# Operation Manual

## TPL76-C35

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04070 kg 35 50 50

Application according to the Operation Manual

made in Switzerland
Operating condition and replacement intervals

The operational limits for the turbocharger $n_B\text{max}$, $t_B\text{max}$, $n_M\text{max}$, $t_M\text{max}$, 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 $n_M\text{max}$, $t_M\text{max}$ are valid for the test operation for a limited time.
# Operation Manual

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1 Preliminary remarks

1.1 Purpose of this manual

This Operation Manual belongs to the turbocharger with the identical serial 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

01 Filter silencer
02 Radial plain bearing
03 Thrust bearing
04 Bearing bush
05 Radial plain bearing
06 Gas outlet casing
07 Gas inlet casing
08 Nozzle ring
09 Turbine wheel
10 Bearing casing
11 Diffuser
12 Compressor wheel
13 Compressor casing
Mode of operation

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

- Turbine
- Compressor

These are both mounted on a common shaft.

The exhaust gases from the diesel engine flow through the gas inlet casing (07) and nozzle ring (08) to the turbine wheel.

The turbine wheel (09) uses the energy contained in the exhaust gas to drive the compressor wheel (12). The compressor then draws in fresh air, compresses it and then forces it into the cylinders.

The exhaust gases escape to free air through an exhaust gas pipe which is connected to the gas outlet casing (06).

The air which is necessary for operation of the diesel engine and is compressed in the turbocharger is drawn through the suction branch or the filter silencer (01) into the compressor wheel (12). This air then passes through the diffuser (11) and leaves the turbocharger through the compressor casing (13).

The rotor runs in two radial plain bearings (02/05). One plain bearing is in the bearing bush (04), and the second one is in the axial thrust bearing (03) at the compressor end.

The plain bearings are connected to a central lubricating oil duct which is fed with oil from the engine's lubricating oil circuit. The oil outlet is always at the lowest point of the bearing casing (10).

Turbocharger version with compressor wheel cooling system

Depending on its range of use, the turbocharger is provided with a compressor wheel cooling system. Compressor wheel cooling means that, after the charge air cooler at the engine end, cooled compressor air is delivered to the turbocharger to cool the compressor wheel.

Depending on the respective operating conditions, it is absolutely essential that the compressor wheel is cooled in order to guarantee its reliability and the replacement intervals. In the case of the turbocharger version with compressor wheel cooling, the cooling air is supplied through the side connection (15) in the bearing casing.
1.3 Intended use

Use on internal combustion engines in general

ABB turbochargers are intended for turbocharging internal combustion engines.

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

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

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

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

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

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

WARNING

Unapproved operation

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

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

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

- Operation Manual
- Instructions of the enginebuilder

State of the art

The turbocharger is designed and built according to the state of the art and is safe to operate.
Flawless condition

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

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

1.4 Deflagration on gas engines

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

ABB Turbo Systems recommends subjecting the turbocharger to a visual inspection after a deflagration event. As part of the inspection, the position of the turbine casing and the position of the compressor casing to the bearing casing must be checked, and the bearing casing must be examined to see if it has shifted in relation to the bracket. A crack inspection of the casings and the bellows is also recommended. The nearest ABB Turbocharging Service Station should be instructed to carry out this inspection and assessment.
1.5 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)

**WARNING**

Protection of health when handling VCIs

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

- 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](http://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](http://www.branopac.com).
- Dispose of the old VCI corrosion protection emitter in an environmentally compatible manner, professionally and in accordance with local regulations.
- Seal the package. The better the external seal is designed, the more permanent the protection.
Long-term storage of 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.

NOTICE

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.
1.6 Essential information

Organisational measures

In addition to the Operation Manual, the general statutory regulations for the prevention of accidents and for environmental protection in the country of use must also be observed.

This also applies to the provision and wearing of personal protective equipment.

NOTICE

The manner in which personnel work on and with the turbocharger with regard to safety and risks is to be checked on a regular basis in accordance with the Operation Manual.

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

NOTICE

Any modifications, additions or conversions made to the turbocharger, which could impair 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.

WARNING

Use original parts

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

- Only use original parts from ABB.

ABB 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.

Storage of new turbochargers

New turbochargers supplied by ABB Turbo Systems can be stored without additional safeguarding measures for a period of 6 months after the delivery date.

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

- After expiry of the 6 months, all surfaces and accessible areas of the turbocharger should be sprayed with anticorrosive agent.
- To do this, the insulating materials must be removed.

NOTICE

Repeat the described measures every 6 months to keep your turbocharger free from rust.
1.7 Symbols and definitions

The following symbols are used in the documents:

▷ Prerequisite
▶ Work step
■ Enumeration, first level
- Enumeration, second level
→ Refers to a page number

Definition of notes

NOTICE

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 Turbocharging Service Stations. They are inspected and certified regularly by ABB Turbo Systems. See also chapter Contact information →14.
1.8 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.
02 Turbocharger operating limits during operation

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

Further information
06 Part number for customer
07 Designation of special design
08 Turbocharger weight in kg
09 Turbocharger type
10 Serial number
11 Year of turbocharger construction
12 Manufacturing plant
1.8.1 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 $n_{B_{\text{max}}}$ and $t_{B_{\text{max}}}$ can considerably shorten the recommended replacement intervals. In such cases, we recommend that you contact the nearest official ABB Turbocharging service station. $n_{M_{\text{max}}}$ and $t_{M_{\text{max}}}$ 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 $n_{M_{\text{max}}}$ and $t_{M_{\text{max}}}$ is not permitted. Non-observance of the recommended replacement intervals can increase the risk of unpredictable component failures.

1.8.2 Positions of the rating plates

A rating plate is attached to the turbocharger foot, one on the left and one on the right. On turbochargers with insulation from ABB, at least one additional rating plate is attached to the insulation of the gas outlet casing.

1.9 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
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CH-5401 Baden
Switzerland

www.abb.com/turbocharging

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2 Safety

2.1 Introduction

Turbochargers manufactured by ABB 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 operating company is responsible for access to the turbocharger as well as the organisational measures that regulate the safe handling of the turbocharger by its personnel.

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

All further safety instructions contained and specifically identified in every chapter of this manual (see section Definition of Safety Instructions) must also be observed.

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

<table>
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<tr>
<td>![Icon] Protective clothing</td>
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<tr>
<td>![Icon] Safety footwear to protect against mechanical hazard and risk of falling</td>
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<table>
<thead>
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<th>To be worn according to the specific work</th>
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<tbody>
<tr>
<td>![Icon] Safety glasses</td>
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<td>![Icon] Safety goggles</td>
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<tr>
<td>![Icon] Safety gloves against</td>
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<tr>
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<tr>
<td>![Icon] Respiratory mask against</td>
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<td>- Dusts</td>
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<td>- Gases</td>
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<tr>
<td>![Icon] Safety helmet</td>
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<tr>
<td>![Icon] Ear protection</td>
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</tbody>
</table>

2.4 Definition of Safety instructions

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

⚠️ **WARNING**

**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.**

⚠️ **CAUTION**

**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.**
### 2.5 Warning plates on the turbocharger

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

![CAUTION]

**CAUTION**

Turbocharger operating at high speed and high temperature! Do not stay near turbocharger during operation!

<table>
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<th>Size [mm]</th>
<th>Product</th>
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<tbody>
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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

⚠️ WARNING

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

- 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.
- 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.

⚠️ CAUTION

**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.

---

**WARNING**

**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.

---

**WARNING**

**Mechanical hazard**

Severe injuries to personnel or fatal accidents can be caused by mechanical influences as a consequence of hazardous and inadequate operational procedures.

- Observe the general rules for occupational safety and prevention of accidents.
- Ensure workplace safety.
- Only perform operations that are described in this chapter.
- Only perform operations for which you have previously received instruction or training.
Hazards due to 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.
WARNING

Hot surfaces on uninsulated turbochargers

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

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

Wear safety gloves to protect against thermal hazards.

Hazards due to 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.

WARNING

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

**WARNING**

**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.
### 2.8 Periodic checking of the pressure vessel

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

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

### 2.9 Lifting loads

**WARNING**

**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 Commissioning

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.

**NOTICE**

With regard to the oil supply, please observe the engine builder’s specifications for lubricating oil selection, oil change intervals, oil filtration, oil pressure and oil temperature.

**Oil filtration**

A lubrication oil filter system with a mesh size $\leq 0.050$ mm is adequate for TPL76-C turbochargers.

**NOTICE**

This filter system can also be achieved by using an additional self-cleaning fine filter.
Oil pressure

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

The permissible oil pressure ranges at measuring point M (blind connection) on the turbocharger are listed below.

