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G 1 Safety precautions and work instructions

Please refer to chapter „Basic safety precautions".

CAUTION

Work on the turbomachine must never be carried out by unqualified personnel.

Staff designed to carry out maintenance, inspections and revisions are obliged to read the following instructions and have a close look at the corresponding drawings and supplier documents to familiarise themselves with the equipment and the required techniques prior to working on turbo machines.

We recommend to have all maintenance carried out by AC personnel.

We recommend that you have AC staff exchange spare parts even after the warranty period has expired to maintain the functional warranty applicable to the spare parts.

- **Waste disposal**

Plant components that have become unusable and finally even the centrifugal compressor itself have to be duly disposed of at the end of their service life.

Oils and liquid gas components must never be drained into the ground or waste water. For this reason, any condensate which is e.g. discharged from the plant, must be conducted via separating systems

In this context, you should note the following:

- Used oils must never be mixed with other materials such as cleaning agents, solutions, and paints.
- Oil containing PCB and oils containing halogen must be collected separate from normal used oils, as they must be disposed of separately.

G 2 Maintenance

For further information about maintenance schedule during operation refer to chapter "Operating instructions".

For maintenance procedures of the plant (lubricating system, cooling system, driver, ...) see instructions of plant manufacturer.

G 3 Inspection

Inspections are classified as follows:

- Oil inspection
- Minor inspection
- Major inspection
- Pressure equipment inspections

The turbomachine only requires to be shut down for the major inspection, which can be carried out either by the owner or by AC under maintenance contract. Oil inspection and minor inspection can be carried out while the equipment is running.

The first major inspection must always be carried out by Atlas Copco specialists in order to protect the owner's warranty rights.

We recommend the following inspection schedule:

Inspection procedure	Due period after 1st commissioning	Intervals
First oil inspection	200 hours	
Second and further oil inspections	1 year	every year
Minor inspection	8,000 hours	every year
Major inspection	16,000 hours	every two years

For turbomachines, which are frequently started and shut down, inspection intervals should be fixed as a function of the "operating data analysis".

Deviating from this schedule, longer or shorter intervals might be required or reasonable.

Intervals between individual inspections should, however, not exceed 24 months for these turbomachines.

Depending on the conditions prevailing in the plant or process, deviations from this schedule should be fixed in co-operation with our Service Department.

It is also possible to conclude an inspection or maintenance contract especially tailored to the needs of your plant with our Service Department. This will be the optimum prerequisite for enabling plant operation free of interference over a long period of time.

Another instrument for the evaluation of your plant is the operating data analysis made by our Service Department.

This analysis is basically vibration analysis to assess the mechanical behaviour of your plant; the thermodynamic behaviour will be checked by efficiency calculations.

Based on our know-how, it puts you in a position to improve planning of revisions, repairs, and standstills.

G 3.1 Oil and oil filter inspection

Inspection of the oil can be undertaken by the owner's chemical laboratory or by the oil supplier's technical maintenance service.

It goes without saying that also Atlas Copco can carry out such an oil inspection. Please contact our Service Department.

Oil samples (about 1 liter) should be taken in warm operating state at a place in the lubricating oil system, which is permanently flown through with oil. Please provide us with a sample (about 1 liter) of new oil for comparison.

If the oil used corresponds to the requirements of our Works Standard, no oil change is required, otherwise, an oil change must be made.

CAUTION

When you work on the lubricating system, make sure that even smallest foreign particles such as dust cannot enter the system.

When making oil inspections, the following additional operations must be carried out:

Briefly open the block valves located at lowest point of oil tank and drain any condensate which has collected.

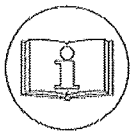
Check filter fouling degree. If required change filter cartridge. It is reasonable to change the oil filter cartridges whenever oil changes are carried out.

- **Oil fillings**

- Quality ISO VG 32
- Quantity first filling: 950 ltr.
- Quantity further fillings: 900 ltr.

- **Changing of oil filter cartridges**

Dual oil filters can be changed while the compressor is operating.



Read manufactures instructions for assembling and maintenance of dual oil filter.

G 3.2 Minor inspection

This procedure is carried out while the turbo machine continues running. It is limited to reading the measurements which are to be entered in the operating data sheets.

When taking measurements, the operating point must be the same at which the first measurement was made subsequent to commissioning the turbomachine.

Compare the readings obtained in every minor inspection with those recorded at the time measurement was made subsequent to commissioning the compressor. Allowance must be made for any differences in suction conditions, cooling water inlet temperature, etc.

If any inadmissibly high deviations are ascertained, the necessary action to correct them must be considered in accordance with the particulars given in chapter "Possible faults, causes and corrections".

In addition, the plant must be checked for loose screws and parts.

Attention should also be given to abnormal noise and vibrations.

If the plant components you specified require shorter inspection intervals than those mentioned here, see sub-suppliers manuals.

G 3.3 Major inspection

The major inspection is a check-up of the complete machine, its major components, clearances, fits, degree of wear and fouling, and, if required, repair or replacement of components.

A part of this inspection is carried out while the machine is running, part of it with machine standing still.

The major inspection includes all tests of the minor inspection.

The following documents of the manual are required for this inspection:

- Data sheets
- Clearance and alignment records, if any
- Technical documentation of AC's sub-suppliers
- Works Standards
- Drawings

If the comparison of the readings obtained shows shutdown of the compressor to be advisable, the checks and procedures listed below must be carried out subsequently, always observing in full the separate manufacturers' instructions.

Gearbox	
Toothing	Teeth and contact pattern
Pinion shaft bearings	Contact pattern and clearance, replace, if necessary.
Bull wheel shaft bearings	Contact pattern and clearance, replace, if necessary.
Shaft bearing fits	Contact pattern, check diameter
Oil seal	Clearance, replace if necessary
Shaft seal	Contact pattern, surface, clearances
Axial shaft position pick-up	Mounting, measuring clearance
Shaft vibration pick-up	Mounting, measuring clearance

The delivered gearing was designed for an unlimited service life, but slight wear of the tooth flank, which has a negligible effect on the service life, cannot be ruled out.

For this reason, the outer appearance of the toothed wheels and their contact patterns are checked in major inspections. If extraordinary wear is detected, the Service Engineering department of Atlas Copco should be contacted.

After about 80,000 operating hours, we recommend to replace the complete set of toothed wheels. The used set of toothed wheels must be sent to AC for dimensional checks and overall inspection.

Compressor	
Adjustable inlet guide vanes	Vanes, ease of adjustment and position, surface
Suction nozzle	Surface
Impeller	Inlet edges, surface cleanliness, concentricity with rotor shaft, crack-test
Coupling	Dismantle spacer, check alignment observe lubricating instruction. When a complete coupling must be replaced, the stand-by coupling must be balanced to G < 2.5. When single parts are replaced, these must be balanced to G < 1 (refer to ISO 1940). Coupling hubs equipped with one shaft key must be balanced with half of the shaft key installed. Otherwise it must be verified that the required balancing quality is obtained also with ungrooved hub despite the existing difference in weight.
Driver	See manufacturers instructions
Plant parts	See manufacturers instructions

WARNING

Danger by suction forces.

