# Operation Manual
## Power2 650-M46

**HT595154_A** English
Original Operation Manual

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
</tr>
<tr>
<td>2</td>
<td>Safety</td>
</tr>
<tr>
<td>3</td>
<td>Safety data sheets</td>
</tr>
<tr>
<td>4</td>
<td>Product description</td>
</tr>
<tr>
<td>4.1</td>
<td>Low-pressure stage</td>
</tr>
<tr>
<td>4.2</td>
<td>High-pressure stage</td>
</tr>
<tr>
<td>4.3</td>
<td>Gas piping</td>
</tr>
</tbody>
</table>
Operating limits and replacement intervals

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

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

1 Introduction .................................................................................................................. 2
1.1 Purpose of the manual ................................................................................................. 2
1.2 Symbols, definitions ...................................................................................................... 2
1.3 Registered trademarks ................................................................................................ 4
1.4 Power2 layout and function .......................................................................................... 5
1.5 Storage of new low-pressure and high-pressure stages .............................................. 6
1.6 Contact information ..................................................................................................... 8
1 Introduction

1.1 Purpose of the manual

Operation Manual
The Operation Manual explains the two-stage turbocharging (Power2) from ABB Turbo Systems and contains instructions for safe operation.

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

Target group
The Operation Manual is aimed at engineers and trained mechanics responsible for the proper operation of the engine and for the Power2 connected to it.

Availability of the Operation Manual
The Operation Manual must be available where the Power2 is used.
All persons operating or working on the Power2 must have read and fully understood the Operation Manual.

1.2 Symbols, definitions

Symbols
The following symbols are used in this document:

► Indicates an action step.
1. Indicaes a numbered action step.
→ Refers to a page number.

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

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

Caution and warning signs are described in chapter Safety.

Terms used

The following terms are used in this document:

- Two-stage turbocharging (Power2)
- Low-pressure stage (Power2 LP)
- High-pressure stage (Power2 HP)
- Low-pressure and high-pressure stage

ABB Turbo Systems

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

Official service stations of ABB Turbo Systems

Official service stations are identified in this document as ABB Turbocharging Service Stations. They are regularly audited and certified by ABB Turbo Systems. Also see chapter Contact information → 8.
Definition of pictograms

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

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

Table 1: Definition of pictograms

1.3 Registered trademarks

The trademarks of outside companies are used in this document. These are marked with the ® symbol.
1.4 Power2 layout and function

The diagram shows the position of the low-pressure (Power2 LP) and high-pressure stage (Power2 HP) within two-stage turbocharging (Power2). The low-pressure stage is always operated in combination with a high-pressure stage connected in series. The two-stage turbocharging (Power2) supplies the engine with the air volume and associated charging pressure required for operation.

Here, the exhaust gases of the internal combustion engine flow through the turbine (22) of the high-pressure stage and subsequently through the bellows (23) of the gas pipe to the turbine (24) of the low-pressure stage. The compressor (25) of the low-pressure stage sucks in fresh air or the air/gas mixture, respectively. This precompressed air or air/gas mixture flows through the intercooler (26) into the compressor (21) of the high-pressure stage. Here the air or air/gas mixture is compressed further and leaves the two-stage turbocharging (Power2) in the direction of the charge air cooler.
1.5 Storage of new low-pressure and high-pressure stages

Storage of new low-pressure and high-pressure stages and cartridge groups for up to 6 months

New low-pressure and high-pressure stages and cartridge groups from ABB Turbo Systems can be stored in their closed packages for 6 months from the date of delivery without additional mothballing measures (indicated by VCI label on package).

Fig. 2: Volatile Corrosion Inhibitor (VCI)

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

Storage of new low-pressure and high-pressure stages and cartridge groups for more than 6 months (VCI)

**WARNING**

Health protection when handling VCI

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

- Ensure proper space ventilation.
- Do not eat, drink or store food at the workplace while working with VCI.
- Wear safety gloves.
- Clean hands and face after working with VCI.
- For more information, see www.branopac.com.

Every 6 months, the following mothballing measures are required:

- Open package.
- Remove VCI corrosion protection emitter from package and replace with a new VCI corrosion protection emitter of the same kind. New VCI corrosion protection emitters can be obtained from www.branopac.com.
- Old VCI corrosion protection emitters must be disposed of in an environmentally compatible, professional way and in compliance with locally applicable regulations.
- Close package. The more tightly the package is sealed, the longer the protection duration.
Long-term storage of replacement low-pressure and high-pressure stages or replacement cartridge groups

ABB Turbo Systems will prepare low-pressure and high-pressure stages or cartridge groups for long-term storage if requested in the purchase order. The package is equipped with a hygrometer (see illustration).

![Package with hygrometer](image)

Every 6 months, the following measures are required:

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

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

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

Replacement components which are ready for operation

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

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

> Scan the QR code to access our website.

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

www.abb.com/turbocharging
# Safety

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>1.2</td>
<td>CE conformity</td>
<td>2</td>
</tr>
<tr>
<td>1.3</td>
<td>Definition of mandatory signs</td>
<td>3</td>
</tr>
<tr>
<td>1.4</td>
<td>Definition of safety instructions</td>
<td>3</td>
</tr>
<tr>
<td>1.5</td>
<td>Intended use</td>
<td>4</td>
</tr>
<tr>
<td>1.6</td>
<td>Deflagration on gas engines</td>
<td>5</td>
</tr>
<tr>
<td>1.7</td>
<td>Warning plates on the low-pressure and high-pressure stage</td>
<td>6</td>
</tr>
<tr>
<td>1.8</td>
<td>Rating plate of the high-pressure and low-pressure stage</td>
<td>7</td>
</tr>
<tr>
<td>1.9</td>
<td>Periodic check of the pressure vessels</td>
<td>9</td>
</tr>
<tr>
<td>1.10</td>
<td>Lifting of loads</td>
<td>10</td>
</tr>
<tr>
<td>1.11</td>
<td>Prerequisites for operation and maintenance</td>
<td>11</td>
</tr>
<tr>
<td>1.12</td>
<td>Hazards during operation and maintenance</td>
<td>12</td>
</tr>
<tr>
<td>1.13</td>
<td>Safe operation</td>
<td>14</td>
</tr>
<tr>
<td>1.14</td>
<td>Safe maintenance</td>
<td>15</td>
</tr>
</tbody>
</table>
1 Safety

1.1 Introduction

The two-stage turbocharging system (Power2) manufactured by ABB Turbo Systems is state of the art and complies with the respective health and safety standards in effect at the time the system was built. Thus Power2 is safe to operate. Nevertheless, there may be some residual risks during operation of the Power2 and work on Power2 components, such as low-pressure stage and high-pressure stage, which:

- Are caused by Power2 itself or its accessories.
- Are caused by the operating equipment used or supplies and materials.
- Are a consequence of insufficient compliance with safety instructions.
- Are a consequence of insufficient or inappropriate performance of maintenance and inspection work.

The operating company is responsible for defining measures that regulate safe access to and safe handling of the Power2.

All instructions contained in this chapter must be observed for safe and trouble-free operation of the Power2 and during all work on the Power2 components.

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

1.2 CE conformity

Information

Low-pressure and high-pressure stages from ABB Turbo Systems comply with the Machinery Directive 2006/42/EC and are partly completed machinery as defined by Article 2 g.
1.3 Definition of mandatory signs

To be worn at all times

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

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

To be worn specific to the respective task

- Safety glasses
- Safety goggles
- Safety gloves to protect against:
  - Mechanical hazard
  - Chemical hazard
  - Thermal hazard
  - Electrical hazard
- Respiratory mask to protect against:
  - Dusts
  - Gases
- Safety helmet
- Ear protection

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

1.4 Definition of safety instructions

⚠️ WARNING

Definition of Warning

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

⚠️ Warning signs must always be observed.

⚠️ CAUTION

Definition of Caution

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

⚠️ Caution signs must always be observed.
1.5 Intended use

Use on internal combustion engines

Power2 from ABB Turbo Systems is intended for charging internal combustion engines.

To ensure compliance with the machinery directive 2006/42/EC when using on gas engines, the Power2 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 specific operating limits of Power2 were determined on the basis of information from the enginebuilder about the intended use. This data is given on the rating plate and is generally different for the low-pressure stage and high-pressure stage.

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

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

⚠️ WARNING
Unapproved operation

Operation of the Power2 outside of the operating limits can be hazardous to personnel.

- Power2 must only be operated within the operating limits.
- Power2 must only be operated by trained personnel.

The intended use of the Power2 includes compliance with all regulations and conditions. In particular, the following must be observed:

- The Operation Manual
- The instructions of the enginebuilder

State of the art

The Power2 is designed and built according to the state of the art and is safe to operate.

Perfect condition

The Power2 must be used in a technically perfect condition and in compliance with its intended use.

ABB Turbo Systems excludes any liability for damage resulting from unauthorized modifications to the Power2 or improper operation.
1.6 **Deflagration on gas engines**

Low-pressure stages from ABB Turbo Systems can tolerate a deflagration with a transient pressure increase of 12 bar (guideline value).

High-pressure stages from ABB Turbo Systems can tolerate a deflagration with a transient pressure increase of 15 bar (guideline value).

After a deflagration event ABB Turbo Systems recommends verifying the following points on the low-pressure and high-pressure stages:

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

If during external inspection anomalies are found or if a particularly strong deflagration event has taken place, it is also recommended to check the bearings of the low-pressure and high-pressure stages before the next start. This inspection and evaluation must be carried out by an ABB Turbocharging Service Station.
1.7 Warning plates on the low-pressure and high-pressure stage

Warning plates are attached to the low-pressure and high-pressure stage, and must be complied with. The warning plates must always be present in the intended locations and must be legible.

Fig. 1: Warning plate

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

Low-pressure and high-pressure stages supplied to the enginebuilder without insulation must be retrofitted with warning plates to be affixed to the insulation. This is the responsibility of the enginebuilder.
### 1.8 Rating plate of the high-pressure and low-pressure stage

#### Rating plate of the low-pressure stage

![Rating Plate Image]

**Fig. 2: Rating plate**

#### Operating limits

1. Operating limits at engine overload (110 %). In test rig operation only, unless otherwise agreed with the enginebuilder.
2. Operating limits during operation

Table 3

#### Recommended replacement intervals

3. Replacement interval of plain bearings in 1000 h
4. Replacement interval of compressor in 1000 h
5. Replacement interval of turbine in 1000 h

Table 4

#### Further data

6. Power2 designation
7. Power2 serial number
8. Power2 stage
9. Serial number of the low or high-pressure stage
10. Year of construction of the low or high-pressure stage
11. Weight of the low or high-pressure stage
12. Part number of the customer of the low or high-pressure stage

Table 5
Rating plate of the high-pressure stage

Operating limits

1. Operating limits at engine overload (110 %). In test rig operation only, unless otherwise agreed with the enginebuilder.

2. Operating limits during operation

Table 6

Recommended inspection and replacement intervals

3. Inspection interval of plain bearings in 1000 h

4. Replacement interval of compressor in 1000 h

5. Replacement interval of turbine in 1000 h

Table 7

Further data

6. Power2 designation

7. Power2 serial number

8. Power2 stage

9. Serial number of the low or high-pressure stage

10. Year of construction of the low or high-pressure stage

11. Weight of the low or high-pressure stage

12. Part number of the customer of the low or high-pressure stage

Table 8
Explanations of the rating plate

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

The operating limits of the low-pressure stage are generally different from the operating limits of the high-pressure stage.

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

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

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

Locations of the rating plates

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

1.9 Periodic check of the pressure vessels

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

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

⚠️ WARNING

Danger due to pressure vessels

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

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

**WARNING**

*Suspended loads*

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

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

Wear safety gloves to protect against mechanical hazards.

Wear safety helmet.

**Fig. 4:** Attachment of loads on the crane hook

**Fig. 5:** Attachment angle

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

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

Responsibility of the operating company

In awareness of its responsibility, the operating company must ensure that only authorised personnel work on the Power2, who:

- Are versed in the general and locally applicable regulations for occupational safety and accident prevention
- Are equipped with the prescribed personal protective equipment
- Have read and understood the Operation Manual
- Have been instructed in the use of the Power2.

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

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

Only authorised personnel may remain in the vicinity of the Power2 when the engine is running.

Competence of personnel

The Power2 may only be operated and serviced by trained and authorised personnel. Basic mechanical training is a prerequisite.

Modifications to the Power2

Modifications to the Power2 must be approved by ABB Turbo Systems.

Original parts and safety

Original parts and accessories must be specially designed by ABB Turbo Systems for the ABB Power2.

WARNING

Use original parts

Operation of the Power2 with non-original parts can impair the safety of the Power2 and can cause serious damage to property and injury to personnel.

- Only use original parts from ABB Turbo Systems.

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

Noise hazards

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

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

Hazards due to hot surfaces

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

- **WARNING**
  - **Danger of burns**
  - Touching hot surfaces or contact with hot operating fluids can cause severe burns.
    - Do not touch hot surfaces. Observe the warning plate on the low-pressure and high-pressure stage.
    - Wear heat-resistant safety gloves and protective clothing.
    - Wait for the low-pressure and high-pressure stage to cool down before carrying out any work.
  - Wear safety gloves to protect against thermal hazards.
WARNING

Hot surfaces on the non-insulated low-pressure and high-pressure stage
Non-insulated low-pressure and high-pressure stages can cause serious injuries to personnel (burns).

ABB Turbo Systems supplies the low-pressure and high-pressure stage 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 low-pressure and high-pressure stage 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 contact with hot surfaces on the low-pressure and high-pressure stage is compulsory.

Wear safety gloves to protect against thermal hazards.

Hazards due to rotating parts

WARNING

Physical hazards due to rotating parts
Contact with rotating parts can cause severe injury. The low-pressure stage must never be used without the filter silencer or air inlet casing, respectively. With the engine stopped, the rotor can rotate due to the stack draught alone.

▶ Operate the low-pressure and high-pressure stage in compliance with the specifications.

▶ Secure the rotor against unintentional rotation during maintenance.

Wear safety gloves to protect against mechanical hazards.
1.13 Safe operation

Mechanical hazards during operation

During standard operation, no mechanical hazards are caused by the low-pressure and high-pressure stage, provided that it has been properly installed.

Low-pressure and high-pressure stages are not designed for sudden pressure loss that may occur due to the piping system between the compressor or the turbine stages bursting.

1.13.1 Safety during commissioning and operation

Safety during commissioning and operation

▶ Visually inspect your working environment before starting work.
▶ Remove any obstacles and objects littering the workplace.
▶ Check all pipes to and from the Power2 for damage and leaks before commissioning.
▶ Check Power2 for recognisable damage or defects every 12 hours of operation or at least once a day.
▶ Report any damage and any alterations of operational characteristics to the responsible department immediately.
▶ In case of damage, take the Power2 out of operation immediately and safeguard against accidental/unauthorised use.
▶ When switching on operating energy supplies (hydraulics, pneumatics, electricity), pay attention to the risks that may occur as a consequence of this energy input.
1.14 Safe maintenance

Occupational safety

**WARNING**

**Injuries to persons**

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

- When working on the Power2, always wear safety footwear and protective clothing to protect against mechanical hazards.
- Keep personal protective equipment in perfect condition.
- Obey mandatory signs.
- Obey the general rules for occupational safety and prevention of accidents.
- Only perform operations that are described in this chapter.
- Only perform operations for which you have received instruction or training.

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

Wear protective clothing.

**WARNING**

**Risk of falling**

When work is performed on the low-pressure or high-pressure stage, there is a risk of falling.

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

- Only perform work on the low-pressure or high-pressure stage when you are in a physically and psychologically stable condition.
- Only work with suitable tools, equipment and appliances that function properly.
- Keep the workplace clean; clear away any loose objects and obstacles on the floor.
- Keep the floor, equipment and the low-pressure and high-pressure stage clean.
- Have oil binding agents ready and provide or keep oil pans at hand.

**Use of assembly devices**

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.

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

**Safety during cleaning**
If cleaning agents or solvents are used for cleaning, the corresponding material safety data sheet and the safety instructions in section Hazards due to operating materials and supplies must be observed.
- Observe the material safety data sheet for the cleaning agent or solvent.
- Wear personal protective equipment (PPE) according to the material safety data sheet.
- Inspect the electric cables for abrasion and damage before and after your cleaning work.

**Safety during disassembly, assembly, maintenance and repair**
- Observe the procedures for set-up, service and inspection work and the inspection intervals.
- Inform the operating staff before starting any service or repair work. Make sure the engine is not started while work is being conducted on the Power2.
- Before taking off any cover or removing any guard from the low-pressure or high-pressure stage, switch off the engine and wait until the low-pressure stage and the high-pressure stage have come to a standstill.
- Make sure that the oil supply is interrupted, especially with an external oil supply.
- Only restart the engine after all parts have been properly fitted again and oil supply is ensured.

