# Operation Manual

**A155-M57**

**HT595251** English  
Original Operation Manual

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**ABB Turbocharging**
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

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1 Introduction

1.1 Purpose of the manual

Fig. 1: Serial number (01) on the rating plate

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

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

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

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

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

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

Symbols
The following symbols are used in this document:

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

Definition of Note

<table>
<thead>
<tr>
<th>NOTICE</th>
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<tr>
<td>Note</td>
</tr>
<tr>
<td>The note provides advice which facilitates the work.</td>
</tr>
</tbody>
</table>

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 Turbocharging
ABB Switzerland Ltd, Turbocharging is identified as ABB Turbocharging or as ABB Turbo Systems in this document.

Official service stations of ABB Turbocharging
Official service stations are regularly audited and certified by ABB Turbocharging. See also 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>
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<th>Meaning</th>
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<tr>
<td>![Tighten with specified torque]</td>
<td>Tighten with specified torque</td>
</tr>
<tr>
<td>![Tighten over specified tightening angle]</td>
<td>Tighten over specified tightening angle</td>
</tr>
<tr>
<td>![Hand-tight, tighten without tools]</td>
<td>Hand-tight, tighten without tools</td>
</tr>
<tr>
<td>![Oil]</td>
<td>Oil</td>
</tr>
<tr>
<td>![Apply screw locking paste (e.g. Loctite)]</td>
<td>Apply screw locking paste (e.g. Loctite)</td>
</tr>
<tr>
<td>![Apply high-temperature grease]</td>
<td>Apply high-temperature grease</td>
</tr>
<tr>
<td>![Apply other paste in accordance with specifications]</td>
<td>Apply other paste in accordance with specifications</td>
</tr>
<tr>
<td>![Oil free, grease free and dry]</td>
<td>Oil free, grease free and dry</td>
</tr>
<tr>
<td>![Affix]</td>
<td>Affix</td>
</tr>
<tr>
<td>![Measure]</td>
<td>Measure</td>
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<tr>
<td>![Note]</td>
<td>Note</td>
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<td>![Visually inspect]</td>
<td>Visually inspect</td>
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<td>![Please note text for numbered work step.]</td>
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<td>![See document]</td>
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</tr>
<tr>
<td>![Dispose of in an environmentally compatible, professional way and in compliance with locally applicable regulations.]</td>
<td>Dispose of in an environmentally compatible, professional way and in compliance with locally applicable regulations.</td>
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</tbody>
</table>

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

Storage of new turbochargers and spare parts up to 6 months

New turbochargers and spare parts can be stored in sealed packaging without additional mothballing measures for up to 6 months from the date of delivery (marked by the VCI label on the package).

![VCI](image)

**Fig. 2: Volatile Corrosion Inhibitor (VCI)**

Only dry rooms in which the relative humidity is between 40...70 % and no condensation can form are suitable for storage.

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

---

**WARNING**

**Protection of health when handling VCIs**

VCI products are not hazardous in the sense of the Hazardous Substances Ordinance. Nevertheless, the following points are to be observed when handling VCIs:

- Observe specifications in the safety data sheet
- Ensure good room ventilation.
- Do not eat, drink or keep food at the workplace while working with VCIs.
- Clean hands and face after working with VCIs.
- For further information refer to [www.branopac.com](http://www.branopac.com).

Wear safety gloves to protect against mechanical hazards.

---

The following mothballing measures are required every 6 months:

- Open the package.
- Remove the VCI corrosion protection emitter from the package and replace it with a new, identical VCI corrosion protection emitter. New VCI corrosion protection emitters can be obtained at [www.branopac.com](http://www.branopac.com).
- Dispose of the old VCI corrosion protection emitter in an environmentally compatible manner, professionally and in accordance with local regulations.
- Seal the package. The better the external seal is designed, the more permanent the protection.
Long-term storage of turbochargers

The turbochargers will be prepared for prolonged storage by ABB Turbo Systems on request. The package is equipped with a hygrometer (see illustration).

Fig. 3: Package with hygrometer

The following measures are required every 6 months:

- Check the hygrometer (02) in the sight-glass. There is an opening (01) in the wooden crate which allows this check to be carried out. When the display field has changed colour at the 70% level, the maximum permissible humidity has been exceeded. In this case the turbocharger must be inspected by an ABB Turbocharging Service Station and repacked.

- Inspect the package for damage. If the package is damaged, the turbocharger must be inspected by an ABB Turbocharging Service Station and repacked.

After every 3 years the following work steps must be performed by an ABB Turbocharging Service Station:

- Inspect the components
- Replace the desiccant agent
- Repackage the components.

If the 70% display field of the hygrometer (02) has not changed colour and the package is undamaged, the turbocharger can be placed into operation without any prior testing by an ABB Turbocharging Service Station.

Unpacking turbochargers

The corrosion protection effect ends after the material is unpacked from the VCI package.

To avoid the formation of condensation, the surroundings and the content of the package must have the same temperature during unpacking.
1.4 Contact information

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

- Scan the QR code to access our website.

ABB Switzerland Ltd, Turbocharging
Bruggerstrasse 71a
CH-5401 Baden
Switzerland

www.abb.com/turbocharging
# Safety

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1 Safety

1.1 Introduction

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

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

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

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

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

1.2 CE conformity

Information

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

<table>
<thead>
<tr>
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<tr>
<td>Protective clothing</td>
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<td>Safety footwear</td>
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Table 1: Personal protective equipment to be worn at all times

<table>
<thead>
<tr>
<th>To be worn specific to the respective task</th>
<th>Safety goggles</th>
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<tr>
<td>Safety glasses</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>Safety gloves to protect against</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>- Mechanical hazard</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>- Chemical hazard</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>- Thermal hazard</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>Respiratory mask to protect against</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>- Dusts</td>
<td>Safety goggles</td>
</tr>
<tr>
<td>- Gases</td>
<td>Safety goggles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety helmet</th>
<th>Ear protection</th>
</tr>
</thead>
</table>

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.

![Warning plate](image)

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 engine builder.
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 $n_{\text{max}}$, $t_{\text{max}}$ 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.

$n_{\text{max}}$, $t_{\text{max}}$ 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 $n_{\text{max}}$ and $t_{\text{max}}$ 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.

![Attachment of loads on the crane hook](image)

**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.

⚠️ WARNING

Use original parts

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

- Only use original parts from ABB Turbo Systems.

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

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

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

⚠️ WARNING
Danger due to noise
Exposure to noise can harm the hearing system, impair health and the psychological state and may lead to lack of attention and irritation.
- When the engine is running, always wear ear protection.
- Always wear ear protection if the sound pressure level exceeds 85 dB(A).

Wear ear protection.

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

⚠️ WARNING
Danger of burns
Touching hot surfaces or contact with hot operating fluids can cause burns.
- Do not touch hot surfaces. Observe the warning plate on the turbocharger.
- Wear heat-resistant safety gloves and protective clothing.
- Wait for the turbocharger to cool down before carrying out any work.

Wear safety gloves to protect against thermal hazards.
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**

<table>
<thead>
<tr>
<th>Variant A</th>
<th>Insulation (01) with integrated burst protection from ABB Turbo Systems.</th>
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<tr>
<td>Variant B</td>
<td>Burst protection (03) and insulation (02) from ABB Turbo Systems.</td>
</tr>
<tr>
<td>Variant C</td>
<td>Burst protection (03) from ABB Turbo Systems with appropriate insulation from the enginebuilder.</td>
</tr>
</tbody>
</table>
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

### A155-M57 HT595251

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<th>Type</th>
<th>A155-M57</th>
<th>HT595251</th>
</tr>
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<td></td>
</tr>
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<td>$n_{\text{B}_{\text{max}}}$</td>
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<td></td>
</tr>
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<tr>
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<td>2020</td>
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</table>

Application according to the Operation Manual

Made in Switzerland
# Product description

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<td>17.5</td>
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<td>18</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
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>

*) 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 08 Gas outlet flange
02 Compressor casing 09 Nozzle ring
03 Diffuser 10 Turbine casing
04 Bearing casing 11 Turbine-end bearing flange
05 Axial thrust bearing 12 Compressor-end bearing flange
06 Radial plain bearing 13 Compressor wheel
07 Turbine
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

![Compressor wheel cooling](image)

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:

![Warning plate locations](image)

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.

![Suspension of complete turbocharger unit](image)

Fig. 5: Suspension of complete turbocharger unit

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight of complete turbocharger unit [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>1200</td>
</tr>
<tr>
<td>A155-M</td>
<td>1800</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.

- 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.

- Secure the lifting gear to the turbocharger (see illustration).
- 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.
- If present: Detach the support (61301) from the engine support.
2.2.1 Loosening the clamping nut

**CAUTION**

Incorrect procedure can make loosening impossible

If individual pressure screws are fully relieved, the pressure screws can become compressed, making it impossible to loosen them.

- Comply with the following steps for loosening the pressure screws.

**CAUTION**

Do not clean pressure screws

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

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

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

1. Working in a circle, break loose each pressure screw (≤ 20°).
2. Working in a circle, loosen each pressure screw by 45° in 4 rounds.
3. 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.

Fig. 8: Loosening the clamping nut

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2.2.2 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

01 Centre of gravity

- Remove the turbocharger from the engine support.
- Remove and dispose of the O-rings (42195, 42200).
- Set down and secure the turbocharger properly at a suitable location.
- 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.