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil pressure at measuring point M $p_{\text{oil,in}}$ [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible, for normal operation</td>
<td>1.3 ... 2.5</td>
</tr>
<tr>
<td>Permissible, during engine warm-up</td>
<td>1.3 ... 5.0</td>
</tr>
<tr>
<td>Temporarily admissible ( &lt; 1 h ) -&gt; alarm</td>
<td>1.1 ... 1.3</td>
</tr>
<tr>
<td>Not permissible -&gt; emergency stop</td>
<td>0.0 ... 1.1</td>
</tr>
<tr>
<td>Permissible, during pre- and post-lubrication (engine stopped)</td>
<td>0.2 ... 2.5</td>
</tr>
</tbody>
</table>

Oil orifice

A metering orifice is installed in the oil inlet of the turbocharger to ensure these oil pressures. The orifice is installed by the enginebuilder and it is fixed in place with a locking ring.
Lubricating oil temperature at the inlet

**CAUTION**

Machine damage

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

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

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at the inlet $T_{oil,inlet}$ [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissible</td>
<td>30 … 80</td>
</tr>
<tr>
<td>Temporarily admissible (&lt; 1 h) -&gt; alarm</td>
<td>&gt; 80</td>
</tr>
<tr>
<td>Not admissible -&gt; stop engine</td>
<td>&gt; 85</td>
</tr>
<tr>
<td>Not admissible -&gt; do not start engine (before start: preheat oil)</td>
<td>&lt; 30</td>
</tr>
</tbody>
</table>

Lubricating oil temperature at outlet

The oil temperature at the outlet is mainly dependant on:

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

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

<table>
<thead>
<tr>
<th>Status for operation</th>
<th>Oil temperature at outlet $T_{oil,outlet}$ [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible</td>
<td>≤ 130</td>
</tr>
<tr>
<td>Temporarily permissible -&gt; alarm</td>
<td>&gt; 130</td>
</tr>
<tr>
<td>Not permissible -&gt; stop engine</td>
<td>&gt; 150</td>
</tr>
</tbody>
</table>

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

![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.

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.

**CAUTION**

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.

**CAUTION**

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.

**NOTICE**

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.

**CAUTION**

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 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
- Air temperature behind compressor and charge air cooler
- Turbocharger speed
- Pressure loss in air filter
- If provided

4.2.3 Servicing work according to the engine manufacturer's instructions

Oil filter

- Clean or replace oil filter in supply line to turbocharger when engine is not running.
4.2.4 **Service work every 8000 ... 12000 hours**

The inspection and assessment of the rotor and the bearing parts must be carried out by an official ABB Turbocharging service station.

- Disassemble turbocharger.
- Measure clearances.
- Clean the turbine and compressor wheels and inspect for damage.
- Clean the turbine and compressor casings and inspect for any cracks and erosion or corrosion.
- Clean bearing casing and blow air through oil ports.
- Clean nozzle ring and check for cracks and erosion.
- Inspect and assess bearing parts and rotor.

4.2.5 **Service work every 24000 ... 36000 hours**

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

- Disassemble turbocharger.
- Clearance measurement.
- Clean the turbine and compressor wheels and inspect for damage.
- Clean turbine casing as well as compressor casing and check for any cracks and erosion or corrosion.
- Clean bearing casing and blow air through oil ports.
- Clean nozzle ring and check for cracks and erosion.
- Dismantle, inspect and balance the rotor.
- Replace plain bearings with original parts from ABB Turbo Systems.
4.3 Replacement intervals for turbocharger components

Rotating components
The recommended replacement intervals for the compressor and turbine wheels due to stress caused by centrifugal forces and load cycles are calculated under consideration of the operating conditions while applying the safety concept for rotating components. They can be found on the turbocharger rating plate. Incalculable influencing parameters can shorten the recommended replacement intervals for the rotor, see Influencing parameters.

Non-rotating components
The expected replacement intervals for non-rotating components and bearing parts are extremely dependent upon system-specific operating conditions, see Influencing parameters.

When the specified, periodic inspections are carried out, the individual components are inspected for wear and tear and replaced if necessary. In this way, trouble-free operation is ensured.

Influencing parameters
The following parameters influence the replacement intervals for turbocharger components:

Parameters influencing bearing parts
- Poor quality of the lubricating oil (lubrication oil filter system, condition of lubricating oil)
- Unusual loads (vibration, start/stop frequency)
- Non-permissible state of rotor unbalance

Parameters influencing non-rotating components exposed to exhaust gas
- Fuel quality (gas, MDO, HFO)
- Load profile (thermal load changes, number of starts/stops)
- Temperature level of exhaust gas
- Turbine cleaning frequency
- Procedure for turbine cleaning
### Parameters influencing rotating components exposed to exhaust gas

- Fuel quality (gas, MDO, HFO)
- Turbine cleaning frequency
- Procedure for turbine cleaning
- Load profile

<table>
<thead>
<tr>
<th>Component</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas inlet casing</td>
<td>50000 ... 100000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Gas outlet casing</td>
<td>50000 ... 100000</td>
<td>35000 ... 100000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Turbine diffuser / cover ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Other casings</td>
<td>100000</td>
<td>100000</td>
</tr>
<tr>
<td>Axial bearing components</td>
<td>24000 ... 36000</td>
<td>24000 ... 36000</td>
</tr>
<tr>
<td>Radial bearing components</td>
<td>24000 ... 36000</td>
<td>24000 ... 36000</td>
</tr>
<tr>
<td>Turbine blades (due to wear)</td>
<td>- -</td>
<td>≥ 12000</td>
</tr>
</tbody>
</table>

### Expected replacement intervals [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas inlet casing</td>
<td>50000 ... 100000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Gas outlet casing</td>
<td>50000 ... 100000</td>
<td>35000 ... 100000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Turbine diffuser / cover ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Other casings</td>
<td>100000</td>
<td>100000</td>
</tr>
<tr>
<td>Axial bearing components</td>
<td>24000 ... 36000</td>
<td>24000 ... 36000</td>
</tr>
<tr>
<td>Radial bearing components</td>
<td>24000 ... 36000</td>
<td>24000 ... 36000</td>
</tr>
<tr>
<td>Turbine blades (due to wear)</td>
<td>- -</td>
<td>≥ 12000</td>
</tr>
</tbody>
</table>

### Recommended replacement intervals [h]

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

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

### NOTICE

The specified values are guides and not guaranteed. (See Influencing parameters.)
4.4 Speed measurement

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

**CAUTION**

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.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>42047</td>
<td>Screw plug</td>
</tr>
<tr>
<td>86505</td>
<td>Speed sensor</td>
</tr>
<tr>
<td>86515</td>
<td>Cable connector for 86505</td>
</tr>
<tr>
<td>86526</td>
<td>F/I converter</td>
</tr>
<tr>
<td>86528</td>
<td>Tachometer</td>
</tr>
</tbody>
</table>
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 $n_{B\text{max}}$.

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 $n_{B\text{max}}$.
- 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 Assembly

If the speed sensor is not fitted on the turbocharger, the following procedure must be adopted to fit it:

- Engine and turbocharger are not running.
- The turbocharger lubricating system is switched off.
- Remove screw plug (42047) from bearing casing.

NOTICE

Part position

The position of the screw plug for measuring the speed is marked "n" on the bearing casing.

- Screw in speed sensor (86505) as far as it will go and tighten to torque specified in table. (See chapter Table of tightening torques.)
- Connect speed sensor using cable connector (86515).
4.4.3 Replacing the speed sensor

**WARNING**

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 to the stop.
- Observe the tightening torque (see the table of tightening torques in the chapter entitled Disassembly and assembly).

**NOTICE**

Sealing of the speed sensor

The speed sensor is designed with a sealing lip and does not require any additional gasket for assembly.

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

4.4.4 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

⚠️ CAUTION

Stopping the engine

Heat in the turbocharger must be dissipated by the further circulating lubricating oil.

- Allow the engine to continue running at idling speed for a further 10 minutes before stopping.
5 Maintenance

5.1 Foreword to Maintenance

Maintenance and servicing work involves regular visual checks and cleaning to ensure that the turbocharger and its attached units function trouble-free.

- The external condition and how dirty the cleaning points specified in this chapter are, must be established by visual checks at the specified intervals.
- The safety precautions must be observed during all maintenance and servicing work.

The cleaning points described in the following are:

- Filter silencer
- Compressor
- Turbine and nozzle ring
5.2 Cleaning the filter silencer

5.2.1 Filter silencer and connecting rod

- 81265 Filter ring (if provided)
- 81266 Cover grid
- 81269 Connecting rods
- 81272 Screwdriver
- 81273 Sheet-metal covering
- 81276 Filter silencer body
- 81136 Absorption segment
- 81137 Lock nut
- E Insert unit = absorption segment + sheetmetal covering
Removing and cleaning filter silencer

If provided

- Remove filter strip (81265).
- Rinse filter strip (81265) using water with detergent additive or, if very dirty, soak it and squeeze out carefully. Rinse it in cold water. Avoid rough treatment (not a jet of water).

**NOTICE**

How dirty the filter strip (81265) is, depends on how clean the drawn-in air is. Clean filter strip every 500 hours of service or more frequently if necessary.

- Unscrew and remove lock nuts (81273).
- Unscrew and remove screws (81272) for connecting rods (81269).
- Remove connecting rods (81269).
- Carefully remove cover grids (81266).
- Pull out insert units (E), bend open sheet metal coverings (81137) and then remove 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. Otherwise there is a risk of damage or deformation.

**NOTICE**

Replace heavily contaminated or damaged parts with original parts from ABB Turbo Systems.

Fitting filter silencer

- Assemble insert units (E) by putting fleece segments (81136) into sheet-metal cover (81137).
- Bend back sheet-metal cover (81137) to original shape.
- Put insert units (E) into slot guides in filter silencer body (81135).

**NOTICE**

If a cleaning container is fitted to the filter silencer (optional depending on turbocharger type), the water injection line must now be refitted. (See also following section Fitting cleaning pipe.)

