## Operation Manual

**A135-M65**

**HT844443** English

Original Operation Manual

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 <strong>Introduction</strong></td>
<td>HZTL4005_EN_F</td>
</tr>
<tr>
<td>2 <strong>Safety</strong></td>
<td>HZTL4022_EN_E</td>
</tr>
<tr>
<td>3 <strong>Safety data sheet</strong></td>
<td>HT844443</td>
</tr>
<tr>
<td>4 <strong>Product description</strong></td>
<td>HZTL4031_EN_H</td>
</tr>
</tbody>
</table>
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.
Introduction

1 Introduction .................................................................................................................. 2
1.1 Purpose of the manual ......................................................................................... 2
1.2 Symbols, definitions .......................................................................................... 3
1.3 Storage of new turbochargers and spare parts ............................................... 5
1.4 Contact information ............................................................................................ 7
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.
1. 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Meaning</th>
<th>Pictogram</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<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>
</tr>
<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>cations</td>
<td></td>
<td></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.

![Volatile Corrosion Inhibitor (VCI)](image)

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.

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.
- 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

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>1.2</td>
<td>CE conformity</td>
<td>2</td>
</tr>
<tr>
<td>1.3</td>
<td>Definition of mandatory signs</td>
<td>3</td>
</tr>
<tr>
<td>1.4</td>
<td>Definition of safety instructions</td>
<td>3</td>
</tr>
<tr>
<td>1.5</td>
<td>Intended use</td>
<td>4</td>
</tr>
<tr>
<td>1.6</td>
<td>Deflagration on gas engines</td>
<td>5</td>
</tr>
<tr>
<td>1.7</td>
<td>Warning plates on the turbocharger</td>
<td>6</td>
</tr>
<tr>
<td>1.8</td>
<td>Turbocharger rating plate</td>
<td>7</td>
</tr>
<tr>
<td>1.9</td>
<td>Periodic check of the pressure vessels</td>
<td>8</td>
</tr>
<tr>
<td>1.10</td>
<td>Lifting of loads</td>
<td>9</td>
</tr>
<tr>
<td>1.11</td>
<td>Prerequisites for operation and maintenance</td>
<td>10</td>
</tr>
<tr>
<td>1.12</td>
<td>Hazards during operation and maintenance</td>
<td>11</td>
</tr>
<tr>
<td>1.13</td>
<td>Safe operation</td>
<td>13</td>
</tr>
<tr>
<td>1.14</td>
<td>Safe maintenance</td>
<td>15</td>
</tr>
</tbody>
</table>
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 against:
  - 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].

For use on pre-mix gas engines with ignitable propellents in the gas control system, the enginebuilder must implement appropriate safety measures for explosion protection [3] (such as flame barriers in the inlet system, for example) to assure that there is no transient pressure increase exceeding a maximum of 12 bar before the turbocharger in case of a deflagration.

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.

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 inspection and replacement intervals of turbocharger components
03 Inspection 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 inspection and 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 $n_{B\text{max}}$ and $t_{B\text{max}}$ can considerably shorten the recommended replacement intervals. In such a case, we recommend that you contact the nearest official service station of ABB Turbo Systems.

$n_{M\text{max}}$, $t_{M\text{max}}$ 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 $n_{M\text{max}}$ and $t_{M\text{max}}$ is not permitted.

Non-observance of the recommended inspection and 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.

---

**Fig. 3:** Attachment of loads on the crane hook

**Fig. 4:** Attachment angle

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.

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use original parts</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>Only use original parts from ABB Turbo Systems.</td>
</tr>
</tbody>
</table>

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.
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.
**WARNING**

**Burst protection and insulation**

Operation without burst protection and insulation or with the wrong combination of burst protection and insulation can cause serious injuries to persons or even fatal accidents.

- Only operate the turbocharger with burst protection fitted and insulation fitted in one of the following, permitted variants.

![Fig. 5](image)

**Variant A**  
Insulation (01) with integrated burst protection from ABB Turbo Systems.

**Variant B**  
Burst protection (03) and insulation (02) from ABB Turbo Systems.

**Variant C**  
Burst protection (03) from ABB Turbo Systems with appropriate insulation from the enginebuilder.
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

## A135-M65

<table>
<thead>
<tr>
<th>Type</th>
<th>A135-M65</th>
<th>HT844443</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n_{\text{M}_{\text{max}}}$</td>
<td>907</td>
<td>1</td>
</tr>
<tr>
<td>$n_{\text{B}_{\text{max}}}$</td>
<td>862</td>
<td>s</td>
</tr>
<tr>
<td>$t_{\text{M}_{\text{max}}}$</td>
<td>630</td>
<td>°C</td>
</tr>
<tr>
<td>$t_{\text{B}_{\text{max}}}$</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>2019</td>
<td></td>
</tr>
</tbody>
</table>

Application according to the Operation Manual

Made in Switzerland

© Copyright 2019 ABB. All rights reserved. HT844443 June 2019
# Product description

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>1.1</td>
<td>Essential information</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Registered trademarks</td>
<td>3</td>
</tr>
<tr>
<td>1.3</td>
<td>Related documents</td>
<td>3</td>
</tr>
<tr>
<td>1.4</td>
<td>Layout and function of the turbocharger</td>
<td>4</td>
</tr>
<tr>
<td>1.5</td>
<td>Warning plates on the turbocharger</td>
<td>6</td>
</tr>
<tr>
<td>1.6</td>
<td>Locations of the rating plates</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Removing and Installing</td>
<td>8</td>
</tr>
<tr>
<td>2.1</td>
<td>Turbocharger weight and transportation</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Removing the turbocharger</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Installing the turbocharger</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Commissioning</td>
<td>22</td>
</tr>
<tr>
<td>3.1</td>
<td>Oil supply</td>
<td>22</td>
</tr>
<tr>
<td>3.2</td>
<td>Inspection procedures</td>
<td>24</td>
</tr>
<tr>
<td>3.3</td>
<td>Commissioning after taking out of operation</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>Monitoring operation</td>
<td>27</td>
</tr>
<tr>
<td>4.1</td>
<td>Oil pressure, oil temperature</td>
<td>27</td>
</tr>
<tr>
<td>4.2</td>
<td>Exhaust gas temperature before turbine</td>
<td>29</td>
</tr>
<tr>
<td>4.3</td>
<td>Turbocharger speed</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Operation and service</td>
<td>33</td>
</tr>
<tr>
<td>5.1</td>
<td>Noise emission</td>
<td>33</td>
</tr>
<tr>
<td>5.2</td>
<td>Service work</td>
<td>35</td>
</tr>
<tr>
<td>5.3</td>
<td>Expected replacement intervals</td>
<td>39</td>
</tr>
<tr>
<td>5.4</td>
<td>Stopping the engine</td>
<td>41</td>
</tr>
<tr>
<td>6</td>
<td>Periodic maintenance work</td>
<td>42</td>
</tr>
<tr>
<td>6.1</td>
<td>Foreword to maintenance</td>
<td>42</td>
</tr>
<tr>
<td>6.2</td>
<td>Cleaning the compressor during operation</td>
<td>43</td>
</tr>
<tr>
<td>6.3</td>
<td>Cleaning the turbine during operation</td>
<td>46</td>
</tr>
<tr>
<td>6.4</td>
<td>Cleaning components mechanically</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Eliminating malfunctions</td>
<td>60</td>
</tr>
<tr>
<td>7.1</td>
<td>Malfunctions when starting</td>
<td>60</td>
</tr>
<tr>
<td>7.2</td>
<td>Malfunctions during operation</td>
<td>61</td>
</tr>
<tr>
<td>7.3</td>
<td>Turbocharger is surging</td>
<td>64</td>
</tr>
<tr>
<td>7.4</td>
<td>Malfunctions when stopping</td>
<td>65</td>
</tr>
<tr>
<td>7.5</td>
<td>Speed measurement system</td>
<td>66</td>
</tr>
</tbody>
</table>
# Table of contents

8  Dismantling and fitting ........................................................................................................... 67
8.1 Introduction .......................................................................................................................... 67
8.2 Weights of individual parts ................................................................................................. 70
8.3 Removing the air inlets ...................................................................................................... 71
8.4 Removing the gas outlet casing ......................................................................................... 72
8.5 Removing the gas outlet flange .......................................................................................... 73
8.6 Removing the compressor casing ....................................................................................... 76
8.7 Pressing off the casing ........................................................................................................ 78
8.8 Removing the cartridge group ............................................................................................ 79
8.9 Removing the nozzle ring .................................................................................................... 81
8.10 Installing the cartridge group on the service support ...................................................... 82
8.11 Measuring clearance A and B ........................................................................................ 83
8.12 Nozzle ring compression PD ........................................................................................... 84
8.13 Installing the nozzle ring .................................................................................................. 85
8.14 Installing the cartridge group ........................................................................................... 86
8.15 Installing the compressor casing ..................................................................................... 89
8.16 Measuring radial clearances N and R ............................................................................... 91
8.17 Installing the air inlets ...................................................................................................... 92
8.18 Installing the gas outlet flange ........................................................................................ 93
8.19 Fitting the insulation of the turbine casing ................................................................... 94
8.20 Installing the gas outlet casing ......................................................................................... 95
8.21 Table of tightening torques .............................................................................................. 97

9  Taking out of operation at short notice ............................................................................... 99
9.1 Possible emergency repairs ................................................................................................ 99
9.2 Installing the replacement turbocharger ........................................................................ 100
9.3 Installing the replacement cartridge group ..................................................................... 100
9.4 Fitting the cover plate ....................................................................................................... 101
9.5 Cover plate drawing .......................................................................................................... 102

10 Mothballing the turbocharger ............................................................................................ 103
10.1 Taking the engine out of operation for up to 12 months ............................................... 103
10.2 Taking the engine out of operation for more than 12 months ..................................... 104

11 Disposing of turbocharger components ........................................................................... 105

12 Spare parts .......................................................................................................................... 106
12.1 Ordering spare parts ......................................................................................................... 106
12.2 Required customer spare part set (97070) ..................................................................... 106
12.3 View of turbocharger with part numbers ..................................................................... 108
12.4 View of turbine cleaning device .................................................................................... 110

Figures ................................................................................................................................... 111

Tables ..................................................................................................................................... 113
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>HZTL4022</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 of the turbocharger

01 Filter silencer / air suction branch
02 Compressor casing
03 Diffuser
04 Bearing casing
05 Axial thrust bearing
06 Radial plain bearing
07 Turbine
08 Gas outlet flange
09 Nozzle ring
10 Turbine casing
11 Turbine-end bearing flange
12 Compressor-end bearing flange
13 Compressor wheel
Mode of operation

The turbocharger is a turbomachine and consists of the following main components:

- Turbine
- Compressor.

These components are installed on a common shaft and form the rotor.

The exhaust gases of the internal combustion engine flow through the turbine casing (10) and the nozzle ring (09) onto the turbine (07). The turbine (07) uses the energy contained in the exhaust gas to drive the rotor and, hence, the compressor wheel (13). The exhaust gases then reach the atmosphere through the exhaust gas pipe connected to the gas outlet flange (08).

The compressor wheel (13) sucks fresh air through the air suction branch or the filter silencer (01). In the compressor wheel (13), the energy required for building up the pressure is transferred to the air. By flowing through the diffuser (03) and the compressor casing (02), the air is compressed further and is then directed to the engine cylinders.

The rotor runs in two radial plain bearings (06) which are located in the bearing casing (04) between the compressor and turbine. The axial thrust bearing (05) is located between the two radial plain bearings.

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 always lies at the deepest point of the bearing casing (04).

1.4.1 Function of the compressor wheel cooling

Fig. 2: Compressor wheel cooling

Depending on the application of an A100 radial turbocharger, 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 a lateral connection in the bearing casing (01).

