial gauge tracer pin is resting on the vibration damper with a preload.
- Push the crankshaft towards the flywheel housing in axial direction until the stop is reached.
- Zero the dial gauge.
- Pull the crankshaft away from the flywheel housing in axial direction until the stop is reached
- Check the reading on the dial gauge.



If the results of both measurements do not match, or if the crankshaft springs back after being moved, check the mounting.

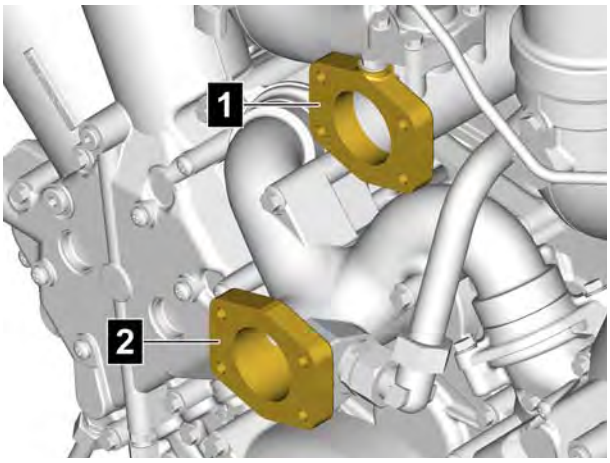
Engines	Crankshaft axial clearance
E3268LE202 / E3262 LE202	0.20-0.40 mm

6.5 Connecting the cooling system

6.5.1 Connecting the engine cooling

The installation drawing provides information about the connections.

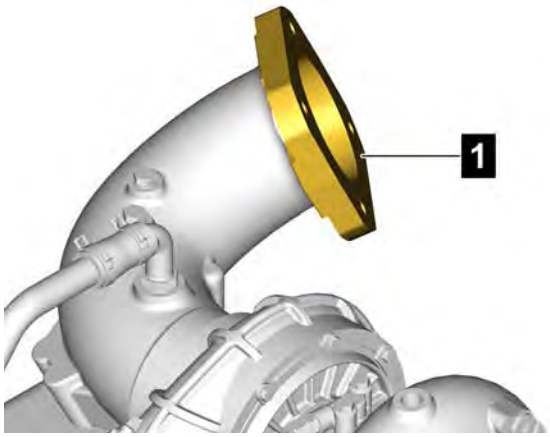
- Connect the coolant outlet 1
- Connect the coolant inlet 2

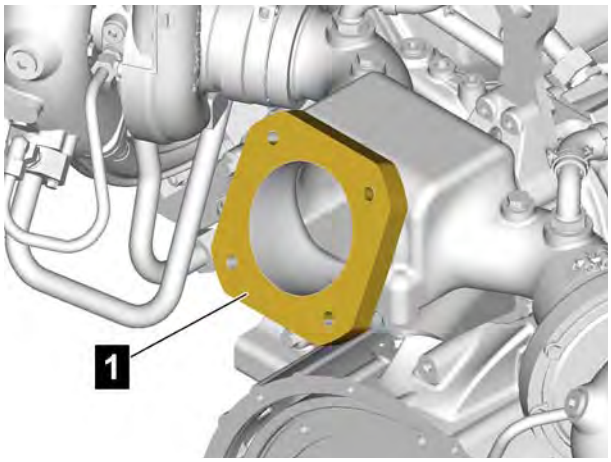


6.6 Mounting the gas inlet

Both cylinder banks merge into a central gas inlet.

The dimensions of the flange 1 for connecting the plant-side gas inlet can be found on the installation drawing, see page 97.



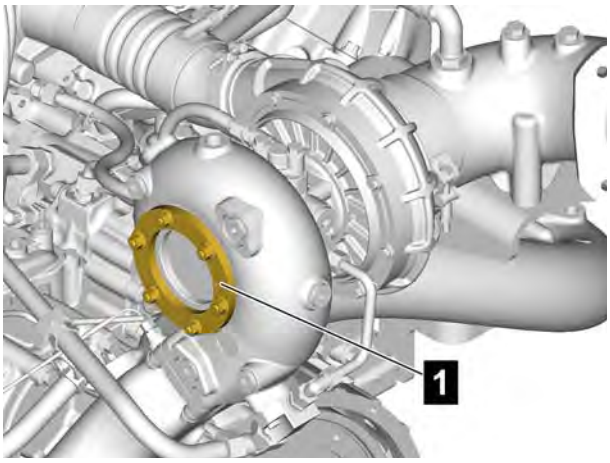


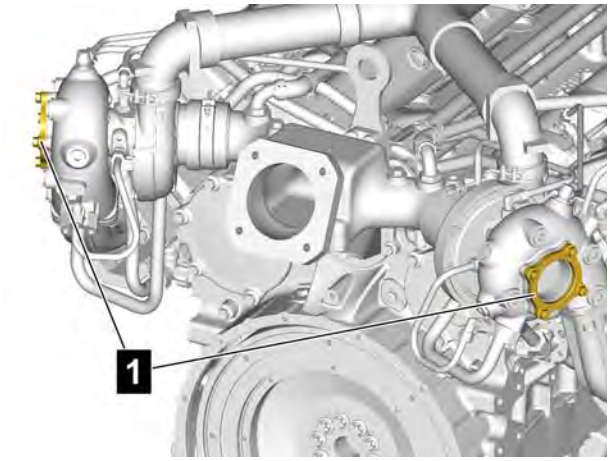
6.7 Mounting the exhaust system

6.7.1 Exhaust gas outlet on engine

The dimensions of the flange 1 for connecting the plant-side exhaust system can be found on the installation drawing, see page 97.

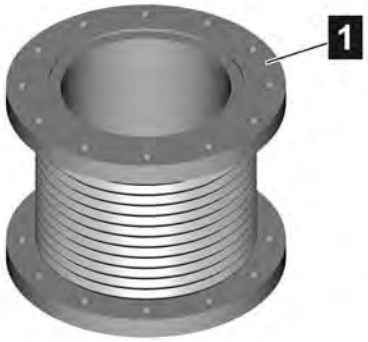
- Connect the exhaust system to the flange 1 on the exhaust turbocharger(s).





6.7.2 Connecting the exhaust system to the engine

Flexible connecting elements which allow engine movements due to the flexible engine mounting and decouple the engine from the exhaust system in terms of vibration must be installed between the engine and the exhaust system.
Example: compensator 1



NOTE

Component damage due to forces acting on the turbocharger.

For this reason:
- Exhaust gas lines must be fastened and supported so that no forces act on the turbocharger.

6.8 Connecting the electrical system

NOTE

Component damage due to corrosion

For this reason:

- The starter battery's negative lead must be fed back to starter terminal 31.
- Connect the engine and all pipe connections from and to the engine with the plant potential using ”ground cables”.

In the case of dual engine plants, independent wiring is required for each engine, i.e. the engines' circuits must not be linked together.

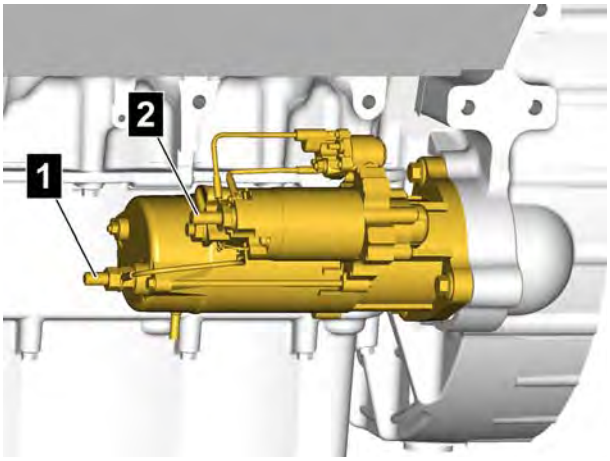
Batteries

Separate batteries for the starter must be provided for **each** engine.

6.8.1 Starter

All MAN industrial gas engines have two-pole starters. The starter battery's positive lead must therefore be fed back to terminal 30 of the starter 2, the starter battery's negative lead to terminal 31 of the starter 1 .

The starter can be mounted either on the left or the right of the engine.



6.9 Torques for screw and bolt connections to Works Standard M 3059

Screws and bolts / nuts with external- or internal hex, head without collar or flange

Thread size x pitch	Strength classes / tightening torques in Nm		
	for **8.8 / 8**	for **10.9 / 10**	for **12.9 / 12**
M4	2.5	4.0	4.5
M5	5.0	7.5	9.0
M6	9.0	13.0	15.0
M7	14.0	20.0	25.0
M8	22.0	30.0	35.0
M8x1	23.0	35.0	40.0
M10	45.0	65.0	75.0
M10x1.25	45.0	65.0	75.0
M10x1	50.0	70.0	85.0
M12	75.0	105.0	125.0
M12x1.5	75.0	110.0	130.0
M12x1.25	80.0	115.0	135.0
M14	115.0	170.0	200.0
M14x1.5	125.0	185.0	215.0
M16	180.0	260.0	310.0
M16x1.5	190.0	280.0	330.0
M18	260.0	370.0	430.0
M18x2	270.0	290.0	450.0
M18x1.5	290.0	410.0	480.0
M20	360.0	520.0	600.0
M20x2	380.0	540.0	630.0
M20x1.5	400.0	570.0	670.0
M22	490.0	700.0	820.0
M22x2	510.0	730.0	860.0
M22x1.5	540.0	770.0	900.0
M24	620.0	890.0	1040.0
M24x2	680.0	960.0	1130.0
M24x1.5	740.0	1030.0	1220.0

6.10 First commissioning

Correct first commissioning is essential for ensuring the operational safety and reliability of the engines. If commissioning is performed incorrectly, engine damage is inevitable.

The procedure comprises several steps:

- Thorough inspection of the installation
- Filling of the engine with engine oil
- Filling of the engine with coolant, bleeding of the cooling system
- Starting of the engine
- A test run, with measurement and archiving of important data

In order to perform first commissioning, personnel require specific knowledge and skills as well as special equipment.

First commissioning may therefore only be performed by persons or workshops authorised and certified by MAN Nuremberg.

NOTE

Incorrectly performed first commissioning results in operating faults that lead to total loss of the engine.

For this reason:
- Commissioning may only be performed by personnel authorised by MAN Nuremberg.

⚠ WARNING

Danger to life due to non-functioning safety equipment

For this reason:
- Before commencing work, check that all safety equipment is functioning and correctly installed.
- Before starting the engine, check that all safety equipment is functioning and correctly installed.

6.11 Commissioning

New or reconditioned engines must not be operated during the first operating hours at loads higher than 3/4 power.

After this time period the engine can be slowly brought up to full power.

NOTE

The liability for material defects no longer applies if non-approved fuels, lubricants and coolants are used
Liability of material defects is terminated if non-approved fluids and lubricants are used.

For this reason:
- Only use approved fluids and lubricants (see “Fuels, Lubricants and Coolants..." publication).
- The requirements on the quality of gas are specified in “MAN data sheet - Minimum requirement on the quality of gas for MAN gas engines".

6.11.1 Gas system

User tip

The gas supply line is not included in MAN's scope of delivery. Commissioning, operation, monitoring of operating conditions, and maintenance of the gas system are all to be performed as described in the manufacturer's instructions.

Setting for commissioning

For commissioning the engine is to be set for the use of a suitable gas/air mixture. Any deviations from this will negatively influence the output power, the engine efficiency and the exhaust emissions.

The requirements on the quality of gas are specified in “MAN data sheet - Minimum requirement on the quality of gas for MAN gas engines".

The operating pressure of the natural gas in the gas line must be at least 20 mbar.
The gas pressure should be steady within this range.

In order to obtain a correct gas/air mixture, the intake air in the engine compartment must be at a temperature of between 10°C and 30°C.
The gas must not contain any condensation when it enters the gas mixer, see “MAN data sheet - Minimum requirement on the quality of gas for MAN gas engines".

Faults

We urgently recommend that you have faults rectified only at an authorised specialist workshop.

Air filter

The maximum pressure differential up and downstream of the filter may not exceed the following:

New	≥	10 hPA
Dirty	≦	30 hPA

.
The filter element must therefore be changed as stated in the maintenance instructions.

Gas filter

The gas filter must filter grain size ≦ 6 µm.

6.11.2 Adding coolant

ENVIRONMENTAL NOTE

Risk of environmental pollution due to incorrect handling of service products
Incorrect handling of environmentally hazardous service products can cause serious damage to the environment.

For this reason:
- Follow the safety instructions.
- Take suitable measures immediately if environmentally hazardous fuels, lubricants or coolants escape into the environment.
- Inform the relevant local authorities of the damage.

The engine's cooling system is to be filled with a mixture of tap water and antifreeze (ethylene glycol or anticorrosion agent). Coolant must be filled according to the filling specifications of the BHKW (combined heat and power plant) manufacturer.

For suitable antifreeze agents see approved Fuels, Lubricants and Coolants according to MAN 324 NF and MAN 248.

Coolant may **only be filled at the filler neck**.

- Remove cap.
- Slowly fill coolant.
- Close expansion tank.
- Run engine for approx. 15 minutes at rated speed.
- Shut off engine and carefully unscrew cap with safety valve to the first stop to release pressure, then carefully open. Add coolant if necessary.
- When adding coolant, do not add cold coolant to a warmed-up engine. Ensure that the proper mixing ratio of “water/antifreeze" is maintained.
- Check coolant before the next commissioning (with engine cold). Add coolant if necessary.
- Repeat this procedure until coolant can no longer be added.

6.11.3 Filling Engine Oil

NOTE

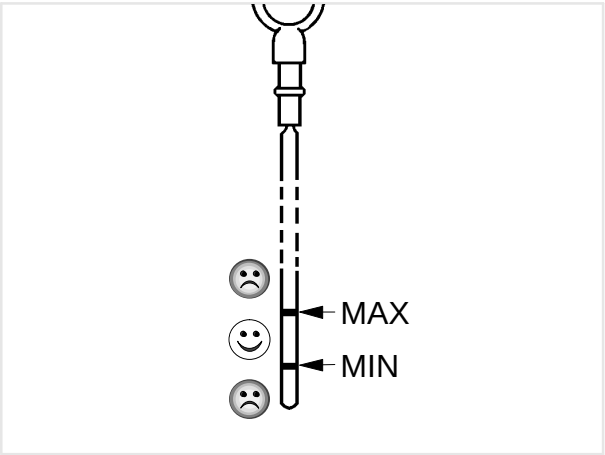
Risk of damage due to incorrect oil quantity
Engine damage

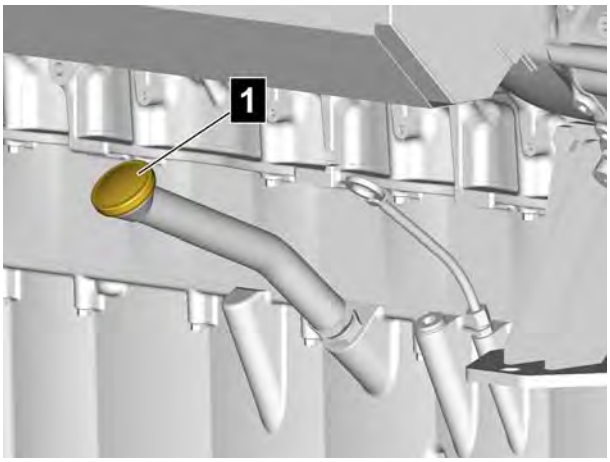
For this reason:
- Never add more than the indicated oil quantity.
- Ensure that the oil level is correct.
- Observe the min./max. mark on the oil dipstick.

1. Unscrew the cap 1 .
2. Slowly fill engine oil into the filler neck.

For oil filling capacity, see “Technical Data” page 92.

3. Screw the cap 1 back on.





7 Operation and use

7.1 Requirements

Before starting any work read and observe the General Safety Instructions and the safety information in this chapter.
Strictly observe these instructions and act prudently to avoid accidents, personal injury and property damage.

