



OPERATING and MOUNTING INSTRUCTIONS for EXHAUST GAS TURBOCHARGER HPR5000

For information only!

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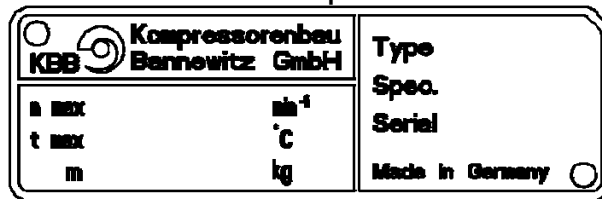
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Name-plate



The data given in the operating instructions only apply to the exhaust gas turbocharger with the serial number mentioned above. The name-plate is affixed at the side of the bearing housing of the exhaust gas turbocharger.

In case you have questions regarding the exhaust gas turbocharger, it is important to give the correct

- TC type (Type)
- Serial No. (Serial)
- Specification No. (Spec.)

Only if these data are known, the request can be handled properly and promptly.

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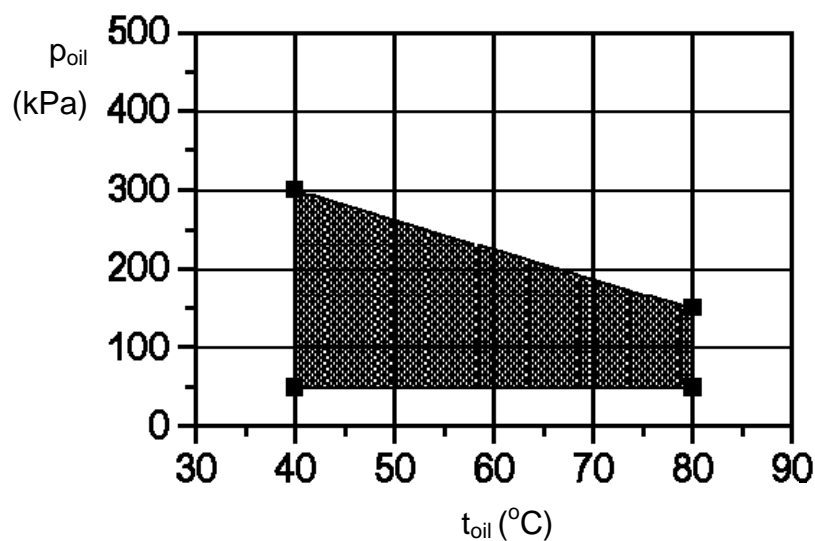
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1 TECHNICAL DATA

1.1 Operating data

Specification	458xxxx
Max. speed	41,500 rpm
Max. exhaust gas temperature upstream of turbine	650 °C
Lubricating oil	
Types of lubricating oil: engine oil with a kinematic viscosity of at 50 °C, e.g. SAE30, SAE40	60 ... 115 mm ² /s
Nominal oil filter fineness upstream of TC	max. 25 µm
Lubricating oil pressure upstream of TC	300 ± 150 kPa
Admissible lubricating oil pressures for special operating states	
at start-up	min. 50 kPa
from start-up to idle running	min. 50 kPa
at standstill (pre-lubrication or re-lubrication/standby mode)	see diagram below
Lubricating oil temperature upstream of TC	40 ... 80 °C
Lubricating oil temperature downstream of TC	max. 100 °C
Lubricating oil flow	20 ... 30 l/min
Sound power level (measured on silencer at 100 mm distance from compressor housing)	108 dB(A) at 37,000 rpm
Counter-pressure downstream of turbine	max. 2.5 kPa(g)
Vacuum upstream of compressor	max. 1.5 kPa(g)



 Admissible lubricating oil pressure for pre-lubrication or re-lubrication (standby operation)

1.2 Alarm values

Measurement	Alarm value
TC speed	0.97 * n max
Exhaust gas temperature before turbine	t max – 15K
Lubricating oil outlet temperature of TC	≤ 120 °C
Lubricating oil pressure before TC	≥ 125 kPa (1.25 bar)



If alarm values are adapted accordingly to the engine data, the values specified above are not to be exceeded and/or be fallen below in the case of lubricating oil pressure!

The maximum speed and the maximum exhaust gas temperature before turbine are indicated on the name-plate and the test certificate!

1.3 Dimensions



All dimensions are specified in mm!

Length *)	1225 ... 1320
Width **)	max. 610
Height **)	max. 690

*) Exhaust gas turbocharger with silencer or intake housing and exhaust-gas elbow

***) Dimensions depend on the housing position

Exhaust gas	Inlet single-nozzle housing	1x Ø 153 mm
	Inlet double-nozzle housing	2x Ø 100 mm
	Inlet three-nozzle housing	3x Ø 85 mm
	Outlet	Ø 300 mm
Charge air	Outlet	Ø 175 mm
Lubricating oil	Inlet at bearing housing	Ø 14.5 mm
	Outlet at bearing housing	Ø 45 mm
Compressor washing	Air piping	M18 x 1.5
	Water piping	M16 x 1.5
Turbine washing	Water piping	M18 x 1.5
	Drainage	Ø 75 mm

Further connection dimensions can be taken from the assembly drawing.



The piping for the pipe connections listed is not included in the scope of supply of Kompressorenbau Bannewitz GmbH.



Pipes have always to be laid free of stress.

1.4 Test connections

The TC is equipped with the following test connections which can be used as required.

- There are two threads each (M18x1.5) provided at the intake, compressor and turbine-inlet housings and at the exhaust-gas elbow for measuring the temperature and pressure.
- For measuring the speed, the bearing housing can be equipped with a speed sensor.

1.5 Weight of important subassemblies

Exhaust gas turbocharger, compl. *)	354 kg
Exhaust gas turbocharger, basic unit	264 kg
Silencer	55 kg
Air-intake bend	18 kg
Compressor housing	86 kg
Turbine housing	77 kg
Exhaust-gas elbow	46 kg
Cartridge (Bearing housing with rotor)	88 kg
Bearing housing	49 kg
Rotor	20 kg
Shaft	14 kg
Compressor impeller	5 kg

*) Basic unit including silencer and exhaust-gas elbow (see name-plate)

1.6 Vibrations

Maximum admissible vibration load at engine for 2 ... 250 Hz :

Admissible value		at TC	at silencer
Velocity	V_{RMS} (mm/s)	max. 45 mm/s	max. 71 mm/s
Amplitude	S_{RMS} mm	max. 0,7 mm	max. 1,1 mm
Acceleration	a_{RMS} (m/s ²)	max. 70 m/s ²	max. 111 m/s ²

2 SAFETY

The exhaust gas turbocharger has been designed on the basis of the following standards and regulations:

1. EC machinery directive (89/392/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC)
2. EN 292 Parts 1 and 2: Safety of machines (fundamentals)
3. EN 294 Safety of machines; Safety distances to be kept to prevent the upper limbs from reaching dangerous zones

2.1 Built-in safety systems

- A safety system for the turbocharger is not necessary as its design and connection with the engine to which it is attached require an inherent safety.
- For general speed monitoring, i.e. without a turn-off function being included, the turbocharger can be equipped with a tachometer.



Assembly and disassembly work must not be done during operation. See chapters 7.5.1 and 7.5.2 for maintenance and cleaning jobs which may be done while the engine is running.

2.2 Safety measures (to be taken by user)

- These operating instructions are part of the exhaust gas turbocharger and shall be always accessible for the operators and maintenance personnel.
- The operating instructions should be read before commissioning the turbocharger. Particular attention should be paid to directions and information relating to dangers.

The user is required

- to make his operators and maintenance personnel familiar with safe working methods
- to supervise the observance of the safety regulations.

The individual jobs in these instructions are described such that they can be understood by skilled workers.

The necessary tools and testing/inspection means must be made available to these workers.

The user must obtain permission to operate the unit from the local authorities and observe the following:

1. labour safety
2. cleaning and maintenance of the machines
3. product disposal
4. environmental protection

3 GENERAL INFORMATION ABOUT DANGER

3.1 Danger zone

The danger zone is defined by the engine as the turbocharger is an integral part of the engine.



During turbocharger operation, the user must keep the danger zone free of any objects so to ensure unhindered access to the unit.



Ear muffs should be worn as the sound level is high. Care should also be taken when approaching the hot housings.

- The exhaust gas turbocharger is mounted on the engine. It may not be interfered with when the engine is running.
- Make sure the exhaust gas pipes at the turbine side cannot come loose during operation since exhaust gas might escape at this point.
- As the exhaust gas turbocharger is an integral part of the engine, its operation is described in connection with the engine. However, its maintenance is described separately in the operating instructions.

3.2 Operators and maintenance personnel

Operators and maintenance personnel are persons who are responsible for transport, assembly, installation, operation, setting, maintenance, cleaning and troubleshooting.



Make sure to observe the following accident prevention regulations:

- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a)

If these regulations are not observed, your life and limb may be endangered!

1. The turbocharger may only be maintained by duly qualified and authorised persons.
2. In maintaining the turbocharger, the responsibilities shall be clearly defined and must be adhered to so as to prevent confusing competences with respect to the safety aspect.
3. The operating instructions shall be followed irrespective of what kind of work (operation, maintenance, repair etc.) is concerned.
4. The cleaning, maintenance and repair work described in these instructions are easy to understand by persons skilled in mechanical, cleaning and maintenance work.
The necessary tools and testing/inspection means must be available to these persons.
5. Operators are not allowed to interfere with the unit in a way that would affect machine safety.
6. It is also within the responsibility of the operator to see to it that no unauthorized person works on the turbocharger.

7. The operator must inform the user without delay of any safety-affecting changes to the turbocharger.
8. In order to ensure a long service life, the exhaust gas turbocharger has to be operated in accordance with the technical specification.

3.3 Installation of spare and wear parts

It is emphasised that spare parts and accessories not supplied by us are not tested/inspected and approved by us. The installation and use of such products may negatively affect the performance of your turbocharger. We assume no liability for damage caused by the use of components and accessories not made by us.

For ordering spare parts and tools, please refer to the

- spare parts list
- tools list.

The spare parts lists attached (see chapter 8.2) contain all spare parts for the turbocharger.

DIN (standard) parts may be bought from specialised dealers.

For the assembly, disassembly and commissioning of the turbocharger, refer to the respective chapters in these operating instructions.



Before doing any maintenance, cleaning or repair work, the engine must have come to a standstill. Therefore turn the engine off and secure it against unintentional re-starting.

See chapters 7.5.1 and 7.5.2 for maintenance jobs which can be done during engine operation.

Make sure to observe the following accident prevention regulations:

- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a).

If these regulations are not observed, your life and limb may be endangered!



See the inspection schedule (see chapter 6.4) for the maintenance intervals.

4 DESIGN

4.1 Brief description

Exhaust gas turbocharger (TC):	Type HPR5000
Specification number:	458xxxx
Mass :	354 kg

4.2 Construction

The exhaust gas turbocharger (TC) HPR5000 is equipped with a single-stage radial flow turbine and a single-stage radial flow compressor.

The turbine wheel and the shaft consist of one part, the compressor impeller is mounted on the shaft. The rotor has a bearing consisting of two plain bearings in a bearing housing. The compressor housing and the turbine housing are flanged to the bearing housing. You can use a silencer or alternatively an intake housing (intake elbow) at the entrance of the compressor housing.

The plain bearings are lubricated by the lubricating oil system of the engine. The lubricating oil flow depends on the oil temperature, oil pressure and TC speed.

4.3 Function

The rotor is driven by the exhaust-gas energy of the diesel engine. The exhaust gases reach the turbine wheel via the turbine housing and the turbine nozzle ring.

The compressor impeller mounted on the same shaft takes in the required combustion air via a silencer, compresses the air to a higher pressure and transports the compressed air to the engine via a charge air cooler.

The TC is not equipped with a special control device. The TC speed is adjusted depending on the operating conditions of the engine.

4.4 Usage to the intended purpose

The exhaust gas turbocharger is intended for supercharging combustion engines. Any other usage is not permitted and has to be cleared up with Kompressorenbau Bannewitz GmbH (KBB) in advance.

Modifications and additional attachments to the TC are subject to a written consent of Kompressorenbau Bannewitz GmbH, non-observance of the aforementioned invalidates any rights of warranty claim.

The usage to the intended purpose also includes that the specified maintenance and inspection work is carried out regularly and to the full extent (see Chapter 6.4).

The TC specification attached to the engine is thermodynamically adjusted and is binding for this engine variant, i.e. if the TC has to be replaced, use the same TC specification again.

5 OPERATION

5.1 Commissioning

Prior to commissioning, it is imperative to make sure that the plain bearings of the TC are supplied with oil. The plain bearings are lubricated by the lubricating oil system of the engine. The lubricating oil flow depends on the oil temperature, oil pressure and TC speed.

The lubricating oil pressures required for special operating conditions are listed in chapter 1.1.

Ensure and check the free return flow of the lubricating oil.

The following has to be checked :

- lubricating oil pressure upstream of TC,
- lubricating oil temperature upstream of TC.



- Ensure the lubricating oil supply of the plain bearings (see chapter 1.1).
- Lubrication has to be started prior to start-up processes.
- Pay special attention to prevent leakages in the oil supply and return pipes to prevent oil from flowing onto the hot, gas-carrying housings in order to prevent the formation of hazardous oil vapours (and fire risk).

5.2 Starting-up

The exhaust gas turbocharger is driven by the exhaust gases of the engine and is started together with the engine.

The TC speed is adjusted depending on the operating conditions of the engine. The charge air pressure required for the engine is fixed by adjusting the turbine nozzle ring and the compressor diffuser during the TC tuning.

If the corresponding meters are available, enter the following measured values into the engine log during engine operation (at least once every 24 operating hours):

- Speed of exhaust gas turbocharger
- Exhaust gas temperature upstream of turbine or downstream of cylinder
- Charge air temperature downstream of compressor or downstream of charge air cooler
- Charge air pressure downstream of compressor
- Lubricating oil temperature upstream of TC
- Lubricating oil pressure upstream of TC



- The engine has to be stopped immediately when the oil pressure falls below the minimum value.
- Pay special attention to prevent leakages in the oil supply and return pipes to prevent oil from flowing onto the hot, gas-carrying housings in order to prevent the formation of hazardous oil vapours (and fire risk).

Additionally perform the following checks at regular intervals :

- Tightness of the exhaust gas, charge air and oil piping
- Smooth running of the exhaust gas turbocharger

The charge air pressure is utilised as a parameter for the exhaust gas turbocharger speed.

Unsteady operation (vibration of TC) indicates an increased unbalance of rotating parts possibly resulting in the rotor or bearing being damaged (see chapter 0).

5.3 Stopping

After the engine has been stopped, the exhaust gas turbocharger continues to run for some time.

The run out period depends on the installation.

If the rotor comes to an immediate standstill, this can be caused by one of the following reasons:

- damaged bearings
- compressor impeller or turbine blades come in contact with the housing as the clearance is compensated due to extensive forces caused by thermal distortion
- clamped foreign matters



The turbocharger is relubricating after turning the engine at least 15 min off.

5.4 Failures

Failures can be detected by abnormal measured values (exhaust gas temperature, charge air pressure, speed), heavy noise or leakages of lubricating oil pipes.