**CAUTION**

**Mechanical operations on the low-pressure and high-pressure stage**
Components of the low-pressure or high-pressure stage can be damaged or destroyed due to improper use.
- Only perform operations that are described in this manual.
- Only perform operations for which you have received instruction or training.

**Safety when taking out of operation or preparing for mothballing**
- Observe the material safety data sheet for the cleaning and mothballing agents.
Wear personal protective equipment (PPE) according to the material safety data sheet.

Mechanical hazards when working on the low-pressure and high-pressure stage

**WARNING**

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

- Secure rotor against turning.

Hazard due to operating materials and supplies

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

**WARNING**

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

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

Wear safety goggles.

Wear safety gloves to protect against chemical hazards.

Wear a respiratory mask to protect against gases.
**WARNING**

**Danger of fire or explosion**

Flammable and combustible operating materials and supplies can catch fire or resulting vapours can lead to an explosion.

- Observe the information in the material safety data sheet for the operating materials and supplies.
- Comply with local legislation.
- Do not allow any exposed flame or ignition source during cleaning work.
- Carry out cleaning in the open or provide sufficient ventilation.

**CAUTION**

**Environmental hazard**

Improper handling of operating materials and supplies can lead to environmental damage.

- Observe the information in the material safety data sheet for the operating materials and supplies.
- Comply with local legislation.

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

**WARNING**

**Danger from insulation materials**

Dust or fibres from insulation materials can have adverse effects on the health or cause irritations. Unsuitable and combustible insulation materials are a fire hazard.

- Only use suitable and non-combustible insulation materials.
- Ensure good ventilation at the workplace.
- Avoid whirling up dust.
- Use dust-free tools and working methods.
- Remove package at the workplace only.
- Proceed with particular care when removing old insulation materials.
- Dispose of insulation materials properly and in an environmentally compatible manner in compliance with the legal regulations.

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

Power2 650-M46

<table>
<thead>
<tr>
<th>Name</th>
<th>Hardware ID</th>
<th>Page</th>
</tr>
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<tr>
<td>Low-pressure stage</td>
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<td>PT002948</td>
<td>3</td>
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<td>PT002945</td>
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</tr>
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<td>High-pressure stage</td>
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Safety data sheet

Power2 650-M46  HT595154
Low-pressure stage  PT002947

Additional Safety Data:

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<tr>
<th>Maximum permissible temperatures</th>
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<tr>
<td><strong>Exhaust gas inlet temperature</strong></td>
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Safety data sheet

Power2 650-M46 HT595154
Low-pressure stage PT002948

Additional Safety Data:

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<td>t_{M\text{max}}[^{\circ}\text{C}]</td>
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# Safety data sheet

## Power2 650-M46  
**HT595154**  
High-pressure stage  
**PT002945**

---

### Maximum permissible temperatures

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<td></td>
<td>During operation</td>
<td>620</td>
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<tr>
<td>Compressor inlet temperature</td>
<td>During operation</td>
<td>55</td>
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</tbody>
</table>

---

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HT595154_A  
April 2020
Safety data sheet

Power2 650-M46  HT595154
High-pressure stage  PT002946

Additional Safety Data:

### Maximum permissible temperatures

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<th>Symbol</th>
<th>Value [°C]</th>
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<td>$t_{\text{max}}$</td>
<td>650</td>
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<tr>
<td></td>
<td>During operation</td>
<td>$t_{\text{Bmax}}$</td>
<td>620</td>
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<tr>
<td>Compressor inlet temperature after intercooler</td>
<td>During operation</td>
<td>$t_{\text{Cmax}}$</td>
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</tr>
</tbody>
</table>
# Product description

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>1.1</td>
<td>Related documents</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Power2 layout and function</td>
<td>5</td>
</tr>
<tr>
<td>1.3</td>
<td>Layout and function of the low-pressure stage</td>
<td>6</td>
</tr>
<tr>
<td>1.4</td>
<td>Layout and function of the high-pressure stage</td>
<td>8</td>
</tr>
<tr>
<td>1.5</td>
<td>Warning plates on the low-pressure and high-pressure stage</td>
<td>10</td>
</tr>
<tr>
<td>1.6</td>
<td>Locations of the rating plates</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Removal and installation</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Commissioning</td>
<td>13</td>
</tr>
<tr>
<td>3.1</td>
<td>Oil supply</td>
<td>13</td>
</tr>
<tr>
<td>3.2</td>
<td>Inspection procedures</td>
<td>15</td>
</tr>
<tr>
<td>3.3</td>
<td>Commissioning after taking out of operation</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>Monitoring during operation</td>
<td>18</td>
</tr>
<tr>
<td>4.1</td>
<td>Lubricating oil pressure</td>
<td>18</td>
</tr>
<tr>
<td>4.2</td>
<td>Lubricating oil temperature</td>
<td>19</td>
</tr>
<tr>
<td>4.3</td>
<td>Speed measurement</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>Operation and service</td>
<td>26</td>
</tr>
<tr>
<td>5.1</td>
<td>Noise emission</td>
<td>26</td>
</tr>
<tr>
<td>5.2</td>
<td>Service work</td>
<td>27</td>
</tr>
<tr>
<td>5.3</td>
<td>Expected replacement intervals</td>
<td>29</td>
</tr>
<tr>
<td>5.4</td>
<td>Stopping the engine</td>
<td>29</td>
</tr>
<tr>
<td>6</td>
<td>Periodic maintenance</td>
<td>30</td>
</tr>
<tr>
<td>6.1</td>
<td>Foreword to maintenance</td>
<td>30</td>
</tr>
<tr>
<td>6.2</td>
<td>Cleaning the compressor during operation</td>
<td>31</td>
</tr>
<tr>
<td>6.3</td>
<td>Cleaning turbine and nozzle ring during operation</td>
<td>34</td>
</tr>
<tr>
<td>7</td>
<td>Troubleshooting</td>
<td>35</td>
</tr>
<tr>
<td>7.1</td>
<td>Malfunctions when starting</td>
<td>35</td>
</tr>
<tr>
<td>7.2</td>
<td>Malfunctions during operation</td>
<td>36</td>
</tr>
<tr>
<td>7.3</td>
<td>Surging of the low-pressure or high-pressure stage</td>
<td>40</td>
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<td>7.4</td>
<td>Malfunctions when stopping</td>
<td>41</td>
</tr>
<tr>
<td>7.5</td>
<td>Speed measurement system</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>Disassembly and assembly</td>
<td>42</td>
</tr>
<tr>
<td>9</td>
<td>Taking out of operation at short notice</td>
<td>43</td>
</tr>
<tr>
<td>10</td>
<td>Taking out of operation for a long period</td>
<td>44</td>
</tr>
</tbody>
</table>
## Table of contents

10.1 General .......................................................................................................................... 44  
10.2 Lubricating oil.............................................................................................................. 44  
10.3 Process for taking out of operation............................................................................ 44  

11 Disposing of low-pressure and high-pressure stage components ............ 45  

12 Spare parts ...................................................................................................................... 46  

Figures .................................................................................................................................. 47  

Tables ................................................................................................................................... 48
1 Introduction

1.1 Related documents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document number</th>
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<tr>
<td>Operation Manual / 1 Introduction</td>
<td>HZTL4003</td>
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<tr>
<td>Operation Manual / 2 Safety</td>
<td>HZTL4021</td>
</tr>
<tr>
<td>Operation Manual / 3 Safety data sheet *)</td>
<td>Serial number of Power2</td>
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</table>

*) This chapter is only present in serialised operation manuals.
1.2 Power2 layout and function

Fig. 1: Power2 layout and function

<table>
<thead>
<tr>
<th>Power2</th>
<th>Two-stage turbocharging</th>
<th>21</th>
<th>HP compressor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power2 LP</td>
<td>Low-pressure stage</td>
<td>22</td>
<td>HP turbine</td>
</tr>
<tr>
<td>Power2 HP</td>
<td>High-pressure stage</td>
<td>24</td>
<td>LP turbine</td>
</tr>
<tr>
<td>A</td>
<td>Exhaust gas inlet from internal combustion engine</td>
<td>25</td>
<td>LP compressor</td>
</tr>
<tr>
<td>B</td>
<td>Exhaust gas outlet</td>
<td>26</td>
<td>Intercooler</td>
</tr>
<tr>
<td>C</td>
<td>Air or air/gas mixture inlet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| D            | Air or air/gas mixture outlet and supply to the charge air cooler | - - - | Not included in the ABB Turbo Systems scope of delivery

The diagram shows the position of the low-pressure (Power2 LP) and high-pressure stage (Power2 HP) within two-stage turbocharging (Power2). The low-pressure stage is always operated in combination with a high-pressure stage connected in series. The two-stage turbocharging (Power2) supplies the engine with the air volume and associated charging pressure required for operation.

Here, the exhaust gases of the internal combustion engine flow through the turbine (22) of the high-pressure stage and then to the turbine (24) of the low-pressure stage. The compressor (25) of the low-pressure stage sucks in fresh air or the air/gas mixture, respectively. This precompressed air or air/gas mixture flows through the intercooler (26) into the compressor (21) of the high-pressure stage. Here the air or air/gas mixture is compressed further and leaves the two-stage turbocharging (Power2) in the direction of the charge air cooler.
1.3 Layout and function of the low-pressure stage

Fig. 2: Layout and function of the low-pressure stage

01 Air suction branch  
02 Injection ring for air  
03 Compressor wheel  
04 Diffuser  
05 Bearing bush with heat shield  
06 Gas outlet casing  
07 Gas inlet casing  
08 Nozzle ring  
09 Turbine  
10 Bearing casing  
11 Compressor casing  
12 Injection ring for blowby
The low-pressure stage (Power2 LP) is a turbomachine and its main components are a turbine and a compressor. These components are installed on a common shaft and form the rotor.

In the low-pressure stage (Power2 LP) shown in the illustration (see Fig. 2: Layout and function of the low-pressure stage → 6), the exhaust gas coming from the high-pressure stage (Power2 HP) flows through the gas inlet casing (07) and the nozzle ring (08) and reaches the turbine (09). The LP turbine uses the energy contained in the exhaust gas to drive the rotor. The exhaust gases then reach the atmosphere through the gas outlet casing (06) and the exhaust gas pipe connected to it.

The rotor runs in two radial plain bearings, which are located between the compressor and the turbine. The axial bearing is also in the form of a plain bearing. The plain bearings are connected to a central lubricating oil duct which is normally supplied by the lubricating oil circuit of the engine. The oil outlet lies at the deepest point of the bearing casing (10).

The LP compressor wheel (03) connected to the shaft sucks in fresh air or an air/gas mixture through the filter silencer or the air suction branch (01). The air is compressed in the LP compressor and the downstream diffuser (04). The compressed air is passed on to the intercooler (26) via the compressor casing (11). The air is cooled in the intercooler (26) and subsequently supplied to the HP compressor (21).

Using the injection ring (02), an air flow can be supplied upstream of the LP compressor stage.

The blowby air can be supplied upstream of the LP compressor stage via the injection ring (12).
1.4 Layout and function of the high-pressure stage

Fig. 4: Layout of the high-pressure stage

01 Air suction branch
02 Bellows
03 Compressor casing
04 Diffuser
05 Bearing casing
06 Turbine
07 Gas piping
08 Nozzle ring
09 Compressor wheel
10 Gas inlet casing (turbine casing)
### Mode of operation of the high-pressure stage (Power2 HP)

![Diagram of the high-pressure stage](image)

**Power2**
- Two-stage turbocharging

**Power2 LP**
- Low-pressure stage

**Power2 HP**
- High-pressure stage

**A**
- Exhaust gas inlet from internal combustion engine

**B**
- Exhaust gas outlet

**C**
- Air or air/gas mixture inlet

**D**
- Air or air/gas mixture outlet and supply to the charge air cooler

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP compressor</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>HP turbine</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Gas pipe (bellows)</td>
<td>23*</td>
<td></td>
</tr>
<tr>
<td>LP turbine</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>LP compressor</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Intercooler</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

*) If present

The high-pressure stage (Power2 HP) is a turbomachine, and its main components are a turbine and a compressor. These components are installed on a common shaft and form the rotor (see Fig. 4: Layout of the high-pressure stage →8).

In the high-pressure stage (Power2 HP) shown in the sectional view (see Fig. 4: Layout of the high-pressure stage →8), the exhaust gas flows through the gas inlet casing (09) and the nozzle ring (08) and reaches the turbine (06). The HP turbine uses the energy contained in the exhaust gas to drive the rotor. The exhaust gases then flow through the gas piping (07) before reaching the turbine of the low-pressure stage (Power2 LP).

The rotor runs in two radial plain bearings which are located in the bearing casing (05) between compressor and turbine. The plain bearings are connected to a central lubricating oil duct which is normally supplied by the lubricating oil circuit of the engine. The oil outlet lies at the deepest point of the bearing casing (05).

The HP compressor wheel (09) connected to the shaft sucks in the precompressed air or an air/gas mixture from the low-pressure stage (25) through the air suction branch (01). The air is compressed further in the HP compressor (21) and the downstream diffuser (04) and subsequently supplied to the charge air cooler via the compressor casing (03).
1.5 Warning plates on the low-pressure and high-pressure stage

Warning plates are affixed at the following locations of the high and low-pressure stage:

![Fig. 6: Location of Power2 LP warning plates](image)

![Fig. 7: Location of Power2 HP warning plates](image)

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

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

Non-insulated high and low-pressure stages

High and low-pressure stages supplied to the enginebuilder without insulation must be equipped later with warning plates to be attached to the insulation. This is the responsibility of the enginebuilder.
1.6 Locations of the rating plates

Low-pressure stage

One rating plate each is attached on the left and the right side of the foot (bearing casing) and to the air suction branch of the low-pressure stage.

High-pressure stage

One rating plate each is attached on the left and the right side of the bearing casing.
2 Removal and installation

▶ For more information on how to remove and install the low-pressure stage, see document Operation Manual / Power2 ... / 4.1 Low-pressure stage.

▶ For more information on how to remove and install the high-pressure stage, see document Operation Manual / Power2 ... / 4.2 High-pressure stage.

▶ For more information on how to remove and install the gas piping, see document Operation Manual / Power2 ... / 4.3 Gas piping.
3 Commissioning

3.1 Oil supply

3.1.1 Introduction

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

The low-pressure and high-pressure stage are usually lubricated with oil from the engine oil circulation.

- The directives of the enginebuilder on the selection of the lubricating oil and the oil change intervals must be followed.

3.1.2 Pre-lubrication

Before the engine is started, the plain bearings of the low-pressure and high-pressure stage must be pre-lubricated, in order to avoid bearing damage caused by dry running.

- Adhere to the admissible oil pressure range.

An electrically driven oil pump is recommended for pre-lubrication.

<table>
<thead>
<tr>
<th>Power2</th>
<th>Pre-lubrication time</th>
</tr>
</thead>
<tbody>
<tr>
<td>650</td>
<td>2 min</td>
</tr>
</tbody>
</table>

Table 2: Pre-lubrication time

3.1.3 Post-lubrication

Post-lubrication is necessary after switching the engine off, in order to avoid oil coking in the vicinity of the shaft seal. The post-lubrication time starts as soon as the oil pressure drops below the admissible value due to switching off the engine.

- Adhere to the admissible oil pressure range (see Table 5: Oil pressure range →19).

An electrically driven oil pump is recommended for post-lubrication.

<table>
<thead>
<tr>
<th>Power2</th>
<th>Post-lubrication time</th>
</tr>
</thead>
<tbody>
<tr>
<td>650</td>
<td>30 min</td>
</tr>
</tbody>
</table>

Table 3: Post-lubrication time
3.1.4 Long-term lubrication

Long-term lubrication occurs if the times specified for the pre- or post-lubrication are exceeded with the engine at a standstill.

► Adhere to the admissible oil pressure range (see Table 5: Oil pressure range → 19).

![CAUTION]

Oil leak while stopped

The shaft sealing system of the low-pressure and high-pressure stage has been designed to ensure optimum tightness during operation of the engine. During standstill, the pressure level in the bearing space may increase until it is above the pressure outside the shaft seal, resulting in a risk of oil leakage.

► Observe the points mentioned in the following to reduce the risk of oil leakage during standstill.

