## Operation Manual

### TPS44-F32

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<th>Type</th>
<th>TPS44-F32</th>
<th>HT590429</th>
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<td>$n_{\text{Max}}$</td>
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<td></td>
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<tr>
<td>$n_{\text{Bmax}}$</td>
<td>1136 1/s</td>
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</tr>
<tr>
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<td></td>
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<tr>
<td>$t_{\text{Bmax}}$</td>
<td>620 °C</td>
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<table>
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<tr>
<th>Year</th>
<th>2019</th>
<th>Application according to the Operation Manual</th>
</tr>
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</table>

made in Switzerland

ABB Turbo Systems Ltd
CH 5401 Baden
Operating condition and replacement intervals

The operational limits for the turbocharger nBmax, tBmax, nMmax, tMmax, inspection- and replacement intervals for the components concerned on the rating plate are valid for the operational mode and compressor inlet condition, which has been agreed upon between the engine builder and ABB.

Note: Replacement intervals of components depends on the load profile, turbine inlet temperature, suction air temperature and turbocharger speed. In case the operation conditions differs significantly from what is considered to be normal for the current application, it is recommended to contact ABB for a re-calculation of replacement intervals. Frequent load alterations, high temperatures and high speed lower the life of components. Unless otherwise agreed, the application limits nMmax, tMmax are valid for the test operation for a limited time.
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1 Preliminary remarks

1.1 Purpose of this manual

This operation manual belongs to the turbocharger with the identical HT number (01), see the cover sheet of the operation manual and the turbocharger rating plate.

Operation Manual

This Operation Manual enables you to familiarize yourself with the turbocharger supplied by ABB Turbo Systems and to use it as intended.

It provides important information in order that the turbocharger can be operated safely, correctly and efficiently.

This Operation Manual complements and expands existing national regulations concerning work safety and accident prevention.

Target group

This Operation Manual is intended for engineers and qualified mechanics who are responsible for operating the engine and the turbocharger installed on it.

Availability of operation manual

An operation manual must be available at all times at the place where the turbocharger is used.

Everyone who operates or works on the turbocharger must have first read and understood the operation manual.
1.2 Layout and function

1 Suction branch / filter silencer
2 Compressor casing
3 Diffuser
4 Bearing casing
5 Axial thrust bearing
6 Radial plain bearing (visible only at turbine end)
7 Turbine
8 Gas outlet flange
9 Nozzle ring
10 Turbine casing
11 Turbine-end bearing flange
12 Compressor-end bearing flange
13 Compressor wheel
Mode of operation

The turbocharger is a turbomachine consisting of the following main components:

- Turbine
- Compressor

These are mounted on a common shaft.

Exhaust gases from the diesel or gas engine flow through the turbine casing (10) and the nozzle ring (9) to impinge on the turbine (7).

The turbine (7) uses the energy contained in the exhaust gas to drive the compressor wheel (13). The compressor draws in fresh air, compresses it and then forces it into the engine's cylinders.

The exhaust gases escape into the ambient air through the exhaust gas pipe, which is connected to the gas outlet flange (8).

The air, which is necessary for operation of the diesel or gas engine and is compressed in the turbocharger, is drawn into the compressor wheel (13) through the suction branch or filter silencer (1). It then passes through the diffuser (3) and leaves the turbocharger through the outlet on the compressor casing (2).

The rotor runs in two radial plain bearings (6), which are located in the bearing flanges (11/12) between the compressor and the turbine. The axial thrust bearing (5) is located between the two radial plain bearings.

The bearings are connected to a central lubricating oil duct which is supplied by the engine's lubricating oil circuit. The oil outlet is always at the lowest point of the bearing casing (4).
1.3 Intended use of the turbocharger

NOTICE

This turbocharger supplied by ABB Turbo Systems has been developed for use on diesel engines to generate the volume of air and the charging pressure required to operate the engine.

The engine builder has provided ABB Turbo Systems with information regarding the intended use of the engine, from which the operating limits specific to the turbocharger shown on the rating plate (such as operating speeds, temperatures, exchange intervals / replacement intervals) have been derived.

If it is used in conjunction with a gas engine, the engine must not be installed in a potentially explosive environment, and precautionary measures must be taken to ensure that the machine room as a whole is classified as not potentially explosive.

Any other use will be regarded as a special application which must first be discussed with ABB Turbo Systems. The manufacturer accepts no liability for other applications. If it is used otherwise, ABB Turbo Systems reserves the right to reject all warranty claims.

State of the art

This turbocharger was built according to state-of-the-art technology and is operationally safe according to recognised safety regulations.

WARNING

Improper operation and maintenance of the turbocharger can result in danger to life and limb of the user or third parties. In addition, improper use may cause damage to the machine.

- The machine may be operated only by trained personnel.

Use of the turbocharger as intended also includes observance of the installation / fitting, disassembly / removal, operating, maintenance / servicing and repair conditions specified by the manufacturer. Disposal regulations set down by local authorities must be observed.

Perfect condition

The turbocharger may be installed only when in technically perfect condition while observing the instructions given in the engine builder's manual. It may be used only for the intended purpose and operated in compliance with the operation manual.

- Malfunctions which could affect safety must be eliminated immediately.

The manufacturer accepts no liability for any damage resulting from unauthorised alterations to the turbocharger.
1.4 Storage of new turbochargers and spare parts

Storage of new turbochargers and spare parts up to 6 months

New turbochargers and spare parts from ABB Turbo Systems 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).

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 (VCI)

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:

► Ensure good room ventilation.
► Do not eat, drink or keep food at the workplace while working with VCIs.
► Wear safety gloves.
► Clean hands and face after working with VCIs.
► For further information refer to www.branopac.com.

Wear safety gloves to protect against chemical 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.
► 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 replacement turbochargers or spare parts

Per order, turbochargers or cartridge groups will be prepared by ABB Turbo Systems for prolonged storage. The package is equipped with a hygrometer (see illustration).

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 or rotor must be inspected by an ABB Turbocharging Service Station and repacked.

► Inspect the package for damage. If the package is damaged, the turbocharger or cartridge group 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
- Exchange the desiccant agent
- Repackage the components.

Replacement components ready for operation

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

Unpacking replacement turbochargers or spare parts

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.
1.5 Essential information

Organisational measures

In addition to this manual, the general, statutory regulations applicable in the respective country for the prevention of accidents and the protection of the environment must be observed.

This also applies to the provision and wearing of personnel protection equipment.

The safety and risk consciousness of the personnel working on and with the turbocharger must be checked regularly with reference to this manual.

The turbocharger must be shut down immediately by stopping the engine in the event of alterations affecting safety or of corresponding operating behaviour. The fault must be reported to the person or department responsible.

Additions and alterations to, and conversions of the turbocharger that could compromise safety require the prior approval of ABB Turbo Systems.
Original parts and safety

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

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.

ABB Turbo Systems accepts no liability for any damage resulting from the use of non-original parts and corresponding accessories.

Competence of personnel

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

ABB Turbocharging Service Stations will be happy to provide information on 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.

Registered Trademarks

Registered trademarks of external companies are used in this document. The trademarks are marked with ®.
1.6 Symbols and definitions

The following symbols are used in the documents:

- Prerequisite
- Step of a procedure
  - List, first level
  - List, second level
  - Refers to a page number

Definition of notes

Note
A note provides suggestions which facilitate the work on the product.

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

The caution and warning signs are described in the chapter Safety.

ABB Turbo Systems

In this document, ABB Turbo Systems Ltd is abbreviated to ABB Turbo Systems.

Official ABB Turbo Systems Service Stations

In this document, official service stations are referred to as ABB Turbo-charging Service Stations. They are inspected and certified regularly by ABB Turbo Systems. See also chapter Contact information [→ 15].
1.7 Turbocharger rating plate

Operating limits

- 01 Turbocharger operating limits at engine overload (110%). Only when operating in the test rig unless otherwise agreed with the enginebuilder.

Recommended inspection and replacement intervals of turbocharger components

- 02 Turbocharger operating limits during operation
- 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 of the special design
- 08 Weight of turbocharger in kg
- 09 Turbocharger type
- 10 Serial number
- 11 Year of construction of turbocharger
1.7.1 **Explanation of the rating plate**

The recommended replacement intervals and the corresponding operational limits are jointly defined with the engine manufacturer. This information is specific to the system.

Operation above the indicated values $n_{\text{Bmax}}$, $t_{\text{Bmax}}$ can considerably shorten the recommended replacement intervals. In such cases, we recommend that you contact the nearest official ABB Turbocharging service station.

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

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

1.7.2 **Positions of the rating plates**

One rating plate (01) each is attached on the left and the right side of the turbocharger bearing casing.
1.8 Contact information

Contact information for the official service stations of ABB Turbo Systems is available online.

- Scan the QR code to access our website.

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

www.abb.com/turbocharging
2 Safety

2.1 Introduction

Turbochargers manufactured by ABB Turbo Systems are state of the art and comply with the pertinent safety and health-protection requirements that applied when the turbocharger was manufactured. Consequently, the turbocharger is safe to operate. Nevertheless, during turbocharger operation and when working on the turbocharger, residual risks can exist which:

- originate from the turbocharger itself and its accessories
- originate from the operating and auxiliary materials used
- are the consequence of insufficient observance of the safety instructions
- are the consequence of unsatisfactory and improper execution of maintenance and inspection work

The operator is responsible for access to the turbocharger as well as the organisational measures which regulate the safe handling of the turbocharger by his personnel.

All instructions in this chapter must be observed to ensure safe and trouble-free turbocharger operation and during work on the turbocharger.

In the same vein, all other specially marked safety instructions in every chapter of this manual must be observed (see the section entitled Definition of safety instructions).
2.2 CE conformity

Information

ABB turbochargers fulfil Directive 2006/42/EC on machinery and are considered partly completed machinery in the sense of Article 2 g.
## 2.3 Definition of mandatory signs

### To be worn at all times

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<th>Item</th>
<th>Description</th>
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<tr>
<td>Protective clothing</td>
<td>Safety footwear to protect against mechanical hazard and risk of falling</td>
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### To be worn according to the specific work

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<th>Item</th>
<th>Description</th>
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<tr>
<td>Safety glasses</td>
<td>Safety goggles</td>
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<tr>
<td>Safety gloves</td>
<td>Respiratory mask to protect against - Dusts - Gases</td>
</tr>
<tr>
<td></td>
<td>Safety helmet</td>
</tr>
<tr>
<td></td>
<td>Ear protection</td>
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</table>
2.4 Definition of Safety Instructions

The following symbols and terms used in this manual concern safety or refer to possible hazards:

**Definition of warning**

Serious personal injuries and even accidents with fatal consequences may occur if work and operating instructions marked with this symbol and the word **WARNING** are either not followed or not followed precisely.

► **Warning signs must be observed at all times.**

**Definition of caution**

Serious machine or property damage may occur if work and operating instructions marked with this symbol and the word **CAUTION** are either not followed or not followed precisely.

► **Caution signs must be observed at all times.**
Warning plates on the turbocharger

Warning plates are attached to the turbocharger at the following places:

If warning plates are not present at the intended places or are not legible, then proceed as follows:

- Order new warning plates from ABB Turbocharging Service Stations.
- Remove unreadable warning plates.
- Clean and degrease surfaces provided for warning plates.
- Attach new warning plates.

Uninsulated turbochargers

When uninsulated turbochargers are delivered to the engine builder, the warning plates must be subsequently attached to the insulation. This is the responsibility of the engine builder.
2.6 Safe operation and maintenance

The instructions specified in this section are for the safety of personnel. Together with the instructions in the Hazards during operation and maintenance section, they allow the user to safely use the turbocharger.

