# Operation Manual

## A175-M62

HT591216 English
Original Operation Manual

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Operating limits and replacement intervals

The recommended replacement intervals and the corresponding operating limits in chapter 3 are jointly defined with the enginebuilder. This information is specific to the product.

Non-observance of the recommended replacement intervals and the operating limits increases the risk of unpredictable component failures.
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1 Introduction

1.1 Purpose of the manual

This Operation Manual belongs to the turbocharger with the identical serial number (01), see chapter 3 (Safety data sheet) and the rating plate on the turbocharger.

Operation Manual
The Operation Manual explains the turbocharger and contains instructions for safe operation.

The Operation Manual is a complement to and expansion of existing national regulations for occupational safety, accident prevention and environmental protection.

Target group
The Operation Manual is aimed at engineers and trained mechanics responsible for the proper operation of the engine and for the turbocharger connected to it.

Availability of the Operation Manual
The Operation Manual must be available where the turbocharger is used.

All persons operating or working on the turbocharger must have read and fully understood the Operation Manual.
1.2 Symbols, definitions

Symbols
The following symbols are used in this document:

- Indicates an action step.
- Indicates a numbered action step.
- Refers to a page number.

Definition of Note

NOTICE
Note
The note provides advice which facilitates the work.

Definition of mandatory signs
Mandatory signs show the protective equipment to be worn for a task. The mandatory signs are described in chapter Safety and must be complied with.

Definition of Caution / Warning
Caution and warning signs are described in chapter Safety.

ABB Turbo Systems
ABB Turbo Systems Ltd is identified as ABB Turbo Systems in this document.

Official service stations of ABB Turbo Systems
Official service stations are identified in this document as ABB Turbocharging Service Stations. They are regularly audited and certified by ABB Turbo Systems. Also see chapter Contact information →7.
Definition of pictograms

The following pictograms can occur in this document. These point out actions that must be taken in accordance with the meaning of the relevant pictogram.

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<td></td>
<td>Tighten with specified torque</td>
<td></td>
<td>Affix</td>
</tr>
<tr>
<td></td>
<td>Tighten over specified tightening angle</td>
<td></td>
<td>Measure</td>
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<tr>
<td></td>
<td>Hand-tight, tighten without tools</td>
<td></td>
<td>Note</td>
</tr>
<tr>
<td></td>
<td>Oil</td>
<td></td>
<td>Visually inspect</td>
</tr>
<tr>
<td></td>
<td>Apply screw locking paste (e.g. Loctite)</td>
<td></td>
<td>Please note text for numbered work step</td>
</tr>
<tr>
<td></td>
<td>Apply high-temperature grease</td>
<td></td>
<td>See document</td>
</tr>
<tr>
<td></td>
<td>Apply other paste in accordance with specifi-</td>
<td></td>
<td>Dispose of in an environmentally compatible, professional way and in compliance with locally applicable regulations</td>
</tr>
<tr>
<td></td>
<td>Oil free, grease free and dry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Definition of pictograms
1.3 Storage of new turbochargers and spare parts

Storage of new turbochargers and spare parts for up to 6 months

New turbochargers and spare parts can be stored in their closed packages for 6 months from the date of delivery without additional mothballing measures, indicated by the VCI label on the package.

![VCI](image)

Fig. 2: Volatile Corrosion Inhibitor (VCI)

Only dry rooms with 40...70 % atmospheric humidity, in which no water condensation can form, are suitable as storage locations.

Storage of new turbochargers and spare parts for more than 6 months

**WARNING**

Health protection when handling VCI

VCI products are not hazardous in terms of the Ordinance on Hazardous Substances. Nevertheless, the following points must be observed when handling VCI:

- Observe information in material safety data sheet
- Ensure proper space ventilation.
- Do not eat, drink or store food at the workplace while working with VCI.
- Clean hands and face after working with VCI.
- For more information, see [www.branopac.com](http://www.branopac.com).

Wear safety gloves to protect against mechanical hazards.

Every 6 months, the following mothballing measures are required:

- Open package.
- Remove VCI corrosion protection emitter from package and replace with a new VCI corrosion protection emitter of the same kind. New VCI corrosion protection emitters can be obtained from [www.branopac.com](http://www.branopac.com).
- Old VCI corrosion protection emitters must be disposed of in an environmentally compatible, professional way and in compliance with locally applicable regulations.
- Close package. The more tightly the package is sealed, the longer the protection duration.
Long-term storage of replacement turbochargers or spare parts

The turbochargers or cartridge groups will be prepared for long-term storage if requested in the purchase order. The package is equipped with a hygrometer (see illustration).

Every 6 months, the following measures are required:

- Check the hygrometer (02) in the sight-glass. There is an opening (01) in the wooden crate to enable you to perform this check. If the 70% indicator field has changed colour, the maximum admissible atmospheric humidity has been exceeded. In this case, the turbocharger or cartridge group must be checked and repackaged by an ABB Turbocharging Service Station.
- Check the package for damage. If the package is damaged, the turbocharger or cartridge group must be checked and repackaged by an ABB Turbocharging Service Station.

After every 3 years, the following steps must be carried out by an ABB Turbocharging Service Station:

- Checking the component
- Replacing the desiccant
- Repackaging the component.

**NOTICE**

Replacement components which are ready for operation

If the 70% field of the hygrometer (02) has not changed colour and the package is not damaged, the replacement turbocharger or replacement cartridge group can be put into operation without previously having been checked by an ABB Turbocharging Service Station.

Unpackaging replacement turbochargers or spare parts

Once the material has been unpackaged from the VCI package, the corrosion protection is no longer effective.

To prevent condensation, the temperature of the package contents must be the same as the ambient temperature.
1.4 Contact information

Contact information for the ABB Turbocharging Service Stations is available online.

Scan the QR code to access our website.

ABB Turbo Systems Ltd
Bruggerstrasse 71a
CH-5401 Baden
Switzerland

www.abb.com/turbocharging
Safety

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1 Safety

1.1 Introduction

Turbochargers manufactured by ABB reflect the state of the art. The respective safety and health protection requirements are met. This ensures safe operation of the turbocharger. Nevertheless, there may be some residual risks during operation of and work on the turbocharger which:

- Are caused by the turbocharger itself or its accessories.
- Are caused by the operating equipment used or supplies and materials.
- Are a consequence of insufficient compliance with safety instructions.
- Are a consequence of insufficient or inappropriate performance of maintenance and inspection work.

The operating company is responsible for defining measures that regulate safe access to and safe handling of the turbocharger.

All instructions contained in this chapter must be observed for safe and trouble-free operation of the turbocharger and during all work on the turbocharger.

All further safety instructions contained and specifically identified in every chapter of this manual (Definition of safety instructions →3) must also be observed.

1.2 CE conformity

Information

ABB turbochargers comply with the Machinery Directive 2006/42/EC and are partly completed machinery as defined by Article 2 g in this directive.
1.3 Definition of mandatory signs

To be worn at all times

- **Protective clothing**
- **Safety footwear** to protect against mechanical hazard and risk of falling

Table 1: Personal protective equipment to be worn at all times

To be worn specific to the respective task

- **Safety glasses**
- **Safety goggles**

- **Safety gloves** to protect against
  - Mechanical hazard
  - Chemical hazard
  - Thermal hazard

- **Respiratory mask** to protect
  - Dusts
  - Gases

- **Safety helmet**
- **Ear protection**

Table 2: Personal protective equipment to be worn specific to the respective task

1.4 Definition of safety instructions

**WARNING**

**Definition of Warning**

Non-compliance or inaccurate compliance with working or operating instructions indicated by this symbol and the word **WARNING** can lead to serious injuries to personnel and even to fatal accidents.

- Warning signs must always be observed.

**CAUTION**

**Definition of Caution**

Non-compliance or inaccurate compliance with working or operating instructions indicated by this symbol and the word **CAUTION** can lead to serious damage to engine or property with grave consequences.

- Caution signs must always be observed.
1.5 Intended use

Use on internal combustion engines in general

ABB turbochargers are intended for turbocharging internal combustion engines.

To ensure compliance with the machinery directive 2006/42/EC when using on gas engines, the turbocharger must be operated in an engine room classified as "not at risk of explosion". This is in accordance with the position paper [2] relating to ATEX issued by EUROMOT [1].

The turbocharger supplies the engine with the air volume or air/gas mixture and the associated charging pressure required for operation.

The turbocharger is solely intended to be operated with a clockwise direction of rotation as viewed from the turbine end.

The specific operating limits of the turbocharger were determined on the basis of information from the enginebuilder about the intended use. These data are given on the rating plate.

ABB accepts no liability and rejects all warranty claims for any non-intended uses.

[1] Euromot = The European Association of Internal Combustion Engine Manufacturers

WARNING

Unapproved operation

Any operation of the turbocharger outside of its operating limits can be hazardous to personnel.

- Only operate the turbocharger within the operating limits.
- Only trained personnel must operate the turbocharger.

The intended use of the turbocharger includes compliance with all regulations and conditions. In particular, the following must be observed:

- Operation Manual
- Instructions of the enginebuilder
State of the art
The turbocharger is designed and manufactured according to the state of the art and is safe to operate.

Perfect condition
The turbocharger must only be used when it is in a technically flawless condition and operated in compliance with its intended use.

ABB excludes any liability for damage resulting from unauthorized modifications to the turbocharger or improper operation.

1.6  Deflagration on gas engines

ABB turbochargers can tolerate a deflagration with a transient pressure increase of 12 bar.

After a deflagration event ABB Turbo Systems recommends verifying the following points on the turbocharger:

- Position of the turbine and compressor casings to the bearing casing
- Shifting of the bearing casing in relation to the bracket
- Cracks in casings

If during external inspection anomalies are found or if a particularly strong deflagration event has taken place, it is also recommended to check the bearings of the turbochargers before the next start. An ABB Turbocharging Service Station should be instructed to carry out this inspection.
1.7 Warning plates on the turbocharger

Warning plates are attached to the turbocharger, which must be observed. The warning plates must always be present in the intended locations and must be legible.

![Warning plate]

Fig. 1: Warning plate

If warning plates are not present in the intended locations or are not legible, they must be replaced with new warning plates. The necessary information can be found in the Operation Manual, Chapter 4 Product description.

Turbochargers supplied to the enginebuilder without insulation must be equipped later with warning plates on the insulation. This is the responsibility of the enginebuilder.
1.8 Turbocharger rating plate

Fig. 2: Rating plate

Operating limits
01 Turbocharger operating limits at engine overload (110 %). In test rig operation only, unless otherwise agreed with the enginebuilder.
02 Turbocharger operating limits during operation

Recommended replacement intervals of turbocharger components
03 Replacement interval of plain bearings in 1000 h
04 Replacement interval of compressor in 1000 h
05 Replacement interval of turbine in 1000 h

Further data
06 Customer part number
07 Designation for special design
08 Weight of turbocharger in kg
09 Turbocharger type
10 Serial number
11 Year of construction of turbocharger
12 Manufacturing plant
Explanations regarding the rating plate

The recommended replacement intervals and the corresponding operating limits are jointly defined with the enginebuilder. This information is specific to the system.

Operation above the indicated values \( n_{\text{Bmax}}, t_{\text{Bmax}} \) can considerably shorten the recommended replacement intervals. In such cases ABB recommends contacting the nearest ABB Turbocharging Service Station.

\( n_{\text{Mmax}}, t_{\text{Mmax}} \) normally apply only when running at overload (110%) during trials on the engine test bed. These limit values can also be permitted during operation for special applications. Operation above \( n_{\text{Mmax}} \) and \( t_{\text{Mmax}} \) is not permitted.

Non-observance of the recommended replacement intervals increases the risk of unpredictable component failures.

Locations of the rating plates

The locations of the rating plates are defined in the Operation Manual, Chapter 4 Product description.

1.9 Periodic check of the pressure vessels

The pressure vessels used by ABB Turbocharging, such as those for wet or dry cleaning, are so-called "simple pressure vessels".

- The locally applicable legal regulations regarding periodic checks of the pressure vessels must be observed.
- The operating company is responsible for the safe operation of the pressure vessel.

**WARNING**

Danger due to pressure vessels

The operating company must make sure the pressure vessels are in proper working condition and monitor them. Necessary repair or maintenance work must be performed promptly, and the required safety measures must be taken.

- Pressure equipment must not be operated if defects are present.
1.10 Lifting of loads

**WARNING**

**Suspended loads**

Loads that are not attached according to regulations can cause injury to personnel or fatal accidents.

- Loads must always be fastened to properly functional lifting gear with a sufficient load limit.
- Pay attention to the correct attachment of loads on the crane hook.
- People must not stand beneath suspended loads.

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

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Fig. 3: Attachment of loads on the crane hook

If there are two or more suspension points, the attachment angle of 45° must not be exceeded. This prevents excessive loading due to diagonal pull.

- Before looping around the components of the turbocharger, let them cool down (maximum 80 °C).
- Attach components of the turbocharger as described in the respective action steps.
- Use a suitable edge guard if there are sharp edges.
- The assembly devices must be completely screwed in and must not unscrew during use.
- Use assembly devices only for the described applications.
- Put down dismantled components of the turbocharger in such a way that they cannot tip over.
1.11 Prerequisites for operation and maintenance

Responsibility of the operating company

In awareness of its responsibility, the operating company must ensure that only authorised personnel work on the turbocharger, who:

- Are versed in the general and locally applicable regulations for occupational safety and accident prevention
- Are equipped with the prescribed personal protective equipment
- Have read and understood the Operation Manual
- Have been instructed in the use of the turbocharger.

The safety-conscious work of the personnel and adherence to the Operation Manual must be checked periodically.

Suitable working materials and personal protective equipment must be kept in a perfect condition.

Only authorised personnel may remain in the vicinity of the turbocharger when the engine is running.

Competence of personnel

The turbocharger must only be operated and serviced by trained and authorised personnel. Basic mechanical training is a prerequisite.

Modifications to the turbocharger

Modifications to the turbocharger must be approved by ABB Turbo Systems.

WARNING

Use original parts

Operation of the turbocharger with non-original parts can impair the safety of the turbocharger and can cause serious damage to property and injury to personnel.

- Only use original parts from ABB Turbo Systems.