- Put cover grids (81266) uniformly into correct position.
- Push connecting rods (81269) through clips on cover grids (81266).
CAUTION

If the connecting rods (81269) are not located correctly in their recesses on the filter silencer body (81135), the cover grids (81266) can twist and shift. There is then a risk of foreign matter and dirt getting into the compressor.

- Join connecting rods (81269) using screws (81272). When tightening the screws (81272), ensure that connecting rods (81269) are located correctly in recesses in filter silencer body (81135). Now tighten screws (81272) alternately until the following maximum torque is reached:

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

- Screw lock nuts (81273) onto screw (81272) and tighten to following torque:

<table>
<thead>
<tr>
<th>Lock nut</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>81273</td>
<td>40</td>
</tr>
</tbody>
</table>
## 5.3 Cleaning the compressor during operation

**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.

**General**

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

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

Consequences of contamination:

- Impaired compressor efficiency
- 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. It does not, however, replace the regular service work, during which the turbocharger is completely dismantled and the compressor is cleaned mechanically.

**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 method

Cleaning of the compressor during operation is carried out using the cleaning method described in the following:

- Wet cleaning

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

Principle of wet cleaning

To clean the compressor stage during operation, water is injected in front of the compressor wheel.

The water does not act as a solvent, but the contamination 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.

⚠️ CAUTION

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

Uncontrolled volumes of water

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

- Never connect the water line without the orifice specified for the turbocharger.

⚠️ CAUTION

Formation of ice at low temperatures

Damage to turbocharger due to the formation of ice during wet cleaning if the intake air temperatures are too low.

- Never carry out wet cleaning if intake air temperatures are under 5 °C.

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.
5.3.1 Wet cleaning with orifice plate on filter silencer (XC2)

Operating state prerequisites for wet cleaning XC2

**WARNING**

Increased stress on material

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

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

Wet cleaning procedure for compressor with XC2

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

Not more than three cleaning cycles should be conducted consecutively.

Cleaning parameters per turbocharger compressor

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>50 ... 100%</td>
<td>3</td>
<td>10</td>
<td>5 ... 50</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Surging of the compressor stage

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

If, despite correct settings, surging of the compressor stage occurs while cleaning the compressor, as a remedial measure the engine load can be reduced further while cleaning the compressor. The reduction of the engine load can lead to a reduction in the effectiveness of the compressor cleaning.

To avoid a decreased engine availability, the compressor stage can be cleaned at reduced engine load during the drying time after wet cleaning of the turbine has been completed. (see section Wet cleaning turbine and nozzle ring during operation). In this case, the water injection time for cleaning the compressor can be increased from ten to forty seconds.
5.3.2 Wet cleaning using external water-pressure vessel (XC3)

Operating state prerequisites for compressor cleaning with XC3

In order to carry out a successful cleaning procedure that has been tested and is recommended by ABB Turbo Systems, the following prerequisite must be met:

- Engine load 50 ... 85%
- Start cleaning cycle according to following description Wet cleaning operation with XC3.

Operating procedure for compressor wet cleaning with XC3

- The operating state prerequisites for compressor cleaning with XC3 must be fulfilled.
- Remove sealing plug (X).
- Fill vessel with required volume of clean water (see table Cleaning parameters).
- Screw in sealing plug (X).
- Push the valve activator (Y) against the spring and hold it for 10 ... 15 seconds until the entire volume of water has been injected.
After cleaning, wait at least 5 minutes to allow turbocharger to dry. The cleaning process can be repeated up to two times.

If the cleaning is still unsuccessful after three cleaning processes and the engine values are unsatisfactory, it is recommended to have the turbocharger checked and cleaned by an ABB Turbocharging Service Station.

**Cleaning parameters per turbocharger compressor**

<table>
<thead>
<tr>
<th>Product</th>
<th>Engine load</th>
<th>Water temperature [°C]</th>
<th>Contents of water vessel [dm³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>50 ... 85%</td>
<td>5 ... 50</td>
<td>1</td>
</tr>
</tbody>
</table>

**Surging of the compressor stage**

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

If, despite correct settings, surging of the compressor stage occurs while cleaning the compressor, as a remedial measure the engine load can be reduced further while cleaning the compressor. The reduction of the engine load can lead to a reduction in the effectiveness of the compressor cleaning.

To avoid a decreased engine availability, the compressor stage can be cleaned at reduced engine load during the drying time after wet cleaning of the turbine has been completed. (see section Wet cleaning turbine and nozzle ring during operation). In this case, the water injection time for cleaning the compressor can be increased from ten to forty seconds.
5.4 Cleaning turbine blades and nozzle ring in operation

The combustion of heavy fuel oil in diesel engines contaminates the turbine blades and nozzle rings of turbochargers. The deposits on the turbine components originate from the following combustion products:

- Soot
- Molten ash
- Cinder
- Incompletely burned fuel
- Sodium vanadyl vanadate

It is advisable to use fuels with a low ash, sulphur, sodium and vanadium content. The fuel must also be correctly stored, prepared and handled.

We recommend using fuels with a vanadium-to-sodium mass ratio of less than 3:1 so that the melting temperature of the sodium vanadyl vanadate is as high as possible.

The amount of contamination increases over time, which is why regular and correctly performed cleaning is important in order to remove the deposits that have formed.

Contaminated turbine components can cause a slight increase in charging pressure because of narrowing of the turbine cross-section. The contamination causes a drop in turbine efficiency, and the engine temperatures downstream of the cylinder can increase. The engine performance must therefore be reduced if necessary.

The contamination of the turbine also causes rotor unbalance. Extremely heavy contamination can lead to non-permissibly high unbalance of the rotor.

Operating experience has shown that, in spite of regular cleaning during operation, it is essential to carry out the overhauls during which the turbine and the nozzle ring are cleaned mechanically. However, if cleaning is carried out properly and the cleaning system is properly dimensioned, the intervals between overhauls can be increased.

**Wet cleaning interval**

The interval between periodic cleaning is very dependent on the operating conditions. As a rule, cleaning should be carried out every 50 to 200 operating hours.

**Cleaning method**

When cleaning the turbine components during operation, use wet cleaning. This cleaning method has been tested and approved by ABB Turbo Systems.

Prerequisites for wet cleaning are that the engine builder approves the process and his instructions are followed.

**Principle of wet cleaning**

Wet cleaning makes use of various effects. Depending on the composition of the contamination, the individual effects with their different levels of intensity have a varying influence on the cleaning result.
- Erosion
  The dirt is removed by the mechanical action of the impacting water droplets.
- Solubility
  Water solubility of the contamination deposits in water.
- Thermal shock
  Spalling of contamination due to temperature difference.

**CAUTION**

**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.

Components at the turbine end are not cleaned until the engine has been started or the engine load reduced. The exhaust gas temperature must not exceed the value specified in the respective cleaning instructions (see section Prerequisites TPL-A/-C: Operating state prerequisites for wet cleaning turbine and nozzle ring → 57).

**CAUTION**

**Reduced service life of the components**

Failure to comply with the minimum stabilisation time before cleaning, the prescribed turbine inlet temperatures and the drying time after cleaning significantly reduces the expected service life of the components.

- Comply with the cleaning parameters given in the tables.

**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. We recommend finding the most suitable method by performing trials.
5.4.1 Wet cleaning turbine and nozzle ring during operation

Prerequisites for wet cleaning of turbine

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

- The engine has just been started or the engine load has been reduced as far as possible (best cleaning is achieved at a load level of roughly 10 ... 15%).
- As soon as the turbine inlet temperature is stable and below 430 °C, wait at least another 10 minutes for the charger parts to cool down.
- Start cleaning cycle according to following description Wet cleaning procedure.

![Diagram showing engine load and time with stages: Cool-down, Cleaning, Drying. Approx. 30 min (Recommended) above 500°C.]}
Layout of cleaning pipes

Wet cleaning procedure for turbine during operation

- Meet prerequisites and operating state requirements without fail before cleaning!
- Make sure water supply (01) is connected, turned on and guaranteed.
- Open drain pipe (08, 09), if provided.
- Switch over 3-way valve (04) from scavenging air mode to water supply.
- Set the required volume of water on the flowmeter as shown in the table (see table Cleaning parameters).
- Shut off the water supply again by switching the 3-way valve (04) to scavenging air mode after injecting the required volume of water.
- The injection process has been completed.
- Close drain hole (if provided) above drain pipe (08, 09).
- After cleaning, wait with engine running for at least 10 minutes without changing load to allow turbocharger to dry.

**CAUTION**

Corrosion damage to bearing casing

In order to avoid corrosion damage to the bearing casing, it is advisable to carry out an additional 30 minutes of operation with TTE > 500°C after the 10 minute drying time.
It is necessary to have the corresponding water pipe pressure in order to achieve the correct water flow rate (see table Cleaning parameters). If the water pressure is too low, the water flow rate specified in the table will not be obtained. In this case, the cleaning effect will be decreased.

Repeating cleaning cycles immediately after each other must be avoided as this can lead to high mechanical loading and consequently to a reduction in the service life of the components.

If cleaning is unsatisfactory, the length of the process can be extended. If the injection time is extended, it must be ensured that no unacceptable volume of water collects in the gas outlet casing. To avoid this, a drainage system for the gas outlet casing should be installed and open during the cleaning process. If a drainage system is not provided, the injected volume of water can be controlled by a flowmeter in the water supply. The maximum volume of water allowed in individual cases must be determined together with an ABB Turbocharging Service Station. The influence of the cleaning water on peripheral equipment, such as a boiler, must be clarified by the operator.