Work safety and work area safety

Risk of falling

There is the risk that someone can fall when working on the turbocharger.

▷ Do not climb on the turbocharger or on parts attached to it or use these as climbing aids.
▷ When working at levels above the head, use climbing aids and work platforms suitable for this purpose.

▷ Observe all general regulations for the prevention of accidents.
▷ Do not work on the turbocharger if you are under physical or mental stress.
▷ Work only with suitable tools as well as equipment and working materials that are in perfect condition.
▷ Electric tools must be solidly earthed, and connecting cables may not be damaged.
▷ Keep the workplace clean, clear away loose objects and remove obstacles on the floor.
▷ Keep the floor, equipment and the turbocharger clean.
▷ Have oil binding materials ready at hand and keep oil catch pans ready or in position.
▷ Eliminate leaks.
▷ Keep fire-protection materials and fire-extinguishing equipment ready.

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 range 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 start-up / commissioning and operation

The turbine casing insulation of the TPS44-F supplied by ABB Turbo Systems is also burst protection.

Serious personal injuries or fatal accidents can occur, if the turbine casing insulation of the TPS44-F supplied by ABB Turbo Systems is removed. The burst protection is integrated into the turbine casing insulation of the TPS44-F supplied by ABB Turbo Systems.

Separate burst protection is fitted to TPS44-F turbochargers without insulation that have been ordered from ABB Turbo Systems.

Never operate TPS44-F turbochargers that have been supplied by ABB Turbo Systems with insulation if this insulation from ABB Turbo Systems is not in place.

Never operate turbochargers without burst protection. If the insulation from ABB Turbo Systems is not in place, the separate burst protection (57200) must be fitted before operation. (See View of turbocharger showing part numbers [126].)

Before starting work, carry out visual inspection of working area.

Remove any obstacles and objects lying around.

Before start-up / commissioning, check all pipes from and to turbocharger for damage and leaks.

Don't work in any way that could impair safety when working on turbocharger.

After about every 12 hours of operation or at least once a day, inspect turbocharger for visible damage and defects.

Immediately report any damage or changes in operational performance to person responsible.

If damage is discovered, immediately shut down turbocharger and secure it against inadvertent or unauthorized use.

When switching on auxiliary power sources (hydraulics, pneumatics, electricity, water), keep an eye open for any hazards resulting from supplying these power sources.

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 and auxiliary materials" must be observed.

Observe the material safety data sheet for the cleaning agent or solvent.
Safe operation and maintenance

- 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 troubleshooting

- Always perform the specified adjustments, servicing as well as inspection work and observe inspection intervals.
- Inform operating personnel about all service and repair work before beginning.
- Before opening a cover or removing a protective device on a turbocharger, the engine must be switched off and the turbocharger must have come to a standstill.
- Ensure that the supply of oil is interrupted, especially with an external oil supply.
- Put the engine into operation only after all parts have been refitted properly.

**Mechanical work on the turbocharger**
Possible damage to or destruction of components on the turbocharger.

- Perform only those tasks that are described in this manual.
- Perform work only for which training has been carried out.

Safety when taking out of operation or preparing for mothballing

- Secure the rotor so it cannot turn. The rotor can turn on its own from the force of the stack draught.
- Clean the turbocharger before mothballing it.
- Observe the material safety data sheet for the cleaning and mothballing agents.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
2.7 Hazards during operation and maintenance

Mechanical hazards during operation

During normal operation, no mechanical hazards emanate from the turbocharger if it has been installed properly.

Risk of injury

Contact with rotating parts can lead to serious injuries. The turbocharger must never be operated without a filter silencer or an air suction branch. When the engine is at a standstill, the rotor can turn on its own because of stack draught.

- Operate the turbocharger in accordance with instructions.
- During maintenance work, secure the rotor against unintentional rotation.

Mechanical hazards when working on the turbocharger

During maintenance work, various risks can occur through the improper handling of components, through the non-observance of work instructions, due to inadequate care or as a consequence of insufficient training.

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 document.
- Only perform operations for which you have previously received instruction or training.
Hazards during operation and maintenance

2.7

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Hazards due to noise

The development of noise during operation is influenced by the installation and operating conditions. Noise with a sound pressure level exceeding 85 dB(A) is harmful.

**WARNING**

Hazards due to noise

Noise can cause impaired hearing, damage to health, mental disturbances, diminished attention and irritation.

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

Wear ear protection.

Hazards due to hot surfaces and substances

During operation, turbocharger surfaces and attached parts as well as operating materials (lubricating oil) become hot. The surface temperature is dependent on the effectiveness of the insulation being used. The temperature can become high enough so that it falls into ranges where burns are possible.

**WARNING**

Risk of burning

Touching hot surfaces or contact with hot operating materials can lead to serious burns.

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

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

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Hot surfaces on the non-insulated turbocharger
Non-insulated turbochargers can cause serious injuries to personnel (burns).

The turbocharger is supplied by ABB Turbo Systems without insulation depending on the order 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 operating and auxiliary materials
Operating and auxiliary materials are substances used for operation or the execution of maintenance work. Oils, greases, coolants, cleaning agents and solvents, acids, etc. can be regarded as hazardous materials. Operating and auxiliary materials can be combustible and easily ignited.

Handling operating and auxiliary materials
Ingestion or inhalation of vapours of operating and auxiliary materials or contact with such can cause damage to health.

- Avoid inhalation and contact with the skin.
- Ensure good ventilation.
- Observe details in the safety data sheets of the operating and auxiliary materials.
- Observe local laws.

Wear safety goggles.

Wear safety gloves to protect against chemical hazards.

Wear a respiratory mask to protect against gases.
WARNING

Risk of fire, explosion
Flammable and combustible operating materials and supplies can catch fire or resulting vapours can lead to an explosion.
- Observe the details in the material safety data sheets of the operating and auxiliary materials.
- 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 aeration and ventilation.

CAUTION

Risk of environmental damage
The escape of operating and auxiliary materials into the atmosphere or contamination of the ground and water due to improper disposal can lead to environmental damage.
- Handle operating and auxiliary materials carefully.

- Heed the instructions for use, safety data sheets and hazard notices on the containers of the operating and auxiliary materials.
- Wear appropriate protective clothing.
- Avoid inhalation and contact with the skin.
- Ensure that the work space is adequately ventilated.
- Seal containers tightly immediately after use and put them away.
- Collect used working and auxiliary materials safely, store them separately in suitable containers and dispose of them properly and in an environmentally compatible manner in accordance with statutory regulations.
- In the event of leaks or after spilling, immediately spread a suitable binding agent and dispose of it properly and in an environmentally compatible manner in accordance with statutory regulations.
Hazards when handling insulating materials

Hazards due to insulating materials
Dust and fibres from insulating materials can cause damage to health or irritations. Unsuitable, combustible insulating materials signify a fire hazard.

- Use only suitable, non-combustible insulating materials.
- Ensure that the work area is well ventilated.
- Avoid stirring up dust.
- Use tools and processes which keep dust to a minimum.
- Remove packing materials only in the work area.
- Take particular care when removing old insulating materials.
- Dispose of insulating materials properly and in an environmentally compatible way in accordance with applicable local regulations.

Wear safety goggles.

Wear a respiratory mask to protect against dusts.

Wear safety gloves to protect against chemical hazards.

- Use only suitable, non-combustible insulating materials.
- Ensure that the work area is well ventilated.
- Wear suitable work clothing (safety glasses, respiratory mask).
- Avoid stirring up dust.
- Use tools and processes which keep dust to a minimum.
- Remove packing materials only in the work area.
- Take particular care when removing old insulating materials.
- Dispose of insulating materials properly and in an environmentally compatible way in accordance with applicable local regulations.
Hazards due to electrical components

Hazard due to electrical components
Electrical components operate with voltages which can present hazards to humans.

- All work on or with electrical components may only be performed by trained specialists.
- Heed any country-specific regulations.
2.8 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. This inspection and evaluation must be carried out by an ABB Turbocharging Service Station.
2.9 Periodic checking of the pressure vessel

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

- The local, statutory regulations covering periodic checks of pressure vessels must be observed.
- The operator is responsible for the safe operation of the pressure vessel.

**Hazards from pressure vessels**

The operator must keep the pressure vessel in a proper condition and monitor it. Necessary repair or maintenance work must be carried out without delay and the required safety precautions must be taken.

» Pressure equipment must not be operated if it has defects.
2.10 Lifting loads

**Suspended loads**

Loads not suspended in compliance with regulations may lead to personal injury or accidents with fatal consequences.

- Loads must always be fastened to technically perfect lifting gear with sufficient loading capacity.
- Make sure the load is suspended properly on the crane hook.
- Do not let anyone stand beneath a suspended load.

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

In the case of two or more suspension points, the slinging angle must not exceed 45°. This avoids excessive loading due to inclined tensile loading.

- Fasten turbocharger assemblies / components as described in respective handling steps.
- Before attaching slings, allow turbocharger components to cool down (maximum 80°C).
- Use suitable protection at sharp edges.
- Completely screw in assembly / fitting devices without fail so that they cannot work loose during use.
- Use assembly / fitting devices only for applications described.
- Make sure removed turbocharger components stand safely and securely.
3 Start-up

3.1 Oil supply

A carefully designed and installed oil supply, which functions in all possible operational conditions, is an important prerequisite for trouble-free turbocharger operation.

The turbocharger is normally lubricated with oil from the engine oil circuit. If a separate lubricating system is used, then emergency lubrication is also to be provided.

- Heed the instructions of the engine builder when selecting the lubricating oil and oil-change intervals.

Oil filtration

Depending on the turbine specifications and bearings used, varying amounts of contaminants have to be filtered out of the lubricating oil to avoid dangerous wear of the bearing parts.

The standard oil filter specification for the turbocharger is 34 µm. This means that contaminants larger than 0.034 mm must be filtered out of the oil with a separation efficiency > 99%.

- Fit an accessory filter if engine oil filter is not efficient enough.
- If the engine is started cold and the flow resistance rises to above 0.5 bar due to deposits of dirt in the accessory filter, a bypass must open which ensures that oil flows to the turbocharger by circumventing the filter.
- Check that oil filters are clean before commissioning.

Also follow the enginebuilder's instructions regarding filter mesh and separation efficiency.
Lubricant

All lubricating oils used for engines are admissible.

Oil inlet viscosity and temperature

The oil-inlet temperature must not exceed 105°C. Permissible oil-inlet viscosities and oil-inlet temperatures are shown in the following chart.

1) Kinematic viscosity (mm²/s = cSt)
2) Oil-inlet temperature (°C)
A Permissible range

Falling below the minimum oil inlet temperature

Serious machine or property damage can be caused by excessively high oil viscosity and the resulting lack of oil in the bearings.

- Do not allow the oil inlet temperature to fall below the minimum 30 °C when starting the engine.
- The oil inlet temperature must never be less than 10 °C.
Oil pressure

The oil pressure in front of the turbocharger must be maintained precisely to ensure trouble-free operation.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil pressure in front of turbocharger [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>2.0 ... 4.5</td>
</tr>
<tr>
<td>Engine start: cold oil, permissible for maximum 15 minutes</td>
<td>≤ 8.0</td>
</tr>
<tr>
<td>Engine idling</td>
<td>≥ 0.2</td>
</tr>
<tr>
<td>Pre- and post-lubrication (engine stopped)</td>
<td>≤ 1.0</td>
</tr>
</tbody>
</table>

**Prelubrication**

Serious machine or property damage might result if the turbocharger is not supplied with oil when the engine is starting.

▸ Activate prelubrication device before starting engine.
Lubricating oil temperature at the inlet

**Machine damage**

Machine damage may result if the oil temperature at the oil inlet exceeds the permissible range.