In addition, the turbocharger version with compressor wheel cooling is indicated by the turbocharger type (M6..) on the rating plate.
1.5 Warning plates on the turbocharger

Warning plates are affixed at the following locations:

Fig. 3: Warning plate 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 (01) each is attached on the left and the right side of the turbocharger bearing casing.
2 Removing and Installing

2.1 Turbocharger weight and transportation

Lifting gear with a sufficient load limit must be used for 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: Suspension of complete turbocharger unit]

A Turbocharger with oil-cooled bearing casing
B Turbocharger with water-cooled bearing casing
C Complete turbocharger unit with gas outlet casing

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight of complete turbocharger unit [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130-M</td>
<td>210</td>
</tr>
<tr>
<td>A135-M</td>
<td>300</td>
</tr>
<tr>
<td>A140-M</td>
<td>500</td>
</tr>
<tr>
<td>A145-M</td>
<td>850</td>
</tr>
</tbody>
</table>

Table 2: Weight of complete turbocharger unit
2.2 Removing the turbocharger

- Disconnect all pipes according to the instructions of the enginebuilder.

![Fig. 6: Turbine cleaning nozzle](image)

- If present: Loosen the turbine cleaning connection. The cleaning nozzle (51301) must be replaced after each removal procedure. If the cleaning nozzle is not to be replaced, the screw connection (01) must not be loosened during disassembly.
The gas outlet casing (61001) can remain fitted in the exhaust gas pipe if the locking nuts are accessible. Otherwise the complete turbocharger unit including gas outlet casing must be removed.

- If present: Loosen and remove the compressor wheel cooling connection. Close the compressor wheel cooling opening with a screw plug (01).
- If present: Disconnect the plug to the speed sensor (86505) and secure the rolled-up cable on the turbocharger. This protects the plug from being crushed.

Apply penetrating oil to thread of stud (02) and nut and let it work in. Do not oil the pressure screws of the clamping nut (D).

If present: Detach the support (61301) from the engine support.

Depending on the bracket version (04), two positioning pins (05) can be used for positioning and safeguarding against wrong fitting of the turbocharger. Therefore the turbocharger must always be removed from and installed on the bracket vertically.
Version with water cooling

CAUTION
Freezing of the cooling water in the bearing casing
If cooling water freezes in the bearing casing, this can lead to severe damage.
- For transport and storage of the turbocharger, drain the cooling water from the bearing casing via one of the two bottom openings of the water connections.

2.2.1 Fastening of the turbocharger

Depending on the type and version, the turbocharger can be fastened in different ways. The appropriate procedure must be chosen to undo the connection.

Oil-cooled bearing casing (A)
- Attach lifting gear to the suspension eye.
- Loosen and remove nuts (E). If clamping nut (D) is present: Loosen in accordance with chapter Loosening the clamping nut →12.
- Positioning the turbocharger for storage →13.

Water-cooled bearing casing (B)
- Loosen and remove water connections. Close the openings of the water connections with screw plugs.
- Attach lifting gear to the suspension eye.
- Loosen and remove nuts (E). If clamping nut (D) is present: Loosen in accordance with chapter Loosening the clamping nut →12.
- Positioning the turbocharger for storage →13.

Hydraulic loosening (round special nut)
- Attach lifting gear to the suspension eye.
- Loosen the round special nut with a hydraulic tool according to the instructions of the enginebuilder.
- Positioning the turbocharger for storage →13.
2.2.2 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.

Fig. 8: Loosening the clamping nut

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. Working in a circle, loosen each pressure screw by 90° in 1...5 rounds until all of the pressure screws have been relieved.
- Loosen clamping nut by hand.
2.2.3 Positioning the turbocharger for storage

**WARNING**

**Risk of tipping**

If the turbocharger is not positioned stably, it may tip over. This can result in serious personal injury.

- Place the turbocharger on a clean, level support.
- Secure the turbocharger to prevent it from tipping over by using wooden beams and wedges and by taking the centre of gravity into account.

![Fig. 9: Turbocharger centre of gravity](image)

01 Centre of gravity

- Remove turbocharger from engine support, set it down properly in an appropriate place and secure it.
- Close or cover the openings of the turbocharger and support.
2.3 Installing the turbocharger

2.3.1 Inserting gaskets

⚠️ CAUTION
Inserting the gaskets
Gaskets that are forgotten, damaged or improperly inserted will lead to oil leaks.
- Always use new gaskets and insert them carefully into the slot.

The oil is supplied (02) and drained (03) through the bracket (01).

The necessary sealing is provided by O-rings. The O-rings are not included in the ABB Turbo Systems scope of delivery.

![Diagram of gasket insertion](image)

Fig. 10: Inserting gaskets into the bracket

| 01 | Bracket          | 04 | Slot for O-ring |
| 02 | Oil supply      | 05 | O-rings        |
| 03 | Oil drain       | 06 | Pin (optional) |

**Pin (06) as installation safety device**

Turbochargers can have an oil inlet either on their right or left side; the oil inlet position can be different for the turbocharger fitted on the left and on the right engine bank.

A pin can be installed in every support as an installation safety device to prevent inadvertent incorrect fitting. This pin fits into the respective slot on the foot of the bearing casing. Instructions of the enginebuilder must be observed.
2.3.2 Fitting threaded rods

Fig. 11: Inserting the threaded rods

1. Lightly oil the surfaces of the threaded rods (02) to be screwed in.
2. Screw the threaded rods into the bracket with the aid of locknuts (01).
3. Remove nuts (01) again.

Requirements for the threaded rods

Fig. 12: Requirements for threaded rods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>Ø 16 / M16</td>
<td>10.9 / 12.9</td>
<td>≥ 30</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>A135</td>
<td>Ø 20 / M20</td>
<td>10.9 / 12.9</td>
<td>≥ 30</td>
<td>270</td>
<td>325</td>
</tr>
<tr>
<td>A140</td>
<td>Ø 24 / M24</td>
<td>10.9 / 12.9</td>
<td>≥ 70</td>
<td>350 ... 360</td>
<td>410 ... 420</td>
</tr>
<tr>
<td>A145</td>
<td>Ø 30 / M30</td>
<td>10.9 / 12.9</td>
<td>≥ 80</td>
<td>415 ... 425</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 3: Requirements for threaded rods

Fastening material, scope of delivery

The threaded rods and nuts for fastening the turbocharger on the bracket are not included in the ABB Turbo Systems scope of delivery.

The clamping nuts are included in the ABB Turbo Systems scope of delivery.
2.3.3 Placing the turbocharger on the bracket

1. Make sure that the gaskets (03) are not damaged and are positioned correctly in the slots.
2. Clean the contact surfaces of the expansion bushes (42190) in the bearing casing.
3. Clean the expansion bushes (42190).
4. Attach the lifting gear to the suspension eye of the bearing casing (A/B) and loop around the gas outlet casing (61001). If the gas outlet casing is already fitted in the exhaust gas pipe, the attachment of the lifting gear on the bearing casing is sufficient.
5. Position the turbocharger on the bracket (04) and align it. Pay attention to the positioning pins (05) in the bracket.
6. When fixing with a standard nut (D), fit expansion bushes (42190) in the correct position in the slot (only relevant for older, water-cooled versions).

Safeguard against wrong fitting (only for water-cooled bearing casings)

Depending on the bracket version (04), two positioning pins (05) can be used for positioning and safeguarding against wrong fitting of the turbocharger. Therefore the turbocharger must always be removed from and installed on the bracket vertically.

A Oil-cooled bearing casing
B Water-cooled bearing casing
C Fixing with clamping nut
D Fixing with standard nut

Fig. 13: Placing the turbocharger on the bracket
Observe the instructions for the fastening variant at hand.

- Fastening the turbocharger with a standard nut →17 (A130 - A140)
- Fastening the turbocharger with a clamping nut →18 (A140 and A145)

2.3.4 Fastening the turbocharger with a standard nut

Fit the nuts and tighten them according to variant 1 or 2 in the table below.

<table>
<thead>
<tr>
<th>Product</th>
<th>Through hole in bearing casing [mm]</th>
<th>Fixing screws [mm]</th>
<th>Variant 1: Tightening torques [Nm] **</th>
<th>Variant 2: Hydraulic pre-tensioning forces [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>Ø 17</td>
<td>M16</td>
<td>280</td>
<td>110</td>
</tr>
<tr>
<td>A135</td>
<td>Ø 21</td>
<td>M20</td>
<td>560</td>
<td>175</td>
</tr>
<tr>
<td>A140</td>
<td>Ø 25</td>
<td>M24</td>
<td>960</td>
<td>250</td>
</tr>
</tbody>
</table>

Table 4: Tightening torque for standard nuts

**) When the turbocharger is mounted on the engine support, the bolt threads and screw heads must be lightly oiled (assumed friction coefficient $\mu = 0.12$ for tightening torque)

- Remove the lifting gear.
2.3.5 Fastening the turbocharger with a clamping nut

Preparations for tightening the clamping nut

**CAUTION**

- Do not clean pressure screws (04)
- 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.

In order to correctly fit the clamping nuts, the pressure screws (04) must not protrude from the clamping nuts (03) in the direction of the thrust washer (02).

- Make sure the pressure screws do not protrude in the direction of the thrust washer.

1. Check whether the expansion bushes (42190) with recess are correctly positioned and do not touch the flange of the core hole cover (A).
2. Clean the thread of the bolt (01) and the contact surface.
3. Lightly oil the bolt thread.
4. Position the thrust washer (02) in place.
5. Tighten clamping nut (03) by hand.
6. Unscrew clamping nut (03) by ¼ of a turn (90°).

The distance between the thrust washer and the clamping nut is now about 1 mm.
Tightening pressure screws

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.

Table 5: Torque-controlled tightening of the pressure screws

<table>
<thead>
<tr>
<th>Product</th>
<th>Fixing screw [mm]</th>
<th>Tightening torques [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A140</td>
<td>M24</td>
<td>35</td>
</tr>
<tr>
<td>A145</td>
<td>M30</td>
<td>45</td>
</tr>
</tbody>
</table>
2.3.6 Connecting the turbocharger

Fig. 16: Connecting the speed sensor

- Connect cable to speed sensor (86515).
- Connect all gas, water and air lines according to the instructions of the enginebuilder.

Version with water-cooled bearing casing

- Fit the water pipes according to the instructions of the enginebuilder.

Version with compressor wheel cooling

**CAUTION**

**Failure of compressor wheel cooling**

Any prolonged failure of the compressor wheel cooling will shorten the replacement interval of the compressor wheel.

- Make sure there is an uninterrupted supply of cooling air during operation.

Fig. 17: Connecting the compressor cooling air intake

- Remove the screw plug on the connection for the compressor wheel cooling (06) and fit the cooling air line.
2.3.7 Attaching the support

Fig. 18: Attaching the support

- If present: Attach support (61301) to engine support or to a connecting piece.
3 Commissioning

3.1 Oil supply

3.1.1 Introduction

In all operating states, a functioning and carefully executed oil supply is an important pre-requisite 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.

3.1.2 Pre-lubrication

Pre-lubrication must be carried out as follows:

- Switch on the oil pump.
- Build up oil pressure &.
- Do not exceed a pre-lubrication time of 2 minutes.
- Start the engine.
- Let the oil pump run until the pump driven by the engine generates sufficient pressure.

3.1.3 Oil filtering

Filtering the lubricating oil with a filter mesh width of ≤ 0.034 mm is sufficient for this turbocharger.

3.1.4 Oil pressure

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

The admissible values are specified in chapter Monitoring operation →27.
3.1.5 Oil orifice in the bearing casing

With an oil inlet pressure of more than 3 bar of overpressure (with engine under load) upstream of the turbocharger, the bearing casings are equipped with an orifice at the oil inlet as standard.

Fig. 19: Oil orifice

01 Bearing casing
02 Oil orifice
03 Circlip
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.

Warning plates

- Check whether warning plates are present and legible.
- Check whether the protective sheets have been removed from new warning plates.

Version with compressor wheel cooling:

**CAUTION**

Failure of compressor wheel cooling

Any prolonged failure of the compressor wheel cooling will shorten the replacement interval of the compressor wheel.

- Make sure there is an uninterrupted supply of cooling air during operation.

- Check whether the compressor wheel cooling is fitted on the bearing casing.
Version with water-cooled bearing casing

⚠️ CAUTION

Failure of bearing casing cooling
Any prolonged failure of the water cooling will shorten the lifetime of the turbocharger.
- Make sure that an uninterrupted supply of cooling water is provided during operation.

- Check whether the water pipes are fitted on the bearing casing.

3.2.3 Checks after commissioning (engine in idle mode)

Lubricating system
- Keep to the lubricating oil pressure at the inlet.
- Keep to the lubricating oil temperature at the inlet.
- Refer to chapter Monitoring operation →27 for admissible values.