In case of irregularities on the TC, reduce the engine load or stop the engine.

Since even minor failures may cause heavy consequential damage, determine and immediately eliminate the cause of failure (see chapter 6.5)

5.5 Emergency operation of the exhaust gas turbocharger

If the exhaust gas turbocharger has to be shut down due to a defect and the engine has to run in emergency operating mode, perform the work according to chapter 7.5.3.



After shutting down the exhaust gas turbocharger, limit the engine output in order to prevent the exhaust gas temperature from exceeding admissible values downstream of the outlet valves.

Pay attention to the operating instructions of the engine manufacturer.

5.6 Measures for extended period without operation

When shutting down an exhaust gas turbocharger, which was operated with an engine before, for more than twelve month, it has to be dismantled from the engine.

An inspection should be carried out in accordance with the maintenance schedule in chapter 6.4.

It is necessary to completely dismantle the exhaust gas turbocharger. All components are to be cleaned and slightly rubbed with oil. Then the exhaust gas turbocharger can be reassembled. All machined surfaces and flanges are to be evenly coated with an anticorrosive agent (such as Tectyl). All openings should be sealed. Additionally, a hygroscopic drying agent can be put into the interior spaces of the compressor housing and the turbine inlet.

The preserved exhaust gas turbochargers and spare parts should be kept in a dry room (humidity of 60 % max.) and protected from moisture, aggressive gases and vapours. At rest, the exhaust gas turbocharger should be protected against steady vibration which may damage the bearings.

The state of the preserved parts and exhaust gas turbochargers should be checked every twelve months.

Before re-operating the exhaust gas turbocharger, it is necessary to clean off the anticorrosive agent.

6 MAINTENANCE

6.1 General

Maintenance and monitoring work is summarised in the maintenance schedule in chapter 6.4.

Proper maintenance work enables failures to be detected in time. Maintenance work also indicates necessary overhauls as well as work to be scheduled during yard or harbour times or on interruptions.

The operating hours specified in the maintenance schedule are to be considered as average values. They can be extended or shortened according to existing operating conditions as well as adjusted to the maintenance intervals of the engine.

It is important to eliminate even minor, apparently insignificant defects immediately and to determine and eliminate their causes in order to prevent consequential damage at the engine or exhaust gas turbocharger.

If the engine is not equipped with an automatic monitoring system with data recording, entries into the engine log are required at least once every 24 operating hours. Thereby, deviations can be detected in time.

6.2 Maintenance work

In order to keep the exhaust gas turbocharger in a safe condition, perform the inspection and check of various subassemblies and components according to the maintenance schedule in chapter 6.4.

The chapter 7.5 includes detailed instructions on the work sequence for assembly and disassembly work.



Make sure to observe the following accident prevention regulations:

- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a)

If bolts and nuts cannot be loosened immediately, do not apply excessive force in order to avoid damage of threads causing subsequent machining. Apply diesel fuel and wait for half an hour. In this way, "seizing" of threads can be avoided in most cases.

For bolted connections under heavy thermal load, bolts and nuts are made of high-temperature material. Make sure that you do not confuse these bolts and nuts with conventional ones during assembly work. In order to prevent burning and to facilitate subsequent disassembly, apply a suitable bolt paste (e.g. molybdenum sulphide paste, graphite) to those bolted connections prior to assembly. Contaminations have to be previously removed from the threads.

During assembly, all bolted connections equipped with locking elements (lock nut, locking plate, spring washer) have to be properly locked.



For a basic overhaul or repairs affecting essential parts of the exhaust gas turbocharger, it is recommended to document their condition. The "Test results" form can be used as a sample (see chapter 7.3).

6.3 Cleaning

Cleaning the silencer

- see chapter 7.5.8

Cleaning the compressor

- Cleaning during operation: see chapter 7.5.1
- Mechanical cleaning: see chapters 7.5.7 and 7.5.8

Remove the compressor housing and silencer. (The compressor impeller remains on the shaft.) Remove all deposits with diesel fuel or another admissible liquid cleansing agent.



Make sure to observe the accident prevention regulations!

While washing, make sure to prevent the cleansing agent from entering the charge air piping or the interior of the turbocharger.

Cleaning the turbine

- Cleaning during operation: see chapter 7.5.2 (for heavy fuel oil operation only)

6.4 Maintenance schedule

6.4.1 Maintenance for operation with Marine Diesel Oil (MDO)



The operating hours given in the table are guidelines which can be reduced for adjustment to the maintenance intervals of the engine.

Item	Chapter	Maintenance work	Required parts	Maintenance interval (operating hours)
1.		Check for abnormal noise		24
2.	7.5.1	Compressor washing during operation, actuate compressor washing system		24 - 48
3.	7.5.8	Clean air filter at silencer		approx. 250 or on demand
4.		Check fastening bolts at the feet, tighten all housing bolts and piping joints		once after commissioning, then every 1,000 hours
5.	7.5.4 - 7.5.12	Inspection I • disassembly • cleaning • checking of rotor & bearings • checking of housings • assembly	(9910) (9920) (9930) (9931)	max. 12,500
6.	7.5.4 - 7.5.12	Inspection II • like inspection I • replacement of the bearings	(4000) (9910) (9920) (9930) (9931)	max. 25,000
7.	7.5.4 - 7.5.12	Inspection III • like inspection I • replacement of the rotor	(2000) (4000) (9910) (9920) (9930) (9931)	max. 50,000

(2000) Rotor
(4000) Bearings (4010) and (4020)

(9910) Set "Gaskets"
(9920) Set "Connecting elements 1"
(9930) Set "Connecting elements 2"
(9931) Set "Connecting elements 2.1"

6.4.2 Maintenance for operation with Heavy Fuel Oil (HFO)



The operating hours given in the table are guidelines which can be reduced for adjustment to the maintenance intervals of the engine.

Item	Chapter	Maintenance work	Required parts	Maintenance interval (operating hours)
1.		Check for abnormal noise		24
2.	7.5.1	Compressor washing during operation, actuate compressor washing system		24 - 48
3.	7.5.2	Turbine washing during operation, actuate turbine washing system Cleaning with water		Approx. 300 depending on HFO quality
4.	7.5.8	Clean air filter at silencer		Approx. 250 or on demand
5.		Check fastening bolts at the feet, tighten all housing bolts and piping joints		once after commissioning, then every 1,000 hours
6.	7.5.4 - 7.5.12	Inspection I • disassembly • cleaning • checking rotor and bearings • checking housing • assembly	(9910) (9920) (9930) (9931)	max. 12,500
7.	7.5.4 - 7.5.12	Inspection II • like inspection I • replacement of bearings	(4000) (9910) (9920) (9930) (9931)	max. 25,000
8.	7.5.4 - 7.5.12	Inspection III • like inspection I • replacement of the rotor • assembly	(2000) (4000) (9910) (9920) (9930) (9931)	max. 50,000

(2000) Rotor

(4000) Bearings (4010) and (4020)

(9910) Set "Gaskets"

(9920) Set "Connecting elements 1"

(9930) Set "Connecting elements 2"

(9931) Set "Connecting elements 2.1"



The nozzle ring is subject to an increased wear for heavy fuel oil operation. Therefore it is a wear part.

The lifetime of the nozzle ring is approximately 12,000 hours, but it depends on HFO quality and operating conditions.

After exceeding the lifetime the nozzle ring should be replaced in case of fundamental change of performance data as charge air pressure and exhaust temperature.

6.5 Trouble-shooting table

Causes	Chapter	Fault									
		Temp. upstream of turbine above adm. max. value	Charge air pressure and/or speed too low	Charge air pressure and/or speed too high	Heavy noise	Delayed start, short coasting	Lubricating oil leakage	Lubricating oil pressure too low	Turbocharger pumps	Turbocharger vibrates	
Silencer or air filter contaminated	7.5.8										
Compressor contaminated	7.5.8										
Charge air cooler contaminated	Engine										
Leaking exhaust gas piping	Engine										
Exhaust gas counter pressure too high downstream of turbine	Engine										
Turbine wheel or compressor impeller damaged (unbalanced)	7.5.10 - 7.5.12										
Defective bearing	7.5.4										
Rotor in contact with housing	7.5.11										
Foreign matter in turbine or compressor (unbalanced)	7.5.8, 7.5.10										
Turbine contaminated	7.5.2										
Turbine nozzle ring contaminated	7.5.2										
Failure of fuel injection at engine	Engine										
Leaking charge air piping	Engine										
High air intake temperature	Engine										
Inlet or outlet valves of the engine contaminated	Engine										
Low air intake temperature	Engine										
Lubricating oil filter contaminated	Engine										
Lubricating oil pressure gauge defective	Engine										
Lubricating oil inlet temperature too high	Engine										
Excessive pressure in oil return	Engine										
Sealing air ineffective											
Gaskets damaged, connections leaking											
Plain compression rings damaged	7.5.11										

7 DISASSEMBLY AND ASSEMBLY

7.1 Introduction

The chapter 7.5 shall enable the user to perform certain repair and maintenance work by himself.

Work sheets are sorted according to the sequence required to disassemble the exhaust gas turbocharger.

It is assumed that the staff is familiar with the work and that the tools required are ready at hand. Furthermore, the exhaust gas turbocharger has to be accessible and corresponding hoists have to be available.



Make sure to observe the following accident prevention regulations:

- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a)

7.2 Checking the components

The check list shown below can be used as instruction for checking the condition of the exhaust gas turbocharger and its major components. As a rule, the user is able to eliminate minor damage. Major damage effecting rigidity, balance and smooth running of rotating components should be eliminated by the manufacturer or an authorized workshop. If damaged parts are returned for repair, ensure an appropriate protection against transportation damage.

After having disassembled the exhaust gas turbocharger, perform the following checks at the cleaned parts. The condition is to be recorded in the "Test results" form, chapter 7.3.

- Rotor, compl.
- Are the turbine blades damaged or did they contact the housing?
 - Are contact traces visible at the housing?
 - Are contact traces visible at the rotor?
 - Does the shaft run smoothly?
 - How is the condition of the bearings?
 - Are the plain compression rings heavily worn?



If re-working is performed or if rotor parts are replaced, rebalancing has to be executed! For admissible residual unbalance, refer to clearance sheet, chapter 7.4)



Wear occurs at the plain compression rings at the turbine and compressor sides in axial direction during running-in, which is intended and could be max. 0.5 mm.

Compressor impeller

- Can you detect any sliding traces or cracks at the compressor impeller?
- Are the bore and the axial surface OK?

- Bearing
- Is the axial clearance of the rotor impeller inadmissible high?
 - Are the running surfaces of the compressor and/or turbine bearings heavily worn?



For evaluation of bearings, refer to chapter 7.5.4 .

Turbine nozzle ring

- Are the guide vanes twisted or worn out?
- Is foreign matter clamped into the ducts?
- Can you detect traces of foreign matter?

Housing

- Are the housings heavily contaminated by oil, dust or soot?
- Is there any leakage at the housing? (Main items: connection flanges, charge air, exhaust gas and oil connections)
- Are all bolts and nuts tight?



7.3 Test results

Exhaust gas turbocharger: Serial No. :
 Specification No. :
 Type of engine : Engine No. :
 Customer name :
 Address :
 (Location, ship's name)
 Latest inspection/overhaul on : by :
 Inspected/overhauled on : by :
 Number of operating hours - since commissioning:
 - since latest inspection/overhaul:

Results of the inspection of components

Rotor/ Shaft

Turbine blades no
 damaged yes
 blade parts missing
 traces of foreign matter

Contamination / deposit no
 on rotor blades slight Plain compression no
 heavy ring damaged yes
 unilateral
 uniform Radial deviation of rotor
 (acc. to Clearance sheet)

mm

Blades tarnished no Blade cracks no
 yes yes
 Location :

Gap: turbine wheel/housing Gap: compressor impeller/housing
 (acc. to clear. sheet) Clear.S12 :mm (acc. to clear. sheet)
 Clear.S1 :mm
 Clear.S14 :mm Clear.S2 :mm

Sliding traces no Rotor rebalanced no
 at shaft yes yes

Bearing seats no Condition prior to good
 damaged yes rebalancing poor

Compressor impeller

Sliding traces no Blade cracks no
 yes yes
 Location:

Contamination clean Quality of good
 contaminated bore average
 oily poor

Turbine nozzle ring

- | | | |
|-------------|-------------------------------|--|
| Guide vanes | <input type="radio"/> good | <input type="radio"/> Part torn out |
| | <input type="radio"/> twisted | <input type="radio"/> Traces of foreign matter |
| | <input type="radio"/> scaled | <input type="radio"/> worn out |

Bearing housing

- | | | |
|--------------------------------|-------------------|--------------------------------|
| <input type="radio"/> clean | Sealing air bores | <input type="radio"/> clean |
| <input type="radio"/> coked | | <input type="radio"/> narrowed |
| <input type="radio"/> corroded | | <input type="radio"/> clogged |

Compressor diffuser

- | | | | |
|---------------|------------------------------|------------------|---------------------------|
| Guide vanes | <input type="radio"/> little | Damage | <input type="radio"/> no |
| contamination | <input type="radio"/> heavy | | <input type="radio"/> yes |
| | | Location : | |

Compressor bearing

- | | | | |
|---|--------------------------------|---|---------------------------|
| | <input type="radio"/> used | Reason | |
| | <input type="radio"/> replaced | | |
| Load-carrying surface of radial bearing | | Load-carrying surface of thrust bearing | |
| B(rad) : | mm | B(ax) : | mm |
| Marks | <input type="radio"/> no | Marks | <input type="radio"/> no |
| | <input type="radio"/> yes | | <input type="radio"/> yes |
| Location: | Depth : | Location: | Depth: |
| | mm | | mm |

Turbine bearing

- | | | | |
|-------|--------------------------------|-----------------------|--------------|
| | <input type="radio"/> used | Load-carrying surface | |
| | <input type="radio"/> replaced | B(rad) : | mm |
| | Reason..... | | |
| Marks | <input type="radio"/> no | Location: | Depth: |
| | <input type="radio"/> yes | | mm |

Silencer

- | | | | |
|---------------|----------------------------|-------------------------|----------------------------|
| Contamination | <input type="radio"/> oil | Condition of felt layer | <input type="radio"/> good |
| | <input type="radio"/> dust | | <input type="radio"/> poor |
| | <input type="radio"/> soot | | |
| Filter mat | <input type="radio"/> yes | | |
| cleaned | <input type="radio"/> no | | |

Other defects/ component/ type :

7.4 Clearance sheet

		V a l u e s (in mm)		
		New condition		Limit clear. max *)
Clear.	Parts designation	min	max	
1	Compressor impeller - compressor housing (radial)	0.55	0.65	0.8
2	Compressor impeller - compressor housing (axial)	0.6	0.7	1.0
5	Tilting clearance (rotor – bearing) (measured at location E)	0,4	0.6	
12	Turbine wheel - turbine housing (radial)	0.55	0.65	0.9
13	Turbine wheel - heat shield	0.8	1.2	1.4
14	Turbine wheel - turbine housing (axial)	0.4	0.7	1.0
15	Rotor - compressor bearing (axial)	0.12	0.2	-
18	Compression ring - turbine bearing cover	0.2	0.5	-
19	Compression ring - compressor bearing cover	0.1	0.3	-