---

**Fig. 10: Inserting the gasket**

- 01 Oil supply
- 02 Oil drain
- 42200 O-ring
- 42201 Bearing casing
- 42202 O-ring
### 2.3.2 Placing the turbocharger on the bracket

![Diagram of turbocharger placement](image)

**Fig. 11: Fitting the turbocharger**

**Step A – Preparing the fixing screws**
1. Insert expansion bush (42190) into bearing casing.
2. Screw the clamping nut (42201) flush onto the threaded rod (42191). The hexagon of the thread screw is at the top.
3. Place the thrust washer (01) of the clamping nut on the expansion bush and, with the clamping nut screwed on, guide the threaded rod through the thrust washer, expansion bush and bearing casing.

**Step B – Preparing the positioning**
- Screw the centering bush (42193) flush onto the threaded rod from below.
- Clean the surface of the bracket, the bearing casing, the centering bush and the centering holes in the bracket.
- Make sure that the covers of the oil connections are removed.
- Make sure that the position of the oil inlet of the bracket matches the oil inlet hole in the bearing casing.
- Make sure that the O-rings are placed correctly in the slots.
2.3 Installing the turbocharger

Step C – Aligning the turbocharger on the bracket
1. Lightly lubricate the hole, into which the centering bush (42193) is inserted, with screw grease.
2. Position threaded rod with centering bush in the bracket.
3. Insert centering bush into bracket until the stop is reached.
4. Carefully lower turbocharger onto bracket and position using the centering bushes (42193) located in the bracket.
5. Check value x.
   ▶ If value x is not reached, the turbocharger must be lifted up from the bracket and re-aligned.

Step D – Fixing the threaded rod in place in the bracket
▶ Using the hexagon, screw the threaded rod into the bracket up to value L.
▶ If value L is not reached or the threaded rod jams while being screwed in, the threaded rod must be loosened by no more than ½ revolution (this will loosen the centering bush which may have jammed the rod). Then continue screwing in the threaded rod.
▶ If value L is not reached, undo the screw connection, carefully take the turbocharger off the bracket and repeat the procedure starting with Step A.
▶ Observe the instructions for fastening the turbocharger with clamping nuts (see chapter Fastening the turbocharger with a clamping nut →17).

---

**Table 3: Fitting the turbocharger, value X, L**

<table>
<thead>
<tr>
<th>Product</th>
<th>Value X</th>
<th>Value L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>112 ±2 mm</td>
<td>52 ±2 mm</td>
</tr>
<tr>
<td>A155</td>
<td>144 ±2 mm</td>
<td>72 ±2 mm</td>
</tr>
</tbody>
</table>

**Fig. 12: Fitting the turbocharger**

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2.3.3 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.

![Diagram](image)

Fig. 13: Preparing the clamping nut for the tightening procedure

1. Clean the thread of the bolt (01) and the contact surface.
2. Lightly oil the bolt thread.
3. Position the thrust washer (02) in place.
4. Tighten clamping nut (03) by hand.
5. 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 4: 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>A150</td>
<td>M30</td>
<td>45</td>
</tr>
<tr>
<td>A155</td>
<td>M36</td>
<td>85</td>
</tr>
</tbody>
</table>

Fig. 14: Tightening pressure screws
2.3.4 Connecting the turbocharger

Fig. 15: 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 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. 16: 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.

2.3.5 Attaching the support

Fig. 17: 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 prerequisite for trouble-free operation of the turbocharger.

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

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

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 →25.
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.
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

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminated oil</td>
</tr>
<tr>
<td>Serious damage to engine or property can be caused by dirt and solid material particles in the oil.</td>
</tr>
</tbody>
</table>
- 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:

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure of compressor wheel cooling</td>
</tr>
<tr>
<td>Any prolonged failure of the compressor wheel cooling will shorten the replacement interval of the compressor wheel.</td>
</tr>
</tbody>
</table>
- Make sure there is an uninterrupted supply of cooling air during operation.
- Check whether the compressor wheel cooling is 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 →25 for admissible values.

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

3.2.4 Checks when starting up the engine

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 →59).

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.

Version with compressor wheel cooling:

- Remove the locking screw 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 →22).
- 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.

<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 x n_{Bmax})</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 5: 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 Turbocharging 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 $T_{oil,inlet}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>$30 \ldots 90^\circ C$</td>
</tr>
<tr>
<td>Temporarily admissible ($&lt; 1$ h) → alarm</td>
<td>$&gt; 90 ^\circ C$</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>$&gt; 95 ^\circ C$</td>
</tr>
<tr>
<td>Not admissible → do not start engine (before start: preheat oil)</td>
<td>$&lt; 30 ^\circ C$</td>
</tr>
</tbody>
</table>

Table 6: 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 $T_{oil,outlet}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>$\leq T_{oil,inlet} + 55$ K ($\leq 145 ^\circ C$)</td>
</tr>
<tr>
<td>Temporarily admissible → alarm</td>
<td>$&gt; T_{oil,inlet} + 55$ K ($&gt; 145 ^\circ C$)</td>
</tr>
<tr>
<td>Not admissible → stop engine</td>
<td>$&gt; 165 ^\circ C$</td>
</tr>
</tbody>
</table>

Table 7: Maximum lubricating oil temperature at the outlet

If the turbocharger has been operated for a longer period of time outside the admissible range, ABB Turbocharging recommends having 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. 19: 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
- *) Alternative mounting position 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 → 65.
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. 20: Replacing the speed sensor](image)

<table>
<thead>
<tr>
<th>Part number</th>
<th>A150</th>
<th>A155</th>
</tr>
</thead>
<tbody>
<tr>
<td>86505</td>
<td>M12 x 1.5</td>
<td>M12 x 1.5</td>
</tr>
<tr>
<td></td>
<td>15 Nm</td>
<td>15 Nm</td>
</tr>
</tbody>
</table>

Table 8: Tightening torque (86505)

- Reduce the engine performance to idling and then stop the engine. Pay attention to post-lubrication ([Stopping the engine →38](#)).
- 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. 21: Noise insulation, bellows → 32).

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

Fig. 21: 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
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**
  **Specific service interval**
  Exceptional stresses such as a high number of starts and stops, 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 specific service interval with ABB Turbocharging.

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.

- Perform a visual control for air, exhaust gas, and oil leaks
- Record operating data and enter it 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 ... 16000 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 →66).
- Clean nozzle ring, turbine casing, compressor casing and diffuser, and check for cracks and erosion/corrosion.
5.2.5 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 information on rating plate</td>
<td></td>
</tr>
<tr>
<td>Bearing parts</td>
<td>12000 ... 32000</td>
<td>12000 ... 24000</td>
</tr>
<tr>
<td>Other casings</td>
<td>50000</td>
<td>50000</td>
</tr>
</tbody>
</table>

Table 9: 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 5: Lubricating oil pressure at oil inlet before turbocharger →25).

- 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 Turbocharging recommends post-lubrication for 10 minutes.

- Observe the oil pressure specified for post-lubrication (see Table 5: Lubricating oil pressure at oil inlet before turbocharger →25).
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 Turbocharging 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 →40</td>
<td>Engine load 50 ... 85%</td>
</tr>
<tr>
<td>50 ... 200 h (^1)</td>
<td>Cleaning the turbine during operation →43</td>
<td>Engine load 20 ... 40% (guideline value)</td>
</tr>
<tr>
<td>According to rating plate (^2)</td>
<td>Cleaning components mechanically →47</td>
<td>Engine stopped</td>
</tr>
<tr>
<td>12000 h</td>
<td>Uncoupled filter silencer A155-M Changing the absorption element →57</td>
<td>Engine stopped</td>
</tr>
</tbody>
</table>

Table 10: Maintenance table

\([\text{h}] = \text{Hours of operation}\)

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

\(^2\) ABB Turbocharging 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 Turbocharging recommends mechanical cleaning of the contaminated components.

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 carried out every 24 ... 72 hours of operation.

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

Cleaning method and operating state

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

This cleaning method is tested and approved by ABB Turbocharging.

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 Turbocharging.

⚠️ 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 Cleaning the compressor during operation

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.

### 6.2.5 Carrying out wet cleaning of the 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>

Table 11: Parameters for wet cleaning of compressor

- 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 Turbocharging recommends mechanical cleaning of the contaminated components.

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 Turbocharging recommends the use of fuels with low ash, sulphur, sodium and vanadium contents.

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. Operating states with incomplete combustion also increase the tendency to form deposits and must be avoided.

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 carried out every 50 to 200 hours of operation.

If the specified cleaning intervals are incompatible with operation of the engine, contact ABB Turbocharging.
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 Turbocharging.

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

Two different turbine cleaning devices are available for turbochargers with single-inlet turbine casing:

1. Device consisting of one cleaning nozzle per turbine casing gas inlet.
2. Device consisting of six cleaning nozzles with connecting pipe for water and scavenging air.

![Fig. 23: Turbine cleaning devices](image)

<table>
<thead>
<tr>
<th>Characteristic/component</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning device</td>
<td>one cleaning nozzle per gas inlet</td>
</tr>
<tr>
<td>Engine load (guideline value)</td>
<td>20 … 40 %</td>
</tr>
<tr>
<td>1) Turbine inlet temperature $T_{TE}$ before water injection</td>
<td>$350$ … $430$ °C</td>
</tr>
<tr>
<td>Stabilisation phase after $T_{TE}$ 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 temperature</td>
<td>$5$ … $30$ °C</td>
</tr>
<tr>
<td>Water pressure (overpressure compared to atmosphere) $p_{WT}$</td>
<td>1.5 bar</td>
</tr>
<tr>
<td>2) External air supply</td>
<td>recommended</td>
</tr>
<tr>
<td>External air pressure $p_{PA}$ relative to turbine inlet pressure $P_{TE}$</td>
<td>$p_{PA} = P_{TE} + 0.5$ bar</td>
</tr>
</tbody>
</table>

Table 12: Turbine wet cleaning, recommended operating state

1) 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.