Never change filter cartridges during machine operation. Foreign bodies or even you can become attached by suction. Exception: changeable filters

G 3.4 Pressure equipment inspections

Take care of officially regulated inspections of pressure equipment. Follow rules and standards valid in your country, see also documentation of manufactures

G 3.5 Electrical calibration

Check all electrical controls for correct calibration and operation at the time of installation and at recommended intervals of one year or 8,000 hours, whichever comes first. For example, check the electrical rated output of sensors at both the zero and the rated pressure. Refer to the wiring schematic, drawings, control system for identification of instruments and their setpoints in chapter H.

G 4 Disassembly of components

Disassemble of functional groups to check satisfactory operation (surface condition such as cracks, wear, corrosion; adherence to dimensions, clearances, etc.), manufacturers' instructions must be complied with and the following information be considered.

G 4.1 Safety precautions for disassembly and re-assembly

WARNING

Danger: suspended load
Danger: falling parts

May lead to severe injuries.

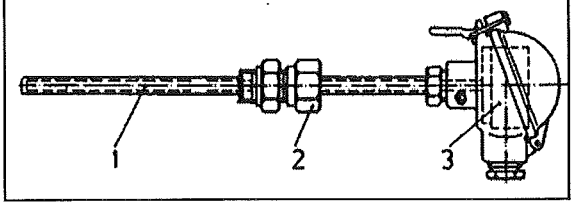
- Use only approved hoisting equipment and cranes of sufficient capacity. For information on weights refer to the foundation and layout plan, or information on packing.
- Employ special auxiliary equipment, e.g. traverses, loading joists, if specified.
- Use only undamaged ropes and chains.
- Protect the edges whenever hoisting chains or ropes are conducted over edges of packing or machinery.
- Lifting eyelets are not always designed to receive the total weight. Pay attention to the information contained on their stickers.
- Secure parts against shifting during transport/handling.
- Observe the shift in center of gravity during transport.
- Refrain from staying below suspended loads.

WARNING

Danger: discharge of compressed gas

May lead to lethal injuries.

- Work must only be carried out during machine standstill periods.
- Prior to doing any work on the turbomachine, safely block the suction and discharge pipe using a blind insert. Do not rely on block valves.
- For resistance thermometers without welded immersion tubes the protective tube 1 is directly subjected to the plant pressure. Removing measuring unit 3 terminal screw connection No. 2 must only be loosened if the system is not pressurized, because otherwise the whole measuring unit is catapulted out of the measuring place (for more information refer to sub-suppliers documentaton at chap. H).



WARNING

Danger: electric voltage

May lead to lethal injuries.

- Prior to working on electrical equipment, de-energize the plant.
- Work on power plants must only be carried out by expert personnel.
- When de-energising units, do not forget auxiliary circuits, e.g. standstill heatings.
- Make sure to protect switches against re-activation when de-energising units.
- Isolate or cover any adjacent life parts.

The following paragraphs mainly include information on how to disassemble the plant.

Disassembly of functional groups for verification of their operatability (surface quality such as cracks, wear, corrosion, dimensional compliance, clearances etc.) should only be carried out as per manufacturer's instructions.

G 4.2 How to remove the shroud

WARNING

USE EXTREME CAUTION.

This part is heavy and can cause severe bodily injury!

1. Lock out the items listed previously. If work has to be done on the first- and second-stage rotor assembly, remove inlet piping to the compressor as well as inlet elbows.
2. Leaving the top and bottom bolts in place, remove the remaining 10 bolts and lock washers holding the shroud to the compressor housing.
3. Place two guide pins, a minimum of 457.2 mm long, 180° apart on a horizontal plane in two of the bolt holes from which the bolts were removed in step 2.
4. Remove the two remaining bolts holding the shroud to the compressor housing
5. Use the four jacking bolt holes in the shroud to separate the shroud from the compressor housing. Tighten the jacking bolts evenly to prevent the shroud from cocking in the compressor housing.
6. Remove the shroud far enough from the compressor housing to wrap a sling around the inside diameter of the shroud, separate the flanges approximately 101.6 mm. Use a choke hitch.

7. Connect the sling, installed in step 6, to an overhead hoist. Take up the slack on the sling.

CAUTION

The diffuser plate will be loose and can easily fall out and cause bodily injury or become damaged.

8. Slide the shroud back; lift away from the compressor housing.

CAUTION

The shroud will tip when it comes free of the compressor housing. Make sure it does not hit and damage the impeller.

9. After the shroud is removed from the compressor, place it on a wooden pallet or blocks of wood. Do not put the shroud directly on a concrete floor as it can be damaged.
10. Remove the diffuser plate and store it in a safe place.

G 4.3 How to remove the gear cap

1. Remove each radial vibration probe (both radial and axial) from the pinion shafts in the following manner:
   - Unscrew the cap from the pipe-mounted terminal box.
   - Disconnect the probe cable from the extension cable.
   - Loosen the lock nut on the probe and unscrew the vibration probe assembly from the compressor.
2. Remove each vibration probe (both radial and axial) from the bull gear shaft (if so equipped) in the following manner:
   - Remove the cover from the conduit outlet.
   - Loosen the lock nut.
   - Unscrew the vibration probe.
   - Remove the conduit outlet.

CAUTION

Protect the tips of removed probes by wrapping them in a soft material. Store them in a safe place.

3. Disconnect the coupling guard by removing the four bolts that hold it in place.
4. Remove the 12 bolts and two dowel pins holding the gear cap to the gearbox. Place two guide pins, at least 304.8 mm long, in two adjacent corner bolt holes to prevent the gear cap from swinging until it is clear of the drive gear.
5. Rig the four holes in the upper corners of the gear cap to an overhead hoist.

CAUTION

Carefully remove the gear cap. Lift it straight up, keeping it level, so that it does not swing and damage the drive gear.

Use the four jacking holes provided in the gear cap to split the gear cap from the gearbox.

6. Place the gear cap on a wooden pallet or blocks of wood.

CAUTION

Do not place the gear cap directly on the ground or floor. The split line may become damaged and cause future oil leaks.

Cover the oil supply holes in the lower half of the gearbox so that nothing can fall into them. Also, if the gearbox is to be left open for an extended time, cover it with polyethylene.

G 4.4 How to remove the impeller

WARNING

Keep clear of hydraulic stretch tooling during initial stretch procedure. Follow pressure requirements closely.