- Keep the oil temperature at the oil inlet as specified in the following table.

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

Lubricating oil temperature at the outlet

The oil temperature at the outlet depends mainly on:

- lubricating oil temperature and pressure at the oil inlet
- engine load and turbocharger speed
- exhaust gas temperature

The maximum permissible oil temperature at the outlet is listed in the following table. The specified oil outlet temperature must be regarded as an alarm value for turbocharger operation and be monitored in accordance with standard regulations.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at outlet $T_{\text{oil,outlet}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible</td>
<td>$\leq 160 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Temporarily permissible → alarm</td>
<td>$&gt; 160 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Not permissible → stop engine</td>
<td>$&gt; 180 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Permissible stop engine</td>
<td>$\leq T_{\text{oil,inlet}} + 55 , ^\circ\text{K}$</td>
</tr>
<tr>
<td>Temporarily permissible → alarm</td>
<td>$&gt; T_{\text{oil,inlet}} + 55 , ^\circ\text{K}$</td>
</tr>
</tbody>
</table>

If the turbocharger has been operated outside the permissible range for a prolonged period of time, ABB Turbo Systems recommends having the turbocharger inspected by an ABB Turbocharging Service Station.
3.2 Inspection work

Inspection work includes preventive visual controls plus monitoring and measuring work before and during commissioning. Inspections help detect changes to the turbocharger. Machine damage can be avoided.

3.2.1 Inspection before commissioning

- **Monitoring devices**
  - Check for correct functioning.

- **Filter mat**
  - Inspect for damage.

- **Lubricating system**
  - Check oil filter for cleanliness before commissioning.

**CAUTION**

Contaminated oil

Particles of dirt and solid matter in the oil can cause serious damage to the machine or property.

- During initial commissioning and after all service work, the complete lubricating system must be flushed thoroughly with warm oil.
- When running in the engine and after all service work on the lubricating system, special running-in filters must be used.

- Check oil pressure in oil supply lines.

**CAUTION**

Prelubrication

Serious machine or property damage might result if the turbocharger is not supplied with oil when the engine is starting.

- Activate prelubrication device before starting engine.

- Check whether the warning plates are present and legible.

- Check whether the protective sheets have been removed.
3.2.2 Check after start-up (engine at idling speed)

Lubricating system

- Check oil pressure in oil supply lines.
- Check oil inlet temperature.

The permissible values are listed in the section Oil supply.

Gas, air and oil lines

- Check all gas, air and oil lines for leaks after starting the engine.

3.2.3 Check when running up engine

- Measure speed, oil pressure and charging pressure at various engine performance levels.
- Measure exhaust gas temperature in front of and behind turbine.
- Measure air temperature in front of and behind compressor.

The measured values must be compared with the values in the acceptance test report, while taking different operating conditions into account.

### NOTICE

Lubricants and pastes used during assembly of the turbocharger liquefy or vaporise and might escape as an oily liquid in the first few hours after commissioning. If oily liquid continues to escape after this period, an oil leak must be suspected. The first step is to check for leakage of the oil supply to the turbocharger. If this is leaky, contact an official ABB Turbocharging service station.

3.2.4 Inspection after 100 service hours

Clean or replace lubricating oil filters after the first 100 service hours.
3.3 Commissioning after taking out of operation

If provided

- Remove cover plates (blind flanges) between compressor casing outlet and charge air duct, before gas inlet and after gas outlet.

- Inspect exhaust gas duct / line in front of and after turbine for any combustion deposits, foreign matter or residual water. Clean and remove.
- Inspect air supply line or filter silencer for any foreign matter. Clean and remove.
- Start up turbocharger oil circulation system at engine end.
- Prepare turbocharger for operation as instructed in section "Inspection work before start-up / commissioning" of chapter headed "Start-up / commissioning".
- Start up turbocharger.
4 Operation

4.1 Noise emissions

**Hazards due to noise**

Noise can cause impaired hearing, damage to health, mental disturbances, diminished attention and irritation.

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

Wear ear protection.

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

The highest sound pressure level of emissions\(^1\) reaches a maximum of 105 dB(A) near the filter silencer and over the entire speed range.

The following prerequisites must be fulfilled on the turbocharger in order to observe this limit value:

- Fitted air-inlet system
- All standard, noise-reducing measures have been taken\(^2\).
- The bellows at the air outlet have been perfectly insulated acoustically by the engine builder. He is also 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

\(^2\) In the event of divergent insulation designs, the engine builder must ensure that equivalent acoustic insulating measures are taken.
Suggestion for noise insulation of the bellows

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

Service work to be carried out during operation involves visual checks, monitoring, measuring, inspection work and functional checks. It is then possible for changes to the turbocharger to be identified and rectified. In this way, it can be ensured that the turbocharger remains in full working order.

Service intervals

Service work on the turbocharger that is neglected or carried out too late can lead to excessive contamination and wear as well as operating failures.

- Carry out service work at specified time intervals.

Shortened service intervals

Despite observance of the service intervals, unusual loads, such as several start-stops a day, harsh environmental factors, poor fuel quality or heavy installation vibration can lead to premature machine damage.

- A shortened service interval must be arranged with ABB Turbo Systems.

Service inspection after 5 years

To prevent age- and stoppage-related machine damage, an inspection by an ABB Turbocharging Service Station is recommended at the latest 5 years after the last service.

4.2.1 Service work every 25 ... 50 hours

- Visual inspection for air, exhaust gas, water and oil leaks.
- Record operating data and enter it in the engine logbook.
- Clarify the cause of any variances.

Unknown changes during operation

The consequences can range from an impairment to a breakdown.

- Have unknown causes clarified by an ABB Turbocharging service station.
4.2.2 Servicing work according to the engine manufacturer's instructions

- Clean or replace oil filter in supply line to turbocharger when engine is not running.

4.2.3 Service work in accordance with instructions on rating plate

(In general, after 8000 - 12000 hours of operation)

Rotor and bearing parts must be inspected and assessed by an ABB Turbocharging Service Station. The following work can be carried in preparation.

- Remove cartridge group as described in chapter Disassembly and assembly.
- Measure clearances.
- Clean turbine and compressor casings and check them for cracks and erosion / corrosion.
- Clean bearing casing and blow air through oil ports / holes.
- Clean nozzle ring and check for cracks and erosion.
4.2.4 Entries in engine logbook

By monitoring the engine, conclusions can be drawn about the turbocharger performance.

The following operating data and measured values must be entered regularly in the engine manufacturer's engine logbook:

- Engine performance and speed
- Air intake temperature
- Exhaust gas temperature in front of and behind the turbine
- Pressure of charge air
- Pressure drop in charge air cooler
- Lubricating oil pressure and lubricating oil temperature

If provided

- Air temperature behind compressor and charge air cooler
- Turbocharger speed
- Pressure loss in air filter
4.3 Expected exchange intervals

Rotating components

The recommended replacement intervals for compressor wheels and turbine wheels are defined depending on the operating conditions and based on the safety concept (SiKo) for rotating parts. These intervals can be found on the turbocharger rating plate.

Non-rotating components

Depending on the system-specific operating conditions, a distinction is made between:

- the replacement interval for the bearing parts and
- the replacement interval for those non-rotating components that are exposed to hot gases.

Decisive in this respect are various influencing parameters, which can drastically shorten the replacement intervals of these parts in extreme cases.

During the specified periodic service work, the individual components are inspected for wear and, if necessary, replaced.

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>50000</td>
<td>10000 … 25000</td>
</tr>
<tr>
<td>Gas outlet flange</td>
<td>50000</td>
<td>35000 … 50000</td>
</tr>
<tr>
<td>Partition wall</td>
<td>50000</td>
<td>35000 … 50000</td>
</tr>
<tr>
<td>Rotor components</td>
<td>See the data on the rating plate</td>
<td></td>
</tr>
<tr>
<td>Bearing parts</td>
<td>12000 … 24000</td>
<td>12000 … 24000</td>
</tr>
<tr>
<td>Other casings</td>
<td>50000</td>
<td>50000</td>
</tr>
</tbody>
</table>

GAS = Natural gas  MDO = Marine diesel oil  HFO = Heavy fuel oil

The specified values are a guide only and not guaranteed (see following section Influencing parameters).
Influencing parameters

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

- Fuel quality and preparation
- Load profile (thermal load cycles, also starts / stops, emergency shut-downs)
- Gas inlet temperature
- Frequency and execution of turbine and compressor cleaning
- Turbocharger specification
- System-specific operating conditions (operating point, combustion quality, composition of exhaust gas)

For bearing parts

- Lubricating oil quality (oil filtration, condition of lubricating oil, oil monitoring)
- Load profile (rpm / speed, pressure conditions, temperature)
- State of rotor unbalance (degree of contamination)
4.4 Speed measurement

A speed measuring system permits continuous monitoring of the turbocharger speed.

**Do not use cables as a climbing aid**

If you pull the speed measurement cables too hard, contacts can be pulled out.

- Do not tension the speed measurement cables.

---

86505(A)  Speed sensor (cable not integrated)  86526  F/I converter
86505(B)  Speed sensor (cable integrated)  86528  Tachometer
86515(A)  Cable connector to 86505(A)  01  Screw plug
86515(B)  Cable connector to 86505(B)  02  Gasket
4.4.1 Speed differences with multiple turbochargers per engine

The speeds of all turbochargers on one engine differ only slightly from each other in normal operation.

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

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

- Reduce engine performance immediately until the highest turbocharger speed no longer exceeds 70% of $n_{B_{max}}$.
- If the engine cannot be stopped, continue to run at this reduced engine performance or turbocharger speed.
- If the turbocharger surges continuously, engine performance must be reduced further.
- Measure the temperatures in the air and gas lines to and from the turbochargers and compare them with standard values.

If the engine can be stopped for a short time:

- Inspect the air and gas lines as well as the turbocharger and eliminate any problems.
- In any event, it is recommended that you contact the nearest ABB Turbocharging Service Station.
4.4.2 Replacing the speed sensor

**Hot cable connector and hot speed sensor**
Risk of burning. During operation, the cable connector and the speed sensor can reach temperatures exceeding 100 °C.
- Wear safety gloves when removing the cable connector and speed sensor.

Wear safety gloves to protect against thermal hazards.

- Reduce engine performance to the idling speed, then stop the engine.
- Switch off the lubricating oil supply to the turbocharger.
- Disconnect the cable connector from the speed sensor.
- Screw out defective speed sensor.

- Screw in a new speed sensor up to the limit block.
- Adhere to tightening torque.

<table>
<thead>
<tr>
<th>Part number</th>
<th>TPS44</th>
<th>TPS48</th>
<th>TPS52</th>
<th>TPS57</th>
<th>TPS61</th>
</tr>
</thead>
<tbody>
<tr>
<td>86505</td>
<td>15 Nm</td>
<td>15 Nm</td>
<td>15 Nm</td>
<td>15 Nm</td>
<td>15 Nm</td>
</tr>
</tbody>
</table>
NOTICE
Sealing the speed sensor
The speed sensor is designed with a sealing lip and does not require an additional gasket when fitted.

- Connect cable connector to speed sensor.
- Switch on lubricating oil supply to turbocharger.

4.4.3 Failure of speed measuring system
Possible reasons for failure of the speed measuring system are described in the chapter Troubleshooting.
4.5 Stopping the engine

**Stopping the engine of oil-cooled turbocharger version**
Heat in the turbocharger must be dissipated by the further circulating lubricating oil.
- Post-lubricate for 15 … 20 minutes.
- Maintain oil pressure of 0.5 … 1.0 bar for post-lubrication.