Original parts and accessories are specially designed by ABB Turbo Systems for the ABB turbochargers.

ABB accepts no liability for any damage resulting from the use of non-original parts and corresponding accessories.
1.12 Hazards during operation and maintenance

Noise hazards

The turbocharger’s noise emission during operation is influenced by its installation and operating conditions. A noise level exceeding 85 dB(A) is harmful.

**WARNING**

Danger due to noise

Exposure to noise can harm the hearing system, impair health and the psychological state and may lead to lack of attention and irritation.

- When the engine is running, always wear ear protection.
- Always wear ear protection if the sound pressure level exceeds 85 dB(A).

Wear ear protection.

Hazards due to hot surfaces

Surfaces of the turbocharger, attached parts and operating fluids (lubricating oil) get hot during operation. The surface temperature depends on the efficacy of the existing insulation. The temperature may rise to a level that can cause burns.

**WARNING**

Danger of burns

Touching hot surfaces or contact with hot operating fluids can cause burns.

- Do not touch hot surfaces. Observe the warning plate on the turbocharger.
- Wear heat-resistant safety gloves and protective clothing.
- Wait for the turbocharger to cool down before carrying out any work.

Wear safety gloves to protect against thermal hazards.
1.12 Hazards during operation and maintenance

**WARNING**

**Hot surfaces on the non-insulated turbocharger**

Non-insulated turbochargers can cause serious injuries to personnel (burns). The turbocharger is supplied with or without insulation in accordance with the purchase order received from the enginebuilder. If supply is without insulation, the enginebuilder is responsible for providing the turbocharger with proper insulation and for providing protection against contact with hot surfaces.

- Compliance with the instructions and specifications given by the enginebuilder to protect against hot turbocharger surfaces is compulsory.

Wear safety gloves to protect against thermal hazards.

### Hazards due to rotating parts

**WARNING**

**Physical hazards**

Contact with rotating parts can cause severe injury. The turbocharger must never be used without the filter silencer or the air suction branch. With the engine stopped, the rotor can rotate due to the stack draught alone.

- Operate the turbocharger in compliance with the specifications.
- Secure the rotor against unintentional rotation during maintenance.

Wear safety gloves to protect against mechanical hazards.

### Hazards due to electrical installations (if present)

**WARNING**

**Dangers during work on electrical installations**

Electrical installations use voltages that can lead to severe injury to personnel or accidents resulting in fatalities.

At the same time, electrical or electronic components and parts can also be damaged or destroyed.

- Only specially trained personnel should perform work on, or with, electrical components.
- Observe national regulations.
ABSOLUTE WARNING

Absence of grounding on electrical installations

Missing or incorrectly fitted grounding conductors can lead to severe injury to personnel or accidents resulting in fatalities.

Electric shock or elevated electromagnetic disturbances can damage or destroy electrical and electronic components.

- Ground electrical installations properly with grounding conductors.
- Check the grounding connections on a regular basis and make sure they are properly connected.

- Switch off the power supply before working on any electrical installations.
- After switching off the power supply, wait for 5 minutes to allow capacitors to discharge and hot components to cool down.
- Ensure the power supply is switched off when working on electrical installations.
- Do not carry out any tests with regard to insulation resistance or voltage on the electrical components.

1.13 Safe operation

Mechanical hazards during operation

During standard operation, no mechanical hazards are caused by the turbocharger itself if it has been properly installed.

Safety during commissioning and operation

- Visually inspect your working environment before starting work.
- Remove any obstacles and objects littering the workplace.
- Check all pipes to and from the turbocharger for damage and leaks before commissioning.
- Check turbocharger for recognisable damage or defects every 12 hours of operation or at least once a day.
- Report any damage and any alterations of operational characteristics to the responsible department immediately.
- In case of damage, take the turbocharger out of operation immediately and safeguard against accidental/unauthorised use.
- When switching on operating energy supplies (hydraulics, pneumatics, electricity), pay attention to the risks that may occur as a consequence of this energy input.
1.14 Safe maintenance

Occupational safety

⚠️ WARNING
Injuries to persons
Severe injuries to personnel or fatal accidents can be caused by mechanical influences as a consequence of hazardous and inadequate operational procedures or non-compliance with safety and health standards.

- When working on the turbocharger always wear safety footwear and protective clothing to protect against mechanical hazards.
- Keep personal protective equipment in perfect condition.
- Obey mandatory signs.
- Observe the general rules for occupational safety and prevention of accidents.
- Only perform operations that are described in this manual.
- Only perform operations for which you have received instruction or training.

Wear safety footwear to protect against mechanical hazard and risk of falling.

Wear protective clothing.

⚠️ WARNING
Risk of falling
When working on the turbocharger, there is a risk of falling.

- Do not climb onto the turbocharger or onto attached parts and do not use them as climbing aids.
- Use suitable climbing aids and working platforms for work above body height.

Comply with the general accident prevention regulations.

Only perform work on the turbocharger when you are in a physically and psychologically stable condition.

Only work with suitable tools, equipment and appliances that function properly.

Power tools must be grounded and cables must be undamaged.

Keep the workplace clean; clear away any loose objects and obstacles on the floor.

Keep the floor, equipment, and turbocharger clean.

Have oil binding agents ready and provide or keep oil pans at hand.

Clean up any spills.

Have fire protection means and extinguishing agents available.
Welding work in the vicinity of the turbocharger

- When performing welding work in the vicinity of the turbocharger, always cover the filter silencer to prevent the filter mat from being damaged.
- Keep flammable objects and substances out of the vicinity of flying sparks.
- Cover all connections on the turbocharger so that no foreign objects can enter the turbocharger.
- Wear personal protective equipment (PPE) for welding operations.

Safety during cleaning

If cleaning agents or solvents are used for cleaning, the corresponding material safety data sheet and the safety instructions in section Hazards due to operating materials and supplies must be observed.

- Observe the material safety data sheet for the cleaning agent or solvent.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
- Inspect the electric cables for abrasion and damage before and after your cleaning work.

Safety during disassembly, assembly, maintenance and repair

- Observe the procedures for set-up, service and inspection work and the inspection intervals.
- Inform the operating staff before starting any service or repair work. Make sure the engine is not started while work is being conducted on the turbocharger.
- Before taking off any cover or removing any guard from the turbocharger, switch off the engine and wait until the turbocharger has come to a standstill.
- Make sure that the oil supply is interrupted, especially with an external oil supply.
- Only restart the engine after all parts have been properly fitted again and oil supply is ensured.

⚠️ CAUTION

Mechanical operations on the turbocharger

Components of the turbocharger can be damaged or destroyed as a result of improper procedures.

- Only perform operations that are described in this manual.
- Only perform operations for which you have received instruction or training.

Safety when taking out of operation or preparing for mothballing

- Secure rotor against turning. The rotor can rotate due to the stack draught alone.
- Observe the material safety data sheet for the cleaning and mothballing agents.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
Mechanical hazards when working on the turbocharger

**WARNING**

Physical hazards due to rotating parts
The rotor can rotate due to the stack draught alone. Contact with rotating parts can cause severe injury.
- Secure rotor against turning.

**WARNING**

Mechanical hazards
Severe injuries to personnel or fatal accidents can be caused by mechanical influences as a consequence of hazardous and inadequate operational procedures.
- Observe the general rules for occupational safety and prevention of accidents.
- Ensure workplace safety.
- Only perform operations that are described in this chapter.
- Only perform operations for which you have previously received instruction or training.

Hazards due to operating materials and supplies
Operating materials and supplies are substances required for the operation of the turbocharger or for the performance of maintenance work. Oils, greases, coolants, detergents and solvents, acids and similar substances can be classified as hazardous substances.

**WARNING**

Handling operating materials and supplies
Swallowing or inhaling vapours of operating materials and supplies or contact with them may be harmful to health.
- Do not breathe in these substances and avoid contact with the skin.
- Ensure proper ventilation.
- Observe the information in the material safety data sheet for the operating materials and supplies.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
- Comply with local legislation.

- Wear safety goggles.
- Wear safety gloves to protect against chemical hazards.
- Wear a respiratory mask to protect against gases.
**WARNING**

**Danger of fire or explosion**
Flammable and combustible operating materials and supplies can catch fire or resulting vapours can lead to an explosion.
- Observe the information in the material safety data sheet for the operating materials and supplies.
- Comply with local legislation.
- Do not allow any exposed flame or ignition source during cleaning work.
- Carry out cleaning in the open or provide sufficient ventilation.

**CAUTION**

**Environmental hazard**
Improper handling of operating materials and supplies can lead to environmental damage.
- Observe the information in the material safety data sheet for the operating materials and supplies.
- Comply with local legislation.

**Hazards due to the handling of insulation materials**

**WARNING**

**Danger from insulation materials**
Dust or fibres from insulation materials can have adverse effects on the health or cause irritations. Unsuitable and combustible insulation materials are a fire hazard.
- Only use suitable and non-combustible insulation materials.
- Ensure good ventilation at the workplace.
- Avoid whirling up dust.
- Use dust-free tools and working methods.
- Remove package at the workplace only.
- Proceed with particular care when removing old insulation materials.
- Dispose of insulation materials properly and in an environmentally compatible manner in compliance with the legal regulations.

- Wear safety goggles.
- Wear a respiratory mask to protect against dusts.
- Wear safety gloves to protect against chemical hazards.
# Safety data sheet

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4600 kg

35

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made in Switzerland
# Product description

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1 Introduction

1.1 Essential information

Design variants
This document is valid for different design variants of turbochargers. There may be sections and descriptions of components that are not relevant for a specific turbocharger variant.

Please contact an ABB Turbocharging Service Station if you have any questions regarding a design variant (see Contact information at www.abb.com/turbocharging).

Accuracy of illustrations
The illustrations in this document are general in nature and intended for ease of understanding. Differences in detail are therefore possible.

1.2 Registered trademarks
The trademarks of outside companies are used in this document. These are marked with the ® symbol.

1.3 Related documents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Manual / 1 Introduction</td>
<td>HZTL4005</td>
</tr>
<tr>
<td>Operation Manual / 2 Safety</td>
<td>HZTL4023</td>
</tr>
<tr>
<td>Operation Manual / 3 Safety data sheet *)</td>
<td>Serial number of the turbocharger</td>
</tr>
</tbody>
</table>

Table 1: Related documents

*) This chapter is only available in serialised operation manuals.
1.4 Layout and function of the turbocharger

Fig. 1: Layout and function

01 Filter silencer / air suction branch
02 Compressor wheel
03 Diffuser
04 Bearing bush
05 Gas outlet casing
06 Gas inlet casing
07 Nozzle ring
08 Turbine
09 Bearing casing
10 Compressor casing
Mode of operation

The turbocharger is a turbomachine consisting of two main components, a turbine and a compressor. These components are mounted on a common shaft and form the rotor.

In the turbocharger shown in the illustration, the exhaust gas flows through the gas inlet casing (06) and the nozzle ring (07) and arrives at the turbine (08). The turbine utilises the energy contained in the exhaust gas to drive the rotor. The exhaust gases then escape into the open air through the gas outlet casing (05) and the exhaust gas pipe connected to it.

The rotor runs in two radial plain bearings, which are located between the compressor and the turbine in the bearing bush (04). The axial bearing is also a plain bearing. The plain bearings are connected to a central lubricating oil duct which is normally supplied by the lubricating oil circuit of the engine. The oil outlet is situated at the lowest point of the bearing casing (09).

The compressor wheel (02) connected to the shaft draws in fresh air through the filter silencer (01) or the air suction branch. The air is compressed in the compressor and the downstream diffuser (03) and then led to the charge air cooler via the compressor casing (10).

Turbocharger version with compressor wheel cooling

![Connection of the compressor wheel cooling](image)

Fig. 2: Connection of the compressor wheel cooling

Depending on the application, the turbocharger is equipped with compressor wheel cooling. With compressor wheel cooling, after the compressor air has cooled down by passing through the charge air cooler on the engine side, it is supplied to the turbocharger for cooling the compressor wheel.

Cooling of the compressor wheel is compulsory to ensure the reliability and replacement intervals for the relevant operating conditions. In the turbocharger version with compressor wheel cooling, the cooling air is supplied through the lateral connection (15) in the bearing casing.
1.5 Warning plates on the turbocharger

Warning plates are affixed at the following locations:

If warning plates are not present in the designated locations or not readable, proceed as follows:

- Order new warning plates from ABB Turbocharging Service Stations.
- Remove any warning plates that have become unreadable.
- Clean and degrease the areas designated for the warning plates.
- Fit new warning plates and remove protective sheets.

Turbochargers supplied to the enginebuilder without insulation must be equipped later with warning plates on the insulation. This is the responsibility of the enginebuilder.
1.6 Locations of the rating plates

Fig. 4: Locations of the rating plates

One rating plate each is attached on the left and the right side of the foot of the turbocharger.

On turbochargers with insulation from ABB Turbo Systems, at least one additional rating plate is attached to the insulation of the gas outlet casing.
2 Removal and installation

2.1 Turbocharger weight

Lifting gear with a sufficient load limit must be used for removing, installing and transporting the turbocharger. The weight specified below applies to the heaviest variant possible. Depending on the specification, the weight specified on the rating plate may be lower than the standard value specified here.

Fig. 5: Turbocharger suspension points

Weight of the entire turbocharger

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>3100</td>
</tr>
<tr>
<td>A175-M</td>
<td>4600</td>
</tr>
</tbody>
</table>

Table 2: Weight of the turbocharger
2.2 Removing the turbocharger

⚠️ WARNING
Risk of tipping

If the turbocharger is not sufficiently supported or not supported at all during removal and installation, it may tip over and cause severe injury to personnel or accidents resulting in fatalities.

- Support the turbocharger at a suitable location.
- Secure with lifting gear wherever possible.

(epoch)

Wear safety helmet.

- If present: Loosen cable to speed sensor.
- Disconnect all gas, air and lubricating oil pipes.

Fig. 6: Turbocharger suspension points

- If present: Remove insulation segments on bearing casing and feet.
- Attach lifting gear to the suspension lug of the bearing casing and through the boles on the turbine-end foot.
**Turbocharger with clamping nuts**

Fig. 7: Removing the foot mounting

1. Treat the threads of the threaded rods with penetrating oil and allow it to work in. Do not oil the pressure screws of the clamping nut.