Before the pinion shaft for the first and second stages can be removed, the second-stage impeller must be removed. Leave the first-stage impeller attached to the pinion and pull the entire rotor assembly through the first-stage compressor housing. Similarly, remove the third-stage pinion with the third-stage impeller attached. The procedure for removing all impellers is the same.

1. Slide the assembly spacer over the impeller nut on the end of the tie bolt, which extends from the tip of the impeller.

   Make sure that the holes in the impeller nut are visible in the window of the spacer.

2. Install the hydraulic cylinder and hold down nut on top of the spacer.
3. Connect the pressure hose to the hydraulic fitting and step clear of the high pressure assembly.
4. Apply pressure as specified on the appropriate instructional drawing in chapter H1, Drawings to stretch the tie bolt and to pull the impeller nut away from the impeller.
5. Spin the impeller nut off with the drill rod.
6. Relieve the pressure.
7. Remove the hydraulic cylinder, hold down nut, spacer, and impeller nut.
8. Place the impeller puller assembly over the end of the tie bolt. Then screw the center bolt in the impeller puller onto the end of the tie bolt, pushing it away, causing the impeller to pull away from the pilot fit on the pinion.

G 4.5 How to remove the pinion bearings, seals, and shafts

The following steps describe the procedure for removing the first- and second-stage pinion. Except where noted, these steps are the same for the third-stage pinion.

CAUTION

Before removing the seals or bearings, note the location of the vibration probes. Be extremely careful not to damage or scratch the surface of the vibration probe tip. Protect all surfaces, as well as the entire body, with a soft material, for example, rubber or bubble plastic, immediately after the seal, bearing, or shaft is removed.

The pinion bearings are tilting-pad bearings. Do not let the pads fall out of the bearing shells. They can easily become damaged or fall into the gearbox.

Some of these pads may have RTDs embedded in them. Be careful not to damage the RTD leads. When you remove a bearing, disconnect the RTD leads from the connectors inside the gearbox.

1. Remove the upper half of the journal bearing nearest the gas inlet pipe:
   - Rotate the bearing until the split line of the bearing matches the split line of the gearbox.
   - Remove the two small Allen head screws that hold the bearing together.
   - Carefully remove the upper half of the bearing.

CAUTION

Do not attempt to split the bearings by using a screwdriver or a chisel as a wedge.

If the upper half of the bearing does not come off by hand, pry it up with two small hex wrenches placed in the oil feed holes on the outer diameter of the bearing.

Store the upper half of the bearing in a safe place. Mark each bearing half for location. They are not interchangeable.

CAUTION

Do not mark on split line of bearing.

2. Leave the bottom half of the bearing in place to support the rotor if the impeller is to be removed. If only the bearing is being changed, roll out the bottom half of the bearing. (It is sometimes easier to roll out this half of the bearing if the impeller is lifted slightly or the end of the shaft is lifted up to take the weight off the bearing.)
3. Remove the oil seals and the gas buffer seals. Rotate each seal so the split line of the seal is parallel with the split line of the gearbox.
4. When the split lines are parallel, disengage the seals by pulling them back toward the center of the shaft. (Pull the air seals with socket-head cap screws).
5. Lift off the top half of the seal.
6. Roll the bottom half of the seal out around the shaft.

CAUTION

When tapping the lower half of the seal to dislodge it, use a soft mallet (wood or plastic); otherwise, the split line of the seal may be damaged.

7. Remove the brass oil seal. Like the buffer seals, the brass oil seal is split horizontally. It has a spring that must be disengaged.
8. After removing the seals, protect the journal area of the shaft with a soft material. Store the seals in a safe place.
9. Roll out the bottom half of the bearing, remembering to mark it for location.
   - Place a piece of wood or rubber between the gearbox bore and the shaft to support the weight of the shaft.
   - Roll out the back bearing (on the second-stage side of the pinion shaft) and mark it for location. Support this end of the shaft also.
10. Slowly and carefully guide the pinion out. At least two people are required for this step.

CAUTION

Take great care not to scrape or bang the shaft!

G 4.6 How to remove the bull gear bearings and drive gear assembly

To inspect or change just the bull gear bearings, the drive gear assembly does not have to be removed. To remove the bearings, follow these steps.

G 4.6.1 How to remove the bearings

1. Remove the two small socket-head cap screws holding the two halves of the bull gear bearings together.
2. Rotate the bearings so the split lines of the bearings match the split lines of the gearbox.
3. Remove the top half of each bearing.

CAUTION

Mark each half of the bearings for location. The halves are not interchangeable.

CAUTION

Do NOT mark on the split line of the bearing.

4. To remove lower halves of the bearings, lift the drive gear slightly. To do this, put a steel rod through one of the holes in the drive gear and rig it to an overhead lift.

Lift the drive gear just enough, approximately 3.175 mm, to take the weight off the bearings.

5. Roll out the bottom halves of the bearings.

CAUTION

Mark the bottom halves for location.

G 4.6.2 How to remove the drive gear assembly

1. Unscrew the eight bolts holding the flexible coupling to the main drive shaft and remove the coupling.
2. Rig the gear for lifting out of the gearbox (as above) by placing a steel rod in one of the holes drilled through the gear. Attach it to an overhead lift.

It is not necessary to remove the bearings. They can be lifted with the gear and removed at a later time.

3. Carefully remove the gear from the gearbox.

CAUTION

Do NOT put the gear directly on the floor.

Place the gear on a stand, supported on the journal bearings by blocks of wood or rubber. Wrap the shaft in a soft material, for example rubber or bubble plastic.

4. Cover the gearbox.

G 5 Inspection

After or during disassembly of the parts described in the previous chapters, carefully inspect the following parts to determine whether they can be reused or should be replaced.

- **General inspection**

Inspect all stationary parts, gearbox, compressor housing, shroud, and diffuser before reassembling the parts. Check for cracks or unusual wear.

G 5.1 Impellers

If the impellers have any buildup, first clean it off using an indus-trial-grade degreaser and a wire brush.

CAUTION

Do NOT use the wire brush on mounting surfaces.

Carefully inspect the impeller for rubs, corrosion, erosion, water damage, or cracks. If any metal (or mass) has been removed from the impeller, it can affect the balance of the rotor assembly and can lead to vibration problems. Rebalance the rotor assembly (see rotor assembly drawing in chapter H1).

G 5.2 Shafts

Inspect the shafts for wear and scratches in the bearing areas. Investigate any buildup or discoloration in the bearing areas.

CAUTION

Never use an abrasive to clean bearing pads or journal surfaces.

Inspect the probe areas of the pinion shafts for scratches or dents. Any marks on these portions of the shaft will give false vibration readings on the vibration monitor.

G 5.3 O-rings

Check O-rings. If they are cut, nicked or cracked, or if they do not spring back to round, replace them.

G 5.4 Gears

Examine the gears for unusual wear, chips, cracks, or broken teeth.

G 5.5 Bearings

Check bearings for excessive or uneven wear, cracks, smearing, scratches, or discoloration.