Leaktightness of pipes

⚠️ WARNING

Risk of burning from hot gas
Escaping gases are hot and will lead to serious burns in the event of contact.
- Check all pipes for leaks in accordance with the enginebuilder’s instructions.

3.2.4 Checks when starting up the engine

If present:
- 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 Eliminating malfunctions →60).

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.
- Remove the screw plugs on the water connections and fit the water pipe.

Version with compressor wheel cooling:

- Remove the screw plug on the cooling air connection and fit the cooling air line.

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 →24).
- The turbocharger is now ready for operation.
4 Monitoring operation

4.1 Oil pressure, oil temperature

Lubricating oil pressure, oil inlet

To limit the oil flow rate through the turbocharger to the admissible values with the engine at full load, an oil orifice is mandatory or already fitted at the turbocharger oil inlet if the oil inlet pressure is > 3 bar.

⚠️ CAUTION
Assuring lubricating oil pressure

Serious damage to the engine or property can result from a missing or insufficient lubricating oil supply.

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

### Status for operation

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Pressure at oil inlet upstream of the turbocharger [bar] Overpressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>2.0 &lt; $p_{oil}$ ≤ 4.5 *)</td>
</tr>
<tr>
<td>Engine start: Cold oil, admissible for a maximum of 15 minutes</td>
<td>&lt; 8.0</td>
</tr>
<tr>
<td>Engine idling, admissible for a maximum of 1 hour</td>
<td>0.5 &lt; $p_{oil}$ ≤ 2.5</td>
</tr>
<tr>
<td>Pre-lubrication and post-lubrication (engine stopped)</td>
<td>0.5 &lt; $p_{oil}$ ≤ 1.0</td>
</tr>
<tr>
<td>Warning signal: ($n ≥ 0.5 \times n_{max}$)</td>
<td>&lt; 1.25</td>
</tr>
<tr>
<td>Alarm signal: Not admissible. Stop the engine immediately.</td>
<td>&lt; 0.6</td>
</tr>
</tbody>
</table>

Table 6: Lubricating oil pressure at oil inlet before turbocharger

*) Depending on use of an oil orifice in accordance with the enginebuilder's specifications.

For monitoring the lubricating oil pressure, ABB Turbo Systems recommends installing a "P" manometer immediately upstream of the turbocharger oil inlet before the orifice. If the pressure is controlled electronically, the relevant signals should be triggered at the warning and alarm values.

*) If the drain pipe is vented, the lubricating oil temperature measuring point can be installed at the outlet in the vent tank. Otherwise the measurement should be taken in the drain pipe as close to the turbocharger as possible.
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.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at the inlet $T_{\text{oil,inlet}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>30 … 105 °C</td>
</tr>
<tr>
<td>Temporarily admissible ($&lt; 1$ h) → alarm</td>
<td>$&gt; 105$ °C</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>$&gt; 110$ °C</td>
</tr>
<tr>
<td>Not admissible → do not start engine (before start: preheat oil)</td>
<td>$&lt; 30$ °C</td>
</tr>
</tbody>
</table>

Table 7: Lubricating 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 $T_{\text{oil,outlet}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>$\leq 160$ °C</td>
</tr>
<tr>
<td>Temporarily admissible → alarm</td>
<td>$&gt; 160$ °C</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>$&gt; 180$ °C</td>
</tr>
<tr>
<td>Admissible</td>
<td>$\leq T_{\text{oil,inlet}} + 55$ K</td>
</tr>
<tr>
<td>Temporarily admissible → alarm</td>
<td>$&gt; T_{\text{oil,inlet}} + 55$ K</td>
</tr>
</tbody>
</table>

Table 8: Lubricating 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 Exhaust gas temperature before turbine

⚠️ CAUTION

Factors influencing replacement intervals

Operation above the operating limits defined on the rating plate can shorten the recommended replacement intervals considerably.

- Measure exhaust gas temperature upstream of turbine.
- Comply with operating limits on rating plate.

- Definition and explanations concerning rating plate: refer to chapter 2 of Operation Manual / Safety.
- Operating limits: refer to chapter 3 of Operation Manual / Safety data sheet or examine rating plate.
4.3 Turbocharger speed

4.3.1 Introduction
A speed measuring system enables the constant monitoring of the turbocharger speed.

**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.

4.3.2 Layout and overview

Fig. 20: Layout and overview of speed measurement system

- 86505 Speed sensor
- 86515 Cable connector
- 86526 F/I converter
- 86528 Tachometer
- 32109 Sealing disc with cams

- 42188 Screw plug
- 42189 Gasket
- 01 Plug with integrated voltage limiter
- *) Installation variant for speed sensor
4.3.3 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 \( n_{B\text{max}} \).

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 \( n_{B\text{max}} \).
- 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.

4.3.4 Malfunctions on the speed measurement system

In the case of malfunctions of the speed measurement system, refer to the chapter entitled Troubleshooting/Speed measurement system \( \rightarrow \) 66.
4.3.5 Replacing the speed sensor

**WARNING**

Hot speed sensor

Danger of burns. The speed sensor can reach temperatures of more than 100 °C during operation.

- Wear safety gloves when disassembling the speed sensor.

Wear safety gloves to protect against thermal hazards.

The speed sensor supplied by ABB is equipped with a sealing lip and an O-ring. No additional gasket is required during assembly.

![Fig. 21: Replacing the speed sensor](image)

<table>
<thead>
<tr>
<th>Part number</th>
<th>A130</th>
<th>A135</th>
<th>A140</th>
<th>A145</th>
</tr>
</thead>
<tbody>
<tr>
<td>86505</td>
<td>M12 x 1.5</td>
<td>15 Nm</td>
<td>M12 x 1.5</td>
<td>15 Nm</td>
</tr>
</tbody>
</table>

Table 9: Tightening torque (86505)

- Reduce the engine performance to idling and then stop the engine. Pay attention to post-lubrication (Stopping the engine →41).
- Switch off the lubricating oil supply to the turbocharger.
- Disconnect cable connector (86515) from speed sensor (86505).
- Unscrew and remove defective speed sensor (86505).
- Screw in new speed sensor (86505) as far as it will go and tighten.
- Connect cable connector (86515) to speed sensor (86505).
- Switch on lubricating oil supply to the turbocharger.
5 Operation and service

5.1 Noise emission

⚠️ 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.

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. 22: Noise insulation, bellows →34).

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

![Diagram showing 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. 22: 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

⚠️ CAUTION

Unknown operational changes
Impairment to the degree of a possible operating failure can be the consequence.

- Have any unknown causes clarified by an ABB Turbocharging Service Station.

- 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.

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 according to instructions of enginebuilder

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

5.2.4 Service work according to data on the rating plate

(Usually after 8000 ... 12000 operating hours)

The rotor and bearing parts must be checked and assessed by an ABB Turbocharging Service Station. The following work can be carried out as preparation.

- Remove turbocharger from engine, dismantle and measure clearance (see Dismantling and fitting, general).
- Clean nozzle ring, turbine casing, compressor casing and diffuser, and check for cracks and erosion/corrosion.
5.2.5 Other service work

If a protective grid is installed in the gas outlet casing (61001) by ABB Turbo Systems:

Fig. 23: Replacing the protective grid

- Remove the protective grid (61205) after 50000 hours and replace it with a new protective grid.
5.2.6 Entries in the engine logbook

The monitoring of the engine system enables conclusions to be drawn on the behaviour of the turbocharger.

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

- Rating and speed of the engine
- Air intake temperature
- Pressure of the charge air
- Pressure loss in the charge-air cooler
- Lubricating oil pressure and lubricating oil temperature

If present:

- Speed of the turbocharger
- Air temperature after the compressor and after the charge-air cooler
- Exhaust gas temperature before and after the turbine
- Pressure loss in the filter silencer.
5.3 Expected replacement intervals

Rotating components

The recommended replacement intervals of the compressor and turbine wheels are specified with the aid of 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.

Expected replacement intervals [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine casing</td>
<td>25000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>25000 ... 50000</td>
<td>10000 ... 25000</td>
</tr>
<tr>
<td>Gas outlet flange</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Heat shield</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Rotor components</td>
<td>See rating plate data</td>
<td></td>
</tr>
<tr>
<td>Bearing parts</td>
<td>12000 ... 24000</td>
<td>12000 ... 24000</td>
</tr>
<tr>
<td>Other casings</td>
<td>50000</td>
<td>50000</td>
</tr>
</tbody>
</table>

Table 10: Expected replacement intervals

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

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

The specified values are guideline values and are not guaranteed. The actual values can deviate considerably from the guideline values, for example, due to the following influences:

- Fuel quality and fuel treatment
- Load profile (thermal cycling, also number of starts/stops, emergency shutdowns, operating point)
- Gas inlet temperature
- Frequency and execution of cleaning process during operation
- Turbocharger specification.
- System-specific operating conditions (combustion quality, exhaust gas composition)

For bearing parts

- Lubricating oil quality (oil filtering, oil condition, oil monitoring)
- Load profile (speed, pressure conditions, temperature)
- Number of starts/stops
- Unbalance of the rotor (degree of contamination).
5.4 Stopping the engine

⚠️ CAUTION
Residual heat in the turbocharger
If the residual heat in the turbocharger is not adequately dissipated, it may damage the engine.
- Adequate cooling of the turbocharger must be ensured after stopping the engine.

- Run the engine for 5 ... 10 minutes at idling speed before stopping it.
- Observe the oil pressure specified for engine idling (see Table 6: Lubricating oil pressure at oil inlet before turbocharger →27).

- Post-lubricate water-cooled bearing casings until the rotors come to a standstill. Deactivate post-lubrication as soon as the rotor comes to a standstill. Deviating procedures must be coordinated with ABB Turbo Systems.
- For oil-cooled bearing casings, post-lubricate for 20 minutes if the turbine inlet temperature ($t_{TE}$) exceeds the following values when the engine is stopped:
  - 550 °C with insulated casing
  - 600 °C with non-insulated casing

At temperatures below the specified values, post-lubrication must be ensured until the rotors come to a standstill. ABB Turbo Systems recommends post-lubrication for 10 minutes.
- Observe the oil pressure specified for post-lubrication (see Table 6: Lubricating oil pressure at oil inlet before turbocharger →27).
6 Periodic maintenance work

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.

To allow you to observe the standard service intervals and to maintain a high turbocharger efficiency, ABB Turbo Systems recommends that the cleaning procedure be carried out during operation. This allows the thermal load of the engine to be kept low while ensuring maximum fuel efficiency.

<table>
<thead>
<tr>
<th>Maintenance interval</th>
<th>Maintenance work</th>
<th>Operating status</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 … 72 h (^1)</td>
<td>Cleaning the compressor during operation (\rightarrow 43)</td>
<td>Engine load 50 … 85 %</td>
</tr>
<tr>
<td>50 … 200 h (^2)</td>
<td>Cleaning the turbine during operation (\rightarrow 46)</td>
<td>Engine load 20 … 40% (guideline value)</td>
</tr>
<tr>
<td>Similar to the service interval (usually every 8000 … 12000 h) (^2)</td>
<td>Cleaning components mechanically (\rightarrow 50)</td>
<td>Engine stopped</td>
</tr>
</tbody>
</table>

Table 11: Maintenance table

[h] = Hours of operation

\(^1\) If the maintenance intervals are incompatible with operation of the engine, contact ABB Turbo Systems.

\(^2\) ABB Turbo Systems recommends having mechanical cleaning carried out by an ABB Turbocharging Service Station during the service work. Otherwise, only carry out mechanical cleaning if cleaning during operation is not sufficient to achieve the thermal load and the rating of the engine.
6.2  Cleaning the compressor during operation

6.2.1  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.

Options and limits

Periodic cleaning during operation delays any major increase in contamination. The cleaning method is suitable as long as the contamination has not progressed far. Very heavily contaminated components can no longer be cleaned using this method. In this case, ABB Turbo Systems recommends having the contaminated components cleaned mechanically by an ABB Turbocharging Service Station.

Periodic cleaning during operation is not a substitute for the service work during which the turbocharger is completely dismantled and cleaned.

Cause and consequences of contamination

The contamination of the compressor stage depends on the degree of purity of the air that is sucked in. Deposits can form in the flow channels if salt, oil mist, exhaust gas or dust are sucked in with the air.