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Safety Shoes
- Safety Gloves

7.2 Safety instructions

Personnel

- Operation of the engine may only be performed by instructed personnel or by trained qualified personnel.

Ground Rules

⚠ WARNING

Danger due to incorrect operation
Incorrect operation can lead to serious injury and damage.

For this reason:
- Perform all operating steps as indicated in these instructions.
- Before commencing work, ensure that all covers and safety equipment are functioning and installed correctly.
- Never shut off any safety equipment while in operation.
- Make sure work space is kept clean and orderly.

7.3 Preparations prior to operation

Simple yet regularly performed engine inspections as part of the daily routine can prevent looming engine damage and engine failure. These inspections require neither tools nor testing equipment. Simple visual and functional checks are sufficient on a daily basis before starting the engine or after long periods of downtime. Each inspection takes just a few minutes

Experience and expertise in dealing with gas engines allow minor errors to be detected at an early stage so that major engine damage can be prevented.

User tip

Engine damage is caused by several smaller faults which, in a chain reaction, can lead to serious engine damage or the engine becoming a total write-off.

For this reason:
- Simply perform visual and functional checks regularly.
- Remedy minor faults or malfunctions immediately.

A basic requirement for trouble-free operation is the provision of service products that have been approved by MAN.

Prior to each operation, check the fuel level, coolant level and oil level.
Top up the diesel fuel, coolant and oil as necessary.

NOTE

The liability for material defects no longer applies if non-approved fuels, lubricants and coolants are used.
Liability of material defects is terminated if non-approved fluids and lubricants are used.

For this reason:
- Only use approved fuels, lubricants and coolants (see “Fuels, Lubricants and Coolants" publication“).

7.3.1 Checking the gas quality, opening the gas supply

⚠ DANGER

Danger to life due to highly inflammable materials
Fire risk due to highly inflammable materials, fluids and gases.

For this reason:
- No smoking is allowed in the danger zone.
- No naked flames or sources of ignition are allowed in the danger zone.
- Keep fire extinguishers at hand.
- Immediately report any suspicious substances, fluids or gases to the person in charge.

1. Check the gas quality, also see “MAN data sheet - Minimum requirements on gas quality for MAN gas engines".
2. Open gas supply.

7.3.2 Checking the coolant

WARNING

Risk of injury due to hot fluid
Coolant gets hot during operation and causes scalding if touched.

For this reason:
- Undo the cap with safety valve carefully.
- Drain the pressure.
- Open the cap carefully.

User tip

The cooling system is not included in MAN's scope of delivery.
Check the coolant level as indicated in the manufacturer's operating instructions.

7.3.3 Topping up the coolant

WARNING

Risk of damage due to excessive temperature difference
Engine damage

For this reason:
- Do not fill with cold coolant.
- Allow the engine to cool down.

User tip

The cooling system is not included in MAN's scope of delivery.
Add coolant according to the manufacturer's operating manual.

ENVIRONMENTAL NOTE

Do not let coolant drip or leak out while refilling. Do not let coolant leak out onto the ground or into bodies of water otherwise this will cause damage to the environment.

Fill the cooling system of the engine with a mixture of tap water and ethylene glycol antifreeze agent or anticorrosion agent.

7.3.4 Check Engine Oil Level

NOTE

Ensure that all of the engine's oil supply has collected in the oil pan

For this reason:

- Perform the oil level check with the engine in a horizontal position, having waited around 5 minutes after stopping the machine.

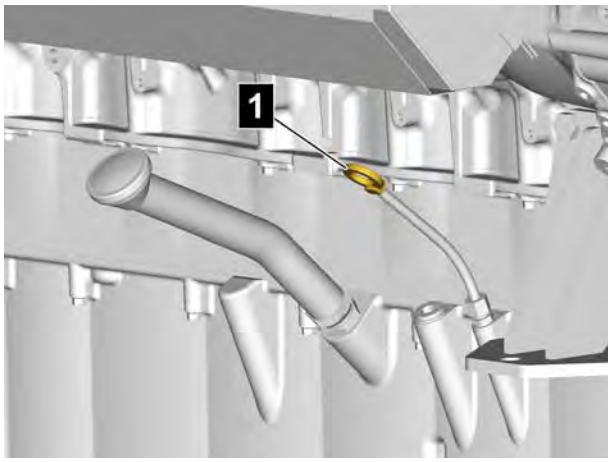
Stop the engine.

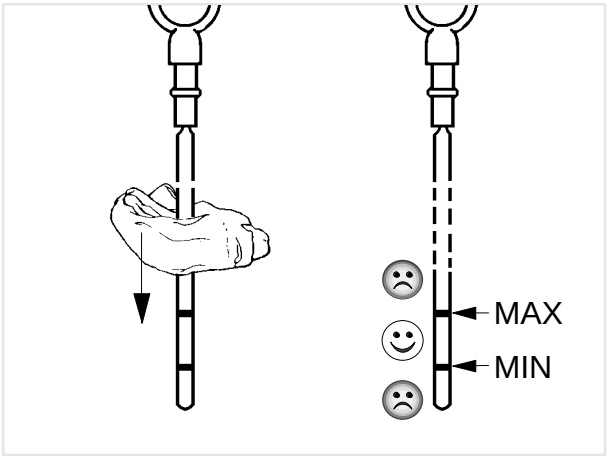
Perform the oil level check after around 5 minutes:

- Pull out the oil dipstick 1 .
- Wipe the oil dipstick 1 with a clean, lint-free cloth.
- Reinsert the oil dipstick 1 as far as the stop.
- Pull the oil dipstick 1 back out.

The oil level should be between both of the marks on the dipstick and should never drop below the lower mark.

- Top up the oil as necessary.
  Do not overfill.





7.3.5 Topping up the engine oil

NOTE

Risk of damage due to incorrect oil quantity
Engine damage

For this reason:
- Never add more than the indicated oil quantity.
- Ensure that the oil level is correct.
- Observe the min./max. mark on the oil dipstick.

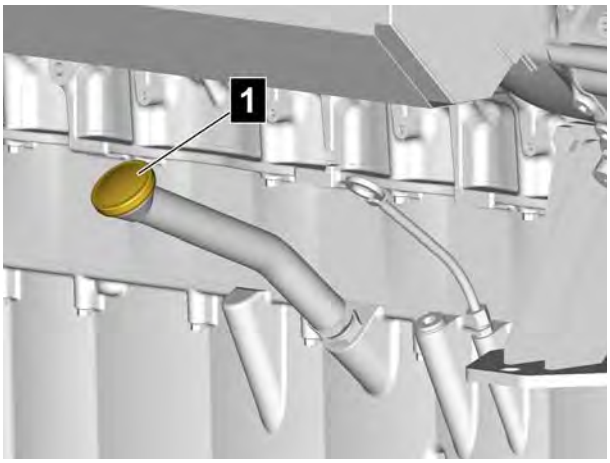
ENVIRONMENTAL NOTE

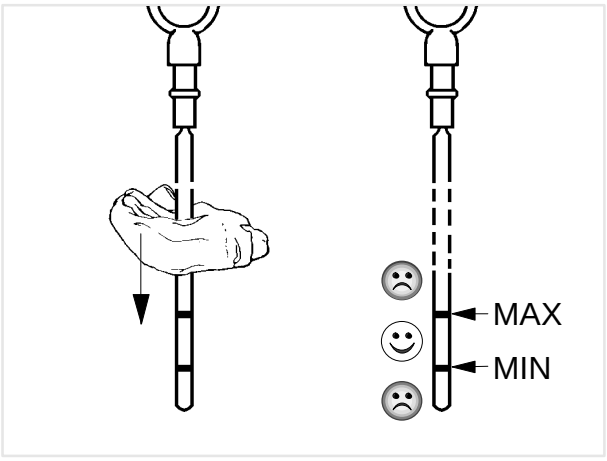
Take care not to spill engine oil when adding it. Engine oil is not allowed to enter the ground or bodies of water.

- Unscrew the cap 1 .
- Add fresh engine oil at the oil filler neck 1 .

The oil level should be between both marks on the dipstick.

- Screw the cap 1 back on.
- Check the engine oil level.





7.4 Operation

WARNING

Risk of injury due to mechanical movements, gases and noise
During operation there is a risk of injury due to movements on the engine and the engine emissions.

For this reason:
- Access to operating room is only allowed for maintenance/repairs.
- Access to operating room is prohibited when engine is running.
- Ensure that no persons are in the operating room and secure it to prevent unauthorised access.

WARNING

Health risk due to leaking exhaust system
Exhaust gases can damage health.

For this reason:
- Immediately stop and repair machines with leaking exhaust systems.
- Ensure sufficient ventilation.

7.4.1 Starting

DANGER

Risk of injury due to moving parts
Rotating or linear moving parts can cause serious or fatal injuries.

For this reason:
- Before starting engine check whether all protective equipment has been properly installed.
- Remove tools and aids out of the hazard area.
- Before starting make sure that no-one is in the engine's danger area.

User tip

A starting sequence may consist of max. 3 successive starting attempts, each lasting 12 seconds.
If no engine speed signal is detected within 3 seconds, starting must be aborted.
There must be at least 30 seconds between 2 starting attempts.
There must be at least 5 minutes between 2 starting sequences.

The electronic ignition system is a high-voltage capacitor ignition system with microprocessor control based on crankshaft revolutions.
The ignition system must be parameterised before commissioning. For further information please refer to the operating manual of the ignition system and to the assembly instructions.

Turn on coolant pump before starting engine.

Turn on starter and run for at least 3 seconds to ensure engine is purged with air.

After purging engine with air the ignition system and the gas supply line can be turned on (this is usually done automatically).

When the rated speed has been reached, the plant can then be operated under load.
Acceleration of the engine from 0% to 100% is made over a time interval of 3 minutes.
This minimises the thermal load on the engine block.

The oil gauge must display lubrication oil pressure. If this is not the case, stop the engine immediately.

7.4.2 Operation monitoring system

NOTE

Engine overload
Engine damage

For this reason:
- Determine and eliminate the cause of faults and malfunctions.

The oil pressure and the coolant temperature are constantly monitored during engine operation.

If the limits are exceeded or not reached, the engine will be automatically shut off.

7.4.3 Emergency shutdown

An emergency-off button, for shutting down the system in an emergency, must be installed for each engine.

7.4.4 Stopping

The load is reduced by means of ramp control from 100% to 0% over a period of at least 3 minutes, thus minimising the thermal load on the engine block.

WARNING

Risk of injury due to highly inflammable materials
Unburnt gases can catch fire.

For this reason:
- If there is damage to the engine shutoff device, do not shut off engine by shutting off ignition system.
- Close main gas valve.
- Turn off ignition system after engine is at a standstill.
- Ensure that the engine cannot be started by unauthorised persons.

User tip

The coolant pump will run on for approx. 5 minutes after engine has stopped.
This minimises the thermal load on the engine block.

1. Shut off gas supply.
2. The engine stops running.
3. After waiting 5 seconds, turn off ignition system and control system.

7.4.5 Data storage box

The data storage box supplies engine operating parameters that can be visualised on display devices via a CAN interface. The display devices are not included in the scope of delivery. The engine operating parameters can be saved in an Excel file.

The following engine parameters can be called up via the CAN interface:

- Engine oil temperature left and right
- Engine oil pressure left and right
- Exhaust temperature upstream of turbine left and right
- Coolant inlet temperature
- Coolant outlet temperature
- Charge mixture temperature
- Charge mixture pressure

8 Maintenance and care

8.1 Requirements

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Safety Shoes
- Safety Gloves

8.2 Safety instructions

Personnel

The engine maintenance items described in the Operating Instructions may only be performed by trained qualified personnel.

Ground rules

⚠ WARNING

Risk of injury due to improperly performed maintenance
Improper maintenance can case serious injuries or considerable property damage.

For this reason:
- Ensure that the engine cannot be started by unauthorised persons.
- Perform all maintenance steps as indicated in these instructions.
- Ensure adequate work space before starting any work.
- Make sure work space is kept clean and orderly.

NOTE

The liability for material defects no longer applies if non-approved fuels, lubricants and coolants are used
Liability of material defects is terminated if non-approved fluids and lubricants are used.

For this reason:
- Only use approved fuels, lubricants and coolants (see “Fuels, Lubricants and Coolants for MAN Industrial and Marine Diesel Engines" publication).

ENVIRONMENTAL NOTE

Coolants

- Antifreeze and mixtures of antifreeze and water are to be handled as hazardous waste. When disposing of used coolant observe the regulations of the local authorities.

Engine Oil

- Oil is not allowed to enter bodies of water or the ground!
  Collect use oil carefully and dispose of it at an approved collection point or depot.
  Observe health protection precautions when handling used engine oil.

Filter inserts and filter cartridges

- Filter inserts and filter cartridges, e.g. oil and fuel filters, are hazardous waste and must be disposed of properly. Observe the regulations issued by the responsible local authorities.

Batteries

- Used batteries contain hazardous substances. Batteries must be taken back by the distributor and properly disposed of or be taken to a place of collection. Never dispose of used batteries in the household refuse.
  Please also observe the country-specific regulations.

8.3 Maintenance schedule

An engine maintenance manual is available to supplement these installation and operating instructions.

It includes a maintenance schedule for all routine maintenance work. The maintenance work is described in this chapter.

8.3.1 Maintenance schedule for natural-gas operation

Interval after operating hours at 1500 rpm [1]	**Scope of maintenance operations**						**Service performed** Stamp/Signature
	E1	E2	E3	R1	R2	R3	
20-50 or after commissioning and R2, R3	x						
400 [2]							
800		x					
1600		x	x				
2400		x					
3200		x	x				
4000		x					
4800		x	x				
5600		x					
6400		x	x				
7200		x					
8000		x	x				
8800		x					
9600		x	x				
10,400		x					
11,200		x	x				
12,000		x					
12,800		x	x				
13,600		x					
14,400		x	x				
15,000				x			
15,200		x					
16,000		x	x				
16,800		x					
17,600		x	x				
18,400		x					
19,200		x	x				
20,000		x					
20,800		x	x				
21,600		x					
22,400		x	x				
23,200		x					
24,000		x	x				
24,800		x					
25,000					x		
25,600		x	x				
26,400		x					

1) The maintenance intervals depend on the operating conditions and the quality of the gas. For scope of maintenance work, see page 69.
2) The cylinder head bolts are to be retightened at 400 operating hours.

Interval after operating hours at 1500 rpm [1)]	Scope of maintenance operations						Service performed Stamp/Signature
	E1	E2	E3	R1	R2	R3	
27,200		x	x				
28,000		x					
28,800		x	x				
29,600		x					
30,000				x			
30,400		x	x				
31,200		x					
32,000		x	x				
32,800		x					
33,600		x	x				
34,400		x					
35,200		x	x				
36,000		x					
36,800		x	x				
37,600		x					
38,400		x	x				
39,200		x					
40,000		x	x				
40,800		x					
41,600		x	x				
42,400		x					
43,200		x	x				
44,000		x					
44,800		x	x				
45,000				x			
45,600		x					
46,400		x	x				
47,200		x					
48,000		x	x				
48,800		x					
49,600		x	x				
50,000					x	x	
50,400		x					
51,200		x	x				

E1	• Check for leaks • Check threaded connections • Change engine oil/analyse oil*) • Change oil filter*) • Record operation data • Check start procedure • Check/set throttle valve • Clean/check gas filter • Clean/check air filter • Clean/check impulse sensor • Check coolant concentration • Check ignition timing • Check cooling circuit/system pressure • Measure crankcase pressure • Measure exhaust back pressure including catalytic converter • Check/clean mixture cooler • Check emissions and oxygen sensor • Check external side of exhaust system for dirt, clean if necessary
E2	• Check for leaks • Check threaded connections • Change engine oil/analyse oil*) • Change oil filter*) • Record operation data • Check spark plugs • Check start procedure • Check intake vacuum

E3	• Check valve clearance, adjust if necessary • Change spark plugs • Measure compression • Check/set throttle valve • Clean/check gas filter • Clean/check air filter • Clean/check impulse sensor • Check coolant concentration • Check/change oil separator • Check ignition timing • Check cooling circuit/system pressure • Measure crankcase pressure • Measure exhaust back pressure including catalytic converter • Check/clean mixture cooler • Check emissions and oxygen sensor • Check/calibrate sensors • Check exhaust system threaded connections
R1	• Replace coolant • Measure crankshaft axial play • Replace turbocharger • Replace exhaust pipe
R2	• Replace cylinder liner • Check/replace connecting rods • Replace piston rings • Replace cylinder heads
R3	• Recondition engine

*) The engine oil service life is to be determined according to MAN Works Standard M 3271-2 using regular oil analysis depending on the operating conditions and the engine oil used.