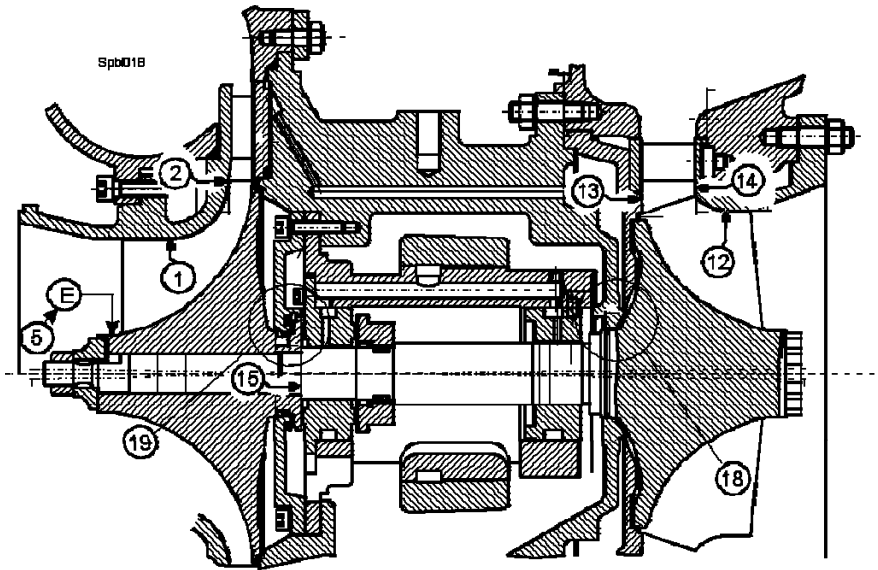
*) re-working or replacement required if exceeded

**) measured at location E

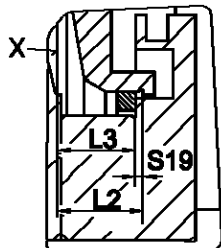
Admissible unbalance of rotor: 13.25 gmm bearing compressor and 13 gmm bearing turbine

Admissible radial deviation of rotor: 0.010 mm (location E)

Tightening torque of rotor nut: 105 (+ 5) Nm



Clear. 19 (S19 = L2 - L3)



X – reference edge bearing housing

Clear. 18



a) compressor bearing fixed

b) compressor bearing loosened

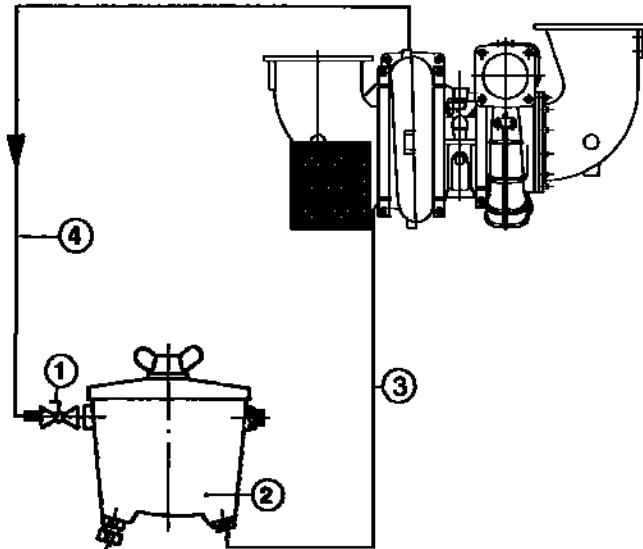
7.5 Work sheets

7.5.1 Compressor washing

(Every 25 - 50 operating hours)

Legend

- 1 Ball valve
- 2 Water tank
- 3 Water piping
- 4 Air piping



Work sequence:

1. Operate the engine close to full load.
2. Open the water tank (2), fill with clean water (no sea water) (approx. 0,5 l), close the water tank.
3. Open the ball valve (1), wait for approx. 20 sec., close valve (1). The compressed air flows through the air piping via the ball valve (1) into the water tank. The water is pressed through the water piping into the injection pipe, atomised by the air taken in and hits the compressor blades at high speed.



- Perform cleaning with warm engine close to full load operation only.
- Continue to operate the engine for at least 10 to 15 min. after cleaning.
- Do not wash before a pause of operation. Corrosion risk!
- Washing is ineffective in case of hardened deposits, thus perform washing at regular intervals.
- Do not use any chemical additives!



If the negative pressure upstream of the compressor is too high, water is already taken in when the water is filled into the water tank and the cleaning effect is reduced. In order to avoid this, you can:

- install the water tank at a lower level or
- include a second stop valve, which is opened after the water tank has been closed, into the water piping.

7.5.2 Turbine washing

(For heavy fuel oil operation only, every 300 operating hours respective depending on HFO quality)

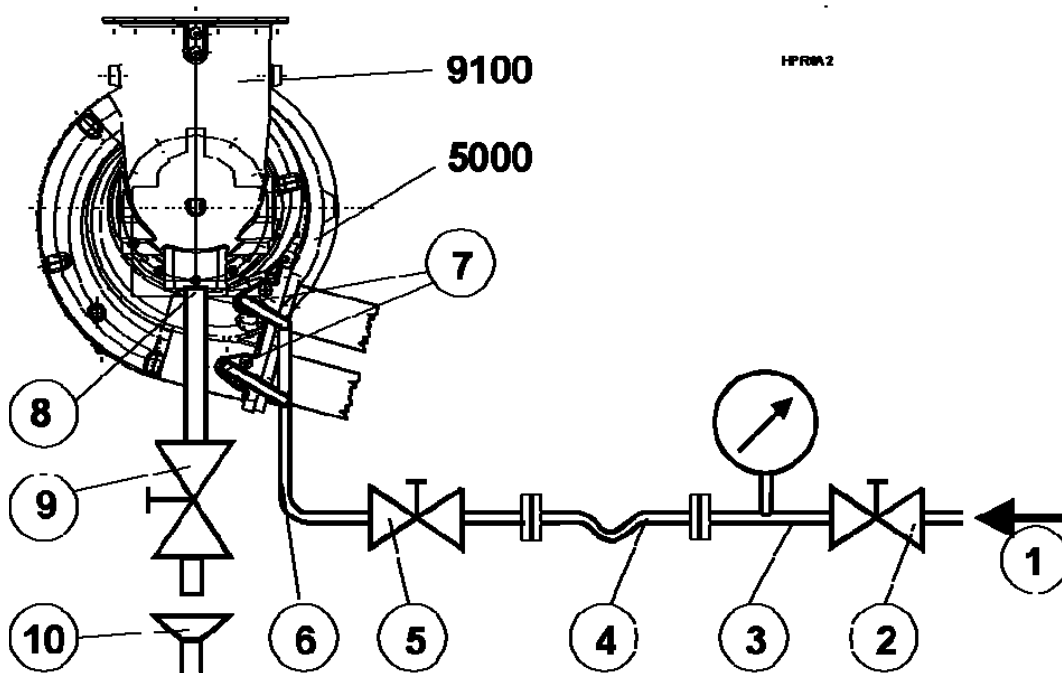


Heavy fuel oil operation results in contamination and deposits on nozzle ring and turbine wheel reducing the efficiency. Due to these deposits the charge air pressure will be increased.

The washing intervals depend on the fuel quality and operating conditions. That's why they must be adjusted based on the experience gained during engine operation if necessary later on. The washing interval could be adjusted from 50 to 600 hours.

The increase of charge air pressure could be used for adjusting the washing interval, which could be adjusted within 50 to 600 hours.

Read and take down the charge air pressure and exhaust gas temperatures at a reference point (at 75 % or 100 % of the output) before and after washing to check the washing effect.



Legend (Example, could vary depending on engine installation)

1 Sanitary fresh water	6 Wash-water piping	10 Escape funnel or sight glass (optional)
2 Regulating valve	7 Injector	5000 Turbine housing
3 Fresh-water piping	8 Connection for drain (optional)	9100 Exhaust gas elbow
4 Removable flexible tube	9 Valve (optional)	
5 Stop valve		

Work sequence:

1. Connect the flexible tube (4) to fresh-water piping (3).
2. Reduce the engine output to approx. 15 % of its rating until the temperature after cylinder has come down to its specified value. (see table)
3. Wait for approx. 10 minutes!
4. Open the valve (9) of the drain (8) (if present).
5. Open valve (2) and adjust the water pressure (see table).

6. Open stop valve (5) for approx. 30 seconds and close again.
7. Wait for approx. 3 minutes so that the injected water can evaporate.
8. Repeat steps 6. and 7. twice or three times.
9. Close the stop valve (5), valve (2) and the valve (9) of the drain.
10. Run dry the exhaust gas turbocharger at constant load for approx. 30 minutes, increase engine load slowly!
11. Repeat the washing process if the exhaust gas turbocharger is affected by vibrations which did not occur before.
12. Remove the flexible tube (4).

Operating values for turbine washing

Engine output	Exhaust gas temperature after cylinder	Exhaust gas temperature before / after the turbine	Water pressure (gauge)	Total washing period
max. 15%	300 – 330 °C	400 – 420 / <330 °C	2.5 – 4.5 bar	3-4x 30 sec



- Hot exhaust gas can escape from the drain - Risk of burning!
- Continue to operate the engine for at least 30 minutes after cleaning.
- Do not wash before a stop of operation. Corrosion risk!
- Washing is ineffective in case of hardened deposits, thus perform washing at regular intervals.
- Pay attention also to instruction of the engine's operating manual!

7.5.3 Shutting down the exhaust gas turbocharger

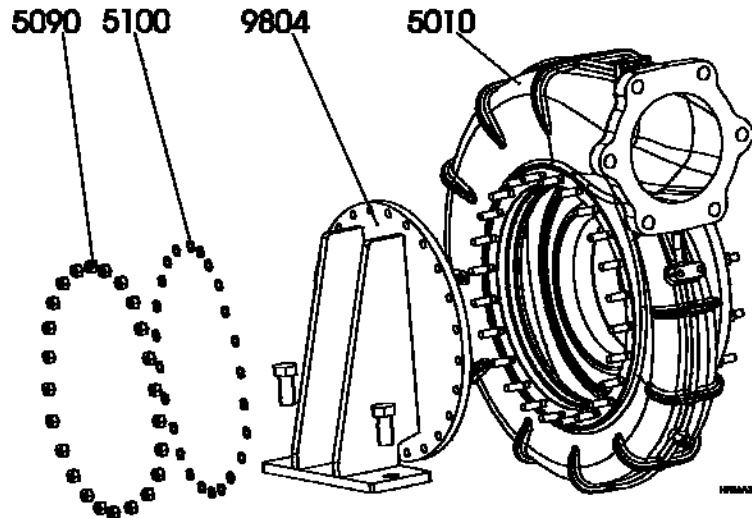


In case of a TC damage especially at the rotor or bearing, it is recommended to shut down the TC in order to avoid any further damage. Pay attention to the operating instructions of the engine manufacturer.



When the engine is operated with a defective exhaust gas turbocharger, limit the engine output in order to prevent the exhaust gas temperature from exceeding admissible values downstream of the cylinder.

Related chapters
7.5.7, 7.5.9, 7.5.10



Initial condition: The turbocharger is mounted on the engine.



Mass of the silencer	approx. 55 kg
Mass of the air intake housing	approx. 18 kg
Mass of the compressor housing	approx. 86 kg
Mass of the cartridge (bearing housing with rotor)	approx. 88 kg

Work sequence:

1. Disassemble the silencer (9010) / air intake housing (9020) (see chapter 7.5.7).
2. Loosen all piping at the compressor housing (6010).
3. Disassemble the compressor housing (6010) (see chapter 7.5.8).
4. Remove the cartridge (1200) (bearing housing with rotor) and turbine nozzle ring (7010) from the turbine housing (5010) (see chapter 7.5.10).



Use a hoist!

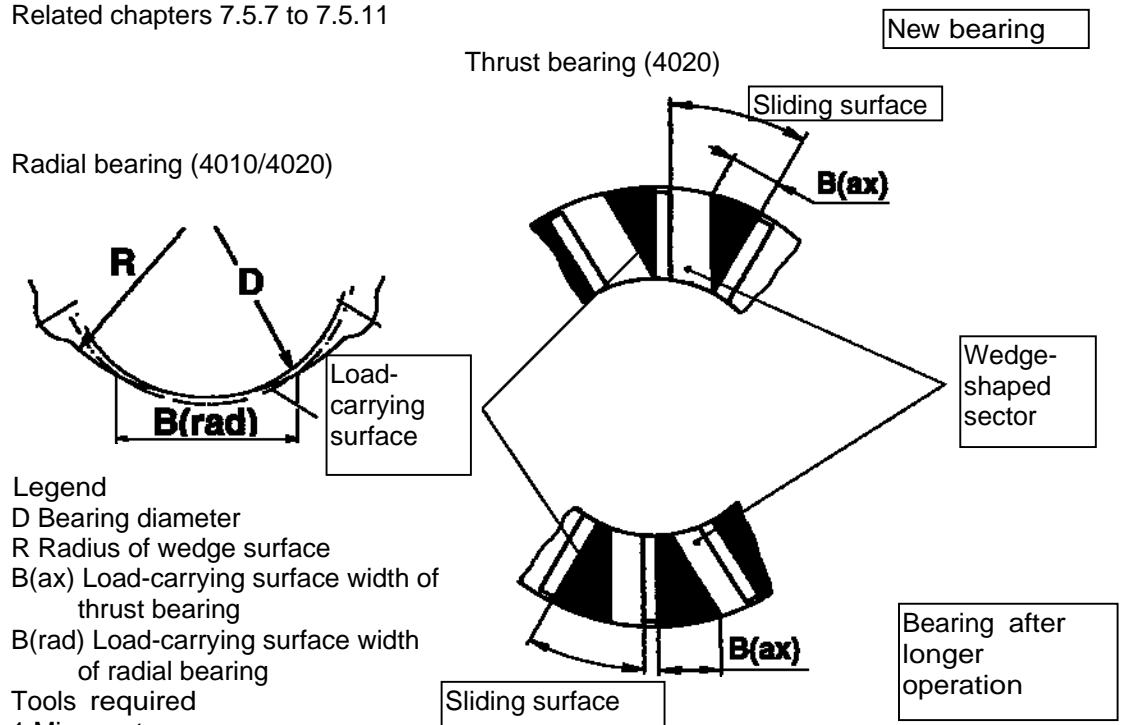


Caution in removing the cartridge in order to avoid damage to the turbine blades.

5. Attach the sealing device (9804) to the turbine housing (5010) and tight with washers (5100) and hexagon nuts (5090).
6. Screw the sealing device (9804) to the engine console.

7.5.4 Bearing check

Related chapters 7.5.7 to 7.5.11



Legend

- D Bearing diameter
- R Radius of wedge surface
- $B(\text{ax})$ Load-carrying surface width of thrust bearing
- $B(\text{rad})$ Load-carrying surface width of radial bearing

Tools required

- 1 Micrometer screw
- 1 Caliper gauge

Initial condition: Compressor bearing (4020) and turbine bearing (4010) are disassembled.