The following measures are recommended for reducing the risk of oil leakage during standstill:

- Reduction of the pressure in the bearing space by a means of an appropriate crankcase vent design.
- Reduction of the pressure decrease outside the shaft seal due to stack draft effect by taking measures at the system side.
- Reduction of the pressure increase in the engine space by taking measures at the system side.
- Interruption of the oil supply to the turbocharger through the shut-off valve.

3.1.5 Oil filtering

<table>
<thead>
<tr>
<th>Power2</th>
<th>Filter mesh width [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>650</td>
<td>≤ 0.034</td>
</tr>
</tbody>
</table>

Table 4: Filter mesh width

3.1.6 Oil pressure

Comply precisely with the oil pressure before the low-pressure and high-pressure stage for trouble-free operation.

The admissible values are specified in chapter Monitoring during operation → 18.

3.1.7 Oil orifice

Metering orifices are installed in the oil inlet of the low-pressure stage and the high-pressure stage in order to safeguard the oil pressures.
3.2 Inspection procedures

3.2.1 Introduction

Inspection procedures include preventative visual controls, monitoring and measuring work before and during commissioning. Inspection procedures enable changes to the low and high-pressure stage to be detected. Engine damage can be prevented.

3.2.2 Checks before commissioning

Filter mat (if available)

- Check for damage and contamination.

Lubricating system

⚠️ CAUTION
Contaminated oil

Serious damage to engine or property can be caused by dirt and solid material particles in the oil.

- For the initial commissioning phase and after all service work, flush the complete lubricating system with warm oil.
- Use special running-in filters when running in the engine and after all service work on the lubricating system.

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

Warning plates

- Check whether warning plates are present and legible.
- Check whether the protective sheets have been removed from new warning plates.
3.2.3 Checks after commissioning (engine in idle mode)

Lubricating system

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

The admissible values are specified in chapter Monitoring during operation →18.

Leaktightness of pipes

**WARNING**

Risk of burning from hot gas

Escaping gases are hot and will lead to serious burns in the event of contact.

- Check all pipes for leaks in accordance with the enginebuilder’s instructions.

3.2.4 Checks when starting up the engine

- Measure speed, oil pressure and charging pressure at various engine performances.
- Measure the exhaust gas temperature before and after the turbine.
- Measure the air temperature before and after the compressor.

The measured values must be compared with the values of the acceptance protocol; different operating conditions must be taken into account here.

Escape of oily fluids

Lubricants and pastes used for the assembly of the low-pressure and high-pressure stage can liquefy or vaporise and escape as oily fluids during the initial hours of operation. Continual escape of an oily fluid indicates a possible oil leak.

If there is a leak, contact an ABB Turbocharging Service Station.
3.3 Commissioning after taking out of operation

If present

- Remove cover plates (blind flanges) from the compressor casing, the gas inlet and the gas outlet.
- Remove the locking screws on the water connections and fit the water pipe.

General

- Check the exhaust gas pipe before and after the turbine for combustion residues or water residues and clean it. Remove any foreign objects that may be present.
- Check and clean filter silencer or air supply line, and remove any foreign objects that may be present.
- With the high-pressure stage, check the bellows located between the radial air suction branch and the compressor casing for damage and replace if necessary.
- Put engine-side oil circulation to the low-pressure and high-pressure stage into operation.
- Prepare the low-pressure and high-pressure stage for operation according to section Checks before commissioning.
- The low-pressure and high-pressure stage is now operational.
4 Monitoring during operation

4.1 Lubricating oil pressure

⚠️ CAUTION

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

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

Lubrication oil measuring points

The pressure measuring point M is at the oil supply channel of the low-pressure stage that is not used for the oil supply.

- 01 Contact surface
- 02 Oil inlet
- 03 Oil outlet
- M Oil pressure measuring point
- T Oil temperature measuring point

The pressure measuring point M must be positioned in the oil supply line immediately at the inlet to the high-pressure stage.
4.2 Lubricating oil temperature

**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>Table 5: Oil pressure range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power2 Status</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
</tbody>
</table>
| 650 | Engine running | Admissible \(1.3 \ldots 2.5\) \(2.0 \ldots 4.5\) \(1.3 \ldots 5.0\) \(2.0 \ldots 8.0\)
Temporarily admissible \(<15\) min after engine start (cold oil) \(1.3 \ldots 1.3\) \(1.3 \ldots 2.0\)
Temporarily admissible \(<1\) h \(\rightarrow\) Warning signal \(1.3 \ldots 2.0\)
Not permissible \(\rightarrow\) Alarm signal \(\rightarrow\) stop the engine immediately \(<1.0\) \(<1.3\)
| Engine stopped | Pre-lubrication | 1.3 ... 2.0 1.3 ... 2.0 |
| Post-lubrication | 1.3 ... 2.0 1.3 ... 2.0 |
| Long-term lubrication | \(<0.7\) \(<0.7\) |

Depending on the design, metering orifices can be installed in the oil inlet of the low-pressure and high-pressure stages in order to adjust the oil pressures.

The specified maximum oil outlet temperature is considered to be an alarm value for the operation of the low-pressure and high-pressure stage and must be monitored according to the current regulations.

If the low-pressure or high-pressure stage has been operated outside of the admissible range for a long period of time, ABB Turbo Systems recommends having the low-pressure or high-pressure stage inspected by an ABB Turbocharging Service Station.
4.3 Speed measurement

4.3.1 Introduction

Speed measurement systems enable the constant monitoring of the speeds of the low-pressure and the high-pressure stage.

4.3.2 Low-pressure stage

4.3.2.1 Layout and functional principle

Fig. 10: Functional principle

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Speed sensor</td>
<td>02</td>
<td>Cable</td>
<td>03</td>
</tr>
<tr>
<td>04</td>
<td>Electronics</td>
<td>05</td>
<td>Cable</td>
<td>06</td>
</tr>
</tbody>
</table>

The speed measurement system consists of a sensor (01) with integrated cables (02, 05), an electronic unit (04) and a plug (06). The sensor operates according to the eddy current principle, and is installed in a radial direction in relation to the compressor wheel. The electronics must be provided with a power supply, and deliver a square pulse signal. The signal frequency depends on the number of main blades on the compressor wheel. The signal amplitude depends on the level of the feed voltage.

**CAUTION**

Do not strain cables

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

- Do not strain the speed measurement cables by pulling.
4.3.2.2 Replacing the speed measurement system

4.3.2.2.1 Low-pressure stage

Removing the speed measurement system

Fig. 11: Dimension X

► Measure and note down dimension X.

Fig. 12: Removing the speed measurement system
Installing the speed measurement system

1. Set speed sensor (86505) in the plate (86507) to dimension X.
2. Secure speed sensor with wedge lock washer (86509) and clamping nut (86505). Observe tightening torque.

Fig. 13: Setting dimension X
3. Secure plate with wedge lock washer (86508) and socket screw (86510). Observe tightening torque.

4. Adjust dimension X until $S = 0$ mm is reached.

5. Position cable and secure it with rubber grommet (86516).

4.3.3 High-pressure stage

4.3.3.1 Layout and functional principle

Voltage pulses are induced at the electromagnetic speed sensor (05) using the sealing disc rotating on the shaft (04). The voltage amplitudes of the pulses are limited in the voltage limiter to a maximum value (< ±15 V), and signal noise is suppressed (< ~1.4 V).

**CAUTION**

Do not strain cables

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

- Do not strain the speed measurement cables by pulling.
4.3.4 Differences in speed between the low-pressure or high-pressure stages on one engine

The speeds of the low-pressure stages differ significantly from the speeds of the high-pressure stages.

A Power2 turbocharging system for V-engines, for example, can consist of multiple low-pressure and multiple high-pressure stages. In this case the speeds of the low-pressure stages only differ a little from each other. The same also applies to the high-pressure stages.

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

If this admissible difference range is exceeded, the following steps must be performed:

- Reduce the engine performance until the maximum speed of all low and high-pressure stages does not exceed 70% of $n_{\text{Bmax}}$.
- If the engine cannot be stopped, it can continue to be driven with this reduced engine performance or at this low-pressure and high-pressure stage speed.
- Measure the temperatures in the air lines and exhaust gas pipes from and to the low-pressure and high-pressure stages and compare with normal values.
- Check the pressure loss of the alternative air inlet and compare it with normal values.

If the engine can be stopped temporarily:

- Inspect air lines, exhaust gas pipes and the low-pressure and high-pressure stages and remedy any malfunctions.
- In any case, contacting the nearest ABB Turbocharging Service Station is recommended.

4.3.5 Malfunction of the speed measurement system

The possible reasons for malfunction of the speed measuring system are described in chapter Troubleshooting / Speed measurement system →41.
5 Operation and service

5.1 Noise emission

**WARNING**

Noise hazards

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

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

Wear ear protection.

The emission sound pressure level (A-weighted) is measured at a distance of 1 metre from the low-pressure and high-pressure stage.

The highest value of the emission sound pressure level1) reaches a maximum of 105 dB(A) near the compressor end (compressor casing, filter silencer, air suction branch).

The following prerequisites must be fulfilled with regard to the low-pressure and high-pressure stage to observe this limit value:

- Air inlet system and piping fitted
- All standard, noise-reducing measures2) have been fitted

The enginebuilder is also responsible for insulating other components such as the charge air/scavenging air lines and the cooler.

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

2) The enginebuilder must provide acoustically equivalent measures in case of deviating insulation versions
5.2 Service work

Service work includes visual controls, monitoring, measuring and inspection as well as function checks. Service work enables the detection and rectification of changes to the low and high-pressure stage and ensures full operability of the low and high-pressure stage.

⚠️ CAUTION

Service intervals

Service work on the low-pressure and high-pressure stage that is omitted or performed too late can cause excessive contamination and wear as well as operating failures.

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

⚠️ CAUTION

Shortened service intervals

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

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

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

5.2.1 Service work every 25 ... 50 hours

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

5.2.2 Service work at 100 hours after commissioning

► Clean or replace the oil filter located in the supply pipe to the low-pressure and high-pressure stage while the engine is stopped.

5.2.3 Service work according to instructions of enginebuilder

► Clean or replace the oil filter located in the supply pipe to the low-pressure and high-pressure stage while the engine is stopped.
5.2.4 **Service work every 12000 ... 16000 hours of operation**

The rotor and bearing parts must be checked and assessed by an ABB Turbocharging Service Station.

- Dismantle low-pressure and high-pressure stage. Measure clearances.
- Clean nozzle ring and casing and check for cracks and erosion/corrosion.

Additional measures in conjunction with the high-pressure stage:

- Replace gaskets every time after disassembly.
- Check bellows between air-inlet casing and compressor casing for cracks and clean (see also chapter Cleaning the HP bellows (if present)).

5.2.5 **Service work according to specifications on the rating plate**

The following work must be carried out by an ABB Turbocharging Service Station:

- Replacement of the bearing parts
- Replacement of the turbine and the compressor

5.2.6 **Entries in the engine logbook**

The monitoring of the engine enables conclusions to be drawn on the behaviour of the low-pressure and high-pressure stage.

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

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

If present:

- Speed of low-pressure and high-pressure stage
- Air temperature before and after the compressor and after the charge air cooler
- Exhaust gas temperature before and after the turbine
- Atmospheric humidity of the suction air (before the low-pressure stage)
5.3 Expected replacement intervals

- For information on the expected replacement intervals of the components of the low-pressure stage, see document Operation Manual / Power2 ... / 4.1 Low-pressure stage.

- For information on the expected replacement intervals of the components of the high-pressure stage, see document Operation Manual / Power2 ... / 4.2 High-pressure stage.

5.4 Stopping the engine

⚠️ CAUTION

Residual heat in the low-pressure and high-pressure stage

If the residual heat in the low-pressure and high-pressure stage is not sufficiently dissipated by the circulating lubricating oil, machine damage could occur.

- Observe the post-lubrication times and the oil pressure specified for post-lubrication (see chapter Monitoring during operation / Lubricating oil pressure).
6 Periodic maintenance

6.1 Foreword to maintenance

Maintenance work includes regular visual controls and cleaning operations which are intended to ensure the trouble-free functioning of the low-pressure and high-pressure stage. In this process, the exterior condition and the degree of contamination of the components on which maintenance work is to be performed are determined.

<table>
<thead>
<tr>
<th>Component to be maintained</th>
<th>Recommended cleaning interval&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Operating state</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP compressor&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>25 ... 100 h</td>
<td>Engine load: 50 ... 100 %</td>
</tr>
<tr>
<td>HP compressor&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP filter silencer&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>500 h</td>
<td>Engine stopped</td>
</tr>
</tbody>
</table>

Table 7: Maintenance intervals

1) If the recommended cleaning intervals are incompatible with operation of the engine, contact ABB Turbo Systems.

2) If present

3) If compressor cleaning present

**Compressor cleaning (if present)**

We recommend cleaning the HP compressor after the LP compressor.

On V-engines with several low-pressure and/or high-pressure stages per engine, ABB Turbo Systems recommends the parallel cleaning of the LP compressors as well as the parallel cleaning of the HP compressors.

This cleaning process is faster and reduces the risk of surging of the low-pressure and high-pressure stages.
6.2 Cleaning the compressor during operation

6.2.1 Introduction

Approval by enginebuilder

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

General

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

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

Consequences of contamination:

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

Periodic cleaning of the compressor during operation prevents or delays any great increase in the contamination, but never replaces the regular service work where the low and high-pressure stages are completely dismantled and the compressors are mechanically cleaned.
6.2.2 Principle of wet cleaning

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

**CAUTION**

Corrosion and deposits when cleaning

Salt water and cooling water treatment substances damage and adversely affect parts of the low-pressure and high-pressure stage.

- Never use salt water, but only pure water for cleaning.

**CAUTION**

Volume of water

Uncontrolled volumes of water can damage the pressure stages and the engine.

- Never connect the water line without the orifice specified for the low-pressure and high-pressure stages.

Surging of the compressor

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

If surging of the compressor stage continues to occur during compressor cleaning despite correct settings, this can be remedied by reducing the engine load further during cleaning of the compressor after consulting an ABB Turbocharging Service Station. The reduction of the engine load can lead to a reduction in the effectiveness of the compressor cleaning.
6.2.3 Wet cleaning with direct water supply

Prerequisites

Do not clean the compressors of the different high and low-pressure stages at the same time, but one after the other.

On V-engines with several low-pressure and/or high-pressure stages per engine, ABB Turbo Systems recommends the parallel cleaning of the LP compressors as well as the parallel cleaning of the HP compressors. This cleaning process is faster and reduces the risk of surging of the low-pressure and high-pressure stages.

Wet cleaning operations for compressor with direct water supply

- Trigger water injection according to the instructions of the enginebuilder.
- Observe water pressure before connection to pressure stage.
- Operate engine for at least five additional minutes after cleaning.

The cleaning process can be repeated up to three times.

The success of the cleaning can be recognised based on the charging pressure or the exhaust gas temperature.

If the cleaning is still unsuccessful after three processes and the engine values are unsatisfactory, it is recommended to have the low-pressure and / or high-pressure stage checked and cleaned by an ABB Turbocharging Service Station.