The following points must be observed with regard to draining the gas outlet casing:

- The exhaust gas temperature behind the turbocharger drops significantly when cleaning (typical turbocharger outlet temperatures during cleaning: 60 ... 180 °C).
- Depending on the engine load, water might run out of the drain pipe. This outflow might not start for two or three minutes, or it might not occur at all.
- If the drainage of the gas outlet casing is omitted, the turbocharger speed and/or the gas inlet temperature must be monitored during the cleaning process. If the load is too low, water can collect in the gas outlet casing. Indicators for this are a sudden severe drop in the turbocharger speed or a very large increase in the gas inlet temperature. In such cases, the cleaning operations must be stopped and the cleaning cycle restarted with reduced water pressure or higher engine load.

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

<table>
<thead>
<tr>
<th>Product</th>
<th>Max. temperature when starting cleaning $T_{\text{Ti}}$ [°C]</th>
<th>Injection time $t_i$ [min]</th>
<th>Water flow rate per turbocharger at $p_{\text{Water}} = 3$ bar $M_w$ [l/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>430</td>
<td>10</td>
<td>37</td>
</tr>
</tbody>
</table>
5.5 Cleaning components mechanically

5.5.1 Introduction

Compressor wheels can be heavily contaminated by badly filtered intake air, as can turbines by 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).

Professional overhauling of the components by an ABB Turbocharging Service Station is required, preferably using the cleaning method described in the following.

**CAUTION**

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 have protective coatings, which can also be damaged.

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

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

- Dispose of contaminated water and cleaning agents in an environmentally compatible manner, professionally and in accordance with valid local regulations.
5.5.2 Turbine-end, non-rotating parts

**WARNING**

Handling operating materials and supplies

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

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

Wear safety goggles.

Wear safety gloves to protect against chemical hazards.

Wear a respiratory mask to protect against gases.

Baked-on layers of contamination, for example from heavy fuel oil or coked oil, occur at the turbine end. The following performance-relevant parts can be cleaned according to the following description.

56001 Nozzle ring
63000 Turbine diffuser

- Place contaminated parts in hot water or in a liquid such as brake cleaner, so that the contamination softens.
- Brush off the contamination or remove it with a steam cleaner.
- Repeat the soaking and brushing if necessary.
- Completely remove any solvents from the parts in clean water.
- Dry components completely.
- Spray cleaned surfaces with penetrating oil. Do not spray the outer surfaces of the turbocharger.
- Dispose of contaminated water and cleaning agent in accordance with the specifications in the safety data sheet.
5.5.3 Cartridge group – General

⚠️ CAUTION

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.

► Remove turbocharger from the engine (see chapter Removal and installation).

► Remove cartridge group (see chapter Disassembly and assembly).

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

5.5.4 Cleaning the cartridge group on the compressor end

⚠️ CAUTION

Selection of the cleaning agent
Cleaning agents which contain chlorine attack metals.

► Use only pH-neutral cleaning agents which do not attack metals.

► Observe safety data sheet.

⚠️ CAUTION

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

► Make sure that no water or contamination can enter into the cartridge group.

► Clean compressor wheel with a scouring cloth or soft brush soaked in water with household cleaning agent. 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 gap between the compressor and the bearing casing with penetrating oil.

► Dispose of contaminated water and cleaning agent in accordance with the safety data sheet.

5.5.5 Cleaning the cartridge group on the turbine end

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

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

The cartridge group must be rotated to do this.

- Two cranes (or chain blocks) must be used for the rotating operation.

Suspending the chain block directly from the crane and rotating the cartridge group is not permitted because of the risk of damage to the compressor wheel.

**Cartridge group with one central suspension point**

![CAUTION](image)

**Damage to compressor wheel**

The lifting gear must not touch the compressor wheel at any time during rotation.

- Choose appropriate lifting gear length.

1. Suspend cartridge group from normal suspension point and suspend from first crane.

2. Secure two lifting loops with swivel lifting eyes in the lower push-off threads and suspend from a second crane.

3. Rotate cartridge group horizontally by lifting the second crane.
4. When the cartridge group is horizontal, secure one chain block to one of the upper push-off threads using a swivel lifting eye and suspend from the second crane.

5. Tighten chain block until entire cartridge group is suspended from second crane.

6. Remove loop from first crane.
Cartridge group with two side suspension points

Or use two swivel lifting eyes at top.

⚠️ CAUTION

Damage to compressor wheel
The lifting gear must not touch the compressor wheel at any time during rotation.
- Choose appropriate lifting gear length.

1. Suspend cartridge group from the two side suspension points on the crane using two lifting loops.
   or
   Attach two swivel lifting eyes to the side and suspend the cartridge group from the crane using two lifting loops.

2. Attach third lifting loop with swivel lifting eye to thread of oil outlet flange.

3. Rotate the cartridge group into a horizontal position by lifting.
4. When the cartridge group is suspended horizontally, attach a chain block to the swivel lifting eye and attach to the first crane.

5. Tighten chain block until entire cartridge group is suspended from first crane.

6. Remove loop from second crane.

**CAUTION**

**Selection of the cleaning agent**

Cleaning agents which contain chlorine attack metals.

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

- Fill the tank with soaking liquid.

- Only immerse the cartridge group until all blades are covered with cleaning agent.

**NOTICE**

**Heating the liquid**

To shorten the soaking time the liquid can be heated to maximum 60 °C.
WARNING

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

CAUTION

Water and contamination in the cartridge group
If water or contamination gets into the cartridge group, the turbocharger function may be impaired and parts in the cartridge group may be damaged.
» Place cartridge group on suitable wooden or metal supports.
» Allow the layers of contamination on the turbine to soak for at least four hours.

Removing contamination

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 contamination manually with a soft brush or wire brush.
**CAUTION**

**Water and contamination in the cartridge group**

If water or contamination 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 contamination does not get into the gap between the sealing cover and turbine.

**CAUTION**

**Non-permissible rotor unbalance after cleaning**

Invisible and 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 with clean water, not salt water.
- Submerge the turbine of the cartridge group in clean water, so that loose particles of contamination detach completely.
- Lift the cartridge group.
- Dry turbine and gap between turbine and sealing cover with a weak jet of compressed air.
- Lightly spray turbine and gap between turbine and sealing cover with penetrating oil.
- Rotate cartridge group back to horizontal position (described procedure in reverse order, see Cleaning the cartridge group on the turbine end →62).
- Dispose of contaminated 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>Turbocharger contaminated</td>
</tr>
<tr>
<td></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 turboc</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>Rotor unbalance</td>
</tr>
<tr>
<td></td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Damaged turbine or com-</td>
<td></td>
</tr>
<tr>
<td>pressor</td>
<td></td>
</tr>
<tr>
<td>Damaged bearing</td>
<td></td>
</tr>
</tbody>
</table>

#### Rubbing of rotating parts

**Normal behaviour, no malfunction**

<table>
<thead>
<tr>
<th>Turbocharger</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- If there is any doubt about the extent of rubbing, then an ABB Turbocharging Service Station must be contacted.</td>
</tr>
<tr>
<td></td>
<td>- Have a dimension check carried out by an ABB Turbocharging Service Station.</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>Engine Engine guard is contaminated or damaged</td>
<td>Clean it</td>
</tr>
<tr>
<td>Turbocharger Filter silencer or diffuser contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Turbocharger Heavy deposits of dirt in the turbine or nozzle ring</td>
<td>Clean it</td>
</tr>
<tr>
<td>Charge air cooler Cooler contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Charge air cooler Charge air duct blocked</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

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 lubricating system</td>
<td>Check / replace it</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</td>
</tr>
<tr>
<td></td>
<td>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 when pulse charging</td>
<td>Contact the enginebuilder</td>
</tr>
<tr>
<td>Turbocharger</td>
<td></td>
</tr>
<tr>
<td>Heavy contamination of the turbine</td>
<td>Clean it</td>
</tr>
<tr>
<td>Damaged rotor components or bearing</td>
<td>Contact an ABB Turbocharging</td>
</tr>
<tr>
<td></td>
<td>Service Station</td>
</tr>
<tr>
<td>Pipes</td>
<td></td>
</tr>
<tr>
<td>Defects such as leaks in the exhaust gas pipes or</td>
<td>Make repairs</td>
</tr>
<tr>
<td>charge 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 ring (with 4-stroke</td>
<td>Contact an ABB Turbocharging</td>
</tr>
<tr>
<td>application)</td>
<td>Service Station</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></td>
<td>Repair it or contact the manufacturer</td>
</tr>
<tr>
<td>Turbocharger</td>
<td>Air starvation, for example filter silencer clogged with dirt</td>
</tr>
<tr>
<td>Compressor / turbine contaminated</td>
<td>Clean it</td>
</tr>
<tr>
<td>Exhaust counterpressure too high</td>
<td>Clean or repair the boiler or exhaust silencer</td>
</tr>
<tr>
<td>Enlarged flow cross-section of the nozzle ring due to deformed blade trailing edges</td>
<td>Contact an ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Damaged or eroded turbine</td>
<td></td>
</tr>
<tr>
<td>Charge air cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Clean it</td>
</tr>
<tr>
<td></td>
<td>Cooling water volume too low</td>
</tr>
<tr>
<td></td>
<td>Top up the water</td>
</tr>
<tr>
<td></td>
<td>Entry temperature of cooling water too high</td>
</tr>
<tr>
<td></td>
<td>Inspect / clean the cooling system</td>
</tr>
<tr>
<td></td>
<td>Inadequate ventilation</td>
</tr>
<tr>
<td></td>
<td>Improve the ventilation</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>Correct it</td>
</tr>
<tr>
<td>Poorly adjusted injection system</td>
<td></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>
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</td>
<td>Turbocharger contaminated</td>
</tr>
<tr>
<td></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</td>
<td>Turbocharger contaminated</td>
</tr>
<tr>
<td></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