Consequences of contamination:
- Impaired compressor efficiency
- Elevated exhaust gas temperatures
- Increased fuel consumption
- Increased rotor unbalance

6.2.2  Cleaning interval

The time period between the periodical cleaning cycles depends greatly on the operating conditions. Cleaning should normally be done every 24 ... 72 hours of operation.

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

Cleaning method and operating state

The compressor is cleaned during operation using the wet cleaning method. It is carried out at an engine load of 50 ... 85 %.

This cleaning method has been tested and approved by ABB Turbo Systems.

V-engines

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.

Sequential charging

With sequential charging, it must be made sure especially after operating periods in the lower range of performance that both turbocharger compressors are cleaned.

6.2.4 Function and safety of wet cleaning

⚠️ CAUTION

Volume of water

Uncontrolled volumes of water can damage the turbocharger and the engine.

- Never connect the water connection directly to a water pipe or a bigger metering container than the one specified by ABB Turbo Systems.

⚠️ WARNING

Danger due to pressure vessels

Personal injury can occur if the locally applicable legal regulations on periodic inspections of the pressure vessels are not complied with.

- The locally applicable legal regulations regarding periodic checks of the pressure vessels must be observed.
- Do not use pressure vessels that are defective.

⚠️ 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.
6.2.5 Carrying out wet cleaning of the compressor

Pressurized air from the compressor casing (72000) of the turbocharger passes through the pipe (02) to the water pressure vessel (27000). As soon as the valve activator (03) is activated, water is pressed into the pipe (01) and routed to the filter silencer or air suction branch.

The water does not act as a solvent. The coating is removed by the mechanical action of the impacting droplets.

### Table 12: Parameters for wet cleaning of compressor

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50 ... 85 %</td>
<td>0.4</td>
<td>5 ... 30</td>
<td>10</td>
</tr>
</tbody>
</table>

- Remove sealing plug (27005).
- Fill container with 0.4 dm³ of pure water.
- Screw in sealing plug (27005) again.
- Push the valve activator (03) against the spring and hold for 10 ... 15 seconds until the entire volume of water is injected.
- Continue to operate the engine for at least five minutes to ensure that all of the water is flushed out of the system.

Not more than three cleaning cycles should be conducted consecutively. Before repeating the process, continue to operate the engine for at least five minutes to ensure that all of the water is flushed out of the system.
6.3 Cleaning the turbine during operation

6.3.1 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.

Options and limits

Periodic cleaning during operation delays any major increase in contamination. The cleaning method is suitable as long as the contamination has not progressed far. Very heavily contaminated components can no longer be cleaned using this method. In this case, ABB Turbo Systems recommends having the contaminated components cleaned mechanically by an ABB Turbocharging Service Station.

Periodic cleaning during operation is not a substitute for the service work during which the turbocharger is completely dismantled and cleaned.

Cause and consequences of contamination

ABB Turbo Systems recommends the use of fuels with low ash, sulphur, sodium and vanadium contents. Operating states with incomplete combustion also increase the tendency to form deposits and must be avoided.

The combustion of heavy fuel oil (HFO) in diesel engines causes contamination of the turbine stage. Poor quality fuel in conjunction with high exhaust gas temperatures can lead to extremely hard deposits on turbine components.

Consequences of contamination:

- Low turbine efficiency
- Elevated exhaust gas temperatures
- Increased charging and ignition pressures with increasing turbocharger speed
- Lower engine performance.

Possible damage to turbocharger:

- After the engine is stopped the rotor may become stuck in contamination deposits
- Damage to turbine heads with blade breaks.

6.3.2 Cleaning interval

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

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

The turbine components are cleaned during operation using the wet cleaning method. This cleaning method is tested and approved by ABB Turbo Systems.

The precondition for wet cleaning is that the enginebuilder approves the process and these regulations are observed.

V-engines

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.

6.3.4 Function and safety of wet cleaning

⚠️ 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.

To clean the turbine stage during operation, water is injected before the nozzle ring. Based on an injection phase of 10 minutes, this cleaning procedure uses the principle of water solubility of dirt deposits.

To prevent corrosion of the inside surfaces of the casings, the engine must be continued to be operated for 10 minutes after a wet cleaning. The exhaust gas temperature downstream of the turbocharger can drop by up to 180 °C during cleaning.
6.3.5 Prerequisites

<table>
<thead>
<tr>
<th>Characteristic/component</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine load (guideline value)</td>
<td>20 … 40 %</td>
</tr>
<tr>
<td>*) Turbine inlet temperature $T_{\text{TE}}$ before water injection</td>
<td>350 … 430 °C</td>
</tr>
<tr>
<td>Stabilisation phase after $T_{\text{TE}}$ has been reached</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Stabilisation phase after turbine cleaning</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Water supply</td>
<td>ensured</td>
</tr>
<tr>
<td>Water pressure (overpressure compared to atmosphere) $p_{\text{WT}}$</td>
<td>1.5 bar</td>
</tr>
<tr>
<td>Water temperature</td>
<td>5 … 30 °C</td>
</tr>
</tbody>
</table>

Table 13: Turbine wet cleaning, recommended operating state

*) The temperature at the turbine inlet can be up to 100 °C higher than the exhaust gas temperature after the cylinder. This must be taken into account when setting the operating point before cleaning.

If necessary, the engine performance must be reduced to meet these conditions. The cleaning cycle can be started when the above conditions are fulfilled.

6.3.6 Carrying out wet cleaning of the turbine

⚠️ CAUTION

Inadmissible thermal stress and flooding of the turbine
Smaller amounts of water can lead to an inadequate cleaning result. Larger amounts of water lead to inadmissible thermal stress on the turbine components and can cause flooding of the turbine.

► It is imperative that turbine cleaning parameters are observed.

⚠️ CAUTION

Maximum temperature at turbine inlet during cleaning
During cleaning, the temperature at the turbine inlet will rise and may strain the material significantly.

► Make sure the maximum temperature at the turbine inlet is not exceeded during cleaning.
6 Periodic maintenance work / 6.3 Cleaning the turbine during operation

Fig. 25: Carrying out wet cleaning of turbine

- Fulfil prerequisites.
- Ensure that the water supply (01) is guaranteed.
- Open the stop valve (02) and set the required water pressure at the manometer (3) (see cleaning parameters in the table (see Table 13: Turbine wet cleaning, recommended operating state → 48)).
  If an optional flowmeter (04) is present, set the water volume flow $V_W$ on the basis of the cleaning parameters in the table (see Table 14: Wet cleaning of turbine, parameters → 49).
- Close the stop valve (02) after 10 minutes.
- Wait for 10 minutes; do not change the load during this stabilisation phase.

If the cleaning result is unsatisfactory or there is water leakage, contact an ABB Turbocharging Service Station.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>350 ... 430</td>
<td>530</td>
<td>4.0</td>
<td>10</td>
</tr>
<tr>
<td>A135</td>
<td>350 ... 430</td>
<td>530</td>
<td>5.5</td>
<td>10</td>
</tr>
<tr>
<td>A140</td>
<td>350 ... 430</td>
<td>530</td>
<td>8.5</td>
<td>10</td>
</tr>
<tr>
<td>A145</td>
<td>350 ... 430</td>
<td>530</td>
<td>12.0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 14: Wet cleaning of turbine, parameters

$^1$ Corresponds to a water pressure $p_{WT}$ of 1.5 bar (overpressure compared to atmosphere)
6.4 Cleaning components mechanically

6.4.1 Preparation

**CAUTION**

Component damage and corrosion

If mechanical cleaning is carried out incorrectly, this can lead to damage and corrosion on the components.

- Pay attention to the specifications in this chapter pertaining to mechanical cleaning.

**CAUTION**

Selection of cleaning tools

Turbocharger components are sensitive and easily sustain mechanical damage. The use of needle descalers (for example) or other striking tools damages the components. Depending on the specification, nozzle rings or turbine casings may have protective coatings which can also be damaged.

- Use only soft tools such as rags, brushes or wire brushes.
- In case of heavy contamination, the cleaning methods described in this chapter (such as soaking, for example) can be repeated until a satisfactory result is achieved.

The disassembly and assembly of the components is described in chapter Fitting and dismantling.

- Contaminated water and cleaning agents must be disposed of in an environmentally compatible, professional way and in compliance with locally applicable regulations.
6.4.2 Cleaning the filter silencer

![Diagram of the filter silencer components with labels 81135, 81136, 81137, 81265, 81266, 81270, 81271]

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. 26: Cleaning the filter silencer →51)

- Loosen the tension bands (81270).
- Remove the cover grid (81266).
- Pull out and bend up the sheet-metal coverings (81137), and remove the absorption segments (81136).
- Clean the absorption segments (81136).
  When cleaning, note that the absorption segments (81136) must only be cleaned lightly with compressed air, a soft brush or a moist cleaning cloth.
- Have any heavily contaminated absorption segments replaced by an ABB Turbocharging Service Station.

Fitting the filter silencer

(see Fig. 26: Cleaning the filter silencer →51)

- Insert the absorption segments (81136) into the sheet-metal coverings (81137).
- Bend the sheet-metal coverings (81137) back to their original shape and insert into the slotted guides in the filter silencer body (81135).
- Fit the cover grid (81266).
- Fit the tension bands (81270) and tighten them at the locks (81271).
- Any tension bands that have become damaged must be replaced.
- Fit the filter ring (81265), if present.
6.4.3 Compressor-end, non-rotating parts

**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.

The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.

![Compressor-end, non-rotating parts](image)

Fig. 27: Compressor-end, non-rotating parts

72000 Compressor casing
77000 Wall insert
79000 Diffuser

- Clean the above-mentioned components with steam or ultrasound. Alternatively, soak in diesel oil or water containing household cleaning agent. After soaking, remove contamination with a brush.
- Dry components completely.
- Spray cleaned surfaces with penetrating oil. Do not spray the outer surfaces of the turbocharger.
- Dispose of contaminated water and cleaning agents in accordance with the information in the material safety data sheet.
6.4.4 **Turbine-end, non-rotating parts**

![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.

Baked layers of contamination, for example, from heavy fuel oil or coked oil occur at the turbine end. The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.
Baked layers of contamination, for example, from heavy fuel oil or coked oil occur at the turbine end. The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.

Dismantle the lamellar sealing ring (56005) in the nozzle ring.

Place contaminated parts in hot water or in a liquid such as brake cleaner to soften the contamination.

Brush away the contamination or remove with a steam cleaner.

Repeat the soaking and brushing process if necessary.

Use clean water to remove all traces of solvent from parts.

Dry components completely.

Spray cleaned surfaces with penetrating oil. Do not spray exterior surfaces of the turbocharger.

Dispose of dirty water and cleaning agents in accordance with the information in the material safety data sheet.

**Option with cleaning nozzle**

The cleaning nozzle (51301) must be replaced after each removal procedure. If the cleaning nozzle is not to be replaced, the screw connection (01) must not be loosened during disassembly.

Water or air can be passed through the piping and into the cleaning nozzle to check whether it is blocked. When installed, the cleaning nozzle can be mechanically cleaned with a needle.
6.4.5 Cartridge group, general

**CAUTION**

**Corrosion**
If the cartridge group is not put back into operation immediately after cleaning, parts may corrode.
- Immediately after cleaning, install the cartridge group and put it back into operation.

Compressor wheels can be heavily contaminated due to poorly filtered suction air; turbines can be heavily contaminated due to exhaust gas residues or coked oil. Cleaning during operation may not suffice to remove such contamination; instead, it may need to be cleaned mechanically during standard service intervals (see the Service work chapter).

- Remove the turbocharger from the engine (see chapter Removing and Installing → 8).
- Remove the cartridge group (see chapter Dismantling and fitting → 67).

First clean the compressor end and then the turbine end according to the following description.

6.4.6 Cleaning the cartridge group on compressor end

**CAUTION**

**Selection of the cleaning agent**
Cleaning agents which contain chlorine attack metals.
- Use only pH-neutral cleaning agents which do not attack metals.
- Observe safety data sheet.

**CAUTION**

**Water and contamination in the cartridge group**
If water or contamination penetrates the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.
- Make sure that no water or contamination can enter into the cartridge group.

- Cleaning procedures should be selected that do not result in removal of the compressor wheel material or cause damage to its surfaces. Clean the compressor wheel with a rag or soft brush which has been soaked in water with a household cleaning agent. Do not use a wire brush!