Cleaning parameters for each compressor

<table>
<thead>
<tr>
<th>Power2</th>
<th>Engine load</th>
<th>Water pressure [bar]</th>
<th>Water injection time [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>650 LP</td>
<td>50 … 100 %</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 8: Cleaning parameters Power2 LP

<table>
<thead>
<tr>
<th>Power2</th>
<th>Engine load</th>
<th>Water pressure [bar]</th>
<th>Water injection time [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>650 HP</td>
<td>50 … 100 %</td>
<td>(p_{VE}^* + 3)</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 9: Cleaning parameters Power2 HP

* Compressor inlet pressure depending on the operating point
6.3 Cleaning turbine and nozzle ring during operation

Power2 650-M is carried out without turbine cleaning function.
7 Troubleshooting

7.1 Malfunctions when starting

Delayed start-up

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Pressure stage contaminated</td>
</tr>
<tr>
<td></td>
<td>Bearing damaged</td>
</tr>
<tr>
<td></td>
<td>Rotor rubbing</td>
</tr>
<tr>
<td></td>
<td>Foreign object in pressure stage</td>
</tr>
</tbody>
</table>

Table 10: Malfunctions when starting – Delayed start-up

Vibrations

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Vibrations from engine</td>
</tr>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Rotor unbalance</td>
</tr>
<tr>
<td></td>
<td>Turbine or compressor damaged</td>
</tr>
<tr>
<td></td>
<td>Bearing damaged</td>
</tr>
</tbody>
</table>

Table 11: Malfunctions when starting – Vibrations

Rubbing of rotating parts

Normal behaviour, not a malfunction

<table>
<thead>
<tr>
<th>Low-pressure or high-pressure stage</th>
<th>A minimal and uniform wear at the circumference of the rotor components caused by slight local rubbing against adjacent components is permitted. This causes the compressor or turbine blades to be somewhat shortened. To prevent significant loss of efficiency, specific tolerances must be fulfilled.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- If there is any doubt about the extent of the rubbing, contact an ABB Turbocharging Service Station.</td>
</tr>
<tr>
<td></td>
<td>- Have a dimension check carried out by an ABB Turbocharging Service Station.</td>
</tr>
</tbody>
</table>

Table 12: Malfunctions when starting – Rubbing of rotating parts
7.2 Malfunctions during operation

Lubricating oil pressure too low

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Oil filter heavily contaminated</td>
</tr>
<tr>
<td></td>
<td>Oil pump in lubricating system de-</td>
</tr>
<tr>
<td></td>
<td>fective</td>
</tr>
<tr>
<td></td>
<td>Manometer displays incorrectly</td>
</tr>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Axial clearance of the rotor exces-</td>
</tr>
<tr>
<td></td>
<td>sive</td>
</tr>
</tbody>
</table>

Table 13: Malfunctions during operation – Lubricating oil pressure too low

Drop in low-pressure stage speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Defects on the connected cylinders</td>
</tr>
<tr>
<td>Low-pressure stage</td>
<td>Heavy contamination of the turbine</td>
</tr>
<tr>
<td></td>
<td>Damaged rotor components or bearing</td>
</tr>
<tr>
<td></td>
<td>Change of operating state of high-pressure</td>
</tr>
<tr>
<td></td>
<td>stage</td>
</tr>
<tr>
<td>Pipes</td>
<td>Defects, such as leaks, in the exhaust gas</td>
</tr>
<tr>
<td></td>
<td>pipes or charge air ducts</td>
</tr>
</tbody>
</table>

Table 14: Malfunctions during operation – Power2 LP speed reductions

Drop in high-pressure stage speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Defects on the connected cylinders</td>
</tr>
<tr>
<td>High-pressure stage</td>
<td>Heavy contamination of the turbine</td>
</tr>
<tr>
<td></td>
<td>Damaged rotor components or bearing</td>
</tr>
<tr>
<td></td>
<td>Change of operating state of low-pressure</td>
</tr>
<tr>
<td></td>
<td>stage</td>
</tr>
<tr>
<td>Pipes</td>
<td>Defects, such as leaks, in the exhaust gas</td>
</tr>
<tr>
<td></td>
<td>pipes or charge air ducts</td>
</tr>
</tbody>
</table>

Table 15: Malfunctions during operation – Power2 HP speed reductions

Increase in low-pressure stage speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure stage</td>
<td>Heavy contamination of the nozzle ring</td>
</tr>
</tbody>
</table>

Table 16: Malfunctions during operation – Power2 LP speed increases
### Increase in high-pressure stage speed

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-pressure stage</td>
<td>Heavy contamination of the nozzle ring</td>
</tr>
<tr>
<td>Low-pressure stage defective</td>
<td></td>
</tr>
<tr>
<td>Pipes</td>
<td>Leak in exhaust gas pipe before the low-pressure stage</td>
</tr>
</tbody>
</table>

Table 17: Malfunctions during operation – Power2 HP speed increases

### Exhaust gas temperature too high

**Engine performance and engine speed unchanged**

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Malfunction in the injection system</td>
</tr>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Insufficient air, for example, because filter silencer is blocked by contamination</td>
</tr>
<tr>
<td>Compressor/turbine contaminated</td>
<td></td>
</tr>
<tr>
<td>Exhaust gas back pressure too high</td>
<td>Clean or repair boiler or exhaust gas silencer</td>
</tr>
<tr>
<td>Turbine damaged or eroded</td>
<td></td>
</tr>
<tr>
<td>Charge air cooler/inter-cooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Cooling water volume too low</td>
</tr>
<tr>
<td></td>
<td>Inlet temperature of cooling water too high</td>
</tr>
<tr>
<td></td>
<td>Insufficient ventilation</td>
</tr>
</tbody>
</table>

Table 18: Malfunctions during operation – Exhaust gas temperature too high
Charge air pressure too low

Engine performance and engine speed unchanged, suction condition normal

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Air receiver not sealed</td>
<td>Repair</td>
</tr>
<tr>
<td>Gas piping between engine and turbine not sealed</td>
<td></td>
</tr>
<tr>
<td>Injection mistimed</td>
<td>Set correctly</td>
</tr>
<tr>
<td>Valve control misadjusted</td>
<td></td>
</tr>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td></td>
</tr>
<tr>
<td>Manometer display not correct</td>
<td>Replace manometer</td>
</tr>
<tr>
<td>Supply pipe to manometer not sealed</td>
<td>Repair leak</td>
</tr>
<tr>
<td>Filter silencer contaminated, therefore pressure drop too high</td>
<td>Clean</td>
</tr>
<tr>
<td>Compressor/turbine contaminated</td>
<td></td>
</tr>
<tr>
<td>Compressor/turbine damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Exhaust gas back pressure too high</td>
<td>Clean or repair boiler or exhaust gas silencer</td>
</tr>
</tbody>
</table>

Table 19: Malfunctions during operation – Charge air pressure too low

Charge air pressure too high

Engine performance and engine speed unchanged, suction condition normal

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
</tr>
<tr>
<td>Malfunction in the injection system</td>
<td>Repair or contact manufacturer</td>
</tr>
<tr>
<td>Injection mistimed</td>
<td>Set correctly</td>
</tr>
<tr>
<td>Engine performance higher than expected</td>
<td>Check engine performance</td>
</tr>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td></td>
</tr>
<tr>
<td>Manometer display not correct</td>
<td>Replace manometer</td>
</tr>
</tbody>
</table>

Table 20: Malfunctions during operation – Charge air pressure too high
Contamination of the compressor

Reduced compressor performance/efficiency and therefore engine performance losses

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Heavy contamination of the compressor components due to the influx of ventilation gases</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased vibration, compressor blade damage due to the influx of ventilation gases</td>
</tr>
</tbody>
</table>

Table 21: Malfunctions during operation – Compressor 1 contamination

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

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Material of the compressor wheel corroded due to the influx of ventilation gases containing corrosive components</td>
</tr>
<tr>
<td></td>
<td>Material of the compressor wheel corroded due to intake air containing exhaust gases or salt</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 22: Malfunctions during operation – Compressor 2 contamination
7.3 Surging of the low-pressure or high-pressure stage

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td>Filter silencer or diffuser contaminated</td>
</tr>
<tr>
<td>Charge air cooler/intercooler</td>
<td>Cooler contaminated</td>
</tr>
<tr>
<td></td>
<td>Charge air duct blocked</td>
</tr>
</tbody>
</table>

Table 23: Surging of the low-pressure or high-pressure stage

**CAUTION**

**Continuous or periodic surging**

If the low-pressure or high-pressure stages surge continuously or periodically, their components may be damaged.

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

**Sporadic surge blows**

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

- A surge blow is accompanied by a loud bang and the escape of hot air from the filter silencer of the low-pressure stage.
  No air escapes from the high-pressure stage.
7.4 Malfunctions when stopping

Runout noises

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td></td>
</tr>
<tr>
<td>Pressure stage contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td></td>
</tr>
<tr>
<td>Foreign object in the pressure stage</td>
<td></td>
</tr>
</tbody>
</table>

Table 24: Malfunctions when stopping – Runout noises

Runout time too short

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td></td>
</tr>
<tr>
<td>Pressure stage contaminated</td>
<td>Clean</td>
</tr>
<tr>
<td>Bearing damaged</td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
<tr>
<td>Rotor rubbing</td>
<td></td>
</tr>
<tr>
<td>Foreign object in the pressure stage</td>
<td></td>
</tr>
</tbody>
</table>

Table 25: Malfunctions when stopping – Runout time too short

7.5 Speed measurement system

Measured speed incorrect

<table>
<thead>
<tr>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-pressure or high-pressure stage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contact ABB Turbocharging Service Station</td>
</tr>
</tbody>
</table>

Table 26: Measured speed incorrect
8 Disassembly and assembly

- For more information on the disassembly and assembly of the low-pressure stage, see document Operation Manual / Power2 ... / 4.1 Low-pressure stage.

- For more information on the disassembly and assembly of the high-pressure stage, see document Operation Manual / Power2 ... / 4.2 High-pressure stage.

- For more information on the disassembly and assembly of the gas piping, see document Operation Manual / Power2 ... / 4.3 Gas piping.
9 Taking out of operation at short notice

- For more information on briefly taking the low-pressure stage out of operation, see document Operation Manual / Power2 ... / 4.1 Low-pressure stage.

- For more information on briefly taking the high-pressure stage out of operation, see document Operation Manual / Power2 ... / 4.2 High-pressure stage.
10 Taking out of operation for a long period

10.1 General

When taking the low-pressure and high-pressure stage out of operation, mothballing measures must be taken in order to minimise the risk of corrosion on components. The necessary measures depend on the condition of the lubricating oil and the process used to take the low-pressure and high-pressure stage out of operation.

10.2 Lubricating oil

No measures must be taken with regard to the lubricating oil if:

- The directives of the enginebuilder on lubricating oil selection and on the oil change intervals are followed.

Or:

- The engine lubricating oil is replaced by a preservative oil and circulated with the pre-lubrication pump before the engine is taken out of operation.

If neither of the criteria above are met, mothballing by an ABB Turbocharging Service Station is necessary. This includes cleaning and applying preservative oil to the relevant components.

10.3 Process for taking out of operation

Different measures are required depending on the process used to take the low-pressure and high-pressure stage out of operation.

- The low-pressure and high-pressure stage remains on the engine
  - Take countermeasures if there is a risk that the rotor will turn due to the stack draught. One option is to install a blind flange on the outlet flange of the gas outlet casing or the compressor casing.
  - If the engine is being taken out of operation for a long period in a corrosive environment, all components through which air flows must be provided with corrosion protection. Contact an ABB Turbocharging Service Station for this purpose.

- Disassembly of the low-pressure and high-pressure stage as a whole unit or in individual parts
  - Seal all openings of the low-pressure and high-pressure stage with paraffin paper and wooden lids.
  - Store the disassembled parts in a dry room with 40-70% atmospheric humidity in which no condensation can form.
  - Check all low-pressure and high-pressure stage parts for corrosion annually.
  - If there are signs of rust, thoroughly clean the parts and renew the corrosion protection.
Disposing of low-pressure and high-pressure stage components

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

The low-pressure and high-pressure stages mainly consist 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).

- 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.

**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.

- The enginebuilder's instructions must be followed for the handling and disposal of the thermal insulation.
12 Spare parts

- For more information on spare parts for the low-pressure stage, see document Operation Manual / Power2 ... / 4.1 Low-pressure stage.

- For more information on spare parts for the high-pressure stage, see document Operation Manual / Power2 ... / 4.2 High-pressure stage.

- For more information on spare parts for the gas piping, see document Operation Manual / Power2 ... / 4.3 Gas piping.
Figures

Fig. 1: Power2 layout and function ............................... 5
Fig. 2: Layout and function of the low-pressure stage ........................................ 6
Fig. 3: Function of the low-pressure stage .................... 7
Fig. 4: Layout of the high-pressure stage .................... 8
Fig. 5: Function of the high-pressure stage ............... 9
Fig. 6: Location of Power2 LP warning plates ........ 10
Fig. 7: Location of Power2 HP warning plates ........ 10
Fig. 8: Location of Power2 LP rating plate .............. 11
Fig. 9: Location of Power2 HP rating plate ............ 11
Fig. 10: Functional principle .................................. 20
Fig. 11: Dimension X .................. .............................. 21
Fig. 12: Removing the speed measurement system ... 21
Fig. 13: Setting dimension X .................................. 22
Fig. 14: Control dimension S .......................... 23
Fig. 15: Layout and overview .......................... 24
Tables

Table 1: Related documents ........................................... 3
Table 2: Pre-lubrication time .......................................... 13
Table 3: Post-lubrication time ................................. 13
Table 4: Filter mesh width ........................................... 14
Table 5: Oil pressure range ........................................... 19
Table 6: Lubricating oil temperature ....................... 19
Table 7: Maintenance intervals .............................. 30
Table 8: Cleaning parameters Power2 LP ............ 33
Table 9: Cleaning parameters Power2 HP ............ 33
Table 10: Malfunctions when starting – Delayed start-up .................................................. 35
Table 11: Malfunctions when starting – Vibrations 35
Table 12: Malfunctions when starting – Rubbing of rotating parts ........................................... 35
Table 13: Malfunctions during operation – Lubricating oil pressure too low.......................... 36
Table 14: Malfunctions during operation – Power2 LP speed reductions ......................... 36
Table 15: Malfunctions during operation – Power2 HP speed reductions ................................. 36
Table 16: Malfunctions during operation – Power2 LP speed increases .............................. 36
Table 17: Malfunctions during operation – Power2 HP speed increases ................................. 37
Table 18: Malfunctions during operation – Exhaust gas temperature too high ..................... 37
Table 19: Malfunctions during operation – Charge air pressure too low ......................... 38
Table 20: Malfunctions during operation – Charge air pressure too high .............................. 38
Table 21: Malfunctions during operation – Compressor 1 contamination ..................... 39
Table 22: Malfunctions during operation – Compressor 2 contamination .............................. 39
Table 23: Surging of the low-pressure or high-pressure stage ......................................... 40
Table 24: Malfunctions when stopping – Runout noises .................................................. 41
Table 25: Malfunctions when stopping – Runout time too short ........................................ 41
Table 26: Measured speed incorrect ....................... 41
# Low-pressure stage

1. **Further applicable documents** ................................................................. 2

2. **Removal and installation** ........................................................................ 3
   2.1 Transport / weight ............................................................................. 3
   2.2 Removing the low-pressure stage .......................................................... 4
   2.3 Installing the low-pressure stage ............................................................ 5

3. **Expected replacement intervals** .............................................................. 6

4. **Disassembly and assembly** ...................................................................... 8
   4.1 Introduction .......................................................................................... 8
   4.2 Weights of assemblies .......................................................................... 10
   4.3 Removing the filter silencer and injection ring ...................................... 11
   4.4 Removing air suction branch and injection ring .................................... 12
   4.5 Axial clearance A prior to disassembly ................................................ 13
   4.6 Removing wall insert .......................................................................... 14
   4.7 Removing the compressor casing .......................................................... 16
   4.8 Removing the cartridge group ............................................................... 17
   4.9 Removing turbine diffuser and nozzle ring .......................................... 19
   4.10 Installing the nozzle ring and turbine diffuser ...................................... 21
   4.11 Installing the cartridge group ............................................................... 23
   4.12 Installing the compressor casing .......................................................... 26
   4.13 Installing the wall insert ..................................................................... 27
   4.14 Axial clearance A after assembly ........................................................ 29
   4.15 Installing injection ring and air suction branch .................................... 30
   4.16 Installing the injection ring and filter silencer ..................................... 31
   4.17 Table of tightening torques .................................................................. 32

5. **Taking out of operation at short notice** .................................................. 34
   5.1 Possible emergency repairs ................................................................. 34

6. **Spare parts** ............................................................................................ 37
   6.1 Ordering spare parts ........................................................................... 37
   6.2 View of low-pressure stage with part numbers ...................................... 40

**Figures** ........................................................................................................ 42

**Tables** .......................................................................................................... 43
## Further applicable documents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Manual / Power2 / 1 Introduction</td>
<td>HZTL4004</td>
</tr>
<tr>
<td>Operation Manual / Power2 / 2 Safety</td>
<td>HZTL4021</td>
</tr>
<tr>
<td>Operation Manual / Power2 / 3 Safety data sheet *)</td>
<td>Power2 serial number (HT……)</td>
</tr>
<tr>
<td>Operation Manual / Power2 650-M / 4 Product description</td>
<td>HZTL4064</td>
</tr>
</tbody>
</table>

Table 1: Related documents

*) This chapter is only present in serialised operation manuals.
2 Removal and installation

2.1 Transport / weight

Swivel lifting eyes to be used

Two swivel lifting eyes (S) are required for the safe lifting of loads. These are not included in the ABB Turbo Systems scope of delivery.

The requirements of the swivel lifting eyes are listed in the table. The operating instructions provided by the swivel lifting eye manufacturer must be observed for the application.

