Repair manual

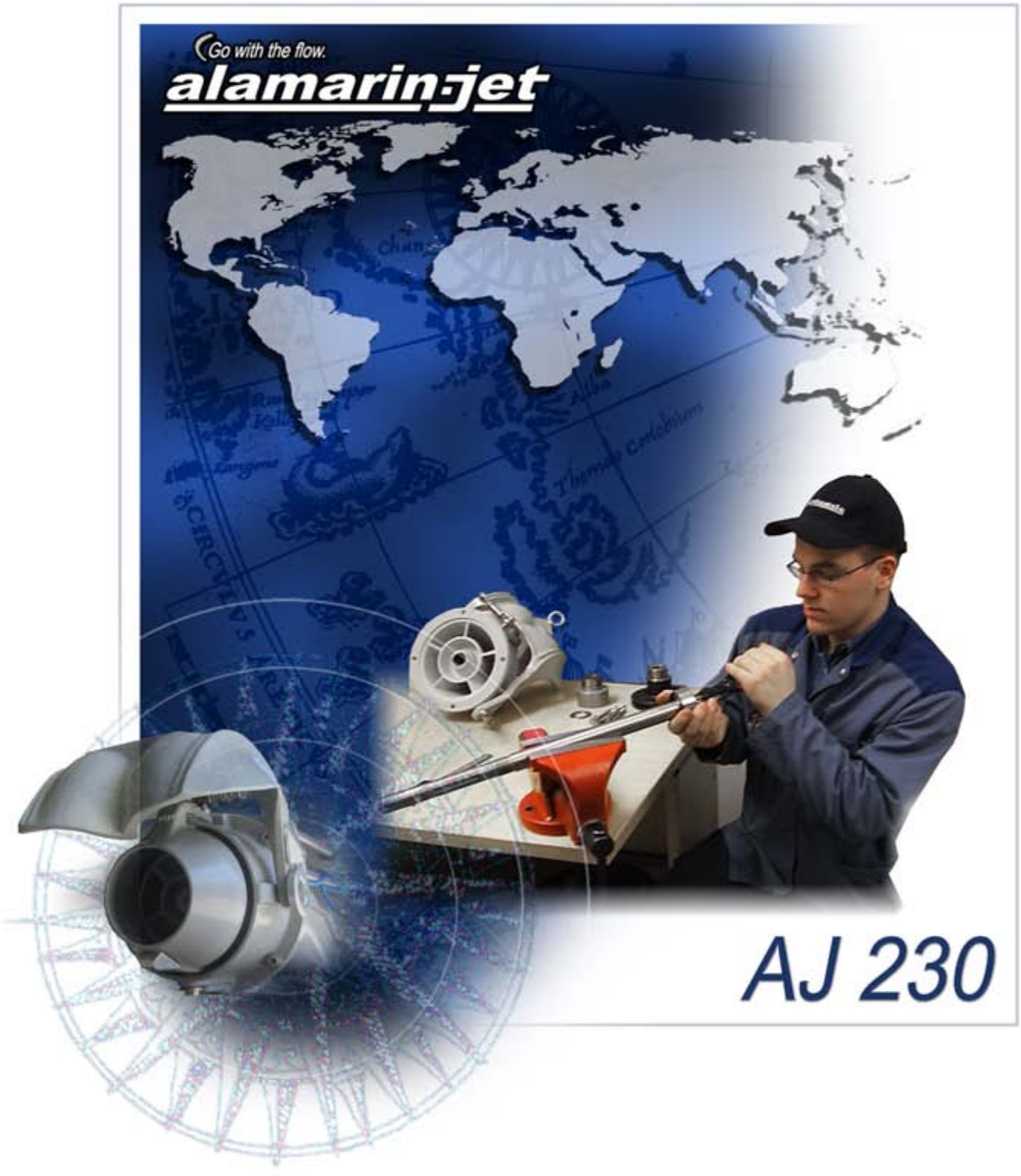

Table of contents

1. Introduction

This is the repair manual for Alamarin-Jet's AJ 230 water jet propulsion unit. This manual is intended for the owners, users, and repair persons of boats that are equipped with the Alamarin-Jet water jet propulsion unit. With the help of this manual, they can carry out the most common repair procedures for AJ 230 water jet propulsion units.

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1.1. Safety precautions

Read these instructions carefully before carrying out any procedures. Always follow these instructions and the safety precautions shown below.