- Dry the compressor wheel and the gap between the compressor and the bearing casing with low-pressure pressurized air.

- Lightly spray the compressor wheel and the gap between the compressor and the bearing casing with penetrating oil.

- Dispose of dirty water and cleaning agents in accordance with the material safety data sheet.
6.4.7 Cleaning the cartridge group on turbine end

Soaking the contamination

Baked layers of contamination from heavy fuel oil or coked oil occur at the turbine end. The contamination can be removed by soaking and brushing. The procedure for soaking the layers of contamination as well as for cleaning the turbine are described in the following.

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
<th>C [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>108</td>
<td>17</td>
<td>205</td>
</tr>
<tr>
<td>A135</td>
<td>128</td>
<td>20</td>
<td>245</td>
</tr>
<tr>
<td>A140</td>
<td>157</td>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>A145</td>
<td>187</td>
<td>30</td>
<td>357</td>
</tr>
</tbody>
</table>

Table 15: Value table for soaking

To soak the layers of contamination on the turbine, the cartridge group can be immersed vertically in a container (02) with fluid.

- Place the container (02) inside a larger container (03) so that the overflowing fluid can be collected.

⚠️ CAUTION

Selection of the cleaning agent

Cleaning agents which contain chlorine attack metals.

- Use only pH-neutral cleaning agents which do not attack metals.
- Observe safety data sheet.

- Fill the container (02) with soaking fluid. To shorten the soaking time, the fluid can be heated up to a maximum of 60 °C.
WARNING

Heating up of cleaning agents and operating fluids
When cleaning agents or operating fluids are heated up, explosive vapours can be produced which are hazardous to health.
- Observe the information in the material safety data sheet.

CAUTION

Water and contamination in the cartridge group
If water or contamination penetrates the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.
- Place the cartridge group on suitable supports (01) made of wood or metal.
- Observe dimension (B) for the supports (01) so that the cartridge group is not immersed too deeply.
- Let the layers of contamination on the turbine soak for four hours.

Removing dirt

WARNING

Health hazard due to soot particles
If soot particles enter the eyes or respiratory tract, this can be harmful to health.
- Avoid the formation of dust.
- Vacuum up dust with a suitable vacuum cleaner.
- Wear a respiratory mask to protect against particles (P1 or P2 mask).
- Wear safety goggles.

Wear safety goggles.

Wear a respiratory mask to protect against dusts.

Wear safety gloves to protect against mechanical hazards.
- Lift up the cartridge group and align it horizontally.
- Remove dirt manually using a soft brush or a wire brush.
CAUTION

Water and dirt in the cartridge group
If water or dirt enters the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.

- Make sure that no water or dirt enters the gap between partition wall and turbine.

CAUTION

Non-permissible rotor unbalance after cleaning
Unevenly distributed residual contamination deposits lead to rotor unbalance. This can result in bearing or turbocharger damage.

- Remove all traces of contamination from the turbine.

- After brushing off the dirt, fill the container (02) with clean water and not with salt water.
- Immerse the turbine of the cartridge group in clean water so that any loose dirt comes off.
- Lift up the cartridge group and align it horizontally.
- Clamp the partition wall to the bearing casing.
- Dry the turbine and the gap between the turbine and the partition wall with low-pressure compressed air.
- Lightly spray the turbine and the gap between the turbine and the partition wall with penetrating oil.
- Dispose of dirty water and cleaning agents in accordance with the information in the material safety data sheet.
7 Eliminating malfunctions

7.1 Malfunctions when starting

Delayed start-up

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Clean (see chapter Periodic maintenance work →42)</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td></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 16: Malfunctions when starting – Delayed start-up

Vibrations

<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>
<tr>
<td>Rotor unbalance</td>
<td></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>Contact enginebuilder</td>
</tr>
<tr>
<td>Vibrations from engine</td>
<td></td>
</tr>
</tbody>
</table>

Table 17: 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 18: 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 19: Malfunctions during operation – Lubricating oil pressure too low

**Speed reduces**

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Turbine and/or nozzle ring severely contaminated</td>
<td>Clean (see chapter Periodic maintenance work → 42)</td>
</tr>
<tr>
<td>Rotor components or bearing damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Engine Defects 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 20: Malfunctions during operation – Speed reduces

**Speed increases**

<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 work → 42) or contact an ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 21: 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>Insufficient air, for example, when filter silencer is blocked by contamination</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>Malfunction in the injection system</td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Cooling water volume too low</td>
</tr>
<tr>
<td></td>
<td>Inlet temperature of cooling water too high</td>
</tr>
<tr>
<td></td>
<td>Insufficient ventilation</td>
</tr>
</tbody>
</table>

Table 22: 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>Manometer display not correct</td>
</tr>
<tr>
<td></td>
<td>Supply pipe to manometer not sealed</td>
</tr>
<tr>
<td></td>
<td>Filter silencer contaminated, therefore pressure drop too high</td>
</tr>
<tr>
<td></td>
<td>Compressor end and/or turbine end contaminated</td>
</tr>
<tr>
<td></td>
<td>Compressor/turbine damaged</td>
</tr>
<tr>
<td></td>
<td>Exhaust gas back pressure too high</td>
</tr>
<tr>
<td>Engine</td>
<td>Air receiver not sealed</td>
</tr>
<tr>
<td></td>
<td>Gas piping between engine and turbine leaking</td>
</tr>
<tr>
<td></td>
<td>Injection mistimed</td>
</tr>
<tr>
<td></td>
<td>Valve control misadjusted</td>
</tr>
<tr>
<td>Pipes</td>
<td>Pipes downstream to the compressor outlet not sealed.</td>
</tr>
</tbody>
</table>

Table 23: Malfunctions during operation – Charge air pressure too low
### Charge air pressure too high

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>Increased speed due to contamination of nozzle ring</td>
<td></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>Injection mistimed</td>
<td>Set correctly</td>
</tr>
<tr>
<td>Engine performance higher than indicated</td>
<td>Check engine performance</td>
</tr>
</tbody>
</table>

Table 24: Malfunctions during operation – Charge air pressure too high

### Reduced compressor performance/efficiency and therefore engine performance losses

⚠️ **CAUTION**

**Compressor damage**

A severely contaminated or corroded compressor wheel can reduce the compressor wheel’s fatigue endurance limit and result in the turbocharger being damaged.

- Rectify malfunction in accordance with the following table.

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger Compressor components severely contaminated by the ventilation gases that have been fed in</td>
<td>Clean (see chapter Periodic maintenance work →42)</td>
</tr>
<tr>
<td></td>
<td>Optimize oil separation</td>
</tr>
<tr>
<td>Increased blade vibration, compressor blade damage due to the ventilation gases that have been fed in</td>
<td>Correct the feed of ventilation gases according to instructions of enginebuilder.</td>
</tr>
<tr>
<td>Material of the compressor wheel corroded due to the feeding in of ventilation gases containing corrosive components</td>
<td>Correct the feed of ventilation gases according to instructions of enginebuilder.</td>
</tr>
<tr>
<td>Material of the compressor wheel corroded due to intake air containing exhaust gases or salt</td>
<td>Prevent exhaust gas leakages in the engine space</td>
</tr>
<tr>
<td></td>
<td>Clean (see chapter Periodic maintenance work →42)</td>
</tr>
</tbody>
</table>

Table 25: Malfunctions during operation – Engine performance losses
### 7.3 Turbocharger is surging

#### WARNING
**Hot air escapes from the filter silencer**

A surge blow is accompanied by a loud bang and escape of hot air from the filter silencer. This may result in injury to personnel.

- Keep a distance from the filter silencer while the turbocharger is surging.

#### Turbocharger surges continuously or periodically

#### 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.

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Filter silencer or diffuser contaminated Clean (see chapter Periodic maintenance work →42)</td>
</tr>
<tr>
<td></td>
<td>Heavy contamination deposits in the turbine or in the nozzle ring Clean/replace</td>
</tr>
<tr>
<td>Engine</td>
<td>Protective grating in front of the turbocharger contaminated or damaged Clean/replace</td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated Clean</td>
</tr>
<tr>
<td></td>
<td>Charge air duct blocked</td>
</tr>
</tbody>
</table>

Table 26: Malfunction – Turbocharger pumping

### Sporadic surge blows

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Engine load reduced 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.</td>
</tr>
</tbody>
</table>

Table 27: Malfunction – Sporadic surge blows
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 (see chapter Periodic maintenance work →42)</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td></td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Check clearances (see chapter Measuring clearance A and B →83). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td>Check clearances (see chapter Radial clearances N and R). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td>Foreign object in the turbocharger</td>
<td>Dismantle turbocharger (see chapter Fitting and dismantling). In case of damage, replace the corresponding parts or contact an ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>

Table 28: Malfunctions when stopping – Runout noises

Runout time too short

The runout time must be noted down as a reference. Because the runout time depends on the oil viscosity, the runout time must always be measured at the same oil temperature.

If the runout time is significantly shorter in comparison to a previous measurement, the following table must be observed.

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Clean (see chapter Periodic maintenance work →42)</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td></td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Check clearances (see chapter Measuring clearance A and B →83). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td>Check clearances (see chapter Radial clearances N and R). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td>Foreign object in the turbocharger</td>
<td>Dismantle turbocharger (see chapter Fitting and dismantling). In case of damage, replace the corresponding parts or contact an ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>

Table 29: Malfunctions when stopping – Runout time too short
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>The screw plug for the sensor is fitted with an additional gasket (copper ring).</td>
<td></td>
</tr>
<tr>
<td>An enlarged distance between the sensor tip and the signal-emitting sealing disc reduces the voltage amplitude of the speed signal.</td>
<td></td>
</tr>
<tr>
<td>For information regarding the disassembly and assembly of the speed sensor, refer to chapter Replacing the speed sensor → 32.</td>
<td></td>
</tr>
<tr>
<td>Install the speed sensor without the additional gasket (copper ring).</td>
<td></td>
</tr>
<tr>
<td>Sensor or cable defective</td>
<td>Contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td>Order new speed sensor (86505) (refer to chapter Ordering spare parts → 106).</td>
<td></td>
</tr>
<tr>
<td>Replacing the speed sensor → 32.</td>
<td></td>
</tr>
</tbody>
</table>

Table 30: Malfunction of the speed measurement system – No 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 metallic particles. This reduces the distance to the signal-emitting sealing disc, which can lead to amplification of the noise component and, hence, to false triggering.</td>
</tr>
<tr>
<td>For information regarding the disassembly and assembly of the speed sensor, refer to chapter Replacing the speed sensor → 32.</td>
<td></td>
</tr>
<tr>
<td>Dismantle the sensor, clean the sensor tip, and fit the sensor back on with the specified tightening torque.</td>
<td></td>
</tr>
</tbody>
</table>

Table 31: Malfunction of the speed measurement system – 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>
<tr>
<td>Table 32: Malfunction of the speed measurement system – Measured speed too low</td>
<td></td>
</tr>
</tbody>
</table>

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

8.1 Introduction

The precondition for the work described in the following is a turbocharger removed from the engine (see chapter Removal and installation).

**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.

**WARNING**

Cutting injuries when working on the turbocharger

Some parts on the turbocharger may have sharp edges. There is a risk of a cutting injury.

- Wear safety gloves against mechanical risks when conducting assembly and disassembly work.

Wear safety gloves to protect against mechanical hazards.

**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 →106](#)).

Oil orifice

- When disassembling the turbocharger, an oil orifice fitted in the oil inlet must not be removed (see also chapter Removing the cartridge group).

Tightening torques for components of the turbocharger

The specified tightening torques of the screw fittings must be observed (Table of tightening torques →97).

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.

Swivel lifting eyes to be used

Two swivel lifting eyes are required for the safe lifting of loads, these are not supplied by ABB Turbo Systems.