CAUTION

Pay particular attention to the pinion bearings, as failure of one of these high-speed bearings can cause severe damage to the rotating elements in the compressor.

G 5.6 Seals

Inspect the oil and gas seals for rubs, split line damage, and bent labyrinth teeth. The teeth on the gas seals are on the shaft, not on the seal itself. Minor rubbing on these seals is not unusual. If the labyrinth teeth (on the shaft) are not damaged and the seal has rubbed only slightly (less than 0.127 mm), the seal can be reused.

G 6 Packing of components to return them to AC's works

Whenever inspections carried out in your plant have revealed the necessity to have components checked in AC's works, you are requested to proceed as follows to pack and ship the parts:

- **Turbomachinery rotors**

Provide bearing places, gears and shaft seal with a suited anti-corrosive. The run-out faces of rotors should be additionally protected by means of foam and adhesive tape. The rotors are to be supported at the bearing places and shipped in a suited box. For this purpose, the wood should be provided with grooves, foam material should be placed under the rotor and the rotor should be thoroughly secured to rule out any shifts in transit. The box must also be provided with the inscription „this side up".

- **Other turbomachinery components**

Plug up all threaded connections of turbomachinery components. Apply a film of anti-corrosive to the parts, if possible. Pack the parts in a suited box and secure them against shifting by means of metal tape or wood. The box must also be provided with the inscription „this side up ".

- **Bearings and other fragile parts**

Bearings and other fragile parts must also be packed in a way that they arrive at AC safe and protected against corrosion. Provide these parts with a layer of anti-corrosive and wrap them in plastic foil.

Suited anti-corrosives

Shell oil V 9703
Fuchs-Anticorit TX 10

If this is not available, mix Vaseline with a turbine oil to make a suited grease yourself.

G 7 Cleaning

WARNING

– **Danger: detergents and solvents**

May lead to skin injuries, acid burns and other severe injuries

- Use only approved detergents and solvents.
- The use of easily inflammable solvents such as benzene, kerosene, naphtha or mineral spirit is prohibited. This applies also to fire-distinguishing liquids such as R12B1. We recommend that you refrain from employing any refrigerants, i.e. fluorinated hydrocarbons, as your contribution to protect the environment.
- Make sure to wear personal protective equipment such as safety goggles, rubber gloves, aprons and, if need be, breathing equipment.
- Make sure to vent closed rooms thoroughly when working with such detergents and solvents.

After use, all detergents and solvents are to be collected in closed containers for proper disposal. Ensure adherence to the warning signs stuck to the containers which give information on which agents may be collected in the individual containers.

- **Cleaning prior to commissioning**

The machine and/or its components have been thoroughly cleaned before they left the works after they had been successfully inspected and accepted by the customer.

To protect the plants against any contamination during transit to the site, all openings were covered by means of covers or plugs or even provided with nitrogen fillings.

The plants are packed and covered during transit to keep rain etc. from entering.

Cleaning of plant parts in this phase, i.e. prior to positioning on the foundation, is restricted to visual inspections for contamination. When any are found, the parts concerned must be cleaned.

Normally, the plant is erected only some weeks after it has left the works. So, it just has to be checked for damaged packing or covers.

Whenever plants are erected which had been delivered more than three months ago, these have to be subjected to thorough inspections by AC staff.

- Remove rough impurities, including rust, from outer surfaces before the components are installed on site.
- Select a suited place to clean the parts by means of vacuum-cleaning, brushing, wiping or high-pressure cleaners or jet blaster. Make sure to remove all cleaning rags and other foreign matter.

After all rust particles have been removed from the parts, coat the latter with the specified paint.

- **Cleaning for inspections**

Remove rough impurities from the outside of the machine, before you proceed to open it.

All parts that might be re-used later on must be thoroughly cleaned. This applies also to stand-by parts to be installed.

CAUTION

When cleaning the gearbox/bearing carrier jointline make sure that solvent does not drip into the gearbox as this will impair the air separation properties of the lubricating oil.

Recommended detergents

The cleaning methods must be selected in consideration of the type and extent of contamination.

- **Pre-cleaning by:**

- Blowing-off with air
- Wiping, brushing
- Vacuum-cleaning
- Highly contaminated parts which are not jeopardised by corrosion caused by contact with water may be cleaned using high-pressure cleaners.

When diluted alkaline solutions are used, e.g. trisodium polyphosphate, these must always be conducted via oil separators or the detergents must be collected and duly disposed of.

These detergents must not be employed to clean plant parts that will come into contact with oil to avoid any neutralisation of anti-foam additives contained in the oil by residues of detergents.

- **De-greasing by:**

- Wiping, brushing
- Flushing with approved halogenated hydrocarbons
- Surface treatment e.g. with tetra-chloroethylene or methyl chloroform

G 8 Reassembly

Before reassembling the parts, clean them thoroughly using industrial degreaser and lint-free cloths

CAUTION

Do NOT use a wire brush on babbitt, brass or aluminum surfaces.

Remove old adhesive from the gearbox split line with industrial degreaser, rags, and a scraper. Use a flat honing stone to recondition the split line of the gearbox.

G 8.1 How to reassemble the bull gear bearings and drive gear assembly

1. Clean all journal and thrust surfaces and lightly coat these surfaces with the lubricating oil recommended in chapter G, Lubrication Oil System.
2. Check the location marks of the bearing halves.

CAUTION

Keep track of which halves go together. The bearings' two halves are made as an assembly; they are NOT interchangeable with other bearing halves.

3. With the drive gear assembly still suspended by an overhead hoist, assemble the two halves of the journal thrust bearing onto the shaft. Tighten the two Allen-head screws.
4. Apply a liberal coat of silicone grease to the split line, cavity and outer diameter of the garter seal (this is a neoprene seal held in place by a spring). Assemble the seal on the shaft with the split line at the 12 o'clock position.
5. In the same manner as steps 1–3, assemble the two halves of the journal bearing on the shaft.
6. Carefully lower the drive gear assembly into the gearbox.

CAUTION

Keep the anti-rotation pins clear of the edge of the gearbox as the assembly is lowered into place.

7. Maneuver the journal-thrust bearing so that the outer diameter of the bearing engages its respective bore in the lower half of the gearbox.
8. Rotate both bearings so that anti-rotation pins rest in their slots.
9. Check the thrust clearance of the bearings by locating a dial indicator on the bull gear coupling hub and measuring the axial float. (See the core unit assembly drawing for clearance tolerance. For general clearance procedures, see Calculating and setting clearances later in this chapter.

G 8.2 How to reassemble the impeller assembly

1. With an industrial degreaser, remove all grease from the tie bolt and the pilot fit.
2. Thread the tie bolt into the pinion shaft until it bottoms out.
3. Using a torque wrench and stud driver, tighten the tie bolt in the pinion (6.779 to 13.558 Nm). Install a rotor shim washer on the impeller with the flat face against the pinion.
4. Apply a thin film of high-pressure lubricating grease (Molykote) to the chamfer and fit.