<table>
<thead>
<tr>
<th>Swivel lifting eye (S)</th>
<th>Power2</th>
<th>Thread</th>
<th>Length</th>
<th>Minimum load limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>650 LP</td>
<td>M24</td>
<td>30 mm</td>
<td>40 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1900 kg</td>
</tr>
</tbody>
</table>

Table 2: Swivel lifting eyes to be used

Lifting gear with a sufficient load limit must be used for removing and installing the low-pressure stage. 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>Complete low-pressure stage</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspension</td>
<td>1900</td>
</tr>
</tbody>
</table>

Table 3: Transporting the low-pressure stage
2.2 Removing the low-pressure stage

⚠️ WARNING
Risk of tipping
If the turbocharger is not sufficiently supported or not supported at all during removal and installation, it may tip over and cause severe injury to personnel or accidents resulting in fatalities.
- Support the turbocharger at a suitable location.
- Secure with lifting gear wherever possible.

-Wear safety helmet.

Fig. 1: Suspension of complete low-pressure stage

- Remove insulation according to the instructions of the enginebuilder.
- Disconnect all gas, air, cleaning and oil pipes according to the instructions of the enginebuilder.
- Disconnect the cable connector from the speed sensor.
- Attach one lifting gear to each of the two bearing casing suspension points.
- Loosen the fixing elements on the foot.
- Lift the low-pressure stage from the engine.
- Put down the low-pressure stage so that all contact surfaces of the feet make contact.
- Also place a support made from hard wood beneath the compressor casing.
2.3 Installing the low-pressure stage

Fig. 2: Suspension of complete low-pressure stage

- Attach one lifting gear to each of the two bearing casing suspension points.
- Check that the orifices specified for the low-pressure stage have been installed in both oil supply lines.
- Check that the gaskets of the oil supply and the oil drain have been correctly installed in the bracket.
- Align the low-pressure stage on the engine.
- Tighten the fixing elements on the foot according to the instructions of the enginebuilder.
- Attach all gas, air, cleaning and oil pipes according to the instructions of the enginebuilder.
- Connect the cable connector to the speed sensor.
- Fit insulation according to the instructions of the enginebuilder.
3 Expected replacement intervals

Rotating components

The recommended replacement intervals for compressor and turbine wheels are specified based on the safety concept for rotating parts (SIKO) and dependant on the operating conditions. These intervals are shown on the rating plate of the low-pressure and high-pressure stage.

Non-rotating components

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

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

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

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

Expected replacement intervals [h]

<table>
<thead>
<tr>
<th>Parts</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas inlet casing</td>
<td>50000 ... 100000</td>
<td>35000 ... 50000</td>
</tr>
<tr>
<td>Gas outlet casing</td>
<td>50000 ... 100000</td>
<td>50000 ... 100000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Turbine diffuser / cover</td>
<td>35000 ... 50000</td>
<td>25000 ... 50000</td>
</tr>
<tr>
<td>Other casings</td>
<td>100000</td>
<td>100000</td>
</tr>
<tr>
<td>Rotor components</td>
<td>See rating plate information</td>
<td></td>
</tr>
<tr>
<td>Bearing parts</td>
<td>See rating plate information</td>
<td></td>
</tr>
<tr>
<td>Turbine blades (due to wear)</td>
<td>- -</td>
<td>≥ 12000</td>
</tr>
</tbody>
</table>

Table 4: Expected replacement intervals [h]

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

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

The actual values can deviate considerably from the guideline values, for example, due to the following influences:

- Fuel quality and fuel treatment
- Load profile (thermal cycling, also number of starts/stops, emergency shutdowns)
- Gas inlet temperature
- Frequency and execution of turbine and compressor cleaning
- Specification of the low-pressure stage
- System-specific operating conditions (combustion quality, exhaust gas composition)

For bearing parts

- Lubricating oil quality (oil filtering, oil condition, oil monitoring)
- Load profile (speed, pressure conditions, temperature)
- Number of starts/stops
- Unbalance of the rotor (degree of contamination).
4 Disassembly and assembly

4.1 Introduction

⚠️ CAUTION

Further operations

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

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

- Mark the casing position for assembly.

Identification of the assembly devices

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

⚠️ WARNING

Servicing the assembly devices

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

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

Customer spare part set

Before starting operations, make sure the required customer spare part set is available (see chapter Spare parts → 37).

Tightening torques for components

The specified bolted connection tightening torques must be observed (see chapter Table of tightening torques → 32).

Tightening torques for assembly devices

Unless described otherwise, the screws and nuts of the assembly devices supplied by ABB must be tightened so they rest firmly against the surface.

Definition of terms

- Suspension point
  Defined loading point on a component or an assembly (blind hole thread, eyelet, lug).
- **Assembly device**
  Devices that are fitted on the low-pressure or high-pressure stage in order to obtain a suspension point. Assembly devices are specially constructed and designed for the defined use; they are not trading goods. Use assembly devices only for the described applications.

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

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

![Fig. 3: Overview of assemblies](image)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Filter silencer</td>
<td>190</td>
</tr>
<tr>
<td>02 Air suction branch</td>
<td>60</td>
</tr>
<tr>
<td>03 Injection ring for air</td>
<td>70</td>
</tr>
<tr>
<td>04 Injection ring for blowby</td>
<td>70</td>
</tr>
<tr>
<td>05 Wall insert</td>
<td>190</td>
</tr>
<tr>
<td>06 Diffuser</td>
<td>25</td>
</tr>
<tr>
<td>07 Compressor casing</td>
<td>210</td>
</tr>
<tr>
<td>08 Cartridge group</td>
<td>330</td>
</tr>
<tr>
<td>09 Turbine diffuser</td>
<td>40</td>
</tr>
<tr>
<td>10 Nozzle ring</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 5: Weights of the assemblies
4.3 Removing the filter silencer and injection ring

- Dismantle insulation as far as necessary.
- If present: Disconnect supply line for compressor cleaning from filter silencer.

1. Fit the swivel lifting eye (90231) to the silencer (81000). Attach the lifting gear to the swivel lifting eye (90231) and loop through the eyelets at the rear of the filter silencer (81000).

2. Loosen nuts (72004) and remove with washers (72003).

3. Remove and put down filter silencer.

4. Loosen and remove nuts (77022). Remove sleeves (77023).

5. Secure injection ring (73000) for air to lifting gear with swivel lifting eye (90231).

6. Remove and put down injection ring (73000) for air.

7. Secure injection ring (73000) for blowby to lifting gear with swivel lifting eye (90231).

8. Remove and put down injection ring (73000) for blowby.
4.4 Removing air suction branch and injection ring

- Disconnect the air line in accordance with the enginebuilder's instructions.
- Dismantle insulation as far as necessary.
- If present: Disconnect supply line for compressor cleaning from air suction branch.

Fig. 5: Removing air suction branch and injection ring

1. Loop around air suction branch (82000) with lifting gear.
2. Loosen nuts (72004) and remove with washers (72003).
3. Remove and put down the air suction branch (82000).
4. Secure injection ring (73000) for air to lifting gear with swivel lifting eye (90231).
5. Remove and put down injection ring (73000) for air.
6. Secure injection ring (73000) for blowby to lifting gear with swivel lifting eye (90231).
7. Remove and put down injection ring (73000) for blowby.
4.5 Axial clearance A prior to disassembly

⚠️ 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.

![Image of measuring axial clearance A]

Fig. 6: Measuring axial clearance A

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

- Measure and note axial clearance (A).

<table>
<thead>
<tr>
<th>Axial clearance A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32 ... 0.53</td>
</tr>
</tbody>
</table>

Table 6: Axial clearance A
4.6 Removing wall insert

⚠️ CAUTION

Clearance between compressor wheel and wall insert
Serious damage to machinery or property can result from rubbing or jamming of the compressor wheel at the wall insert.

- Check that the compressor wheel does not rub against the wall insert during disassembly/assembly by rotating the rotor.

Fig. 7: Removing wall insert 1

1. Use three press-off screws (90920) to press off the wall insert (77000) until the lifting device can be fitted.
2. Remove the press-off screws (90920).
3. Remove two studs (72002) in the upper area.
4. Unplug cable connector (86515) and fix speed measurement cable in wall insert.

5. Fit bracket (90030) with screws (90955) and nuts (90415). Fit two plates (90031) and secure with plate (90032), screw (90656) and nut (90432).

6. Secure lifting gear to swivel lifting eye (90231).

7. Carefully move out wall insert.

8. Fit support angle (90480) with screws (90955) and nut (90415).


10. Remove plate (90032), screw (90656), nut (90432) and plates (90031). Remove lifting gear and bracket (90030).

11. Remove O-rings (77040 / 79020 / 79021).

12. Loosen screws (77016) and remove diffuser (79000).
4.7 Removing the compressor casing

1. Remove two studs (72002) and screw (72021) in the upper area.
2. Fit bracket (90030) with four screws (90959).
3. Fit four plates (90031) and secure with plate (90032), screw (90656) and nut (90432).

4. Secure lifting gear to swivel lifting eye (90231) and secure compressor casing (72000) to crane.
5. Loosen and remove nuts (61037).
6. Press off compressor casing (72000) with three press-off screws (90924).
7. Move out compressor casing (72000) and put down.
4.8 Removing the cartridge group

**CAUTION**

Clearance between blade tip and casing

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

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

---

1. Remove the O-ring (42012).
2. Loosen and remove the screws (42087).
3. Fit swivel lifting eye (90231) to bracket (90030) and screw bracket to cartridge group with two screws (90955).
4. Fit five plates (90031) and secure with plate (90032), screw (90656) and nut (90432).
5. Secure lifting gear to swivel lifting eye (90231) and secure cartridge group to crane.
Disassembly and assembly / 4.8 Removing the cartridge group

7. Carefully move out cartridge group.
8. Put cartridge group into the fixtures in the turned-over toolbox cover.
9. Remove plate (90032), screw (90656), nut (90432) and plates (90031).
11. Remove O-rings (42017 / 42018).

**CAUTION**

**Damage to cartridge group and toolbox cover**

The turned-over toolbox cover may only be used as intermediate storage for the cartridge group.

- The cover must be on a level surface.
- The cover may not be used to transport the cartridge group.

---

Fig. 13: Moving out cartridge group

Fig. 14: Putting down cartridge group onto cover
4.9 Removing turbine diffuser and nozzle ring

1. Loosen and remove the screws (61056).
2. Secure connecting flange (90428) to star plate (90414) with screws (90950) and nuts (90431).
3. Align arm of star plate (90414) marked FRONT in direction of gas outlet flange and screw star plate to turbine diffuser with screws (90961).

5. Secure guide tube (90422) to bracket (90030) with screws (90955) and nuts (90415).
6. Do not fit front bolt (90033) yet.
4.9 Removing turbine diffuser and nozzle ring

1. Insert bracket with guide tube into connecting flange.
2. Secure guide tube with bolt (90033).
3. Secure lifting gear to swivel lifting eye (90231).
4. Fit four plates (90031) and secure with plate (90032), screw (90656) and nut (90432).
6. Carefully move out turbine diffuser (63000).
7. Put down turbine diffuser.
   Remove plate (90032), screw (90656), nut (90432) and plates (90031).
   Remove press-off screws (90902).
8. Loosen screws (56017) with box spanner insert (90770) and remove together with clamps (56018).
9. Remove nozzle ring (56001).
4.10 Installing the nozzle ring and turbine diffuser

Fig. 19: Installing the nozzle ring and turbine diffuser

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>56017</td>
<td>M8 Tx40</td>
</tr>
<tr>
<td></td>
<td>25 Nm</td>
</tr>
</tbody>
</table>

Table 7: Tightening torque (56017)

1. Fit nozzle ring (56001).
2. Coat thread of screws (56017) with high-temperature grease. Fit clamps (56018) and screws (56017).
3. Tighten screws with torque spanner using the box spanner insert (90770). Observe the tightening torque.
4. Screw in a guide stud (90316) in the upper area on the left and right.
5. Secure lifting gear to swivel lifting eye (90231).
   (Installation of bracket and plate (see Fig. 17: Removing turbine diffuser and nozzle ring 3 →20))
6. Insert turbine diffuser (63000) via the guide studs.
7. Coat a screw (61056) with high-temperature grease and screw in to secure the turbine diffuser.
Disassembly and assembly / 4.10 Installing the nozzle ring and turbine diffuser

Fig. 20: Installing the nozzle ring and turbine diffuser 2

### Table 8: Tightening torque (61056)

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>61056</td>
<td>M10x90 50 Nm</td>
</tr>
</tbody>
</table>

1. Remove plate and bracket.
2. Loosen screws (90961) and remove together with star plate (90414). Remove guide stud (90316).
3. Coat thread of remaining screws (61056) with high-temperature grease and fit screws. Observe the tightening torque.
4.11 Installing the cartridge group

**CAUTION**

Clearance between blade tip and casing

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

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

> Fit new O-rings (42017 / 42018).

1. Screw bracket to cartridge group with two screws (90955).
2. Fit swivel lifting eye (90231) to bracket (90030) and secure lifting gear to swivel lifting eye.
3. Fit five plates (90031) and secure with plate (90032), screw (90656) and nut (90432).
4. Lift the cartridge group.
Fig. 23: Inserting the cartridge group

### Table 9: Tightening torque (42087)

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>42087</td>
<td>M12x60</td>
</tr>
<tr>
<td></td>
<td>80 Nm</td>
</tr>
</tbody>
</table>

1. Screw in a guide stud (90321) in the upper area on the left and right.
2. Insert cartridge group via the guide stud.
3. Coat a screw (42087) with high-temperature grease and screw in to secure the cartridge group.
4. Remove plates (90031) and bracket (90030).
5. Remove the guide stud (90321).
6. Coat thread of remaining screws (42087) with high-temperature grease and fit screws. Observe the tightening torque.
7. Fit a new O-ring (42012).
Control dimension after installing cartridge group

⚠️ CAUTION

Control dimension outside the tolerance value

If the control dimension is out of tolerance, the cartridge group has not been correctly installed and can be the cause of serious damage to the machine or property.

- Remove and reinstall the cartridge group.
- Always replace jammed gasket rings with new ones.
- If the control dimension is still out of tolerance, contact an ABB Turbocharging Service Station.

Fig. 24: Measuring control dimension X

After installing the cartridge group, the control dimension (X) must be measured.

<table>
<thead>
<tr>
<th>Control dimension X [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.0 ±0.1</td>
</tr>
</tbody>
</table>

Table 10: Control dimension X
### 4.12 Installing the compressor casing

**Fig. 25: Installing the compressor casing**

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>61037</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td>250 Nm</td>
</tr>
<tr>
<td>61037 (nuts that are difficult to access)</td>
<td>Pre-tightening torque 60 Nm</td>
</tr>
<tr>
<td></td>
<td>Tightening torque angle 90° ±5°</td>
</tr>
<tr>
<td>72021</td>
<td>M10x20</td>
</tr>
<tr>
<td></td>
<td>70 Nm</td>
</tr>
</tbody>
</table>

Table 11: Tightening torque (61037 / 72021)

1. Secure lifting gear to swivel lifting eye (90231) and insert compressor casing. (Installation of bracket and plates (see Fig. 10: Removing the compressor casing 1 →16)).

2. Fit nuts (61037). Observe the tightening torque.

3. Remove plates (90031) and bracket (90030).

4. Fit screw (72021). Observe the tightening torque.
### 4.13 Installing the wall insert

**CAUTION**

Clearance between compressor wheel and wall insert

Serious damage to machinery or property can result from rubbing or jamming of the compressor wheel at the wall insert.

- Check that the compressor wheel does not rub against the wall insert during disassembly/assembly by rotating the rotor.

Fig. 26: Installing wall insert 1

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>77016</td>
<td>M5x35 5 Nm</td>
</tr>
</tbody>
</table>

Table 12: Tightening torque (77016)

1. Coat the threads of screws (77016) with Loctite® 243 and secure diffuser (79000) with screws (77016). Observe the tightening torque.
2. Fit new O-rings (77040 / 79020 / 79021).
3. Secure lifting gear to swivel lifting eye (90231).
4. Fit two plates (90031) and secure with plate (90032), screw (90656) and nut (90432).
5. Lift the wall insert and remove the support angle (90480).
6. Carefully insert the wall insert.
4.13 Installing the wall insert

1. Remove plate (90032), screw (90656), nut (90432) and plates (90031).
2. Remove the bracket (90030).
3. Detach speed measurement cable from provisional holder and insert cable connector (86515).
4. Fit four studs (72002) in the upper area. Observe the tightening torque.

Table 13: Tightening torque (72002)

<table>
<thead>
<tr>
<th>Part number</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>72002</td>
<td>M16x334 50 Nm</td>
</tr>
</tbody>
</table>

Fig. 27: Installing wall insert 2
4.14 Axial clearance A after assembly

**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.

Fig. 28: Measuring axial clearance A

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

- Measure and note axial clearance (A).