![Swivel lifting eyes](image)

**Table 33: Swivel lifting eyes**

<table>
<thead>
<tr>
<th>Product</th>
<th>Thread M</th>
<th>Length L [mm]</th>
<th>Minimum load limit [kg]</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M10</td>
<td>17 mm</td>
<td>100 kg</td>
<td>2</td>
</tr>
<tr>
<td>A135</td>
<td>M10</td>
<td>17 mm</td>
<td>150 kg</td>
<td>2</td>
</tr>
<tr>
<td>A140</td>
<td>M12</td>
<td>21 mm</td>
<td>250 kg</td>
<td>2</td>
</tr>
<tr>
<td>A145</td>
<td>M12</td>
<td>21 mm</td>
<td>300 kg</td>
<td>2</td>
</tr>
</tbody>
</table>

Ring nuts to be used

Two ring nuts (M16) are required for safer lifting of the cartridge group, which are not included in the ABB Turbo Systems scope of delivery.

![Ring nut](image)
8.2 Weights of individual parts

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

Fig. 32: Weights of assemblies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Filter silencer</td>
<td>19</td>
<td>30</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>02 Radial air suction branch</td>
<td>6</td>
<td>8</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>03 Axial air suction branch</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>04 Compressor casing</td>
<td>24</td>
<td>40</td>
<td>60</td>
<td>95</td>
</tr>
<tr>
<td>05 Wall insert</td>
<td>6</td>
<td>8</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>06 Diffuser</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>07 Cartridge group</td>
<td>40</td>
<td>60</td>
<td>110</td>
<td>180</td>
</tr>
<tr>
<td>08 Nozzle ring</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>09 Burst ring</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>10 Turbine casing * 1 inlet</td>
<td>50</td>
<td>75</td>
<td>135</td>
<td>210</td>
</tr>
<tr>
<td>Turbine casing * 2 inlets</td>
<td>45</td>
<td>65</td>
<td>125</td>
<td>190</td>
</tr>
<tr>
<td>Turbine casing * 3 inlets</td>
<td>-</td>
<td>-</td>
<td>125</td>
<td>190</td>
</tr>
<tr>
<td>11 Gas outlet flange</td>
<td>7</td>
<td>13</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>12 Gas outlet casing</td>
<td>30</td>
<td>35</td>
<td>65</td>
<td>120</td>
</tr>
</tbody>
</table>

* including burst protection
8.3 Removing the air inlets

Mark the casing position for assembly.

1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
2. Loosen and remove V-clamp (72020).
3. Remove filter silencer (81000) or air suction branch (82000), set it down properly in an appropriate place and secure it.
4. Remove and dispose of the O-ring (81010 / 82010).
8.4 Removing the gas outlet casing

Removing the insulation

Fig. 34: Removing the insulation

- Remove gas outlet casing insulation.
Mark the casing position for assembly.

Fig. 35: Removing the gas outlet casing

1. Attach lifting gear to the gas outlet casing (61001).
2. Loosen and remove nuts (51009).
3. If present: Detach support (61301) from bracket.
4. Remove the gas outlet casing (61001), set it down properly in an appropriate place and secure it.
5. Remove and dispose of the gasket (61002).

8.5 Removing the gas outlet flange

Depending on the way of fixing the gas outlet flange, the appropriate Working Instruction has to be consulted (pressing off using 3 or 6 press-off screws).

If the following Working Instructions are not observed, this can lead to cracks in the gas outlet casing.

The following variants are possible:

- Pressing off using 3 press-off screws.
- Pressing off using 6 press-off screws.
Gas outlet flange with 3 press-off screws

**CAUTION**
Cracks in the gas outlet casing
Non-observance of the action steps described can lead to inadmissible cracks on the gas outlet flange.
- Observe the maximum tightening torques when pressing off.
- Follow the action steps described.

Only dismantle the gas outlet flange if this is necessary for service work.
- If necessary: Treat the centering seat with rust remover through the press-off threads and the clearance holes.
- Mark the casing position for assembly.

![Diagram of gas outlet flange]

**Fig. 36: Dismantling the gas outlet flange**

<table>
<thead>
<tr>
<th>Product</th>
<th>Press-off screws (strength 8.8) *</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>3 x M 8 x 20</td>
<td>≤ 20 Nm</td>
</tr>
<tr>
<td>A135</td>
<td>3 x M10 x 25</td>
<td>≤ 40 Nm</td>
</tr>
<tr>
<td>A140</td>
<td>3 x M12 x 30</td>
<td>≤ 65 Nm</td>
</tr>
<tr>
<td>A145</td>
<td>3 x M12 x 30</td>
<td>≤ 65 Nm</td>
</tr>
</tbody>
</table>

Table 35: 3 press-off screws

* not included in the ABB Turbo Systems scope of delivery

1. Press off and remove the gas outlet flange (57002) with screws (01) according to the table. If it is not possible to press off the gas outlet flange with the maximum tightening torque, contact an ABB Turbo Systems Service Station.

2. If present: Remove the C-ring (57003).
Gas outlet flange with 6 press-off screws

⚠️ CAUTION

Cracks in the gas outlet casing
Non-observance of the action steps described can lead to inadmissible cracks on the gas outlet flange.
- Observe the maximum tightening torques when pressing off.
- Follow the action steps described.

Only dismantle the gas outlet flange if this is necessary for service work.
- If necessary: Treat the centering seat with rust remover through the press-off threads and the clearance holes.
- Mark the casing position for assembly.

Table 36: 6 press-off screws

<table>
<thead>
<tr>
<th>Product</th>
<th>Press-off screws (strength 8.8) *</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>6x M6 x 20</td>
<td>≤ 10 Nm</td>
</tr>
<tr>
<td>A135</td>
<td>6x M8 x 25</td>
<td>≤ 20 Nm</td>
</tr>
<tr>
<td>A140</td>
<td>6x M10 x 30</td>
<td>≤ 40 Nm</td>
</tr>
<tr>
<td>A145</td>
<td>6x M12 x 30</td>
<td>≤ 65 Nm</td>
</tr>
</tbody>
</table>

* not included in the ABB Turbo Systems scope of delivery.

1. Evenly press off and remove the gas outlet flange (57002) with screws (01) according to the table. If it is not possible to press off the gas outlet flange with the maximum tightening torque, contact an ABB Turbo Systems Service Station.

2. If present: Remove the C-ring (57003).
8.6 Removing the compressor casing

Removing the compressor casing

Mark the casing position for assembly.

1. Loosen screws (72011) and remove together with fastening strips (72012).
2. Attach swivel lifting eye (S) to the compressor casing and the lifting gear.
3. Remove the compressor casing (72000) and turn it 180°.
4. Remove and dispose of the O-ring (42012).
5. Undo screws (79041) and remove from the compressor casing (72000) with fixing discs (79040) and diffuser (79000).

If the compressor casing cannot be loosened, it can be pressed off against the turbine casing using the press-off tool (90042) (see chapter Pressing off the casing →78).
**Dismantling the wall insert**

1. Knock the wall insert (77000) out of the compressor casing (72000) with a plastic tip hammer.
2. Attach swivel lifting eye (S) to the compressor casing (72000) and the lifting gear.
3. Lift up the compressor casing (72000).
4. Remove and dispose of the O-ring (77005).
8.7 Pressing off the casing

⚠️ CAUTION

Axial force of the press-off tool

Using the press-off tool (90042), a high level of axial force can be generated. If the casing is pressed off with too much force on one side, the rotor can be damaged.

- Use the tool on both sides in alternation and make sure not to press off too hard on either side.

![Diagram showing press-off tool and casing](image)

Fig. 40: Press off the casing
8.8 Removing the cartridge group

Fig. 41: Removing insulation sheets

- If present: Remove the insulation sheets (01, 02, 03).
- Mark the casing position for assembly.

Do not remove oil orifice (if present)

To limit the oil flow rate through the bearing casing during operation (engine under load) to the admissible values, an oil orifice is mandatory at the oil inlet of the bearing casing if the oil inlet pressure is > 3 bar (overpressure).

If an oil orifice is fitted in the oil inlet of the bearing casing, it must not be removed.

Fig. 42: Oil orifice

01 Bearing casing
02 Oil orifice
03 Circlip
8. Dismantling and fitting / 8.8 Removing the cartridge group

1. Treat threads of studs (51006) with penetrating oil and leave to take effect.
2. Undo nuts (51007) and remove Verbus Ripp® washers (51003) together with fastening strips (51002).

3. Insert screws from service support into cartridge group.
4. Secure ring nuts (VRM) onto the screws with washers.
5. Secure the lifting gear to the ring nuts and suspension eye as shown.
6. Remove the cartridge group vertically from the turbine casing.
7. Turn the cartridge group into the horizontal rotor axis.

If the cartridge group cannot be loosened, the press-off tool (90042) can be used (see chapter Pressing off the casing → 78).
8.9 Removing the nozzle ring

1. If present: Remove the metal C-ring (51105).
2. Position the fastening strips (51002) in place.
3. Pull out the nozzle ring (56001) with the two extraction devices (90070) and the service support base (90012).
4. Remove the lamellar sealing ring (56005).
5. Remove the burst ring (57210).

Fig. 45: Removing the nozzle ring
8.10 Installing the cartridge group on the service support

1. Remove ring nuts (VRM).
2. Remove service support screws.
3. Fit service support (90012) according to the illustration.
4. Insert the cartridge group.
5. Fit the nuts.

Fig. 46: Installing the cartridge group on the service support
8.11 Measuring clearance A and B

- Measure and record clearances A and B after the removal and before the installation of the cartridge group.
- Attach the dial indicator and align it for the respective clearance as per the illustration.

![Diagram of measuring clearance A and B](image)

### Table 37: Permissible clearances A and B

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130-M</td>
<td>0.08 ... 0.16</td>
<td>0.47 ... 1.00</td>
</tr>
<tr>
<td>A135-M</td>
<td>0.10 ... 0.18</td>
<td>0.58 ... 1.16</td>
</tr>
<tr>
<td>A140-M</td>
<td>0.12 ... 0.21</td>
<td>0.70 ... 1.37</td>
</tr>
<tr>
<td>A145-M</td>
<td>0.15 ... 0.25</td>
<td>0.88 ... 1.56</td>
</tr>
</tbody>
</table>

1. Move the rotor to and fro up to the stop. In order to obtain a correct measurement, elevate the turbine a little.
2. Measure clearance A and compare it with the permissible values in the table.
3. Raise the compressor and push the turbine down at the same time.
4. Raise the turbine and push the compressor down at the same time.
5. Measure clearance B and compare it with the permissible values in the table.

⚠️ 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.
8.12 Nozzle ring compression PD

In order for the nozzle ring (56001) to be fixed during operation, it must be clamped between the heat shield (42400) and the turbine casing (51000).

1. Measure dimensions A, B and S on cleaned surfaces.
2. Calculate compression (PD).

If the calculated value (PD) lies outside the specified range, contact an ABB Turbocharging Service Station.

Table 38: Nozzle ring compression PD

<table>
<thead>
<tr>
<th>Product</th>
<th>Nozzle ring compression PD [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130-M</td>
<td>-0.15 ... 0.15</td>
</tr>
<tr>
<td>A135-M</td>
<td>-0.16 ... 0.16</td>
</tr>
<tr>
<td>A140-M</td>
<td>-0.16 ... 0.16</td>
</tr>
<tr>
<td>A145-M</td>
<td>-0.16 ... 0.16</td>
</tr>
</tbody>
</table>

Fig. 48: Nozzle ring compression PD
8.13 Installing the nozzle ring

*) Variant A1 or A2, depending on the nozzle ring version.

1. Fit the lamellar sealing ring (56005) in the correct slot (see detail A1/A2). When doing this, pay attention to correct winding of the lamellar sealing ring (see detail B).

2. Secure the lamellar sealing ring (56005) with adhesive tape (01).

3. Place the burst ring (57210) in the turbine casing.

4. Insert the nozzle ring (56001) (with the cams facing downwards) into the turbine casing as far as it will go. Align the cams on the nozzle ring with the recesses of the turbine casing (51000). Do not remove the adhesive tape (01).

5. If present: Fit the metal C-ring (51105).
8.14 Installing the cartridge group

Lifting the cartridge group and rotating it by 90°

1. Loosen and remove nuts.
2. Lift the cartridge group out of the service support (90012).
3. Insert the screws of the service support from above and fit ring nuts (VRM) with washers.
4. Attach lifting gear to the ring nuts (VRM).
5. Lift cartridge group at the side of the ring nuts (VRM) and turn it into a vertical position.