Work sequence 1 : Load-carrying surface of radial bearings

1. Carefully clean the bearing!
2. Determine the width of the load-carrying surface $B(\text{rad})$!
3. Visual inspection!



Replace bearing if :

- the width of the load-carrying surface $B(\text{rad})$ at the compressor and turbine has reached 16 mm,
- heavy dirt marks can be seen.

Determine the causes!

Work sequence 2 : Load-carrying surface of thrust bearings

1. Carefully clean the bearing.
2. Determine the width of the load-carrying surface $B(\text{ax})$.
3. Determine the axial clearance S_{15} .
4. Visual inspection!



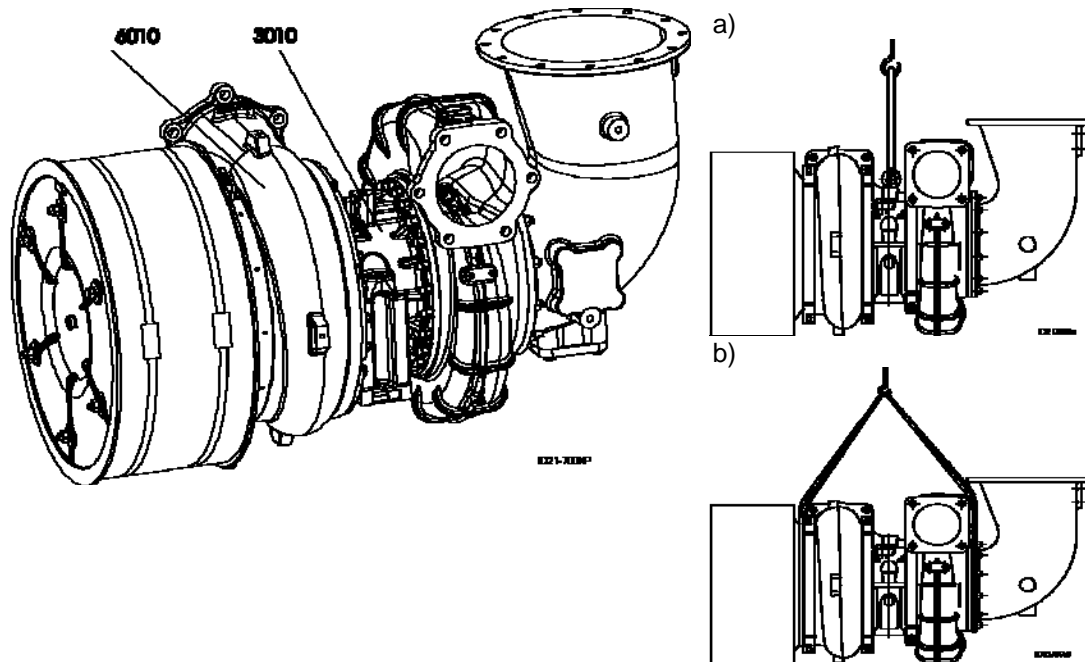
Replace bearings if :

- $B(\text{ax})$ is larger than $2/3$ of the sliding surface,
- the sliding surfaces reveal heavy dirt marks.



If bearing material is deposited on the bearing surfaces of the shaft, a repair is required in an authorized workshop.

7.5.5 Disassembly of the complete turbocharger



Mass of complete TC is approx. 354 kg

Make sure to observe the following accident prevention regulations:

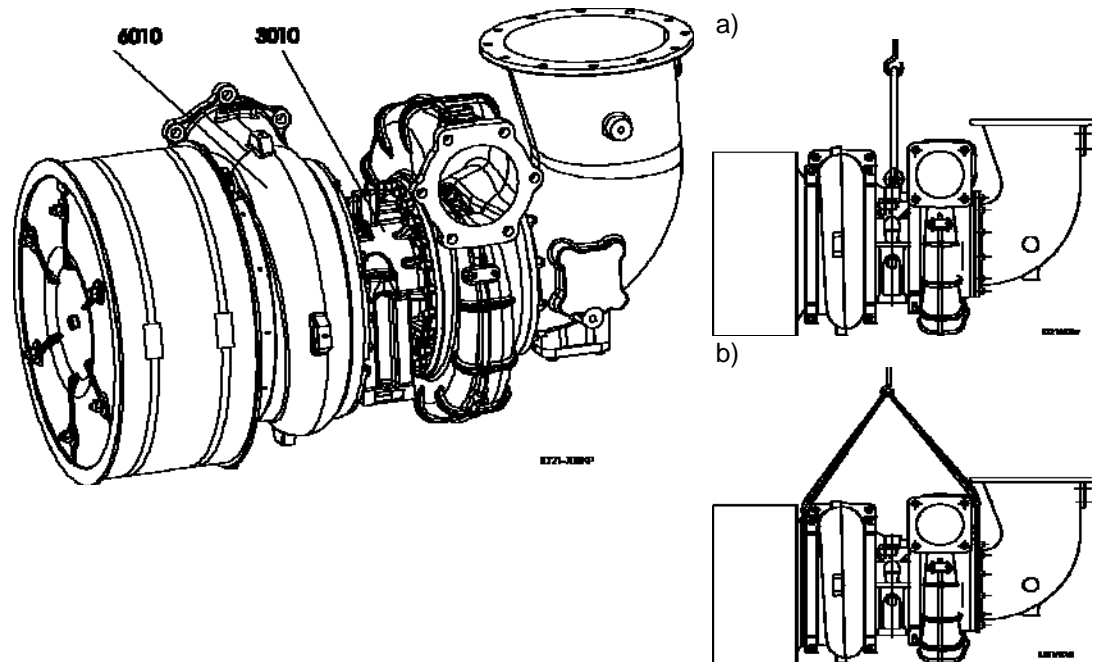
- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a)

Pay attention to piping and sheathings!

Work sequence :

1. Remove the sheathings from the turbine housing and loosen the exhaust gas piping if necessary.
2. Loosen the exhaust gas piping from the turbine housings. Pay attention to gaskets!
3. Loosen the piping at the compressor housing (6010), remove them if necessary.
4. Attach the exhaust gas turbocharger to a hoist. For this purpose
 - a) Screw the eye screw into the bearing housing (3010) or
 - b) Put two ropes around the flange between the silencer and the compressor housing and between the turbine housing and the exhaust-gas elbow.
5. Loosen and remove the fastening screws at the sides of the bearing housing (3010).
6. Lift and carefully place the exhaust-gas turbocharger on a wooden base, secure against tilting.
7. Cover the openings of the lubricating oil pipes in the engine console in order to prevent dirt from entering the lubricating oil system.

7.5.6 Assembly of the complete turbocharger



Mass of complete TC is approx. 354 kg

Make sure to observe the following accident prevention regulations:

- winches, hoisting and drawing gear (VBG 8)
- load take-up devices for hoisting operations (VBG 9a)

Pay attention to piping and sheathings!

Work sequence :

1. Attach the complete TC to a hoist (see chapter 7.5.5) and put it onto the engine console. Pay attention to the pipe connections!
2. Screw in and tighten the fastening screws at the sides of the bearing housing (3010).
3. Connect the exhaust gas piping to the turbine housings.
4. Attach the sheathing.
5. Connect the charge air piping.
6. Connect the water and air piping for compressor washing.
7. Tighten the bolts at the connecting pipes.
8. Supply lubricating oil to TC and check all flanged connections for leakages.

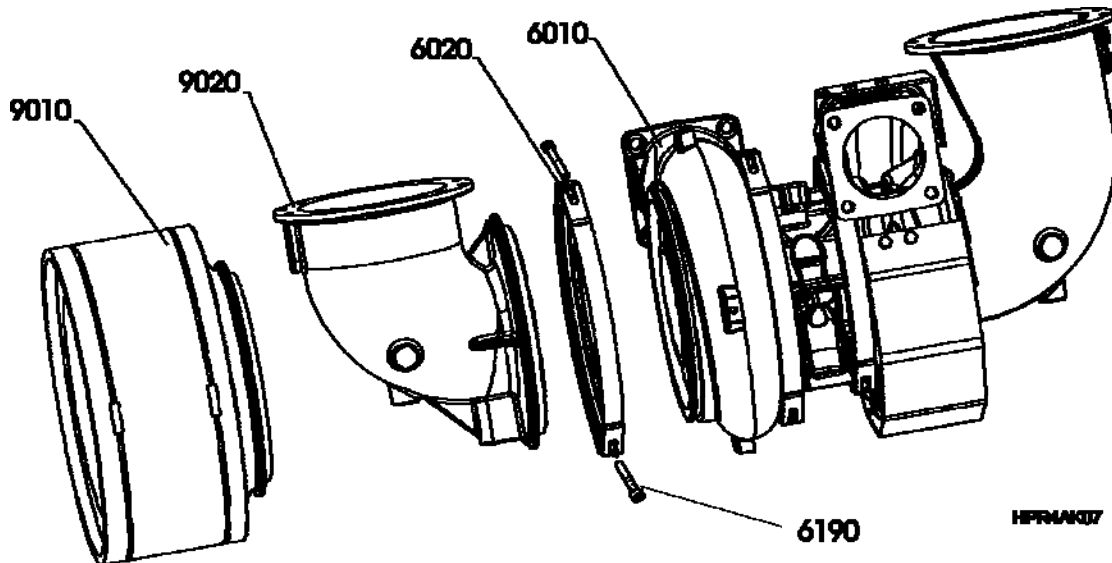


After having installed the TC, check that the assembly is free of stresses and forces. Rework piping, if necessary.



Only use perfect gaskets for the pipe joints. Apply molybdenum sulphide lubricant to the connecting bolts of the exhaust gas piping prior to installation.

7.5.7 Assembly and disassembly of the silencer or air-intake housing



Mass of the silencer approx. 55 kg

Mass of the air-intake housing approx. 18 kg

Tightening moment of V-band 35 Nm !

Work sequence 1 : Disassembly of silencer / air-intake housing

1. Put a rope around the silencer (9010) or intake housing (9020) and attach it to a hoist.
2. Slightly loosen the V-band (6020) at both screws (6190).
3. Remove the V-band (6020) from the flange.
4. Pull off the silencer/air-intake housing in axial direction from the compressor housing (6010).

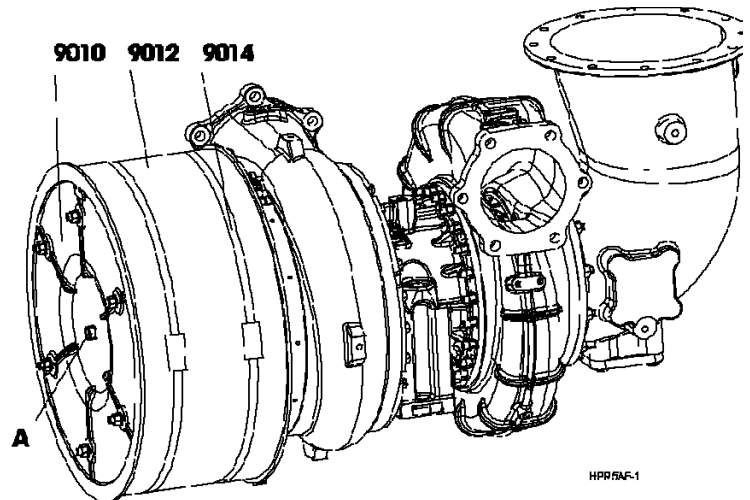
Work sequence 2 : Assembly of silencer / air-intake housing

1. Put a rope around the silencer (9010) or intake housing (9020) and attach it to a hoist.
2. Slide silencer / air-intake housing in axial direction onto the compressor housing (6010).
3. Install the V-band (6020) and tighten at both screws (6190).

7.5.8 Cleaning the silencer

(Every 250 or 12,500 operating hours)

Related chapter 7.5.7



General

In most cases merely the filter mat has to be cleaned. For this purpose the silencer may stay at the exhaust gas turbocharger.

The given maintenance interval of 250 operating hours is just a mean guide value, since the accumulation of dirt in the filter mat and the pressure drop resulting therefrom are largely dependent on the environment. For operation under extreme conditions, it is recommended to add a maintenance indicator (water gauge) signalling the right moment for cleaning.

This indicator shall be adjusted so as to give the cleaning signal when a vacuum of app. 100 mm w.g. is reached at point A intended for mounting (e.g. a MANN maintenance indicator for air filters, max. 200 mm w.g. = 20 mbar).

Work sequence: Cleaning the filter mat

1. Open and remove the tension tapes (9014)
2. Pull the filter mat (9012) from the silencer (9010) .
3. Put the filter mat (9012) into a cleansing liquid for approx. 10 hours. Subsequently rinse in the liquid and externally clean with a soft brush, stub out and let dry the filter mat.
4. Install the filter mat (9012) and tension tapes (9014).

Work sequence: Cleaning the silencer



If the silencer is heavily contaminated or if an inspection is carried out, the silencer has to be cleaned completely..

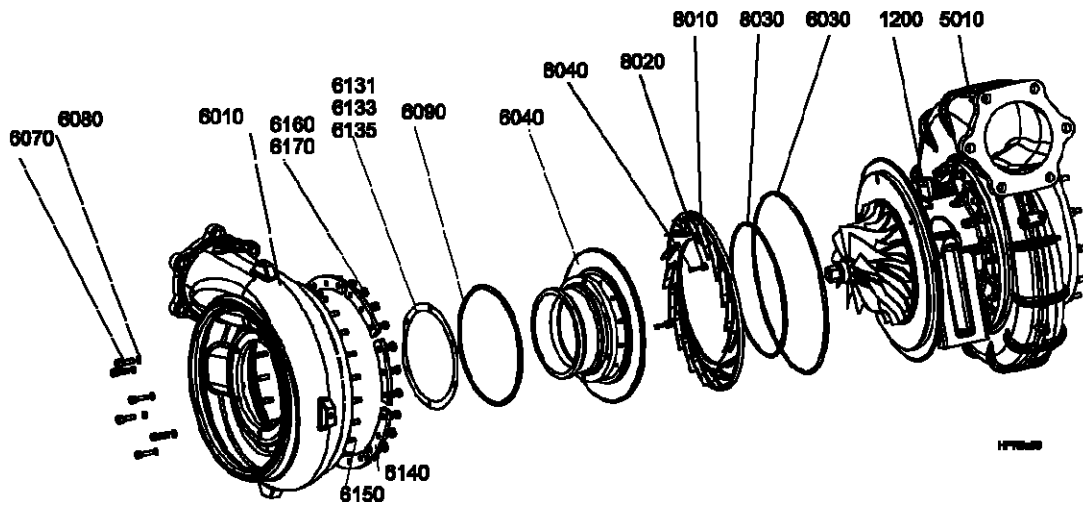
1. Dismount the silencer (9010) (see chapter 7.5.7).
2. Put the silencer for approx. 10 hours into a cleansing liquid. Subsequently, externally clean with a soft brush and let dry.
3. Install the silencer (9010).



To operate the exhaust gas turbocharger without a filter mat is not permitted!