CAUTION

Do NOT get grease on the driving face

5. Slide the impeller over the tie bolt and onto the shaft, lining up the keyway with the index pin and against the chamfered edge of the fit.
6. Assemble the tie bolt stretching spacer, cylinder and nut.
7. Hydraulically jack the impeller and pinion together. Remove the tooling assembly and tie bolt stretch nut. Install the tie bolt nut against the impeller.
8. Slide the assembly spacer over the impeller nut.

Make sure that the holes in the impeller nut are visible in the window of the spacer.

9. Install the hydraulic stretching cylinder and hold down the nut on top of the spacer, drawing the hold-down nut snug (hand tight) against the cylinder.
10. Attach the dial indicator to the face of the hold- down nut and set the indicator to "0".
11. Connect the pressure hose to the hydraulic fitting and step clear of the high-pressure assembly.
12. Apply pressure as shown in step 3 of the appropriate instructional drawing in chapter H1, Drawings.
13. Hold the pressure for 2–3 minutes. Record the indicator reading and the pump pressure. Snug down the impeller nut with the drill rod.
14. Relieve the pressure.

CAUTION

Only use minimal torque with the drill rod. Do not enlarge the holes in the impeller nut.

15. Repeat steps 12–14.
16. Increase the pressure again to that used in step 12, loosen the impeller nut, relieve the pressure, and remove the boltstretching tools.
17. Retighten the tie bolt as in step 3 (6.779 to 13.558 Nm).
    Repeat steps 8–11.
18. Apply final assembly pressure shown in step 7 of the appropriate instructional drawing in chapter H1, Drawings and tighten the impeller nut.
19. Record final bolt stretch and pressure.
20. Remove the hydraulic cylinder assembly from the tie bolt.

CAUTION

Make sure to retract the hydraulic piston of the pump fully, or the next time the pump is used, the pump seal will be blown off.

G 8.3 How to reassemble the pinion bearings, seals and shaft assembly

These instructions are for the first-, second-, and third-stage pinion.

1. With the pinion shaft still out of the gearbox, install the bearing brass oil ring and guard spring, aligning the ring on the shaft in approximately its final position.
2. Carefully guide the pinion shaft back into the gearbox in the same manner that it was removed.
3. Temporarily support the shaft with a soft support between the journal surfaces and the gearbox (or by someone holding the shaft).
4. Check the bearing halves for location and lightly coat the bearings with oil.
5. Roll the lower half of the bearings into place, making sure that the brass oil ring is lined up properly with its respective slot in the bearing assembly.
6. Slightly rotate the whole assembly until the bearing split line matches the gearbox split line.
7. Apply high-temperature grease to the outer diameters and split lines of the buffer seals.
8. Install the lower halves of the seals on the shaft, roll them around to the bottom, and install the upper halves.
9. Slide both halves of the seals down the pinion shaft into the bore in the compressor housing, making sure to offset the split line of the seals about 15° from the split line of the gearbox.
10. Install the upper halves of the bearings, making sure that the anti-rotation pins are installed in their grooves.
11. Mount the second-stage impeller following the instructions above. (If the first- or third-stage impellers have been removed, it is easier to mount them on their respective shafts before replacing the shafts in the compressor).

Do NOT install the gear cap at this point. Set the clearances for the rotor assemblies before installing the gear cap.

G 8.4 How to reassemble the shroud assembly

1. Clean the shroud using degreaser and, if necessary, fine emery cloth.
2. Replace the diffuser plate and spring pin. The spring pin is for retention of the diffuser.
3. Place an O-ring around the shroud and coat it with a high-temperature, anti-seize compound.
4. Using the same rigging and guide pins as in disassembly, install the shroud.
5. Line up the guide pin on the compressor housing with the hole on the flange of the shroud.

CAUTION

Install the shroud as straight as possible to avoid damage to the impeller, and binding between the shroud and the compressor housing.

6. It may be necessary to pull the shroud in the last inch. Torque the bolts evenly to avoid binding (coat these bolts with a high-temperature, anti-seize compound to make their removal easier in the future).

G 9 Calculating and setting clearances

G 9.1 How to set the impeller-to-shroud clearances

If rotors, bearings, shrouds or diffuser plates are changed, readjust the impeller-to-shroud axial clearance at the impeller discharge. Check clearances and make adjustments in the following manner.

G 9.2 Set the third-stage pinion clearances

G 9.2.1 Preparation

In preparation to set the third-stage pinion clearances, make sure that the following tasks are done.

- The third stage rotor is installed.
- The shroud is bolted tightly.
- The axial bearing shim pack is removed.
- A dial indicator is placed on the end surface of the third tie bolt so that the axial movement of the assembly can be measured.

G 9.2.2 Setting clearances

1. Push the rotor assembly toward the shroud until the impeller touches the shroud. Zero the indicator.
2. Pull the rotor assembly back toward the motor until assembly clearances are achieved.
   - With the impeller-side bearing thrust face against the pinion, measure the distance between the gearbox shim slot and the bearing collar.
   - Add or subtract the required shims of the shim pack to obtain the measured gap, then assemble to bearing halves using 4–40 screws. This is the loaded thrust bearing.
3. Push the rotor assembly toward the shroud until the loaded thrust bearing is tight.
4. Check the impeller-to-shroud clearance reading, which should be within the axial clearance tolerance shown on the Core Unit Assembly drawing in chapter H1, Drawings.
5. Remove the shim pack and push the rotor assembly toward the shroud to make sure the indicator returns to zero. If the indicator does not return to zero, repeat steps 1–4 until it does.
6. Rotate the rotor assembly 90° and repeat steps 1–5 until four readings 90° apart are taken. These readings should not vary more than 0.0508 mm If they do, contact Atlas Copco Comptec Inc., Parts and Service Centre. (See Preface, Receiving and Storage for address, telephone, and fax numbers.)
7. Use the smaller reading for impeller-to-shroud clearance. If the clearance is not within the tolerances shown on the gearbox and compressor housing drawing, add or subtract shims to the shim pack until the desired clearance is obtained.
8. Install the remaining shims on the opposite side of the loaded thrust bearing to obtain a snug fit.
9. Install shims on the motor side of the other thrust bearing; the unloaded thrust bearing.

10. Push the rotor assembly toward the third-stage shroud and zero the dial indicator. Push the rotor assembly toward the motor and record the dial indicator reading. The indicator reading is the axial float.
    If this reading is different from the tolerance given on the drawing, the shims will have to be shifted. Move the shims from the impeller side to the motor side of the unloaded thrust bearing if the measured float is too large, and vice versa, if it is too small.
11. Install shims on the impeller side of the unloaded thrust bearing to obtain a snug fit.