Installing the cartridge group

Fig. 50: Lifting the cartridge group and rotating it by 90°

Fig. 51: Installing the cartridge group
8 Dismantling and fitting / 8.14 Installing the cartridge group

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M8</td>
<td>25</td>
</tr>
<tr>
<td>A135</td>
<td>M10</td>
<td>45</td>
</tr>
<tr>
<td>A140</td>
<td>M12</td>
<td>75</td>
</tr>
<tr>
<td>A145</td>
<td>M12</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 39: Tightening torque (51007)

1. Coat thread of studs (51006) with high-temperature grease.
2. Align the casing position of the cartridge group to the marking.
3. Lower the cartridge group into the turbine casing.
4. Remove ring nuts and screws.
5. Fit fastening strips (51002) with Verbus Ripp® washers (51003) and hexagon nuts (51007).
6. Tighten the hexagon nuts (51007).
WARNING

The turbine casing insulation supplied by ABB Turbo Systems also acts as burst protection

Serious injuries or accidents resulting in fatalities can occur if the turbine casing insulation (01) supplied by ABB Turbo Systems is removed. A burst protection is integrated into this turbine casing insulation supplied by ABB Turbo Systems.

For turbochargers which were ordered from ABB Turbo Systems without insulation or which are equipped with the insulation (02), separate burst protection (03) is fitted.

If the insulation from ABB Turbo Systems (01) is not installed, the separate burst protection (03) plus either the insulation (02) or an appropriate insulation supplied by the enginebuilder must be installed for operation.

► Never operate a turbocharger without burst protection and insulation.

Fig. 52: Turbine casing insulation / Burst protection
8.15 Installing the compressor casing

Fitting the wall insert and the diffuser

Always replace the O-ring (77005) (see section Spare parts).

**A130 - A140**
1. Fit new O-ring (77005).
2. Install the wall insert (77000) in the compressor casing.
3. Fit diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

**A145**
1. Fit the lifting beam (90258) to the wall insert (77000).
2. Fit the swivel lifting eye (S) to the lifting beam. Secure lifting gear to the swivel lifting eye.
3. Fit new O-ring (77005).
4. Install the wall insert (77000) in the compressor casing.
5. Fit diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>A135</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>A140</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>A145</td>
<td>M6</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 40: Tightening torque (79041)

© Copyright 2019 ABB. All rights reserved.
Installing the compressor casing

1. Fit new O-ring (42012).
2. Thoroughly clean the fastening strips (72012) before assembly.
3. Attach swivel lifting eyes (S) to compressor casing (72000). Secure lifting gear to the swivel lifting eyes.
4. Install the compressor casing (72000).
5. Install the fastening strips (72012) with screws (72011). Observe the tightening torque. If these screws do not have a Verbus Ripp® integrated, Verbus Ripp® washers (72010) must also be fitted.

Fig. 53: Installing the compressor casing

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M8</td>
<td>35</td>
</tr>
<tr>
<td>A135</td>
<td>M10</td>
<td>70</td>
</tr>
<tr>
<td>A140</td>
<td>M12</td>
<td>105</td>
</tr>
<tr>
<td>A145</td>
<td>M14</td>
<td>170</td>
</tr>
</tbody>
</table>

Table 41: Tightening torque (72011)
8.16 Measuring radial clearances N and R

1. Push the feeler gauges (01) into the gap without clearance simultaneously at the top (N1) and the bottom (N2).

2. Calculate clearance N and compare it with the permissible values in the table.

3. Push the feeler gauges (01) into the gap without clearance simultaneously at the top (R2) and the bottom (R1).

4. Calculate clearance R and compare it with the permissible values in the table.

**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.
8.17 Installing the air inlets

Fig. 55: Installing the air inlets

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M12</td>
<td>60</td>
</tr>
<tr>
<td>A135</td>
<td>M12</td>
<td>60</td>
</tr>
<tr>
<td>A140</td>
<td>M12</td>
<td>60</td>
</tr>
<tr>
<td>A145</td>
<td>M12</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 43: Tightening torque (72020)

1. Secure lifting gear to filter silencer (81000).
2. Fit a new O-ring (81010) to the filter silencer (81000) or a new O-ring (82010) to the air suction branch (82000).
3. Fit the filter silencer (81000) or air suction branch (82000) with the V-clamp (72020).
4. Observe the tightening torque.
8.18 Installing the gas outlet flange

1. If present: Insert the metal C-ring (57003) into the turbine casing (51000) and secure with high-vacuum grease.

2. Install the gas outlet flange (57002) in the turbine casing.

3. Measure radial clearance (R) (see chapter Radial clearances N and R).

Fig. 56: Installing the gas outlet flange
8.19 Fitting the insulation of the turbine casing

Fig. 57: Fitting the insulation

Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →97).
8.20 Installing the gas outlet casing

Fig. 58: Installing the gas outlet casing

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>M8</td>
<td>20</td>
</tr>
<tr>
<td>A135</td>
<td>M10</td>
<td>40</td>
</tr>
<tr>
<td>A140</td>
<td>M12</td>
<td>65</td>
</tr>
<tr>
<td>A145</td>
<td>M12</td>
<td>65</td>
</tr>
</tbody>
</table>

Table 44: Tightening torque (51009)

1. Insert a new gasket (61002) into the gas outlet casing (61001).
2. Coat the threads of the studs (51008) with high-temperature grease.
3. Attach the lifting gear to the gas outlet casing (61001) and position the gas outlet casing in the correct position on the turbine casing (51000).
4. If present: Fit support (61301).
5. Fit hexagon nuts (51009). Observe the tightening torque.
Fitting the insulation

Fig. 59: Fitting the insulation

- Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →97).

© Copyright 2019 ABB. All rights reserved.

Page 96 / 113
### 8.21 Table of tightening torques

The following tightening torques must be observed for the specified screw connections:

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>A130</th>
<th>A135</th>
<th>A140</th>
<th>A145</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>72020</td>
<td>M12 60 Nm</td>
<td>M12 60 Nm</td>
<td>M12 60 Nm</td>
<td>M12 60 Nm</td>
</tr>
<tr>
<td>04</td>
<td>79041</td>
<td>M6 8 Nm</td>
<td>M6 8 Nm</td>
<td>M6 8 Nm</td>
<td>M6 8 Nm</td>
</tr>
<tr>
<td>08</td>
<td>51007</td>
<td>M8 25 Nm</td>
<td>M10 45 Nm</td>
<td>M12 75 Nm</td>
<td>M12 75 Nm</td>
</tr>
<tr>
<td>09</td>
<td>51009</td>
<td>M8 20 Nm</td>
<td>M10 40 Nm</td>
<td>M12 65 Nm</td>
<td>M12 65 Nm</td>
</tr>
<tr>
<td>11</td>
<td>72011</td>
<td>M8 35 Nm</td>
<td>M10 70 Nm</td>
<td>M12 105 Nm</td>
<td>M14 170 Nm</td>
</tr>
<tr>
<td>15</td>
<td>86505</td>
<td>M12 x 1.5 15 Nm</td>
<td>M12 x 1.5 15 Nm</td>
<td>M12 x 1.5 15 Nm</td>
<td>M12 x 1.5 15 Nm</td>
</tr>
<tr>
<td>16a *)</td>
<td>- -</td>
<td>M10 40 Nm</td>
<td>M10 40 Nm</td>
<td>M12 65 Nm</td>
<td>M12 65 Nm</td>
</tr>
</tbody>
</table>

*) With the variant "insulation with integrated burst protection", this position can be ignored.
The following tightening torques must be observed for the specified screw connections:

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>A130</th>
<th>A135</th>
<th>A140</th>
<th>A145</th>
</tr>
</thead>
<tbody>
<tr>
<td>16a / 16b</td>
<td>- -</td>
<td>M10 40 Nm</td>
<td>M10 40 Nm</td>
<td>M12 65 Nm</td>
<td>M12 65 Nm</td>
</tr>
<tr>
<td>16b 2)</td>
<td>- -</td>
<td>M8 20 Nm</td>
<td>M8 20 Nm</td>
<td>M10 40 Nm</td>
<td>M10 40 Nm</td>
</tr>
<tr>
<td>18</td>
<td>- -</td>
<td>M6 10 Nm</td>
<td>M6 10 Nm</td>
<td>M6 10 Nm</td>
<td>M6 10 Nm</td>
</tr>
<tr>
<td>19</td>
<td>- -</td>
<td>M8 25 Nm</td>
<td>M8 25 Nm</td>
<td>M8 25 Nm</td>
<td>M8 25 Nm</td>
</tr>
<tr>
<td>20</td>
<td>- -</td>
<td>M10 45 Nm</td>
<td>M10 45 Nm</td>
<td>M10 45 Nm</td>
<td>M10 45 Nm</td>
</tr>
</tbody>
</table>

Table 46: Tightening torques for insulation

1) Tightening torque for attaching the insulation with integrated burst protection at the turbine casing

2) Tightening torque for attaching the insulation to the burst protection.
9 Taking out of operation at short notice

9.1 Possible emergency repairs

⚠️ 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.

🛡️ CAUTION

Directives for taking out of operation

Serious damage to engine or property can be caused by non-compliance with the directives for blanking the turbocharger off the engine.

- Follow the directives of the enginebuilder.

If the engine has to be operated again as quickly as possible following a turbocharger defect, then the following options are available for emergency repairs:

- If present: Installing the replacement turbocharger →100.
- If present: Installing the replacement cartridge group →100.
- If a replacement turbocharger or cartridge group is not available: Fit cover plate →101 and contact an ABB Turbocharging Service Station.
- Observe the following sections in connection with the emergency repairs mentioned.
9.2 Installing the replacement turbocharger

To enable you to quickly put an engine back into operation after a turbocharger has sustained damage, ABB Turbo Systems recommends having a replacement turbocharger or appropriate spare parts available in storage. The defective turbocharger can be removed and the replacement turbocharger installed within a short period of time.

- Remove defective turbocharger (see chapter Removing and Installing →8).
- Install replacement turbocharger (see chapter Removing and Installing →8).
- Send the defective turbocharger to an ABB Turbocharging Service Station for inspection and repair.

9.3 Installing the replacement cartridge group

![WARNING]

Incorrect handling of a cartridge group

Incorrect handling of a cartridge group can damage the turbocharger and cause injuries to persons.

- Have repairs to the cartridge group carried out by an ABB Turbocharging Service Station only.

To enable you to quickly put an engine back into operation after a turbocharger has sustained damage, ABB Turbo Systems recommends having a replacement cartridge group available in storage. The defective cartridge group can be removed and the replacement cartridge group installed within a short period of time. A replacement cartridge group is ready for use immediately and includes the complete bearing casing with bearing and a balanced rotor.

The repair of a cartridge group requires special tools and the expertise of an ABB Turbocharging Service Station. The rotating parts rotate extremely fast, and are sensitive to unbalance.

- Remove defective cartridge group (see chapter Dismantling and fitting →67).
- Install replacement cartridge group (see chapter Dismantling and fitting →67).
- Send the defective cartridge group to an ABB Turbocharging Service Station for inspection and repair.
9.4  Fitting the cover plate

- Remove turbocharger (see chapter Removing and Installing → 8).

- **Gas outlet casing removed**
  - Fit the turbine casing with the gas outlet casing into the gas pipe again.
  - Attach the cover plate (see following section).

- **Gas outlet casing not removed**
  - Fit the turbine casing into the gas pipe and on the gas outlet casing again.
  - Attach the cover plate (see following section).

![Diagram](image)

Fig. 62: Fitting the cover plate

- Make sure that the oil connections in the bracket are equipped with gaskets.
  1. Close opening in turbine casing (51000) with cover plate (01).
  2. Thoroughly clean the fastening strips (51002) before assembly.
  3. Coat the threads of the studs (51006) with high-temperature grease.
  4. Fasten cover plate (01) to turbine casing (51000) with fastening strips (51002), Verbus Ripp® washers (51003) and nuts (51007) and screw to bracket.
9.5 Cover plate drawing

The cover plate is not included in the ABB Turbo Systems scope of delivery and must be manufactured by the operating company according to the following drawing.