2) External air supply for continuous blowing off of the cleaning nozzles between cleaning intervals.
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.

Fig. 24: Carrying out wet cleaning of turbines

- Fulfil prerequisites.
- Ensure that the water supply (01) is guaranteed.
- Open the stop valve (02) and set the water volume flow $V_w$ with a flowmeter (03) (see cleaning parameters).
- 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.

**Parameter for 1-nozzle cleaning**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>350 ... 430</td>
<td>530</td>
<td>14.0</td>
<td>10</td>
</tr>
<tr>
<td>A155</td>
<td>350 ... 430</td>
<td>530</td>
<td>19.0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 13: Wet cleaning of turbines, parameters for 1-nozzle cleaning

$^1$ Corresponds to a water pressure $p_{WT}$ of 1.5 bar (overpressure compared to atmosphere) before the cleaning nozzle
Parameter for 6-nozzle cleaning

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>350 ... 430</td>
<td>530</td>
<td>18.0</td>
<td>10</td>
</tr>
<tr>
<td>A155</td>
<td>350 ... 430</td>
<td>530</td>
<td>25.0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 14: Wet cleaning of turbines, parameters for 6-nozzle cleaning

$^1$ Corresponds to a water pressure $p_{WT}$ of 2.5 bar (overpressure compared to atmosphere) at the connection point WA/WG

## 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 parts is described in the respective Disassembly and Assembly chapters.

- 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

Fig. 25: Cleaning the filter silencer

81135  Filter silencer body  81286
81136  Absorption segment  81266  Cover grid
81137  Sheet-metal covering  81270  Tension band
81265  Filter ring  81271  Lock

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. 25: Cleaning the filter silencer →48)

- 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. 25: Cleaning the filter silencer →48)

- 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)

- 79000 Compressor casing
- 77000 Wall insert
- 72000 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.

Fig. 27: Turbine end, non-rotating parts

- 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.

**Option with 6-nozzle cleaning**

See Removing and installing 6-nozzle turbine cleaning component (optional) → 143.
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 → 10).
- Remove the cartridge group (see chapter Dismantling and fitting, general → 66).

First clean compressor end and then 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.

![Diagram of turbine end]

Fig. 28: Soaking the turbine end

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
<th>C [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>200</td>
<td>35</td>
<td>382</td>
</tr>
<tr>
<td>A155</td>
<td>240</td>
<td>40</td>
<td>454</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.  

Wear a respiratory mask according to 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.
6.5 Changing the absorption element

The absorption element (81148) in uncoupled filter silencers must be replaced every 12000 hours of operation.

Disassembling the absorption element

1. Remove the filter silencer (see Fig. 41: Removing the uncoupled filter silencer →78).
2. Dismantle the hexagon-head screws (81152) with washers (81153) and mounting plate (81149).
3. Remove the socket screws (81154), roll pins (81151), flanges (81145 / 81146) and absorption element (81148).

Fig. 29: Disassembling the absorption element
Installing the absorption element

Fig. 30: Installing the absorption element

<table>
<thead>
<tr>
<th>Product</th>
<th>81152 [Nm]</th>
<th>81154 [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A155-M</td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 16: Tightening torque (81152 / 81154)

1. Fit the new absorption element (81148) and flanges (81145 / 81146) with roll pins (81151) and socket screws (81154). Tighten socket screws (81154) crosswise. Observe the tightening torque.

2. Check value $X = 15 \text{ mm } \pm 0.1 \text{ mm}$ along the circumference at four points ($0^\circ$, $90^\circ$, $180^\circ$ and $270^\circ$).
   If value $X$ is not satisfied, unscrew the socket screws (81154) and repeat step one.

3. Fit the mounting plate (81149) with washers (81153) and hexagon-head screws (81152). Observe the tightening torque.

4. Remove the filter silencer (see Fig. 76: Installing the uncoupled filter silencer (see Table 53: Tightening torque (72054) →111).
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 →39)</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 17: 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 18: Malfunctions when starting – Vibrations

Rubbing of rotating parts

Normal behaviour, not a malfunction

<table>
<thead>
<tr>
<th>Turbocharger</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▪ If there is any doubt about the extent of the rubbing, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td></td>
<td>▪ Have a dimension check carried out by an ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>

Table 19: 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 20: 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 →39)</td>
</tr>
<tr>
<td>Turbocharger 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 21: 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 →39) or contact an ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 22: Malfunctions during operation – Speed increases
Eliminating malfunctions

7.2 Malfunctions during operation

**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>Clean (see chapter Periodic maintenance work → 39)</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>Clean</td>
</tr>
<tr>
<td></td>
<td>Cooling water volume too low</td>
</tr>
<tr>
<td></td>
<td>Fill</td>
</tr>
<tr>
<td></td>
<td>Inlet temperature of cooling water too high</td>
</tr>
<tr>
<td></td>
<td>Check/clean cooling system</td>
</tr>
<tr>
<td></td>
<td>Insufficient ventilation</td>
</tr>
<tr>
<td></td>
<td>Improve ventilation</td>
</tr>
</tbody>
</table>

Table 23: 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>Replace manometer</td>
</tr>
<tr>
<td>Supply pipe to manometer not sealed</td>
<td>Repair leak</td>
</tr>
<tr>
<td>Filter silencer contaminated, therefore pressure drop too high</td>
<td>Clean (see chapter Periodic maintenance work → 39)</td>
</tr>
<tr>
<td>Compressor end and/or turbine end contaminated</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Compressor/turbine damaged</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>Engine</td>
<td>Air receiver not sealed</td>
</tr>
<tr>
<td></td>
<td>Repair</td>
</tr>
<tr>
<td>Gas piping between engine and turbine leaking</td>
<td></td>
</tr>
<tr>
<td>Injection mistimed</td>
<td>Set correctly</td>
</tr>
<tr>
<td>Valve control misadjusted</td>
<td></td>
</tr>
</tbody>
</table>
| Pipes                        | Pipes downstream to the compressor outlet not sealed. | Repair.

Table 24: 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>Manometer display not correct</td>
</tr>
<tr>
<td></td>
<td>Increased speed due to contamination of nozzle ring</td>
</tr>
<tr>
<td>Engine</td>
<td>Malfunction in the injection system</td>
</tr>
<tr>
<td></td>
<td>Injection mistimed</td>
</tr>
<tr>
<td></td>
<td>Engine performance higher than indicated</td>
</tr>
</tbody>
</table>

Table 25: 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</td>
<td>Compressor components severely contaminated by the ventilation gases that have been fed in</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased blade vibration, compressor blade damage due to the ventilation gases that have been fed in</td>
</tr>
<tr>
<td></td>
<td>Material of the compressor wheel corroded due to the feeding in of ventilation gases containing corrosive components</td>
</tr>
<tr>
<td></td>
<td>Material of the compressor wheel corroded due to intake air containing exhaust gases or salt</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 26: 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</td>
</tr>
<tr>
<td></td>
<td>Heavy contamination deposits in the turbine or in the nozzle ring</td>
</tr>
<tr>
<td>Engine</td>
<td>Protective grating in front of the turbocharger contaminated or damaged</td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Charge air duct blocked</td>
</tr>
</tbody>
</table>

Table 27: 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.</td>
</tr>
<tr>
<td></td>
<td>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 28: 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>Turbocharger contaminated Clean (see chapter Periodic maintenance work → 39)</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Check clearances (see chapter Measuring clearance A and B → 94). 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 → 104). 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 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>Turbocharger contaminated Clean (see chapter Periodic maintenance work → 39)</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Check clearances (see chapter Measuring clearance A and B → 94). 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 → 104). 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 30: 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. An enlarged distance between the sensor tip and the signal-emitting sealing disc reduces the voltage amplitude of the speed signal.</td>
</tr>
<tr>
<td>Sensor or cable defective</td>
<td>Contact an ABB Turbocharging Service Station. Order new speed sensor (86505) (refer to chapter Ordering spare parts → 158). Replacing the speed sensor → 30.</td>
</tr>
</tbody>
</table>

Table 31: 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></td>
<td>For information regarding the disassembly and assembly of the speed sensor, refer to chapter Replacing the speed sensor → 30. Dismantle the sensor, clean the sensor tip, and fit the sensor back on with the specified tightening torque.</td>
</tr>
</tbody>
</table>

Table 32: 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>- -</td>
</tr>
<tr>
<td></td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 33: Malfunction of the speed measurement system – Measured speed too low

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, general

8.1 Introduction

**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 work
This Operation Manual may be used to carry out only the work described in it. Further work that is carried out in an incorrect way can lead to serious damage to the machine.
- ABB Turbocharging recommends having further work carried out only by trained personnel from an ABB Turbocharging Service Station.

Tightening torques for assembly devices
Unless described otherwise, the screws and nuts of the assembly devices supplied by ABB must be tightened so they are tight-fitting.

**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 →89).
8.2 Material required

**Customer spare part set**

Before starting operations, make sure the required customer spare part set is available (see chapter [Spare parts →158](#)).

**Customer tool set**

Before starting work, make sure the required tool set is available (see chapter [Tools →165](#)). Not all tools are marked with a part number. Identification is guaranteed by the tool list. This list is enclosed with the tool set.

![WARNING]

**Servicing the tools**

The tools must be checked for damage before and after use.

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

**Swivel lifting eyes**

Swivel lifting eyes are required for the safe lifting of loads, which are not supplied by ABB.