Pay attention to applicable accident prevention regulations (handling of hazardous, volatile, combustible solvents) and fire protection regulations (DIN 14096). Cleaning by P3-solution or trichlorethylene is prohibited. If other solvents are used, check the compatibility with the filter material. In case of ship operation pay attention to the regulations of the classification societies with regard to washing liquids.

7.5.9 Assembly and disassembly of the compressor housing



Mass of cartridge (bearing housing with rotor) approx. 88 kg.
 Mass of compressor housing approx. 86 kg.
 Make sure not to damage the compressor impeller during assembly and disassembly of the compressor housing.

Work sequence 1 : Disassembly of the compressor housing

1. Slightly loosen the hexagon nuts (6160) at the clamping flanges (6140).
2. Turn the compressor housing (6010) until the eye bolt can be attached to the hoist.
3. Completely loosen and remove the clamping flanges (6140).
4. Remove the compressor housing (6010) and put it on a wooden base.
5. Loosen and remove the screws (6070) and washers (6080).
6. Remove the compressor housing (6010) from the insert (6040), pay attention to the shims (6131 – 6135).
7. Loosen and remove the screws (8040) together with stop bushings (8020).
8. Remove the compressor diffuser (8010).
9. Remove O-rings (6030, 6090 and 8030) and check for damage.

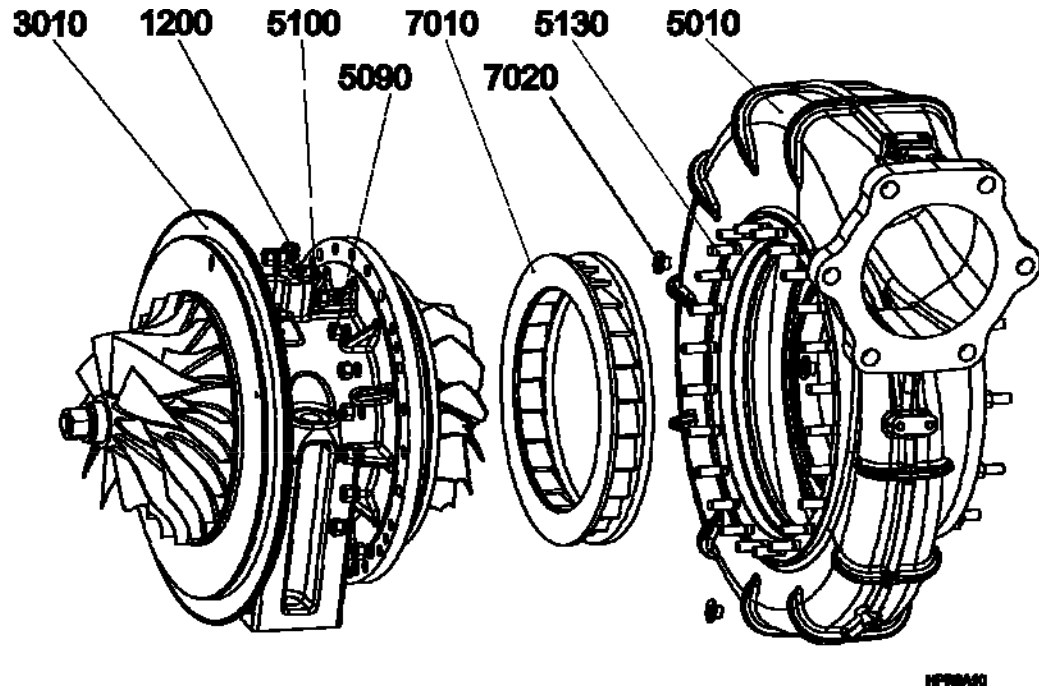
Work sequence 2 : Assembly of the compressor housing

1. Install and, if necessary, replace the O-rings (6030, 6090 and 8030).
2. Lay the insert (6040) with shim (6131 – 6135) according to clearance S2 on a wooden base. And then lay the compressor housing (6010) on the insert (6040).
3. Tighten the insert (6040) with screws (6070) and washers (6080).
4. Slide the compressor diffuser (8010) onto the bearing housing centring (3010) and fasten with the stop bushings (8020) and screws (8040).
5. Attach the compressor housing (6010) to a hoist and slide it onto the bearing housing (3010).
6. Install the clamping flanges (6140) and slightly fasten with washers (6170) and hexagon nuts (6160).
7. Turn the compressor housing (6010) into the required housing position.
8. Tighten the hexagon nuts (6160) at the clamping flanges (6140).



- Mark the position of the compressor housing (6010)!

7.5.10 Assembly and disassembly of the turbine housing



Mass of cartridge (bearing housing and rotor) approx. 88 kg.

Mass of the turbine housing approx. 77 kg.

Caution in assembling and disassembling in order to avoid damage to the turbine blades.

Caution in disassembling the turbine housing in order to prevent the turbine nozzle ring from falling out!

Work sequence 1 : Disassembly of the turbine housing

1. Loosen and remove the hexagon nuts (5090) and washers (5100).
2. Screw eye bolt into the bearing housing (3010) and attach it to a hoist.
3. Loosen and remove both screws on the side of bearing housing (3010).
4. Forcing-off uniformly the bearing housing (3010) with forcing screws. Are the connection with carbon glued, net with diesel fuel and wait a minute.
5. Move careful the bearing housing (3010) out of the turbine housing (5010) in axial direction. Put it on a wooden base.
6. Remove the turbine nozzle ring (7010) from the turbine housing (5010).

Work sequence 2 : Assembly of the turbine housing

1. Clean the connecting flange between the bearing housing and turbine housing from combustion residues using fine abrasive cloth. Subsequently, apply a molybdenum sulphide lubricant to the flange.
2. Insert the turbine nozzle ring (7010) into the turbine housing (5010), pay attention to the position of the locating bolts (7020)!
3. Fasten the bearing housing (3010) by means of a rope at the hoist and move it towards the turbine housing (5010)
4. Carefully slide the bearing housing (3010) into the turbine housing. Screw fast the hexagon nuts (5090) with washers (5100).
5. Tighten the screws for the feet on the engine console.
6. Check the rotor for contact by slightly rotating it.

7.5.11 Disassembly of the rotor, complete

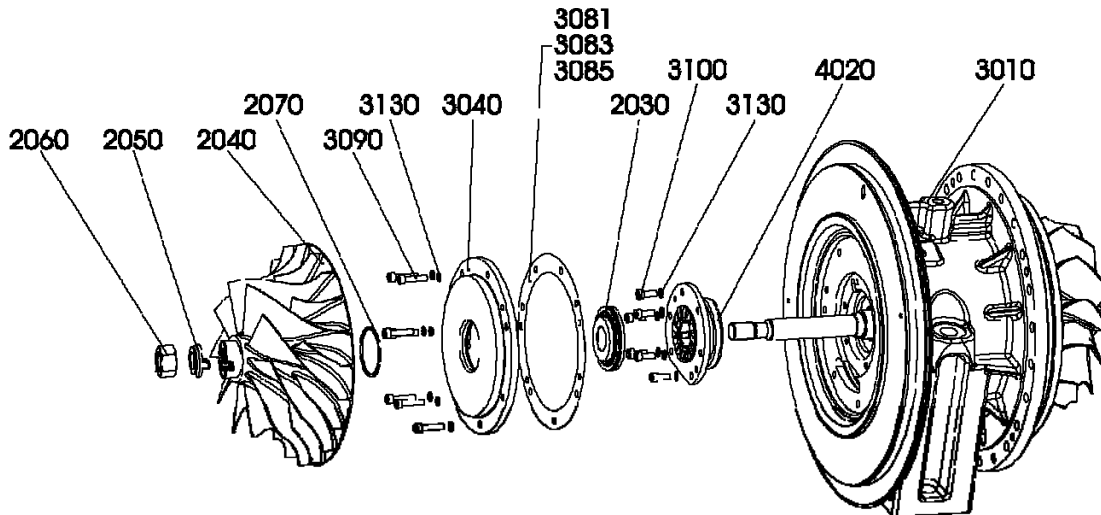


For disassembling the rotor, mount the cartridge on an assembling trestle.



Mass of the cartridge (bearing housing and rotor) approx. 88 kg

Mass of the complete rotor 20 kg



HPR5A12c

Work sequence :

1. Disassemble the speed sensor (9110) - if provided – and remove it.
2. Put the locking device (9801) on the turbine wheel and attach the device to the flange of bearing housing (3010).
3. Loosen the rotor nut (2060) with a torque spanner.
4. Remove the rotor nut (2060) and coupling disk (2050).
5. Carefully remove the compressor impeller (2040) from the shaft (2010).



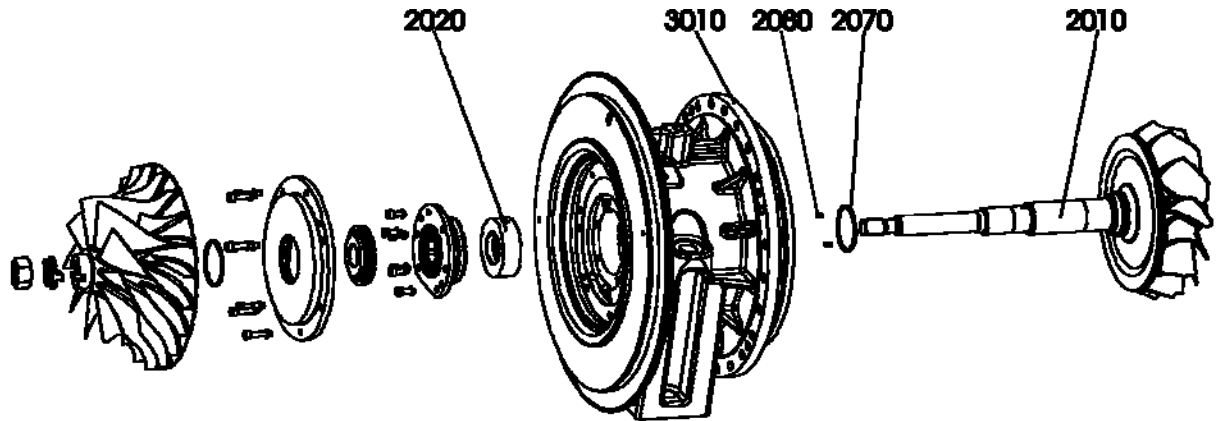
The installation position of the compressor impeller in relation to the shaft is marked or has to be remarked with a scribe.

6. Loosen the screws (3090).
7. Remove the bearing cover of the compressor (3040); if necessary force off the cover with screws (3090). The plain compression ring (2090) is located in the bearing cover.



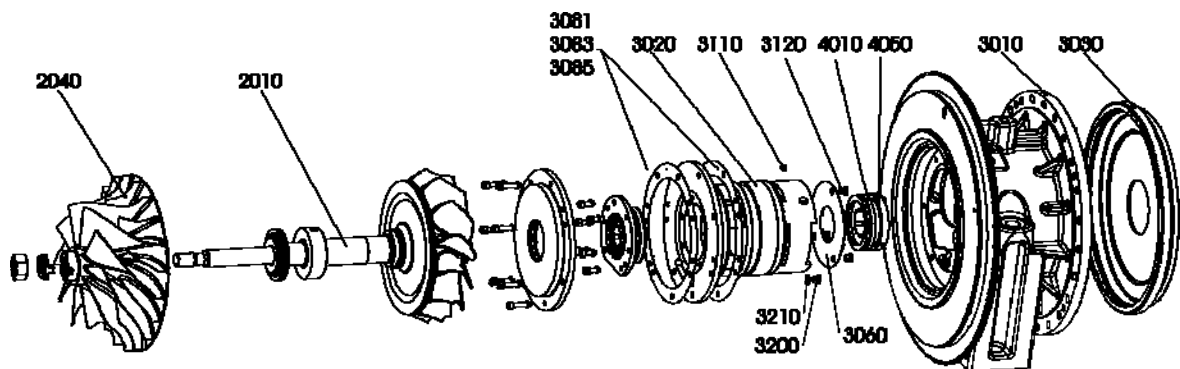
Pay attention to the gaskets (3081/2/5) under the bearing cover (3040)!

8. Remove the spacer (2030) from the shaft.
9. Loosen the screws (3100).
10. Remove the compressor bearing (4020), force off if necessary.



HPR5A12b

11. Put the extractor (9803) on the shaft (2010) and screw it into the threads of the thrust ring (2020).
12. Remove the thrust ring (2020) from the shaft.
13. Carefully pull the shaft (2010) out of the bearing housing (3010).
14. Remove the plain compression ring (2070) from the shaft.
15. Remove the feather key (2080) from the shaft.



HPR5A12c

16. Remove the heat shield (3030).
17. Pull the bearing guide sleeve (3020) out of the bearing housing (3010) by using forcing screws, do not cant.



Pay attention to the gaskets (3081/3/5) under the bearing guide sleeve (3020)!

18. Loosen the screw plugs (3120), remove the separating plate (3060).
19. Loosen the screw plug (3200) with spring washer (3210).
20. Pull the turbine bearing (4010) out of the bearing guide sleeve (3020).



Now the turbocharger is disassembled. Check, evaluate and clean the parts according to chapters 7.2 and 7.3.

7.5.12 Assembly of the rotor, compl.

Related chapters 7.5.5 - 7.5.11

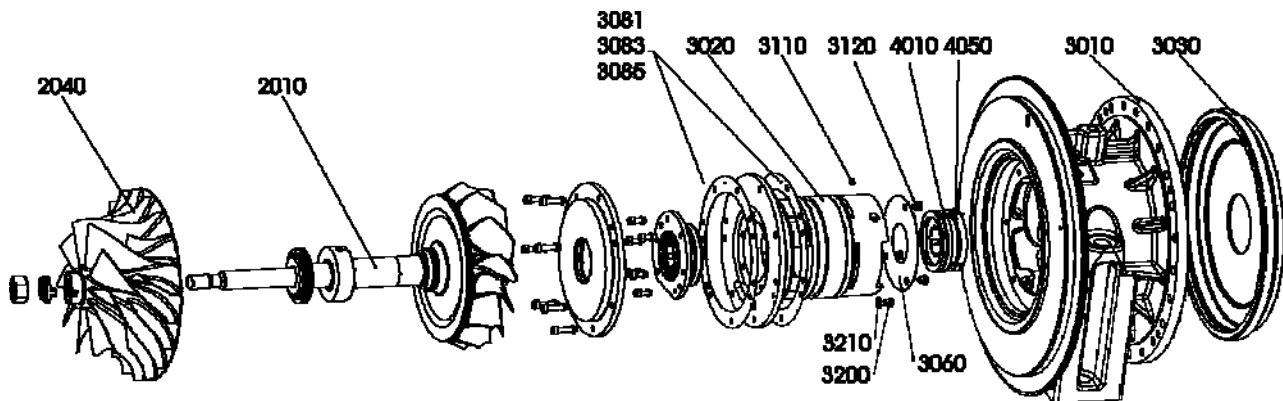


Mass of the cartridge (bearing housing and rotor) approx. 88 kg

Mass of the complete rotor 20 kg



- For assembling the rotor, mount the bearing housing on an assembling trestle.
- Prior to the assembly, check the cleanliness of the bearing housing, oil-conducting ducts and sealing air piping.
- If all components and gaskets are to be reused, it is not necessary to check the clearances, otherwise pay attention to the specification given in the clearance sheet, chapter 7.4.