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal amplitude non existent or poor</td>
<td>Fitting error</td>
</tr>
<tr>
<td></td>
<td>The screw plug for the sensor is fitted with a gasket. When fitting the speed sensor, this gasket must be removed. If it 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>Dirty sensor tip</td>
<td>The sensor tip is magnetic and can thus attract metal particles. As a result, the distance to the auxiliary bearing decreases, which can lead to amplification of the noise component and consequently to faulty triggering. Remove the sensor, clean its tip and refit the sensor using the specified tightening torque.</td>
</tr>
<tr>
<td>Measured speeds too high</td>
<td>Dirty sensor tip</td>
</tr>
<tr>
<td>Measured speed too low</td>
<td>- -</td>
</tr>
<tr>
<td>Other sources of errors</td>
<td>- -</td>
</tr>
</tbody>
</table>

Contact ABB Turbocharging service station.
7 Removal and installation

7.1 Turbocharger weight

Lifting gear with a sufficient load limit must be used for removing and installing the turbocharger. The following weight specification is the heaviest variant possible. This standard value may deviate from the data on the rating plate depending on the specification.

<table>
<thead>
<tr>
<th>Weight [kg]</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4070</td>
</tr>
</tbody>
</table>
7.2 Removing the turbocharger

- A suitable suspension device (as illustrated) must be used when removing and installing the turbocharger. The suspension device is not supplied by ABB Turbo Systems.
- Disconnect all gas, air and oil pipes in accordance with the enginebuilder’s instructions.

**CAUTION**

Oil orifice plates

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

- Check correct installation of oil orifice plates.

<table>
<thead>
<tr>
<th>Suspension dimension</th>
<th>Distance in [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>860</td>
</tr>
<tr>
<td>B</td>
<td>1210</td>
</tr>
<tr>
<td>C</td>
<td>800</td>
</tr>
</tbody>
</table>

Use the two suspension eyes on the bearing casing (L1, L2) (observe the marking on the insulation).

The two suspension eyes on the turbine-end foot (T1, T2) are used for horizontal alignment of the turbocharger.

- Remove the insulation shell from the bearing casing and turbine-end foot. Leave the remaining insulation on the turbocharger.
Version with compressor wheel cooling system

- Dismantle air supply line. (See also chapter entitled Preliminary remarks / Layout and functionality)

- Inspect the lifting gear.
- Secure lifting gear to the suspension eyes of the bearing casing and the turbine-end foot.
- Unplug the cable connector on the speed sensor.
- Unscrew the fixing screws on the feet.
- Lift the turbocharger off the engine and set it down to one side.

**WARNING**

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

- Support the turbocharger at a suitable point.
- Cover the oil connection.
7.3 Installing the turbocharger

- Remove the cover from the oil connection.
- Inspect the lifting gear.
- Fasten the lifting gear to the suspension lugs on the bearing casing and the turbine-end foot.

**CAUTION**

**Oil orifice plates**

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

- Check correct installation of oil orifice plates.

- Fit the turbocharger to the engine.
- Tighten the fixing screws on the foot.

**NOTICE**

The fastening specifications for the foot fixing screws are supplied to the engine builder by ABB Turbo Systems and given in his manual.

- Fasten the gas, air and oil lines in accordance with the engine builder’s instructions.

**Version with compressor wheel cooling system**

- Fit the air supply line (also see the chapter entitled Preliminary remarks / Layout and functioning).

- Plug in the cable connector on the speed sensor.
8 Disassembly and assembly

8.1 Introduction

**CAUTION**

Further work

Further tasks, which are not described here, may be carried out only by trained personnel from an ABB Turbocharging service station.

- Only carry out those tasks that are described in this chapter.

- Mark the casing position for assembly.

**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.

**WARNING**

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.
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 attachment point on a component or an assembly (blind hole thread, eye, lug).

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

- **Lifting gear**
  Equipment for lifting and transporting loads (ropes, chain block, crane). Lifting gear is not supplied by ABB.
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>Item</th>
<th>Description</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Filter silencer</td>
<td>280</td>
</tr>
<tr>
<td>2</td>
<td>Axial air suction branch</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Radial air suction branch</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>Compressor casing internal part</td>
<td>220</td>
</tr>
<tr>
<td>5</td>
<td>Wall insert</td>
<td>220</td>
</tr>
<tr>
<td>6</td>
<td>Diffuser</td>
<td>45</td>
</tr>
<tr>
<td>7</td>
<td>Compressor casing external part</td>
<td>310</td>
</tr>
<tr>
<td>8</td>
<td>Cartridge group</td>
<td>900</td>
</tr>
<tr>
<td>9</td>
<td>Turbine diffuser</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>Nozzle ring</td>
<td>23</td>
</tr>
<tr>
<td>11</td>
<td>Radial gas inlet casing with segment connection</td>
<td>250</td>
</tr>
<tr>
<td>12</td>
<td>Segment</td>
<td>18</td>
</tr>
<tr>
<td>13</td>
<td>Radial gas inlet casing with flange connection</td>
<td>190</td>
</tr>
</tbody>
</table>
Complete compressor casing internal part

<table>
<thead>
<tr>
<th>Weight [kg]</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>490</td>
</tr>
</tbody>
</table>

**NOTICE**

The total weight of the complete internal part of the compressor casing includes the internal part of the compressor casing, the diffuser and the wall insert.
8.3 Removing and fitting filter silencer or air suction branch

- Disconnect all air lines / ducts in accordance with engine builder’s instructions.
- Remove the insulation where necessary.
- Loop the lifting gear around the air suction branch.
- Unscrew the nuts (74027) and remove them together with their washers (74018).
- Remove the air suction branch and set it down to one side.

Installing the air suction branch

- Install the air suction branch in reverse order.
8 Disassembly and assembly / 8.3 Removing and fitting filter silencer or air suction branch

Removing filter silencer

- Remove insulation where necessary.
- Pass lifting gear through rib on filter silencer and through eyelets at rear.
- Unscrew nuts (74027) and remove them together with washers (74018).
- Remove filter silencer and set it down to one side.

Fitting the filter silencer

- Fit filter silencer in reverse order.
8.4 Axial clearance

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

Wear safety gloves to protect against mechanical hazards.

The axial clearance (A) must be measured before removing and after installing the cartridge group.

▶ Measure and note the axial clearance (A).

<table>
<thead>
<tr>
<th>Clearance A [mm]</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.43 … 0.69</td>
</tr>
</tbody>
</table>

⚠️ CAUTION

Clearances outside the tolerance
Serious damage to engines or property can be caused by clearances outside the tolerance and excessively worn parts.

▶ Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.
8.5 Removing cartridge group

**CAUTION**

Locked safety segments (76080) during disassembly

Observe the maximum tightening torque for the nuts (90458) so as not to shear off the threaded studs of the safety segments (76080).

- Fit four nuts (74027) complete with washers (74018), equally spaced around circumference, and tighten.

- Remove insulation (from bearing casing).

Removing safety segments / releasing casing

- Take nuts (90458) out of toolbox and screw them onto threaded studs of safety segments (76080) on internal part of compressor casing (76000).

- Tighten nuts (90458) to a maximum torque of 30 Nm.

The internal part of the compressor casing (76000) has now been separated from the external part (74000) and can be removed.

**NOTICE**

Note the control dimension (u).

---

Check dimension (u) [mm]

<table>
<thead>
<tr>
<th>Dimension</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
<td>21.8</td>
</tr>
</tbody>
</table>
Removing the compressor casing internal part

- Remove two studs (74029 / 74026) at the point where the lifting device (90190) will be fitted later.
- Using press-off screws (90900), push apart the compressor casing internal part (76000) until the lifting device (90190/90195) can be attached.
- Slightly lift and then withdraw the compressor casing internal part including the wall insert and diffuser.
- Attach the support angle (90025) using screws (90021) and nuts (74027).
- Put down the compressor casing internal part including the wall insert and diffuser on the support angle and an underlay.
- Remove the O-ring (76040).
Transporting / turning internal part of compressor casing

- Carefully turn internal part of compressor casing complete with wall insert and diffuser about support angle (90025) and put onto underlay.
- Set down casing on flange (F).
- Set down internal part of compressor casing in such a way that lifting device (90190/90195) can be removed.

**WARNING**

Ensure that the shim does not slip.
- Rest the internal part of the compressor casing only on flange (F).
- Check shim and adjust as necessary.
Removing diffuser and wall insert

- Remove screws (76002).
- Remove diffuser (79000) using swivel lifting eyes (90235).
- Press away wall insert (77000) using press-off screws (90230) and remove from internal part of compressor casing (76000) using swivel lifting eyes (90235).
Removing external part of compressor casing

- Fasten lifting device (90190/90195) to external part of compressor casing (74000) using screws and secure to crane.
- Remove screws (42280).
- Uniformly press away external part of compressor casing (74000) using press-off screws (90900) and remove.