2. Undo the clamping nuts at the compressor-end and turbine-end foot (see **Loosening the clamping nut →11**).

3. Fit transport screws (90334 / 90335) to secure the sliding block (68003) on the left and right on the turbine-end foot.

- Lift the turbocharger from the engine and put it down.
- Cover all oil connections.
2.2.1 Loosening the clamping nut

**CAUTION**

Incorrect procedure can make loosening impossible
If individual pressure screws are fully relieved, the pressure screws can become compressed, making it impossible to loosen them.
- Comply with the following steps for loosening the pressure screws.

**CAUTION**

Do not clean pressure screws
The pressure screws are equipped with a permanent sliding layer that must not be removed. In case of non-compliance, it cannot be ensured that the necessary tension force is reached.
- Do not clean pressure screws.
- Do not lubricate pressure screws.

If a screw jams, the previously loosened screw must be tightened again a little.

1. Working in a circle, break loose each pressure screw (≤ 20°).
2. Working in a circle, loosen each pressure screw by 45° in 4 rounds.
3. In 1 to 5 rounds, loosen each pressure screw by 90° in circular order until all pressure screws have been relieved.
- Unscrew and remove the clamping nut by hand.

Fig. 8: Loosening the clamping nut

1. ≤20°  
2. 45°  
3. 90°
2.3 Installing the turbocharger

2.3.1 Steps for fastening the turbocharger with clamping nuts

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of tipping</td>
</tr>
<tr>
<td>If the turbocharger is not sufficiently supported or not supported at all during removal and installation, it may tip over and cause severe injury to personnel or accidents resulting in fatalities.</td>
</tr>
<tr>
<td>▶ Support the turbocharger at a suitable location.</td>
</tr>
<tr>
<td>▶ Secure with lifting gear wherever possible.</td>
</tr>
</tbody>
</table>

Wear safety helmet.

Fig. 9: Turbocharger suspension points

- If present: Remove insulation segment on the bearing casing.
- Attach lifting gear to the suspension lug of the bearing casing and the turbine-end foot.
- Remove the covers from the oil connections.
- Align turbocharger and place on bracket.
Removing auxiliary screws

Fig. 10: Removing auxiliary screw

- Remove shipping screws (90334 / 90335) on the left and right side of the foot and place in the toolbox.

The turbocharger is delivered with a pre-installed sliding block (68003). The shipping screws secure the sliding block in the preset position. In operation, the foot can slip due to thermal expansion.

- Tighten clamping nuts as described in the following sections.

- Connect all gas, air and oil pipes.
- If present: Re-fit the insulation segments.
- If present: Connect cable to speed sensor.
Compressor-end (CE) foot

![Compressor-end foot diagram]

Fig. 11: Compressor-end foot

Turbine-end (TE) foot

![Turbine-end foot diagram]

Fig. 12: Turbine-end foot

### Screw dimensions and number of cup springs

<table>
<thead>
<tr>
<th>Product</th>
<th>Foot bolt dimension [mm]</th>
<th>Strength class</th>
<th>Dimension CE [mm]</th>
<th>Dimension TE [mm]</th>
<th>Number of cup springs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a1</td>
<td>b1</td>
<td>c1</td>
</tr>
<tr>
<td>A170-M</td>
<td>M30</td>
<td>10.9</td>
<td>82</td>
<td>Ø32x23</td>
<td>68</td>
</tr>
<tr>
<td>A175-M</td>
<td>M36</td>
<td>10.9</td>
<td>95</td>
<td>Ø38x31</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 3: Foot bolt dimensions

Holes b1/b2 are needed to achieve the required clamping length. An additional drill hole is not needed at the higher turbine-end foot side (01).
Fixing clamping nuts

Fig. 13: CE foot contact surface

- Tighten clamping nuts on compressor end (CE) (see Tightening the clamping nut →16).

Fig. 14: TE foot: Handling of cup spring contact surface / foot contact surface

- Coat the contact surface (F) for the cup springs (X) (see Table 3: Foot bolt dimensions →14) at the foot of the turbine end (TE) with high-temperature grease.
- Tighten clamping nuts on turbine end (TE) (see Tightening the clamping nut →16).
2.3.1.1 Tightening the clamping nut

**CAUTION**

Do not clean pressure screws (d)
The pressure screws are equipped with a permanent sliding layer that must not be removed.

Do neither clean nor lubricate the pressure screws. In case of non-compliance, it cannot be ensured that the necessary tension force is reached.

- Do not clean pressure screws.
- Do not lubricate pressure screws.

**NOTICE**

Pressure screws (d) must not protrude from the clamping nut (c) in the direction of the thrust washer (b)

In order to correctly fit the clamping nuts, the pressure screws must not protrude in the direction of the thrust washer.

---

**Fig. 15: Tightening the foot bolts (1)**

1. Clean bolt thread (a) and contact surface.
   Coat the bolt thread with grease.
2. Fit thrust washer (b) (component of clamping nut).
3. Tighten clamping nut (c) by hand.
4. Screw back clamping nut by ¼ of a turn (90°).

The distance between the thrust washer and the clamping nut is now about 1 mm.
2.3 Installing the turbocharger

![Fig. 16: Tightening the clamping nut (2)](image)

**Torque-controlled tightening**

<table>
<thead>
<tr>
<th>Product</th>
<th>Fixing screw [mm]</th>
<th>Tightening torques of pressure screws [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>M30</td>
<td>45</td>
</tr>
<tr>
<td>A175-M</td>
<td>M36</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 4: Clamping screw tightening torques

1. Screw in pressure screws crosswise by hand until reaching the stop.
2. Tighten pressure screws crosswise to 50 % of the tightening torque specified in the table.
3. Tighten pressure screws crosswise to 100 % of the tightening torque specified in the table.
4. Work in a circle to tighten all pressure screws to 100 % of the tightening torque specified in the table.
5. Tighten pressure screws to 100 % in 5 … 7 rounds until the required residual tightening angle of < 20° is achieved.
3 Commissioning

3.1 Oil supply

3.1.1 Introduction

In all operating states, a functioning and carefully executed oil supply is an important prerequisite for trouble-free operation of the turbocharger.

The lubrication of the turbocharger is usually carried out with oil from the engine oil circulation.

- Comply with the enginebuilder’s specifications regarding the selection of lubricating oil and the oil change intervals.

For more information on the oil supply, refer to Chapter Oil pressure, oil temperature →21.

3.1.2 Pre-lubrication and post-lubrication

The pre-lubrication time is at least 2 minutes.

The post-lubrication time is 10 minutes.

If the engine is operated in idle mode 10 minutes before stopping, no additional post-lubrication is required.

3.1.3 Oil filtering

Filtering of the lubricating oil with a filter mesh width of ≤ 0.050 mm is sufficient for the turbocharger.

3.1.4 Oil pressure

Comply precisely with the oil pressure before the turbocharger for trouble-free operation.
3.2 Inspection procedures

3.2.1 Introduction

Inspection procedures include preventative visual controls, monitoring and measuring work before and during commissioning. Inspection procedures enable changes to the turbocharger to be detected. Machine damage can be prevented.

3.2.2 Checks before commissioning

Filter mat (if available)
- Check for damage and contamination.

Lubricating system

⚠️ CAUTION
Contaminated oil
Serious damage to engine or property can be caused by dirt and solid material particles in the oil.
- For the initial commissioning phase and after all service work, flush the complete lubricating system with warm oil.
- Use special running-in filters when running in the engine and after all service work on the lubricating system.

- Check that the oil filter is clean before commissioning.
- Check the oil pressure in the oil supply pipes.

3.2.3 Checks after commissioning (engine in idle mode)

Lubricating system
- Check the oil pressure in the oil supply pipes.
- Check oil inlet temperature.

The admissible values are specified in section Oil supply.

Gas, air and oil pipes
- After starting the engine, check all gas, air and oil pipes for leaks.
3.2.4 Checks when starting up the engine

- Measure speed, oil pressure and charging pressure at various engine performances.
- Measure the exhaust gas temperature before and after the turbine.
- Measure the air temperature before and after the compressor.
- Compare the measured values with the values of the acceptance report. Different operating conditions indicate a malfunction (see Chapter Troubleshooting →50).

Escape of oily fluids

Lubricants and pastes used during assembly can liquefy or vaporise and escape as oily fluids during the initial hours of operation. Continual escape of an oily fluid indicates an oil leak.

- If there is a leak, contact an ABB Turbocharging Service Station.

3.3 Commissioning after taking out of operation

If present

- Remove cover plates (blind flanges) from the compressor casing, the gas inlet and the gas outlet.

General

- Check the exhaust gas pipe before and after the turbine for combustion residues or water residues and clean it. Remove any foreign objects that may be present.
- Check and clean filter silencer or air supply line, and remove any foreign objects that may be present.
- Put engine-side oil circulation to the turbocharger into operation.
- Prepare the turbocharger for operation (see Checks before commissioning →19).
- The turbocharger is now ready for operation.
4 Monitoring during operation

4.1 Oil pressure, oil temperature

Lubricating oil pressure

⚠️ CAUTION
Assuring lubricating oil pressure
Serious damage to engine or property can result from missing or insufficient lubricating oil supply.

- The lubricating oil pressure must be monitored during operation and the necessary pressure assured at the oil inlet.

For monitoring the lubricating oil pressure, ABB Turbo Systems recommends installing a manometer "M". If the pressure is controlled electronically, the appropriate signals are to be triggered at the warning and alarm values.

![Fig. 17: Lubricating oil pressure measuring point](image)

The permitted oil pressure ranges at measuring point M of the turbocharger are listed below.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Pressure at measuring point M $P_{\text{oil, in}}$ [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>1.3 ... 2.5</td>
</tr>
<tr>
<td>Engine start: Cold oil, admissible for max. 15 minutes</td>
<td>1.3 ... 5.0</td>
</tr>
<tr>
<td>Pre-lubrication</td>
<td>1.3 ... 2.5</td>
</tr>
<tr>
<td>Post-lubrication</td>
<td>1.3 ... 2.5</td>
</tr>
<tr>
<td>Long-term lubrication</td>
<td>0.2 ... 0.5</td>
</tr>
<tr>
<td>Warning signal: Temporarily admissible (&lt;1 h)</td>
<td>1.0 ... 1.3</td>
</tr>
<tr>
<td>Alarm signal: Not permissible. Stop the engine immediately</td>
<td>&lt; 1.0</td>
</tr>
</tbody>
</table>

Table 5: Oil pressure range

Lubricating oil temperature at the inlet

⚠️ CAUTION
Machine damage
If the oil temperature at the oil inlet exceeds the admissible range, this may lead to engine damage.

- Observe oil temperature at the oil inlet according to the following table.
Monitoring during operation

4.1 Oil pressure, oil temperature

Status for operation

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at the inlet $T_{\text{oil,inlet}}$ [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Temporarily admissible ($&lt; 1$ h) → alarm</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>&gt; 95</td>
</tr>
</tbody>
</table>

Table 6: Oil temperature at the inlet

Lubricating oil temperature at the outlet

The oil temperature at the outlet is mainly dependant on:

- Lubricating oil temperature and pressure at the oil inlet
- Engine load and turbocharger speed
- Exhaust gas temperature

The maximum admissible oil temperature at the outlet is listed in the following table. The specified oil outlet temperature is to be considered as alarm value for the turbocharger operation and must be monitored according to the current regulations.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at the outlet $T_{\text{oil,outlet}}$ [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>≤ 135</td>
</tr>
<tr>
<td>Temporarily admissible → alarm</td>
<td>&gt; 135</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>&gt; 155</td>
</tr>
</tbody>
</table>

Table 7: Oil temperature at the outlet

If the turbocharger was operated for a longer period of time outside of the admissible range, ABB Turbo Systems recommends to have the turbocharger inspected by an ABB Turbocharging Service Station.
4.2 Turbocharger speed

4.2.1 Introduction

Speed measurement systems enable the constant monitoring of the turbocharger speeds.

⚠️ CAUTION

Do not strain cables

If you pull the speed measurement cables too hard, contacts can be pulled out.
- Do not strain the speed measurement cables by pulling.

4.2.2 Layout and overview

Fig. 18: Speed measurement

86505  Speed sensor
86506  O-ring
86515  Cable connector
86526  F/I converter
86528  Tachometer
42047  Screw plug
32118  Auxiliary bearing with cams
*)  Alternative mounting position for speed sensor
4.2.3 Speed differences with several turbochargers per engine

The speeds of all turbochargers on an engine vary only slightly from each other in standard operation.

The difference between the highest and the lowest turbocharger speed must not be more than 3 %, relative to the speed limit $n_{Bmax}$.

If this permissible range of difference is exceeded, the following steps must be carried out:

- Reduce the engine performance immediately to the point at which the maximum turbocharger speed does not exceed 70 % of $n_{Bmax}$.
- If the engine cannot be stopped, it can continue to be driven at this reduced engine load or turbocharger speed.
- If a turbocharger surges continuously, the engine performance must be reduced further.
- Measure the temperatures in the air lines and gas piping from and to the turbochargers and compare with normal values. If clear deviations of temperature are found, the nearest ABB Turbocharging Service Station has to be contacted.
- Check the pressure loss of the alternative air inlet and compare it with normal values.

If the engine can be stopped temporarily:

- Inspect air lines, gas piping and the turbochargers and remedy any malfunctions.
- In any case, contacting the nearest ABB Turbocharging Service Station is recommended.
4.2.4 Replacing the speed sensor

**WARNING**

Hot cable connector and hot speed sensor
Danger of burns. The cable connector and speed sensor can reach temperatures in excess of 100 °C during operation.
- When disassembling the cable connector and speed sensor, wear safety gloves.

Wear safety gloves to protect against thermal hazards.

- Reduce the engine performance to idling and then stop the engine. Pay attention to post-lubrication (Stopping the engine →32).
- Switch off the lubricating oil supply to the turbocharger.
- Disconnect the cable connector from the speed sensor.
- Screw out defective speed sensor.
- Screw in new speed sensor to the stop.

The speed sensor is designed with a sealing lip and does not require any additional gasket for assembly.
- Connect cable connector (86515) with the speed sensor (86505)
- Switch on lubricating oil supply to the turbocharger.