![Fig. 31: Swivel lifting eyes](image)

**Table 34: 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>A150</td>
<td>M8</td>
<td>13 mm</td>
<td>75 kg</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>M16</td>
<td>21 mm</td>
<td>1000 kg</td>
<td>2</td>
</tr>
<tr>
<td>A155</td>
<td>M8</td>
<td>13 mm</td>
<td>150 kg</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>M16</td>
<td>21 mm</td>
<td>1400 kg</td>
<td>2</td>
</tr>
</tbody>
</table>

**Press-off screws**

Six press-off screws (01) are required to press off the gas outlet flange, which are not supplied by ABB.
Dismantling and fitting, general / 8.2 Material required

Fig. 32: Press-off screws

<table>
<thead>
<tr>
<th>Product</th>
<th>Thread</th>
<th>Length</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M12</td>
<td>30 mm</td>
<td>3 or 6</td>
</tr>
<tr>
<td>A155</td>
<td>M16</td>
<td>30 mm</td>
<td>3 or 6</td>
</tr>
</tbody>
</table>

Table 35: Press-off screws

Dismantling screw for the optional 6-nozzle turbine cleaning component

A dismantling screw (01) is required to dismantle and fit the cleaning nozzles, which is not supplied by ABB.

Fig. 33: Dismantling screw

<table>
<thead>
<tr>
<th>Product</th>
<th>Thread</th>
<th>Length [mm]</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>M8</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>A155-M</td>
<td>M10</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 36: Dismantling screw
Lifting gear

⚠️ WARNING

Suspended loads

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

- Only fasten the turbocharger, assemblies or individual parts on properly functional lifting gear with sufficient load limit.
- Pay attention to the correct attachment of loads on the crane hook.
- People must not stand beneath suspended loads.

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

Definition of terms

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

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

- **Lifting gear**
  Equipment for the lifting and transporting of loads (ropes, chain block, crane). Lifting gear is not supplied by ABB.
8.3 Disassembly and assembly concepts

Removal and installation with removed air inlet and gas outlet

Fig. 34: Removing the cartridge group with compressor and turbine casing

When dismantling with removed air inlet and gas outlet options, the air suction branch or filter silencer, as well as the gas outlet casing are removed from the turbocharger for the time being. The cartridge group, the turbine casing and the compressor casing can then be detached from the engine and dismantled in an assembled state. Reassembly is carried out in reverse order.

A prerequisite is that the interfaces between the alternative air inlet (filter silencer or air suction branch) and the compressor casing, as well as between the turbine casing and gas outlet casing, are accessible at the engine side.
Cartridge concept

The cartridge concept incorporates the removal and installation of the turbocharger from/onto the engine, whereby the air inlet (filter silencer or air suction branch), the compressor casing and the cartridge group can be individually dismantled and fitted in the order shown in the illustration.

The turbine casing and optional gas outlet casing remain on the engine during the process. In addition, the nozzle ring can also be dismantled/fitted with this concept (not shown).

When employing the cartridge concept, the turbine casing and the optional gas outlet casing remain on the engine. Adequate support or suspension of these components must be ensured.

A prerequisite is that the interfaces between the cartridge group and the turbine casing, as well as between the cartridge group and the compressor casing, are accessible at the engine side.

Fig. 35: Cartridge concept
ABB offers an optional spanner holder (90165) (see Dismantling and fitting, special tools for fastening strips →133) which, in the event of limited accessibility, can be used to facilitate the loosening of nuts and the application of tightening torques for the strip connection between the cartridge group and the turbine casing.

The spanner holder (90165) should only be used for loosening the nuts and applying tightening torques for the nuts at the position shown.

Other screws or nuts on the turbocharger should not be tightened with this tool.
## 8.4 Weights of individual parts

![Figure 37: Weights of assemblies](image)

<table>
<thead>
<tr>
<th>Designation</th>
<th>A150  [kg]</th>
<th>A155  [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Filter silencer</td>
<td>90</td>
<td>140</td>
</tr>
<tr>
<td>02 Radial air suction branch</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>03 Compressor casing with insulation</td>
<td>180</td>
<td>280</td>
</tr>
<tr>
<td>04 Wall insert</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>05 Diffuser</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>06 Cartridge group</td>
<td>220</td>
<td>360</td>
</tr>
<tr>
<td>07 Nozzle ring</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>08 Burst ring</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>09 Turbine casing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inlet *</td>
<td>320</td>
<td>500</td>
</tr>
<tr>
<td>2 inlets *</td>
<td>290</td>
<td>460</td>
</tr>
<tr>
<td>3 inlets *</td>
<td>300</td>
<td>460</td>
</tr>
<tr>
<td>10 Gas outlet flange</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>11 Gas outlet casing with insulation</td>
<td>160</td>
<td>240</td>
</tr>
</tbody>
</table>

Table 37: Weights of assemblies

* including burst protection and insulation
8.5 **Table of tightening torques**

Fig. 38: Overview of tightening torques

1) Only A155-M with uncoupled filter silencer
The following tightening torques must be observed for the designated screw fittings:

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>A150</th>
<th>A155</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>72051</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>275 Nm</td>
<td>275 Nm</td>
</tr>
<tr>
<td>02a</td>
<td>72054</td>
<td>- -</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>275 Nm</td>
</tr>
<tr>
<td>04</td>
<td>79041</td>
<td>M6</td>
<td>M6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 Nm</td>
<td>8 Nm</td>
</tr>
<tr>
<td>08</td>
<td>51007</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>175 Nm</td>
<td>175 Nm</td>
</tr>
<tr>
<td></td>
<td>51007 with spanner holder (90165)</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85 Nm</td>
<td>70 Nm</td>
</tr>
<tr>
<td>09</td>
<td>51009</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 Nm</td>
<td>200 Nm</td>
</tr>
<tr>
<td>11</td>
<td>72011</td>
<td>M16</td>
<td>M18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>275 Nm</td>
<td>370 Nm</td>
</tr>
<tr>
<td>15</td>
<td>86505</td>
<td>M12 x 1.5</td>
<td>M12 x 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 Nm</td>
<td>15 Nm</td>
</tr>
<tr>
<td>16a</td>
<td>- -</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 Nm</td>
<td>200 Nm</td>
</tr>
<tr>
<td>20</td>
<td>81154</td>
<td>- -</td>
<td>M6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 Nm</td>
</tr>
<tr>
<td>21</td>
<td>81155</td>
<td>- -</td>
<td>M8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55 Nm</td>
</tr>
<tr>
<td>22</td>
<td>81152</td>
<td>- -</td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50 Nm</td>
</tr>
</tbody>
</table>

Table 38: 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>A150</th>
<th>A155</th>
</tr>
</thead>
<tbody>
<tr>
<td>16a / 16b</td>
<td>- -</td>
<td>M16 200 Nm</td>
<td>M16 200 Nm</td>
</tr>
<tr>
<td>16b 2)</td>
<td>- -</td>
<td>M12 65 Nm</td>
<td>M12 65 Nm</td>
</tr>
<tr>
<td>18</td>
<td>- -</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>
</tr>
<tr>
<td>20</td>
<td>- -</td>
<td>M10 45 Nm</td>
<td>M10 45 Nm</td>
</tr>
</tbody>
</table>

Table 39: 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 Dismantling and fitting with removed air inlet and gas outlet

9.1 Removing air inlets

1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
2. Loosen the hexagon-head screws (72051) and remove them with fastening strips (72012).
3. Remove the filter silencer (81000) or air suction branch (82000).
4. Remove and dispose of the O-ring (81010 or 82010).

Fig. 40: Removing the air inlets
A155-M Uncoupled filter silencer

Fig. 41: Removing the uncoupled filter silencer

1. Secure lifting gear to filter silencer (81000).
2. Unscrew the hexagon-head screws (72054) and remove along with Verbus Ripp® washers (72053) and three safety plates (72055).
3. Remove the filter silencer (81000).
9.2 Removing the gas outlet casing

Mark the casing position for assembly.

**Variant without support**

1. If present: Remove waste gate pipe.
2. Remove insulation ring.
3. Fit swivel lifting eyes (S) to the gas outlet casing (61001). Attach lifting gear to swivel lifting eye and secure to a crane hook.
4. Loosen and remove nuts (51009).
5. Remove the gas outlet casing (61001), set it down properly in an appropriate place and secure it.
6. Remove and dispose of the gasket (61002).
Dismantling and fitting with removed air inlet and gas outlet / 9.2
Removing the gas outlet casing

Variant with support

Fig. 43: Removing gas outlet casing with support 1

1. If present: Remove waste gate pipe.
2. Remove gas outlet casing insulation.
3. Remove insulation ring.
4. Remove fixing screws of support (61301) to bracket.
5. Fit swivel lifting eyes (S) to the gas outlet casing (61001). Attach lifting gear to swivel lifting eye and secure to a crane hook.
9.2 Removing the gas outlet casing

6. Loosen nuts (51009) and remove together with support (61301).

7. Remove the gas outlet casing (61001), set it down properly in an appropriate place and secure it.

8. Remove and dispose of the gasket (61002).

Fig. 44: Removing gas outlet casing with support 1
9.3 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.
Dismantling and fitting with removed air inlet and gas outlet / 9.3
Removing the gas outlet flange

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.

![Fig. 45: Dismantling the gas outlet flange](image)

<table>
<thead>
<tr>
<th>Product</th>
<th>Press-off screws (strength 8.8) *</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>3 x M16 x 30</td>
<td>≤ 150 Nm</td>
</tr>
<tr>
<td>A155</td>
<td>3 x M16 x 40</td>
<td>≤ 150 Nm</td>
</tr>
</tbody>
</table>

Table 40: 3 press-off screws

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 Turbocharging Service Station.
2. Attach swivel lifting eye (S) to the gas outlet flange. Secure lifting gear to the swivel lifting eye.
3. Remove the gas outlet flange.
4. If present: Remove the metal 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.

Dismantle the gas outlet flange only if this is necessary for service work.