<table>
<thead>
<tr>
<th>Axial clearance A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32 ... 0.53</td>
</tr>
</tbody>
</table>

Table 14: Axial clearance A
4.15 Installing injection ring and air suction branch

Fig. 29: Installing the air suction branch

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>72004</td>
<td>M16 200 Nm</td>
</tr>
</tbody>
</table>

Table 15: Tightening torque (72004)

1. Secure injection ring (73000) for blowby to lifting gear with swivel lifting eye (90231).
2. Fit injection ring (73000) for blowby and remove lifting gear.
3. Secure injection ring (73000) for air to lifting gear with swivel lifting eye (90231).
4. Fit injection ring (73000) for air and remove lifting gear.
5. Loop around air suction branch (82000) and secure to lifting gear.
6. Fit air suction branch (82000) and remove lifting gear.
7. Fit nuts (72004) with washer (72003). Observe the tightening torque.

- Reinstall dismantled insulation.
- Reinstall all air lines according to the instructions of the enginebuilder.
4.16 Installing the injection ring and filter silencer

Fig. 30: Installing the injection ring and filter silencer

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>72004</td>
<td>M16</td>
</tr>
<tr>
<td></td>
<td>200 Nm</td>
</tr>
<tr>
<td>72004 (nuts that are difficult to access)</td>
<td>Pre-tightening torque 60 Nm</td>
</tr>
<tr>
<td></td>
<td>Tightening angle 60° ±5°</td>
</tr>
<tr>
<td>77022</td>
<td>150 Nm</td>
</tr>
</tbody>
</table>

Table 16: Tightening torque (72004 / 77022)

1. Secure injection ring (73000) for blowby to lifting gear with swivel lifting eye (90231).
2. Fit injection ring (73000) for blowby and remove lifting gear.
3. Secure injection ring (73000) for air to lifting gear with swivel lifting eye (90231).
4. Fit injection ring (73000) for air and remove lifting gear.
5. Fit sleeves (77023) and nuts (77022) in accordance with position of filter silencer and tighten nuts (77022).
6. Fit the swivel lifting eye (90231) to the silencer (81000). Attach the lifting gear to the swivel lifting eye (90231) and loop through the eyelets at the rear of the filter silencer (81000).
7. Fit the filter silencer.
8. Fit nuts (72004) and washers (72003) and tighten nuts (72004).
   ▶ If present: Fit supply line for compressor cleaning to filter silencer.
   ▶ Reinstall dismantled insulation.
4.17 Table of tightening torques

Fig. 31: Overview of tightening torques
The following tightening torques [Nm] must be observed for the designated screw fittings:

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread and tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>42087</td>
<td>M12x60 80 Nm</td>
</tr>
<tr>
<td>56017</td>
<td>M8 Tx40 25 Nm</td>
</tr>
<tr>
<td>61037</td>
<td>M16 250 Nm</td>
</tr>
</tbody>
</table>
| 61037 (nuts that are difficult to access) | Pre-tightening torque 60 Nm  
Tightening angle 90° ±5° |
| 61056       | M10x90 50 Nm                |
| 72002       | M16x334 50 Nm               |
| 72004       | M16 200 Nm                  |
| 72004 (nuts that are difficult to access) | Pre-tightening torque 60 Nm  
Tightening angle 60° ±5° |
| 72021       | M10x20 70 Nm                |
| 77016       | M5x35 5 Nm                  |
| 77022       | M16 150 Nm                  |

Table 17: Tightening torques
5 Taking out of operation at short notice

5.1 Possible emergency repairs

**WARNING**

Danger of fire and explosion due to lubricating oil leaks

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

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

Wear safety gloves to protect against thermal hazards.

**CAUTION**

Directives for taking out of operation

Serious damage to engine or property can be caused by non-compliance with the directives for blanking off the low-pressure or high-pressure stage on the engine.

- Follow the directives of the enginebuilder.

If damage has occurred to the low-pressure stage and the engine has to be brought back into operation again as quickly as possible, the following emergency repair option is available:

- Attaching the cover plate
5.1.1 Manufacturing the cover plate

The cover plate and the other parts that are required are not part of the scope of delivery of ABB Turbo Systems and must be manufactured by the operator on the basis of the drawing (see Fig. 32: Cover plate / gasket, sleeves and screws →35).

Parts required

- 1 Cover plate (01) (recommended material: 1.4541 / 1.4571)
- 1 Gasket (02) (temperature resistant up to 550 °C)
- 8 additional screws (03) to the screws (42087) from the scope of delivery
- 15 sleeves (04)

---

Fig. 32: Cover plate / gasket, sleeves and screws

**Cover plate (gasket), sleeves and screws, dimensions [mm]**

<table>
<thead>
<tr>
<th>Ø1</th>
<th>Ø2</th>
<th>Ø3</th>
<th>Ø4</th>
<th>Ø5</th>
<th>B1</th>
<th>B2</th>
<th>L1</th>
<th>M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>655</td>
<td>600</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>10</td>
<td>32</td>
<td>60</td>
<td>M12</td>
</tr>
</tbody>
</table>

Table 18: Cover plate / gasket
5.1.2 Fitting the cover plate

1. Remove alternative air inlet, wall insert, compressor casing and cartridge group.
2. Close opening in bearing casing with gasket (02) and cover plate (01).
3. Secure cover plate (01) with spacer sleeves (04) and screws (42087 / 03).
4. Reinstall compressor casing, wall insert and alternative air inlet.

---

**CAUTION**

**Escaping lubricating oil**

Complete sealing of the lubricating oil supply is not guaranteed with the cover plate fitted.

- Shut off lubricating oil supply to low-pressure stage at engine side.
6 Spare parts

6.1 Ordering spare parts

⚠️ CAUTION

Spare part storage

All spare parts that were ordered together with the low-pressure and/or high-pressure stage must be kept intact and ready for use.

➤ Carefully clean any rusted parts and grease them.

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

- Serial number of Power2 (HT……)
- Serial number of the low or high-pressure stage (PT……)
- Designation and part number.

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

➤ If different model variants are not taken into account in this document, contact an ABB Turbocharging Service Station.

➤ Dispose of placed and unusable parts in an environmentally-friendly and professional manner in accordance with the local regulations.

➤ Dispose of the packaging of new parts in an environmentally-friendly and professional manner in accordance with the local regulations.
Required customer spare part set (97070) for a low-pressure stage

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

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>42012 / 79020</td>
<td>O-ring</td>
<td>2</td>
</tr>
<tr>
<td>42017</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42018</td>
<td>O-ring</td>
<td>2</td>
</tr>
<tr>
<td>42087</td>
<td>Hexagon-head screw</td>
<td>1</td>
</tr>
<tr>
<td>56017</td>
<td>Hexalobular-head screw</td>
<td>3</td>
</tr>
<tr>
<td>56018</td>
<td>Clamp</td>
<td>3</td>
</tr>
<tr>
<td>61037</td>
<td>Hexagon nut</td>
<td>3</td>
</tr>
<tr>
<td>61056</td>
<td>Hexagon-head screw</td>
<td>8</td>
</tr>
<tr>
<td>72003</td>
<td>Washer</td>
<td>3</td>
</tr>
<tr>
<td>72004</td>
<td>Hexagon nut</td>
<td>4</td>
</tr>
<tr>
<td>77016</td>
<td>Hexagon-head screw</td>
<td>5</td>
</tr>
<tr>
<td>77040</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>79021</td>
<td>O-ring</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 20: Customer spare part set (97070)
6.2 View of low-pressure stage with part numbers

Fig. 35: Low-pressure stage with part numbers

(......) only available in customer spare part set (97070)
### Low-pressure stage part numbers

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Cartridge group</td>
</tr>
<tr>
<td>42001</td>
<td>Bearing casing</td>
</tr>
<tr>
<td>42012</td>
<td>O-ring</td>
</tr>
<tr>
<td>42017</td>
<td>O-ring</td>
</tr>
<tr>
<td>42018</td>
<td>O-ring</td>
</tr>
<tr>
<td>42087</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>51001</td>
<td>Gas inlet casing, radial</td>
</tr>
<tr>
<td>51001</td>
<td>Gas inlet casing, axial</td>
</tr>
<tr>
<td>56001</td>
<td>Nozzle ring</td>
</tr>
<tr>
<td>56017</td>
<td>Hexalobular-head screw</td>
</tr>
<tr>
<td>56018</td>
<td>Clamp</td>
</tr>
<tr>
<td>61001</td>
<td>Gas outlet casing</td>
</tr>
<tr>
<td>61009</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>61037</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>61050</td>
<td>Spiral-wound gasket</td>
</tr>
<tr>
<td>61056</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>63000</td>
<td>Turbine diffuser</td>
</tr>
<tr>
<td>68002</td>
<td>Foot, turbine end</td>
</tr>
<tr>
<td>72000</td>
<td>Compressor casing</td>
</tr>
<tr>
<td>72002</td>
<td>Stud</td>
</tr>
<tr>
<td>72003</td>
<td>Washer</td>
</tr>
<tr>
<td>72004</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>72021</td>
<td>Socket screw</td>
</tr>
<tr>
<td>73000</td>
<td>Injection ring (Air)</td>
</tr>
<tr>
<td>73000</td>
<td>Injection ring (Blowby)</td>
</tr>
<tr>
<td>77000</td>
<td>Wall insert</td>
</tr>
<tr>
<td>77016</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>77023</td>
<td>Sleeve</td>
</tr>
<tr>
<td>77040</td>
<td>O-ring</td>
</tr>
<tr>
<td>79000</td>
<td>Diffuser</td>
</tr>
<tr>
<td>79020</td>
<td>O-ring</td>
</tr>
<tr>
<td>79021</td>
<td>O-ring</td>
</tr>
<tr>
<td>82000</td>
<td>Air suction branch</td>
</tr>
<tr>
<td>86505 / 86515</td>
<td>Speed sensor / connecting cable</td>
</tr>
</tbody>
</table>

Table 21: Low-pressure stage part numbers
Figures

Fig. 1: Suspension of complete low-pressure stage 4
Fig. 2: Suspension of complete low-pressure stage 5
Fig. 3: Overview of assemblies ...................................... 10
Fig. 4: Removing the filter silencer and injection ring 11
Fig. 5: Removing air suction branch and injection ring .................................................. 12
Fig. 6: Measuring axial clearance A .................................. 13
Fig. 7: Removing wall insert 1 ........................................ 14
Fig. 8: Removing wall insert 2 .................................... 15
Fig. 9: Removing wall insert 3 .................................... 15
Fig. 10: Removing the compressor casing 1 .......... 16
Fig. 11: Removing the compressor casing 2 .......... 16
Fig. 12: Moving out cartridge group 1 .................. 17
Fig. 13: Moving out cartridge group 2 .................. 18
Fig. 14: Putting down cartridge group onto cover . 18
Fig. 15: Removing turbine diffuser and nozzle ring 1 .. 19
Fig. 16: Removing turbine diffuser and nozzle ring 2 .. 19
Fig. 17: Removing turbine diffuser and nozzle ring 3 .. 20
Fig. 18: Removing turbine diffuser and nozzle ring 4 .. 20
Fig. 19: Installing the nozzle ring and turbine diffuser 1........................................................................ 21
Fig. 20: Installing the nozzle ring and turbine diffuser 2 ........................................................................ 22
Fig. 21: Installing O-rings ........................................... 23
Fig. 22: Installing cartridge group 1 .......................... 23
Fig. 23: Inserting the cartridge group ................. 24
Fig. 24: Measuring control dimension X ............... 25
Fig. 25: Installing the compressor casing ................. 26
Fig. 26: Installing wall insert 1 .................................. 27
Fig. 27: Installing wall insert 2 .................................. 28
Fig. 28: Measuring axial clearance A ..................... 29
Fig. 29: Installing the air suction branch ................. 30
Fig. 30: Installing the injection ring and filter silencer 31
Fig. 31: Overview of tightening torques ................... 32
Fig. 32: Cover plate / gasket, sleeves and screws... 35
Fig. 33: Fitting the cover plate ................................. 36
Fig. 34: Installing the casing ...................................... 36
Fig. 35: Low-pressure stage with part numbers ....... 40
# Tables

Table 1: Related documents ............................................ 2  
Table 2: Swivel lifting eyes to be used ........................... 3  
Table 3: Transporting the low-pressure stage .......... 3  
Table 4: Expected replacement intervals [h].............. 6  
Table 5: Weights of the assemblies .................................. 10  
Table 6: Axial clearance A ............................................... 13  
Table 7: Tightening torque (56017).......................... 21  
Table 8: Tightening torque (61056) ......................... 22  
Table 9: Tightening torque (42087) ......................... 24  
Table 10: Control dimension X ................................. 25  
Table 11: Tightening torque (61037 / 72021) .......... 26  
Table 12: Tightening torque (77016) ......................... 27  
Table 13: Tightening torque (72002) ......................... 28  
Table 14: Axial clearance A .......................................... 29  
Table 15: Tightening torque (72004) ......................... 30  
Table 16: Tightening torque (72004 / 77022) .......... 31  
Table 17: Tightening torques ................................. 33  
Table 18: Cover plate / gasket ..................................... 35  
Table 19: Tightening torque (42087) ......................... 36  
Table 20: Customer spare part set (97070) ............ 38  
Table 21: Low-pressure stage part numbers .......... 41
High-pressure stage

1 Further applicable documents .............................................................. 2

2 Removal and installation ....................................................................... 3
  2.1 Transport / weight ........................................................................ 3
  2.2 Removing the high-pressure stage .................................................. 4
  2.3 Installing the high-pressure stage .................................................... 7

3 Expected replacement intervals ........................................................... 13

4 Disassembly and assembly ................................................................. 15
  4.1 Introduction .................................................................................... 15
  4.2 Weights of assemblies .................................................................... 17
  4.3 Removing the compressor casing .................................................. 18
  4.4 Removing the cartridge group ....................................................... 19
  4.5 Installing the cartridge group ......................................................... 22
  4.6 Installing the compressor casing .................................................. 25
  4.7 Radial clearances N and R ............................................................ 26
  4.8 Axial clearance A and radial clearance B ....................................... 27
  4.9 Table of tightening torques ............................................................ 28

5 Taking out of operation at short notice .................................................. 29
  5.1 Possible emergency repairs ............................................................ 29
  5.2 Installing a replacement cartridge group ....................................... 30
  5.3 Fitting the cover plate .................................................................... 31
  5.4 Cover plate drawing ....................................................................... 32

6 Spare parts .......................................................................................... 35
  6.1 Ordering spare parts ...................................................................... 35
  6.2 View of high-pressure stage with part numbers .......................... 36

Figures .................................................................................................. 38

Tables .................................................................................................... 39
# Further applicable documents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Manual / Power2 / 1 Introduction</td>
<td>HZTL4004</td>
</tr>
<tr>
<td>Operation Manual / Power2 / 2 Safety</td>
<td>HZTL4021</td>
</tr>
<tr>
<td>Operation Manual / Power2 / 3 Safety data sheet *)</td>
<td>Power2 serial number (HT……)</td>
</tr>
<tr>
<td>Operation Manual / Power2 600-M / 4 Product description</td>
<td>HZTL4064</td>
</tr>
</tbody>
</table>

*Table 1: Related documents

*) This chapter is only present in serialised operation manuals.
2 Removal and installation

2.1 Transport / weight

Swivel lifting eyes to be used

Two swivel lifting eyes (S) are required for the safe lifting of loads. These are not included in the ABB Turbo Systems scope of delivery.

The requirements of the swivel lifting eyes are listed in the table. The operating instructions provided by the swivel lifting eye manufacturer should be observed.

<table>
<thead>
<tr>
<th>Swivel lifting eye (S)</th>
<th>Power2</th>
<th>Thread</th>
<th>Length</th>
<th>Minimum load limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>650 HP</td>
<td>M16</td>
<td>20 mm</td>
<td>30 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>750 kg</td>
</tr>
</tbody>
</table>

Table 2: Swivel lifting eyes to be used

Lifting gear with a sufficient load limit must be used for removing and installing the high-pressure stage. The following weight specifications apply to the heaviest variant possible. Depending on the specification, the weight specified on the rating plate may be lower than the standard values specified here.

<table>
<thead>
<tr>
<th>Complete high-pressure stage</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspension</td>
<td>750 kg</td>
</tr>
</tbody>
</table>

Table 3: Transport / weight of high-pressure stage
2.2 Removing the high-pressure stage

Preparing for removal

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

2. If present: Unplug the plug to the speed sensor (86505) and secure the rolled-up cable (2 m) to the high-pressure stage. This protects the plug from being crushed.