4.2.5 Malfunction of the speed measurement system

The possible reasons for malfunction of the speed measurement system are described in chapter Troubleshooting (Reasons for malfunction of the speed sensor).
5  Operation and service

5.1  Noise emission

**WARNING**

Noise hazards

Exposure to noise can harm the hearing system, impair health and the psychological state and may lead to lack of attention and irritation.

- When the engine is running, always wear ear protection.
- Always wear ear protection if the sound pressure level exceeds 85 dB(A).

Wear ear protection.

The emission sound pressure level (A-weighted) is measured at a distance of 1 meter from the turbocharger.

The highest value of the emission sound pressure level\(^1\) reaches a maximum of 105 dB(A) near the filter silencer. The following prerequisites must be fulfilled with regard to the turbocharger to observe this limit value:

- Air-inlet system has been fitted
- All standard, noise-reducing measures\(^2\) have been fitted
- Bellows at the air outlet has been acoustically insulated by the enginebuilder (see Fig. 19: Noise insulation, bellows \(\rightarrow\)27).

The enginebuilder is responsible for insulating the charge air/scavenging air line and the charge air cooler.

1)  Directive 2006/42/EC, 1.7.4.2 / u / Paragraphs 5 + 7: A-weighted emission sound pressure level

2)  The enginebuilder must provide acoustically equivalent measures in case of deviating insulation versions
Suggestion for noise insulation, bellows

01 Compressor casing
02 Bellows
03 Charge air duct / scavenging air duct
04 Insulation cushion
05 Insulation mat (at least 15 mm)
06 Sheet metal cover

Fig. 19: Noise insulation, bellows
5.2 Service work

Service work includes visual controls, monitoring, measuring and inspection as well as functional checks. Service work enables the detection and rectification of changes to the turbocharger and ensures full operability of the turbocharger.

**CAUTION**

Service intervals

Any service work on the turbocharger that is omitted or performed too late can cause excessive contamination, wear and operating failures.

- Carry out the service work at the specified time intervals.

**CAUTION**

Shortened service intervals

Exceptional stresses such as several starts/stops per day, harsh environmental conditions, poor fuel quality or high system vibrations can lead to untimely machine damage even if the prescribed service intervals are observed.

- Agree on a shortened service interval with ABB Turbo Systems.

To prevent machine damage caused by ageing and downtime, we recommend having an inspection carried out by an ABB Turbocharging Service Station no later than 5 years after the last service.

5.2.1 Service work every 25 … 50 hours

- Visual check for air, exhaust gas, water and oil leaks.
- Record operating data and enter in the engine logbook.
- In case of deviations, determine the cause.

**CAUTION**

Unknown operational changes

Unknown operating conditions may result in problems ranging from impairment to possible operating failure.

- Unknown causes must be clarified by an ABB Turbocharging Service Station.

5.2.2 Service work at 100 hours after commissioning

- Clean or replace the oil filter located in the supply pipe to the turbocharger while the engine is stopped.
5.2.3 Service work every 8000 ... 12000 hours of operation

Checking and assessment of the rotor and the bearing parts must be carried out by an ABB Turbocharging Service Station.

- Dismantle the turbocharger.
- Clearance measurement.
- Clean turbine casing and compressor casing and check for cracks and erosion/corrosion.
- Clean bearing casing and blow through oil holes.
- Clean nozzle ring and check for cracks and erosion.
- Check and assess rotor and bearing parts.
- Balancing rotor.

5.2.4 Service work every 24000 ... 36000 hours of operation

Service work on the rotor and bearing parts must be carried out by an ABB Turbocharging Service Station. Damaged and worn out parts must be replaced with original ABB parts.

- Disassemble the turbocharger.
- Clearance measurement.
- Clean turbine casing and compressor casing and check for cracks and erosion/corrosion.
- Clean bearing casing and blow through oil holes.
- Clean nozzle ring and check for cracks and erosion.
- Dismantle the rotor, inspect and balance it.
- Replace the plain bearings.

5.2.5 Service work according to instructions of enginebuilder

- Clean or replace the oil filter located in the supply pipe to the turbocharger while the engine is stopped.
5.2.6 Entries in the engine logbook

Monitoring the engine system enables conclusions to be made on the operating behaviour of the turbocharger.

The following operating data and measured values must be entered regularly into the engine logbook of the enginebuilder:

- Performance and speed of the engine
- Speed of the turbocharger
- Air intake temperature
- Exhaust gas temperature before and after the turbine
- Pressure of the charge air
- Pressure loss in the charge air cooler
- Lubricating oil pressure and lubricating oil temperature

If present:

- Air temperature after the compressor and after the charge-air cooler
- Pressure loss in the filter silencer
5.3 Expected replacement intervals

Rotating components
The recommended replacement intervals for compressor wheels and turbine wheels are specified based on the safety concept for rotating parts (SIKO) and dependent on the operating conditions. These intervals are shown on the rating plate of the turbocharger.

Non-rotating components
Depending on the system-specific operating conditions, a differentiation must be made between the intervals to be expected for:

- replacing the bearing parts and
- replacing the non-rotating components exposed to hot gas.

A decisive role is played by various influencing parameters which, in extreme cases, can drastically reduce the replacement interval of these parts.

During the prescribed periodic service work, the individual parts are examined for wear and replaced if necessary.

Influencing parameters for bearing parts
- Inferior lubricating oil quality (lubricating oil filtering, lubricating oil condition)
- Exceptional stresses (vibrations, start/stop frequency)
- Inadmissible unbalance of the rotor

Influencing parameters for exhaust gas-charged, non-rotating components
- Fuel quality (gas, MDO, HFO)
- Load profile (thermal cycling, number of start/stop cycles)
- Temperature level of the exhaust gas
- Frequency of turbine cleaning
- Turbine cleaning process

Influencing parameters for exhaust gas-charged, rotating components
- Fuel quality (gas, MDO, HFO)
- Frequency of turbine cleaning
- Turbine cleaning process
- Load profile
Expected replacement intervals [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas inlet casing</td>
<td>50000 ... 100000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Gas outlet casing</td>
<td>50000 ... 100000</td>
<td>35000 ... 100000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Turbine diffuser / cover ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Other casings</td>
<td>100000</td>
<td>100000</td>
</tr>
<tr>
<td>Turbine blades (due to wear)</td>
<td>- -</td>
<td>≥ 12000</td>
</tr>
</tbody>
</table>

Table 8: Expected replacement intervals

GAS = Gas
MDO = Marine Diesel Oil
HFO = Heavy Fuel Oil

Recommended replacement intervals [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>See rating plate data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor components</td>
<td></td>
</tr>
<tr>
<td>Bearings</td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Recommended replacement intervals

The specified values are guideline values and not guaranteed values, see Influencing parameters.

5.4 Stopping the engine

**CAUTION**

Stopping the engine

In the turbocharger, the heat from the lubricating oil that continues to circulate must be dissipated.

- Let the engine continue to run at idling speed for 10 minutes before stopping it.
- Post-lubrication can also be used instead of engine idling (see Pre-lubrication and post-lubrication →18).
6 Periodic maintenance

6.1 Foreword to maintenance

Maintenance work includes regular visual controls and cleaning operations which are intended to ensure the trouble-free functioning of the turbocharger.

Described maintenance points:

- Filter silencer
- Diffuser
- Compressor
- Turbine and nozzle ring
6.2 Cleaning the filter silencer

Cleaning the filter ring (if present)

- Remove filter ring (81265).
- Clean filter ring (81265) as required or every 500 hours of operation and replace after the fifth cleaning process at the latest. Contamination of the filter ring depends on the degree of purity of the sucked-in air.
- Rinse the filter ring (81265) with water and mild detergent or, in the case of heavy contamination, soak and carefully push through. Rinse in cold water. Avoid high mechanical loads (water jet).
- Let the filter ring dry completely before assembling.
- Dirty water and mild detergent must be disposed of in compliance with locally applicable regulations.
Cleaning the absorption segments
(see Fig. 20: Cleaning the filter silencer → 34)

- Loosen and remove lock nuts (81273).
- Loosen and remove screws (81272) to the connecting rods (81269).
- Remove connecting rods (81269).
- Remove and clean cover grid (81266).
- Pull out insert units (E), bend up sheet-metal coverings (81137) and take out absorption segments (81136).
- Clean the absorption segments (81136).
  When cleaning, note that the absorption segments (81136) must only be cleaned lightly with pressurized air, with a soft brush or a moist cleaning cloth.
- Have any heavily contaminated absorption segments and filter rings as well as damaged connecting rods replaced by an ABB Turbocharging Service Station.

Fitting the cover grids and absorption segments
(see Fig. 20: Cleaning the filter silencer → 34)

⚠️ CAUTION
Penetration of dirt and foreign particles
Any penetration of dirt and foreign particles into the compressor can damage it.
- Fit the connecting rods (81269) correctly in the slots on the filter silencer body (81135).
- It must not be possible to rotate or move the cover grid (81266) after assembly.
- Check the position and alignment of the connecting rods during and after assembly.

- Assemble the insert units (E) by inserting the absorption segments (81136) into the sheet-metal coverings (81137).
- Bend the sheet-metal coverings (81137) back into the original shape.
- Insert the insert units (E) into the slotted guides in the filter silencer body (81135).
If a cleaning container is attached to the filter silencer (option, depending on turbocharger), the water injection pipe must now be reinstalled.
- Place the cover grids (81266) evenly and in the correct position.
6 Periodic maintenance / 6.2 Cleaning the filter silencer

- Push the connecting rods (81269) through the lugs of the cover grids (81266).
- Connect the connecting rods (81269) with the screws (81272). While tightening the screws (81272), make sure that the connecting rods (81269) lie correctly in the slots on the filter silencer body (81135). Now alternately tighten the screws (81272) up to the following maximum tightening torque:

<table>
<thead>
<tr>
<th>Screw</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>81272</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 10: Tightening torque (81272)

- Fit lock nuts (81273) on screws (81272) and tighten with the following tightening torque:

<table>
<thead>
<tr>
<th>Lock nut</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>81273</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 11: Tightening torque (81273)

- Fit the filter ring (81265), if present.
6.3 Cleaning the slotted diffuser

- Remove the diffuser (see Removing the compressor casing →62).

Fig. 22: Cleaning the slotted diffuser

- Clean the diffuser slots (S).
  When cleaning, please note that this should only take place using compressed air at low pressure, a brush and a moist cleaning cloth.

- Have any heavily contaminated or damaged diffusers replaced by an ABB Turbocharging Service Station.
6.4 Cleaning the compressor during operation

6.4.1 Introduction

Approval by enginebuilder

The following instructions for wet cleaning only apply to cleaning with pure water and under the precondition that the enginebuilder approves the process.

General

The contamination of the compressor stage (compressor wheel and diffuser) depends on the degree of purity of the sucked-in air.

Deposits can form in the flow channels if salt, oil mist or dust are sucked in with the air.

Consequences of contamination:

- Impaired compressor efficiency
- Higher exhaust gas temperatures
- Increased fuel consumption
- Increased rotor unbalance

Periodic cleaning of the compressor during operation prevents or delays any major increase in contamination. But it never replaces the regular service work where the turbocharger is completely dismantled and the compressor is mechanically cleaned.

6.4.2 Cleaning interval

The time period between the periodical cleaning cycles depends greatly on the operating conditions. Cleaning should normally be done every 25 ... 100 hours of operation.

If the specified cleaning intervals are incompatible with operation of the engine, contact ABB Turbo Systems.
6.4.3 Principle of wet cleaning

Principle of wet cleaning

To clean the compressor stage during operation, water is injected before the compressor wheel.

The water does not act as a solvent. The coating is removed by the mechanical action of the impacting droplets. The process is particularly suitable as long as the contamination is not too advanced.

⚠️ CAUTION

Corrosion and deposits when cleaning
Salt water and cooling water treatment substances damage and adversely affect turbocharger parts.
► Never use salt water, but only pure water for cleaning.

⚠️ CAUTION

Volume of water
Uncontrolled volumes of water can damage the turbocharger and the engine.
► Never connect the water line without the orifice specified for the turbocharger.
6.4.4 Wet cleaning with direct water supply

Prerequisites

On V-engines with several turbochargers per engine, parallel cleaning of both turbochargers is recommended. This cleaning process is faster and reduces the risk of surging of the turbocharger.

**WARNING**

*Increased stress on material*

During cleaning of the compressor at an engine load of 85 to 100 %, the stress on the material of the compressor-end turbocharger parts can be increased.

- No personnel is allowed to be present in the vicinity of the turbocharger during compressor cleaning.
- Compressor cleaning must be activated from the engine control panel.

Wet cleaning operations for compressor with direct water supply

- Trigger water injection according to the specifications of the enginebuilder.
- Observe specified water pressure upstream of the connection to the turbocharger.
- Operate engine for at least five additional minutes after cleaning.

Not more than three cleaning cycles should be conducted consecutively.

**Cleaning parameters for each compressor**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>50 ... 100</td>
<td>2.5 ... 4.5</td>
<td>10</td>
<td>25 ... 100</td>
<td>2.9</td>
</tr>
<tr>
<td>A175-M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.4</td>
</tr>
</tbody>
</table>

Table 12: Compressor cleaning parameters
Surging of the compressor stage

Should repeated surging of the compressor stage occur during compressor cleaning, first the cleaning parameters (water flow rate) as well as the engine-side system must be checked with regard to deviations (e.g. an increased pressure loss in the charge air cooler) and corrected if necessary.

If surging of the compressor stage continues to occur during compressor cleaning despite correct settings, this can be remedied by reducing the engine load further during cleaning of the compressor. The reduction of the engine load can lead to a reduction in the effectiveness of the compressor cleaning.

To avoid a reduction in engine availability, the compressor stage can be cleaned at reduced engine load during the drying time after wet cleaning of the turbine has been completed (see section Cleaning turbine and nozzle ring →44).
6.4.5  Wet cleaning with external water pressure vessel

Operating state prerequisites for cleaning the compressor

On V-engines with several turbochargers per engine, parallel cleaning of both turbochargers is recommended. This cleaning process is faster and reduces the risk of surging of the turbocharger.