G 9.3 Set the first- and second-stage pinion clearances

If new parts are installed, the minimum-thickness rotor shim washer needs to be assembled on the second-stage impeller (maximum shim to minimum core parts may cause crushing of rotor).

G 9.4 Obtain the shroud-to-shroud clearance reading

1. Remove the loaded shim packs from both bearings. Refer to the bulleted information below.
   - Roll out the lower half bearing with impellers, shrouds, and lower half bearings installed.
   - The loaded shim pack governing the first-stage impeller-to-shroud clearance is the shim pack closest to the first- stage impeller.
   - The loaded shim pack governing the second-stage impeller-to-shroud clearance is the shim pack closest to the second-stage impeller.
   - Remove the shim packs by removing the screws that hold them.
2. Reassemble the lower half bearings.
3. Push the rotor assembly toward the second stage until the impeller touches the shroud.
4. Install a dial indicator on the end surface of the second-stage tie bolt. Zero the indicator.
5. Push the rotor assembly toward first-stage inlet until the first-stage impeller touches the shroud.
6. Record the reading from the dial indicator. This reading is the shroud-to-shroud clearance—the total axial movement of the rotor assembly before the impeller rubs the shrouds on either side.
7. Repeat steps 3–6 at 90° intervals, three more times. The smaller value measured is the minimum shroud-to-shroud clearance. If this value varies by more than 0.0508 mm, contact Atlas Copco Parts and Service Centre.

G 9.5 Obtain the impeller-to-shroud clearance reading

1. Obtain the impeller-to-shroud allowable clearance tolerances from the Core Unit Assembly drawing in chapter H1, Drawings.
2. Add together the two maximum allowable impeller-to-shroud clearances (first stage and second stage).
3. Similarly, add together the two minimum allowable impeller- to-shroud clearance numbers (first stage and second stage), and the minimum allowable float.
4. If the maximum shroud-to-shroud clearance that was measured (in previous steps 3–6) is larger than the sum of the maximum allowable clearances plus the maximum float (step 2, ...), increase the total length of the rotor assembly by increasing the thickness of the spacer behind the second-stage impeller. If the clearance is smaller than the minimum allowable clearance plus the minimum float (step 3, ...), decrease the thickness of the spacer.
5. To change the spacer, remove the impeller. Adjust the spacer by grinding it or by replacing it with a full-size one that has been ground to the required size.
6. Reinstall the impeller and repeat steps beginning with step 2 under Getting the shroud-to-shroud clearance reading through step 5 above until the measured shroud-to-shroud clearance is within the tolerances shown in the drawing.
   Then, set the first-stage impeller clearance as follows.

G 9.6 Set the first-stage impeller clearance

1. Push rotor assembly toward the second stage until it touches the shroud. Zero the dial indicator.
2. Repeat step 1 (as a double-check).
3. Push the rotor assembly toward the first stage until the loaded shim pack is fully compressed.
4. Record the dial indicator reading.
5. Subtract this reading from the minimum shroud-to-shroud clearance obtained in previous step 6. This is the **first-stage cold clearance.**
6. Then, take the reading from step 3 and subtract the maximum axial float (shown on drawing). This is the **minimum allowable second-stage cold clearance.**
7. Install the second stage loaded shim pack.
8. Push the rotor assembly toward the second stage. The dial indicator reading is the **second-stage cold clearance.** This reading should be equal to or greater than the number obtained in step 6 and should fall within the tolerance given on the drawing.
9. Push the rotor assembly toward the first stage. The difference between the dial indicator readings (this step and step 8) is the axial float, which also must fall within the given tolerance on the drawing.

10. If the measured axial float is not within tolerance, make adjustments to the shim packs as follows.
    - To give the assembly more axial float, tighten up one of the stages, logically the most open stage, as shown on the drawing.
    - Remove units of 0.0508 mm shim from the loaded side and add them to the unloaded side of the bearing that has the tightest minimum clearance.
    - Conversely, if the float is too large, adjust the shim pack of the bearing on the tight side by taking a shim from the unloaded side and adding it to the loaded side. This will increase the clearance and decrease the float.
11. Install the top halves of the bearings.

G 9.7 Lead check

A good second check for setting impeller-to-shroud clearances is to run a "lead check" in the following manner:

CAUTION

Check only one impeller at a time.

1. Drape a short section (50.8 to 76.2 mm) of 3.175 mm lead solder over the trailing edge of the impeller at three places, 120° apart and 12.7 mm in from the outer diameter of the impeller. Secure the solder with masking tape.
2. Assemble the diffuser plate and install the shroud, drawing down the bolts to the correct torque.
3. Wait 15 minutes.
4. Disassemble shroud and diffuser plate.
5. CAREFULLY remove the lead strips without bending them and measure the crushed thickness with a vernier caliper.
6. Using the measured axial float obtained in step 7 under Getting the shroud-to-shroud clearance reading, subtract the axial float number from the thickness of each lead strip. The smaller value gives the minimum cold clearance between the edge of the impeller and the shroud. This number should be the same as the cold clearance calculated for that stage in the previous section and should fall within the tolerance shown on the Core Unit Assembly drawing in chapter H1, Drawings.

CAUTION

If any of the gears are changed, check gear backlash in four places. The backlash must be between 0.254 and 0.635 mm. If it is not, contact the Atlas Copco Parts and Service Centre.

G 9.8 How to reassemble the gear cap

Seal the gear cap per work standards in chapter H2, then follow these steps to reassemble.

CAUTION

Do NOT put sealant on the bearings

1. With the same rigging and guide pins that were used to remove the gear cap (see chapter How to remove the gear cap), carefully replace the gear cap.

CAUTION

Keep the cap level when lowering it. Make sure that it does not swing and damage the drive gear.

2. Torque the gear cap per procedure 903.99.0, given in chapter H2, Additional Specifications and Procedures.
3. Replace the vibration probes.

CAUTION

Handle the probes with great care so as not to damage the probe tips.

4. Replace any piping that was removed; for example, inlet piping.
5. Recheck bull gear float to ensure that the bearings did not move before the gear cap was tightened down.