**NOTICE**

**Insulation on external part of compressor casing**

The insulation on the external part of the compressor casing does not need to be taken off when removing or fitting the casing.

- Remove O-ring (42012).
Removing the cartridge group

- Unplug cable connector (86515) and unscrew speed sensor (86505) with O-ring (86506).
- Disconnect oil inlet and oil outlet pipes.

**CAUTION**

**Oil orifice plates**

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

- Check correct installation of oil orifice plates.

**Version with compressor wheel cooling system**

- Remove air supply line. (See also chapter entitled Preliminary remarks / Layout and functionality)
When pressing off, use diametrically opposite press-off threads. Otherwise the bearing casing can jam and damage the turbine blades.

- Check lifting gear and attach to bearing casing (42001).
- Loosen nuts (61037) and remove Verbus Ripp® washers (61051).
- Screw guide rod (90490) onto threaded stud (X) to balance cartridge group.
- Evenly press off cartridge group by screwing press-off screws (90900) into the designated holes.

**CAUTION**

If the blades have insufficient or no clearance between the rotor and the casing, the blades and the casing may be damaged.

- Check that the blades do not rub on the turbine diffuser by rotating the rotor.

- Withdraw cartridge group.
- Remove screws (42064) together with flange (42044) and also remove possible contamination behind the flange.
- Fit supports (90450) using screws (42280) and put down cartridge group.
- Cover the oil connections.
8.6 Dismantling and installing the turbine diffuser and nozzle ring

Removing turbine diffuser

- Put assembly plate (90020) over strain bolts (61036).
- Insert extension (A) of torque spanner (B) through hole in assembly plate and loosen screws (61056) one after other.
- Don't remove screws (61056) yet.
- Replace two screws (61056) with guide studs (90320).
- Fit assembly plate (90020) over studs (61036).
- Screw nuts (61037) onto start of threads of studs (61036) to secure.
- Remove remaining screws (61056).
- Press away turbine diffuser (63000) using press-off screws (90901) and withdraw it until assembly plate (90020) touches nuts (61037).
- Loop lifting gear around turbine diffuser (63000) and secure to crane.
- Remove nuts (61037) and assembly plate (90020) from studs.
- Fully withdraw turbine diffuser and remove.
- Remove guide studs (90320).
8.6 Dismantling and installing the turbine diffuser and nozzle ring

Removing the nozzle ring

1. Bend up the locking plates (56018), undo nuts (56022) and remove.
2. Pull out nozzle ring (56001).
3. Remove threaded stud (56021).

⚠️ CAUTION

Fastening the nozzle ring

When fitting the nozzle ring, new threaded studs (56021), nuts (56022) and locking plates (56018) from the customer spare part set (97070) must be used.

⚠️ CAUTION

Clogged areas on the nozzle ring

If a nozzle ring is clogged in some areas or is covered by loose parts, it is recommended to appoint an ABB Turbocharging Service Station to inspect the turbine blades and carry out a crack inspection.
Installing the nozzle ring

**CAUTION**

**Fastening the nozzle ring**

When fitting the nozzle ring, new threaded studs (56021), nuts (56022) and locking plates (56018) from the customer spare part set (97070) must be used.

- Push in nozzle ring (56001) as far as it will go at the cover of the gas inlet casing.
- Coat threads of threaded studs (56021) with high-temperature grease and fit threaded studs. Fit the locking plates (56018) and nuts (56022).
- Tighten nuts (56022) and bend locking plates (56018) over.

**CAUTION**

**Correct assembly**

The nozzle ring must be easily movable after assembly.
Fitting turbine diffuser

- Coat all screw threads on and in the gas casings with high-temperature grease.

- Fasten turbine diffuser (63000) to lifting gear.
- Align marking "TOP" with the position of the gas outlet flange and pay attention to where the positioning pin is in the gas outlet casing.
- Fit turbine diffuser (63000) to guide studs (90320).
- Put assembly plate (90020) over strain bolts (61036) and guide studs (90320).
- Remove lifting gear and push in turbine diffuser.
- Using three screws (61056), alternately and uniformly screw in turbine diffuser as far as it will go.
- Insert torque spanner extension through hole in assembly plate and tighten screws (61056) one after other. (See illustration in section Removing turbine diffuser)

8.7 Installing cartridge group

⚠️ CAUTION

Oil orifice plates

An orifice plate for adjusting the oil pressure is fitted in each of the two oil inlet channels in the bearing casing. When the cartridge group, the bearing casing or the turbocharger is fitted to the engine, it must be ensured that the orifice plates that are specified for the turbocharger have been installed in the two oil inlet channels.
- Check correct installation of oil orifice plates.
- Remove cover from oil connection.
- Fit flange (42044) with new gasket (42045) and screws (42064).
- Check lifting gear and attach to bearing casing (42001) in such a way that cartridge group is suspended in a straight position.
- Screw guide rod (90490) onto threaded stud (X) to balance cartridge group.
- Remove supports (90450) and carefully insert cartridge group.
- Fit three oiled nuts (61037) complete with new Verbus Ripp® washers (61051) around circumference at 120° intervals.
- Tighten the three nuts (61037) evenly and alternately with pre-tightening torque of (MV) (see chapter Table of tightening torques).
- Each time the three nuts (61037) are gradually tightened, check rotor by turning it. The blades must not touch other parts.

⚠️ CAUTION ⚠️

If the blades have insufficient or no clearance between the rotor and the casing, the blades and the casing may be damaged.

- Fit the remaining oiled nuts (61037) complete with new Verbus Ripp® washers (61051) and tighten with pre-tightening torque (MV) (see chapter Table of tightening torques).
- Tighten all nuts (61037) in a star pattern with tightening angle (DW) (see chapter Table of tightening torques).
8. Disassembly and assembly / 8.7 Installing cartridge group

- Remove the lifting gear.
- Remove guide rod (90490).
- Screw in the speed sensor (86505) together with the O-ring (86506) and plug in the cable connector (86515).
- Reconnect oil and air lines.

**Version with compressor wheel cooling system**

- Fit the air supply line. (See also chapter entitled Preliminary remarks / Layout and functionality)
Fitting external part of compressor casing

- Fasten lifting device (90190/90195) to external part (74000) of compressor casing and secure it with crane.
- Fit O-ring (42012).
- Fit external part of compressor casing (74000) and fasten using screws (42280).
- Remove lifting device (90190/90195).
Fitting diffuser and wall insert

- Screw swivel lifting eyes (90235) into holes in wall insert (77000).
- Align mark (A) with notch (B).
- Fit centering screws (90230) in such a way that spigots on centering screws protrude maximum 5 mm.
- Lower wall insert and align centering screws (90230) with threaded holes.
- Remove swivel lifting eyes (90235) and centering screws (90230).
- Put the diffuser (79000) in place using the swivel lifting eyes (90235).
- Remove the swivel lifting eyes (90235).
- Fit screws (76002).
Turning / transporting internal part of compressor casing

- Fasten lifting device (90190/90195) to front side of flange (F).
- Carefully turn internal part of compressor casing (76000) complete with wall insert and diffuser about support angle (90025) and lift up vertically.

**WARNING**

Ensure that the shim does not slip.
* The two compressor casing parts are centred via the long cylindrical flange. No guide pieces are needed.

- Check whether the nuts (90458) of the three safety segments have been tightened (safety segments are in the "not engaged" position).
- Fit O-ring (76040).
- Remove the support angle (90025), screws (90021) and nuts (74027).
- Align the compressor casing internal part (76000) with the compressor casing external part as shown in the illustration on the next page.
- Carefully insert the compressor casing internal part (76000) including the wall insert and diffuser into the compressor casing external part and then remove the lifting device (90190/90195).
NOTICE
Align the compressor casing internal part (76000) with the notch (see the arrow) so that the notch is positioned at the rib of the compressor casing external part (74000) (see the arrow).

- Fully insert the compressor casing internal part (76000).
- Fit the studs (74026/74029).
Engaging safety elements / securing casing

**CAUTION**

**Locked safety segments (76080) during assembly**

The safety segments (76080) are not in the operating position. Additional axial securing of the two compressor casings (74000/76000) is not guaranteed.

- Fit four nuts (74027) complete with washers (74018), equally spaced around circumference, and tighten.

- Unscrew nuts (90458) on threaded studs of safety segments (76080) on internal part of compressor casing (76000).

The internal part of the compressor casing (76000) is now secure relative to the external part (74000).

**NOTICE**

Note the control dimension (s). The safety segments (76080) are in the operating condition again ("engaged").

<table>
<thead>
<tr>
<th>Check dimension (s) [mm]</th>
<th>Dimension</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td></td>
<td>16.5</td>
</tr>
</tbody>
</table>

- Put nuts (90458) back into toolbox.
Measuring and checking axial clearance

**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>Clearance A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TPL76-C</strong></td>
</tr>
<tr>
<td>0.43 … 0.69</td>
</tr>
</tbody>
</table>

- Measure and note axial clearance A.

**CAUTION**

If the axial clearance (A) is out of tolerance, an official ABB Turbo Systems service station must be contacted.

- Connect oil lines and all air lines in accordance with engine builder specifications.
- Fit filter silencer or air suction branch and fasten with nuts (74027) and washers (74018).
- Refit insulation if it was removed.
8.8 Dismantling and fitting nozzle ring at turbine end

**NOTICE**
If only the nozzle ring has to be removed, this can be done at the turbine end.

**CAUTION**
Clogged partial areas on the nozzle ring
If a nozzle ring is found to be clogged over partial areas or covered by loose parts, it is recommended that you have a turbine blade inspection including a crack inspection carried out by an ABB Turbocharging Service Station.