To carry out the cleaning operation checked and recommended by ABB Turbo Systems, the following prerequisites must be fulfilled:

- Engine load 50 ... 85 %
- Start the cleaning operation according to the following description.

Operation of compressor wet cleaning

Fig. 23: Operation of water pressure vessel

Operation of the water pressure vessel

- The prerequisites for operating state for cleaning the compressor with XC3 must be fulfilled before the cleaning.
- Screw out sealing plug (X).
- Fill container with pure water.
- Screw in sealing plug (X).
- Push valve activator (Y) against the spring and hold for 10 to 15 seconds until the whole volume of water is injected.
After cleaning operations, a waiting period of at least **5 minutes** is required for the turbocharger to dry.

If the cleaning is unsuccessful after three attempts, we recommend having the turbocharger checked and cleaned by an ABB Turbocharging Service Station in the event of unsatisfactory engine values.

**Cleaning parameters for each turbocharger compressor**

<table>
<thead>
<tr>
<th>Product</th>
<th>Engine load</th>
<th>Water temperature [°C]</th>
<th>Contents of metering container [dm³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>50 ... 85%</td>
<td>5 ... 50</td>
<td>1</td>
</tr>
<tr>
<td>A175-M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Compressor cleaning parameters

**Surging of the compressor stage**

Should repeated surging of the compressor stage occur during compressor cleaning, first the cleaning parameters (water flow rate) as well as the engine-side system must be checked with regard to deviations (e.g. an increased pressure loss in the charge air cooler) and corrected if necessary.

If surging of the compressor stage continues to occur during compressor cleaning despite correct settings, this can be remedied by reducing the engine load further during cleaning of the compressor. The reduction of the engine load can lead to a reduction in the effectiveness of the compressor cleaning.

To avoid a reduction in engine availability, the compressor stage can be cleaned at reduced engine load during the drying time after wet cleaning of the turbine has been completed (see section Cleaning turbine and nozzle ring →44).
6.5 Cleaning turbine and nozzle ring

6.5.1 Introduction

Approval by enginebuilder
The following instructions for wet cleaning only apply to cleaning with pure water and under the precondition that the enginebuilder approves the process.

General
The combustion of heavy fuel oil (HFO) has the effect of contaminating the turbine stage (turbine wheel and nozzle ring).
The use of fuels with poor quality in conjunction with high exhaust gas temperatures can lead to extremely hard deposits on turbine components.
ABB Turbo Systems recommends the use of fuels with low ash, sulphur, sodium and vanadium contents.

Consequences of contamination:
- Low turbine efficiency
- Elevated exhaust gas temperatures
- Increased charging and ignition pressures with increasing turbocharger speed
- Lower engine performance
- Rotor sticking after stopping the engine

Periodic cleaning of the turbines during operation prevents or delays any major increase in contamination, but never replaces the regular service procedures where the turbocharger is completely dismantled and mechanically cleaned.

6.5.2 Cleaning interval

The time period between the periodical cleaning cycles depends greatly on the operating conditions. Cleaning should normally be done every 50 ... 200 hours of operation.

If the specified cleaning intervals are incompatible with the operation of the engine, contact ABB Turbo Systems.
6.5.3 Cleaning method

Cleaning of the turbine and the nozzle ring during operation is carried out by the cleaning method described in the following and is tested and approved by ABB Turbo Systems:

- Wet cleaning

Wet cleaning makes use of various effects. These effects are used with varying levels of intensity, depending on the type of contamination:

- Erosion
  The dirt is removed by the mechanical action of the impacting water droplets

- Solubility
  Water solubility of the dirt deposits in water

- Thermal shock
  Spalling of the dirt due to the temperature differential

⚠️ CAUTION

Corrosion and deposits when cleaning
Salt water and cooling water treatment substances damage and adversely affect turbocharger parts.
- Never use salt water, but only pure water for cleaning.

The influence of the cleaning water on the peripheral units (such as the boiler) must be clarified by the operator before commencing wet cleaning.

The turbine-end components are cleaned at reduced engine load. The exhaust gas temperature must not exceed the value specified in the cleaning instructions (see section Prerequisites).

⚠️ CAUTION

Reduced service life of the components
Failure to comply with the minimum stabilisation time before cleaning, the prescribed turbine inlet temperatures and the drying time after cleaning significantly reduces the expected service life of the components.
- Comply with the cleaning parameters given in the tables (see Table 14: Cleaning parameters Wet cleaning of turbine and nozzle ring →49).

V-engines

On V-engines with several turbochargers, we recommend the parallel cleaning of both turbochargers for each engine. This cleaning process is faster and reduces the risk of surging of the turbochargers.
### 6.5.4 Wet cleaning of turbine and nozzle ring

**Prerequisites:**

**Procedure without automated cleaning**

The following operating state and the following prerequisites have been tested and approved by ABB Turbo Systems for cleaning operations:

- Set the engine load between 20 … 50 % so that the turbine inlet temperature is between 380 … 430 °C.

![Fig. 24: Turbine and nozzle ring cleaning cycle](image)

- Once the turbine inlet temperature is stable and has dropped below 430 °C, wait at least another 10 minutes to allow the turbine-end turbocharger parts to cool down.

- Start the cleaning cycle according to the following description Wet cleaning procedure.
Procedure with automated cleaning

The following operating state and the following prerequisites have been tested and approved by ABB Turbo Systems for cleaning operations:

- Set the engine load as follows:
  - Turbine mass flow $M_{\text{turb}} \approx 4.1 \text{ kg/s}$
  - Turbine pressure ratio $P_{\text{IT}} \approx 1.1$
  - Turbine inlet temperature between 380 … 430 °C

![Cleaning cycle of turbine and nozzle ring with load ramp](image)

- As soon as the turbine inlet temperature is stable and less than 430 °C, wait for least 10 additional minutes for the turbine-end turbocharger components to cool down.

- Start the cleaning cycle according to the following description Wet cleaning procedure.

- Continuously increase the engine load during washing:
  - Turbine mass flow $M_{\text{turb}} \approx 6.5 \text{ kg/s}$
  - Turbine pressure ratio $P_{\text{IT}} = 1.6 \ldots 2.0$
  - Turbine inlet temperature $< 430 \, ^\circ\text{C}$
Procedure

Fig. 26: Procedure Wet cleaning of turbine and nozzle ring

The prerequisites and the operating state must be fulfilled prior to cleaning.

- Make sure that the water supply (01) is connected, switched on and safeguarded.
- Switch the 3-way valve (04) from scavenging air mode to water supply.
- Set the necessary water quantity on the flowmeter (08) according to the table Cleaning parameters (see Table 14: Cleaning parameters Wet cleaning of turbine and nozzle ring → 49).
- Shut off the water supply again by switching the 3-way valve (04) to scavenging air mode after the prescribed injection time has elapsed.

The injection process is complete.

- After cleaning, continue to operate the engine for at least 10 minutes without any load change.

It is necessary to have the corresponding water pipe pressure in order to achieve the correct water flow rate (see Table 14: Cleaning parameters Wet cleaning of turbine and nozzle ring → 49). If there is insufficient water pressure, the water flow rate specified in the table will not be achieved. A reduced cleaning effect can be expected in this case.

Repetition of wet cleaning

The repeating of cleaning cycles one immediately after the other must be avoided as this can lead to excessive mechanical stress, hence reducing the operating life of the components.

If the cleaning process is ineffective, the duration can be extended. If the injection time is extended, it is important to ensure that no impermissible volume of water collects in the gas outlet casing. A drainage system should be installed for the gas outlet casing and opened during cleaning. If there is no drainage system, the amount of water injected can be monitored with a flowmeter in the water supply. The permitted amount of water must be determined with the help of an ABB Turbocharging Service Station.

To be observed during cleaning

- The action of the cleaning water on the peripheral units (such as boiler) must be clarified by the operator.
The exhaust gas temperature downstream of the turbocharger drops drastically during cleaning (typical turbocharger outlet temperatures during cleaning: 60...180°C).

If there is no drainage of the gas outlet casing, the turbocharger speed and/or the gas inlet temperature must be monitored during the cleaning process. If the load is too low, water can collect in the gas outlet casing. Indicators for this are a sudden severe drop in the turbocharger speed or a very large increase in the gas inlet temperature. In such cases, the cleaning operations must be stopped and the cleaning cycle restarted with reduced water pressure or higher engine load.

### Cleaning parameters for wet cleaning of turbine and nozzle ring

<table>
<thead>
<tr>
<th>Product</th>
<th>Maximum temperature when starting cleaning $T_{n}$ [$^\circ$C]</th>
<th>Injection time $t_{i}$ [min]</th>
<th>Water volume flow per turbocharger at $p_{\text{Water}} = 3$ bar $V_{w}$ [dm³/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>430</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>A175-M</td>
<td></td>
<td></td>
<td>41</td>
</tr>
</tbody>
</table>

Table 14: Cleaning parameters Wet cleaning of turbine and nozzle ring
7 Troubleshooting

7.1 Malfunctions when starting

Delayed start-up

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger contaminated</td>
<td>Clean (Periodic maintenance → 33)</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td></td>
</tr>
<tr>
<td>Foreign object in the turbocharger</td>
<td></td>
</tr>
</tbody>
</table>

Table 15: Malfunctions when starting – Delayed start-up

Vibrations

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Rotor unbalance</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Turbine or compressor damaged</td>
<td></td>
</tr>
<tr>
<td>Bearing damaged</td>
<td></td>
</tr>
<tr>
<td>Engine</td>
<td>Vibrations from engine</td>
</tr>
<tr>
<td></td>
<td>Contact enginebuilder</td>
</tr>
</tbody>
</table>

Table 16: Malfunctions when starting – Vibrations

Rubbing of rotating parts

Normal behaviour, not a malfunction

Turbocharger A slight amount of uniform wear at the circumference of the rotor components caused by slight local rubbing against adjacent components is permitted. This causes the compressor or turbine blades to be somewhat shortened. To prevent significant loss of efficiency, specific tolerances must be fulfilled.

- If there is any doubt about the extent of the rubbing, contact an ABB Turbocharging Service Station.
- Have a dimension check carried out by an ABB Turbocharging Service Station.

Table 17: Malfunctions when starting – Rubbing of rotating parts
7.2 Malfunctions during operation

Lubricating oil pressure too low

**WARNING**

Danger of fire and explosion due to lubricating oil leaks

Leaking oil may ignite on hot surfaces. This can result in serious injuries to personnel or fatal accidents.

- Cordon off danger area.
- Raise the alarm and, depending on the situation, stop the engine.
- Seal the oil leak.
- Soak up oil and dispose of in an environmentally compatible manner.

Wear safety gloves to protect against thermal hazards.

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Axial clearance of the rotor excessive</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Engine Oil filter heavily contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Engine Oil pump in lubricating system defective</td>
<td>Check/replace</td>
</tr>
<tr>
<td>Engine Manometer displays incorrectly</td>
<td>Replace manometer</td>
</tr>
</tbody>
</table>

Table 18: Malfunctions during operation – Lubricating oil pressure too low

Drop in speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Heavy contamination of the turbine and/or nozzle ring</td>
<td>Clean (see chapter Periodic maintenance →33)</td>
</tr>
<tr>
<td>Engine Defect on the connected cylinders in pulse charging</td>
<td>Contact enginebuilder</td>
</tr>
<tr>
<td>Pipes Defects, such as leaks, in the exhaust gas pipes or charge air ducts</td>
<td>Repair</td>
</tr>
</tbody>
</table>

Table 19: Malfunctions during operation – Drop in speed

Increase in speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Light to medium contamination of the turbine and/or nozzle ring (with 4-stroke application)</td>
<td>Clean (see chapter Periodic maintenance →33) or contact an ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 20: Malfunctions during operation – Speed increases
### Exhaust gas temperature too high

Engine performance and engine speed unchanged

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Insufficient air, for example, when filter silencer is blocked by dirt</td>
<td>Clean (Periodic maintenance → 33)</td>
</tr>
<tr>
<td>Compressor/turbine contaminated</td>
<td></td>
</tr>
<tr>
<td>Exhaust gas back pressure too high</td>
<td>Clean or repair boiler or exhaust gas silencer</td>
</tr>
<tr>
<td>Turbine damaged or eroded</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Malfunction in the injection system</td>
<td>Repair or contact manufacturer</td>
</tr>
<tr>
<td>Charge air cooler</td>
<td></td>
</tr>
<tr>
<td>Cooler contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Cooling water volume too low</td>
<td>Fill</td>
</tr>
<tr>
<td>Inlet temperature of cooling water too high</td>
<td>Check/clean cooling system</td>
</tr>
<tr>
<td>Insufficient ventilation</td>
<td>Improve ventilation</td>
</tr>
</tbody>
</table>

Table 21: Malfunctions during operation – Exhaust gas temperature too high

### Charge air pressure too low

Engine performance and engine speed unchanged, suction condition normal

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Manometer display not correct</td>
<td>Replace manometer</td>
</tr>
<tr>
<td>Supply pipe to manometer not sealed</td>
<td>Repair leak</td>
</tr>
<tr>
<td>Filter silencer contaminated, therefore pressure drop too high</td>
<td>Clean (Periodic maintenance → 33)</td>
</tr>
<tr>
<td>Compressor end and/or turbine end contaminated</td>
<td></td>
</tr>
<tr>
<td>Compressor/turbine damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Exhaust gas back pressure too high</td>
<td>Clean or repair boiler or exhaust gas silencer</td>
</tr>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Air receiver not sealed</td>
<td>Repair</td>
</tr>
<tr>
<td>Gas pipe between engine and turbine not sealed</td>
<td></td>
</tr>
<tr>
<td>Injection mistimed</td>
<td>Set correctly</td>
</tr>
<tr>
<td>Valve control misadjusted</td>
<td></td>
</tr>
<tr>
<td>Pipes</td>
<td></td>
</tr>
<tr>
<td>Pipes downstream to the compressor outlet not sealed.</td>
<td>Repair.</td>
</tr>
</tbody>
</table>

Table 22: Malfunctions during operation – Charge air pressure too low
7.3 Surging of the turbocharger

**CAUTION**

Continuous or periodic surging

If the turbocharger surges continuously or periodically, parts of the turbocharger may be damaged.