- With blows from a plastic tip hammer, ensure that the gas outlet flange does not cant.
- 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](image)

Table 41: 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>A150</td>
<td>6 x M12 x 30</td>
<td>≤ 65 Nm</td>
</tr>
<tr>
<td>A155</td>
<td>6 x M12 x 30</td>
<td>≤ 150 Nm</td>
</tr>
</tbody>
</table>

Table 41: 6 press-off screws

* not included in the ABB 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 Turbocharging Service Station.
2. Attach swivel lifting eye (S) to the gas outlet flange. Secure lifting gear to the swivel lifting eye.
3. Remove the gas outlet flange.
4. If present: Remove the metal C-ring (57003).
9.4 Removing the cartridge group with compressor and turbine casing

1. 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.

2. Remove the compressor casing insulation.

3. Remove the turbine casing insulation.
9. Dismantling and fitting with removed air inlet and gas outlet / 9.4
Removing the cartridge group with compressor and turbine casing

4. If present: Loosen and remove the compressor wheel cooling connection. Close the compressor wheel cooling opening with a screw plug (01).

5. 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.

6. Attach lifting gear to the cartridge group and secure to a crane.

7. Loosen clamping nut (see Loosening the clamping nut →12).

8. Lift the cartridge group with the compressor and turbine casing.

9. Fit two swivel lifting eyes (S) and secure to a second set of lifting gear.

10. Turn the compressor and turbine casing and set down on suitable supports.

11. Remove lifting gear from cartridge group. Leave second lifting gear attached to compressor casing for safety.

12. Remove and dispose of the O-rings (42195, 42200).
9.5 Removing the compressor casing

Mark the casing position for assembly.

If the compressor casing cannot be loosened, it can be pressed off against the turbine casing with the press-off tool (90042).

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. Put the compressor casing (72000) down onto a suitable support.
5. Remove and dispose of the O-ring (42012).
Dismantling the diffuser and the wall insert

1. Loosen the screws (79041) and remove with fixing discs (79040).
2. Remove diffuser (79000).
3. Fit the swivel lifting eye (S) to the wall insert (77000). Secure lifting gear to the swivel lifting eye.
4. Remove the wall insert (77000). When doing this, make sure that the wall insert does not "stick" to the compressor casing (72000).
5. Remove and dispose of the O-ring (77005).

Fig. 52: Dismantling the diffuser and the wall insert
9.6 Removing the cartridge group

Mark the casing position for assembly.

Fig. 53: Removing cartridge group 1

<table>
<thead>
<tr>
<th>Product</th>
<th>Position</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>01</td>
<td>150</td>
</tr>
<tr>
<td>A155</td>
<td>01</td>
<td>150</td>
</tr>
</tbody>
</table>

Table 42: Tightening torque (90012-01)

1. Treat threads of studs (51006) with penetrating oil and leave to take effect.
2. Loosen nuts (51007) and remove Verbus Ripp® washers (51003) together with the fastening strips (51002).
3. Fit the cross-piece of the service support (90012). Observe the tightening torque.
If the cartridge group cannot be loosened, the press-off tool (90042) can be used.

4. Secure the first set of lifting gear to the bearing casing.

5. Secure the second set of lifting gear to the service support with a swivel lifting eye. The length of the lifting gear must be selected in such a way that the compressor wheel is not touched when turning the cartridge group.

6. Remove the cartridge group vertically from the turbine casing.
Dismantling and fitting with removed air inlet and gas outlet / 9.6
Removing the cartridge group

7. Place a suitable protective cover over the compressor wheel.
8. Turn the cartridge group into the horizontal rotor axis.
9. Remove lifting gear from service support and cross-piece.

Fig. 55: Removing cartridge group 3
9.7 Installing the cartridge group on the service support

1. Assemble the service support (90012) with longitudinal and cross-pieces.
2. Fit service support to cartridge group.
3. Put down cartridge group.

Fig. 56: Installing the cartridge group on the service support
9.8 Removing the nozzle ring

1. Pull out the nozzle ring (56001) with the two extraction devices (90070).
2. Remove the lamellar sealing ring (56005).
9.9 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.

![Fig 58: Measuring clearance A and B](image)

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>0.12 ... 0.22</td>
<td>0.72 ... 1.28</td>
</tr>
<tr>
<td>A155-M</td>
<td>0.12 ... 0.22</td>
<td>0.79 ... 1.40</td>
</tr>
</tbody>
</table>

Table 43: Permissible clearances A and B

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.
9.10 Nozzle ring compression PD

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

Fig. 59: Nozzle ring compression PD

1. Measure values 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>
<thead>
<tr>
<th>Product</th>
<th>Nozzle ring compression PD [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>-0.17 ... 0.17</td>
</tr>
<tr>
<td>A155-M</td>
<td>-0.17 ... 0.17</td>
</tr>
</tbody>
</table>

Table 44: Nozzle ring compression PD
9.11 Installing nozzle ring

1. Fit the lamellar sealing ring (56005) (see A-A). When doing this, pay attention to correct winding of the lamellar sealing ring (see detail B).

2. Align the cams on the nozzle ring with the recesses of the turbine casing (51000).

3. Insert the nozzle ring (56001) into the turbine casing up to the stop.

Fig. 60: Installing the nozzle ring
9.12 Installing the cartridge group

1. Fasten lifting gear to cartridge group and lift cartridge group.
2. Remove service support (90012).
3. Dismantle service support.

Fig. 61: Lifting the cartridge group and rotating it by 90°
9.12 Installing the cartridge group

4. Re-fit the cross-piece of the service support (90012). Observe the tightening torque.

5. Place the protective cover over the compressor wheel.

6. Secure the second set of lifting gear to the cross-piece with a swivel lifting eye. The length of the lifting gear must be selected in such a way that the compressor wheel is not touched.

7. Turn the cartridge group into the vertical position of the rotor axis.
8. Coat the threads of the studs (51006) with high-temperature grease.

9. Align casing position of cartridge group with marking and lower into the turbine casing.

10. Remove lifting gear cross-piece of service support.

11. Install the fastening strips (51002) with Verbus Ripp® washers (51003) and hexagon nuts (51007). Observe the tightening torque.

### Table 46: Tightening torque (51007)

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>175</td>
</tr>
<tr>
<td>A155</td>
<td>M16</td>
<td>175</td>
</tr>
</tbody>
</table>
9.13 Installing the compressor casing

Fitting the wall insert and the diffuser

1. Fit a new O-ring (77005).
2. Fit the swivel lifting eyes (S) to the wall insert (77000). Secure lifting gear to the swivel lifting eye.
3. Install the wall insert (77000) into the compressor casing and, when doing so, pay attention to the positioning pin in the compressor casing.
4. Fit the diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

Table 47: Tightening torque (79041)

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>A155</td>
<td>M6</td>
<td>8</td>
</tr>
</tbody>
</table>

Fig. 64: Fitting the wall insert and the diffuser
Installing the compressor casing

Fig. 65: Installing the compressor casing

1. Fit new O-ring (42012).
2. Thoroughly clean the fastening strips (72012) before assembly.
3. Install the compressor casing (72000).
4. Install the fastening strips (72012) with screws (72011). Observe the tightening torque.

Table 48: Tightening torque (72011)

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>275</td>
</tr>
<tr>
<td>A155</td>
<td>M18</td>
<td>370</td>
</tr>
</tbody>
</table>
9.14 Turning the cartridge group with compressor and turbine casing

Fig. 66: Turning the cartridge group with compressor and turbine casing

1. Attach second lifting gear to bearing casing and secure to the crane hook. This lifting gear must be attached during the entire rotating procedure.

2. Lift cartridge group with compressor and turbine casing with the first lifting gear and lower it with the second lifting gear.

3. Remove second lifting gear and swivel lifting eye.
9.15 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. Fit swivel lifting eye (S) to the gas outlet flange (57002). Secure lifting gear to the swivel lifting eye.

3. Install gas outlet flange in turbine casing (51000).

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

Fig. 68: Measuring clearances N and R

<table>
<thead>
<tr>
<th>Product</th>
<th>N [mm]</th>
<th>R [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>0.64 ... 1.09</td>
<td>0.71 ... 1.13</td>
</tr>
<tr>
<td>A155-M</td>
<td>0.78 ... 1.29</td>
<td>0.86 ... 1.33</td>
</tr>
</tbody>
</table>

Table 49: Permissible 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.
9.17 **Fitting the insulation**

Fig. 69: Fitting the insulation

- Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →74).
9.18 Installing the cartridge group with compressor and turbine casing

1. Fit new O-rings (42195, 42200).
2. Remove cover from oil inlet and outlet and carefully lower cartridge group with compressor and turbine casing onto bracket.
3. Mount and tighten the clamping nut (see Fastening the turbocharger with a clamping nut → 17).
4. Remove lifting gear from bearing casing.
5. If present: Remove the screw plug from the connection for the compressor wheel cooling (01) and fit the cooling air line.
6. If present: Plug in the plug to the speed sensor (86505).
   ▶ If present: Fit connecting pipe for turbine cleaning.
9.19 Installing the gas outlet casing

Variant without support

1. Coat thread of bolts (51008) with high-temperature grease.
2. Insert a new gasket (61002) into the gas outlet casing (61001).
3. Fit swivel lifting eyes (S) to the gas outlet casing (61001). Secure lifting gear to the swivel lifting eye.
4. Place gas outlet casing at turbine casing (51000). Observe the marking.
5. Fit hexagon nuts (51009). Observe the tightening torque.
6. Fit insulation ring. Observe tightening torques (see Table of tightening torques →74).
7. If present: Attach waste gate pipe. Tighten in accordance with enginebuilder’s specifications.