- Only a person with adequate training is allowed to carry out the procedures described in this manual.
- The person carrying out the procedures must always wear the appropriate protective equipment.
- The work premises must be sufficiently large, safe and well-lit.
- The tools that are to be used must be clean and appropriate for the intended purpose.

1.2. Symbols

Please refer to table 1 for a description of the symbols used in this manual.

Table 1. The symbols used in the manual

Icon	Description
	DANGER Negligence in the performance of a procedure can endanger your life.
	WARNING Negligence in the performance of the procedures can lead to personal injury, breakdown of equipment, or serious malfunction of the equipment.

Icon	Description
	CAUTION The procedure involves minor danger or a possibility of minor damage to equipment.
	WARRANTY The warranty is voided if the procedure is carried out incorrectly.
	NOTE Important notice or fact.
	TIP Additional information that facilitates the performance of work or a procedure.
	MAINTENANCE ON LAND The boat must be lifted out of the water for maintenance.
	MAINTENANCE IN WATER The maintenance procedure can be carried out in water.
	CARRIED OUT BY ONE PERSON One person can carry out the procedure.
	CARRIED OUT BY TWO PERSONS The maintenance procedure requires two persons.
	INDICATOR ARROW
	ARROW DESCRIBING MOTION

2. Intermediate shaft

Between the jet and the engine, there is always an intermediate shaft which transmits the power from the engine to the jet's main shaft. Normally, the intermediate shaft has been chosen and installed by the boat's manufacturer.

There are different types of intermediate shaft. The joint types used in the intermediate shaft also vary. Intermediate shaft joint types used in boats equipped with the jet are depicted in table 2.

Table 2. Intermediate shaft joint types

Type	Description
Constant speed joint	A constant speed joint is a cardan shaft, which allows angle deviations. On the engine side, it is attached to the flywheel, to a coupling flange installed by the engine manufacturer or to the gearbox. The joints are based on balls rolling on a spherical surface. The constant speed joint enables vibration-free running even if the joint angles at different ends of the shaft deviate from each other.
Rubber joint	The rubber joint is an elastic rubber element on the intermediate shaft. The rubber element dampens the vibration and sudden torsional loads that are transmitted from the engine to the boat's hull, and allows some angle deviation.
Cardan shaft	The cardan shaft is an articulated shaft. The cardan shaft has been pivoted with spider bearings. The joint angles at different ends of the shaft must be of equal size to attain vibrationless running.

2.1. Removing the intermediate shaft joint

The removal process is similar in all joint types. When removing the joint, note that there may be an adapter flange between the joint and the engine. The adapter flange is used to fit the shaft and engine flange hole spacings to each other. There may also be an adapter flange between the jet's coupling flange and the joint.

Removing the intermediate shaft joint:

1. Open the joint fastening screws from the jet side and leave the possible adapter attached to the coupling flange.

   Depending on the model, the screws can be hex or socket screws (figure 1).

Figure 1. Intermediate shaft fastening bolts

2. Open the joint fastening screws from the engine side and leave the adapter (if one exists) attached to the flywheel or flywheel coupling flange adapter.

2.2. Repairing the intermediate shaft joint

Follow the intermediate shaft and joint manufacturer's instructions when repairing the intermediate shaft joint.

2.3. Installing the intermediate shaft joint

The intermediate shaft joint is reinstalled in the reverse order to which it was removed. Always follow the joint manufacturer's instructions when installing the intermediate shaft joint.

Tightening the fastening screws

The fastening screws of the intermediate shaft joints must be tightened sufficiently well so that the joint is attached evenly against the coupling flange.

Before tightening the screws, check whether the joint manufacturer has given any special tightening instructions and follow them when necessary.

Tightening the fastening screws of the intermediate shaft joints:

1. Apply thread locking compound to the thread.

   Follow the shaft manufacturer's recommendations regarding locking compound.

2. Using a torque wrench, tighten the screws gradually in a crosswise sequence until they are at the correct torque.

   Check the correct torque with the joint manufacturer.

Balance

The intermediate shaft will function correctly when the joints at different ends are at the correct angle, the intermediate shaft is in balance and the installation has been carried out correctly. Imbalance in the intermediate shaft, flanges that have been tightened or attached incorrectly, or too big angles at the joints will cause rapid breakdown of the equipment.

WARRANTY!

If an intermediate shaft that has been installed or balanced incorrectly causes damage, this will not be covered by the warranty.

3. Coupling flange

The jet's main shaft has a coupling flange. The coupling flange type depends on the intermediate shaft type and engine power. The most common coupling flange types are DIN 120, VNA 15 and VNA 21.