Oil analysis table

Natural gas		
Engine operating hours		
Mineral oil	Partial or full synthetic oil	
50 oper. h	50 oper. h	Oil change
Max. 400 oper. h	Max. 800 oper. h	Oil change with oil analysis
The oil service life can be increased in stages by analysing the oil (in stages up to a max. 100 oper. h) *)		

*) Only after consultation with MAN Diesel SE, Dept. SUEP

8.3.2 Maintenance schedule for special gas operation

Interval after operating hours at 1500 rpm [1]	**Scope of maintenance operations**						**Service performed** Stamp/Signature
	E1	E2	E3	R1	R2	R3	
20-50 or after commissioning and R2, R3	x						
400 [2]		x					
800		x					
1200		x					
1600		x	x				
2000		x					
2400		x					
2800		x					
3200		x	x				
3600		x					
4000		x					
4400		x					
4800		x	x				
5200		x					
5600		x					
6000		x					
6400		x	x				
6800		x					
7200		x					
7600		x					
8000		x	x				
8400		x					
8800		x					
9200		x					
9600		x	x				
10000		x					
10400		x					
10800		x					
11200		x	x				
11600		x					
12000		x					
12400		x					
12800		x	x				
13200		x					
13600		x					
14000		x					
14400		x	x				
14800		x					
15000				x			
15200		x					

Interval after operating hours at 1500 rpm [1]	Scope of maintenance operations						Service performed Stamp/Signature
	E1	E2	E3	R1	R2	R3	
15600		x					
16000		x	x				
16400		x					
16800		x					
17200		x					
17600		x	x				
18000		x					
18400		x					
18800		x					
19200		x	x				
19600		x					
20000		x					
20400		x					
20800		x	x				
21200		x					
21600		x					
22000		x					
22400		x	x				
22800		x					
23200		x					
23600		x					
24000		x	x				
24400		x					
24800		x					
25000					x		
25200		x					
25600		x	x				
26000		x					
26400		x					
26800		x					

1) The maintenance intervals depend on the operating conditions and the quality of the gas. For scope of maintenance work, see page 74.
2) The cylinder head bolts are to be retightened at 400 operating hours.

Interval after operating hours at 1500 rpm [1)]	Scope of maintenance operations						Service performed Stamp/Signature
	E1	E2	E3	R1	R2	R3	
27200		x	x				
27600		x					
28000		x					
28400		x					
28800		x	x				
29200		x					
29600		x					
30000				x			
30400		x	x				
30800		x					
31200		x					
31600		x					
32000		x	x				
32400		x					
32800		x					
33600		x	x				
34000		x					
34400		x					
35200		x	x				
35600		x					
36000		x					
36800		x	x				
37600		x					
38000		x					
38400		x	x				
38800		x					
39200		x					
39600		x					
40000		x	x				
40400		x					
40800		x					
41200		x					
41600		x					
41600		x	x				
42000		x					
42400		x					
42800		x					
43200		x	x				
43600		x					
44000		x					
44400		x					
44800		x	x				
45000				x			
45200		x					

Interval after operating hours at 1500 rpm [1)]	Scope of maintenance operations						Service performed Stamp/Signature
	E1	E2	E3	R1	R2	R3	
45600		x					
46000		x					
46400		x	x				
46800		x					
47200		x					
47600		x					
48000		x	x				
48400		x					
48800		x					
49200		x					
49600		x	x				
50000					x	x	
50400		x					
50800		x					
51200		x	x				
51600		x					
52000		x					
52400		x					
52600		x	x				
53000		x					
53400		x					
53800		x					
53200		x	x				
53600		x					
54000		x					
54400		x					
54800		x	x				
55200		x					
55600		x					
56000		x					
56400		x	x				
56800		x					
57200		x					
57600		x					
58000		x	x				
59200		x					
59600		x					
60000		x	x	x	x	x	
61400		x					
61800		x					

E1	• Check for leaks • Check threaded connections • Change engine oil/analyse oil*) • Change oil filter*) • Record operation data • Check start procedure • Check/set throttle valve • Clean/check gas filter • Clean/check air filter • Clean/check impulse sensor • Check coolant concentration • Check ignition timing • Check cooling circuit/system pressure • Measure crankcase pressure • Measure exhaust back pressure including catalytic converter • Check emissions and oxygen sensor • Check external side of exhaust system for dirt, clean if necessary
E2	• Check for leaks • Check threaded connections • Change engine oil/analyse oil*) • Change oil filter*) • Record operation data • Check spark plugs • Check start procedure • Check intake vacuum

E3	• Check valve clearance, adjust if necessary • Change spark plugs • Measure compression • Check/set throttle valve • Clean/check gas filter • Clean/check air filter • Clean/check impulse sensor • Check coolant concentration • Check/change oil separator • Check ignition timing • Check cooling circuit/system pressure • Measure crankcase pressure • Measure exhaust back pressure including catalytic converter • Check/clean mixture cooler • Check emissions and oxygen sensor • Check/calibrate sensors • Check exhaust system threaded connections
R1	• Replace coolant • Measure crankshaft axial play • Replace turbocharger • Replace exhaust pipe multi-piece ring
R2	• Replace cylinder liner • Check/replace connecting rods • Replace piston rings • Replace cylinder heads
R3	• Recondition engine

*) The engine oil service life is to be determined according to MAN Works Standard M 3271-2 using regular oil analysis depending on the operating conditions and the engine oils used.
- Regular analysis of the oil is to be made for fluctuating gas compositions

Oil analysis table

Special gases (biogas/landfill gas/sewage gas)		
Engine operating hours	Oil operating hours	
50 oper. h	50 oper. h	Oil change
up to max. 450 oper. h	400 oper. h	Oil change with oil analysis
The oil service life can be increased in stages by analysing the oil (in stages up to a max. 50 oper. h) *)		

*) Only after consultation with MAN Diesel SE, Dept. SUEP

8.4 Maintenance work

8.4.1 Engine oil change

⚠ WARNING

Risk of injury due to hot oil
Engine oil gets hot during operation and causes scalding if touched.

For this reason:
- Only touch the oil drain screws using protective gloves.

User tip

Use a container with a capacity of at least 100 litres for the oil change.

User tip

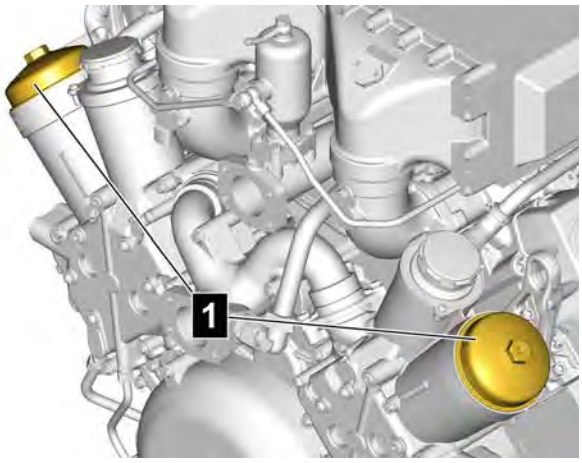
Replace the oil filter inserts each time the engine oil is changed.

Drain engine oil

Drain engine oil with engine at operating temperature.

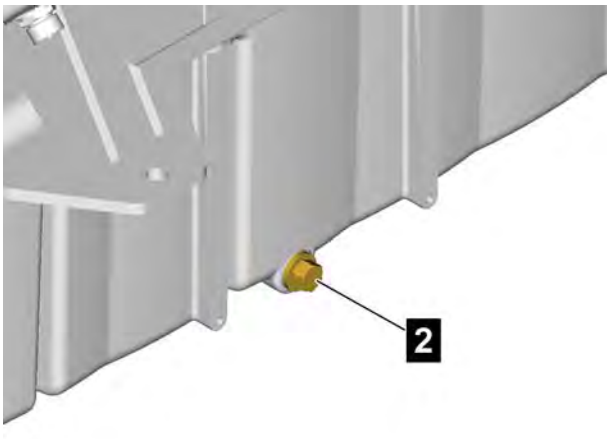
1. Loosen the oil filter cover 1 and unscrew by 2-3 turns.

The engine oil then flows out of the oil module into the oil pan.

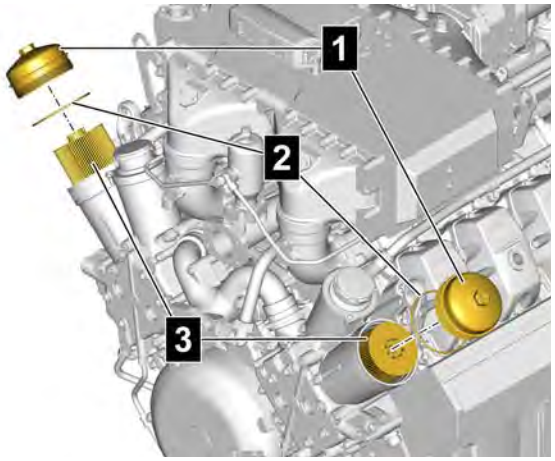


3. Position the container below the oil drain plug 2 .
4. Unscrew the oil drain plug 2 at the oil pan and allow all the oil to drain.
5. Screw the oil drain plug 2 back in with a new sealing ring and tighten it.

Tightening torque . . . . . 80 Nm



Change Oil Filter Element



1. Unscrew oil filter cover 1 with O-ring 2 and oil filter insert 3 and then remove.
2. Remove oil filter insert 3 and O-ring 2 from oil filter cover 1 .
3. Clean oil filter cover 1 .
4. Fit new O-ring 2 on oil filter cover 1 .
5. Insert new oil filter insert 3 into oil filter cover 1 .
6. Insert oil filter cover 1 with oil filter insert 3 into the oil module and then tighten.

Tightening torque . . . . . 40-50 Nm

Filling Engine Oil

NOTE

Risk of damage due to incorrect oil quantity
Engine damage

For this reason:
- Never add more than the indicated oil quantity.
- Ensure that the oil level is correct.
- Observe the min./max. mark on the oil dipstick.

NOTE

Risk of damage due to lack of oil pressure
Engine damage

For this reason:
- If the engine has been running for around 10 seconds and the oil is not pressurised, stop the engine immediately.
- Determine the cause of the problem.

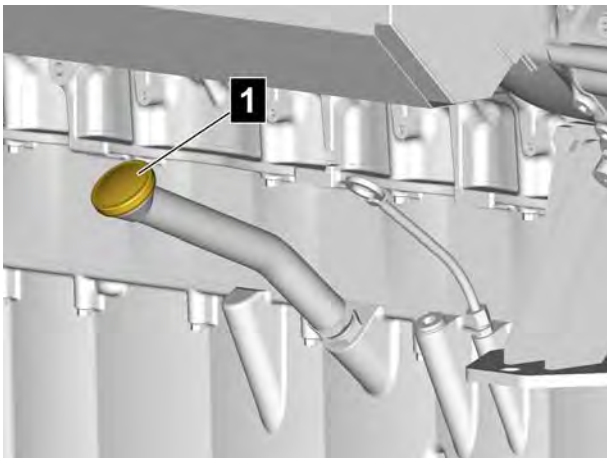
ENVIRONMENTAL NOTE

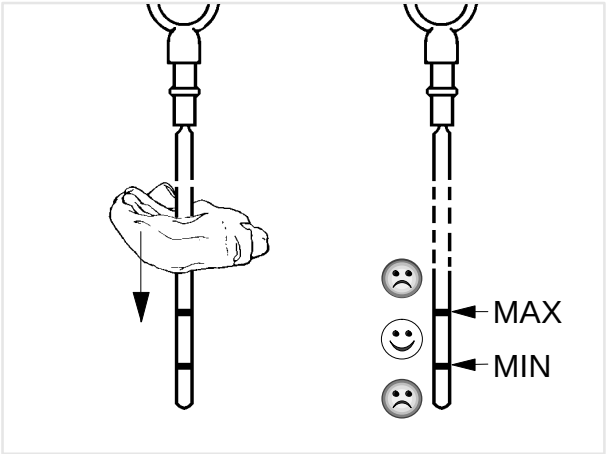
Take care not to spill engine oil when adding it. Engine oil is not allowed to enter the ground or bodies of water.

1. Unscrew cap 1 .
2. Add fresh engine oil at the oil filler neck 1 .

For oil filling capacity, see “Technical Data“ page 92.

3. Screw the cap 1 back on.
4 Start engine and let it run for a few minutes at low speed.
5. Shut down the engine.
6. Check engine for leaks.
7. Check engine oil level after 20 minutes.





Check Engine Oil Level

NOTE

Ensure that all of the engine's oil supply has collected in the oil pan

For this reason:

- Perform the oil level check with the engine in a horizontal position, having waited around 5 minutes after stopping the machine.

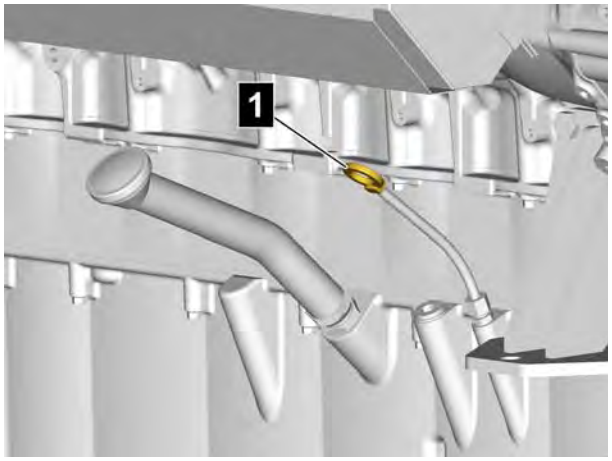
Stop the engine.

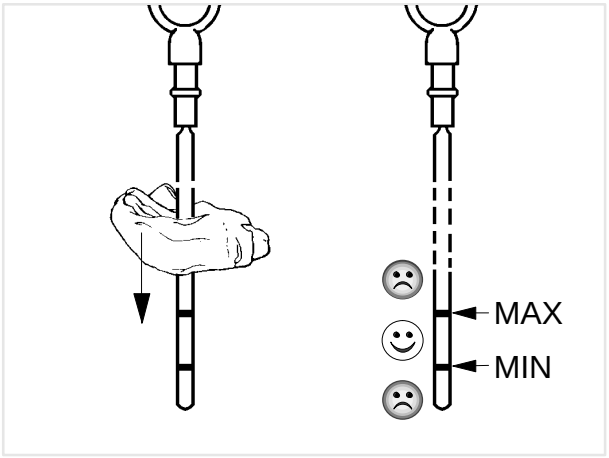
Perform the oil level check after around 5 minutes:

- Pull the oil dipstick 1 out.
- Wipe the oil dipstick 1 with a clean, lint-free cloth.
- Reinsert the oil dipstick 1 as far as the stop.
- Pull the oil dipstick 1 back out.

The oil level should be between both of the marks on the dipstick and should never drop below the lower mark.

- Top up the oil as necessary.
  Do not overfill.





8.4.2 Changing the coolant

WARNING

Risk of injury due to hot fluid
Coolant gets hot during operation and causes scalding if touched.

For this reason:
- Only touch the coolant drain screw using protective gloves.

User tip

Use a container with a capacity of at least 100 litres for the coolant change.