---

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>200</td>
</tr>
<tr>
<td>A155</td>
<td>M16</td>
<td>200</td>
</tr>
</tbody>
</table>

Table 50: Tightening torque (51009)
9.19 Installing the gas outlet casing

### Variant with support

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>200</td>
</tr>
<tr>
<td>A155</td>
<td>M16</td>
<td>200</td>
</tr>
</tbody>
</table>

Table 51: Tightening torque (51009)

1. Coat thread of bolts (51008) with high-temperature grease.
2. Insert a new gasket (61002) into the gas outlet casing (61001).
3. Fit swivel lifting eyes (S) to gas outlet casing (61001). Secure lifting gear to the swivel lifting eye.
4. Place gas outlet casing on the turbine casing (51000). Observe the marking.
5. Fit support (61301).
6. Fit hexagon nuts (51009). Observe the tightening torque.
Dismantling and fitting with removed air inlet and gas outlet / 9.19 Installing the gas outlet casing

7. Fit the screws of the support. Tighten in accordance with enginebuilder’s specifications.
8. Fit insulation ring. Observe tightening torques (see Table of tightening torques →74).
9. Fit gas outlet casing insulation (see Table of tightening torques →74).
10. If present: Attach waste gate pipe. Tighten in accordance with enginebuilder’s specifications.
9.20 Installing air inlets

Fig. 75: Installing the air inlets

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>275</td>
</tr>
<tr>
<td>A155</td>
<td>M18</td>
<td>370</td>
</tr>
</tbody>
</table>

Table 52: Tightening torque (72051)

1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
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. Install the filter silencer (81000) or air suction branch (82000).
4. Fit the fastening strips (72012) with hexagon-head screws (72051). Observe the tightening torque.
A155-M Uncoupled filter silencer

Fig. 76: Installing the uncoupled filter silencer

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A155</td>
<td>M16</td>
<td>275</td>
</tr>
</tbody>
</table>

Table 53: Tightening torque (72054)

1. Secure lifting gear to filter silencer (81000).
2. Install the filter silencer (81000).
3. Fit the hexagon nuts (72054) together with Verbus Ripp® washers (72053) and three new safety plates (72055) (uniformly at 120° to one another). Observe the tightening torque.
10 Dismantling and fitting, cartridge concept

10.1 Removing air inlets

1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
2. Loosen the hexagon-head screws (72051) and remove them with fastening strips (72012).
3. Remove the filter silencer (81000) or air suction branch (82000).
4. Remove and dispose of the O-ring (81010 or 82010).
A155-M Uncoupled filter silencer

Fig. 78: Removing the uncoupled filter silencer

1. Secure lifting gear to filter silencer (81000).
2. Unscrew the hexagon-head screws (72054) and remove along with Verbus Ripp® washers (72053) and three safety plates (72055).
3. Remove the filter silencer (81000).
10.2 Removing the compressor casing

- Mark the casing position for assembly.

Fig. 79: Removing the compressor casing

1. Remove the compressor casing insulation.
2. Fit swivel lifting eye (S) to the compressor casing (72000). Secure lifting gear to the swivel lifting eye.
3. Loosen screws (72011) and remove together with fastening strips (72012).
4. Remove the compressor casing (72000).
If the compressor casing cannot be loosened, it can be pressed off against the turbine casing with the press-off tool (90042).

Fig. 80: Pressing off compressor casing

1. Remove front turbine casing insulation.

Fig. 81: Remove the diffuser

1. Remove and dispose of the O-ring (42012).
2. Set the compressor casing (72000) down on a suitable support.
Dismantling the diffuser and the wall insert

1. Loosen the screws (79041) and remove with fixing discs (79040).
2. Remove diffuser (79000).
3. Fit the swivel lifting eye (S) to the wall insert (77000). Secure lifting gear to the swivel lifting eye.
4. Remove the wall insert (77000). When doing this, make sure that the wall insert does not “stick” to the compressor casing (72000).
5. Remove and dispose of the O-ring (77005).

Fig. 82: Dismantling the diffuser and the wall insert
10.3 Removing the cartridge group

Removing the insulation

Fig. 83: Removing insulation sheets

- Remove insulation sheets.
Removing the cartridge group

1. Apply two marking lines (M) to the left and right of the cartridge group and the bracket.
2. Support and fix the turbine casing.
3. Loosen the clamping nut (42201) (see Loosening the clamping nut → 12).
4. Screw threaded rod (42191) up to value X at the hexagon.
5. Lift the centering bush (42193) using the threaded rod (42191) and hold it firmly.
   If the centering bush jams:
   Remove the clamping nut and rotate the threaded rod upwards using a standard nut.
6. Rotate the clamping nut (42201) downwards until the stop is reached.

<table>
<thead>
<tr>
<th>Product</th>
<th>Value X [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>112 ±2 mm</td>
</tr>
<tr>
<td>A155-M</td>
<td>144 ±2 mm</td>
</tr>
</tbody>
</table>

Table 54: Threaded rod, value X
If the cartridge group cannot be loosened, the press-off tool (90042) can be used.

1. Treat threads of studs (51006) with penetrating oil and leave to take effect.
2. Loosen nuts (51007) and remove Verbus Ripp® washers (51003) together with fastening strips (51002).
3. Pull the cartridge group from the turbine casing and remove it.
1. Remove the centering bush (42193) and the threaded rod (42191) along with the clamping nut (42201).

2. Remove and dispose of the O-rings (42195, 42200).

3. Attach the cartridge group to the service support (90012).

4. If present: Remove the metal C-ring (51105).

Fig. 86: Removing cartridge group 2
10.4 Removing the nozzle ring

1. Pull out the nozzle ring (56001) with the two extraction devices (90070).
2. Remove the lamellar sealing ring (56005).
10.5 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]

**Table 55: Permissible clearances A and B**

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>0.12 ... 0.22</td>
<td>0.72 ... 1.28</td>
</tr>
<tr>
<td>A155-M</td>
<td>0.12 ... 0.22</td>
<td>0.79 ... 1.40</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.
10.6 Nozzle ring compression PD

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

Fig. 89: Nozzle ring compression PD

1. Measure values 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>
<thead>
<tr>
<th>Product</th>
<th>Nozzle ring compression PD [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>-0.17 ... 0.17</td>
</tr>
<tr>
<td>A155-M</td>
<td>-0.17 ... 0.17</td>
</tr>
</tbody>
</table>

Table 56: Nozzle ring compression PD
10.7 Installing nozzle ring

Fig. 90: Installing the nozzle ring

1. Fit the lamellar sealing ring (56005) (see A-A). When doing this, pay attention to correct winding of the lamellar sealing ring (see detail B).
2. Align the cams on the nozzle ring with the recesses of the turbine casing (51000).
3. Insert the nozzle ring (56001) into the turbine casing up to the stop.
10.8 Installing the cartridge group

1. Attach lifting gear to bearing casing.
2. Remove fixing screws.
3. Lift the cartridge group out of the service support (90012).
4. Fit new O-rings (42195, 42200).
5. Screw the clamping nut (42201) flush onto the threaded rod (42191). The hexagon of the thread screw is at the top. Place the washer (01) of the clamping nut onto the expansion bush and, with the clamping nut screwed on, guide the threaded rod through the washer, expansion bush and bearing casing.
6. Screw the centering bush (42193) flush onto the threaded rod from below.
7. Lift the centering bush (42193) using the threaded rod (42191) and hold it firmly.
8. Rotate the clamping nut (42201) downwards until the stop is reached.
Dismantling and fitting, cartridge concept / 10.8 Installing the cartridge group

![Fig. 92: Installing the cartridge group 2](image)

**Table 57: Threaded rod, value X and L**

<table>
<thead>
<tr>
<th>Product</th>
<th>Value X [mm]</th>
<th>Value L [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>112 ±2 mm</td>
<td>52 ±2 mm</td>
</tr>
<tr>
<td>A155-M</td>
<td>144 ±2 mm</td>
<td>72 ±2 mm</td>
</tr>
</tbody>
</table>

**Table 58: Tightening torque (51007)**

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>M16</td>
<td>175</td>
</tr>
<tr>
<td>A155-M</td>
<td>M16</td>
<td>175</td>
</tr>
</tbody>
</table>

1. Lightly lubricate the hole in the bracket, into which the centering bush (42193) is inserted, with screw grease.
2. If present: Insert the metal C-ring (51105).
3. Move the cartridge group into the turbine casing and align with the markings (M) made on the bracket at the time of disassembly.
4. Screw clamping nut (42201) upwards to end of threaded rod and insert the centering bush (42193) into the hole.
   Check value X (if value X is not reached, the turbocharger must be re-aligned).
5. Screw in the threaded rod until value L is reached.
6. Tighten the pressure screws of the clamping nut (see **Tightening pressure screws →18**).
7. Secure fastening strips (51002) together with nuts (51007) and Verbus Ripp® washers (51003).
10.9 Installing the compressor casing

Fitting the wall insert and the diffuser

1. Fit a new O-ring (77005).
2. Fit the swivel lifting eyes (S) to the wall insert (77000). Secure lifting gear to the swivel lifting eye.
3. Install the wall insert (77000) into the compressor casing and, when doing so, pay attention to the positioning pin in the compressor casing.
4. Fit the diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

Fig. 93: Fitting the wall insert and the diffuser

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>A155</td>
<td>M6</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 59: Tightening torque (79041)
Installing the compressor casing

Fig. 94: Installing the compressor casing

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>275</td>
</tr>
<tr>
<td>A155</td>
<td>M18</td>
<td>370</td>
</tr>
</tbody>
</table>

Table 60: Tightening torque (72011)

- Thoroughly clean the fastening strips (72012) before assembly.
- 1. Fit a new O-ring (42012).
- 2. Install the compressor casing (72000).
- 3. Install the fastening strips (72012) with screws (72011). Observe the tightening torque.
10.10 Radial clearances N and R

Measurement of clearance R optional (only possible if gas outlet casing is dismantled).