**Stopping the engine of water-cooled turbocharger version**
Heat in the turbocharger must be dissipated.
- Allow turbocharger cooling water to run for 15 … 20 minutes after stopping engine.
- Allow oil lubrication to continue running until rotor comes to a stop.
  Further post-lubrication is not required and not recommended.
5 Maintenance

5.1 Foreword to Maintenance

General maintenance work involves regular visual checks and cleaning tasks which are intended to ensure the trouble-free functioning of the turbocharger.

The maintenance points described here are differentiated as follows:

- Cleaning during operation:
  - Compressor
  - Turbine and nozzle ring.

- Mechanical cleaning of individual components:
  - Filter silencer
  - Casings, diffuser, nozzle ring
  - Cartridge group: Compressor, turbine

**Risk of damage during mechanical cleaning**

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

- If cleaning during operation is not sufficient to achieve acceptable values regarding thermal load and engine performance, mechanical cleaning of certain spots can be carried out.
- Perform mechanical cleaning, especially of the cartridge group, only once within the service interval.

**Cleaning method**

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

- Dispose of dirty water and cleaning agents in an environmentally compatible manner, professionally and in accordance with valid local regulations.
5.2 Cleaning the compressor during operation

General

The contamination of the compressor stage (compressor wheel, wall insert and diffuser) depends on the degree of purity of the taken-in air.

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
- Higher exhaust gas temperatures
- Increased fuel consumption
- Increased rotor unbalance

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

NOTICE

If the coating of dirt is very thick and hard, the compressor can only be cleaned manually when disassembled. This cleaning must be carried out by an ABB Turbocharging Service Station.

Cleaning interval

The interval between periodic cleaning is very dependent on the operating conditions. In general, cleaning should be carried out every 25 ... 100 operating hours.

Should the specified cleaning intervals prove incompatible with engine operation, please contact ABB Turbo Systems.
Cleaning the compressor while in operation is carried out as wet cleaning. This cleaning method has been tested and approved by ABB Turbo Systems.

To clean the compressor stage during operation, water is injected in front of the compressor wheel through an injection pipe fitted in the filter silencer or the suction branch.

The water does not act as a solvent, but the dirt deposit is removed by the mechanical impact of the droplets. This is a very suitable process, provided that the degree of contamination is not too high.

**Principle of wet cleaning**

To clean the compressor stage during operation, water is injected in front of the compressor wheel through an injection pipe fitted in the filter silencer or the suction branch.

The water does not act as a solvent, but the dirt deposit is removed by the mechanical impact of the droplets. This is a very suitable process, provided that the degree of contamination is not too high.

**Corrosion and deposits when cleaning**

Damage and impairment of turbocharger parts due to salt water and cooling water additives

- Don't use salt water for cleaning, but only clean fresh water.

**CAUTION**

The injection pipe must on no account be connected directly via a cock to a water pipe or a dosing vessel larger than the one supplied. This prevents uncontrolled volumes of water entering the turbocharger and engine, which can lead to serious damage.

**V-engines**

In the case of V-engines with several turbochargers on each engine, we recommend parallel cleaning of the compressors. This cleaning process is faster and the risk of turbocharger surging is reduced.

**Sequential charging**

In the case of sequential charging, care must be taken to ensure that turbocharger compressors are cleaned regularly, especially after periods of operation in the lower performance range.
Cleaning the compressor during operation

5.2 Page 58

5.2.1 Wet cleaning compressor using external water pressure vessel (XC1)

Approval by enginebuilder

These instructions for wet cleaning only apply when cleaning is carried out with clean water and under the precondition that the enginebuilder approves the process.

Supplying water from the externally mounted water vessel is suitable only for those applications where a negative pressure exists in front of the compressor wheel (not used for: blowers connected in front of the compressor or high-pressure compressor stages with two-stage charging).

Operating state prerequisites for cleaning compressor with XC1

To be able to carry out a satisfactory cleaning process that has been tested and is recommended by ABB Turbo Systems, the following prerequisites must be fulfilled:

- Run engine at load from 50 ... 85 %.
- Start cleaning cycle according to following description Wet cleaning operation with XC1.
Cleaning the compressor during operation

Procedure for wet cleaning the compressor with XC1

- Remove sealing plug (X).
- Fill the vessel (Z) with clean water.
- Screw in the sealing plug.
- Push the valve activator (Y) against the spring and hold for 10 to 15 seconds until the entire volume of water has been injected.
- Do not repeat the cleaning cycle until a stabilisation period of at least 10 minutes has elapsed.

**NOTICE**

Whether or not cleaning has been successful can be seen from the charging or flushing pressure and also from the exhaust gas temperatures. If the cleaning process is unsatisfactory, it can be repeated up to 2 times.

If the cleaning result is still not satisfactory after three attempts and the engine values are also unsatisfactory, we recommend that you have the turbocharger inspected and cleaned by an official ABB Turbocharging Service Station.

**Cleaning parameters per turbocharger compressor**

<table>
<thead>
<tr>
<th>Product</th>
<th>Engine load</th>
<th>Contents of cleaning medium vessel [dm³]</th>
<th>Water injection time t₁ [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS</td>
<td>50 ... 85 %</td>
<td>0.4</td>
<td>10</td>
</tr>
</tbody>
</table>
5.3 Turbine cleaning during operation

The combustion of fuels such as heavy fuel oil (HFO) in diesel engines produces contamination of the turbocharger's turbine components. In combination with a high exhaust gas temperature, poor quality fuel can lead to particularly hard deposits on the nozzle ring and especially on the gas outlet flange.

ABB Turbo Systems recommends using fuels with a low ash, sulphur, sodium and vanadium content.

Consequences of contamination:

- Poor turbine efficiency
- Elevated exhaust gas temperatures
- Higher charging and ignition pressures as turbocharger speed rises
- Lower engine performance.
- After stopping the engine, the rotor can become stuck in contamination deposits.

Experience with turbocharger operation shows that the intervals between overhauls can be extended if cleaning while in operation is carried out periodically. Wet cleaning the turbine, as described below, should be used for 4-stroke applications when there are heavy deposits from, for example, HFO.

Under no circumstances is periodic cleaning of the turbine during operation a substitute for the service work carried out when the turbocharger is completely dismantled and cleaned mechanically.

Turbines which are very heavily contaminated cannot be cleaned this way any longer. In this case, the contaminated components must be mechanically cleaned by an ABB Turbocharging Service Station.

**NOTICE**

Regular cleaning

Regular turbine cleaning during operation prevents or delays excessive build-up of contamination.

Cleaning intervals

The interval between periodic cleaning is very dependent on the operating conditions. In general, cleaning should be carried out every 50 to 200 operating hours.
Cleaning intervals
Should the specified cleaning intervals prove incompatible with engine operation, please contact ABB Turbo Systems.

Cleaning method
Turbine components are cleaned during operation using the wet cleaning processes described in the following. These have been tested and are approved by ABB Turbo Systems.

The turbine casing design and the type of turbine casing sealing are decisive for the choice of cleaning method.

Approval by engine manufacturer
The prerequisite for wet cleaning is that the engine manufacturer approves the method and his instructions are followed.

5.3.1 Wet cleaning methods

Process with short water injection time (3 x 30 seconds cleaning)

The cleaning process with short water injection time is used for turbocharger designs without additional sealing by means of C-rings.

The process is based on the principle of thermal shock in combination with a subsequent flushing phase.

Process with long water injection time (10 minutes cleaning)

The cleaning process with a long water injection time is used for turbocharger designs with additional sealing by means of C-rings.

Based on a 10-minute injection phase, this cleaning process utilises the water solubility of the dirty deposits.
### 5.3.2 Prerequisites

#### Risk of corrosion and deposits

Impairment and damage of turbocharger by salt water and cooling water additives in flow ducts
- Don't use salt water for cleaning, but only clean fresh water.
- Avoid corrosion on casing inner surfaces.
- Let engine run for 10 minutes after wet cleaning.

#### Maximum temperature in front of turbine during cleaning

When cleaning, the temperature in front of the turbine will rise and can heavily stress the material of turbine components. The temperature at the turbine inlet can be up to 100 °C higher than the exhaust gas temperature after the cylinder. This should be taken into consideration when setting the operating point before cleaning.
- Don't exceed maximum temperature in front of turbine when cleaning.

#### Impermissible thermal stressing and flooding of the turbine

Smaller volumes of water can result in poor cleaning. Larger volumes of water lead to impermissible thermal stressing of the turbine components and can cause flooding of the turbine.
- Be absolutely sure to observe turbine cleaning parameters.

#### V-engines

In the case of V-engines with several turbochargers on each engine, we recommend parallel cleaning of both turbochargers. This cleaning process is faster and the risk of turbocharger surging is reduced.
Recommended operating state for turbine wet cleaning

The following operating state has been tested and is approved by ABB Turbo Systems:

<table>
<thead>
<tr>
<th>Characteristic / component</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>short water injection time</td>
</tr>
<tr>
<td>Engine load (guide value)</td>
<td>20 ... 40 %</td>
</tr>
<tr>
<td>Turbine inlet temperature T_{TE before water injection}</td>
<td>350 - 400 °C</td>
</tr>
<tr>
<td>Water supply</td>
<td>ensured</td>
</tr>
<tr>
<td>Water pressure (overpressure over atmosphere) $p_{WT}$</td>
<td>2.0 bar</td>
</tr>
</tbody>
</table>

If necessary, engine performance must be reduced to maintain these conditions.

The cleaning cycle can now be started based on the following description.
5.3.3 Procedure for method with short water injection time

- Prerequisites have been fulfilled.
- Wait 10 minutes during a stabilising phase after reducing the engine load.
- Open the shut-off valve.
- Set the required water flow rate as specified in the table of cleaning parameters using the flowmeter and inject for 30 seconds.
- Observe a pause of 3 or 5 minutes as specified in the table.
- Repeat the 30-second water injection two times.
- Close the shut-off valve.
- Wait 10 minutes during a stabilising phase before increasing engine load again.

This completes the turbine cleaning process.

Cleaning parameters during the process

<table>
<thead>
<tr>
<th>TPS</th>
<th>Temperature in front of the turbine during cleaning [°C]</th>
<th>Water volume flow 1) [dm³/min]</th>
<th>Injection time [min]</th>
<th>Pause between injections [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>≤ 450</td>
<td>4.5</td>
<td>0.5 (3 x)</td>
<td>3</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td></td>
<td>17</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

1) corresponds to a water pressure $p_{WT}$ of 2.0 bar (overpressure over atmosphere)

Maximum temperature in front of turbine during cleaning

When cleaning, the temperature in front of the turbine will rise and can heavily stress the material of turbine components. The temperature at the turbine inlet can be up to 100 °C higher than the exhaust gas temperature after the cylinder. This should be taken into consideration when setting the operating point before cleaning.
- Don't exceed maximum temperature in front of turbine when cleaning.
5.3.4 Procedure for method with long water injection time

▷ Prerequisites have been fulfilled.
▷ Wait 10 minutes as a stabilising phase after reducing the engine load.
▷ Open the shut-off valve.
▷ Set the required water flow rate as specified in the table of cleaning parameters using a flowmeter and inject for 10 minutes.
▷ Close the shut-off valve.
▷ Wait 10 minutes as a stabilising phase before increasing the engine load again.

This completes the turbine cleaning process.

Cleaning parameters during the process

<table>
<thead>
<tr>
<th>TPS</th>
<th>Temperature in front of the turbine during cleaning [°C]</th>
<th>Water volume flow ¹) [dm³/min]</th>
<th>Injection time [min]</th>
<th>Stabilising phase before / after water injection [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>≤ 530</td>
<td>2.5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td></td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹) corresponds to a water pressure $p_{WT}$ of 1.5 bar (overpressure over atmosphere)

**CAUTION**

Maximum temperature in front of turbine during cleaning

When cleaning, the temperature in front of the turbine will rise and can heavily stress the material of turbine components. The temperature at the turbine inlet can be up to 100 °C higher than the exhaust gas temperature after the cylinder. This should be taken into consideration when setting the operating point before cleaning.