3.1. Removing the coupling flange

The removal process is similar in all coupling flange types. When removing the coupling flange, note that there may be an adapter between the coupling flange and the intermediate shaft, which enables fastening.

It is recommended that the coupling flange is removed with the help of an extraction tool specifically designed for this purpose, which is available as an accessory to the AJ 230 jet.

Removing the coupling flange:

1. Unscrew the coupling flange M16 fastening nut (figure 2, point A).

   Also remove the nut spacer (figure 2, point B).

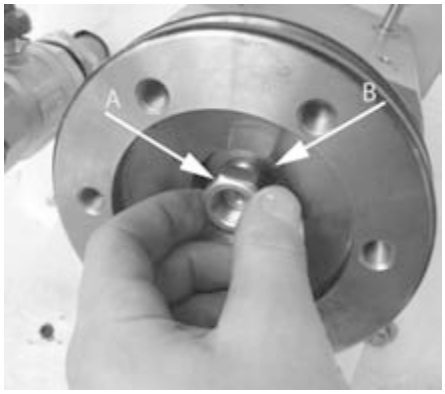


Figure 2. Removing the coupling flange nut

2. Pull the flange off with an extraction tool (figure 3).

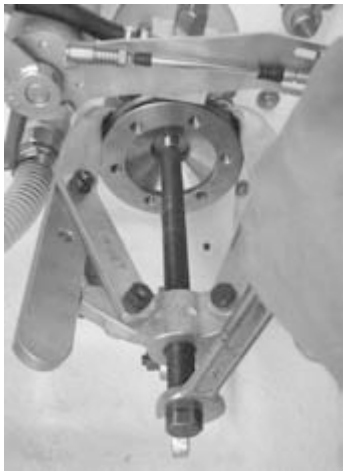


Figure 3. Removing the coupling flange with an extraction tool

3. Remove the wedge from the groove (figure 4).

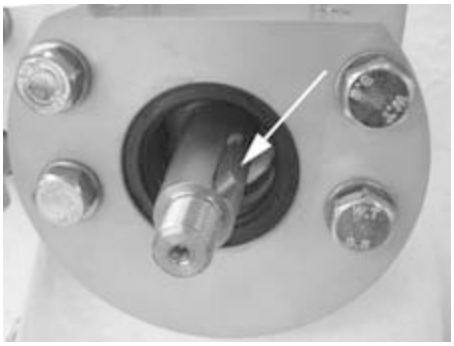


Figure 4. Coupling flange wedge

3.2. Repairing the coupling flange

The coupling flange often cannot be repaired, but instead must be replaced entirely.

3.3. Installing the coupling flange

The coupling flange is reinstalled in the reverse order to which it was removed.

Installing the coupling flange:

1. Set the wedge in the groove.
2. Push the coupling flange back onto the shaft.
3. Put the nut spacer in place.
4. Apply thread locking compound to the thread at the end of the shaft.

   The appropriate thread locking compound type is given in appendix 3. *Tightening torques*, page 61.

5. Tighten the nut.

   The tightening torque of the nut is 100 Nm.

TIP!

While tightening the nut, the shaft may rotate. You can stop the shaft from rotating by pushing a bolt through the intermediate shaft's fastening bolt hole against the surface of the bearing housing (figure 5).

Figure 5. Preventing the shaft from rotating

4. Main shaft and bearing

The main shaft has a bearing at both ends. The front bearing housing is two-piece, the rear-end bearing housing is one-piece.

4.1. Front bearing

The two-piece front bearing housing consists of the actual bearing housing and a support bearing housing. The bearing housing is fixed to the unit's body with four hex screws. The actual bearing housing is also attached to the body with sealing and adhesive compound.

4.1.1. Front bearing disassembly

Before the bearing can be disassembled, remove

- the stator, with the reversing deflector and steering nozzle (section 10.1. *Removing the stator*, page 55)
- the impeller (section 5.1. *Removing the Impeller*, page 24).
- the coupling flange (section 3.1. *Removing the coupling flange*, page 7).

Then, remove

- the intermediate shaft from the coupling flange
- the oil pump of the reversing deflector's actuating cylinder (section 7.2.1. *Removing the hydraulic pump*, page 43).

Front bearing disassembly:

1. Open the fastening screws (four in total, figure 6).

Figure 6. Bearing housing fastening screws

2. Pull off the support bearing housing (figure 7).

   It is not necessary to remove the actual bearing housing unless it is damaged.