If provided
- The fitted spiral-wound gasket (61050) may be used only once!
- Make ready a new spiral-wound gasket (61050).

**Disassembly**
- Remove insulation from gas inlet casing (51001) and disconnect cleaning pipe (if provided).
- Secure gas inlet casing using lifting gear.

**CAUTION**
When looping the securing line around the casing, make sure that no cleaning pipes are squashed or damaged. Do not fasten the lifting gear to cleaning pipes under any circumstances.

**NOTICE**
Mark positions of gas inlet casing and segments.
Segment connection

- Undo screws (61044) and remove segments (51012).

Flange connection

- Undo and remove screws (61044).
- Pull gas inlet casing (51001) complete with nozzle ring (56001) away from gas outlet casing (61001).

⚠️ CAUTION

Use suitable underlays when putting down gas inlet casing.

1) If present

- Remove gasket (61050).
Bend up the locking plates (56018), undo nuts (56022) and remove.

Pull out nozzle ring.

Remove threaded stud (56021).

**CAUTION**

**Fastening the nozzle ring**

When fitting the nozzle ring, new threaded studs (56021), nuts (56022) and locking plates (56018) from the customer spare part set (97070) must be used.

**CAUTION**

**Clogged areas on the nozzle ring**

If a nozzle ring is clogged in some areas or is covered by loose parts, it is recommended to appoint an ABB Turbocharging Service Station to inspect the turbine blades and carry out a crack inspection.

**Nozzle ring assembly**

- Carefully clean slots and contact surfaces of the casings and keep them free of metal chips.
- Keep slots and spiral-wound gasket free of oil and grease.

**CAUTION**

**Fastening the nozzle ring**

When fitting the nozzle ring, new threaded studs (56021), nuts (56022) and locking plates (56018) from the customer spare part set (97070) must be used.
Push in nozzle ring (56001) as far as it will go at the cover of the gas inlet casing.

- Coat threads of threaded studs (56021) with high-temperature grease and fit threaded studs. Fit the locking plates (56018) and nuts (56022).
- Tighten nuts (56022) and bend locking plates (56018) over.

**CAUTION**

**Correct assembly**

The nozzle ring must be easily movable after assembly.

1) If present

- Fix a new spiral-wound gasket (61050) in the slot at three evenly distributed points with a little superglue (for example "Loctite 454 Gel").

- Position gas inlet casing complete with nozzle ring on gas outlet casing (61001).
Tightening of segment connection

NOTICE

Radial gas inlet casing with segment 51012

In the case of the radial inlet casing with segments, the segments are positioned by a pin in the slot on the casing. The centering bolt (90177) is always needed.

→ First place segment (51012) complete with roll pin on gas inlet casing, fix it in correct radial position using centering bolt (90177) and then fit it loosely using screws (61044).

NOTICE

In only one of the three segments is there a roll pin as an aid when positioning the gas inlet casing. This segment fits in only one position in the gas inlet casing (note the circles in the illustration). Consequently, begin with this segment.

→ Put remaining segments (51012) in place on gas inlet casing (51001) and fit them loosely using screws (61044).

→ Replace centering bolts (90177) with screws (61044).

Check

→ Collar (C) of segments (51012) must be in slot (S).
Tighten screws (61044) in accordance with following procedure and in following order:

- Begin with two middle screws of individual segments and then continue outwards alternately.

**NOTICE**

**Screw tightening sequence**

The screw positioning numbers must be marked on the component. This enables simple and efficient tightening.

<table>
<thead>
<tr>
<th>Tightening torques for screws (61044) [Nm] with spiral-wound gasket</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Screw in all screws hand-tight</td>
</tr>
<tr>
<td>Step 2</td>
<td>140</td>
</tr>
<tr>
<td>Step 3</td>
<td>280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tightening torques for screws (61044) [Nm] without spiral-wound gasket</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Screw in all screws hand-tight</td>
</tr>
<tr>
<td>Step 3</td>
<td>280</td>
</tr>
</tbody>
</table>

- Beginning with screw 1, tighten all screws in a clockwise direction with tightening torque from step 3.
- Remove lifting gear from gas inlet casing (51001).
- Connect cleaning pipe (if present) and attach insulation to gas inlet casing (51001).
Tightening flange connection

- Fit screws (61044).
- Tighten screws (61044) in accordance with following procedure and in following order:

**NOTICE**

**Screw tightening sequence**

The screw positioning numbers must be marked on the component. This enables simple and efficient tightening.
Tightening torques for screws (61044) [Nm]

<table>
<thead>
<tr>
<th>Tightening torques for screws (61044) [Nm] with spiral-wound gasket</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TPL76-C</strong></td>
</tr>
<tr>
<td>Step 1: screw in all screws hand-tight</td>
</tr>
<tr>
<td>Step 2: 140</td>
</tr>
<tr>
<td>Step 3: 280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tightening torques for screws (61044) [Nm] without spiral-wound gasket</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TPL76-C</strong></td>
</tr>
<tr>
<td>Step 1: screw in all screws hand-tight</td>
</tr>
<tr>
<td>Step 3: 280</td>
</tr>
</tbody>
</table>

Checking the tightening torque

- Beginning with screw 1, tighten all screws in a clockwise direction with tightening torque from step 3.
- Remove lifting gear from gas inlet casing (51001).
- Connect cleaning pipe (if present) and attach insulation to gas inlet casing (51001).
8.9 Table of tightening torques
### 8.9 Table of tightening torques

<table>
<thead>
<tr>
<th>Position</th>
<th>Part number</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82005</td>
<td>M16 x 1.5 45</td>
</tr>
<tr>
<td>3</td>
<td>76002</td>
<td>M6 10</td>
</tr>
<tr>
<td>4</td>
<td>74027</td>
<td>M18 170</td>
</tr>
<tr>
<td></td>
<td>With washer</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>74026/74029</td>
<td>M18 40</td>
</tr>
<tr>
<td>6</td>
<td>42280</td>
<td>M18 280</td>
</tr>
<tr>
<td>7</td>
<td>61036</td>
<td>M18 40</td>
</tr>
<tr>
<td></td>
<td>61051 (VR) 1)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>61037 2,3)</td>
<td>M18 MV 80 / DW 90°</td>
</tr>
<tr>
<td>9</td>
<td>42059, 42064</td>
<td>M16 105</td>
</tr>
<tr>
<td>17</td>
<td>61044</td>
<td>M18 280</td>
</tr>
<tr>
<td>21</td>
<td>61056</td>
<td>M18 280</td>
</tr>
<tr>
<td>22</td>
<td>56021</td>
<td>M8 20</td>
</tr>
<tr>
<td></td>
<td>56022</td>
<td>M8 25</td>
</tr>
<tr>
<td>29</td>
<td>86505</td>
<td>M18x1.5 150</td>
</tr>
</tbody>
</table>

1) Place new Verbus Ripp® washers onto strain bolts (7). New Verbus Ripp® washers must be fitted every time the unit is assembled.

2) a) Tighten three nuts at 120° intervals to pre-tightening torque MV (lightly oil contact surface of nut).
b) Tighten the remaining nuts with pre-tightening torque MV.
c) Tighten all nuts (in a star pattern) with tightening angle DW.

3) After putting a new Verbus Ripp® washer under each nut (8), tighten with pre-tightening torque of MV 80 Nm, then mark the 0° point and tighten (under tightening angle control) to a DW of 90°.

| VR | Verbus Ripp® Washer |
| MV | Pre-tightening torque |
| DW | Tightening angle |
9 Taking out of operation at short notice

9.1 Possibilities for emergency repair

**WARNING**

Danger of fire and explosion due to lubricating oil leaks

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

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

Wear safety gloves to protect against thermal hazards.

**CAUTION**

Directives for taking out of operation

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

- Follow the directives of the enginebuilder.

If the diesel engine must be capable of operation again as soon as possible after damage to the turbocharger (emergency repair), the following possibilities are available:

- Locking turbocharger rotor
- Fitting the cover plate
- Shutting off inlets and outlets
- Turbocharger bypass
9.2 Locking the rotor

⚠️ CAUTION
A locked rotor must be removed and checked for unbalance after the turbocharger repair.

<iostream>

NOTICE
An exception is a test rig run up to a maximum of 25% of the engine load in the case of new engines with one or several turbochargers. This is sometimes requested by customers. As operation with a locked rotor is only brief and the loads are low in these cases, subsequent removal of the rotor is not necessary.

⚠️ CAUTION
During operation of the engine with a blocked turbocharger, the lubricating oil system must remain connected to this turbocharger also and be turned on if the gas inlet cannot be blocked. (See section Further measures and information for operation with a blocked rotor for 4-stroke engines.) Otherwise components that are still intact can be damaged through overheating.
Shut off the oil supply in the event of lubricating oil leaking from the turbocharger.
9.2 Locking the rotor

**NOTICE**

Carry out work as described in the chapter *Disassembly and assembly*.

- Remove silencer or air suction branch.
- Insert lifting device (90427) into compressor wheel.
- Twist screws (94006) into free threaded holes in compressor wheel and tighten to values shown in Table of tightening torques.