▷ Don't exceed maximum temperature in front of turbine when cleaning.
5.4 Cleaning components mechanically

5.4.1 Introduction

Choosing cleaning tools
Turbocharger components are sensitive to mechanical damage. The use of needle guns or other impact tools, for example, damages the components. Depending on the specification, nozzle rings and turbine casings have protective coatings, which can also be damaged.

- Only use soft tools such as cloths, brushes or wire brushes.
- In the event of heavy contamination, the cleaning methods that have been described such as soaking can be repeated until a satisfactory result has been achieved.

- Dispose of dirty water and cleaning agents in an environmentally compatible manner, professionally and in accordance with valid local regulations.

Disassembly and assembly
The disassembly and assembly of the components is described in chapter Disassembly and assembly.
5.4.2 Cleaning the filter silencer

Disassembly and assembly
The procedure for disassembly and assembly of the filter silencer is described in the chapter entitled Disassembly and Assembly.

Cleaning the filter ring (if provided)

- Remove filter ring (81265).
- Clean filter ring (81265) as required or every 500 operating hours, and replace after the fifth cleaning operation at the latest. The degree of contamination of the filter ring depends on the cleanliness of the air that is drawn in.
- Wash filter ring (81265) using water containing light-duty detergent or, if very heavily contaminated, soak it while squeezing carefully. Rinse in cold water. Avoid rough handling (do not use a water jet).
- Allow the filter ring to dry out completely before assembly.
- Dispose of dirty water and gentle detergents in accordance with valid local regulations.
Cleaning the absorption segments

- Loosen the tension bands (81270).
- Remove the cover grid (81266).
- Pull out the sheet-metal coverings (81137), bend them up and remove the absorption segments (81136).
- Clean the absorption segments (81136). During cleaning, ensure that the absorption segments (81136) are only cleaned with a mild jet of compressed air, soft brush or a damp cloth.
- Have absorption segments which are heavily contaminated replaced by an official ABB Turbocharging Service Station.

Fitting the filter silencer

- Insert the absorption segments (81136) into the sheet-metal coverings (81137).
- Bend the sheet-metal coverings (81137) back into their original shape and insert them into the slot guides in the silencer body (81135).
- Fit the cover grid (81266).
- Fit the tension bands (81270) and apply tension at the locks (81271).
- Damaged tension bands must be replaced with new ones.
- If provided, fit the filter ring (81265).
5.4.3 Compressor-end, non-rotating parts

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 performance-relevant parts can be cleaned according to the following description.

- Clean the components specified above with steam or allow to soak in diesel oil or water with household detergent. After soaking, remove the dirt with a brush.
- Dry components completely.
- Spray cleaned surfaces with penetrating oil. Do not spray the outer surfaces of the turbocharger.
- Dispose of dirty water and cleaning agent in accordance with the specifications in the safety data sheet.
5.4.4 Turbine-end, non-rotating parts

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.

![Diagram of turbine-end components]

- Place contaminated parts in hot water or in a liquid such as carbon remover to soften the contamination.
- Brush away the contamination or remove with a steam cleaner.
- Repeat the soaking and brushing if necessary.
- Use clean water to completely clean parts of any solvents.
- 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.

5.4.5 Cartridge group

Introduction

Corrosion
If the cartridge group is not put into operation again immediately after cleaning, parts may corrode.

- Re-install and use the cartridge group immediately after cleaning.

Compressor wheels or turbines may be heavily contaminated due to heavy fuel oil operation or coked oil. Such contamination may possibly no longer be removed through cleaning during operation and must be cleaned mechanically during the standard service intervals (see chapter entitled Service work).

- Remove turbocharger from the engine (see chapter Removal and installation [⇒ 85]).
- Remove cartridge group (see chapter Disassembly and assembly [⇒ 91]).

First clean the compressor end and then the turbine end in accordance with the following description.
Cleaning the compressor end

**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.

**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.

- Clean compressor wheel with a cloth or soft brush soaked in water with household detergent. Do not use any wire brushes!
- Dry the compressor wheel and the gap between the compressor and the bearing casing with a weak jet of compressed 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 agent in accordance with the safety data sheet.
Cleaning the turbine end

Soaking the dirt

Baked-on layers of dirt from heavy fuel oil or coked oil, occur at the turbine end. The contamination can be removed by soaking and brushing. The soaking of the layers of dirt as well as the cleaning of the turbine are described below.

<table>
<thead>
<tr>
<th>Product</th>
<th>A [mm]</th>
<th>B [mm]</th>
<th>C [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS44</td>
<td>91</td>
<td>15</td>
<td>173</td>
</tr>
<tr>
<td>TPS48</td>
<td>108</td>
<td>17</td>
<td>205</td>
</tr>
<tr>
<td>TPS52</td>
<td>128</td>
<td>20</td>
<td>245</td>
</tr>
<tr>
<td>TPS57</td>
<td>157</td>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>TPS61</td>
<td>187</td>
<td>30</td>
<td>357</td>
</tr>
</tbody>
</table>

To soak the layers of dirt on the turbine, the cartridge group can be submerged vertically in a tank (02) with liquid.

- Place the tank (02) in a larger container (03), so that the excess liquid can be collected.

**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 tank (02) with soaking liquid.
Heat the liquid
To shorten the soaking time the liquid can be heated to maximum 60 °C.

Heating up of cleaning agents and operating fluids
When cleaning agents or operating fluids are heated up, explosive va-
pours 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.

Water and dirt in the cartridge group
If water or dirt gets into the cartridge group, the turbocharger function
may be impaired and parts in the cartridge group may be damaged.
▷ Place the cartridge group on suitable wooden or metal supports (01).
▷ Maintain dimension (B) for the supports (01), so that the cartridge
group does not submerge too deep.

▷ Allow the layers of dirt on the turbine to soak for four hours.
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.

➤ Raise the cartridge group and align horizontally.
➤ Remove dirt manually with a soft brush or wire brush.
Water and dirt in the cartridge group

If water or dirt gets into the cartridge group, the turbocharger function may be impaired and parts in the cartridge group may be damaged.

- Make sure that water or dirt does not get into the gap between the partition wall and turbine.

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 contamination, fill the tank (02) with clean water, not salt water.
- Submerge the turbine of the cartridge group in clean water, so that loose particles of dirt detach completely.
- Raise the cartridge group and align horizontally.
- Clamp the partition wall with the bearing casing.
- Dry the turbine and the gap between the turbine and partition wall with a weak jet of compressed air.
- Lightly spray the turbine and the gap between the turbine and partition wall with penetrating oil.
- Dispose of dirty water and cleaning agent in accordance with the specifications in the safety data sheet.
6 Troubleshooting

6.1 Malfunctions when starting

Sluggish start-up

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Clean it</td>
</tr>
<tr>
<td>Turbocharger contaminated</td>
<td></td>
</tr>
<tr>
<td>Damaged bearing</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rubbing rotor</td>
<td></td>
</tr>
<tr>
<td>Foreign object in turbocharger</td>
<td></td>
</tr>
</tbody>
</table>

Vibrations

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor unbalance</td>
<td></td>
</tr>
<tr>
<td>Damaged turbine or compressor</td>
<td></td>
</tr>
<tr>
<td>Damaged bearing</td>
<td></td>
</tr>
</tbody>
</table>

Rubbing of rotating parts

<table>
<thead>
<tr>
<th>Normal behaviour, no malfunction</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Minor uniform wear around the periphery of rotor components, caused by slight local rubbing of adjacent components, is permissible. The compressor blades and turbine blades are then shortened somewhat. Certain tolerances must be observed to avoid a significant loss of efficiency.</td>
<td></td>
</tr>
<tr>
<td>- If there is any doubt about the extent of rubbing, then an ABB Turbocharging Service Station must be contacted.</td>
<td></td>
</tr>
<tr>
<td>- Have a dimension check carried out by an ABB Turbocharging Service Station.</td>
<td></td>
</tr>
</tbody>
</table>
6.2 Surging of the turbocharger

Turbocharger surging

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Guard in front of the turbocharger is contaminated or damaged</td>
<td>Clean / replace it</td>
</tr>
<tr>
<td>Turbocharger Filter silencer or diffuser contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Heavy deposits of dirt in the turbine or nozzle ring</td>
<td></td>
</tr>
<tr>
<td>Charge air cooler Cooler contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Charge air duct blocked</td>
<td></td>
</tr>
</tbody>
</table>

Prolonged or periodic surging

Possible damage to components, such as the compressor wheel, turbine blades, bearings and filter silencer

- Have the cause clarified immediately by an ABB Turbocharging service station and rectified.
- Have components inspected for damage and, if necessary, replaced by an ABB Turbocharging service station.

Sporadic surge blows

Surging of the turbocharger can occur during certain operating conditions such as when reducing the engine performance quickly when manoeuvring. At the same time, the flow direction in the compressor is momentarily reversed. Such sporadic surge blows do not impair the safe operation of the turbocharger.

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

Lubricating oil pressure too low

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Oil filter heavily contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Defective oil pump in lubricat-</td>
<td>Check / replace it</td>
</tr>
<tr>
<td>ing system</td>
<td></td>
</tr>
<tr>
<td>Manometer display wrong</td>
<td>Replace the manometer</td>
</tr>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Rotor axial clearance too large</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Reduction in speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Defects of connected cylinders</td>
<td>Contact the enginebuilder</td>
</tr>
<tr>
<td>when pulse charging</td>
<td></td>
</tr>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Heavy contamination of the</td>
<td>Clean it</td>
</tr>
<tr>
<td>turbine</td>
<td></td>
</tr>
<tr>
<td>Damaged rotor components or</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>bearing</td>
<td></td>
</tr>
<tr>
<td>Pipes</td>
<td></td>
</tr>
<tr>
<td>Defects such as leaks in the</td>
<td>Make repairs</td>
</tr>
<tr>
<td>exhaust gas pipes or charge</td>
<td></td>
</tr>
<tr>
<td>air ducts</td>
<td></td>
</tr>
</tbody>
</table>

Increase in speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Heavily contaminated nozzle</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>ring (with 4-stroke application)</td>
<td></td>
</tr>
</tbody>
</table>
## Exhaust gas temperature too high

Engine performance and engine speed unchanged

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Malfunctioning injection system</td>
</tr>
<tr>
<td>Repair it or contact the manu-facturer</td>
<td></td>
</tr>
<tr>
<td>Turbocharger</td>
<td>Air starvation, for example filter silencer clogged with dirt</td>
</tr>
<tr>
<td>Clean it</td>
<td></td>
</tr>
<tr>
<td>Compressor / turbine contami-nated</td>
<td></td>
</tr>
<tr>
<td>Exhaust counterpressure too high</td>
<td></td>
</tr>
<tr>
<td>Clean or repair the boiler or exhaust silencer</td>
<td></td>
</tr>
<tr>
<td>Damaged or eroded turbine</td>
<td></td>
</tr>
<tr>
<td>Contact an ABB Turbocharging Service Station</td>
<td></td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td>Clean it</td>
<td></td>
</tr>
<tr>
<td>Cooling water volume too low</td>
<td></td>
</tr>
<tr>
<td>Top up the water</td>
<td></td>
</tr>
<tr>
<td>Entry temperature of cooling water too high</td>
<td></td>
</tr>
<tr>
<td>Inspect / clean the cooling system</td>
<td></td>
</tr>
<tr>
<td>Inadequate ventilation</td>
<td></td>
</tr>
<tr>
<td>Improve the ventilation</td>
<td></td>
</tr>
</tbody>
</table>
Charge air pressure too low