![Diagram showing measurement of clearances N and R](image)

**Table 61: Permissible clearances N and R**

<table>
<thead>
<tr>
<th>Product</th>
<th>N [mm]</th>
<th>R [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>0.64 ... 1.09</td>
<td>0.71 ... 1.13</td>
</tr>
<tr>
<td>A155-M</td>
<td>0.78 ... 1.29</td>
<td>0.86 ... 1.33</td>
</tr>
</tbody>
</table>

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.
10.11 Fitting the insulation

Fig. 96: Fitting the insulation

Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →74).
10.12 Installing air inlets

Fig. 97: Installing the air inlets

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>275</td>
</tr>
<tr>
<td>A155</td>
<td>M18</td>
<td>370</td>
</tr>
</tbody>
</table>

Table 62: Tightening torque (72051)

1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
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. Install the filter silencer (81000) or air suction branch (82000).
4. Fit the fastening strips (72012) with hexagon-head screws (72051). Observe the tightening torque.
A155-M Uncoupled filter silencer

1. Secure lifting gear to filter silencer (81000).
2. Install the filter silencer (81000).
3. Fit the hexagon nuts (72054) together with Verbus Ripp® washers (72053) and three new safety plates (72055) (uniformly at 120° to one another). Observe the tightening torque.

**Table 63: Tightening torque (72054)**

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A155</td>
<td>M16</td>
<td>275</td>
</tr>
</tbody>
</table>

Fig. 98: Installing the uncoupled filter silencer
11 Dismantling and fitting, special tools for fastening strips

ABB offers an optional special tool set (90160) which, in the event of limited accessibility, can be used to facilitate the loosening of nuts and the application of tightening torques for the strip connection between the cartridge group and the turbine casing.

See also chapter Tools → 165.

The spanner holder (90165) should only be used for loosening the nuts and applying tightening torques for the nuts at the position shown.

Other screws or nuts on the turbocharger should not be tightened with this tool.
11 Dismantling and fitting, special tools for fastening strips

Customer tool (not included in the ABB scope of delivery)

Fig. 99: Customer tool

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Collection tub 500x400x30mm</td>
<td>1</td>
</tr>
<tr>
<td>02</td>
<td>Torque spanner 40-200 Nm with plug connection for holding insertion tools 14x18 mm</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 64: Customer tool

Customer tool (not included in the ABB scope of delivery)

Fig. 100: Customer tool

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Universal pliers</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 65: Customer tool
11.1 Application, special tools

Removing the fastening strips

Fig. 101: Positioning the collection tub

1. Position the collection tub (01) to catch any fixing elements if they fall.
2. Loosen the two nuts on one side by using the spanner holder (90165).
3. Loosen the two nuts on the other side by using the spanner holder (90166).

The cartridge group is fitted at this point in time. To enable a clear representation of the work step, the cartridge group is not illustrated in work step 4.

Fig. 102: Removing the fastening strips

4. Remove the nuts (51007) with spanner holder (90165/90166) and attached torque spanner (02). Remove washers (51003) and fastening strips (51002).

Any falling screw material will be caught in the collection tub (01).
5. Loosen the nuts (51007) from the remaining fastening strips and remove the lugs (51002) with washers (51003).
11. Dismantling and fitting, special tools for fastening strips / 11.1 Application, special tools

**Fitting the fastening strips**

![Diagram of fitting the fastening strips]

**Fig. 103:** Fitting the upper fastening strips

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>M16</td>
<td>175</td>
</tr>
<tr>
<td>A155</td>
<td>M16</td>
<td>175</td>
</tr>
</tbody>
</table>

Table 66: Tightening torque (51007)

1. Fit the nuts (51007) of the (upper) fastening strips (51002) illustrated and tighten with a torque spanner (02) without a spanner holder. Observe the tightening torque.

![Diagram of fitting the bottom fastening strip]

**Fig. 104:** Fitting the bottom fastening strip

2. Position the collection tub (01) to catch any fixing elements if they fall.
3. Tighten the two nuts on one side by using the spanner holder (90165).
4. Tighten the two nuts on the other side by using the spanner holder (90166).

The cartridge group is fitted at this point in time. To enable a clear representation of the work step, the cartridge group is not illustrated in work step 5.
11. Dismantling and fitting, special tools for fastening strips / 11.1 Application, special tools

Table 67: Tightening torque (51007) with spanner holder

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>M16</td>
<td>85</td>
</tr>
<tr>
<td>A155-M</td>
<td>M16</td>
<td>70</td>
</tr>
</tbody>
</table>

5. Fit the nuts (51007) with spanner holder (90165 / 90166) and attached torque spanner (02). Observe the tightening torque.
11.1.1 A155-M Fit fastening strips with extended special tool

1. Fit nuts (51007) of the (upper) fastening strips (51002) shown in the picture and tighten with the torque spanner (02) without a spanner holder. Observe the tightening torque.

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A155</td>
<td>M16</td>
<td>175</td>
</tr>
</tbody>
</table>

Table 68: Tightening torque (51007)
The cartridge group is already fitted at this point in time. The cartridge group is not illustrated in the following images so that all work steps are visually clear.

2. Position fastening strip (51002) in the tool disassembly segment (90164).

3. Clamp the lugs (A) of the tool disassembly segment slightly using the universal pliers (03) to fix the fastening strip.

4. Position the fastening strip with the tool disassembly segment onto the set screws.

5. Push the fastening strip with the tool disassembly segment in the direction of the turbine casing as far as possible.

6. Depress the tool disassembly segment and remove it.
7. Fix the washer (51003) with clamping device (90163) and check to ensure it is properly seated.
8. Position the washer (51003) on the set screw.
9. Remove the clamping device.
11. Dismantling and fitting, special tools for fastening strips / 11.1 Application, special tools

Fig. 109: Attach nut

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A155-M</td>
<td>M16</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 69: Tightening torque (51007) with spanner holder

10. Screw nut (51007) loosely to the locking device (90162).
11. First position the cord end in the direction of the axis before winding up.
12. Wind up the cord 7-10 times around the nut and over the cord end.
13. Position the locking device (90162) with attached nut (51007) exactly onto the threaded stud and press on.
14. Fit the nut (51007) to the set screw by pulling the cord.
15. Fit nuts (51007) with fixing washers (90165) and attached torque spanner (02). Observe the tightening torque.
12 Removing and installing 6-nozzle turbine cleaning component (optional)

12.1 Disassembly

The following illustration shows the initial situation before the 6-nozzle turbine cleaning component is dismantled.

Before disassembly, mark the positions of the elbows (51311).

1. Just loosen the union nuts (51316) of the elbows (51311). Do not remove them yet.
2. Just loosen the screws (51314). Do not remove them yet.
Removing and installing 6-nozzle turbine cleaning component (optional) / 12.1 Disassembly

► Remove the elbows (51311) from the connecting pieces (51313) in the specified order (01, 02, 03, 04, 05).

1. Undo union nuts (51316) of pipe (51312).
2. Remove pipe.
12 Removing and installing 6-nozzle turbine cleaning component (optional) / 12.1 Disassembly

Fig. 114: Disassembly of the connecting pieces

1. Unscrew hexagon-head screws (51314) from connecting pieces (51313).
2. Remove gaskets (51302).
3. Remove connecting pieces.
4. Remove gaskets from holes.

Fig. 115: Disassembly of the cleaning nozzle

⚠️ Remove cleaning nozzles (51301) with screw (01) in accordance with the following table.

<table>
<thead>
<tr>
<th>Product</th>
<th>Thread</th>
<th>Length [mm]</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>M8</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>A155-M</td>
<td>M10</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 70: Dismantling screw
12.2  Assembly

Clean all of the components and axial contact surfaces of the gaskets before assembling the turbine casing.

Fig. 116: Assembly of the cleaning nozzle

Table 71: Dismantling screw

<table>
<thead>
<tr>
<th>Product</th>
<th>Thread</th>
<th>Length [mm]</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>M8</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>A155-M</td>
<td>M10</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>

1. Screw the screw (01) into the cleaning nozzle (51301) as far as it will go.
2. Insert the cleaning nozzle with screw as far as it will go.
3. Rotate the cleaning nozzle clockwise until the cleaning nozzle lowers further and is thus correctly positioned.
4. Remove the screw (01), ensuring that the cleaning nozzle remains in position.

Fig. 117: Assembly of the connecting pieces

1. Position gaskets (51302) on holes.
2. Position connecting pieces (51313).
3. Position gaskets (51302) on connecting pieces (51313).
4. Coat thread and contact surfaces of hexagon-head screws (51314) with high-temperature grease. Tighten screws by hand only.
Removing and installing 6-nozzle turbine cleaning component (optional) / 12.2 Assembly

Fig. 118: Pipe assembly

1. Coat thread and contact surfaces of cutting ring with high-temperature grease.
2. Position pipe (51312).
3. Position union nuts (51316) of pipe on connecting piece (51313) and screw-in fitting (51305) and tighten by hand only.

Fig. 119: Elbow 1 assembly

- Coat thread and contact surfaces of cutting ring with high-temperature grease.
- Screw union nuts (51316) of elbows (51311) in the specified order (01, 02, 03, 04, 05) to the connecting pieces (51313).
12 Removing and installing 6-nozzle turbine cleaning component (optional) / 12.2 Assembly

1. Tighten hexagon-head screws (51314) to tightening torque.
2. Tighten union nuts (51316) of elbows (51311) to tightening torque.