3. Treat the threads of the threaded rods (42191) with penetrating oil and allow it to take effect. Do not oil the pressure screws of the clamping nut (42201).

4. Secure lifting gear to high-pressure stage with two swivel lifting eyes (01).

5. Loosen the clamping nuts (42201) in accordance with the following section.

---

Fig. 1: Removing the high-pressure stage

1. Loosen screws (72013) between bellows (82300) and compressor casing (72000) and remove with washer (72014). The air suction branch (82000) with the bellows does not have to be dismantled from the air line. To protect the bellows, the high-pressure stage must not be lifted up together with the radial air suction branch and the bellows.

2. If present: Unplug the plug to the speed sensor (86505) and secure the rolled-up cable (2 m) to the high-pressure stage. This protects the plug from being crushed.

3. Treat the threads of the threaded rods (42191) with penetrating oil and allow it to take effect. Do not oil the pressure screws of the clamping nut (42201).

4. Secure lifting gear to high-pressure stage with two swivel lifting eyes (01).

5. Loosen the clamping nuts (42201) in accordance with the following section.
2.2.1 Loosening the clamping nut

**CAUTION**

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

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

**CAUTION**

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

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

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

1. Working in a circle, break loose each pressure screw (≤ 20°).
2. Working in a circle, loosen each pressure screw by 45° in 4 rounds.
3. Working in a circle, loosen each pressure screw by 90° in 1...5 rounds until all of the pressure screws have been relieved.

- Loosen clamping nut by hand.
Removing the high-pressure stage

1. Unscrew the threaded rods (42191) until they have been completely removed from the engine support and the centre sleeve (42193).
2. Check whether the threaded rods (42191) can be moved.
3. Screw the threaded rods back into the centre sleeve by a few revolutions.
4. Manually lift threaded rods (42191) until the centring bushes (42193) are in the bearing casing. If necessary, shake the threaded rods until the centre sleeves (42193) release themselves from the engine support.
5. Screw down clamping nuts (42201) to the end of the expansion bush (42190). The threaded rod remains in position.
6. Remove the high-pressure stage.
7. Cover the oil connections (01) in the bracket to protect them from dirt.
2.3 Installing the high-pressure stage

2.3.1 Inserting gaskets

**CAUTION**

Inserting the gaskets

Gaskets that are forgotten, damaged or improperly inserted will lead to oil leaks.

- Always use new gaskets and insert them carefully into the slot.

![Diagram showing gaskets in the slots of the bearing casing](image)

Fig. 4: Gaskets in the slots of the bearing casing

- 42001 Bearing casing
- 42198 O-ring
- 42199 O-ring
- 01 Oil supply
- 02 Oil drains

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

- Insert the O-rings (42198 and 42199) into the slots of the bearing casing.
2.3.2 Placing the high-pressure stage on the bracket

1. Insert expansion bush (42190) into bearing casing.
2. Screw the clamping nut (42201) flush onto the threaded rod (42191). The hexagon of the thread screw is at the top.
3. Place thrust washer (01) of clamping nut onto expansion bush.
4. Lead threaded rod (42191) with screwed-on clamping nut through thrust washer, expansion bush and bearing casing.
5. Screw the centring bush (42193) flush onto the threaded rod from below.

Fig. 5: Preparing the fastening elements of the high-pressure stage
1. Lightly lubricate hole into which centering bush (42193) is inserted with screw grease.
2. Position threaded rod with centering bush into bracket and insert until stop.
3. Carefully lower high-pressure stage onto bracket and position using the centering bushes (42193) located in the bracket.
4. Check value \( x \).
   If value \( x \) is not reached, the high-pressure stage must be lifted up from the bracket and realigned.
5. Screw threaded rod into bracket up to value \( L \) using hexagon.
   If value \( L \) is not reached or the threaded rod jams while being screwed in, the threaded rod must be loosened by no more than ½ revolution (this will loosen the centering bush which may have jammed the rod). Then continue screwing in.
   If value \( L \) is not reached, undo the screw connection, carefully take the high-pressure stage off the bracket and repeat the procedure starting with Step 1.

▶ Observe the steps for fastening the high-pressure stage (see following section).

<table>
<thead>
<tr>
<th>Value ( X )</th>
<th>Value ( L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>135 ±2 mm</td>
<td>70 mm</td>
</tr>
</tbody>
</table>

Table 4: Values \( X \) and \( L \)
2.3.3 Steps for fastening the high-pressure stage

1. Tighten the clamping nuts (42201) (see section Tightening the clamping nut).
2. Connect the cable connector (86515) to the speed sensor.
   ▶ Connect all gas pipes and air lines.

Fig. 7: Steps for fastening the high-pressure stage
2.3.4 Tightening the clamping nut

Preparations for tightening the clamping nut

⚠️ CAUTION

- Do not clean pressure screws (04)
- The pressure screws are equipped with a permanent sliding layer that must not be removed.
- Do neither clean nor lubricate the pressure screws. In case of non-compliance, it cannot be ensured that the necessary tension force is reached.
  - Do not clean pressure screws.
  - Do not lubricate pressure screws.

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

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

Fig. 8: Preparing the clamping nut for the tightening procedure

1. Clean the thread of the bolt (01) and the contact surface.
2. Lightly oil the bolt thread.
3. Position the thrust washer (02) in place.
4. Tighten clamping nut (03) by hand.
5. Unscrew clamping nut (03) by ¼ of a turn (90°).

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

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

Rotating components
The recommended replacement intervals for compressor and turbine wheels are specified based on the safety concept for rotating parts (SIKO) and dependant on the operating conditions. These intervals are shown on the rating plate of the low-pressure and high-pressure stage.

Non-rotating components
Depending on the system-specific operating conditions, a differentiation must be made between the intervals to be expected for:
- replacing the bearing parts and
- replacing the non-rotating components exposed to hot gas.

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

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

Table 5: Expected replacement intervals [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>GAS / MDO</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine casing</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Nozzle ring</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Gas outlet flange</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Heat shield</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Heat sheet metal</td>
<td>25000 ... 50000</td>
<td>25000</td>
</tr>
<tr>
<td>Collecting grid in gas outlet casing</td>
<td>20000</td>
<td>20000</td>
</tr>
<tr>
<td>Rotor components</td>
<td>See rating plate data</td>
<td></td>
</tr>
<tr>
<td>Bearing parts</td>
<td>12000 ... 24000</td>
<td></td>
</tr>
<tr>
<td>Other casings</td>
<td>50000</td>
<td>50000</td>
</tr>
</tbody>
</table>

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

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

The actual values can deviate considerably from the guideline values, for example, due to the following influences:

- Fuel quality and fuel treatment
- Load profile (thermal cycling, also number of starts/stops, emergency shutdowns)
- Gas inlet temperature
- Frequency and execution of turbine and compressor cleaning
- Specification of the high-pressure stage
- System-specific operating conditions (combustion quality, exhaust gas composition)
- Atmospheric humidity after the intercooler.

For bearing parts

- Lubricating oil quality (oil filtering, oil condition, oil monitoring)
- Load profile (speed, pressure conditions, temperature)
- Number of starts/stops
- Imbalance of the rotor (degree of contamination).
4 Disassembly and assembly

4.1 Introduction

The precondition for the work described in the following is a high-pressure stage that has been removed from the engine (see chapter Removal and installation →3).

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

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

► Mark the casing position for assembly.

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

⚠️ WARNING
Servicing the assembly devices
Assembly devices must be checked for damage before and after use.

► Visually inspect for corrosion, cracks, deformation and wear.

► Damaged assembly devices must no longer be used and must be replaced.

Customer spare part set
Before starting operations, make sure the required customer spare part set is available (see chapter Spare parts →35).

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

Tightening torques for components
The specified bolted connection tightening torques must be observed (see chapter Table of tightening torques →28).
Tightening torques for assembly devices

Unless described otherwise, the screws and nuts of the assembly devices supplied by ABB must be tightened so they rest firmly against the surface.

Definition of terms

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

- **Assembly device**
  Devices that are fitted on the low-pressure or high-pressure stage in order to obtain a suspension point. Assembly devices are specially constructed and designed for the defined use; they are not trading goods. Use assembly devices only for the described applications.

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

Swivel lifting eyes to be used

Two swivel lifting eyes (S) are required for the safe lifting of loads. These are not included in the ABB Turbo Systems scope of delivery.

The requirements of the swivel lifting eyes are listed in the table. The operating instructions provided by the swivel lifting eye manufacturer must be observed for the application.

<table>
<thead>
<tr>
<th>Swivel lifting eye (S)</th>
<th>Power2</th>
<th>Thread</th>
<th>Length</th>
<th>Minimum load limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>650 HP</td>
<td>M10</td>
<td>15 mm</td>
<td>400 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M16</td>
<td>20 mm</td>
<td>750 kg</td>
</tr>
</tbody>
</table>

Table 6: Swivel lifting eyes to be used
4.2 Weights of assemblies

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

![Diagram of assembly parts]

**Fig. 10 Weights of the assemblies**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Radial air suction branch</td>
<td>95</td>
</tr>
<tr>
<td>02 Bellows</td>
<td>60</td>
</tr>
<tr>
<td>03 Compressor casing</td>
<td>160</td>
</tr>
<tr>
<td>04 Wall insert</td>
<td>30</td>
</tr>
<tr>
<td>05 Diffuser</td>
<td>12</td>
</tr>
<tr>
<td>06 Cartridge group</td>
<td>160</td>
</tr>
<tr>
<td>07 Nozzle ring</td>
<td>6</td>
</tr>
<tr>
<td>08 Turbine casing</td>
<td>220</td>
</tr>
</tbody>
</table>

Table 7: Weights of the assemblies
4.3 Removing the compressor casing

- Mark the casing position for assembly.
- Measure radial clearance N before removing the compressor casing (72000) (see chapter Radial clearances N and R → 26).
- Remove expansion bushes and threaded rods from bearing casing.

Fig. 11: Removing the compressor casing

1. Loosen screws (72011) and remove together with fastening strips (72012).
2. Screw two swivel lifting eyes (01) into compressor casing (72000) and secure lifting gear.
3. Remove compressor casing (72000) and place on soft surface.
4. Loosen nuts (77022) and remove with washer (77021). Wall insert (77000) is loose.
5. Remove O-ring (77005).
4.4 Removing the cartridge group

Mark the casing position for assembly.

Do not remove oil orifice (if present)

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

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

---

**Fig. 12: Oil orifice in the bearing casing**

01 Bearing casing  
02 Oil orifice  
03 Circlip
WARNING
Looping the lifting gear around the cartridge group
The looped lifting gear can slip off and lead to serious injuries to persons or even to fatal accidents.

- Make sure the surface for the loop on the cartridge group is free from oil.
- Wear safety gloves to protect against mechanical hazards.
- Wear safety helmet.

Fig. 13: Removing the cartridge group

1. Treat threads of studs (51006) with penetrating oil and leave to take effect.
2. Loosen nuts (51007) and remove Verbus Ripp® washers (51003) together with fastening strips (51002).
3. Attach swivel lifting eyes (01) to the cartridge group (10900)
4. Secure lifting gear to swivel lifting eye and loop around the cartridge group (10900) (see illustration above).
5. Remove the cartridge group and turn it 90°.
6. Place cartridge group with fitted expansion sleeves (42190) on service support (90012).
7. Hand-tighten the cartridge group with the threaded rod (42191) and the clamping nut (42201) on the service support (90012).
8. Remove metal C-ring (51105).

- Measure axial clearance A and radial clearance B (see Table 12: Permissible clearances A and B →27).
Removing the nozzle ring

1. Pull out the nozzle ring (56001) by hand.

2. Remove the lamellar sealing ring (56005) from the nozzle ring and replace it with a new one after cleaning the nozzle ring.
4.5 Installing the cartridge group

Nozzle ring compression

In order for the nozzle ring (56001) to be fixed during operation, it must be clamped between the heat shield (43001) and the turbine casing (51000).

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

<table>
<thead>
<tr>
<th>Compression PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09 ... 0.37 mm</td>
</tr>
</tbody>
</table>

Table 8: Nozzle ring compression PD

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

**NOTICE**

Chamfering (02) on nozzle ring and turbine casing

The nozzle ring (56001) can only be fitted into the turbine casing (51000) if both of the chamferings (02) on diameter D are aligned with one another.

1. Fit the lamellar sealing ring (56005) in the nozzle ring (56001). Make sure the lamellar sealing ring is fitted correctly in the right slot (see above illustration).

2. Insert the nozzle ring into the turbine casing as far as it will go and check for correct positioning, chamfering (02).

---

Fig. 16: Installing the nozzle ring
Installing the cartridge group

**WARNING**

Looping the lifting gear around the cartridge group

The looped lifting gear can slip off and lead to serious injuries to persons or even to fatal accidents.

- Make sure the surface for the loop on the cartridge group is free from oil.
- Wear safety gloves to protect against mechanical hazards.
- Wear safety helmet.

Fig. 17: Installing the cartridge group

1. Insert new metal C-ring (51105) into turbine casing (51000).
2. Screw in swivel lifting eyes (01) on cartridge group (10900) and secure lifting gear.
3. Lift cartridge group out of service support (90012) and remove expansion bush (42190).
4. Rotate cartridge group by 90° and also loop lifting gear around cartridge group (10900) as shown.
5. Move cartridge group into turbine casing. When doing this, ensure that the metal C-ring (51105) is not crushed at one side.
6. Secure fastening strips (51002) together with nuts (51007) and secure and tighten the Verbus Ripp® washers (51003).

<table>
<thead>
<tr>
<th>Part number</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>51007</td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>75</td>
</tr>
</tbody>
</table>

Table 9: Tightening torque (51007)
4.6 Installing the compressor casing

- Always replace the O-rings (42012 and 77005) with new ones (see Table 17: Customer spare part set (97070) →35).

Fig. 18: Installing the compressor casing

1. Fit new O-ring (77005) into wall insert (77000).
2. Screw two swivel lifting eyes (01) into compressor casing (72000) and secure lifting gear.
3. Lower compressor casing (72000) onto wall insert (77000) and fit with washer (77021) and nuts (77022).
4. Thoroughly clean the fastening strips (72012) before assembly.
5. Fit the diffuser (79000) with screw (42007).
7. Position compressor casing (72000) on cartridge group (109000).
8. Fit the fastening strips (72012) with screws (72011) and tighten.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>42007</td>
<td>M10 50</td>
</tr>
<tr>
<td>72011</td>
<td>M12 130</td>
</tr>
<tr>
<td>77022</td>
<td>M10 75</td>
</tr>
</tbody>
</table>

Table 10: Tightening torques (42007, 72011, 77022)
4.7 Radial clearances N and R

4.7.1 Measuring radial clearances N and R

Fig. 19: Measuring clearances N and R

\[
N = \frac{N_1 + N_2}{2}
\]

\[
R = \frac{R_1 + R_2}{2}
\]

Table 11: Permissible clearances N and R

<table>
<thead>
<tr>
<th>Clearance N</th>
<th>Clearance R</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 ... 0.80 mm</td>
<td>0.65 ... 1.00 mm</td>
</tr>
</tbody>
</table>

1. Push the feeler gauges (01) into the gap such that there is no clearance. The upper direction (N1) and lower direction (N2) must be covered simultaneously.
2. Calculate clearance N and compare it with the permissible values in the table.
3. Push the feeler gauges (01) into the gap such that there is no clearance. The upper direction (R2) and lower direction (R1) must be covered simultaneously.
4. Calculate clearance R and compare it with the permissible values in the table.

⚠️ CAUTION

Clearances outside the tolerance

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

- Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.
4.8 Axial clearance A and radial clearance B

4.8.1 Measuring clearance A and B

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

```
<table>
<thead>
<tr>
<th>Axial clearance A</th>
<th>Radial clearance B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.24 ... 0.44 mm</td>
<td>0.91 ... 1.51 mm</td>
</tr>
</tbody>
</table>
```

Table 12: Permissible clearances A and B

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

⚠️ CAUTION

Clearances outside the tolerance

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

- Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.
### 4.9 Table of tightening torques

![Overview of tightening torques](image)

The following tightening torques [Nm] must be observed for the designated screw fittings:

<table>
<thead>
<tr>
<th>Part number</th>
<th>Thread / tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>72005, 82005, 82007</td>
</tr>
<tr>
<td></td>
<td>M18x1.5</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>02</td>
<td>82022</td>
</tr>
<tr>
<td></td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>85</td>
</tr>
<tr>
<td>03</td>
<td>72013</td>
</tr>
<tr>
<td></td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>85</td>
</tr>
<tr>
<td>04</td>
<td>77022</td>
</tr>
<tr>
<td></td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td>75</td>
</tr>
<tr>
<td>05</td>
<td>42007</td>
</tr>
<tr>
<td></td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>06</td>
<td>72011</td>
</tr>
<tr>
<td></td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>130</td>
</tr>
<tr>
<td>07</td>
<td>42009</td>
</tr>
<tr>
<td></td>
<td>M20</td>
</tr>
<tr>
<td></td>
<td>65</td>
</tr>
<tr>
<td>08</td>
<td>51007</td>
</tr>
<tr>
<td></td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>75</td>
</tr>
<tr>
<td>09</td>
<td>61072 (V-clamp)</td>
</tr>
<tr>
<td></td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>86505</td>
</tr>
<tr>
<td></td>
<td>M12x1.5</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>42188</td>
</tr>
<tr>
<td></td>
<td>M12x1.5</td>
</tr>
<tr>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>

Table 13: Tightening torques [Nm]
5 Taking out of operation at short notice

5.1 Possible emergency repairs

⚠️ WARNING

Danger of fire and explosion due to lubricating oil leaks

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

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

Wear safety gloves to protect against thermal hazards.