Engine performance and engine speed unchanged, air intake condition normal

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Air receiver leaking</td>
<td>Make repairs</td>
</tr>
<tr>
<td>Gas piping between the engine and the turbine leaking</td>
<td></td>
</tr>
<tr>
<td>Poorly adjusted injection system</td>
<td>Correct it</td>
</tr>
<tr>
<td>Poorly adjusted valve control</td>
<td></td>
</tr>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Manometer display wrong</td>
<td>Replace the manometer</td>
</tr>
<tr>
<td>Line to manometer leaking</td>
<td>Repair the leak</td>
</tr>
<tr>
<td>Contaminated filter silencer causing excessive loss of pressure</td>
<td>Clean it</td>
</tr>
<tr>
<td>Compressor / turbine contaminated</td>
<td></td>
</tr>
<tr>
<td>Damaged compressor / turbine</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Exhaust counterpressure too high</td>
<td>Clean or repair the boiler or exhaust silencer</td>
</tr>
</tbody>
</table>

Charge air pressure too high

Engine performance and engine speed unchanged, air intake condition normal

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Malfunctioning injection system</td>
<td>Repair it or contact the manufacturer</td>
</tr>
<tr>
<td>Poorly adjusted injection system</td>
<td>Correct it</td>
</tr>
<tr>
<td>Engine performance higher than expected</td>
<td>Check engine performance</td>
</tr>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Manometer display wrong</td>
<td>Replace the manometer</td>
</tr>
</tbody>
</table>
Fouling of the compressor due to the feeding in of ventilation gases

Reduced compressor performance/efficiency, hence engine performance losses

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Heavy fouling of the compressor components</td>
<td>Clean compressor</td>
</tr>
<tr>
<td></td>
<td>Optimize oil separation</td>
</tr>
<tr>
<td>Increased vibrations, compressor blade damage</td>
<td>Correct the feed of ventilation gases according to instructions of enginebuilder.</td>
</tr>
</tbody>
</table>

Reduced fatigue strength of the compressor wheel, compressor blade failure.

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Material of compressor wheel corroded</td>
<td>Check the fuel and its corrosive components, and change fuel if necessary.</td>
</tr>
</tbody>
</table>
6.4 Malfunctions when stopping

Noises during run-down

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Damaged bearing</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rubbing rotor</td>
<td></td>
</tr>
<tr>
<td>Foreign object in turbocharger</td>
<td></td>
</tr>
</tbody>
</table>

Run-down time too short

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Damaged bearing</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rubbing rotor</td>
<td></td>
</tr>
<tr>
<td>Foreign object in turbocharger</td>
<td></td>
</tr>
</tbody>
</table>
## 6.5 Speed measurement system

### Possible causes

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>No signal or amplitude is poor</td>
<td>Fitting error</td>
</tr>
<tr>
<td></td>
<td>The screw plug for the sensor is fitted with an additional gasket (copper ring). When fitting the speed sensor, this gasket must be removed. If the gasket is fitted by mistake, the distance from the sensor tip to the signal-generating sealing disc increases. As a result, the voltage amplitude of the speed signal decreases, which can cause problems for the evaluation electronics. This problem is eliminated by removing the gasket.</td>
</tr>
<tr>
<td>Defective sensor</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Measured speeds too high</td>
<td>Contaminated sensor tip</td>
</tr>
<tr>
<td></td>
<td>The sensor tip is magnetic and can thus attract metal particles. As a result, the distance to the signal-generating sealing disc is reduced, which can lead to amplification of the noise component and consequently to faulty triggering. Dismantle the sensor, clean its tip and refit the sensor using the specified tightening torque.</td>
</tr>
<tr>
<td>Measured speed too low</td>
<td>- -</td>
</tr>
<tr>
<td>Other sources of errors</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td></td>
<td>If none of the above measures eliminates the malfunction, we recommend that you have the speed measuring system inspected by an ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>
# 7 Removal and installation

## 7.1 Transport

<table>
<thead>
<tr>
<th>Suspension of uninsulated turbocharger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger with oil-cooled bearing casing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suspension of insulated turbocharger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharger with oil-cooled bearing casing</td>
</tr>
</tbody>
</table>
7.2 Turbocharger weights

Lifting gear with a sufficient load limit must be used for removing and installing the turbocharger. The following weight specification is the heaviest possibility. This guide value can differ from data on the rating plate, depending on the specification.

<table>
<thead>
<tr>
<th>TPS44 [kg]</th>
<th>TPS48 [kg]</th>
<th>TPS52 [kg]</th>
<th>TPS57 [kg]</th>
<th>TPS61 [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>180</td>
<td>250</td>
<td>410</td>
<td>650</td>
</tr>
</tbody>
</table>

Turbocharger weights
7.3 Remove the turbocharger

- Disconnect all exhaust gas and air lines according to the instructions of the enginebuilder.

Version with water-cooled bearing casing:

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

If present, remove hard insulation as follows:

- Remove screws and sheet metal (B) from the bearing casing insulation.
- Remove the remaining screws from the bearing casing insulation (A).
- Pull the bearing casing insulation up and off. The bearing casing insulation can be compressed to facilitate the removal process.

- Unplug the cable connector from the speed sensor.
- Attach lifting gear to bearing casing.
- If a gas outlet bend is present, sling lifting gear around it or secure it to the lifting gear with a swivel lifting eye (C).
- Loosen the fixing screws (D) on the bearing casing.
- Lift the turbocharger from the engine and put it down.
- Cover oil connections.
7.4 Installing the turbocharger

- Remove covers from oil connections.
- Visually inspect O-ring gaskets of oil supply and drain pipe (O-ring gaskets for engine are not delivered by ABB Turbo Systems).

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

<table>
<thead>
<tr>
<th>Product</th>
<th>Through hole in bearing casing [mm]</th>
<th>Thread size [mm]</th>
<th>Tightening torque [Nm]</th>
<th>Strength class in acc. with DIN/ISO 898</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS44</td>
<td>17</td>
<td>M16</td>
<td>230</td>
<td>10.9/12.9</td>
</tr>
<tr>
<td>TPS48</td>
<td>17</td>
<td>M16</td>
<td>230</td>
<td>10.9/12.9</td>
</tr>
<tr>
<td>TPS52</td>
<td>21</td>
<td>M20</td>
<td>455</td>
<td>10.9/12.9</td>
</tr>
<tr>
<td>TPS57</td>
<td>21</td>
<td>M20</td>
<td>455</td>
<td>10.9/12.9</td>
</tr>
<tr>
<td>TPS61</td>
<td>25</td>
<td>M24</td>
<td>780</td>
<td>10.9/12.9</td>
</tr>
</tbody>
</table>

- Attach lifting gear to bearing casing.
- If a gas outlet manifold is provided, sling lifting gear around it additionally or fasten it to lifting gear using a swivel lifting eye (C) (see also section Transport / Weights).
- Lift turbocharger, place on bracket and align.
- Tighten fixing screws (D) to the bearing casing in accordance with the table above.
- Fasten all gas, water and air lines in accordance with the enginebuilder's instructions.
If present:

- Fit speed sensor and plug in cable connector.
- Adapt and fit bearing casing insulation (A).
- Adapt and fit sheet metal (B) of bearing casing insulation.

Version with water-cooled bearing casing:

- Remove the screw plugs from the water connections and fit the water pipes in accordance with the enginebuilder’s instructions.
8 Disassembly and assembly

8.1 Introduction

Precondition for the work described below is a turbocharger removed from the engine (refer to the chapter entitled Removal and Installation).

**Further work**

Only the work described in this Operation Manual may be carried out. Incorrectly performed disassembly and assembly of the cartridge group can lead to serious machine damage.

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

**Marking casing positions for assembly**

ABB Turbo Systems recommends that the casing positions are marked before disassembling the turbocharger.

**Identifying assembly devices**

Not all assembly devices are marked with a part number. They can be identified using the tool list. This list is enclosed in the toolbox.

**Maintaining assembly devices**

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

- Visually check for corrosion, cracks, deformation and wear.
- Don't use damaged assembly devices, but replace them.
Customer spare parts set

Before beginning work, ensure that the required customer spare parts sets are available.

► See chapter Spare parts.

Oil orifice

► When disassembling the turbocharger, a fitted oil orifice must not be removed.

Tightening torques for turbocharger components

The specified tightening torques of screw connections for turbocharger components must be observed. (See section Table of tightening torques.)

Tightening torques for assembly devices of ABB Turbo Systems

If nothing else is described, the screws and nuts of the assembly devices must be tightened down firmly.

WARNING

Suspended loads

Loads not suspended in compliance with regulations may lead to personal injury or accidents with fatal consequences.

► Attach turbochargers, assemblies or individual components only to lifting gear which is in technically perfect condition and has sufficient load capacity.

► Make sure the load is suspended properly on the crane hook.

► Do not let anyone stand beneath a suspended load.

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

Definition of terms

► **Suspension point**
  Defined load carrying point on a component or an assembly (blind hole thread, eye, lug).

► **Assembly device**
  Devices mounted on the turbocharger to create a suspension point. Assembly devices are calculated and designed especially for the de-
fined application. They are not commercially available products. Use assembly / fitting devices only for the applications described.

- **Lifting gear**
  Equipment for lifting and transporting loads (ropes, chain hoists, cranes). Lifting gear is not supplied by ABB Turbo Systems.

**Swivel lifting eye to be used**

A swivel lifting eye is required to lift loads safely (not supplied by ABB).

<table>
<thead>
<tr>
<th>Swivel lifting eye</th>
<th>Product</th>
<th>Thread M</th>
<th>Length L</th>
<th>Minimum load limit (loading capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TPS44</td>
<td>M8</td>
<td>13 mm</td>
<td>150 kg</td>
</tr>
<tr>
<td></td>
<td>TPS48</td>
<td>M10</td>
<td>17 mm</td>
<td>250 kg</td>
</tr>
<tr>
<td></td>
<td>TPS52</td>
<td>M10</td>
<td>17 mm</td>
<td>250 kg</td>
</tr>
<tr>
<td></td>
<td>TPS57</td>
<td>M12</td>
<td>21 mm</td>
<td>350 kg</td>
</tr>
<tr>
<td></td>
<td>TPS61</td>
<td>M12</td>
<td>21 mm</td>
<td>500 kg</td>
</tr>
</tbody>
</table>
8.2 Module weights

The specified weights of individual parts or assemblies are guides rounded off to the next highest value.

<table>
<thead>
<tr>
<th>Description</th>
<th>TPS44 [kg]</th>
<th>TPS48 [kg]</th>
<th>TPS52 [kg]</th>
<th>TPS57 [kg]</th>
<th>TPS61 [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Filter silencer</td>
<td>15</td>
<td>19</td>
<td>30</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>2 Radial air suction branch</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>3 Axial air suction branch</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>4 Compressor casing</td>
<td>17</td>
<td>24</td>
<td>35</td>
<td>55</td>
<td>90</td>
</tr>
<tr>
<td>5 Wall insert</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>6 Diffuser</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7 Cartridge group</td>
<td>25</td>
<td>35</td>
<td>50</td>
<td>85</td>
<td>140</td>
</tr>
<tr>
<td>8 Nozzle ring</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>9 Burst ring</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>10 Turbine casing with external burst protection</td>
<td>1 inlet</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>2 inlets</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>3 inlets</td>
<td>-</td>
<td>-</td>
<td>55</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>4 inlets</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>95</td>
</tr>
<tr>
<td>11 Gas outlet flange</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>12 Exhaust manifold</td>
<td>16</td>
<td>18</td>
<td>25</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>
8.3 Disassembling and assembling turbocharger

Removing the compressor casing

**WARNING**

Risk of burning

Touching hot surfaces or contact with hot operating materials can lead to serious burns.