- Gradually reduce the engine load.
- Have the cause clarified and remedied immediately by an ABB Turbocharging Service Station.
- Have parts assessed for damage and, if necessary, replaced by an ABB Turbocharging Service Station.

### Surging of the turbocharger

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Filter silencer or diffuser contaminated</td>
</tr>
<tr>
<td></td>
<td>Clean (Periodic maintenance →33)</td>
</tr>
<tr>
<td></td>
<td>Heavy dirt deposits in the turbine or in the nozzle</td>
</tr>
<tr>
<td></td>
<td>ring</td>
</tr>
<tr>
<td>Engine</td>
<td>Protective grating in front of the turbocharger</td>
</tr>
<tr>
<td></td>
<td>contaminated or damaged</td>
</tr>
<tr>
<td></td>
<td>Clean/replace</td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Clean</td>
</tr>
<tr>
<td></td>
<td>Charge air duct blocked</td>
</tr>
</tbody>
</table>

Table 24: Surging of the turbocharger
Sporadic surge blows

Surging of the turbocharger can occur during certain operating states, such as when reducing the engine load quickly when manoeuvring. When this happens, the flow direction in the compressor is momentarily reversed. Such sporadic surge blows do not impair the safe operation of the turbocharger.

- A surge blow is accompanied by a loud bang and escape of hot air from the filter silencer.

7.4 Malfunctions when stopping

Runout noises

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Clean</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td></td>
</tr>
<tr>
<td>Foreign object in the turbocharger</td>
<td></td>
</tr>
</tbody>
</table>

Table 25: Malfunctions when stopping – Runout noises

Shortened runout time

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Clean</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td></td>
</tr>
<tr>
<td>Foreign object in the turbocharger</td>
<td></td>
</tr>
</tbody>
</table>

Table 26: Malfunctions when stopping – Shortened runout time
7.5 Speed measurement system

No signal or poor signal amplitude of the speed measurement

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>The speed sensor was accidentally fitted with an additional gasket.</td>
</tr>
<tr>
<td></td>
<td>An enlarged distance between the sensor tip and the signal-emitting</td>
</tr>
<tr>
<td></td>
<td>sealing disc reduces the voltage amplitude of the speed signal.</td>
</tr>
<tr>
<td>Sensor defective</td>
<td>Contact ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>

Table 27: Malfunction, No speed measurement signal or poor signal amplitude

Measured speed too high

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Sensor tip contaminated, since it is magnetic and can attract</td>
</tr>
<tr>
<td></td>
<td>metallic particles. This reduces the distance to the</td>
</tr>
<tr>
<td></td>
<td>signal-emitting sealing disc, which can lead to amplification of</td>
</tr>
<tr>
<td></td>
<td>the noise component and, hence, to false triggering.</td>
</tr>
<tr>
<td></td>
<td>For information regarding the disassembly and assembly of the speed</td>
</tr>
<tr>
<td></td>
<td>sensor, refer to the chapter Turbocharger speed.</td>
</tr>
<tr>
<td></td>
<td>Dismantle the sensor, clean the sensor tip, and fit the sensor</td>
</tr>
<tr>
<td></td>
<td>back on with the specified tightening torque.</td>
</tr>
</tbody>
</table>

Table 28: Malfunction, Measured speed too high

Measured speed too low

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 29: Malfunction, Measured speed too low

**NOTICE**

Other causes of malfunction

If none of the measures described above remedy the malfunction, have the speed measurement system checked by an ABB Turbocharging Service Station.
8 Disassembly and assembly

8.1 Introduction

**CAUTION**

**Further operations**

This Operation Manual may be used to carry out only those operations that are described in it. Further operations that are executed in an incorrect way can lead to serious damage to the machine.

- ABB Turbo Systems recommends having further operations carried out only by trained personnel from an ABB Turbocharging Service Station.

Mark the casing position for assembly.

**Identification of the assembly devices**

Not all assembly devices are marked with a part number. Identification is guaranteed by the tool list. This list is enclosed with the toolbox.

**WARNING**

**Servicing the assembly devices**

Assembly devices must be checked for damage before and after use.

- Visually inspect for corrosion, cracks, deformation and wear.
- Damaged assembly devices must no longer be used and must be replaced.

**Customer spare part set**

Before starting operations, make sure the required customer spare part set is available (see chapter **Spare parts →103**).

**Tightening torques for components of the turbocharger**

The specified tightening torques of the screw fittings must be observed (**Table of tightening torques →90**).

**Tightening torques for assembly devices**

Unless described otherwise, the screws and nuts of the assembly devices supplied by ABB must be tightened so they rest firmly against the surface.
WARNING
Suspended loads
Loads that are not attached according to regulations can cause injury to personnel or fatal accidents.
- Only fasten the turbocharger, assemblies or individual parts on properly functional lifting gear with sufficient load limit.
- Pay attention to the correct attachment of loads on the crane hook.
- People must not stand beneath suspended loads.

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

Definition of terms
- **Suspension point**
  Defined loading point on a component or an assembly (blind hole thread, eyelet, lug).

- **Assembly device**
  Devices that are fitted on the turbocharger in order to obtain a suspension point. Assembly devices are specially constructed and designed for the defined use; they are not commercially available products. Use assembly devices only for the described applications.

- **Lifting gear**
  Equipment for the lifting and transporting of loads (ropes, chain block, crane). Lifting gear is not supplied by ABB.
8.2 Weights of assemblies

The specified weights of the individual parts or assemblies are rounded-up standard values.

Fig. 27: Assemblies

<table>
<thead>
<tr>
<th>Position</th>
<th>Component</th>
<th>A170-M [kg]</th>
<th>A175-M [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Filter silencer</td>
<td>260</td>
<td>400</td>
</tr>
<tr>
<td>02</td>
<td>Radial air suction branch</td>
<td>120</td>
<td>170</td>
</tr>
<tr>
<td>03</td>
<td>Wall insert</td>
<td>210</td>
<td>320</td>
</tr>
<tr>
<td>04</td>
<td>Diffuser</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>05</td>
<td>Compressor casing</td>
<td>430</td>
<td>620</td>
</tr>
<tr>
<td>06</td>
<td>Cartridge group</td>
<td>750</td>
<td>1100</td>
</tr>
<tr>
<td>07</td>
<td>Turbine diffuser</td>
<td>80</td>
<td>130</td>
</tr>
<tr>
<td>08</td>
<td>Cover ring</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>09</td>
<td>Nozzle ring</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>Gas inlet casing, radial</td>
<td>170</td>
<td>230</td>
</tr>
</tbody>
</table>

Table 30: Assembly weights
8.3 Removing / Installing air-inlets

Removing the filter silencer

► Dismantle insulation as far as necessary.

1. Loop lifting gear through the fin on the filter silencer and secure to the eyelets at the rear with shackles (90195).
2. Loosen nuts (72027) and remove with washers (72028).

► Remove and put down filter silencer.

Installing the filter silencer

The installation of the filter silencer is carried out in reverse order.

► Tighten nuts (72027) to the specified tightening torque.

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>27027</td>
<td>M18 170 Nm</td>
<td>M20 220 Nm</td>
</tr>
</tbody>
</table>

Table 31: Tightening torque (27027)
Removing the air suction branch

- Disconnect all air lines according to the instructions of the enginebuilder.
- Dismantle insulation as far as necessary.

![Diagram of air suction branch disassembly]

1. Loop lifting gear around air suction branch.
2. Loosen and remove the nuts (72027) with washers (72028).

- Remove and put down the air suction branch.

Installing the air suction branch

The installation of the air suction branch is carried out in reverse order.

- Tighten nuts (72027) to the specified tightening torque.

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>27027</td>
<td>M18</td>
<td>M20</td>
</tr>
<tr>
<td></td>
<td>170 Nm</td>
<td>220 Nm</td>
</tr>
</tbody>
</table>

Table 32: Tightening torque (27027)
8.4 Axial clearance A prior to disassembly

**WARNING**
Physical hazards due to sharp edges on compressor wheel
The compressor wheel has sharp edges which can result in injury.
- Wear safety gloves.

Wear safety gloves to protect against mechanical hazards.

The axial clearance (A) must be measured prior to removal and after installation of the cartridge group.

**CAUTION**
Clearances outside the tolerance
Serious damage to engines or property can be caused by clearances outside the tolerance and excessively worn parts.
- Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.

![Axial Clearance Diagram]

Fig. 30: Axial clearance

<table>
<thead>
<tr>
<th>Product</th>
<th>Axial clearance A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>0.30 ... 0.61</td>
</tr>
<tr>
<td>A175-M</td>
<td>0.35 ... 0.69</td>
</tr>
</tbody>
</table>

Table 33: Axial clearance

- Measure and note axial clearance (A).
8.5 Removing the compressor casing

Removing wall insert

1. Loosen screws (72011) and remove with washers (72008).
2. To secure the wall insert, screw in one screw (72011) a third of the way.
3. Press off wall insert with three press-off screws (90900) until the lifting device (90190/90195) can be fitted.
4. Using shackle (90195) and lifting gear, fit lifting device (90190) to wall insert (77000).
5. Put on shackle (90195) and fasten to lifting gear.
6. Remove locking screw (72011).
7. Pull out wall insert (77000).
Transporting and turning wall insert

Fig. 32: Transporting and turning wall insert

1. Fit support angle (90025) with bolts and nuts.
2. Carefully turn wall insert over support angle (90025) and place on supports.

NOTICE

Reusing the lifting device

Place wall insert such that lifting device (90190/90195) can be removed.
Removing the diffuser

1. Remove and dispose of the O-ring (77040).
2. Loosen and remove screws (77015).
3. Loop diffuser (79000) with lifting gear and remove.

Fig. 33: Removing the diffuser
Remove compressor casing

1. Using shackle (90195) and lifting gear, fasten lifting device (90190) to compressor casing (72000) and secure to crane.
2. Loosen and remove nuts (61037).
3. Use press-off nuts (61090) to fully press off and remove compressor casing (72000).
4. Remove and dispose of the O-ring (42012).
8.6 Removing the cartridge group

⚠️ CAUTION

Safety-relevant screws
The six screws (01) are relevant for containment safety and must not be loosened.

Fig. 35: Safety-relevant screws
CAUTION

Oil orifice plates
An orifice plate for adjusting the oil pressure is fitted in each of the two oil inlet channels in the bearing casing. When the cartridge group, the bearing casing or the turbocharger is fitted to the engine, it must be ensured that the orifice plates that are specified for the turbocharger have been installed in the two oil inlet channels.

- Check correct installation of oil orifice plates.

Version with compressor wheel cooling

- Dismantle air supply line (see Compressor wheel cooling →5).

- Separate oil inlet and outlet pipes.

Fig. 36: Removing cartridge group 1

1. Unplug cable connector (86515) and unscrew speed sensor (86505) with O-ring (86506). Dispose of the O-Ring (86506).
2. Loosen screw (25013) and remove washer (25014).
3. Press off the spinner nose cone (25012) using the press-off screw (90917).
4. Loosen and remove the screw (61059).
5. Loosen and remove nuts (42128).
6. Attach lifting gear to bearing casing.
**CAUTION**

Clearance between blade tip and casing

Serious damage to machinery or property can result from the rubbing or jamming of the blade tips on the casing.

- Check that the blades do not rub on the turbine diffuser during disassembly/assembly by rotating the rotor.

---

2. Evenly press off cartridge group by screwing three press-off screws (90900) into the designated holes.

2. Using two guide rods (90490), move out cartridge group.

3. Fit supports (90450) and put down cartridge group.
8.7 Removing nozzle ring

Removing turbine diffuser

1. Remove screws (61069).
3. Fit guide plates (90328) with nuts (61037).
4. Screw in guide stud (90802).

5. Pull turbine diffuser (63000) out as far as it will go at guide plates.
6. Loop around turbine diffuser and secure to lifting gear.
7. Remove nuts (61037) and guide plates (90328).
8. Completely pull out and put down turbine diffuser.
Removing cover ring

1. Refit guide plates (90328) with nuts (61037).
2. Undo and remove (57005) bolts. Press off cover ring with the press-off screws (90916 for A170-M or 90901 for A175-M) in the provided holes.
3. Pull cover ring (57001) out as far as it will go at the guide plates.
4. Loop around cover ring and secure to lifting gear.
5. Remove guide plates (90328) and nuts (61037).
6. Fully pull out and put down cover ring (57001).
Removing nozzle ring

1. Bend open locking washers (56015), undo and remove screws (56014).
2. Secure retaining plate (90338) with screws (90339) and hook guide rod (90336) into retaining plate.
3. Fit guide plate (90328) with nuts (61037).

4. Pull nozzle ring (56001) out as far as it will go at guide plate.
5. Loop around nozzle ring (56001) and secure to lifting gear.
6. Remove guide plate (90328) and nuts (61037).
7. Fully pull out and put down nozzle ring (56001).

Blocked areas on nozzle ring

If a nozzle ring is blocked in some areas or is covered by loose parts, we would recommend appointing an ABB Turbocharging Service Station to inspect the turbine blades and carry out a crack inspection.
8.8 Installing nozzle ring

Fig. 44: Installing nozzle ring 1

1. Secure retaining plate (90338) with screws (90339) and hook in guide rod (90336).
2. Using lifting gear, position nozzle ring (56001) on guide rod (90336). Do not take strain off lifting gear yet.
3. Fit guide plate (90328) with nuts (61037).
4. Remove the lifting gear.
5. Position nozzle ring (56001) in gas outlet casing.
6. Undo nuts (61037) and remove guide plate (90328).
7. Undo screws (90339) and remove retaining plate (90338) with guide rod (90336).
8. Coat the threads of screws (56014) and the contact surface between screw and locking washer with high-temperature grease.
9. Fit the nozzle ring (56001) on the gas inlet casing (51001) using the screws (56014) and locking washers (56015).
10. Bend over locking washers (56015).
Installing cover ring

Fig. 46: Installing cover ring

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>57005</td>
<td>M14</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td>130 Nm</td>
<td>200 Nm</td>
</tr>
</tbody>
</table>

Table 35: Tightening torque (57005)

1. Using lifting gear, move in cover ring (57001) over guide studs (90802) with notch (V) facing the gas outlet flange until the lifting gear is on the gas outlet casing.
2. Fit guide plates (90328) with nuts (61037).
3. Remove the lifting gear.
4. Slide in cover ring as far as it will go.
5. Remove guide plates (90328) and nuts (61037).
6. Coat threads of screws (57005) with high-temperature grease.
7. Fit and tighten screws (57005).
Installing turbine diffuser

1. Using lifting gear, move turbine diffuser (63000) in over guide studs (90802) until the lifting gear is on the gas outlet casing.
2. Fit guide plates (90328) with nuts (61037).
3. Remove the lifting gear.
4. Slide in turbine diffuser as far as it will go.
5. Remove nuts (61037), guide plates (90328) and guide studs (90802).