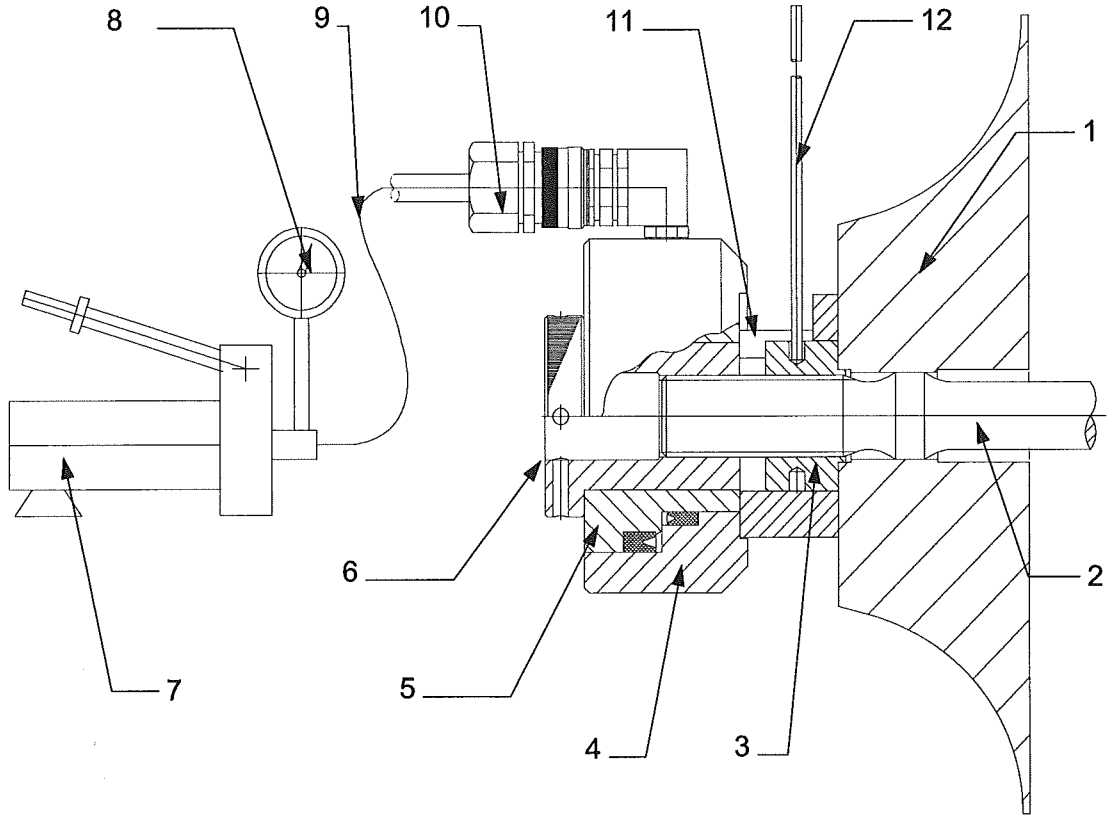
G 10 Tools

The following list includes special tools required to carry out assembly procedures on the machine; also tool material numbers are added. Please use only tools mentioned here.

Standard tools such as wrenches, torque wrenches and others are not included in AC's scope of supply presupposing that they are available on site. Furthermore we do not deliver dial gauges and necessary auxiliary equipment.

	Material number
Hydraulic tensioning device impeller	1320 707 868
Hydr. body	1320 709 708
Tie nut	1320 709 712
	1320 708 057
Impeller assembly device	1320 707 988
Hydr. body	6970 089 450
Tie nut	1320 707 834
Distance sleeve	1320 708 521
Hydr. pump	6970 015 121

G 10.1 Screw pre-stressing device



1	Impeller	7	Hydraulic pump
2	Impeller tie bolt	8	Pressure gauge
3	Impeller nut	9	Hydraulic hoses
4	Hydraulic cylinder	10	Hydraulic connection
5	Hydraulic piston	11	Distance adapter
6	Tie nut	12	Adjusting rod

- **General**

These operating instructions are designed to inform you about the operation and safe handling of the screw pre-stressing device (referred to hereafter as SSV).

Please read these instructions thoroughly and make sure that they are accessible to all users.

- **Safety**

Safe handling of the SSV and its hydraulic accessories is conditional upon adherence to the general accident prevention regulations and the following instructions:

WARNING

Danger of life and liberty

May lead to serve injuries

- When leakage occur during pressurization, de-pressurise immediately and seal the leakage or replace defective parts.
- In case of repair, use exclusively original spare parts. Inexpert replace-ment of damaged parts by non-original spare parts is prohibited.
- All components are exclusively to be handled as specified in the operating instructions and the assembly drawing. A change in procedure or application of the SSV is prohibited.
- In order to use the SSV, the projecting end of the thread has to be sufficiently long to avoid cracks in thread turns.
- When pressurising the unit, all staff in question have to keep a sufficient safety distance and stay away from the direction of the screw axis.
- The SSV must only be operated and handled by expert staff.
- The specified max. stressing pressure must not be exceeded in any case. It must be watched at the manometer of the pressure generator during the entire stressing or loosening procedure. When the specified pressure is reached, stop pressurising immediately.
- During pressurisation when stressing or loosening the screw connection, always observe the admissible stroke of the SSV. Any excess in this stroke entails damage to the SSV and danger of accidents or generation of insufficient pre-stressing force.
- When coupling high-pressure hoses, always ensure that the connections are made properly.
- The hydraulic hoses have to be installed in a way that they are not run over by vehicles or walked over by people. Never lay hoses across sharp objects (danger of cutting) and never bend or jam them in (see also chapter: "coupling of high-pressure hoses".)

To achieve a high-precision screw connection, it is vital to observe the following instructions:

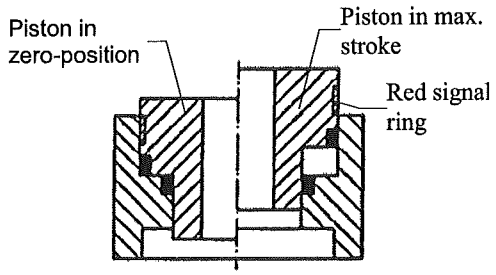
- Prior to applying the device clean all threads and remove any damage to avoid any seizing.
- The base plate of the SSV must be level and free of dirt. Further, check for scariness toward the screw axis to avoid the screw bolt being subjected to bending stress during pressurisation (stressing).

- **Stroke indicator**

The SSV is equipped with stroke indicator that shows when the piston has reached its maximum admissible stroke. The piston of the SSV is provided with a red ring. If the piston is in it zero-position, the ring is hidden by the cylinder of the SSV (see picture).

CAUTION

The max. admissible stroke of the SSV is reached, when the signal ring is fully visible. If this is the case, stop pressurising immediately (refer to sheet "stressing and loosening procedure").



- **Coupling of high-pressure hoses**

Always couple only when the unit is depressurised.

Pull the hose with a manual force of about 100 N to make sure that the connection is correctly tight.

- **Stressing procedure of the SSV**

Prior to stressing make sure that the components to be stressed are in the correct position toward each other. Then, apply the SSV to the screw bolt as shown on the drawing. The bore in the piston of the SSV has to aligned centrally toward the screw axis before the tie nut is screwed on to avoid any inclination of the bolt. Tighten the tie nut until it fits tight to the front surface of the piston so that the distance sleeve contacts the flange (impeller hub). Also ensure that the piston of the SSV is in its zero position in the process and that the hydraulic connections and the window openings are easily accessible.