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

Wear safety gloves to protect against thermal hazards.

- Disconnect all air lines in accordance with the enginebuilder's instructions.
- Remove the screws for the compressor casing insulation and dismantle the insulation.
- Undo the V-clamp (72020) and remove the filter silencer (81000) or air suction branch (82000).
Removing the insulation

If provided

- Loosen and remove the screws for the insulation plates (1, 2).
- If provided: Remove the insulation plates (1, 2).
- Remove the remaining screws for the insulation (3).
- Remove the insulation (3).
Slightly loosen the screws (72011) and turn the compressor casing (72000) until the swivel lifting eye can be fastened to the lifting gear.

(77006* only provided with the wall insert with acceleration aid.)

If the compressor casing cannot be removed easily, it can be pressed off using the press-off tool (90042) against the turbine casing. To do this, the two cover plates (1, 2) must be removed from the hard insulation on the turbine casing.

**Axial force**

The press-off tool can generate a high axial force and, if it is not used properly (too much pressure on one side), it can damage the rotor.

It should thus be used alternately on both sides while avoiding excessive pressure on either side.

Loosen the screws (72011) and remove them together with the fastening strips (72012).

Move the compressor casing (72000) with the wall insert (77000) carefully away, doing so horizontally.

Tap the wall insert (77000) out of the compressor casing using a nylon hammer and remove the O-ring seal (77005).
TPS61 wall insert removal

- Fasten lifting beam (90258) to wall insert.
- Fasten swivel lifting eye (a) to lifting beam.
- Remove wall insert (77000) using lifting gear.

Loosen screws (72041) and remove them together with lockwashers (72040) and diffuser (79000) from compressor casing (72000).
Installing compressor casing

- Refit wall insert (77000) and O-ring (77005) in the reverse order.

**NOTICE**

O-rings

Used O-rings must always be replaced with new ones. O-rings are only available as a set (see chapter Spare parts).

Fitting the diffuser

TPS..-F31/32 / FV31/32

- Refit diffuser in reverse order.

- Fit compressor housing in reverse order.
- Thoroughly clean fastening strips (72012) before fitting them.
Removing the cartridge group

- Check the lifting gear and fasten it to bearing casing (42001).
- Disconnect all lines in accordance with the engine builder’s instructions, remove the insulation, remove the turbocharger and compressor casing together with the filter silencer (also see the previous chapter).

**WARNING**

Risk of burning

Touching hot surfaces or contact with hot operating materials can lead to serious burns.

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

Wear safety gloves to protect against thermal hazards.

- The bearing casing is difficult to loosen.
- Use the press-off tool (90042) against the turbine casing to press off the bearing casing (see the following illustration).

**CAUTION**

Axial force

The press-off tool can generate a high axial force and, if it is not used properly (too much pressure on one side), it can damage the rotor. It should thus be used alternately on both sides while avoiding excessive pressure on either side.
Withdraw nozzle ring (56001) using two extraction devices (90070) and withdraw bottom part of service support (90012).

Remove C-ring (51105).

Mount the cartridge group on the service support (90012) and bolt it down firmly.

Loosen screw (42008) and remove diffuser (79000) complete with O-ring (42012).

Measure the axial and radial clearances (see the section Axial and radial clearances).
Installing the cartridge group

**O-rings**

Used O-rings must always be replaced with new ones. O-rings are only available as a set (see chapter Spare parts).

**Protruding insulation**

The insulation on the turbine casing may protrude at the gas outlet side. This can be pushed back in with a screw driver.

- Fit the lamellar sealing ring (56005, if present) in the correct slot (see detail A). When doing this, pay attention to correct winding of the lamellar sealing ring (see detail B).
- Secure the lamellar sealing ring with adhesive tape.
- Insert the nozzle ring (56001) (with the cam facing forwards) into the turbine casing as far as it will go. Align the cam on the nozzle ring with the recesses of the turbine casing and insert it into the turbine casing (51000) as far as it will go. Do not remove the adhesive tape (01).

**If present**

- Insert the C-ring (51105) into the turbine casing and secure with high-vacuum grease.
To ensure the nozzle ring is held in place during operation, it must be clamped between the partition wall and the turbine casing.

**Notice**

Calculate the press fit (PD) as shown.

\[ PD = (A + B + C) - S \]

If the calculated value (PD) is less than 0.1 mm, an official ABB Turbocharging Service Station must be contacted.

**Notice**

Measure the axial and radial clearances (see the section Axial and radial clearances).
Nozzle ring press fit for multiple inlet turbine casing

- Calculate the press fit (PD) as shown.

\[ PD = (A + B + C) - S \]

If the calculated value (PD) is outside ±0.2 mm, an official ABB Turbocharging Service Station must be contacted.

- Measure the axial and radial clearances (see the section Axial and radial clearances).
Assembly of diffuser
TPS..-F33

- Fasten diffuser (79000) and O-ring (42012) using screw (42008).
- Check lifting gear and fasten to bearing casing (42001).
- Unscrew the cartridge group and lift it out of the service support (90012).
- Apply high-temperature grease to the centering points and screw threads.

- Remove temporary covers from oil connections.

**CAUTION**

Don't damage or shift gasket rings (A) in the mounting support when fitting the cartridge group. The gasket rings (A) are supplied by the engine builder.
If two turbochargers are mounted on an engine, one with a left-hand and one with a right-hand oil inlet, a pin can be fitted in the bracket as a precaution against incorrect positioning. This pin (B) locates in a corresponding groove in the foot of the bearing casing.

Fasten the cartridge group using fastening strips (51002), Verbus Ripp® washers (51003) and nuts (51007) (also see the chapter entitled Table of tightening torques).

Fasten the bearing casing (42001) using the fixing screws (C).

Tighten the fixing screws (C) to the torques listed in the following table.

*) For the assembly of the turbocharger on the engine support, the threads of the screws and screw heads must be lightly oiled (assumed coefficient of friction μ = 0.12 for the tightening torque).

<table>
<thead>
<tr>
<th>Product</th>
<th>Hole in the bearing casing [mm]</th>
<th>Fixing screws C [mm]</th>
<th>Tightening torques [Nm] **</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS44</td>
<td>Ø 17</td>
<td>M16</td>
<td>230</td>
</tr>
<tr>
<td>TPS48</td>
<td>Ø 17</td>
<td>M16</td>
<td>230</td>
</tr>
<tr>
<td>TPS52</td>
<td>Ø 21</td>
<td>M20</td>
<td>455</td>
</tr>
<tr>
<td>TPS57</td>
<td>Ø 21</td>
<td>M20</td>
<td>455</td>
</tr>
<tr>
<td>TPS61</td>
<td>Ø 25</td>
<td>M24</td>
<td>780</td>
</tr>
</tbody>
</table>
Plug in the cable connector (86515) for the speed sensor (86505) and (if provided) fit the insulation plates (1, 2).

**Removing gas outlet bend and gas outlet flange**

- Disconnect all lines in accordance with engine builder's instructions and remove insulation. (See also preceding chapter.)

- Loop lifting gear around gas outlet bend (51100).
- Remove gas outlet bend (51100) and gasket (52406). Only gas outlet bends from ABB Turbo Systems have the gasket (52406).
- Remove gas outlet flange (52400) and, if fitted, C-ring (52408).
Fitting the gas outlet flange and gas outlet bend

- If provided, fit the C-ring (52408).
- Fit the gas outlet flange (52400).
- In the case of gas outlet bends (51100) from ABB Turbo Systems: always replace the gasket (52406) (see the chapter entitled Spare parts).
- Apply high-temperature grease to contacting surfaces and threads.
- Fit the turbine casing using the nuts (52433) while observing tightening torques specified in the table of tightening torques.

If provided

- Fasten the insulation.

- Attach pipes in accordance with the enginebuilder's instructions.
8.4 Axial clearance A and radial clearance B

Following removal and before installation of the cartridge group, the axial clearance A and radial clearance B must be measured and noted.

**NOTICE**

In order to correctly measure the axial clearance A, the turbine must be raised slightly.

**WARNING**

Risk of injury due to sharp edges on the compressor wheel

The compressor wheel has sharp edges which can cause injuries.

Wear safety gloves.

Wear safety gloves to protect against mechanical hazards.

<table>
<thead>
<tr>
<th>Axial clearance A and radial clearance B [mm]</th>
<th>TPS44</th>
<th>TPS48</th>
<th>TPS52</th>
<th>TPS57</th>
<th>TPS61</th>
</tr>
</thead>
<tbody>
<tr>
<td>A minimum</td>
<td>0.08</td>
<td>0.08</td>
<td>0.10</td>
<td>0.12</td>
<td>0.15</td>
</tr>
<tr>
<td>A maximum</td>
<td>0.16</td>
<td>0.16</td>
<td>0.18</td>
<td>0.21</td>
<td>0.25</td>
</tr>
<tr>
<td>B minimum *</td>
<td>0.51</td>
<td>0.50</td>
<td>0.61</td>
<td>0.72</td>
<td>0.81</td>
</tr>
<tr>
<td>B maximum *</td>
<td>1.00</td>
<td>1.00</td>
<td>1.15</td>
<td>1.31</td>
<td>1.55</td>
</tr>
</tbody>
</table>

* Permissible B clearances for standard radial bearings. If the clearances measured on TPS57 or TPS61 are outside the permissible range, this can indicate radial bearings with a special bearing geometry. Different permissible values are valid for radial bearings with a special bearing geometry (see the table below).
The type of bearing can be determined by measuring the rotor run-out time. To do so, the rotor must be pushed by hand, once to the left (L) and once to the right (R), with a force as close to the same in both directions. The resulting run-out times until the rotor comes to a stop are measured for the anticlockwise and clockwise rotations and then compared. With standard radial bearings, the run-out time for anticlockwise and clockwise rotating rotors is the same.

If one run-out time is at least 1.5 times longer than the other, then radial bearings with a special bearing geometry are installed. The following B clearances are valid for these special bearings.

<table>
<thead>
<tr>
<th></th>
<th>TPS57</th>
<th>TPS61</th>
</tr>
</thead>
<tbody>
<tr>
<td>B minimum</td>
<td>0.46</td>
<td>0.52</td>
</tr>
<tr>
<td>B maximum</td>
<td>0.73</td>
<td>0.82</td>
</tr>
</tbody>
</table>

**Clearances out of tolerance**

Clearances out of tolerance and excessively worn components can be the cause of serious damage to machinery and property.

- Have components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.
8.5 Radial clearances N and R

N and R

These are the theoretical values of the radial clearance between the compressor wheel and the wall insert and/or turbine wheel and the gas outlet flange.

The minimum and maximum values result from the manufacturing tolerances of the compressor wheel and turbine wheel or the wall insert and gas outlet flange.

N1 and N2 as well as R1 and R2 are each measured at the same time using two feeler gauges.

To measure N1 and N2, the feeler gauges must be pushed between the wall insert and the compressor wheel free of play, in each case above and below.

To measure R1 and R2, the feeler gauges must be pushed between the gas outlet flange and the turbine free of play, in each case above and below.
The mean values measured must be within the permissible values of the radial clearance N and R.