Fig. 47: Installing turbine diffuser 1

6. Coat threads of screws (61069) with high-temperature grease.
7. Fit and tighten screws (61069).

Fig. 48: Installing turbine diffuser 2

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>61069</td>
<td>M14</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td>130 Nm</td>
<td>200 Nm</td>
</tr>
</tbody>
</table>

Table 36: Tightening torque (61069)
8.9 Installing the cartridge group

**CAUTION**

Clearance between blade tip and casing

Serious damage to machinery or property can result from the rubbing or jamming of the blade tips on the casing.

- Check that the blades do not rub on the turbine diffuser during disassembly/assembly by rotating the rotor.

---

Fig. 49: Installing the cartridge group 1

1. Fasten lifting gear to bearing casing and lift cartridge group slightly.
2. Remove support (90450).
3. Using two guide rods (90490), carefully move in cartridge group.
4. Remove guide rods (90490).
Fig. 50: Installing the cartridge group 2

1. Coat thread of screw (61059) and two bolts for the nuts (42128) with high-temperature grease.

2. Secure cartridge group with screw (61059) and nuts (42128).

3. Remove the lifting gear.

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>61059 / 42128</td>
<td>M22 415 Nm</td>
<td>M24 490 Nm</td>
</tr>
<tr>
<td>86505</td>
<td>M18x1.5 150 Nm</td>
<td>M18x1.5 150 Nm</td>
</tr>
</tbody>
</table>

Table 37: Tightening torque (61059 / 42128 / 86505)
If present:

CAUTION
Severe damage to the turbocharger
If the spinner nose cone (25012) is not fitted correctly, it can work loose during operation and cause severe damage to the turbocharger.

- Follow the assembly instructions.
- Observe control dimension Z.

![Diagram of assembly process]

1. Remove residual glue from the inner thread of the threaded stud (25008) by using a screw tap.
2. Clean and degrease the inner thread of the threaded stud and screw (25013).
3. Coat the outer contact surface (A) between the spinner nose cone and the compressor wheel over its entire circumference with Molykote® TP42.
4. Apply Loctite® 542 to the inner thread of the threaded stud.

<table>
<thead>
<tr>
<th>Product</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner thread size (25008)</td>
<td>M8</td>
<td>M10</td>
</tr>
</tbody>
</table>

Table 38: Inner thread size (25008)
Fig. 52: Fitting the spinner nose cone (25012)

Table 39: Tightening torque (25013)

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>25013</td>
<td>M8</td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td>20 Nm</td>
<td>40 Nm</td>
</tr>
</tbody>
</table>

5. Fit the spinner nose cone and secure with washer (25014) and screw. Counterhold the compressor wheel (25000) by hand and tighten the screw. Observe the tightening torque.

6. Measure distance Z between spinner nose cone and compressor wheel at no less than three points around the circumference.

Permissible distance Z: 0.1 – 0.7 mm
Permissible difference of the measurements: ± 0.1 mm
Installing the cartridge group

1. Screw in and tighten speed sensor (86505) with new O-ring (86506).
2. Insert cable connector (86515).

**CAUTION**

**Oil orifice plates**

An orifice plate for adjusting the oil pressure is fitted in each of the two oil inlet channels in the bearing casing. When the cartridge group, the bearing casing or the turbocharger is fitted to the engine, it must be ensured that the orifice plates that are specified for the turbocharger have been installed in the two oil inlet channels.

- Check correct installation of oil orifice plates.

- Remove temporary covers on oil connections.
- Fit all oil pipes according to instructions of enginebuilder.

**Version with compressor wheel cooling**

- Fit air supply line (see Compressor wheel cooling →5).
8.10 Installing the compressor casing

Installing the compressor casing external part

1. Distributed evenly around the circumference, screw the press-off nuts (61090) onto the studs of the bearing casing and turn them by hand until they are at the end of the thread.

2. Grease the new O-ring (42012) and fit it.

3. Fasten lifting device (90190 / 90195) to compressor casing (72000) and secure to crane.

4. Position the compressor casing (72000).
   
   Tighten nuts (61037) crosswise.

5. Remove lifting device (90190 / 90195).

6. Tighten the three press-off nuts (61090) against compressor casing (72000) by applying the corresponding tightening torque.

---

Table 40: Tightening torque (61037 / 61090)

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>61037</td>
<td>M22 415 Nm</td>
<td>M24 490 Nm</td>
</tr>
<tr>
<td>61037 (nats diffic)</td>
<td>Pre-tight</td>
<td>Pre-tight</td>
</tr>
<tr>
<td></td>
<td>access torque 30 Nm</td>
<td>torque 40 Nm</td>
</tr>
<tr>
<td></td>
<td>Tightening 45° ±5°</td>
<td>Tightening 45° ±5°</td>
</tr>
<tr>
<td>61090</td>
<td>M22 50 Nm</td>
<td>M24 50 Nm</td>
</tr>
</tbody>
</table>
Installing diffuser

1. Loop diffuser (79000) with lifting gear and position it on wall insert (77000).
2. Attach diffuser with screws (77015).
3. Grease the new O-ring (77040) and fit it.

Table 41: Tightening torque (77015)

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>77015</td>
<td>M5</td>
<td>M6</td>
</tr>
<tr>
<td></td>
<td>6 Nm</td>
<td>10 Nm</td>
</tr>
</tbody>
</table>
1. Fasten lifting device (90190 / 90195) to front of flange. Carefully turn wall insert (77000) with fitted diffuser over the support angle (90025) and pull up vertically.

2. Remove support angle (90025), bolts and nuts.

3. Fit guide studs (90319).

4. Carefully install the wall insert (77000) in the compressor casing. Make sure both markings are in the correct position.
Fitting the wall insert

1. Remove lifting device (90190/90195).
2. Slide wall insert (77000) into compressor casing up to stop and remove guide stud (90319).
3. Secure wall insert with screws (72011) and washers (72008).

For assembly of the alternative air inlet, see section Removing / Installing air-inlets  → 59.

---

**Table 42: Tightening torque (72011)**

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>72011</td>
<td>M20 580 Nm</td>
<td>M24 1000 Nm</td>
</tr>
</tbody>
</table>

---

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8.11 Axial clearance A after assembly

**WARNING**
Physical hazards due to sharp edges on compressor wheel
The compressor wheel has sharp edges which can result in injury.
- Wear safety gloves.

**CAUTION**
Clearances outside the tolerance
Serious damage to engines or property can be caused by clearances outside the tolerance and excessively worn parts.
- Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.

The axial clearance (A) must be measured prior to removal and after installation of the cartridge group.

![Axial clearance](image)

**Fig. 58: Axial clearance**

<table>
<thead>
<tr>
<th>Product</th>
<th>Axial clearance A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>0.30 ... 0.61</td>
</tr>
<tr>
<td>A175-M</td>
<td>0.35 ... 0.69</td>
</tr>
</tbody>
</table>

Table 43: Axial clearance

- Measure and note axial clearance (A).
8.12 Removing and installing turbine-end nozzle ring

Removing nozzle ring
If only the nozzle ring needs to be removed, this can be dismantled at the turbine end.

⚠️ CAUTION
Leaking connection
Reusing the removed spiral-wound gasket (61050) will result in leaking connections. Spiral-wound gaskets may only be used once.
▸ Provide new spiral-wound gasket (61050).

ℹ️ NOTICE
Blocked areas on nozzle ring
If a nozzle ring is blocked in some areas or is covered by loose parts, we would recommend appointing an ABB Turbocharging Service Station to inspect the turbine blades and carry out a crack inspection.

In order to access the fixing screws, and loop round and transport the gas inlet casing, the insulation has to be removed as required.

⚠️ CAUTION
Damaged cleaning pipes
When looping around, ensure that any cleaning pipes present are not pressed or damaged.
▸ Never secure the lifting gear to the cleaning pipes.
1. If present: Remove connecting pipe for turbine cleaning.
2. Loop around gas inlet casing (51001) and secure with lifting gear.
3. Loosen screws (61009) and move out gas inlet casing with nozzle ring.
4. Bend open locking washers (56015), undo and remove screws (56014).
5. Pull out nozzle ring (56001).
6. Remove spiral-wound gasket (61050) and provide new one.
Installing the nozzle ring

Fig. 60: Installing the nozzle ring at the turbine end

<table>
<thead>
<tr>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>56014</td>
<td>M10</td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td>50 Nm</td>
<td>50 Nm</td>
</tr>
<tr>
<td>61009</td>
<td>M18</td>
<td>M20</td>
</tr>
<tr>
<td>Tighten crosswise in stages</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>170</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>280</td>
<td>380</td>
</tr>
</tbody>
</table>

Table 44: Tightening torque (56014 / 61009)

1. Coat threads of new screws (56014) with high-temperature grease. 
   Fit the nozzle ring (56001) to the gas inlet casing (51001) using the screws (56014) and new locking washers (56015). Bend over locking washers.
2. Fix new spiral-wound gasket (61050) in groove of gas outlet casing (61001) at three evenly distributed points with a little superglue (such as Loctite® 454).
3. Fit two guide studs (90321) in the upper part of the gas outlet casing (61001).
4. Coat threads of screws (61009) with high-temperature grease.
5. Loop round gas inlet casing (51001) and, using lifting gear, slide over guide studs until at the gas outlet casing (61001) and secure with screws (61009).
6. Remove the guide stud (90321).
7. Fit remaining screws (61009), then tighten all screws (61009).
8. If present: Fit connecting pipe for turbine cleaning

► Refit dismantled insulation.
8.12 Removing and installing turbine-end nozzle ring
8.13 Table of tightening torques

Fig. 61: Tightening torques 1

Fig. 62: Tightening torques 2
### Thread sizes and tightening torques [Nm]

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>A170-M</th>
<th>A175-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>82005</td>
<td>M22x1.5 80</td>
<td>M22x1.5 80</td>
</tr>
<tr>
<td>02</td>
<td>77015</td>
<td>M5 6</td>
<td>M6 10</td>
</tr>
<tr>
<td>03</td>
<td>61036</td>
<td>M22 60</td>
<td>M24 80</td>
</tr>
<tr>
<td>04</td>
<td>61037</td>
<td>M22 415</td>
<td>M24 490</td>
</tr>
<tr>
<td>05</td>
<td>61090</td>
<td>M22 50</td>
<td>M24 50</td>
</tr>
<tr>
<td>06</td>
<td>61059 / 42128</td>
<td>M22 415</td>
<td>M24 490</td>
</tr>
<tr>
<td>07</td>
<td>61069</td>
<td>M14 130</td>
<td>M16 200</td>
</tr>
<tr>
<td>08</td>
<td>63001</td>
<td>M14 170</td>
<td>M18 240</td>
</tr>
<tr>
<td>09</td>
<td>56014</td>
<td>M10 50</td>
<td>M10 50</td>
</tr>
<tr>
<td>10</td>
<td>61009</td>
<td>M18 280(^1)</td>
<td>M20 380(^2)</td>
</tr>
<tr>
<td>11</td>
<td>57005</td>
<td>M14 130</td>
<td>M16 200</td>
</tr>
<tr>
<td>12</td>
<td>42059</td>
<td>M16 200</td>
<td>M16 200</td>
</tr>
<tr>
<td>13</td>
<td>72011</td>
<td>M20 580</td>
<td>M24 1000</td>
</tr>
<tr>
<td>14</td>
<td>72027</td>
<td>M18 170</td>
<td>M20 220</td>
</tr>
<tr>
<td>15</td>
<td>72026</td>
<td>M18 40</td>
<td>M20 50</td>
</tr>
<tr>
<td>16</td>
<td>25013</td>
<td>M8 20</td>
<td>M10 40</td>
</tr>
<tr>
<td>17</td>
<td>86505</td>
<td>M18x1.5 150</td>
<td>M18x1.5 150</td>
</tr>
</tbody>
</table>

Table 45: Tightening torques

1) Tighten screws (61009) crosswise in four steps  (see Table 46: Tightening torques 61009 →92).
Tightening sequence

Fig. 63: Flange tightening sequence

<table>
<thead>
<tr>
<th>Product</th>
<th>Tightening torque (61009) [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Step 1</td>
</tr>
<tr>
<td>A170-M</td>
<td>hand-tight</td>
</tr>
<tr>
<td>A175-M</td>
<td>hand-tight</td>
</tr>
</tbody>
</table>

Table 46: Tightening torques 61009
9 Taking a turbocharger out of operation

9.1 Possible emergency repairs

⚠️ CAUTION
Directives for taking out of operation
Serious damage to engine or property can be caused by non-compliance with the directives for locking/blanking off the turbocharger on the engine.
► Follow the directives of the enginebuilder.

⚠️ WARNING
Danger of fire and explosion due to lubricating oil leaks
Leaking oil may ignite on hot surfaces. This can result in serious injuries to personnel or fatal accidents.
► Cordon off danger area.
► Raise the alarm and, depending on the situation, stop the engine.
► Seal the oil leak.
► Soak up oil and dispose of in an environmentally compatible manner.

💧 Wear safety gloves to protect against thermal hazards.

If damage has occurred to the turbocharger and the engine has to be brought back into operation again as quickly as possible, the following emergency repair options are available:

► Lock the rotor
► Attach a cover plate
► Blank off the inlet and outlet flanges of casings
► Bypass the turbocharger
9.2 Locking the rotor

9.2.1 Introduction

⚠️ CAUTION

Cooling of a locked rotor

Serious damage to engine or property can be caused by the overheating of intact turbocharger components.

If the gas inlet is not blanked off, the lubricating oil supply remains switched on (see section Further information for operation of 4-stroke engines with locked rotor).