HPR5A12a

Work sequence :

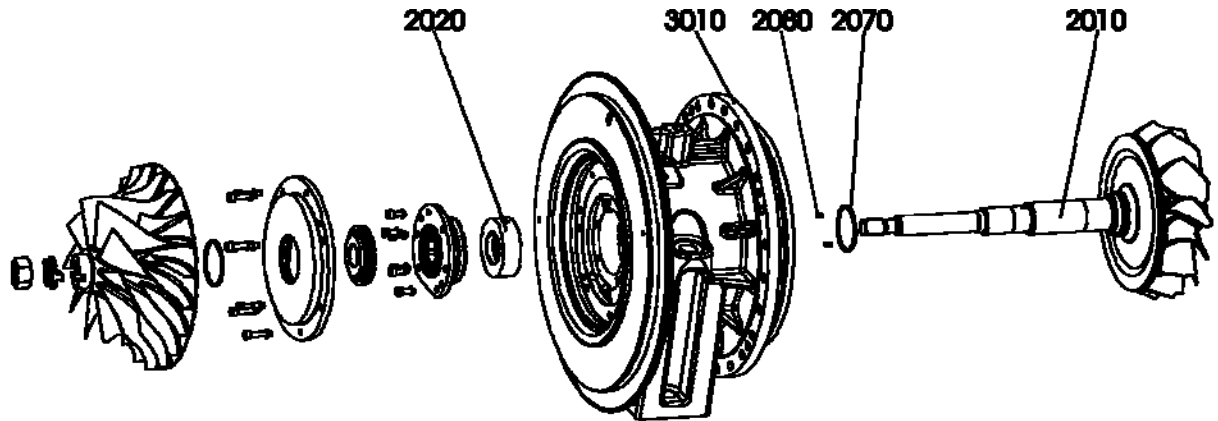
1. Insert the turbine bearing (4010) into the bearing guide sleeve (3020) and tighten with the screw plug (3200) and washer (3210).
2. Check that the thread plug (3110) is screwed into the bearing guide sleeve (3020)!



Always install the turbine bearing (4010) with 3 cylindrical pins (4050) (protection against torsion)!

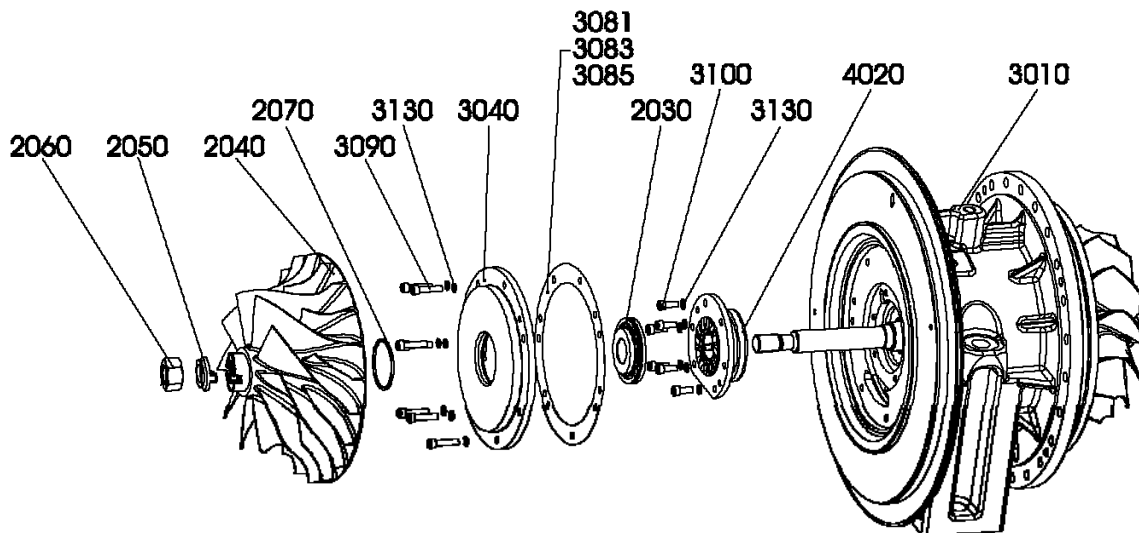
Always insert the thread plug (3110) in the bearing guide sleeve (3020). Do not forget the thread plug when components are replaced!

3. Insert the separating plate (3060), fasten with screw plugs (3120).
4. Insert the bearing guide sleeve (3020) with the original gasket (3081/3082/3085) or a gasket of the same thickness into the bearing housing (3010), do not cant.
5. Fasten the bearing guide sleeve (3020) with two screws.
6. Attach the heat shield (3030) to the centring on the bearing housing.



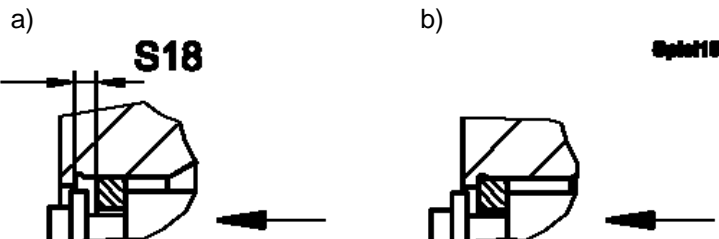
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7. Insert the plain compression ring of the turbine (2070) into the shaft groove.
8. Insert the feather key (2080) into the groove.
9. Use the guide sleeve (9805) to move in the shaft.
10. Apply clean oil to the turbine bearing. Carefully insert the shaft (2010) into the bearing housing (3010).
11. Apply oil to the thrust ring (2020) and put the ring onto the shaft.



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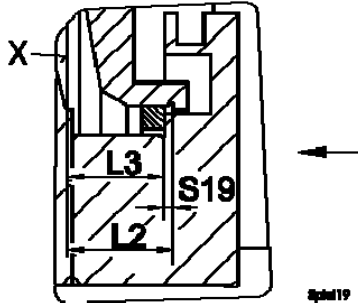
12. Apply oil to the compressor bearing (4020). Put the bearing onto the shaft with its flat flange side pointing downward and fasten with screws (3100) and washers(3130).
13. Check clearance S13 by means of feeler gauge. Press the shaft from the turbine side towards the bearing housing.
14. Check clearance S18: (only if components are replaced)



- a) Fasten the compressor bearing (4020) with the screws (3100). Press the shaft (2010) against the bearing housing. Apply a dial gauge to the shaft end and adjust it to zero.

b) Loosen the screws (3100) and again force-off the compressor bearing (4020) by approx. 1 mm. The shaft is displaced by the clearance S18; correct by changing the thickness of the gasket (3081-3085) under the bearing guide sleeve if necessary.

15. Attach the locking device (9801) for the rotor to the turbine wheel and fasten it to the flange of the bearing housing.
16. Slide the spacer (2030) onto the shaft up to the shoulder; pay attention to the assembly position.
17. Check clearance S19: ($S19 = L2 - L3$)
(X – reference edge at bearing housing)



- Determine the dimension L3.
 - Again remove the spacer (2030).
 - Install the compressor bearing cover (3040).
 - Determine the dimension L2 and calculate S19 ($S19 = L2 - L3$).
 - Correct S19 by changing the thickness of the gasket under the compressor bearing cover (3040).
18. Install and fasten the compressor bearing cover (3040) with screws (3090) and washers (3130).
 19. Insert the plain compression ring (2090) into the bearing cover (3040).
 20. Slide the compressor impeller (2040) onto the shaft (2010); pay attention to the assembly position.
 21. Grease the threads with a lubricant containing MoS₂. Install the coupling disk (2050) and rotor nut (2060).



The mounting marks at the shaft and the compressor impeller must match.

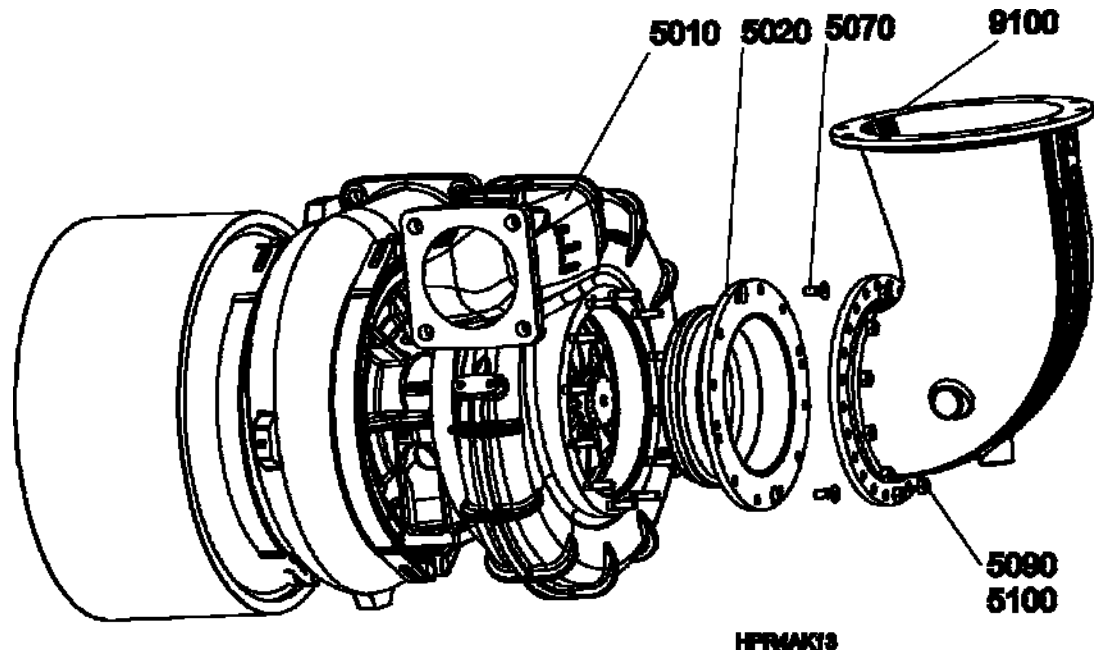


Lock the rotor by means of the locking device (9801). It is imperative to use a universal joint with the torque spanner!

22. Tighten the rotor nut (2060) with 105 Nm.
23. Check the rotor for smooth running: Slowly rotate the rotor. It must be possible to rotate the rotor easily without sensible resistance.
24. Check the rotor for truth of rotation: Apply a dial gauge to the end of the compressor impeller and measure the radial run-out of the rotor while slowly rotating the rotor. For the radial run-out refer to the Clearance sheet in chapter 7.4.

Now the bearing housing with rotor is assembled. The exhaust gas turbocharger can be completed according to chapters 7.5.5 to 7.5.10.

7.5.13 Disassembly of the exhaust-gas elbow



Mass of the exhaust-gas elbow 46 kg

Initial condition: Exhaust gas piping is disassembled.

Work sequence:

1. Attach the exhaust-gas elbow (9100) by means of a rope to a hoist.
2. Loosen and remove the hexagon nuts (5090) together with the washers (5100).
3. Remove the exhaust-gas elbow (9100) in axial direction from the turbine housing (5010) and put it on a wooden base.
4. Loosen the screws (5070).
5. Force the turbine housing insert (5020) with forcing screws off the turbine housing (5010).

8 SPARE PARTS AND TOOLS

8.1 General

The following details are required for an order:

1. Address of orderer
2. Type of turbocharger
3. Serial number of turbocharger (see name-plate on page 2)
4. Specification number of turbocharger (see name-plate on page 2)
5. Part number, designation and quantity
6. Shipment address

The spare parts box supplied by order contains a selection of the most important wear parts and a relevant listing.

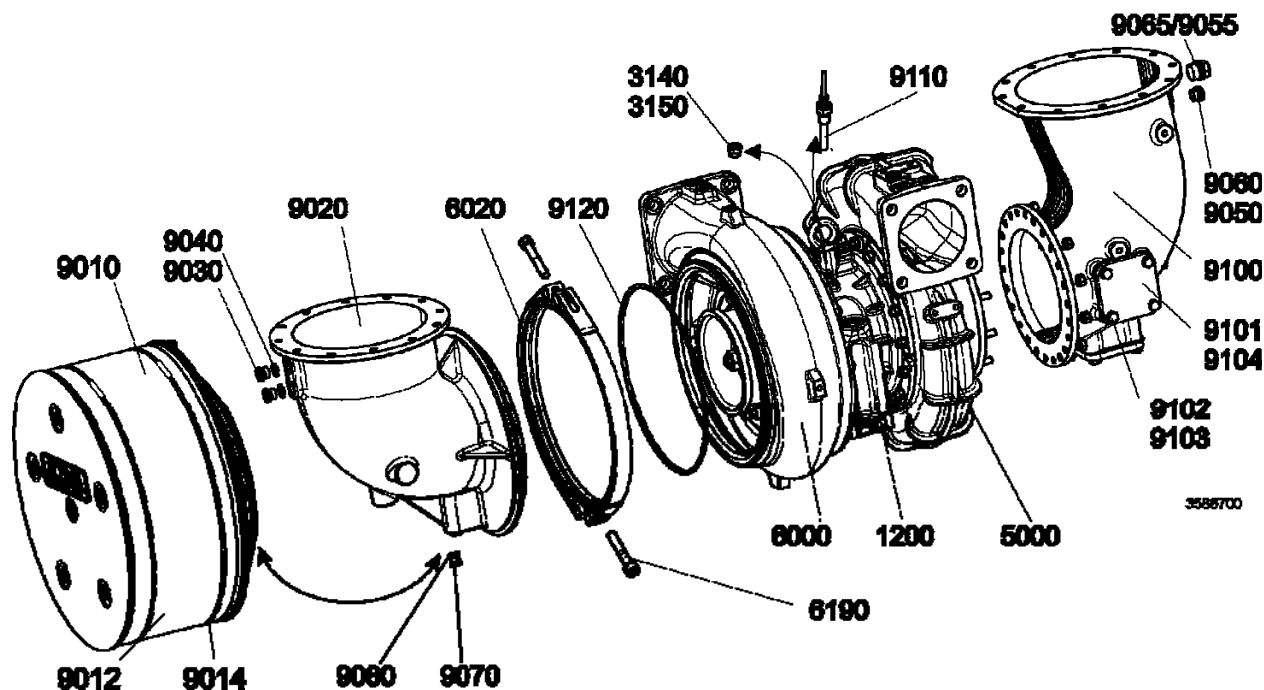


The parts contained in the spare parts box are preserved for a storage period of two years.

A certain selection of tools is also supplied if ordered. These tools are necessary to maintain and repair the exhaust gas turbocharger and are not included in the basic equipment of every workshop.