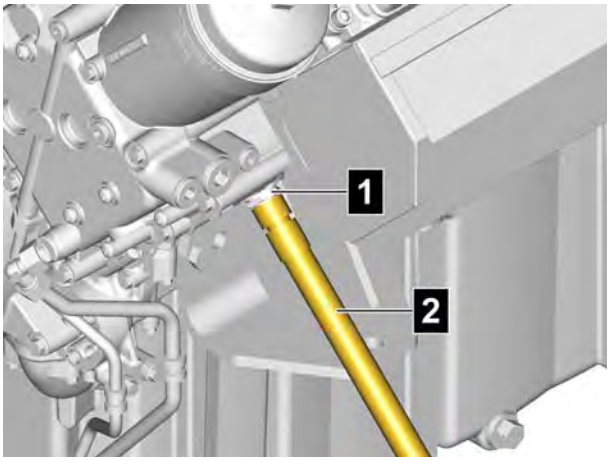
ENVIRONMENTAL NOTE

Risk of environmental pollution due to incorrect handling of service products
Coolant gets hot during operation and causes scalding if touched.

For this reason:
- Take suitable measures immediately if environmentally hazardous fuels, lubricants or coolants escape into the environment.
- Inform the relevant local authorities of the damage.

Drain coolant

1. Briefly open and close cap (large cap) on the filler neck of the expansion tank to compensate for a difference in pressure.
2 Unscrew the cap on the drain valve 1 .
3. Screw the hose 2 onto the drain valve.
4. Drain coolant.
5. Unscrew the hose 2 from the drain valve.
5. Reinstall drain plugs.
6. Reinstall cap.
7. Fill and vent cooling system.



Topping up/bleeding the coolant

WARNING

Risk of injury due to hot fluid
Coolant gets hot during operation and causes scalding if touched.

For this reason:
- Observe the safety instruction of the manufacturer of the combined heat and power plant.

WARNING

Risk of damage due to excessive temperature difference
Engine damage

For this reason:
- Do not fill with cold coolant.
- Allow the engine to cool down.

ENVIRONMENTAL NOTE

Risk of injury due to hot fluid
Serious environmental damage can result.

For this reason:
- Follow the safety instructions.
- Take suitable measures immediatelyif environmentally hazardous fuels, lubricants or coolants escape into the environment.
- Inform the relevant local authorities of the damage.

Fill the cooling system of the engine with a mixture of tap water and ethylene glycol antifreeze agent or anticorrosion agent.

For suitable antifreeze agents see approved Fuels, Lubricants and Coolants according to MAN 324 NF and MAN 248.

Coolant may **only be filled at the filler neck**.

1. Remove cap.
2. Slowly fill coolant.
3. Close expansion tank.
4. Run engine for approx. 15 minutes at rated speed.
5. Shut off engine and carefully unscrew cap with safety valve to the first stop to release pressure, then carefully open. Add coolant if necessary.
6. When adding coolant, do not add cold coolant to a warmed-up engine. Ensure that the proper mixing ratio of “water/antifreeze" is met.
7. Check coolant before the next commissioning (with engine cold). Add coolant if necessary.
8. Repeat this procedure until coolant can no longer be added.

Cooling system with membrane expansion reservoir

1. After filling the cooling system, run electric coolant pump for approx. 15 minutes and then vent cooling system.
2. Observe cooling system pressure and check coolant level.

9 Faults

The following chapter describes the possible faults which can occur and the work to correct them.

For those faults that cannot be rectified by the following information, contact the manufacturer of the entire system or MAN Service.

9.1 Requirements

Before starting any work read and observe the General Safety Instructions and the safety information in this chapter.
Strictly observe these instructions and act prudently to avoid accidents, personal injury and property damage.

9.2 Safety instructions

Personnel

Engine faults may only be rectified by specially trained qualified personnel or by the manufacturer of the entire system.

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Safety Shoes
- Safety Gloves

Ground Rules

⚠ WARNING

Risk of injury and damage due to untrained personnel

For this reason:
- Only trained personnel are allowed to remedy faults.
- Ensure that the engine cannot be started by unauthorised persons.
- Ensure adequate work space before starting any work.
- Make sure the work space is kept clean and orderly.

9.3 Troubleshooting chart

Fault	Possible cause	Remedy
Engine does not start	● Shutoff solenoid valve of gas supply closed/does not open	
	● Zero pressure regulator of gas supply not correctly set or faulty	
	● Air filter clogged	
	● Exhaust clogged (exhaust back pressure too high)	
	● Electric circuit interrupted	● Set main switch to "on" ● Replace faulty fuses ● Repair any loose, corroded and broken wires and contacts
	● Battery dead	● See information at "Starter"
	● Starter/solenoid switch faulty	
	● Ignition system control unit faulty	● Clearance incorrectly set
	● Impulse sensor faulty	
	● Spark plugs faulty or worn	
	● Spark plug connectors wet	
	● Ignition timing incorrect	● A faulty tank system can cause oil to get into the pressure gas system. Clean entire system.
	● Gas inlets in gas mixer (venturi pipe) clogged/oiled	
	● Valves do not close or are stuck	● Remove objects that interfere with the movement of the fan, power output, alternator, etc.
	● Crank assembly is externally blocked	
	● Engaging lever/bearing pin of engaging lever broken	● Remedy from manufacturer service
	● Internal engine damage (piston seizure, maybe due to incorrect oil type)	
Engine starts but does not reach idle speed or stalls	● Quality of gas does not meet the specifications or is contaminated	● See "Fuels, Lubricants and Coolants...."
	● Throttle valve does not open/actuation level sticks/actuator is de-energized or faulty	● Remedy from manufacturer service
	● Air filter clogged	
Engine does not start or poorly starts in warmed up condition	● Spark plug faulty	
	● Ignition cable faulty	
	● Ignition coil faulty	
	● Ignition timing incorrectly set	● Remedy from manufacturer service
	● Insufficient compression in cylinder or more than 3-4 bar pressure difference between the cylinders	

Fault	Possible cause	Remedy
Engine does not start or starts poorly in cold condition	● Spark plug faulty ● Ignition cable faulty ● Ignition coil faulty ● Ignition timing incorrectly set ● Starter turns slowly ● Check quality of gas	● Remedy from manufacturer service ● Battery with insufficient charge or damaged ● Voltage drop between battery and starter too high
Rough idling with engine warm, misfiring	● Spark plug faulty ● Ignition cable faulty ● Ignition coil faulty ● Ignition timing incorrectly set ● Valve clearance not OK ● Zero pressure regulator of gas supply not correctly set or faulty ● Insufficient compression in cylinder or more than 3-4 bar pressure difference between the cylinders	● Remedy from manufacturer service
Engine speed fluctuations during operation	● Spark plug faulty ● Ignition cable faulty ● Ignition coil faulty ● Ignition timing incorrectly set ● Shutoff solenoid valve of gas supply closed/does not open ● Tachometer faulty ● Gas pressure regulator faulty ● Oxygen sensor faulty	● Remedy from manufacturer service
Poor performance	● Spark plug faulty ● Ignition cable faulty ● Ignition coil faulty ● Ignition timing incorrectly set ● Throttle valve not in full throttle position, actuation linkage sticks, throttle valve incorrectly adjusted ● Zero pressure regulator of gas supply not correctly set or faulty ● Gas metering valve faulty ● Gas/air mixture too rich or too lean ● More power than the engine can produce is demanded ● Gas quality does not meet the regulations ● Cross section of oxygen regulation valve is not set to the current gas quality ● Oil level in oil pan too high	● See "Fuels, Lubricants and Coolants..." ● Remedy from manufacturer service ● Check whether the guide tube is correctly installed and the correct oil dipstick is being used ● If coolant is discovered in the engine oil, check cylinder head gasket, cylinder liner gasket and piston rings

Fault	Possible cause	Remedy
Poor performance	● Air filter clogged ● Exhaust pipe clogged ● Air intake pipe leaks ● Charge mixture cooler dirty/leaks ● Charge mixture ducting leaks ● Turbocharger leaks, faulty, dirty ● Insufficient compression in cylinder or more than 3-4 bar pressure difference between the cylinders	● Remedy from manufacturer service
Coolant temperature too high, loss of coolant	● Coolant level too low ● Air in coolant circuit ● Radiator very dirty, fins clogged ● V-belt for coolant pump not correctly tightened (slips) ● Cap with work valves on expansion tank/radiator is faulty or leaks ● Temperature display faulty ● Coolant pump leaks, defective (bearing damage) ● Thermostat faulty, does not open ● Coolant lines leak, clogged or twisted	● Remedy from manufacturer service
Lube-oil pressure too low	● Oil level in oil pan too low ● Engine temperature to high ● Oil pressure indicator faulty ● Selected oil viscosity is inappropriate for ambient temperature (too thin) ● Oil in oil pan is too thin (contains condensation) ● Bearing heavily worn ● Oil pump gears heavily worn ● Safety valve in oil circuit faulty (does not close, spring is worn or broken)	● See "Fuels, Lubricants and Coolants..." ● Remedy from manufacturer service
Lube-oil pressure too high	● Engine cold ● Selected oil viscosity is inappropriate for ambient temperature (too thick) ● Oil pressure indicator faulty ● Safety valve in oil circuit faulty (does not open) ● Oil lines/oil ducts clogged	● See "Fuels, Lubricants and Coolants..." ● Remedy from manufacturer service

Fault	Possible cause	Remedy
Lube-oil consumption too high	● Lube-oil quality does not meet the regulations ● Oil level in oil pan too high ● Leaks in lube-oil circuit especially at the turbocharger and oil cooler ● Piston rings heavily worn ● Valve stems heavily worn, bent ● Crankcase breather clogged	● See "Fuels, Lubricants and Coolants..." ● Check whether the guide tube is correctly installed and the correct oil dipstick is being used ● If coolant is discovered in the engine oil, check cylinder head gasket, cylinder liner gasket and piston rings ● Remedy from manufacturer service
Gas consumption too high	● Gas quality does not meet the regulations ● Ignition timing incorrectly set ● Charge mixture cooler dirty/leaks ● Charge mixture ducting leaks ● Valve seat leaks ● Air filter clogged ● Exhaust gas recirculation cooler dirty	● See "Fuels, Lubricants and Coolants..." ● Check intake vacuum ● Remedy from manufacturer service ● Check exhaust back pressure
Blue smoke	● Lube oil penetrates into combustion chamber (pistons/piston rings worn or piston rings broken) ● Turbine and compressor impeller in turbocharger dirty (rough running, out of balance) ● Valve stem/guide worn	● Remedy from manufacturer service
White smoke	● Coolant penetrates into combustion chamber (cylinder head/gasket leaks)	
Engine knocking	● Ignition timing incorrectly set ● Valve clearance not OK ● Valves stick ● Piston pin or crankshaft bearing loose ● Piston ring broken	● Check thermostat ● Remedy from manufacturer service
Engine too "loud"	● Intake or exhaust pipe leaks ● Timing gears worn, gear backlash too large ● Valve clearance too large ● Turbine and compressor impeller in turbocharger dirty (rough running, out of balance) ● Poly-V-belt slips ● Engine bearing not suitable/worn	● Remedy from manufacturer service
Exhaust temperature/ exhaust back pressure too high (thermal overload)	● Unsuitable exhaust piping; heat exchanger and catalytic converter have too high resistance	● Remedy from manufacturer service

Starter

Fault	Possible cause	Remedy
		To be repaired by a vehicle electrician or by the manufacturer service
● Pinion gear does not turn or turns slowly	● Battery has insufficient charge ● Terminal is loose, oxidised, poor connection to ground ● Starter terminal or carbon brushes are short circuited to ground ● Carbon brushes stick or have poor contact	
● Pinion gear does not engage	● Pinion gear or starter ring gear are very dirty or damaged	
● Pinion gear engages, but stops turning	● Solenoid switch faulty ● Overrunning clutch slips ● Starter switch faulty	
● Pinion gear continues to turn after starter switch is released	● Solenoid switch faulty	
● Pinion gear does not disengage after engine starts	● Starter faulty	● Immediately shut down engine

10 Decommissioning and recommissioning

10.1 Requirements

Personal Protective Equipment

The following protective equipment must be worn:

- Protective Clothing
- Safety Shoes
- Safety Gloves

10.2 Safety instructions

Personnel

Decommissioning and recommissioning of the engine may only be performed by trained and qualified personnel.

Ground Rules

⚠ WARNING

Risk of injury and damage due to untrained personnel

For this reason:

- Ensure that the engine cannot be started by unauthorised persons.
- Perform all work steps as indicated in these instructions.
- Ensure adequate work space before starting any work.
- Make sure the work space is kept clean and orderly.

10.3 Temporary decommissioning of an engine

Temporary anticorrosion protection according to MAN Works Standard M 3069 is required if an engine is decommissioned, depending on the duration.

The Works Standard can be obtained from our After-Sales Service department at the Nuremberg plant.

User tip

A proper and careful recommissioning of new or operated engines has a great impact on the operating safety and remaining life of the engines.
In general the goal is to preserve the decommissioned engines or new engines (after the factory tests).
If the engine is not preserved before decommissioning, there is a risk of corrosion on the cylinder liners, piston rings and valves, especially if the intake and exhaust openings are not closed and the engine is stored in the open. Ingress of foreign matter, rainwater and the like may necessitate complete disassembly of the engine.

10.4 Recommissioning of decommissioned engines

10.4.1 Commissioning of preserved engines to MAN Works Standard M 3069

1. Remove external preservation. Never use a high pressure cleaner for this.
2. Remove caps from intake and exhaust openings.
3. Check cooling system; add antifreeze according to the Fuels, Lubricants and Coolants list (see “Fuels, Lubricants and Coolants..."); check concentration and correct.
4. Check engine oil level and add fresh approved engine oil if necessary.
5. Check the operation of the monitoring and emergency shut off equipment.
6. Check condition and proper installation of elastic fasteners, such as V-belts, coolant hoses and charge air hoses. Retighten if necessary.
7. With the gas supply shut off, crank the engine with the starter until the oil is pressurised. Do not actuate the starter for any more than 12 seconds.
8. Open gas supply and start engine. After engine is running, operate engine above idle speed to avoid insufficient lubrication of the cylinder liners.
9. Check engine for leaks, unusual noises and observe the oil pressure and all temperatures. Increase engine speed in steps.
10. After a max. of 25 operating hours, drain preservation oil from engine and change oil filter; fill engine with fresh approve engine oil.

10.4.2 Commissioning of non-preserved engines

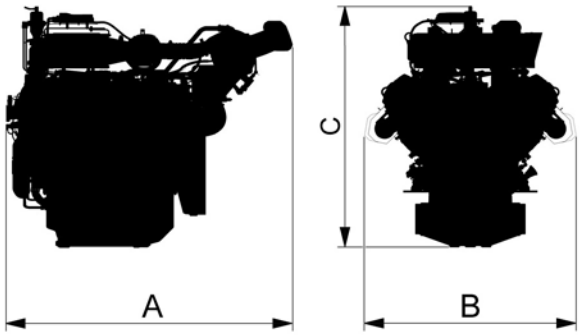
In addition to the work steps for a preserved engine, the commissioning of a non-preserved engine requires the following extra work depending on the possible non-use damages.

1. Check combustion chambers with an endoscope, to do this, remove/install spark plugs.
   Check valve for easy movement; check valve clearance and adjust if necessary.
   Replace any damaged/corroded parts.
2. Drain old oil from engine and change oil filter. Fill engine with fresh approved engine oil.
3. Check cooling system for corrosion; check coolant for proper concentration; if in doubt, change coolant. Before adding new coolant , clean coolant chambers and remove/install coolant pump and thermostat if necessary; replace the slide ring seal of the coolant pump and thermostat elements; pressure test cooling system.
4. Check clean air system, air filter and turbocharger for dirt and corrosion. Clean or repair if necessary.
5. Clean/check/replace gas filter.