<table>
<thead>
<tr>
<th>Product</th>
<th>N [mm]</th>
<th>R [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS44</td>
<td>0.15 … 0.49</td>
<td>0.36 … 0.67</td>
</tr>
<tr>
<td>TPS48</td>
<td>0.22 … 0.58</td>
<td>0.47 … 0.77</td>
</tr>
<tr>
<td>TPS52</td>
<td>0.30 … 0.67</td>
<td>0.59 … 0.92</td>
</tr>
<tr>
<td>TPS57</td>
<td>0.40 … 0.86</td>
<td>0.75 … 1.11</td>
</tr>
<tr>
<td>TPS61</td>
<td>0.50 … 0.94</td>
<td>0.90 … 1.32</td>
</tr>
</tbody>
</table>

Clearances out of tolerance
Clearances out of tolerance and excessively worn components can be the cause of serious damage to machinery and property.
► Have components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.
8.6 Table of tightening torques

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

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>TPS44</th>
<th>TPS48</th>
<th>TPS52</th>
<th>TPS57</th>
<th>TPS61</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72020</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>42008</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>52433</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>65</td>
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<td>9</td>
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<td>10</td>
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<td>15</td>
<td>15</td>
<td>15</td>
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</tr>
</tbody>
</table>
9 Taking out of operation

9.1 Shutting down the turbocharger

If the turbocharger is damaged and the engine can be shut down for only a short time for emergency repairs, proceed as follows:

► Fit the cover plate.

CAUTION

Always heed precisely the engine builder's instructions in case of engine operation with a blocked / throttled turbocharger!

Dismantling the turbocharger

► Dismantle the turbocharger (see the section Dismantling and fitting the turbocharger).
► Do not dismantle the nozzle ring.
Fitting the cover plate

- Close the opening in the turbine casing using the cover plate (A).
- Fasten the cover plate on the turbine casing (51000) using the fastening strips (51002), Verbus Ripp® Verbusripp washers (51003) and nuts (51007) and screw it down securely on the support.

**NOTICE**

Thoroughly clean the fastening strips (51002) before fitting them. Apply high-temperature grease to the stud threads (51006).
Cover plate drawing

The cover is not supplied by ABB Turbo Systems and must be manufactured by the operator according to the following drawing.

Material: Common structural steel, according to DIN EN 10025-2

Dimensions in [mm]

<table>
<thead>
<tr>
<th>Product</th>
<th>B1 ±0.5</th>
<th>B2</th>
<th>B3</th>
<th>B4 ±0.2</th>
<th>B5</th>
<th>B6</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS44</td>
<td>62.6</td>
<td>54</td>
<td>110</td>
<td>11.0</td>
<td>1</td>
<td>144</td>
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<td>TPS48</td>
<td>65.7</td>
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<td>130</td>
<td>11.7</td>
<td>1.5</td>
<td>150</td>
</tr>
<tr>
<td>TPS52</td>
<td>79.6</td>
<td>78</td>
<td>155</td>
<td>14.2</td>
<td>1.5</td>
<td>180</td>
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<tr>
<td>TPS57</td>
<td>98.2</td>
<td>100</td>
<td>190</td>
<td>17.2</td>
<td>2</td>
<td>220</td>
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<tr>
<td>TPS61</td>
<td>116.8</td>
<td>120</td>
<td>226</td>
<td>20.5</td>
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<td>260</td>
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<table>
<thead>
<tr>
<th>Product</th>
<th>B7</th>
<th>ØD1 ±0.2</th>
<th>ØD1* ±0.2</th>
<th>ØD2</th>
<th>R1</th>
<th>M</th>
</tr>
</thead>
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<tr>
<td>TPS44</td>
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<td>191.3</td>
<td>17</td>
<td>≤88</td>
<td>M8</td>
<td></td>
</tr>
<tr>
<td>TPS48</td>
<td>35.7</td>
<td>222.7</td>
<td>227.7</td>
<td>≤105</td>
<td>M8</td>
<td></td>
</tr>
<tr>
<td>TPS52</td>
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<td>265.7</td>
<td>271.7</td>
<td>≤125</td>
<td>M8</td>
<td></td>
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<tr>
<td>TPS57</td>
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<td>325.7</td>
<td>332.5</td>
<td>≤153</td>
<td>M10</td>
<td></td>
</tr>
<tr>
<td>TPS61</td>
<td>56.8</td>
<td>387.7</td>
<td>395.9</td>
<td>≤182</td>
<td>M10</td>
<td></td>
</tr>
</tbody>
</table>
*) Diameter for turbine casing designs for optional C-ring sealing

Information about the turbine casing design (with / without C-ring sealing) can be requested from an ABB Turbocharging Service Station.
10 Mothballing the turbocharger

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

Condition of engine lubricating oil

The turbocharger normally remains mounted on the engine. Mothballing a turbocharger depends on the condition of the lubricating oil:

- If the total acid number (TAN) is lower than 2 mg KOH/g, no measures have to be taken.
- If the engine lubricating oil is replaced by preserving oil before taking the engine out of operation and this is circulated by the pre-lubrication pump, no measures have to be taken. Any remaining old engine oil will therefore be flushed away and the bearing sections largely protected against corrosion.

Mothballing measures

**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.
Mothballing the turbocharger

Taking the engine out of operation for up to 12 months

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

- Dismantle the turbocharger.
- The rotor and the bearing parts must be removed by an official ABB Turbocharging service station and refitted afterwards.
- Clean all parts.
- Machined, bright surfaces of steel and cast parts must be oiled with anticorrosive oil.
- Reassemble complete turbocharger.

**Rotor turning in stack draught**

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

- Install blind flange between compressor casing outlet flange and charge air duct.
10.2 Taking the engine out of operation for more than 12 months

If the engine is taken out of service, the following alternatives are possible with the turbocharger:

- The turbocharger remains mounted on the engine.
- The turbocharger casing remains mounted on the engine, but the rotor and the bearing parts are removed and stored separately by an ABB Turbocharging Service Station.
- The turbocharger is removed completely, either as a whole or in individual parts.

See the section Taking out of operation for up to 12 months, under Mothballing measures, for the measures always necessary when mothballing turbocharger parts.

If the turbocharger remains mounted on the engine, refer to the section Taking out of operation for up to 12 months, under Rotating the rotor in stack draught.

If the entire turbocharger is removed, or if the turbocharger is re-assembled from the individual components thereof:

▶ Close all turbocharger openings using wooden covers and paraffin paper.

Suitable storage locations are only dry rooms where the relative humidity is between 40 … 70 % and no condensation can form.

Condition of the mothballed turbocharger

▶ Check the mothballed turbocharger parts for corrosion once per annum.
▶ If there are signs of rust: Clean parts thoroughly and renew protection against corrosion.
11 Disposing of turbocharger components

Handling damaged thermal insulation

**WARNING**

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 particles (P1 or P2 mask).
- Wear work gloves made of leather.

Wear safety goggles.

Wear a respiratory mask to protect against dusts.

Wear safety gloves to protect against mechanical hazards.

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

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

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

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

12.1 Ordering spare parts

When making inquiries or ordering spare parts, the following data must be specified:

- Turbocharger type
- Serial number (HT……)
- Description and part number

Spare parts can be ordered from an official ABB Turbocharging Service Station.

- If different design versions have not been taken into consideration in this document, please contact an ABB Turbocharging Service Station.

### Storage of spare parts

All spare parts ordered with the turbocharger must be kept complete and ready for use.

- Parts showing signs of rust should be carefully cleaned and greased.

- Dispose of replaced and unusable parts in a professional and environmentally compatible way.

#### Customer spare part set (97070)

The customer spare part set (97070) is required for the work described in this manual.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Socket screw</td>
<td>42008</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>42012</td>
</tr>
<tr>
<td>1</td>
<td>Gasket</td>
<td>52406 *</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>77005</td>
</tr>
<tr>
<td>2</td>
<td>Counter-sunk screw</td>
<td>72041</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>81010 / 82010</td>
</tr>
</tbody>
</table>

* This gasket can be used only when using a gas outlet casing from ABB Turbo Systems.
12.2 View of turbocharger showing part numbers
### Part numbers and Description

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10900</td>
<td>Cartridge group</td>
</tr>
<tr>
<td>42008</td>
<td>Socket screw</td>
</tr>
<tr>
<td>42012</td>
<td>O-ring</td>
</tr>
<tr>
<td>51000</td>
<td>Turbine casing</td>
</tr>
<tr>
<td>51002</td>
<td>Fastening strips</td>
</tr>
<tr>
<td>51100</td>
<td>Exhaust bend</td>
</tr>
<tr>
<td>51105</td>
<td>Metal C-ring</td>
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<tr>
<td>52400</td>
<td>Gas outlet flange</td>
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<tr>
<td>52406</td>
<td>Gasket</td>
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<tr>
<td>52408</td>
<td>Metal C-ring</td>
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<tr>
<td>56001</td>
<td>Nozzle ring</td>
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<tr>
<td>57200</td>
<td>Burst protection</td>
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<td>57210</td>
<td>Burst ring</td>
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<tr>
<td>72000</td>
<td>Compressor casing</td>
</tr>
<tr>
<td>72011</td>
<td>Socket screw</td>
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<tr>
<td>72012</td>
<td>Fastening strips</td>
</tr>
<tr>
<td>72020</td>
<td>V-clamp</td>
</tr>
<tr>
<td>72041</td>
<td>Counter-sunk screw with cross slotted head</td>
</tr>
<tr>
<td>77000</td>
<td>Wall insert</td>
</tr>
<tr>
<td>77005</td>
<td>O-ring</td>
</tr>
<tr>
<td>79000</td>
<td>Diffuser</td>
</tr>
<tr>
<td>81000</td>
<td>Filter silencer</td>
</tr>
<tr>
<td>81010</td>
<td>O-ring</td>
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<tr>
<td>82000</td>
<td>Axial air suction branch</td>
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<tr>
<td>82010</td>
<td>O-ring</td>
</tr>
<tr>
<td>86505(A)</td>
<td>Speed sensor (cable not integrated)</td>
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<tr>
<td>86505(B)</td>
<td>Speed sensor (cable integrated)</td>
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<td>86515(A)</td>
<td>Cable connector for 86505(A)</td>
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<tr>
<td>86515(B)</td>
<td>Cable connector for 86505(B)</td>
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<tr>
<td>86526</td>
<td>F/I converter</td>
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<tr>
<td>86528</td>
<td>Tachometer</td>
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</table>

* depends on the turbocharger specification.
12.3 View of cartridge group showing part numbers
### Spare parts

**View of cartridge group showing part numbers**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
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<tbody>
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<td>21000</td>
<td>Shaft</td>
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<tr>
<td>21002</td>
<td>Piston ring</td>
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<tr>
<td>25000</td>
<td>Compressor wheel</td>
</tr>
<tr>
<td>32101</td>
<td>Plain bearing bush</td>
</tr>
<tr>
<td>32103</td>
<td>Locking ring</td>
</tr>
<tr>
<td>32105</td>
<td>Thrust ring</td>
</tr>
<tr>
<td>32106</td>
<td>Thrust bearing</td>
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<td>32108</td>
<td>Piston ring</td>
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<td>32109</td>
<td>Sealing disc</td>
</tr>
<tr>
<td>32110</td>
<td>Bearing flange</td>
</tr>
<tr>
<td>32111</td>
<td>Auxiliary bearing</td>
</tr>
<tr>
<td>32112</td>
<td>Bearing flange</td>
</tr>
<tr>
<td>32113</td>
<td>Socket screw</td>
</tr>
<tr>
<td>32114</td>
<td>Socket screw</td>
</tr>
<tr>
<td>32221</td>
<td>Bearing cover</td>
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<tr>
<td>32222</td>
<td>O-ring</td>
</tr>
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<td>42001</td>
<td>Bearing casing</td>
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<tr>
<td>42002</td>
<td>Socket screw</td>
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<tr>
<td>42008 (in customer spare part set)</td>
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<tr>
<td>43001</td>
<td>Partition wall</td>
</tr>
<tr>
<td>43012*</td>
<td>Metal C-ring</td>
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</table>