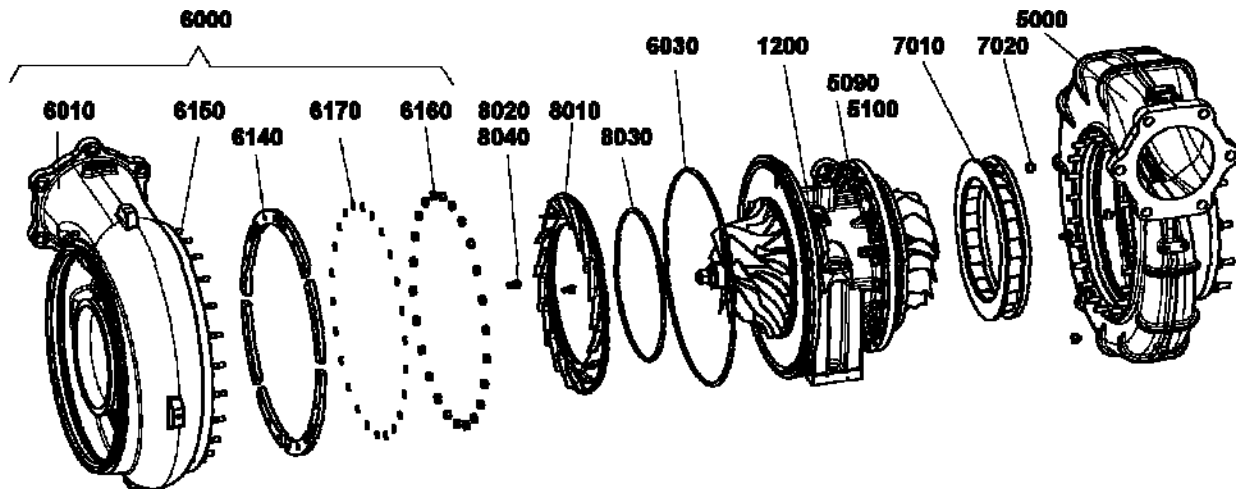
8.2 Spare parts

8.2.1 Exhaust gas turbocharger, complete (1000)



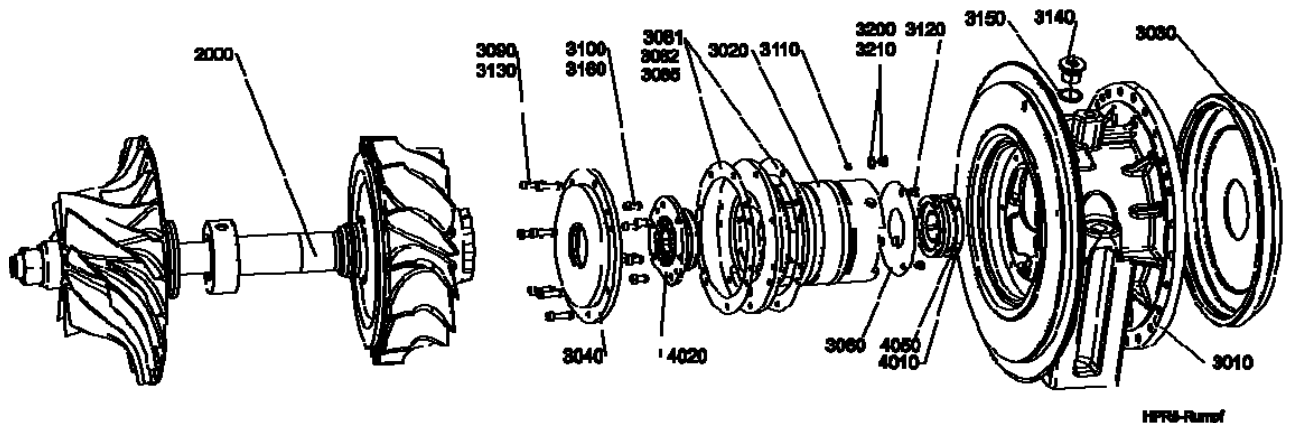
Part No.	Quantity	Designation	Remarks
1200	1	Cartridge	
3140	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
3150	1	Gasket	only available within the 'Connecting elements 1' (9920) set
5000	1	Turbine housing	
6000	1	Compressor housing	
6020	1	V-band	
6190	2	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
9010	1	Silencer	
9012	1	Filter mat	
9014	2	Tension tape	
9020	1	Intake housing	
9030	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
9040	1	Gasket	only available within the gasket set (9910)
9050	2	Screw plug	only available within the 'Connecting elements 2' (9930) set
9055	1	Screw plug	only available within the 'Connecting elements 2' (9930) set
9060	2	Gasket	only available within the gasket set (9910)
9065	1	Gasket	only available within the gasket set (9910)
9070	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
9080	1	Gasket	only available within the gasket set (9910)
9100	1	Exhaust gas elbow	
9101	3	Flange	
9102	12	Hexagon screw	only available within the 'Connecting elements 2' (9930) set
9103	12	Ripped washer	only available within the 'Connecting elements 2' (9930) set
9104	3	Gasket	only available within the gasket set (9910)
9110	1	Speed sensor	or screw plug (3140) with gasket (3150)

8.2.2 Exhaust gas turbocharger, basic unit (1100)



Part No.	Quantity	Designation	Remarks
1200	1	Cartridge	
5000	1	Turbine housing	
5090	36	Hexagon nut	only available within the 'Connecting elements 2' (9930) set
5100	36	Ripped washer	only available within the 'Connecting elements 2' (9930) set
6000	1	Compressor housing	
6010	1	Compressor housing	
6030	1	O-Ring, compressor housing	only available within the gasket set (9910)
6140	8	Clamping flange	
6150	24	Stud bolt	only available within the 'Connecting elements 1' (9920) set
6160	24	Hexagon nut	only available within the 'Connecting elements 1' (9920) set
6170	24	Ripped washer	only available within the 'Connecting elements 1' (9920) set
7010	1	Turbine nozzle ring	
7020	3	Locating bolt	only available within the 'Connecting elements 2' (9930) set
8010	1	Compressor diffuser	
8020	2	Stop bushing	only available within the 'Connecting elements 1' (9920) set
8030	1	O-Ring, compressor diffuser	only available within the gasket set (9910)
8040	2	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set

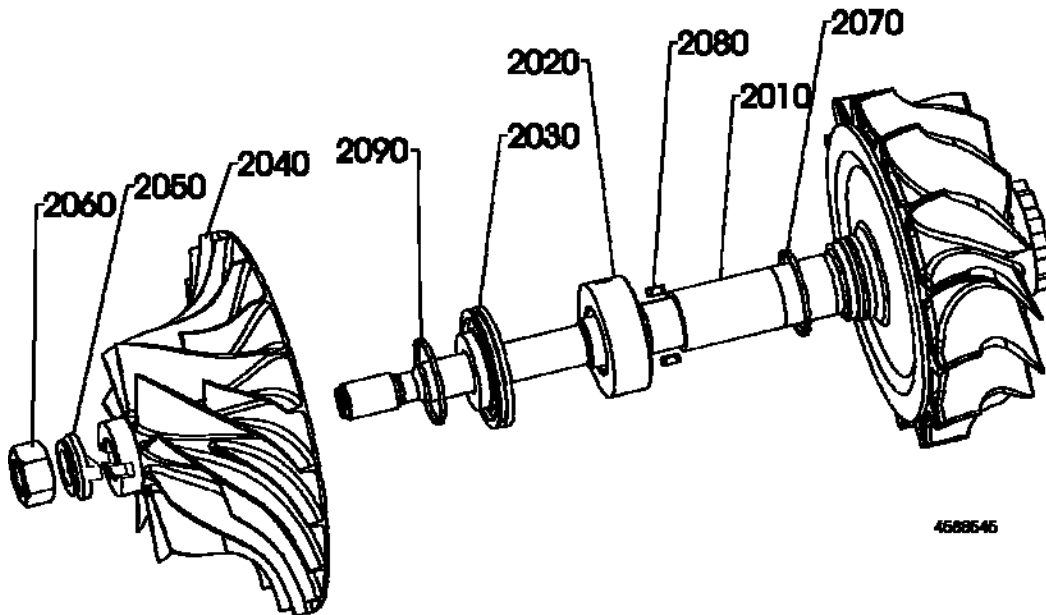
8.2.3 Cartridge (1200)



Part No.	Quantity	Designation	Remarks
2000	1	Rotor	
3010	1	Bearing housing	
3020	1	Bearing guide sleeve	
3030	1	Heat shield	
3040	1	Bearing cover, compressor	
3060	1	Separator plate	
3081	*)	Gasket, bearing cover (0.1)	only available within the gasket set (9910)
3082	*)	Gasket, bearing cover (0.2)	only available within the gasket set (9910)
3085	*)	Gasket, bearing cover (0.5)	only available within the gasket set (9910)
3090	7	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
3100	6	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
3110	1	Thread plug	only available within the 'Connecting elements 1' (9920) set
3120	3	Screw plug	only available within the 'Connecting elements 1' (9920) set
3130	7	Ripped washer	only available within the 'Connecting elements 1' (9920) set
3140	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
3150	1	Gasket	only available within the 'Connecting elements 1' (9920) set
3160	6	Ripped washer	only available within the 'Connecting elements 1' (9920) set
3200	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
3210	1	Spring washer	only available within the 'Connecting elements 1' (9920) set
4010	1	Turbine bearing complete	
4020	1	Compressor bearing	
4050	3	Cylindrical pin	also available within the 'Bearings' (4000) set

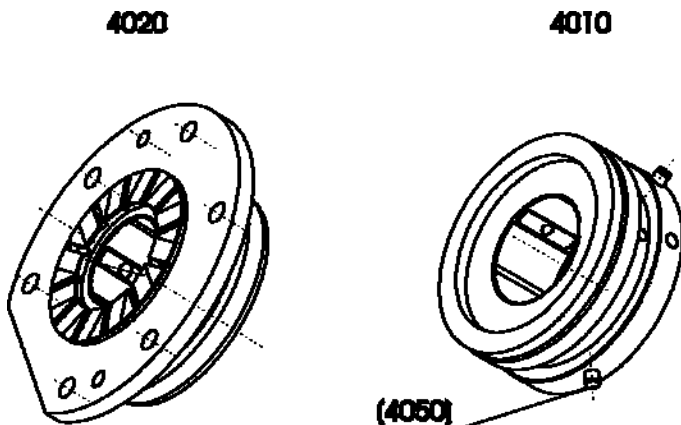
*) according clearance setting

8.2.4 Rotor (2000)



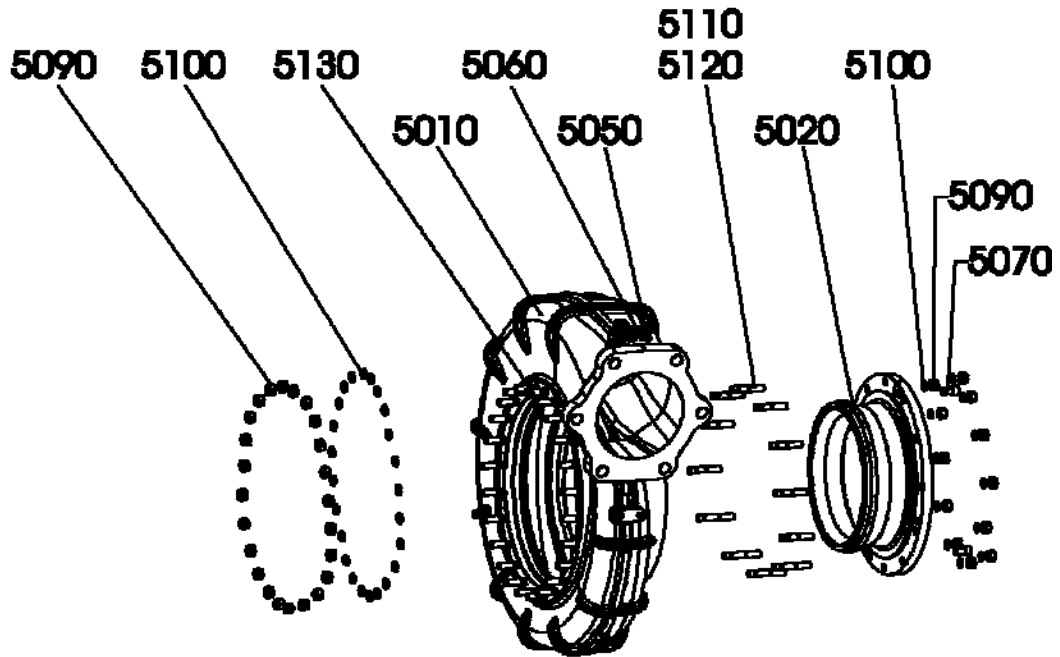
Part No.	Quantity	Designation	Remarks
2010	1	Shaft	
2020	1	Thrust ring	
2030	1	Spacer	
2040	1	Compressor impeller	
2050	1	Thrust disc/Driving plate	
2060	1	Rotor nut	
2070	1	Compression ring	also available within the gasket set (9910)
2080	2	Feather key	only available within the 'Connecting elements' (9920) set
2090	1	Compression ring	also available within the gasket set (9910)

8.2.5 Bearings (4000)



Part No.	Quantity	Designation	Remarks
4010	1	Turbine bearing	(inclusive 3x4050 assembled)
4020	1	Compressor bearing	

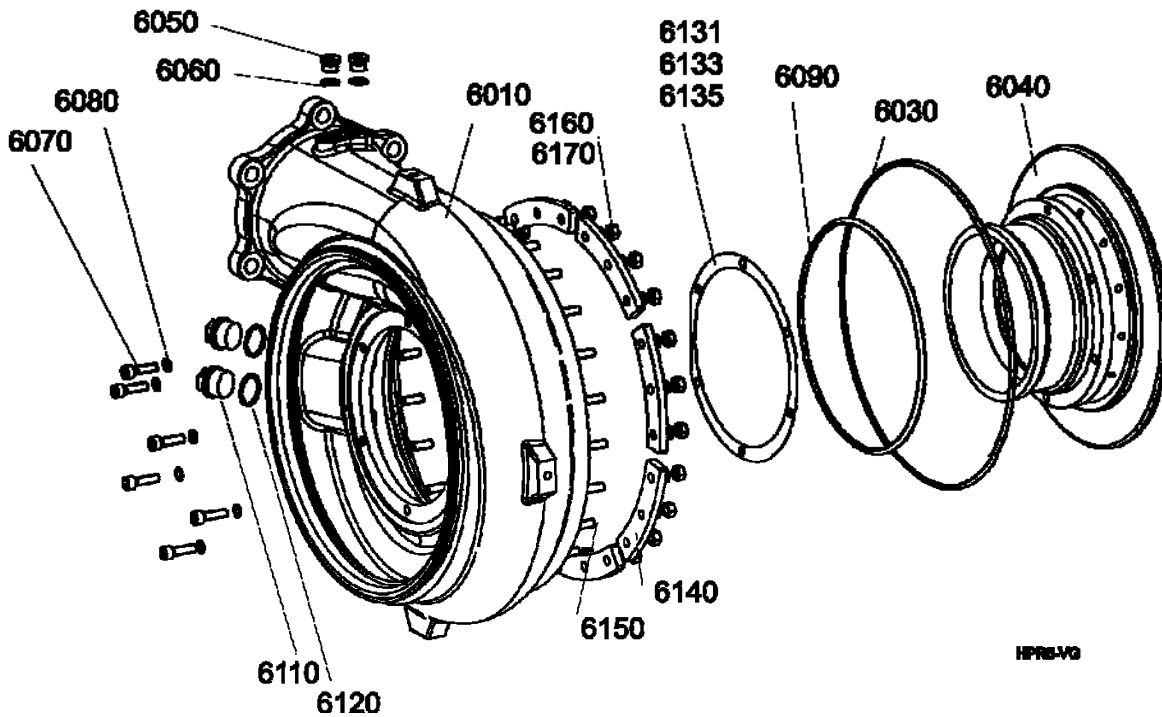
8.2.6 Turbine housing (5000)