Fig. 63: Cover plate drawing

<table>
<thead>
<tr>
<th>Product</th>
<th>B1 ± 0.5</th>
<th>B2</th>
<th>B3</th>
<th>B4 ± 0.2</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>ØD1 ± 0.2</th>
<th>ØD2</th>
<th>R1</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>A130</td>
<td>65.7</td>
<td>60</td>
<td>130</td>
<td>11.7</td>
<td>1.4</td>
<td>150</td>
<td>35.7</td>
<td>227.7</td>
<td>17</td>
<td>≤105</td>
<td>M8</td>
</tr>
<tr>
<td>A135</td>
<td>79.6</td>
<td>80</td>
<td>155</td>
<td>14.2</td>
<td>1.6</td>
<td>180</td>
<td>39.6</td>
<td>271.7</td>
<td>21</td>
<td>≤125</td>
<td>M8</td>
</tr>
<tr>
<td>A140</td>
<td>98.2</td>
<td>102</td>
<td>190</td>
<td>17.2</td>
<td>2.0</td>
<td>220</td>
<td>48.2</td>
<td>332.5</td>
<td>25</td>
<td>≤153</td>
<td>M10</td>
</tr>
<tr>
<td>A145</td>
<td>116.8</td>
<td>120</td>
<td>226</td>
<td>20.5</td>
<td>2.4</td>
<td>260</td>
<td>56.8</td>
<td>395.9</td>
<td>31</td>
<td>≤182</td>
<td>M10</td>
</tr>
</tbody>
</table>

Table 47: Cover plate dimensions [mm]
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.

© Copyright 2019 ABB. All rights reserved.
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 →103, 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:
- Turbocharger type
- Serial number of the turbocharger
- 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.

12.2 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 in 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>61002 *</td>
<td>Gasket</td>
<td>1</td>
</tr>
<tr>
<td>77005</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>79041</td>
<td>Counter-sunk screw</td>
<td>2</td>
</tr>
<tr>
<td>81010/ 82010</td>
<td>O-ring</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 48: Customer spare part set 97070

* This gasket can only be installed when a gas outlet casing from ABB Turbo Systems is used.
12.3 View of turbocharger with part numbers

Fig. 64: Overview of part numbers

(......) only available in customer spare part set (97070).
Table 49: Spare parts list

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>10900</td>
<td>Cartridge group</td>
</tr>
<tr>
<td>42008</td>
<td>Socket screw</td>
</tr>
<tr>
<td>42012</td>
<td>O-ring</td>
</tr>
<tr>
<td>42201*</td>
<td>Clamping nut</td>
</tr>
<tr>
<td>51000</td>
<td>Turbine casing</td>
</tr>
<tr>
<td>51002</td>
<td>Fastening strip</td>
</tr>
<tr>
<td>51105*</td>
<td>Metal C-ring</td>
</tr>
<tr>
<td>51500</td>
<td>Burst protection</td>
</tr>
<tr>
<td>56001</td>
<td>Nozzle ring</td>
</tr>
<tr>
<td>56005</td>
<td>Lamellar sealing ring</td>
</tr>
<tr>
<td>57002</td>
<td>Gas outlet flange</td>
</tr>
<tr>
<td>57003*</td>
<td>Metal C-ring</td>
</tr>
<tr>
<td>57210</td>
<td>Burst ring</td>
</tr>
<tr>
<td>61001</td>
<td>Gas outlet casing</td>
</tr>
<tr>
<td>61002</td>
<td>Gasket</td>
</tr>
<tr>
<td>61200</td>
<td>Burst protection</td>
</tr>
<tr>
<td>61205</td>
<td>Protective grid</td>
</tr>
<tr>
<td>61301*</td>
<td>Support</td>
</tr>
<tr>
<td>72000</td>
<td>Compressor casing</td>
</tr>
<tr>
<td>72011</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>72012</td>
<td>Fastening strip</td>
</tr>
<tr>
<td>72020</td>
<td>V-clamp</td>
</tr>
<tr>
<td>77000</td>
<td>Wall insert</td>
</tr>
<tr>
<td>77005</td>
<td>O-ring</td>
</tr>
<tr>
<td>79000</td>
<td>Diffuser</td>
</tr>
<tr>
<td>79041</td>
<td>Counter-sunk screw</td>
</tr>
<tr>
<td>81000</td>
<td>Filter silencer</td>
</tr>
<tr>
<td>81010</td>
<td>O-ring</td>
</tr>
<tr>
<td>82000</td>
<td>Air suction branch</td>
</tr>
<tr>
<td>82010</td>
<td>O-ring</td>
</tr>
<tr>
<td>86505*</td>
<td>Speed sensor</td>
</tr>
<tr>
<td>86515*</td>
<td>Cable connector</td>
</tr>
<tr>
<td>86526*</td>
<td>F/I converter</td>
</tr>
<tr>
<td>86528*</td>
<td>Tachometer</td>
</tr>
</tbody>
</table>

* Depending on the specification of the turbocharger
12.4  View of turbine cleaning device

12.4.1  One cleaning nozzle per turbine inlet

![Diagram of turbine cleaning device]

Fig. 65: Overview of part numbers

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>51301</td>
<td>1 inlet = 1 cleaning nozzle</td>
</tr>
<tr>
<td></td>
<td>2 inlets = 2 cleaning nozzles</td>
</tr>
<tr>
<td></td>
<td>3 inlets = 3 cleaning nozzles</td>
</tr>
<tr>
<td>51302</td>
<td>Gasket</td>
</tr>
<tr>
<td>51303</td>
<td>Screw plug</td>
</tr>
</tbody>
</table>

Table 50: Spare parts list
Figures

Fig. 1: Layout and function of the turbocharger .......................... 4
Fig. 2: Compressor wheel cooling ........................................... 5
Fig. 3: Warning plate locations ............................................... 6
Fig. 4: Locations of the rating plates ....................................... 7
Fig. 5: Suspension of complete turbocharger unit ....................... 8
Fig. 6: Turbine cleaning nozzle .............................................. 9
Fig. 7: Removing the turbocharger .......................................... 10
Fig. 8: Loosening the clamping nut ........................................ 12
Fig. 9: Turbocharger centre of gravity .................................... 13
Fig. 10: Inserting gaskets into the bracket ............................... 14
Fig. 11: Inserting the threaded rods ...................................... 15
Fig. 12: Requirements for threaded rods ................................. 15
Fig. 13: Placing the turbocharger on the bracket ..................... 16
Fig. 14: Preparing the clamping nut for the tightening procedure .................................................. 18
Fig. 15: Tightening pressure screws ...................................... 19
Fig. 16: Connecting the speed sensor .................................... 20
Fig. 17: Connecting the compressor cooling air intake ................ 20
Fig. 18: Attaching the support ............................................. 21
Fig. 19: Oil orifice .......................................................... 23
Fig. 20: Layout and overview of speed measurement system ........ 30
Fig. 21: Replacing the speed sensor ...................................... 32
Fig. 22: Noise insulation, bellows ....................................... 34
Fig. 23: Replacing the protective grid .................................... 37
Fig. 24: Carrying out wet cleaning of compressor .................... 45
Fig. 25: Carrying out wet cleaning of turbine .......................... 49
Fig. 26: Cleaning the filter silencer ....................................... 51
Fig. 27: Compressor-end, non-rotating parts ......................... 53
Fig. 28: Turbine end, non-rotating parts ................................. 55
Fig. 29: Soaking the turbine end .......................................... 57
Fig. 30: Swivel lifting eyes ............................................... 69
Fig. 31: Starpoint ring nut VRM ......................................... 69
Fig. 32: Weights of assemblies ............................................ 70

Fig. 33: Removing the air inlets ........................................... 71
Fig. 34: Removing the insulation .......................................... 72
Fig. 35: Removing the gas outlet casing ............................... 73
Fig. 36: Dismantling the gas outlet flange ......................... 74
Fig. 37: Removing the gas outlet flange ............................ 75
Fig. 38: Removing the compressor casing ......................... 76
Fig. 39: Dismantling the wall insert .................................... 77
Fig. 40: Press off the casing ............................................. 78
Fig. 41: Removing insulation sheets .................................... 79
Fig. 42: Oil orifice .......................................................... 79
Fig. 43: Removing cartridge group 1 ................................. 80
Fig. 44: Removing cartridge group 2 ................................. 80
Fig. 45: Removing the nozzle ring ..................................... 81
Fig. 46: Installing the cartridge group on the service support .................................................. 82
Fig. 47: Measuring clearance A and B ................................ 83
Fig. 48: Nozzle ring compression PD ................................. 84
Fig. 49: Installing the nozzle ring ...................................... 85
Fig. 50: Lifting the cartridge group and rotating it by 90° .................. 86
Fig. 51: Installing the cartridge group .................................. 86
Fig. 52: Turbine casing insulation / Burst protection .................. 88
Fig. 53: Installing the compressor casing ............................ 90
Fig. 54: Measuring clearances N and R .............................. 91
Fig. 55: Installing the air inlets .......................................... 92
Fig. 56: Installing the gas outlet flange ............................. 93
Fig. 57: Fitting the insulation ........................................... 94
Fig. 58: Installing the gas outlet casing .......................... 95
Fig. 59: Fitting the insulation ............................................ 96
Fig. 60: Tightening torques ............................................. 97
Fig. 61: Tightening torques for insulation ......................... 98
Fig. 62: Fitting the cover plate ....................................... 101
Fig. 63: Cover plate drawing ....................................... 102
Fig. 64: Overview of part numbers .................................. 108
Fig. 65: Overview of part numbers.......................... 110
Tables

Table 1: Related documents ........................................ 3
Table 2: Weight of complete turbocharger unit .......... 8
Table 3: Requirements for threaded rods .......... 15
Table 4: Tightening torque for standard nuts .......... 17
Table 5: Torque-controlled tightening of the pressure screws ........................................ 19
Table 6: Lubricating oil pressure at oil inlet before turbocharger ........................................ 27
Table 7: Lubricating oil temperature at the inlet .... 28
Table 8: Lubricating oil temperature at the outlet .... 28
Table 9: Tightening torque (86505) ......................... 32
Table 10: Expected replacement intervals .......... 39
Table 11: Maintenance table ................................ 42
Table 12: Parameters for wet cleaning of compressor ........................................ 45
Table 13: Turbine wet cleaning, recommended operating state ........................................ 48
Table 14: Wet cleaning of turbine, parameters ...... 49
Table 15: Value table for soaking ......................... 57
Table 16: Malfunctions when starting – Delayed start-up ........................................ 60
Table 17: Malfunctions when starting – Vibrations 60
Table 18: Malfunctions when starting – Rubbing of rotating parts ........................................ 60
Table 19: Malfunctions during operation – Lubricating oil pressure too low ........................................ 61
Table 20: Malfunctions during operation – Speed reduces ........................................ 61
Table 21: Malfunctions during operation – Speed increases ........................................ 61
Table 22: Malfunctions during operation – Exhaust gas temperature too high ........................................ 62
Table 23: Malfunctions during operation – Charge air pressure too low ........................................ 62
Table 24: Malfunctions during operation – Charge air pressure too high ........................................ 63
Table 25: Malfunctions during operation – Engine performance losses ........................................ 63
Table 26: Malfunction – Turbocharger pumping ........................................ 64
Table 27: Malfunction – Sporadic surge blows ........ 64
Table 28: Malfunctions when stopping – Runout noises ........................................ 65
Table 29: Malfunctions when stopping – Runout time too short ........................................ 65
Table 30: Malfunction of the speed measurement system – No signal or poor signal amplitude ........................................ 66
Table 31: Malfunction of the speed measurement system – Measured speed too high ........................................ 66
Table 32: Malfunction of the speed measurement system – Measured speed too low ........................................ 66
Table 33: Swivel lifting eyes .................................. 69
Table 34: Weights of assemblies .................................. 70
Table 35: 3 press-off screws .................................. 74
Table 36: 6 press-off screws .................................. 75
Table 37: Permissible clearances A and B ........ 83
Table 38: Nozzle ring compression PD ................ 84
Table 39: Tightening torque (51007) .................... 87
Table 40: Tightening torque (79041) .................... 89
Table 41: Tightening torque (72011) .................... 90
Table 42: Permissible clearances N and R .......... 91
Table 43: Tightening torque (72020) .................... 92
Table 44: Tightening torque (51009) .................... 95
Table 45: Tightening torques .................................. 97
Table 46: Tightening torques for insulation .... 98
Table 47: Cover plate dimensions [mm] .......... 102
Table 48: Customer spare part set 97070 .......... 106
Table 49: Spare parts list .................................... 109
Table 50: Spare parts list .................................... 110