▶ If there is a lubricating oil leak on the turbocharger, stop the oil supply.

A locked rotor must be removed after emergency operation and checked for unbalance (see chapter Removing the cartridge group → 66).

The unbalance check must be carried out by an ABB Turbocharging Service Station.

Exception

The exception concerns customer requirements for test bed runs of new engines at a maximum engine load of up to 25%.

In these cases, subsequent removal of the rotor is not required as the engine is only operated briefly with a locked rotor.

In these test bed runs, it is not allowed to remove any set screws from the compressor wheel when fitting the locking device (see section Fitting the locking device → 95).
9.2.2 Fitting the locking device

**CAUTION**

Turbocharger damage resulting from rotor unbalance
Removing the balancing screws from the compressor wheel will result in rotor unbalance.
- Only use free threaded holes to fit the lifting spigot (74027).

- Remove filter silencer or air suction branch (see chapter entitled *Removing / Installing air-inlets →59*).

![Diagram of Fitting the locking device]

Fig. 64: Fitting the locking device

<table>
<thead>
<tr>
<th>Product</th>
<th>Part number 72011</th>
<th>Part number 94006 / 94007</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>170 Nm</td>
<td>25 Nm</td>
</tr>
<tr>
<td>A175-M</td>
<td>220 Nm</td>
<td>50 Nm</td>
</tr>
</tbody>
</table>

Table 47: Locking device tightening torque

1. Press off the spinner nose cone (25012) with the press-off screw (90917).
2. Remove two studs (72026) and three screws (72011) in the upper area.
3. Insert the lifting spigot (90441) into the compressor wheel.
   Screw bolts (94007) into the free threaded holes of the compressor wheel.
4. Position assembly/disassembly device (94003) with bolts (72011) and lifting spigot (90427).
   Rotate compressor wheel in such a way that the holes in the lifting spigot (90427) correspond with the holes in the assembly/disassembly device (94003).
5. Secure assembly/disassembly device (94003) to the lifting spigot (90427) with bolts (94006).
### 9.2.3 Further information for operation of 4-stroke engines with locked rotor

#### 4-stroke engine with one turbocharger

No further measures are necessary. The engine can be operated as a suction engine according to the instructions of the enginebuilder.

#### 4-stroke engine with several turbochargers

##### Separate receivers

In engines with separate air and exhaust gas receivers, no further measures are necessary. The engine can be operated as a suction engine according to the instructions of the enginebuilder.

##### Common air receiver

**CAUTION**

*Excessive speeds on undamaged turbochargers*

The speed limit $n_{\text{max}}$ specified on the rating plate of the turbocharger must not be exceeded. Serious damage to engine or property can be caused by excessive speeds.

- Observe the speeds of the undamaged turbochargers.
- Reduce the engine load if necessary.

If the engine is equipped with a common air receiver and separate exhaust gas receivers, the bellows on the compressor outlet of the damaged turbocharger must always be removed and the air line on the engine side must be blanked off. Otherwise the undamaged turbocharger can spin "empty" (without load) and run at overspeed.

Depending on the turbocharging system of the engine, the locked rotor is exposed to more or less strong pulses from the exhaust gas system. Especially in pulse charging (turbine casing with more than one gas inlet), the locking device is heavily strained by this process. Therefore the following operating limits should not be exceeded:

- In constant-pressure-similar systems (1 gas inlet), the engine can be operated at a maximum engine load of up to 25%. The pressure in the charge air receiver must not exceed 0.9 bar overpressure.
- In pulse charging (2 to 4 gas inlets), the engine can be operated at a maximum engine load of up to 20%. The pressure in the charge air receiver must not exceed 0.5 bar overpressure.
9.3 Fitting the cover plate

The cover plate (01) and spacer sleeves (02) (material: general construction steel, in compliance with DIN EN 10025-2) must be manufactured according to the drawing from the operator.

Fig. 65: Cover plate (01) / spacer sleeves (02) dimensions

Cover plate (01) / spacer sleeves (02) dimensions [mm]

<table>
<thead>
<tr>
<th>Product</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>B8</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>13</td>
<td>432</td>
<td>50</td>
<td>50</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>96</td>
</tr>
<tr>
<td>A175-M</td>
<td>13</td>
<td>500</td>
<td>50</td>
<td>50</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>112</td>
</tr>
</tbody>
</table>

Table 48: Cover plate dimensions 1

<table>
<thead>
<tr>
<th>Product</th>
<th>Ø 1</th>
<th>Ø 2</th>
<th>Ø 3</th>
<th>Ø 4</th>
<th>Ø 5</th>
<th>Ø 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>835</td>
<td>915</td>
<td>872.4</td>
<td>24</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>A175-M</td>
<td>965</td>
<td>1050</td>
<td>1007.5</td>
<td>26</td>
<td>36</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 49: Cover plate dimensions 2

<table>
<thead>
<tr>
<th>Product</th>
<th>α 1</th>
<th>α 2</th>
<th>α 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A170-M</td>
<td>4 x 90°</td>
<td>37.5°</td>
<td>24 x 15°</td>
</tr>
<tr>
<td>A175-M</td>
<td>4 x 90°</td>
<td>37.5°</td>
<td>24 x 15°</td>
</tr>
</tbody>
</table>

Table 50: Cover plate dimensions 3
1. Remove the cartridge group (see chapter Disassembly and assembly / Removing the cartridge group →66).
2. Close the opening in the gas outlet casing with the cover plate (01).
3. Attach cover plate with spacer sleeves (02) and nuts (61037).
   - Close the lubricating oil supply to the turbocharger.

**9.3.1 Further measures and information for the operation of 4-stroke engines with a cover plate of the turbocharger**

**4-stroke engine with a turbocharger**
No further measures are necessary. The engine can be operated as a suction engine according to the instructions of the enginebuilder.

**4-stroke engine with several turbochargers**

**Separate receivers**
In engines with separate air and exhaust gas receivers, no further measures are necessary. The engine can be operated as a suction engine according to the instructions of the enginebuilder.
Common air receiver

**CAUTION**

**Excessive speeds on undamaged turbochargers**

The speed limit $n_{\text{max}}$ specified on the rating plate of the turbocharger must not be exceeded. Serious damage to engine or property can be caused by excessive speeds.

- Observe the speeds of the undamaged turbochargers.
- Reduce the engine load if necessary.

The air line must be blanked off on the engine side because the undamaged turbochargers build up a receiver pressure.

### 9.4 Blanking off the inlets and outlets

The chapter is only applicable for engines with several turbochargers and joint air and exhaust gas receivers.

- Close the lubricating oil supply to the turbocharger.
- Blank off flange from compressor casing outlet, gas inlet and gas outlet by the installation of cover plates.
- Observe specifications from enginebuilder.

### 9.5 Engines with bypass around the turbocharger

The chapter only applies for engines with one turbocharger and for systems on which the connections for a bypass have been prepared and the necessary pipe connections have been provided.

- Close the lubricating oil supply to the turbocharger.
- Open the bypass around the turbocharger.
- Observe specifications from enginebuilder.
10 Mothballing the turbocharger

10.1 Taking the engine out of operation for up to 12 months

State of the engine lubricating oil

The turbocharger normally remains attached to the engine. The measures to be taken for mothballing the turbocharger depend on the state of the lubricating oil. No measures are required under the following conditions:

- Acid number (TAN) < 2 mg KOH/g
- The engine lubricating oil is replaced by a preservative oil and circulated with the pre-lubrication pump before the engine is taken out of operation. Residues of old engine oil are flushed away in this way and the bearing parts are largely protected against corrosion.

Preparations for mothballing

**WARNING**

**Handling operating materials and supplies**

Swallowing or inhaling vapours of operating materials and supplies or contact with them may be harmful to health.

- Do not breathe in these substances and avoid contact with the skin.
- Ensure proper ventilation.
- Observe the information in the material safety data sheet for the operating materials and supplies.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
- Comply with local legislation.

- Wear safety goggles.
- Wear safety gloves to protect against chemical hazards.
- Wear a respiratory mask to protect against gases.

If the acid number (TAN) is greater than 2 mg KOH/g, the following mothballing measures are necessary after taking the engine out of operation:

- Dismantle the turbocharger.
- The rotor and bearing parts must be dismantled and subsequently refitted by an ABB Turbocharging Service Station.
- Clean all parts.


- Coat plain surfaces of steel and cast parts with anticorrosive oil.
- Fit turbocharger completely.

**Rotation of the rotor in the stack draught**

If the rotor turns as a result of the stack draught:

- Install a blind flange between the outlet flange of the compressor casing and the charge air duct.

### 10.2 Taking the engine out of operation for more than 12 months

If the engine is taken out of operation, the following variants are possible with regard to the turbocharger:

- Turbocharger remains attached to the engine
- The casings of the turbocharger remain attached to the engine, the rotor and bearing parts are dismantled by an ABB Turbocharging Service Station and stored separately
- The turbocharger is completely removed, either as a whole unit or in individual parts

For the measures always necessary for preparing the turbocharger parts for mothballing, see section Taking the engine out of operation for up to 12 months, subsection Preparations for mothballing.

If the turbocharger remains attached to the engine, see section Taking the engine out of operation for up to 12 months, subsection Rotor turning in stack draught.

If the complete turbocharger is removed or the turbocharger is assembled again from the individual parts:

- Seal all openings of the turbocharger with paraffin paper and wooden lids.

Only dry rooms with 40 ... 70 % atmospheric humidity, in which no water condensation can form, are suitable as storage locations.

**State of the mothballed turbocharger**

- Check the turbocharger parts annually for corrosion.
- If there are signs of rust: Thoroughly clean parts and renew corrosion protection.
11 Disposing of turbocharger components

**WARNING**

Handling damaged thermal insulation

Damaged thermal insulation can lead to dust exposure. The glass fibres can cause mechanical irritation of the eyes, skin, and respiratory tracts.

- Avoid the formation of dust.
- Vacuum up dust with a suitable vacuum cleaner.
- Wear a respiratory mask to protect against dusts (P1 or P2 mask).
- Wear work gloves made of leather.

- Wear safety goggles.
- Wear a respiratory mask to protect against dusts.
- Wear safety gloves to protect against mechanical hazards.

Disposal must be environmentally compatible, professional, and in compliance with locally applicable regulations.

The turbocharger consists largely of metal (cast iron materials, steel, nickel-steel alloys, aluminium and bearing brass).

Further components are: Non-metallic materials (filter components of felt and polyethylene), lubricants (engine oil), electronic parts (speed sensor and associated components), and thermal insulation.

- Dispose of metals as scrap metal for recycling.
- Dispose of non-metallic materials as waste.
- Dispose of residues of lubricants as waste oil.
- Dispose of electronic components as electronic waste.
- Dispose of thermal insulation as hazardous waste.
12 Spare parts

12.1 Ordering spare parts

**CAUTION**

Spare part storage

All spare parts that were ordered together with the turbocharger must be kept intact and ready for use.

- Carefully clean any rusted parts and grease them.

Please quote the following data when making queries and ordering spare parts:

(Locations of the rating plates → 7)

- Turbocharger type
- Serial number (HT……)
- Designation and part number.

Spare parts can be ordered from any ABB Turbocharging Service Station.

- If different model variants are not taken into account in this document, contact an ABB Turbocharging Service Station.
- Dispose of placed and unusable parts in an environmentally-friendly and professional manner in accordance with the local regulations.
- Dispose of the packaging of new parts in an environmentally-friendly and professional manner in accordance with the local regulations.

**Required customer spare part set (97070)**

For the operations described in the Operation Manual, the customer spare part set (97070) is required. These parts are only available as part of the complete set.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>42012</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42041</td>
<td>Gasket</td>
<td>1</td>
</tr>
<tr>
<td>42045</td>
<td>Gasket</td>
<td>2</td>
</tr>
<tr>
<td>42059 / 42064</td>
<td>Hexagon-head screw</td>
<td>2</td>
</tr>
<tr>
<td>56014</td>
<td>Hexagon-head screw</td>
<td>2</td>
</tr>
<tr>
<td>56015</td>
<td>Locking washer</td>
<td>2</td>
</tr>
<tr>
<td>57005</td>
<td>Hexagon-head screw</td>
<td>5</td>
</tr>
<tr>
<td>61037</td>
<td>Hexagon nut</td>
<td>3</td>
</tr>
<tr>
<td>61069</td>
<td>Hexagon-head screw</td>
<td>3</td>
</tr>
<tr>
<td>77015</td>
<td>Socket screw</td>
<td>3</td>
</tr>
<tr>
<td>77040</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>86506</td>
<td>O-ring (speed sensor)</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 51: Customer spare part set (97070)
12.2 View of turbocharger with part numbers

Fig. 67: Turbocharger with part numbers

(......) only available in customer spare part set (97070)
## Turbocharger

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>51001</td>
<td>Gas inlet casing, radial</td>
</tr>
<tr>
<td>56001</td>
<td>Nozzle ring</td>
</tr>
<tr>
<td>56014 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>56015 (in customer spare part set)</td>
<td>Locking washer</td>
</tr>
<tr>
<td>57001</td>
<td>Cover ring</td>
</tr>
<tr>
<td>57005 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>61001</td>
<td>Gas outlet casing</td>
</tr>
<tr>
<td>61037 (in customer spare part set)</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>61050</td>
<td>Gasket</td>
</tr>
<tr>
<td>61069 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>63000</td>
<td>Turbine diffuser</td>
</tr>
<tr>
<td>68001</td>
<td>Foot, compressor end</td>
</tr>
<tr>
<td>68002</td>
<td>Foot, turbine end</td>
</tr>
<tr>
<td>68003</td>
<td>Sliding block</td>
</tr>
<tr>
<td>72000</td>
<td>Compressor casing</td>
</tr>
<tr>
<td>77015 (in customer spare part set)</td>
<td>Socket screw</td>
</tr>
<tr>
<td>77000</td>
<td>Wall insert</td>
</tr>
<tr>
<td>77040 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>79000</td>
<td>Diffuser</td>
</tr>
<tr>
<td>81000</td>
<td>Filter silencer</td>
</tr>
<tr>
<td>82000</td>
<td>Radial air suction branch</td>
</tr>
</tbody>
</table>

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