After all hydraulic connections have been correctly made, start pressurising to pre-stress screws by means of the hydraulic pump. When the required stressing pressure is reached, stop pressurising. The induced force causes the screw bolt to extend, the components to be stressed to edge, and the impeller nut to lift from the impeller. Use the adjusting rod to screw the nut back to the impeller and depressurise the pump.

Repeat this operation twice to compensate for any settling. Pre-stressing of the screw connection is now accomplished.

After the piston has been returned to its zero position, uncouple the hydraulic hoses. To prevent impurities, close coupling sleeves and coupling nipples or loosened screw connections at once by applying protective caps.

Unscrew the tie nut and remove the SSV from the screw bolt.

- **Loosening procedure of the SSV**

Loosening of screw connections is effected as described for pre-stressing.

When the tie nut contacts the front face of the piston and the distance sleeve contacts the flange, turn the tie nut back by half a turn to one turn of the nut.

Start pressurising after all hydraulic hoses have been properly coupled.

During the pressurisation operation a slight de-stressing moment must be applied to the main nut by means of the adjusting rod or the pinion. Interrupt the depressurisation operation at the moment the impeller nut can be loosened.

CAUTION

This pressure is slightly lower than the stressing pressure that was applied to pre-stress the connection! Should it turn out to be impossible to loosen the impeller nut when the original pre-stressing pressure is reached, interrupt the pressurisation operation at once. Contact expert staff to find the associated reason.

When the loosening pressure is reached, turn the impeller nut back by the value that the screw bolt and the components spring back in the course of the loosening opera-tion.

The impeller nut must never be turned back to the extent that it contacts the piston or the cylinder, as this might lead to the SSV being stressed in itself.

De-pressurize after the impeller nut has been turned back. Loosening of the screw connection has now been accomplished.

Prior to taking off the SSV return the piston to its zero position (refer to page "Piston return stroke"). Now, uncouple the hydraulic hoses. To prevent impurities, close coupling sleeves and coupling nipples or loosened screw connections at once by means of protective caps.

Unscrew the tie nut and take the SSV off the screw bolt.

CAUTION

The pressure required to loosen the impeller nut must never exceed the pre-stressing pressure that was used to pre-stress the connection! Should it turn out to be impossible to loosen the impeller nut when the original pre-stressing pres-sure is reached, stop pressurizing at once. Contact expert staff to find the associated reason.

Strict adherence to safety and work instructions is mandatory!

Should it be impossible to loosen the tie nut after the pressure has been bled, it has been turned back by too low a measure prior to pressurisation.

Pressurize again until the original stressing pressure is reached, turn the impeller nut and de-pressurize again (stressing procedure).

Now, continue to turn the tie nut back.

CAUTION

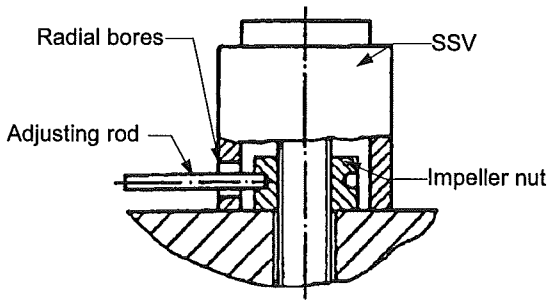
Pay attention to the permissible stroke of the SSV.

Repeat the described loosening procedure.

Should it be impossible to loosen the impeller nut after de-pressurization, it has been turned back by too low a measure. Pressurize again and turn the impeller nut further back. Then, de-pressurize again.

- **Adjustment and turnback of the impeller nut**

During the loosening procedure, never turn back the impeller nut to the extent that it contacts the piston or the cylinder, as the impeller nut will get stuck after depressurization.



The impeller nut is equipped with several radial bores to receive the adjusting rod (included in scope of supply). The impeller nut is accessible through the window opening in the distance sleeve or in the support cylinder of the SSV.

- **Piston return stroke**

Manual piston return stroke

The manual piston return stroke is effected by screwing down the SSV itself on the screw bolt prior to taking the SSV off. In the process, the piston must be brought into contact with the cylinder by means of the tie nut.

- **Exchanging the gaskets**

Should leakage occur at the piston of the SSV, it might be necessary to exchange the gasket.

Drive out the piston by carefully beating with a hammer while using a plastic spacer to protect the SSV from accidental damage. To facilitate the removal of the piston, take off the high-pressure connection and loosen the breather screw, if any. By removing the hydraulic connection it is also possible to conduct compressed air carefully into the piston area. In the process, any breather screw remains closed

WARNING

Danger of life and liberty

May lead to severe injuries.

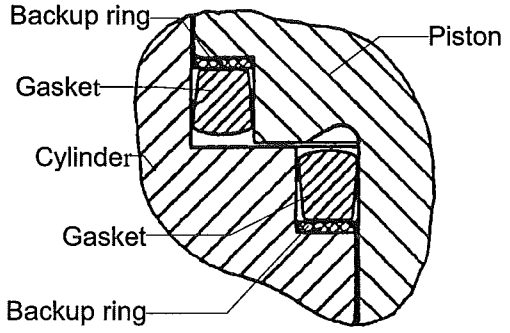
- Sudden input of pressure may lead to an uncontrolled ejection of the piston.

After the piston is taken out, remove the gaskets and the backup rings from the pis-ton and the cylinder.

Carefully clean the single parts using lint-free material and check them for damage. You may use compressed air for cleaning, but never aggressive cleaning liquids.

Then apply a slight film of hydraulic oil to the single components and assemble new backup rings and gaskets on piston and cylinder as specified on the drawing.

As illustrated in the picture, first assemble the single backup ring, then place the gasket with its flat side onto the backup ring.



Piston and cylinder can now be re-assembled by putting the components together. Doing so, adherence to the instructions for „assembly and disassembly of the SSV for the exchange of gaskets" is mandatory, depending on the individual model. Drive in the piston until it fits tightly to the cylinder (piston in its zero position) by slightly beating on the upper piston part with a hammer (use plastic spacer). It is essential that the piston does not tilt in the process, since this might damage the gaskets and the components.

When installing the piston make sure that air can escape from the piston area.

- **Maintenance and storage**

The SSV does not require regular maintenance, but the following instructions should be observed:

- **Storage of the SSV**

After each application of the SSV repair any damage and clean it to make sure that it is ready for the next application.

To avoid corrosion, we advise to apply a layer of oil to the SSV and in particular its thread. All coupling nipples, coupling sleeves and also loosened screw connections are to be covered by protective caps.

Also check the single components of the SSV and its accessory for completeness, this includes also the manual.

Then store the SSV in a dry place where it is also protected against any mechanical damage.

Temperatures in that place must range from -20°C to +70°C to rule out any damage to the gaskets.

Vertical storage of the SSV (thread axis vertical) will increase gasket service life.