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Part No.	Quantity	Designation	Remarks
5010	1	Turbine housing	
5020	1	Insert, turbine housing	
5050	3	Screw plug	only available within the 'Connecting elements 2' (9930) set
5060	3	Gasket	only available within the 'Connecting elements 2' (9930) set
5070	2	Cylindrical screw	only available within the 'Connecting elements 2' (9930) set
5090	36	Hexagon nut	only available within the 'Connecting elements 2' (9930) set
5100	36	Ripped washer	only available within the 'Connecting elements 2' (9930) set
5110	12	Stud bolt	only available within the 'Connecting elements 2' (9930) set
5120	4	Stud bolt	only available within the 'Connecting elements 2' (9930) set
5130	24	Stud bolt	only available within the 'Connecting elements 2' (9930) set

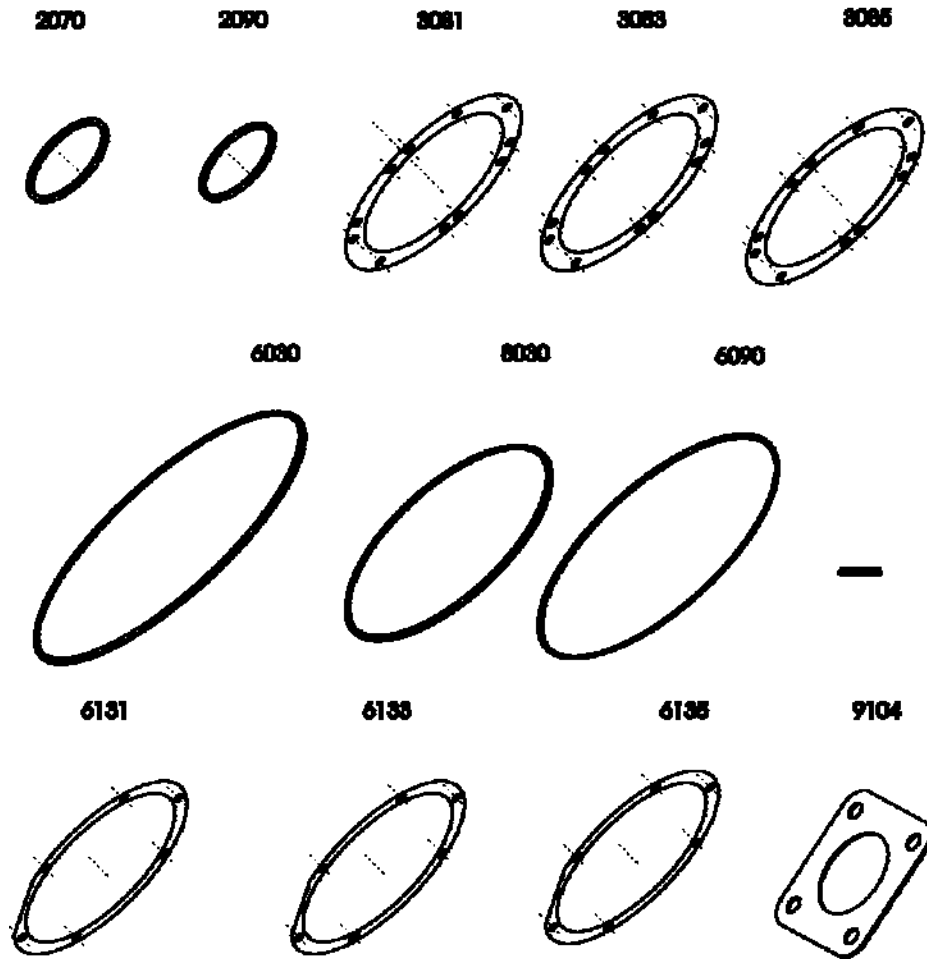
8.2.7 Compressor housing (6000)



Part No.	Quantity	Designation	Remarks
6010	1	Compressor housing	
6030	1	O-Ring, compressor housing	only available within the gasket set (9910)
6040	1	Insert, compressor housing	
6050	1	Screw plug	only available within the 'Connecting elements' (9920) set
6060	1	Gasket	only available within the 'Connecting elements' (9920) set
6070	6	Cylindrical screw	only available within the 'Connecting elements' (9920) set
6080	6	Ripped washer	only available within the 'Connecting elements' (9920) set
6090	1	O-Ring, compressor housing insert	only available within the gasket set (9910)
6110	2	Screw plug	optional connection for jetassist
6120	2	Gasket	optional connection for jetassist
6131	*)	Shim (0.1)	only available within the gasket set (9910)
6133	*)	Shim (0.15)	only available within the gasket set (9910)
6135	*)	Shim (0.2)	only available within the gasket set (9910)
6140	8	Clamping flange	
6150	24	Stud bolt	only available within the 'Connecting elements' (9920) set
6160	24	Hexagon nut	only available within the 'Connecting elements' (9920) set
6170	24	Ripped washer	only available within the 'Connecting elements' (9920) set

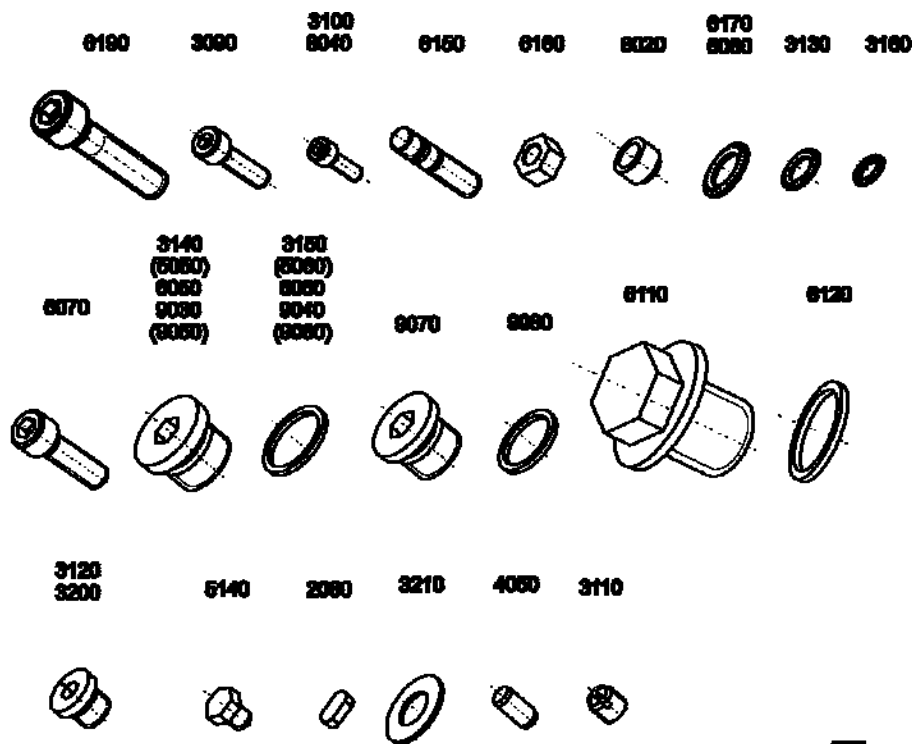
*) according clearance setting

8.2.8 Gasket set (9910)



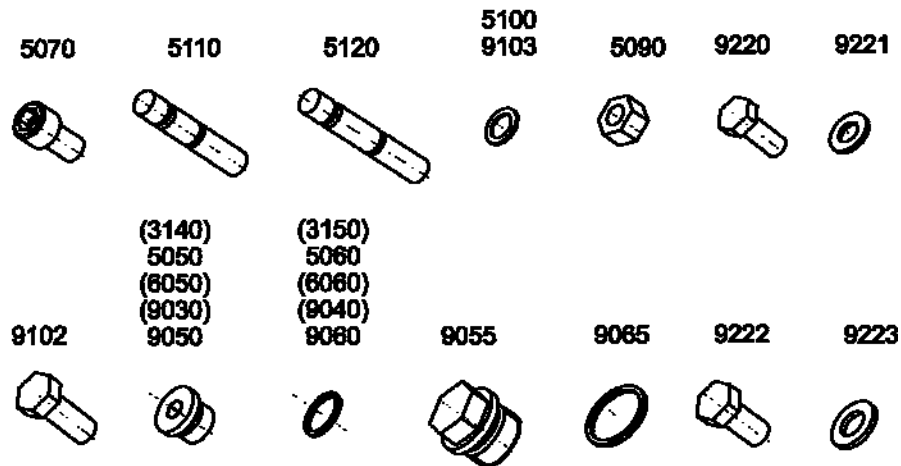
Part No.	Quantity	Designation	Remarks
2070	1	Compression ring	only available within the gasket set (9910)
2090	1	Compression ring	only available within the gasket set (9910)
3081	2	Gasket, bearing cover (0.1)	only available within the gasket set (9910)
3083	2	Gasket, bearing cover (0.2)	only available within the gasket set (9910)
3085	1	Gasket, bearing cover (0.3)	only available within the gasket set (9910)
6030	1	O-Ring, compressor housing	only available within the gasket set (9910)
6090	1	O-Ring, compressor housing insert	only available within the gasket set (9910)
6131	2	Shim (0.1)	only available within the gasket set (9910)
6133	1	Shim (0.15)	only available within the gasket set (9910)
6135	2	Shim (0.2)	only available within the gasket set (9910)
8030	1	O-Ring, compressor diffuser	only available within the gasket set (9910)
9104	3	Gasket	only available within the gasket set (9910)

8.2.9 Connecting elements 1 (9920)



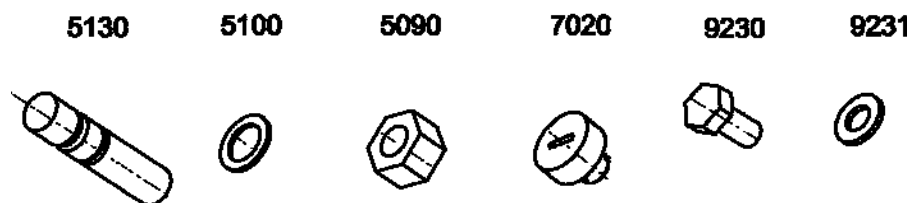
Part No.	Quantity	Designation	Remarks
2080	2	Feather key	only available within the 'Connecting elements 1' (9920) set
3090	7	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
3100	6	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
3110	1	Thread plug	only available within the 'Connecting elements 1' (9920) set
3120	3	Screw plug	only available within the 'Connecting elements 1' (9920) set
3130	7	Ripped washer	only available within the 'Connecting elements 1' (9920) set
3140	1	Screw plug	also available within the 'Connecting elements 2' (9930) set
3150	1	Gasket	also available within the 'Connecting elements 2' (9930) set
3160	6	Ripped washer	only available within the 'Connecting elements 1' (9920) set
3200	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
3210	1	Ripped washer	only available within the 'Connecting elements 1' (9920) set
4050	3	Cylindrical pin	also available within the 'Bearings' (4000) set
5140	4	Hexagon-head bolt	only available within the 'Connecting elements 1' (9920) set
6050	2	Screw plug	also available within the 'Connecting elements 2' (9930) set
6060	2	Gasket	also available within the 'Connecting elements 2' (9930) set
6070	6	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
6080	6	Ripped washer	only available within the 'Connecting elements 1' (9920) set
6110	2	Screw plug	only available within the 'Connecting elements 1' (9920) set
6120	2	Gasket	only available within the 'Connecting elements 1' (9920) set
6150	24	Stud bolt	only available within the 'Connecting elements 1' (9920) set
6160	24	Hexagon nut	only available within the 'Connecting elements 1' (9920) set
6170	24	Ripped washer	only available within the 'Connecting elements 1' (9920) set
6190	2	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
8020	2	Stop bushing	only available within the 'Connecting elements 1' (9920) set
8040	2	Cylindrical screw	only available within the 'Connecting elements 1' (9920) set
9030	2	Screw plug	also available within the 'Connecting elements 2' (9930) set
9040	2	Gasket	also available within the 'Connecting elements 2' (9930) set
9070	1	Screw plug	only available within the 'Connecting elements 1' (9920) set
9080	1	Gasket	only available within the 'Connecting elements 1' (9920) set

8.2.10 Connecting elements 2 (9930)



Part No.	Quantity	Designation	Remarks
5050	9	Screw plug	also available within the 'Connecting elements 1' (9920) set
5060	9	Gasket	also available within the 'Connecting elements 1' (9920) set
5070	2	Cylindrical screw	only available within the 'Connecting elements 2' (9930) set
5090	12	Hexagon nut	
5100	12	Ripped washer	only available within the 'Connecting elements 2' (9930) set
5110	12	Stud bolt	only available within the 'Connecting elements 2' (9930) set
5120	4	Stud bolt	only available within the 'Connecting elements 2' (9930) set
9050	2	Screw plug	only available within the 'Connecting elements 2' (9930) set
9055	1	Screw plug	only available within the 'Connecting elements 2' (9930) set
9060	2	Gasket	only available within the 'Connecting elements 2' (9930) set
9065	1	Gasket	only available within the 'Connecting elements 2' (9930) set
9102	12	Hexagon screw	only available within the 'Connecting elements 2' (9930) set
9103	12	Ripped washer	only available within the 'Connecting elements 2' (9930) set
9220	4	Hexagonal screw	optional for sheeting
9221	4	Washer	optional for sheeting
9222	4	Hexagonal screw	optional for sheeting
9223	4	Washer	optional for sheeting

8.2.11 Connecting elements 2.1 (9931)



Part No.	Quantity	Designation	Remarks
5090	36	Hexagon nut	also available within the 'Connecting elements 2' (9930) set
5100	36	Ripped washer	also available within the 'Connecting elements 2' (9930) set
5130	24	Stud bolt	also available within the 'Connecting elements 2' (9930) set
7020	3	Locating bolt	
9230	24	Hexagonal screw	optional for sheeting
9231	24	Washer	optional for sheeting

8.3 Tools

Part No.	Quantity	Designation	Remarks
9801	1	Locking device	Included in set of tools (9800)
9803	1	Extractor, thrust ring	Included in set of tools (9800)
9804	1	Sealing device	Not included in set of tools (9800) / to be ordered separately
9805	1	Guide sleeve	Included in set of tools (9800)
9806	2	Hexagon screw	Included in set of tools (9800) / forcing screw for turbine housing
9807	4	Hexagon screw	Included in set of tools (9800) / for (9801)
9808	1	Eye bolt	Included in set of tools (9800)
9809	2	Eye bolt	Included in set of tools (9800)
9810	1	Eye bolt	Included in set of tools (9800)