<table>
<thead>
<tr>
<th>Product</th>
<th>51314 [Nm]</th>
<th>51316 [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150-M</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>A155-M</td>
<td>100</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 72: Tightening torque (51314 / 51316)
13 Fitting the cleaning nozzles with multi-inlet turbine casings

Fig. 121: Fit the cleaning nozzles

1. The designation (P.) on the turbine casing must correspond with the designation (P.) on the cleaning nozzle.

2. The edges for the defined installation position in the turbine casing and at the cleaning nozzle must correspond.
14 Taking out of operation at short notice

14.1 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.

Wear safety gloves to protect against thermal hazards.

**⚠️ 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 →151.
- If present: Installing the replacement cartridge group →151.
- If a replacement turbocharger or cartridge group is not available: Fit cover plate →152 and contact an ABB Turbocharging Service Station.
- Observe the following sections in connection with the emergency repairs mentioned.
14.2 Installing the replacement turbocharger

To enable you to quickly put an engine back into operation after a turbocharger has sustained damage, ABB Turbocharging 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 →10).
- Install replacement turbocharger (see chapter Removing and Installing →10).
- Send the defective turbocharger to an ABB Turbocharging Service Station for inspection and repair.

14.3 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 Turbocharging 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 quickly, and are sensitive to unbalance.

- Remove defective cartridge group (see chapter Dismantling and fitting, general →66).
- Install replacement cartridge group (see chapter Dismantling and fitting, general →66).
- Send the defective cartridge group to an ABB Turbocharging Service Station for inspection and repair.
14.4 Fitting the cover plate

- Remove turbocharger (see chapter Removing and Installing →10).

- 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 of fitting the cover plate]

Fig. 122: 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.
14.5 Cover plate drawing

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

Material: General structural steel, in accordance with DIN EN 10025-2.

![Cover plate drawing](image)

Fig. 123: Cover plate drawing

<table>
<thead>
<tr>
<th>Product</th>
<th>B1 ± 0.5</th>
<th>B2</th>
<th>B3 ± 0.2</th>
<th>B4 ± 0.1</th>
<th>B5 ± 0.2</th>
<th>B6</th>
<th>ØD1 ± 0.2</th>
<th>ØD2</th>
<th>R1</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>138.9</td>
<td>135</td>
<td>240</td>
<td>21.4</td>
<td>2.0</td>
<td>320</td>
<td>71.4</td>
<td>413.6</td>
<td>33</td>
<td>≤ 196 M12</td>
</tr>
<tr>
<td>A155</td>
<td>164.6</td>
<td>160</td>
<td>286.5</td>
<td>25.5</td>
<td>2.0</td>
<td>385</td>
<td>84.6</td>
<td>492</td>
<td>39</td>
<td>≤ 232 M16</td>
</tr>
</tbody>
</table>

Table 73: Cover plate dimensions [mm]
Taking out of operation at short notice / 14.5 Cover plate drawing

**Table 74: Cover plate dimensions [mm]**

<table>
<thead>
<tr>
<th>Product</th>
<th>A</th>
<th>B</th>
<th>D1</th>
<th>D2 ± 0.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A150</td>
<td>90</td>
<td>10</td>
<td>90 ± 0.2</td>
<td>28.2</td>
</tr>
<tr>
<td>A155</td>
<td>107</td>
<td>12</td>
<td>111 ± 0.1</td>
<td>37.2</td>
</tr>
</tbody>
</table>

Fig. 124: Dimensions for cover plate
15 Mothballing the turbocharger

15.1 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.
15 Mothballing the turbocharger / 15.2 Taking the engine out of operation for more than 12 months

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

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

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

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

**15.2 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 →155, 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.
16 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.
17  

Spare parts

17.1  

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.

17.2  

Required customer spare part set (97070)

For the work 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>42195</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42200</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 75: Customer spare part set 97070

* This gasket can only be installed when a gas outlet casing from ABB is used.
17 Spare parts / 17.2 Required customer spare part set (97070)
17.3 View of turbocharger with part numbers

* Depending on the specification of the turbocharger

(……) only available in customer spare part set (97070).
### Part number | Designation
--- | ---
- - | Cartridge group
42012 (in customer spare part set) | O-ring
42167 | Orifice
42170 (option) | Bearing casing insulation
42190 | Expansion sleeve
42191 | Threaded rod
42193 | Centering bush
42195 (in the customer spare part set) | O-ring
42196 | Oil orifice
42200 (in the customer spare part set) | O-ring
42201 | Clamping nut
51000 | Turbine casing
51002 | Fastening strip
51010 | Bearing casing insulation
51105* | Metal C-ring
51500 | Burst protection
56001 | Nozzle ring
56005 | Lamellar sealing ring
57002 | Gas outlet flange
57003* | Metal C-ring
57210 | Burst ring
61001 | Gas outlet casing
61002 (in the customer spare part set) | Gasket
61301* | Support
72000 | Compressor casing
72011 | Hexagon-head screw
72012 | Fastening strip
72060 | Hood
72061 | Insulating bush
77000 | Wall insert
77005 (in customer spare part set) | O-ring
79000 | Diffuser
79040 | Fixing disc
79041 (in the customer spare part set) | Counter-sunk screw
81000 | Filter silencer
81010 (in the customer spare part set) | O-ring
82000 | Air suction branch
82010 (in the customer spare part set) | O-ring
86505* | Speed sensor
86515* | Cable connector
86526* | F/I converter
86528* | Tachometer

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

17.4.1 One cleaning nozzle per turbine inlet

Fig. 126: 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 77: Spare parts list
17.4.2 6-nozzle turbine cleaning

![Diagram of 6-nozzle turbine cleaning device]

Table 78: Spare parts list

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>51301</td>
<td>Cleaning nozzle</td>
</tr>
<tr>
<td>51302</td>
<td>Gasket</td>
</tr>
<tr>
<td>51303</td>
<td>Screw plug</td>
</tr>
<tr>
<td>51304</td>
<td>Flange</td>
</tr>
<tr>
<td>51305</td>
<td>Screw-in fitting</td>
</tr>
<tr>
<td>51308</td>
<td>Stud</td>
</tr>
<tr>
<td>51309</td>
<td>Expansion sleeve</td>
</tr>
<tr>
<td>51310</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>51311</td>
<td>Elbow</td>
</tr>
<tr>
<td>51312</td>
<td>Pipe</td>
</tr>
<tr>
<td>51313</td>
<td>Connecting piece</td>
</tr>
<tr>
<td>51314</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>51316</td>
<td>Union nut</td>
</tr>
<tr>
<td>51317</td>
<td>Sealing stud</td>
</tr>
</tbody>
</table>

Fig. 127: Overview of part numbers
17.5  View of uncoupled filter silencer A155

Fig. 128: Overview of part numbers

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>72052</td>
<td>Set screw</td>
</tr>
<tr>
<td>72053</td>
<td>Verbus Ripp® washer</td>
</tr>
<tr>
<td>72054</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>72055</td>
<td>Safety plate</td>
</tr>
<tr>
<td>81000</td>
<td>Filter silencer</td>
</tr>
<tr>
<td>81145</td>
<td>Flange, compressor end</td>
</tr>
<tr>
<td>81146</td>
<td>Flange, turbine end</td>
</tr>
<tr>
<td>81147</td>
<td>Fixing ring</td>
</tr>
<tr>
<td>81148</td>
<td>Absorption element</td>
</tr>
<tr>
<td>81149</td>
<td>Mounting plate</td>
</tr>
<tr>
<td>81150</td>
<td>Fastening strips</td>
</tr>
<tr>
<td>81151</td>
<td>Roll pin</td>
</tr>
<tr>
<td>81152</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>81153</td>
<td>Washer</td>
</tr>
<tr>
<td>81154</td>
<td>Socket screw</td>
</tr>
<tr>
<td>81155</td>
<td>Hexagon-head screw</td>
</tr>
</tbody>
</table>

Table 79: Spare parts list
## 18 Tools

For the work described in the Operation Manual, the customer tool set 90000 is required.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service support</td>
<td>1</td>
</tr>
<tr>
<td>Plastic insert</td>
<td>1</td>
</tr>
<tr>
<td>Threaded insert</td>
<td>1</td>
</tr>
<tr>
<td>Socket screw</td>
<td>2</td>
</tr>
<tr>
<td>Press-off tool</td>
<td>2</td>
</tr>
<tr>
<td>Extraction device</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 80: Customer tool set 90000

ABB offers an optional special tool set (90160) which, in the event of limited accessibility, can be used to facilitate the loosening of nuts and the application of tightening torques for the strip connection between the cartridge group and the turbine casing.

Special tool (90160):

![Special tool image]

Fig. 129: Special tool

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>90160</td>
<td>Special tool, complete</td>
<td>1</td>
</tr>
<tr>
<td>90161</td>
<td>Bag</td>
<td>1</td>
</tr>
<tr>
<td>90165</td>
<td>Spanner holder</td>
<td>1</td>
</tr>
<tr>
<td>90166</td>
<td>Spanner holder</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 81: Special tool (90160)
Extended special tool (90160) for A155:

![Special tool](image)

**Fig. 130: Special tool**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>90160</td>
<td>Special tool, complete</td>
<td>1</td>
</tr>
<tr>
<td>90161</td>
<td>Bag</td>
<td>1</td>
</tr>
<tr>
<td>90162</td>
<td>Locking device</td>
<td>1</td>
</tr>
<tr>
<td>90163</td>
<td>Clamping piece</td>
<td>1</td>
</tr>
<tr>
<td>90164</td>
<td>Tool disassembly segment</td>
<td>1</td>
</tr>
<tr>
<td>90165</td>
<td>Spanner holder</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 82: Special tool (90160)

Tool sets can be ordered from any ABB Turbocharging Service Station. The following specifications must be included in the order:

- Turbocharger type
- Designation and part number of the tool set.
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