⚠️ CAUTION

Directives for taking out of operation

Serious damage to engine or property can be caused by non-compliance with the directives for blanking off the low-pressure or high-pressure stage on the engine.

- Follow the directives of the enginebuilder.

If the engine has to be brought back into operation again as quickly as possible in the event of a low-pressure or high-pressure stage defect, there are options for emergency repairs:

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

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

**WARNING**

**Cartridge group**

Incorrect handling of a cartridge group can damage the low-pressure or high-pressure stage and cause injuries to persons.

- Always have repairs to the cartridge group carried out by an ABB Turbocharging Service Station.

**NOTICE**

**Quick recommissioning**

To enable you to put a defective low-pressure or high-pressure stage back into operation quickly, ABB Turbo Systems recommends having a replacement cartridge group available in stock. A replacement cartridge group can be installed within a short period of time, and the low-pressure or high-pressure stage can be operated again.

A replacement cartridge group is ready for use immediately and includes the complete bearing casing with bearing and a balanced rotor.

- For information on how to remove and install the cartridge group, see chapter Disassembly and assembly.
- Send the defective cartridge group to an ABB Turbocharging Service Station for inspection and repair.
5.3 Fitting the cover plate

The cover plate has two functions. It seals the turbine casing from exhaust gas and the bracket from oil leaks.

- Remove high-pressure stage (see chapter Removal and installation → 3).
- Fit the turbine casing with the gas outlet casing into the gas pipe again.
- Attach the cover plate (see following section).

Fig. 22: Attaching the cover plate

1. With the high-pressure stage, make sure that the oil connections of the high-pressure stage are sealed with a gasket under the cover plate (01) or with O-rings inside the cover plate (01). If the O-rings of the high-pressure stage are used, slots must be cut into the contact surface of the cover plate (see Fig. 24: Figure for cover plate, slots for O-rings → 33).

2. Close the opening in the turbine casing (51000) with the cover plate (01).

3. Thoroughly clean the fastening strips (51002) before assembly. Coat the threads of the studs (51006) with high-temperature grease.

4. Fasten cover plate (01) to turbine casing (51000) with fastening strips (51002), Verbus Ripp® washers (51003) and nuts (51007) and screw to bracket.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>51007</td>
<td>M12 75</td>
</tr>
</tbody>
</table>

Table 14: Tightening torque (51007)
5.4 **Cover plate drawing**

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


---

**Figure 23: Cover plate drawing**

<table>
<thead>
<tr>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>ØD1</th>
<th>ØD2</th>
<th>R1</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 0.5</td>
<td>100</td>
<td>230</td>
<td>29.3</td>
<td>2</td>
<td>310</td>
<td>70.4</td>
<td>367</td>
<td>31</td>
<td>≤ 173</td>
<td>M10</td>
</tr>
</tbody>
</table>

**Table 15: Cover plate dimensions [mm]**
Slots for O-rings in cover plate

Fig. 24: Figure for cover plate, slots for O-rings

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>R1</th>
</tr>
</thead>
<tbody>
<tr>
<td>251</td>
<td>125.5</td>
<td>78</td>
<td>39</td>
<td>5.2</td>
<td>31.5</td>
<td>5.2</td>
<td>4.5</td>
<td>5.2</td>
<td>4.5</td>
<td>24</td>
</tr>
</tbody>
</table>
6 Spare parts

6.1 Ordering spare parts

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

- Serial number of Power2 (HT…….)
- Serial number of the low or high-pressure stage (PT…….)
- Designation and part number.

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

If different model variants are not taken into account in this document, contact an ABB Turbocharging Service Station.

Required customer spare part set (97070) for a high-pressure stage

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

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>42010</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42012</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42198</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>42199</td>
<td>O-ring</td>
<td>1</td>
</tr>
<tr>
<td>51005</td>
<td>Socket screw</td>
<td>3</td>
</tr>
<tr>
<td>51105</td>
<td>Metal C-ring</td>
<td>1</td>
</tr>
<tr>
<td>56005</td>
<td>Lamellar sealing ring</td>
<td>1</td>
</tr>
<tr>
<td>77005</td>
<td>O-ring</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 17: Customer spare part set (97070)

⚠️ CAUTION

Spare part storage

All spare parts that were ordered together with the low-pressure and/or high-pressure stage must be kept intact and ready for use.

- Carefully clean any rusted parts and grease them.

- Dispose of replaced parts and parts that are not reusable in a professional and environmentally compatible manner.
6.2 View of high-pressure stage with part numbers

Fig. 25: High-pressure stage with part numbers

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

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>42009</td>
<td>Screw plug</td>
</tr>
<tr>
<td>42010 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>42012 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>42190</td>
<td>Expansion bush</td>
</tr>
<tr>
<td>42191</td>
<td>Threaded rod</td>
</tr>
<tr>
<td>42193</td>
<td>Centring bush</td>
</tr>
<tr>
<td>42196</td>
<td>Orifice, oil inlet</td>
</tr>
<tr>
<td>42197</td>
<td>Locking ring</td>
</tr>
<tr>
<td>42198 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>42199 (in customer spare part set)</td>
<td>O-ring</td>
</tr>
<tr>
<td>42201</td>
<td>Clamping nut</td>
</tr>
<tr>
<td>51000</td>
<td>Turbine casing</td>
</tr>
<tr>
<td>51002</td>
<td>Fastening strip</td>
</tr>
<tr>
<td>51005</td>
<td>Socket screw</td>
</tr>
<tr>
<td>51105 (in customer spare part set)</td>
<td>Metal C-ring</td>
</tr>
<tr>
<td>56001</td>
<td>Nozzle ring</td>
</tr>
<tr>
<td>56005 (in customer spare part set)</td>
<td>Lamellar sealing ring</td>
</tr>
<tr>
<td>61003</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>61300</td>
<td>Support</td>
</tr>
<tr>
<td>72000</td>
<td>Compressor casing</td>
</tr>
<tr>
<td>72012</td>
<td>Fastening strip</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>82000</td>
<td>Air suction branch</td>
</tr>
<tr>
<td>82300</td>
<td>Bellows</td>
</tr>
<tr>
<td>86505</td>
<td>Speed sensor</td>
</tr>
</tbody>
</table>

Table 18: High-pressure stage with part numbers
Figures

Fig. 1: Removing the high-pressure stage ................. 4
Fig. 2: Loosening the clamping nut ......................... 5
Fig. 3: Removing the high-pressure stage ............... 6
Fig. 4: Gaskets in the slots of the bearing casing ..... 7
Fig. 5: Preparing the fastening elements of the high-pressure stage ............................................. 8
Fig. 6: Placing the high-pressure stage on the bracket ...................................................................... 9
Fig. 7: Steps for fastening the high-pressure stage ... 10
Fig. 8: Preparing the clamping nut for the tightening procedure ............................................................. 11
Fig. 9: Tightening pressure screws .......................... 12
Fig. 10: Weights of the assemblies ............................ 17
Fig. 11: Removing the compressor casing ............... 18
Fig. 12: Oil orifice in the bearing casing .................. 19
Fig. 13: Removing the cartridge group .................... 20
Fig. 14: Removing the nozzle ring ............................ 21
Fig. 15: Nozzle ring compression PD ........................ 22
Fig. 16: Installing the nozzle ring ............................ 23
Fig. 17: Installing the cartridge group ...................... 24
Fig. 18: Installing the compressor casing .................. 25
Fig. 19: Measuring clearances N and R ................... 26
Fig. 20: Measuring clearance A and B ........................ 27
Fig. 21: Overview of tightening torques .................... 28
Fig. 22: Attaching the cover plate ............................. 31
Fig. 23: Cover plate drawing .................................... 32
Fig. 24: Figure for cover plate, slots for O-rings ...... 33
Fig. 25: High-pressure stage with part numbers ... 36
# Tables

Table 1: Related documents ........................................... 2
Table 2: Swivel lifting eyes to be used ....................... 3
Table 3: Transport / weight of high-pressure stage 3
Table 4: Values X and L................................................. 9
Table 5: Expected replacement intervals [h]......... 13
Table 6: Swivel lifting eyes to be used ...................... 16
Table 7: Weights of the assemblies ......................... 17
Table 8: Nozzle ring compression PD .................... 22
Table 9: Tightening torque (51007) ......................... 24
Table 10: Tightening torques (42007, 72011, 77022) ... 25
Table 11: Permissible clearances N and R ............ 26
Table 12: Permissible clearances A and B .............. 27
Table 13: Tightening torques [Nm] ......................... 28
Table 14: Tightening torque (51007) .................... 31
Table 15: Cover plate dimensions [mm].................. 32
Table 16: Dimensions of cover plate, slots for O-rings [mm] .................................................. 33
Table 17: Customer spare part set (97070) .......... 35
Table 18: High-pressure stage with part numbers . 37
Gas piping

1 Commissioning and operating ................................................................. 2

2 Periodic maintenance ........................................................................... 3

3 Removal and installation ........................................................................ 4
   3.1 Weight ............................................................................................. 4
   3.2 Removing gas piping ................................................................. 4
   3.3 Installing gas piping ................................................................. 5

4 Storage and disposal............................................................................... 6

5 Spare parts ............................................................................................. 7
   5.1 Ordering spare parts ................................................................. 7
   5.2 View of gas piping with part numbers ........................................ 8

Figures .................................................................................................... 9

Tables ..................................................................................................... 10
# Commissioning and operating

## Checks before commissioning
All components of the gas piping must be checked visually:

- There must not be any damage to sealing surfaces (evenly fine surfaces)
- There must not be any visible damage to the bellows (e.g. dents, cracks, scratches or weld spatters).
- All criteria mentioned also apply to the C-ring gaskets. Moreover, they must not exhibit any buckling.

## Checks after commissioning (engine in idle mode)
- After starting the engine, check all gas pipes for leaks.

Discolourations on the insulation, the smell of exhaust gas and unusual noises (whistling, hissing) can indicate small leaks. If such new and unusual signs are found, their cause must be determined.

### Noise emission
See main chapter 4 (Operation Manual / Power2 650-M / Product description)

### Expected replacement interval

<table>
<thead>
<tr>
<th>Product</th>
<th>Replacement interval [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas piping GEJ920</td>
<td>50000</td>
</tr>
</tbody>
</table>

Table 1: Expected replacement interval
2 Periodic maintenance

<table>
<thead>
<tr>
<th>Component to be maintained</th>
<th>Recommended cleaning interval</th>
<th>Operating state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas piping</td>
<td>At every disassembly</td>
<td>Engine stopped</td>
</tr>
</tbody>
</table>

Table 2: Maintenance interval

The following maintenance work must be carried out on the gas piping:

- If present: Remove insulation.
- Perform a visual inspection for cracks and deposits.

Always replace bellows with cracks with a new bellows.

Remove any deposits found on the bellows mechanically (using brushes).

- Perform a visual inspection of the sealing points (flange connection to the gas inlet casing and gas outlet casing).

Always replace bellows with damaged sealing locations with a new bellows.

Always replace dismantled gaskets with new gaskets.
3 Removal and installation

3.1 Weight

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas piping GEJ920</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 3: Weight

3.2 Removing gas piping

Only use textile lifting gear to lift the gas piping.

- Loosen nuts (51013) and remove with Verbus Ripp® washers (51012) and screws (51011).
- Loosen the V-clamp (61072) and slide at bellows side.
- Remove gas piping (85001) with metal C-rings (85002/61007).
3.3 Installing gas piping

**WARNING**
Gas leakage
Gaskets that were installed incorrectly or are defective can lead to gas leaks.
- Dispose of used or defective gaskets.
- Always insert new gaskets.

Only use textile lifting gear to lift the gas piping.

Fig. 2: Installing gas piping

- Coat threads of all screws with high-temperature grease.
- Position gas piping (85001) with new metal C-rings (85002/61007).
- Fit V-clamp (61072) and tighten to the tightening torque specified in the table.
- Fit screws (51011) with Verbus Ripp® washers (51012) and nuts (51013) and tighten to the tightening torque specified in the table.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Maximum tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>61072</td>
<td>60</td>
</tr>
<tr>
<td>51013 (nut with Verbus Ripp® washer)</td>
<td>325</td>
</tr>
<tr>
<td>51011 (screw)</td>
<td>230</td>
</tr>
</tbody>
</table>

Table 4: Tightening torque (51011 / 51013 / 61072)

The tightening torques for nut and screw specified in the table refer to the part which is turned during tightening. The other part must be locked in place with a wrench.
4 Storage and disposal

Storing gas piping

The bellows of the gas piping are made of rustproof chromium-nickel steel and can be stored in their undamaged original packaging for an unlimited time.

They must be stored in such a way that mechanical damage to the parts can be excluded.

See also main chapter 4 (Operation Manual / Power2 650-M / Product description)

Disposing of gas piping components

See main chapter 4 (Operation Manual / Power2 650-M / Product description)
5  

Spare parts

5.1  

Ordering spare parts

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

- Serial number of Power2 (HT……)
- Serial number of the low or high-pressure stage (PT……)
- Designation and part number.

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

If different model variants are not taken into account in this document, contact an ABB Turbocharging Service Station.

Customer spare part set (97150) required to inspect the gas piping

For the operations described in the Operation Manual, the customer spare part set (97150) is required. These parts are only available in the complete set.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>51011</td>
<td>Hexagon-head screw</td>
<td>3</td>
</tr>
<tr>
<td>51012</td>
<td>Verbus Ripp® Washer</td>
<td>3</td>
</tr>
<tr>
<td>51013</td>
<td>Hexagon nut</td>
<td>3</td>
</tr>
<tr>
<td>61007</td>
<td>Metal C-ring</td>
<td>1</td>
</tr>
<tr>
<td>61050</td>
<td>Gasket</td>
<td>1</td>
</tr>
<tr>
<td>85002</td>
<td>Metal C-ring</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Customer spare part set (97150)

⚠️ CAUTION

Spare part storage

All spare parts that were ordered together with the low-pressure and/or high-pressure stage must be kept intact and ready for use.

- Carefully clean any rusted parts and grease them.

- Dispose of replaced parts and parts that are not reusable in a professional and environmentally compatible manner.
5.2 View of gas piping with part numbers

Fig. 3: Gas piping with part numbers

( . . . . . ) only available in customer spare part set (97150)

<table>
<thead>
<tr>
<th>Part number</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>51011 (in customer spare part set)</td>
<td>Hexagon-head screw</td>
</tr>
<tr>
<td>51012 (in customer spare part set)</td>
<td>Verbus Ripp® Washer</td>
</tr>
<tr>
<td>51013 (in customer spare part set)</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>61007 (in customer spare part set)</td>
<td>Metal C-ring</td>
</tr>
<tr>
<td>61050 (in customer spare part set)</td>
<td>Gasket</td>
</tr>
<tr>
<td>61072</td>
<td>V-clamp</td>
</tr>
<tr>
<td>85001</td>
<td>Bellows</td>
</tr>
<tr>
<td>85002 (in customer spare part set)</td>
<td>Metal C-ring</td>
</tr>
</tbody>
</table>

Table 6: Gas piping with part numbers
Figures

Fig. 1: Removing gas piping ........................................ 4
Fig. 2: Installing gas piping........................................... 5
Fig. 3: Gas piping with part numbers ......................... 8
# Tables

Table 1: Expected replacement interval ....................... 2  
Table 2: Maintenance interval .................................... 3  
Table 3: Weight .................................................. 4  
Table 4: Tightening torque (51011 / 51013 / 61072) . 5  
Table 5: Customer spare part set (97150) ................. 7  
Table 6: Gas piping with part numbers ....................... 8