11 Technical data

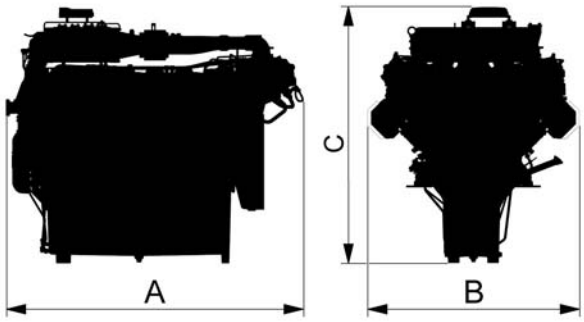
11.1 Dimensions and weight

11.1.1 E3268 LE212/LE222



Specification	Value	Unit
Weight (dry) E3268 LE212/LE222	1432	kg
A	1372	mm
B	1245	mm
C	1470	mm

11.1.2 E3262 LE202/LE212



Specification	Value	Unit
Weight (dry) E3262 LE202/LE212	1849	kg
A	1748	mm
B	1243	mm
C	1500	mm

11.2 Installation location and space requirements

Observe these installation instructions.

11.3 Engine data

11.3.1 E3268 LE212/LE222

Engine model	**E3268 LE212/LE222**
Design	V 90°
Operating Principle	4-stroke petrol/gas engine charged with mixturecooling
Number of cylinders	8
Bore	132 mm
Stroke	157 mm
Displacement	17,188 cc
Compression	
E3268 LE212	12 : 1
E3268 LE222	13,6 : 1
Output if German Technical Instructions on Air Quality Control comply with	
natural-gas mode	
E3268LE212	370 kW bei 1500 1/min
The output figures apply to operation with natural gas with a calorific value of 10 kWh/m^3 and a methane number > 80. If the calorific value is lower, the output will be reduced accordingly. Consultation with MAN required.	
Output if German Technical Instructions on Air Quality Control comply with	
biogas mode	
E3268 LE222	370 kW bei 1500 1/min
The output figures apply to operation with biogas (60% CH_4, 40% CO_2) with a calorific value of 6 kWh/m^3 and a methane number of 140.	
Firing order	1-5-7-2-6-3-4-8
Valve clearance (cold engine)	
Intake	0.50 mm
Exhaust	0.60 mm
Valve timing	
Intake opens	12° before TDC
Intake closes	48° after BDC
Exhaust opens	61° before TDC
Exhaust closes	11° after TDC

Ignition timing - crank angle before TDC	Natural gas operation	Biogas operation
E3268 LE 212 1500 rpm - German Technical Instructions on Air Quality Control	18° ± 1°	
E3268 LE 222 1800 rpm - German Technical Instructions on Air Quality Control		20° ± 1°
Engine lubrication	Force feed lubrication	
Lubrication oil pressure during operation (depends on engine speed, oil temperature and engine load)	must be monitored via an oil pressure monitor or a display device	
Oil filter	2 oil filters Full-flow filters each with 1paper filter cartridge	
Oil capacity in oil sump (litres)	max. 95 l	
Engine cooling system	Liquid cooling	
Coolant temperature	80 / 88°C engine inlet/outlet	
Coolant filling capacity	in engine approx. 34 l	
Electrical equipment		
Starter	24 V; 7 kW	

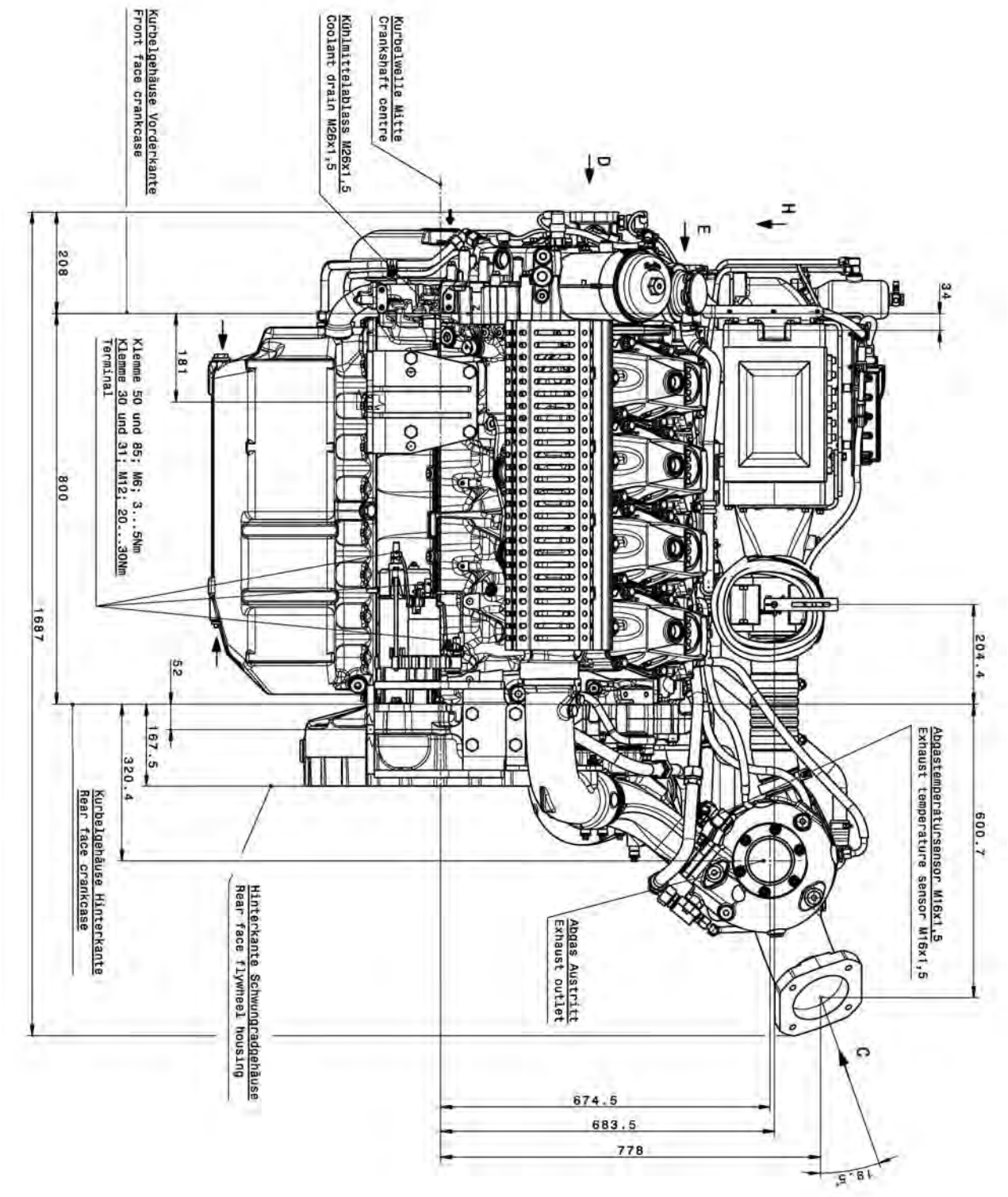
11.3.2 E3262 LE202/LE212

Engine model	**E3262 LE202/LE212**
Design	V 90°
Operating Principle	4-stroke petrol/gas engine charged with mixture cooling
Number of cylinders	12
Bore	132 mm
Stroke	157 mm
Displacement	25,782 cc
Compression E3262 LE202 E3262 LE212	 12 : 1 13,6 : 1
Output if German Technical Instructions on Air Quality Control comply with natural-gas mode E3262LE202 The output figures apply to operation with natural gas with a calorific value of 10 kWh/m^3 and a methane number > 80. If the calorific value is lower, the output will be reduced accordingly. Consultation with MAN required.	 550 kW bei 1500 1/min 580 kW bei 1800 1/min
Output if German Technical Instructions on Air Quality Control comply with biogas mode E3262 LE202 E3262 LE212 The output figures apply to operation with biogas (60% CH_4, 40% CO_2) with a calorific value of 6 kWh/m^3 and a methane number of 140.	 550 kW bei 1500 1/min 580 kW bei 1800 1/min 550 kW bei 1500 1/min 580 kW bei 1800 1/min
Firing order	1-12-2-11-3-10-6-7-5-8-4-9
Valve clearance (cold engine) Intake Exhaust	 0.50 mm 0.60 mm
Valve timing Intake opens Intake closes Exhaust opens Exhaust closes	 12° before TDC 48° after BDC 61° before TDC 11° after TDC

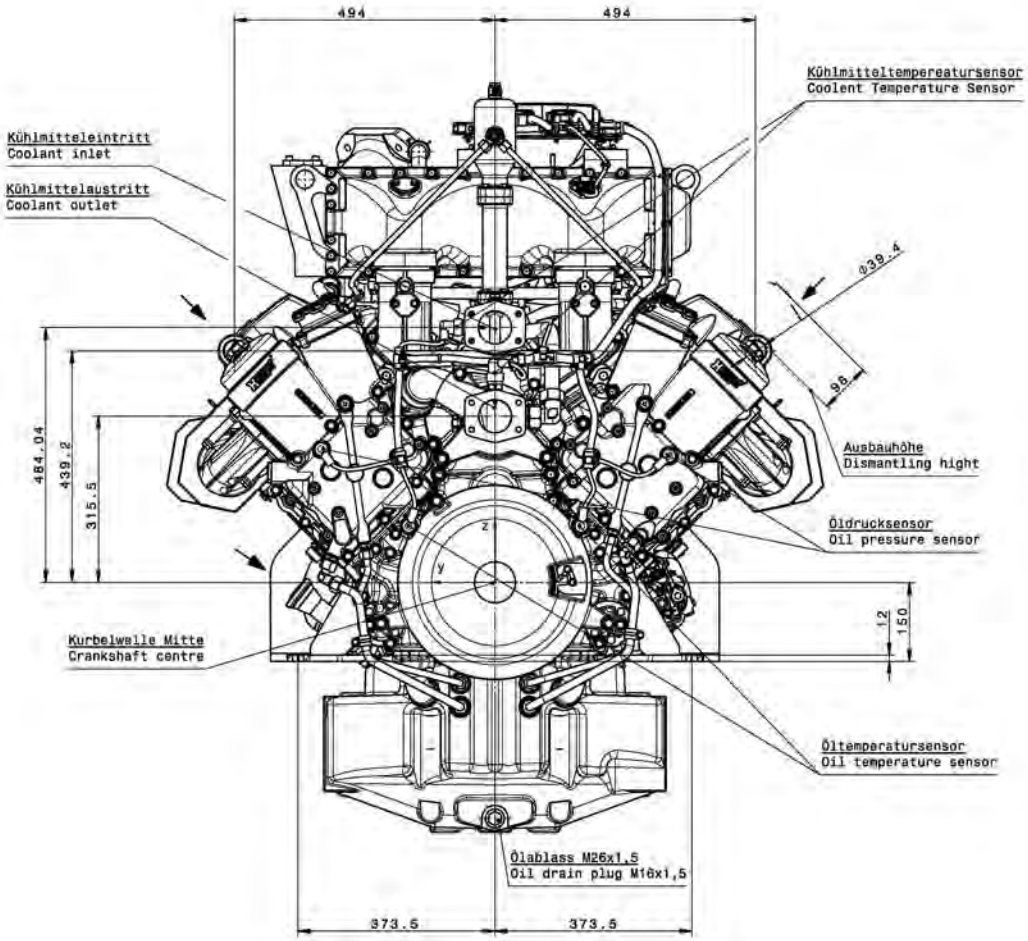
Ignition timing - crank angle before TDC	Natural gas operation	Biogas operation
E3262 LE 202		
1500 rpm - German Technical Instructions on Air Quality Control	16° ± 1°	20° ± 1°
1800 rpm - German Technical Instructions on Air Quality Control	20° ± 1°	20° ± 1°
E3262 LE 212		
1500 rpm - German Technical Instructions on Air Quality Control	16° ± 1°	20° ± 1°
1800 rpm - German Technical Instructions on Air Quality Control	20° ± 1°	20° ± 1°
Engine lubrication	Force feed lubrication	
Lubrication oil pressure during operation (depends on engine speed, oil temperature and engine load)	must be monitored via an oil pressure monitor or a display device	
Oil filter	2 oil filters Full-flow filters each with one filter cartridge	
Oil capacity in oil sump (litres)	max. 105 l	
Engine cooling system	Liquid cooling	
Coolant temperature	80 / 88°C engine inlet/outlet	
Coolant filling capacity	in engine approx. 50 l	
Electrical equipment		
Starter	24 V; 7 kW	