**CAUTION**

Don't remove any balancing screws from the compressor wheel. Use only free threaded holes to fit the lifting device.

---

**Table of tightening torques**

<table>
<thead>
<tr>
<th>Part no.</th>
<th>TPL76-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>74027</td>
<td>M18</td>
</tr>
<tr>
<td></td>
<td>135 Nm</td>
</tr>
<tr>
<td>94006</td>
<td>M8</td>
</tr>
<tr>
<td></td>
<td>25 Nm</td>
</tr>
</tbody>
</table>
Taking out of operation at short notice / 9.2 Locking the rotor

- Put assembly/disassembly device (90020) over studs (74026) and lifting device (90427).
- Turn compressor wheel until holes in lifting device (90427) align with holes in assembly/disassembly device (90020).
- Fasten assembly/disassembly device to lifting device (90427) using screws (94006).
- Secure assembly/disassembly device (90020) to compressor housing by screwing nuts (74027) onto studs (74026). (See also chapter Table of tightening torques.)

Fitted assembly plate CV 33, CV 34

⚠️ CAUTION

Make sure all components are clean and free from grease.
Further measures and information for operation with blocked rotor for 4-stroke engines

4-stroke engine with one turbocharger

No further measures are necessary. The engine can be operated as a naturally-aspirated engine according to the engine builder's instructions.

4-stroke engine with several turbochargers

Separate receivers

No further measures are necessary on engines with separate air and exhaust gas receivers. The engine can be operated as a naturally-aspirated engine according to the engine builder's instructions.

Common air receiver

If the engine is equipped with a common air receiver and separate exhaust gas receivers, the bellows at the compressor outlet of the damaged turbocharger must be removed and the air duct on the engine side must be closed off. If this is not done, the undamaged turbocharger can race under no load and run at overspeed.

Depending on the engine turbocharging system, more or less powerful pulses from the exhaust gas system act on the locked rotor. The locking device is then heavily stressed, particularly in the case of pulse charging (turbine casing with more than one gas inlet). With this in mind, the following operating limits should not be exceeded:

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

⚠️ CAUTION ⚠️

Attention must always be paid to the speed of the undamaged turbocharger. The speed limit $n_{B_{\text{max}}}$ given on the rating plate must not be exceeded.
9.3 Fit cover plate

NOTICE
The cover plate (material: General structural steel, in accordance with DIN EN 10025-2) must be manufactured in-house according to the drawing.

<table>
<thead>
<tr>
<th>Product</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>B8</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>13</td>
<td>470</td>
<td>50</td>
<td>50</td>
<td>9</td>
<td>12</td>
<td>8</td>
<td>82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Ø 1</th>
<th>Ø 2</th>
<th>Ø 3</th>
<th>Ø 4</th>
<th>Ø 5</th>
<th>Ø 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>915</td>
<td>990</td>
<td>950</td>
<td>20</td>
<td>28</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>α 1</th>
<th>α 2</th>
<th>α 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPL76-C</td>
<td>4 x 90°</td>
<td>37.5°</td>
<td>24 x 15°</td>
</tr>
</tbody>
</table>
NOTICE

Carry out the work as described in the chapter Removal and fitting.

- Remove cartridge group.
9.3 Fit cover plate

- Close off opening in gas outlet casing using cover plate.
- Fasten cover plate using spacer sleeves and nuts (61037).

**CAUTION**

Shut off the supply of lubricating oil to the turbocharger.
Further measures and information for operation with a turbocharger with cover plate on 4-stroke engines

4-stroke engine with one turbocharger

No further measures are necessary. The engine can be operated as a naturally-aspirated engine according to the engine builder's instructions.

4-stroke engine with several turbochargers

Separate receivers

No further measures are necessary on engines with separate air and exhaust gas receivers. The engine can be operated as a naturally-aspirated engine according to the engine builder's instructions.

Common receiver

The air line must be closed off at the engine end because the undamaged turbochargers build up a receiver pressure.

⚠️ CAUTION

The engine can be operated according to the engine builder's instructions. Attention must always be paid to the speed of the undamaged turbocharger. The speed limit $n_{\text{max}}$ given on the rating plate must not be exceeded.
9.4 Blocking the inlets and outlets

**CAUTION**
Shut off the lubricating oil supply to the turbocharger.

- Shut off compressor casing outlet, gas inlet and gas outlet by fitting cover plates.

**NOTICE**
In this respect, refer to the engine manufacturer's instructions.

9.5 Bypass the turbocharger

**CAUTION**
Shut off the lubricating oil supply to the turbocharger.

- This applies to engines with one turbocharger only:
- The connections are ready and pipes for the bypass are available.
- Fit bypass around turbocharger.

**NOTICE**
In this respect, refer to the engine manufacturer's instructions.
10 Mothballing the turbocharger

10.1 Taking 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 prelubrication pump, no measures have to be taken. Any remaining old engine oil will thus be flushed away and the bearing sections largely protected against corrosion.

Mothballing measures

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:

- Remove turbocharger.
- Rotor and bearing parts must be removed by an official ABB Turbocharging service station and refitted afterwards.
- Clean all parts.
- Oil machined, bright surfaces of steel and cast parts using anticorrosive oil.
- Reassemble complete turbocharger.

Rotor turns 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 out of operation for more than 12 months

If the engine is taken out of service, the following can be done 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.
- 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 next to the engine using the individual parts:

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

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

Condition of the mothballed turbocharger

- Check the mothballed turbocharger parts for corrosion every year.
- If there are signs of rust: Clean parts thoroughly and renew protection against corrosion.
11 Disposing of turbocharger components

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

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

Wear safety goggles.

Wear a respiratory mask to protect against dusts.

Wear safety gloves to protect against mechanical hazards.

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

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

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

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

12.1  Ordering spare parts

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

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

⚠️ CAUTION

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.

Required customer spare part set (97070)

The customer spare part set (97070) is required for the work described in this Operation Manual. These parts are available only as a complete set.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>O-ring</td>
<td>42012</td>
</tr>
<tr>
<td>1</td>
<td>Gasket</td>
<td>42041</td>
</tr>
<tr>
<td>2</td>
<td>Gasket</td>
<td>42045</td>
</tr>
<tr>
<td>2</td>
<td>Hexagon-head screw</td>
<td>42059, 42064</td>
</tr>
<tr>
<td>6</td>
<td>Locking plate</td>
<td>56018</td>
</tr>
<tr>
<td>6</td>
<td>Stud</td>
<td>56021</td>
</tr>
<tr>
<td>6</td>
<td>Hexagon nut</td>
<td>56022</td>
</tr>
<tr>
<td>3</td>
<td>Hexagon nut</td>
<td>61037</td>
</tr>
<tr>
<td>12</td>
<td>Hexagon-head screw</td>
<td>61044, 61056</td>
</tr>
<tr>
<td>17</td>
<td>Verbus Ripp® washer</td>
<td>61051</td>
</tr>
<tr>
<td>3</td>
<td>Socket screw</td>
<td>76002</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>76040</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>77005</td>
</tr>
<tr>
<td>1</td>
<td>O-ring</td>
<td>86506</td>
</tr>
</tbody>
</table>
12.2 View of turbocharger with part numbers
<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Cartridge group</td>
</tr>
<tr>
<td>42012 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>51001</td>
<td>Gas inlet casing</td>
</tr>
<tr>
<td>51012</td>
<td>Segment</td>
</tr>
<tr>
<td>56001</td>
<td>Nozzle ring</td>
</tr>
<tr>
<td>56018 (in customer spare part set)</td>
<td>Locking plate</td>
</tr>
<tr>
<td>56021 (in customer spare part set)</td>
<td>Threaded stud</td>
</tr>
<tr>
<td>56022 (in customer spare part set)</td>
<td>Nut</td>
</tr>
<tr>
<td>61001</td>
<td>Gas outlet casing</td>
</tr>
<tr>
<td>61037 (in customer spare part set)</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>61044 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>61050 (in customer spare part set)</td>
<td>Gasket</td>
</tr>
<tr>
<td>61051 (in customer spare part set)</td>
<td>Verbus Ripp® washer</td>
</tr>
<tr>
<td>61056 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>61065</td>
<td>Gasket</td>
</tr>
<tr>
<td>61066</td>
<td>Blind flange</td>
</tr>
<tr>
<td>61067</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>63000</td>
<td>Turbine diffuser</td>
</tr>
<tr>
<td>68001</td>
<td>Foot at compressor end</td>
</tr>
<tr>
<td>68002</td>
<td>Foot at turbine end</td>
</tr>
<tr>
<td>68006</td>
<td>Cup spring</td>
</tr>
<tr>
<td>68007</td>
<td>Bush</td>
</tr>
<tr>
<td>61079</td>
<td>Gasket</td>
</tr>
<tr>
<td>74000</td>
<td>Compressor casing external part</td>
</tr>
<tr>
<td>76000</td>
<td>Compressor casing internal part</td>
</tr>
<tr>
<td>76002 (in customer spare part set)</td>
<td>Socket screw</td>
</tr>
<tr>
<td>76040 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>76080</td>
<td>Safety segments</td>
</tr>
<tr>
<td>77000</td>
<td>Wall insert</td>
</tr>
<tr>
<td>77005 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>79000</td>
<td>Diffuser</td>
</tr>
<tr>
<td>81000</td>
<td>Filter silencer</td>
</tr>
<tr>
<td>82000</td>
<td>Radial air suction branch</td>
</tr>
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</table>