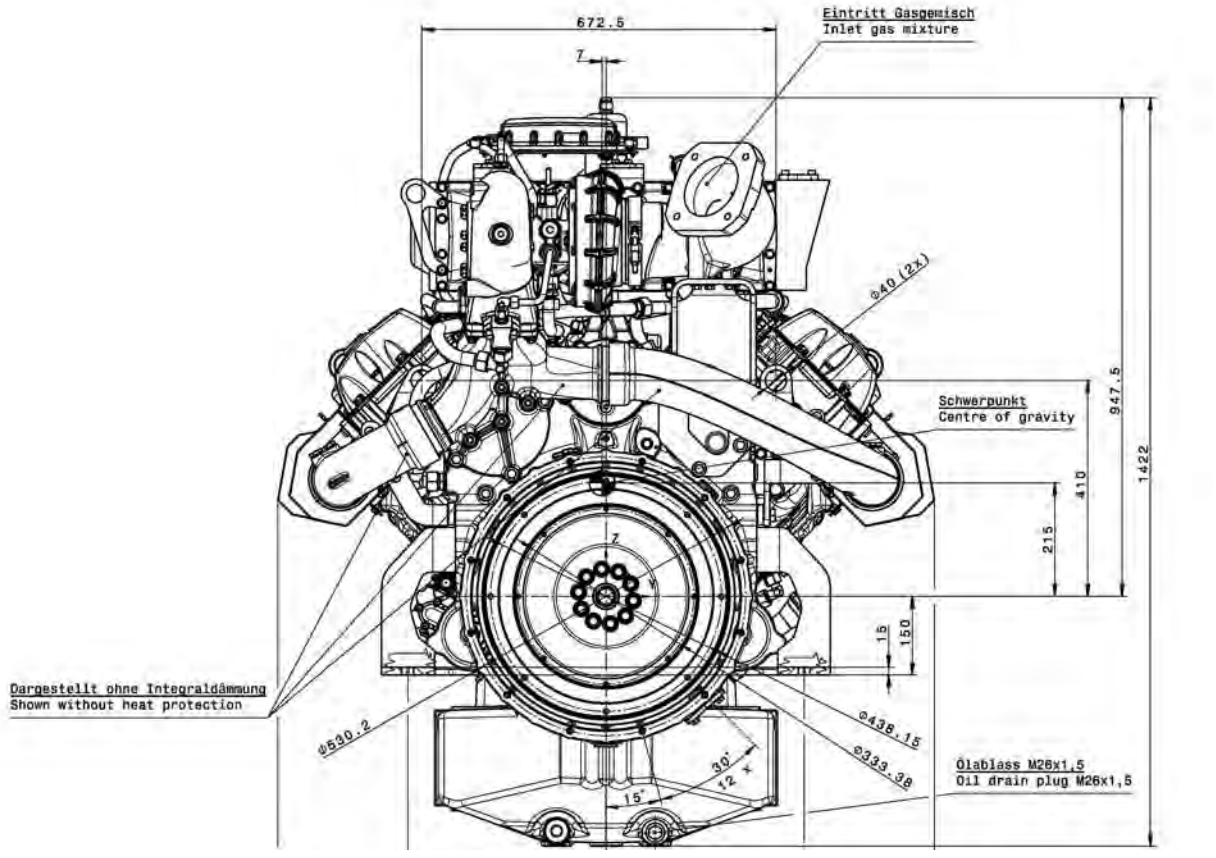
12 Installation drawing

12.1 Installation drawing E3268 LE212/LE222



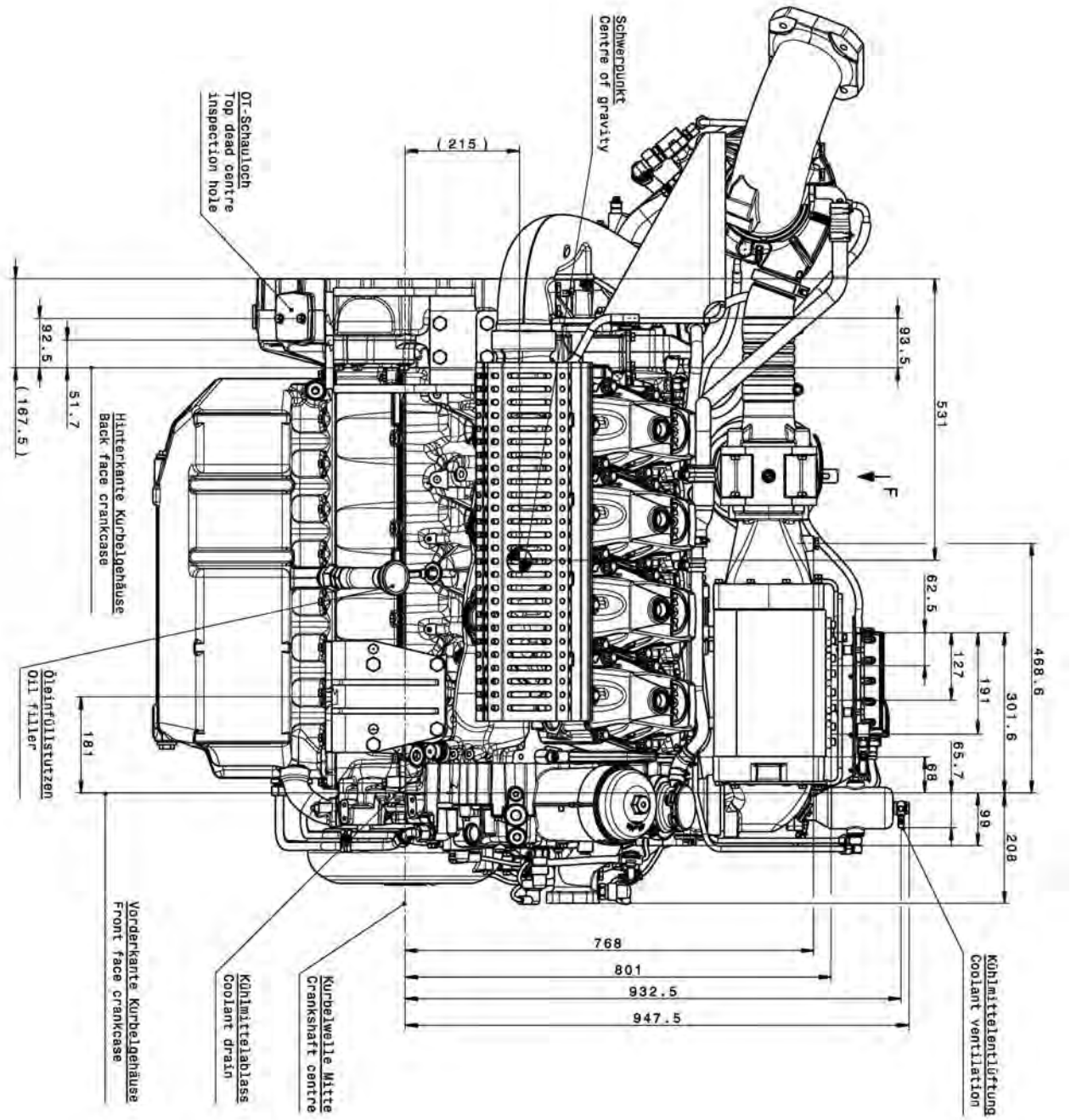
Installation drawing



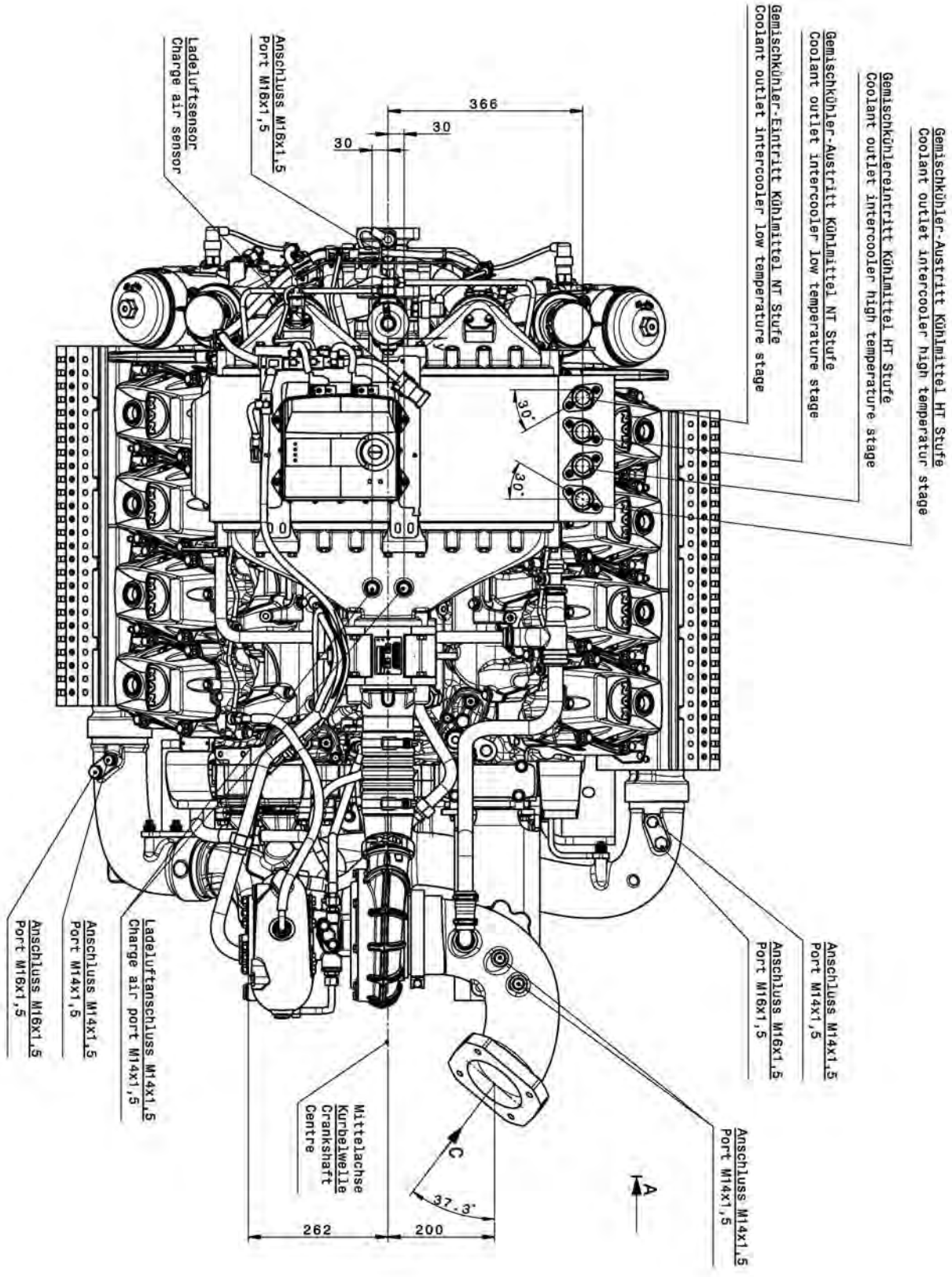


Carefully read these Operating Instructions before starting any work!
This is especially valid for the chapter on General Safety Instructions
and the safety instructions in each of the chapters.

Installation drawing



Installation drawing



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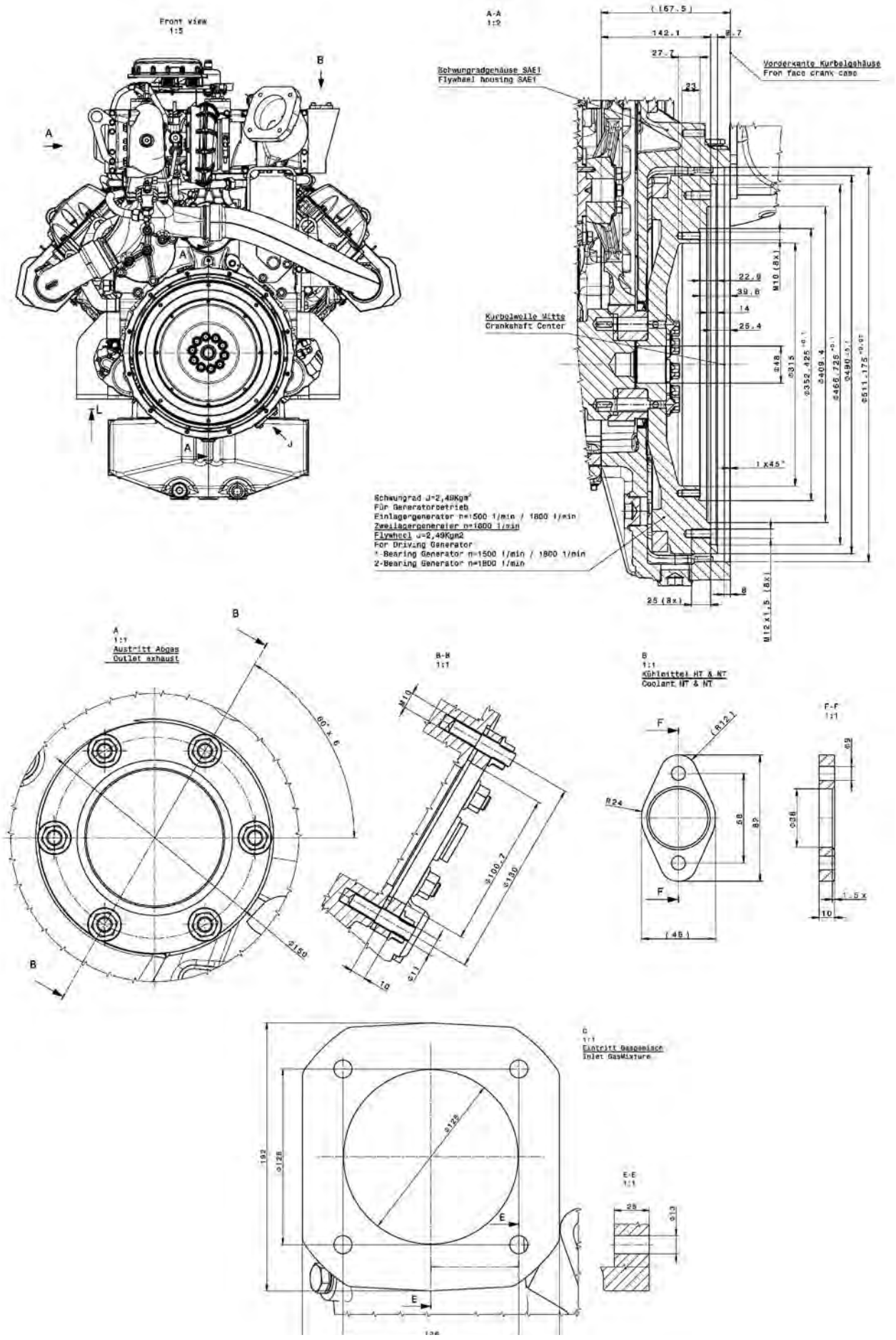
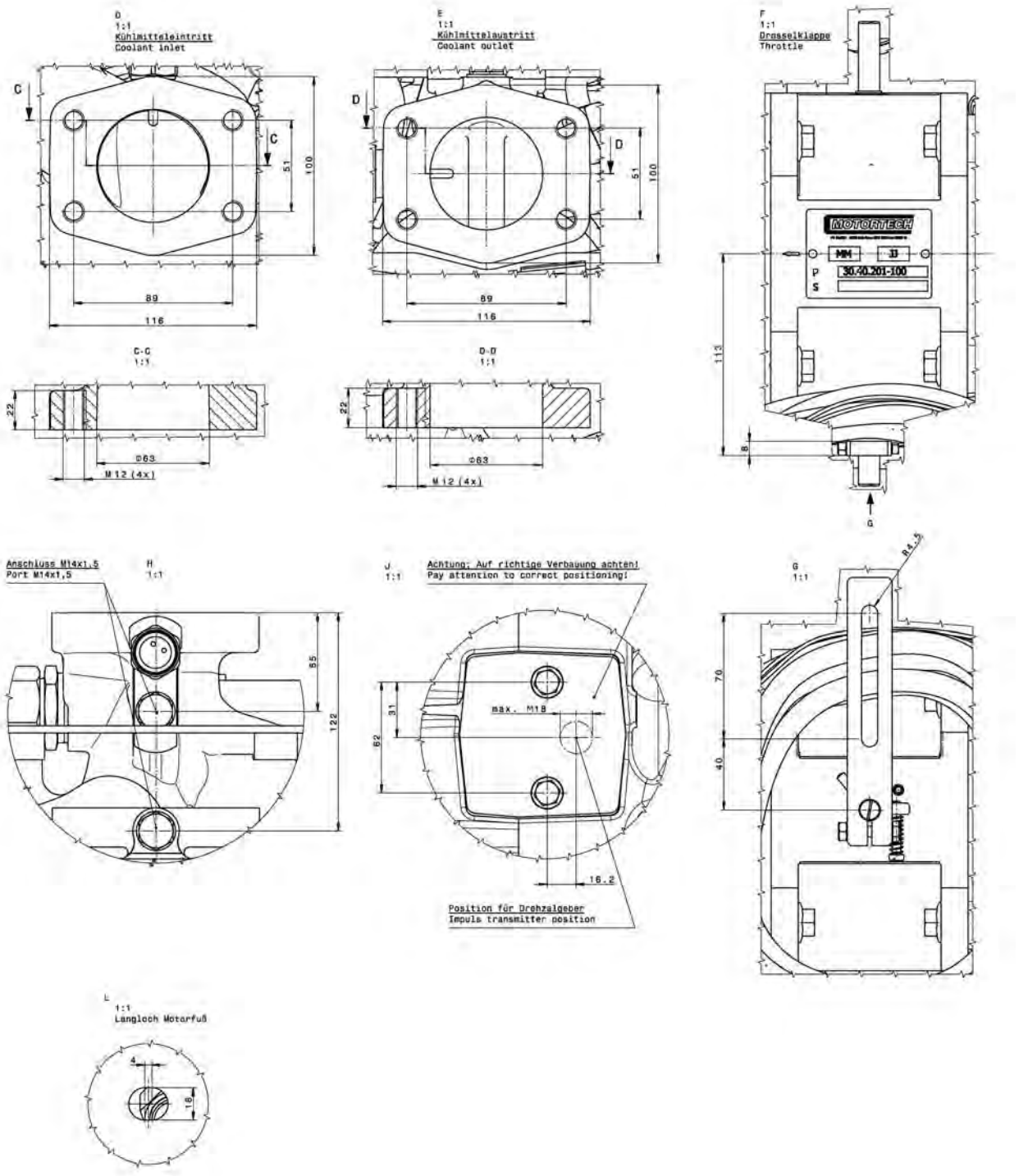

Front view
1:5
A-A
1:2
Schwungradgehäuse SAE1
Flywheel housing SAE1
Vorderkante Kurbelgehäuse
Fron face crank case
Kurbelwelle Mitte
Crankshaft Center
Schwungrad J=2,49Kgm²
Für Generatorbetrieb
Einlagergenerator n=1500 1/min / 1800 1/min
Zweilagergenerator n=1800 1/min
Flywheel J=2,49Kgm2
For Driving Generator
1-Bearing Generator n=1500 1/min / 1800 1/min
2-Bearing Generator n=1800 1/min
A
1:1
Austritt Abgas
Outlet exhaust
B-B
1:1
B
1:1
Kühlmittel HT & NT
Coolant HT & NT
F-F
1:1
C
1:1
Eintritt Gasgemisch
Inlet Gasmixture
E-E
1:1

Installation drawing



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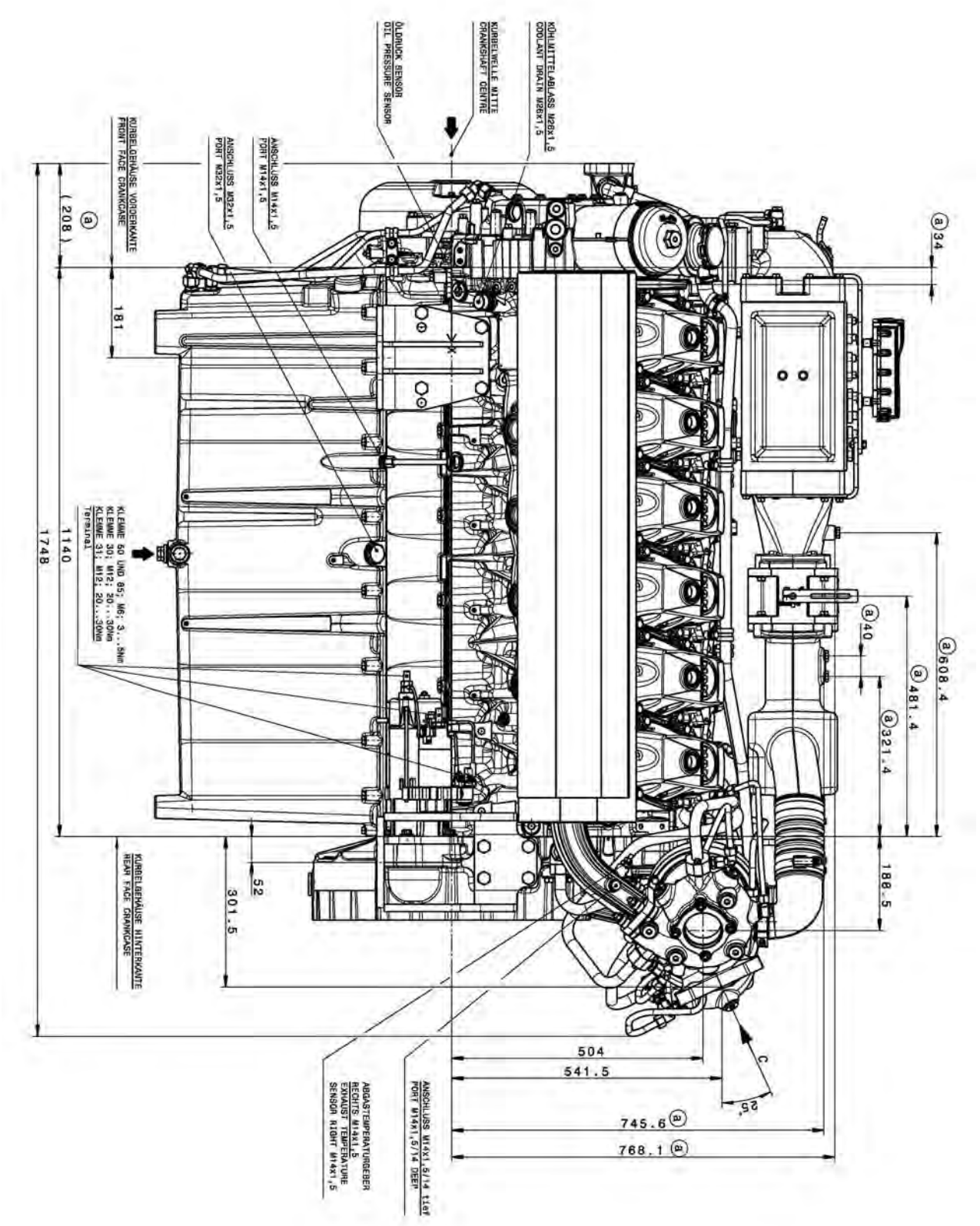
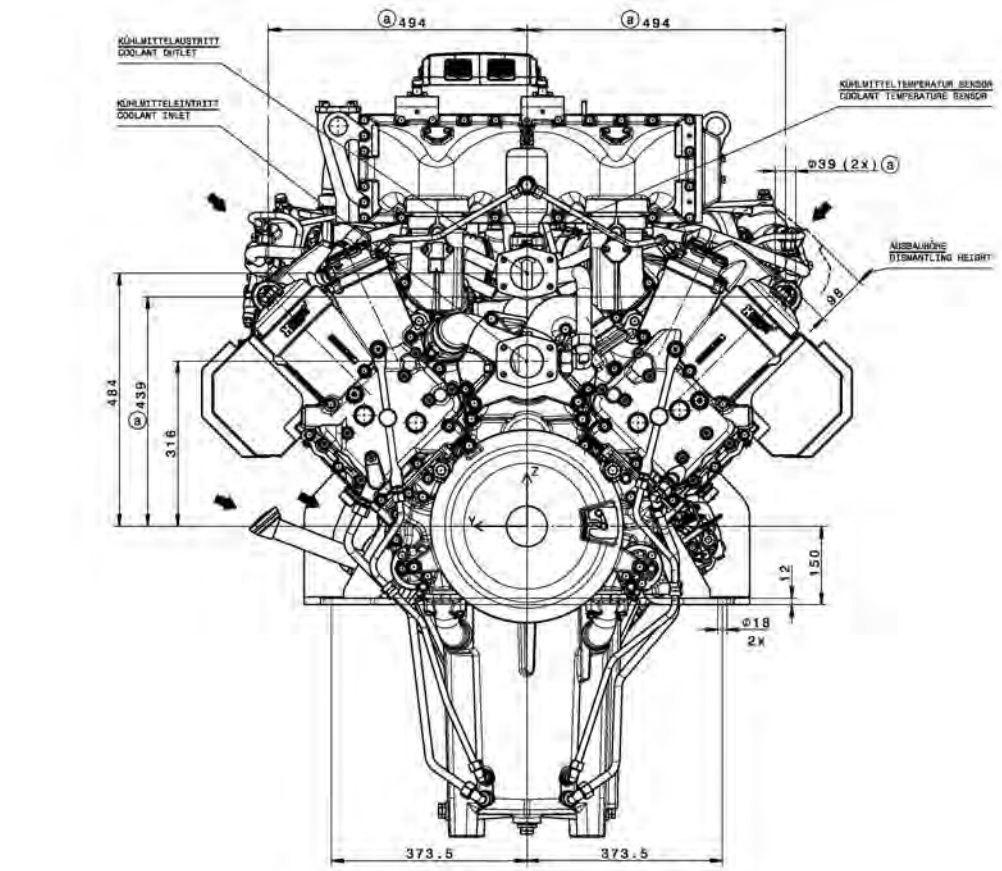
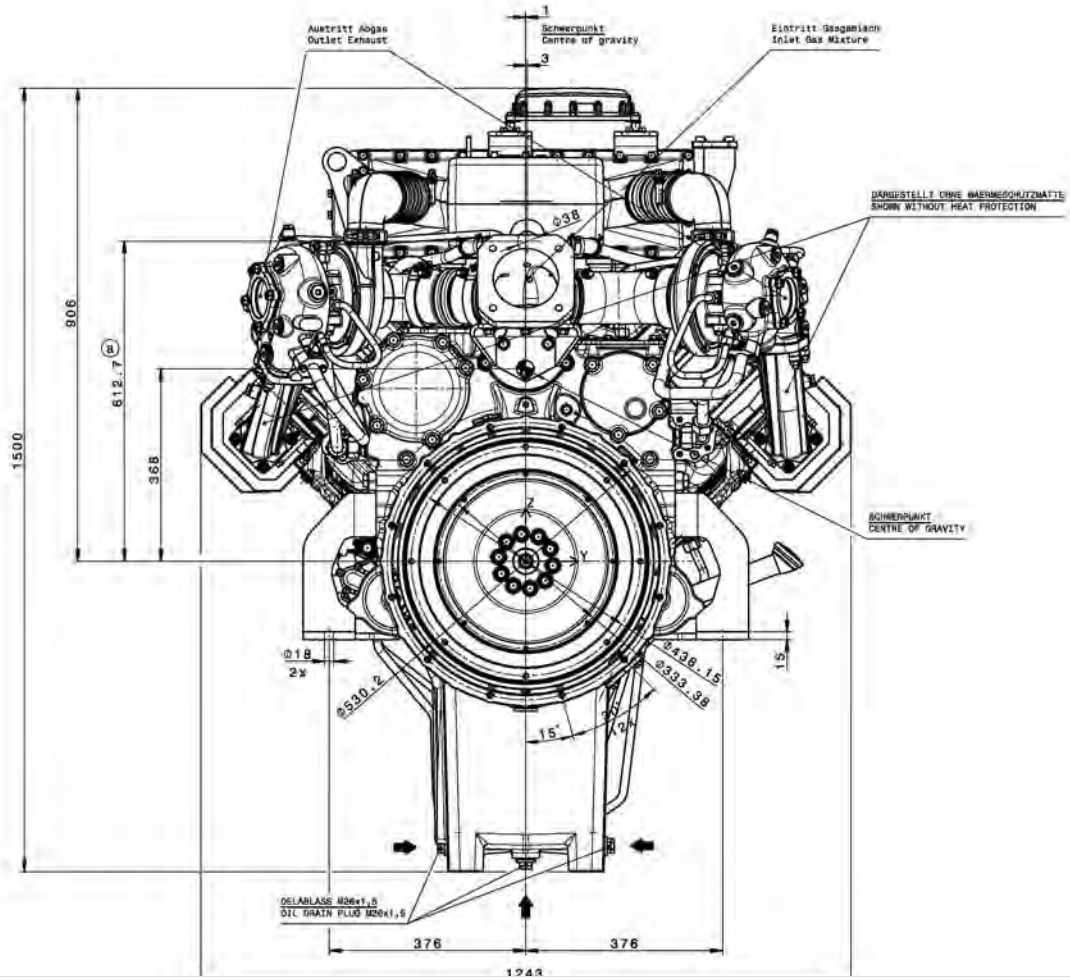
12.2 Installation drawing E3262 LE202/LE212







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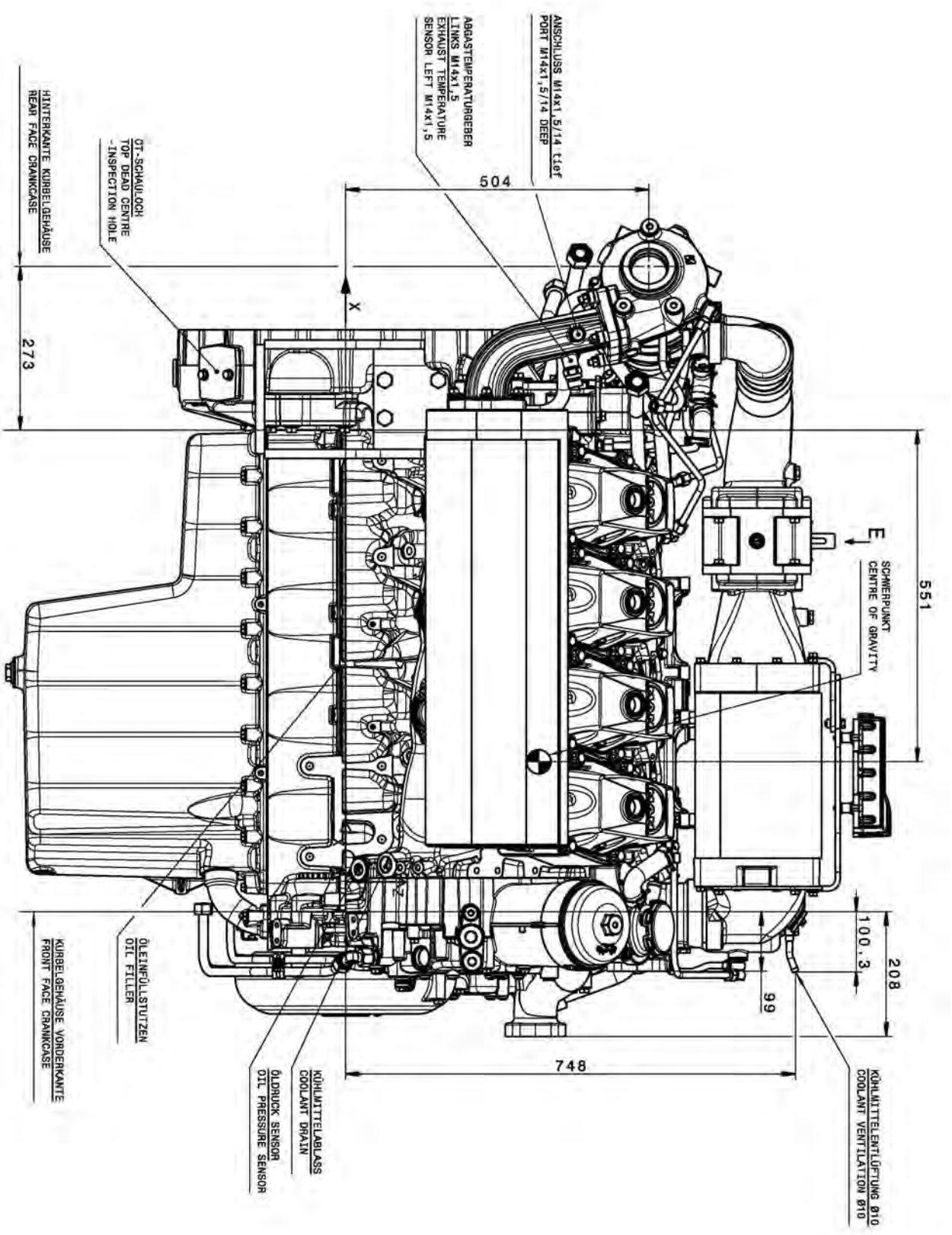
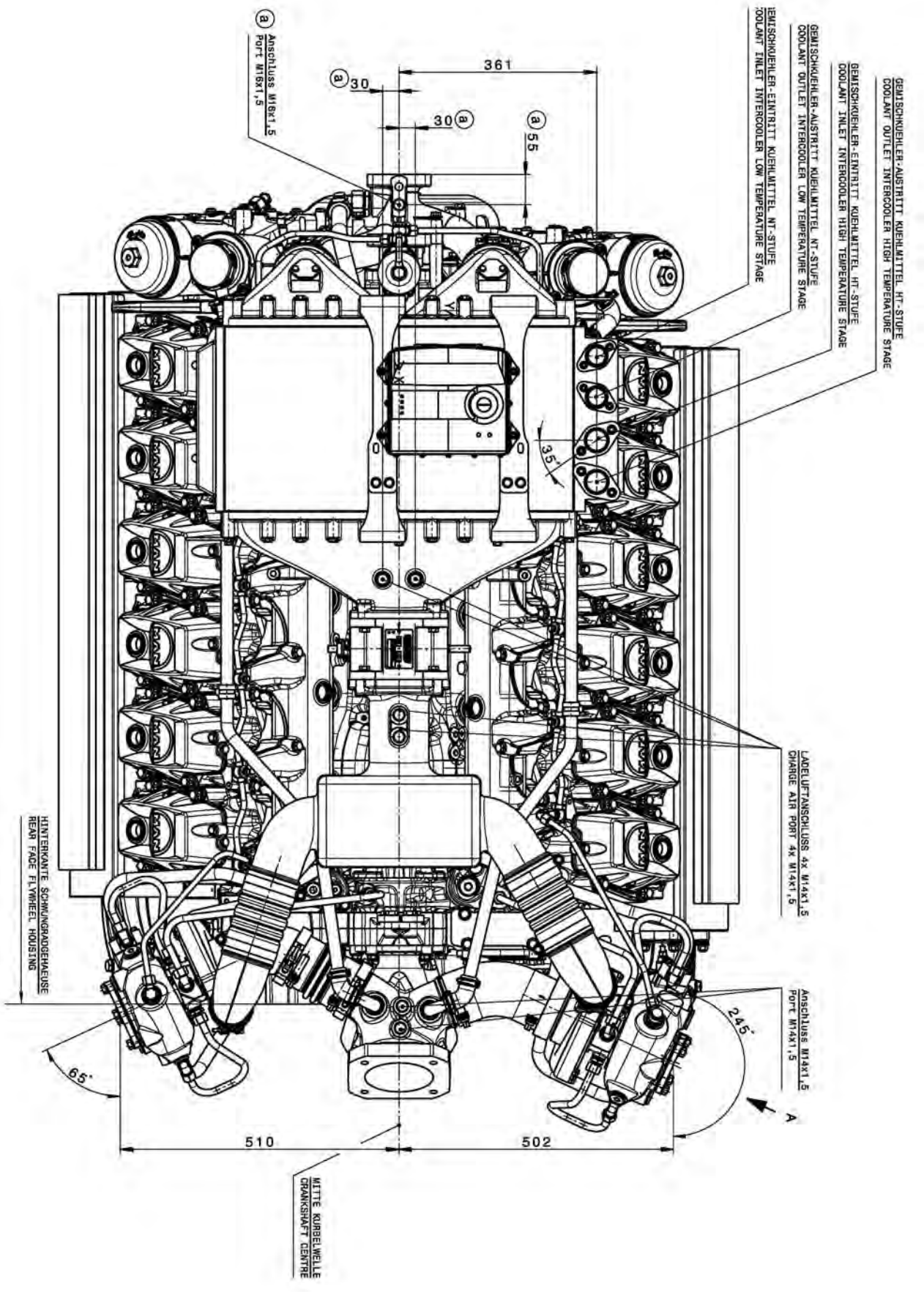
Installation drawing



Installation drawing



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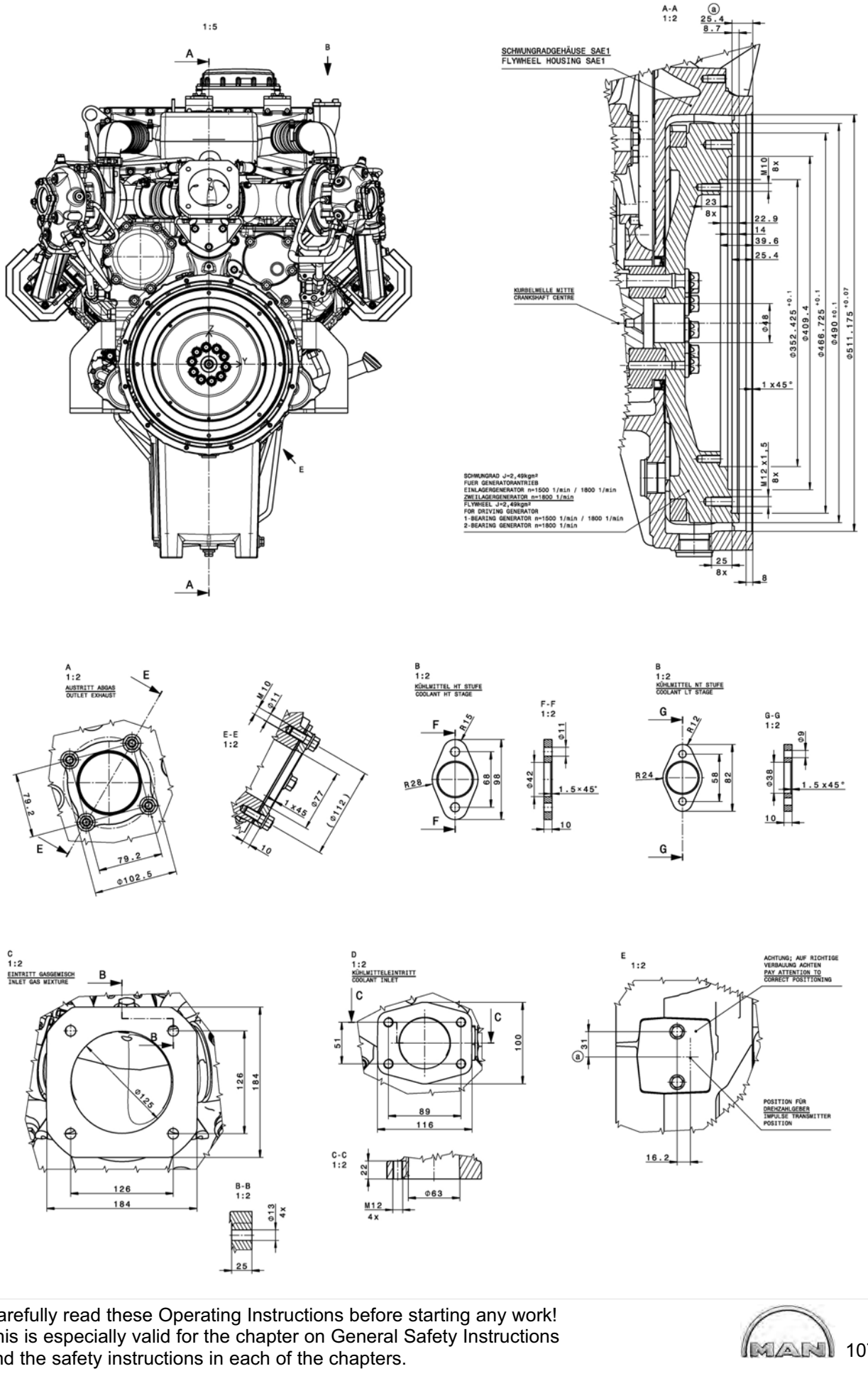
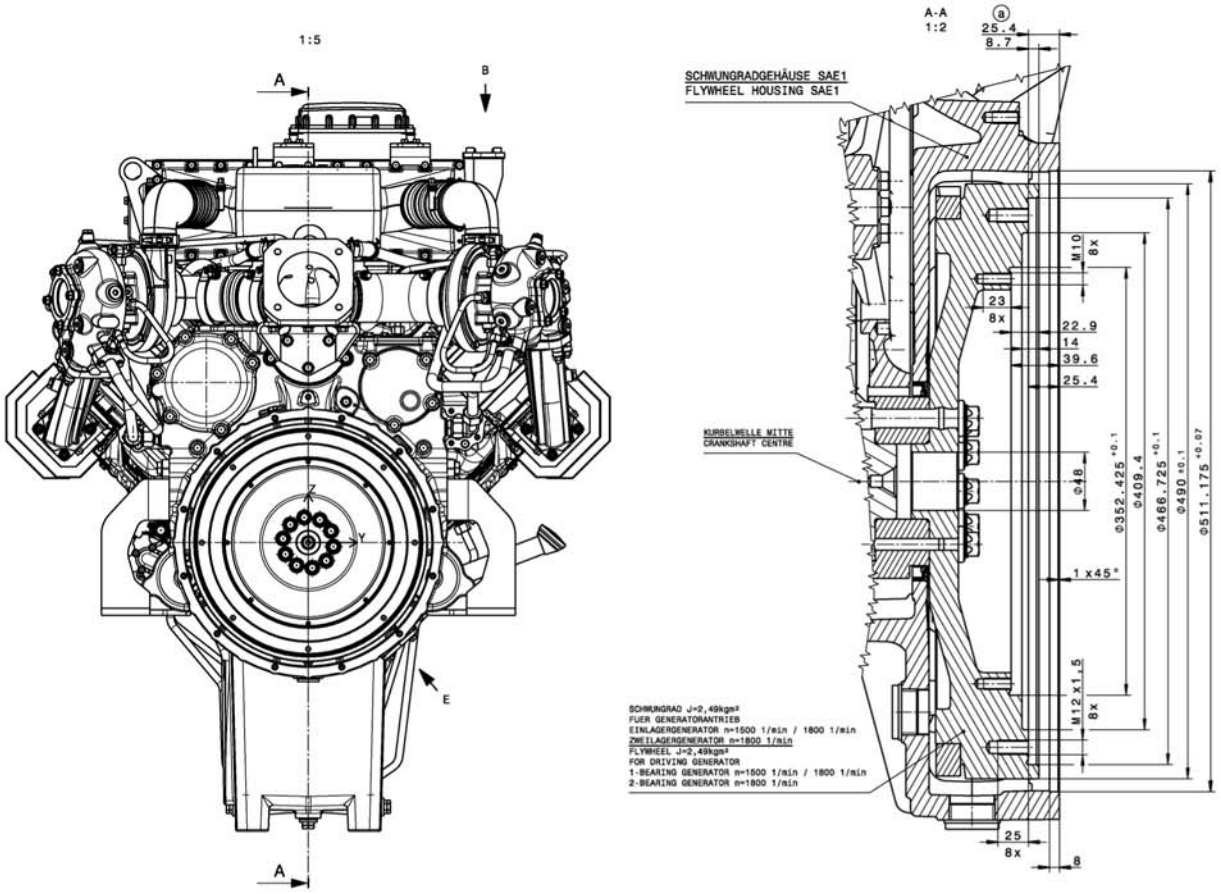
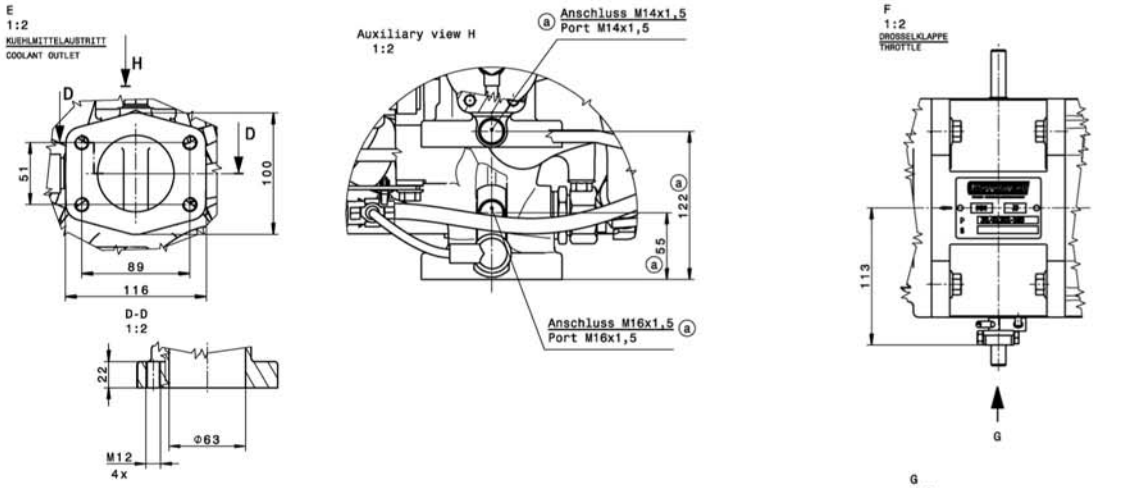
Installation drawing



Installation drawing





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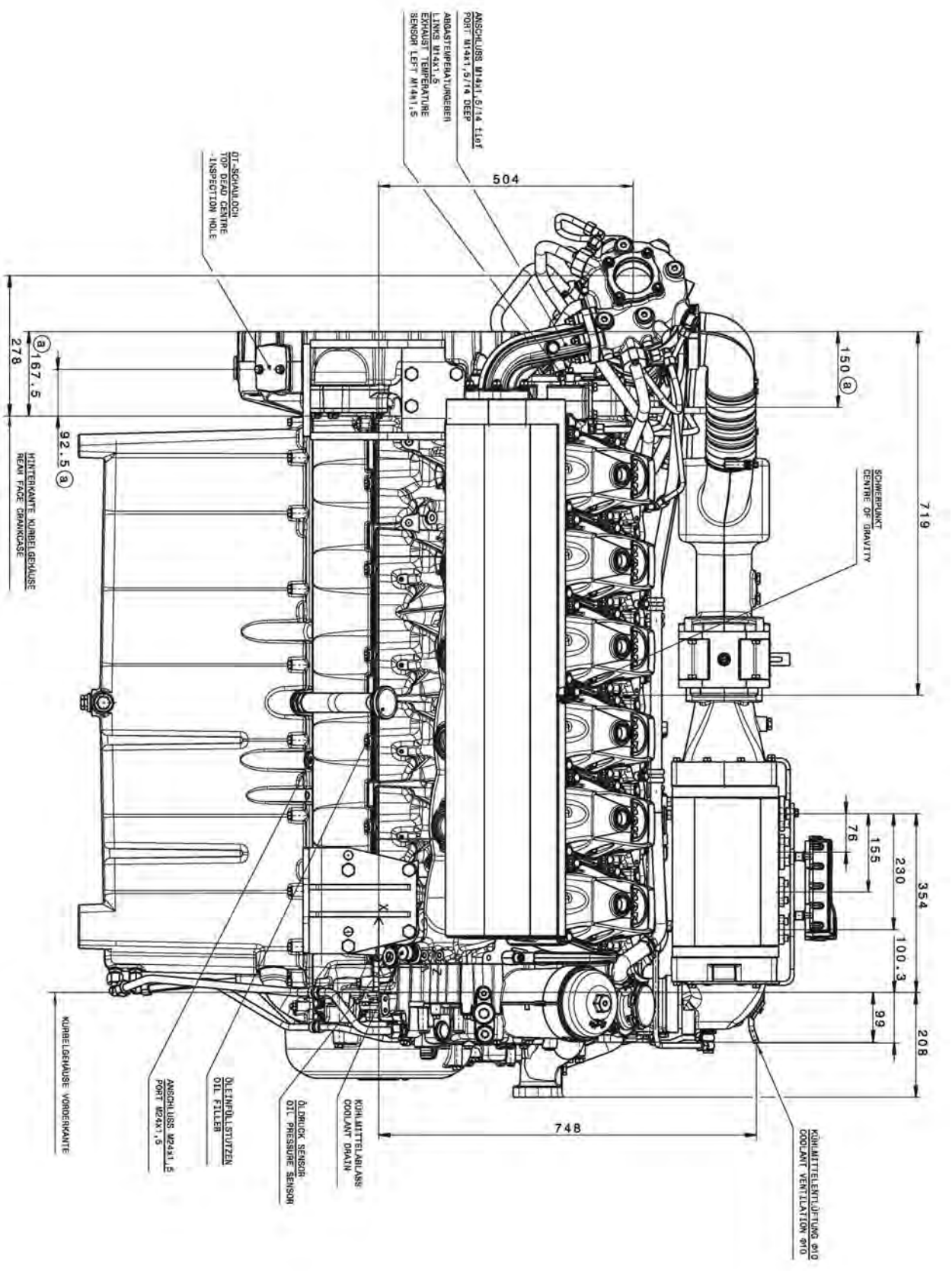
and the safety instructions in each of the chapters.

Installation drawing



13 Indices

13.1 Abbreviations

A . . . . . Amps

Ah . . . . . Amp hours

bzw. . . . . Respectively

C . . . . . Celsius

CAN . . . . . network for control units, data bus system in vehicle (Controller Area Network)

cm^3 . . . . . Cubic centimetre

evtl. . . . . Possibly

Fa. . . . . Company

ggf. . . . . If necessary

h . . . . . Hours

kg . . . . . Kilogram

Tl. . . . . Terminal

kW . . . . . Kilowatt

LCD . . . . . **L**iquid **C**rystal **D**isplay

LED . . . . . **L**ight **E**mitting **D**iode

m . . . . . Metre

MAX . . . . . Maximum

min . . . . . Minutes

MIN . . . . . Minimum

mm . . . . . Millimetre

Nm . . . . . Newton meter

TDC . . . . . Top dead centre

U_{Bat} . . . . . Battery voltage

usw. . . . . etc.

BDC . . . . . Bottom dead centre

V . . . . . Volt

W . . . . . Watt

e.g. . . . . For example

zul. . . . . permissible

> . . . . . Greater than

< . . . . . Less than

rpm . . . . . Revolutions per minute

13.2 List of keywords

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