Figure 7. Removing the support bearing housing

3. Remove the entire rear end of the jet (section 10.1. *Removing the stator*, page 55, point Removing the stator as a complete unit and 5.1. *Removing the Impeller*, page 24).

4. Remove the shaft.

   The shaft protrudes into the engine room with the bearings. The adapter may be tight, but when pushed from the outside, enough force is produced to remove the shaft (figure 8).

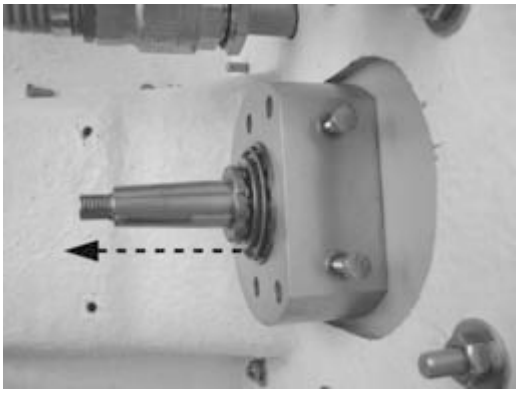


Figure 8. Push direction of the shaft

5. Remove the bearing.

   An angular ball bearing is fitted to the shaft (figure 9, point A), which receives the thrust and carries some of the radial loads. The bearing is locked with a safety plate (figure 9, point B) and a spinner nut (figure 9, point C).

   5.1. Bend the safety plate's spinner nut locking latch up and unscrew the spinner nut.

   5.2. Push the bearing in the direction of the spinner nut (figure 9, point D).

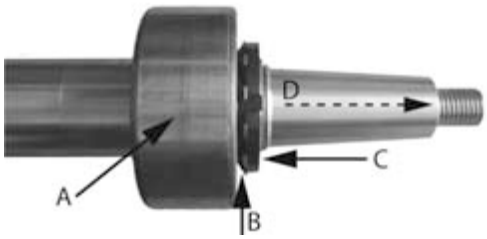


Figure 9. Angular ball bearing

6. Remove the groove ball bearing that carries radial loads from behind the safety ring (figure 10) in the support bearing housing.

   6.1. Remove the safety ring (figure 10).

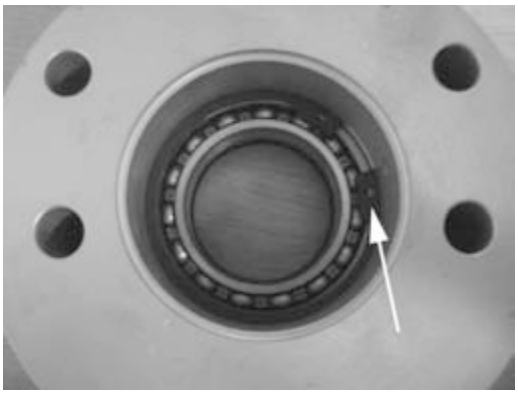


Figure 10. Safety ring

   6.2. Push the seal and the bearing from the seal side at the same time (figure 11).

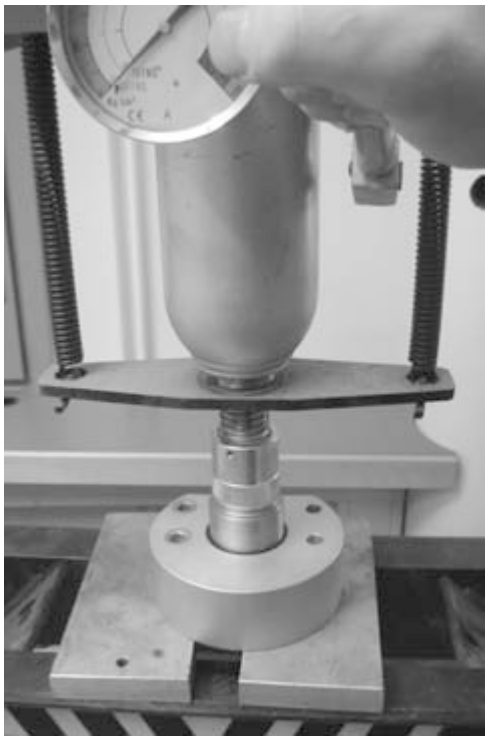


Figure 11. Removing the groove ball bearing

7. Remove the two remaining shaft seals from the bearing housing with a screwdriver, for example (figure 12).

> **NOTE!**
>
> Do not scratch the bearing housing surfaces.

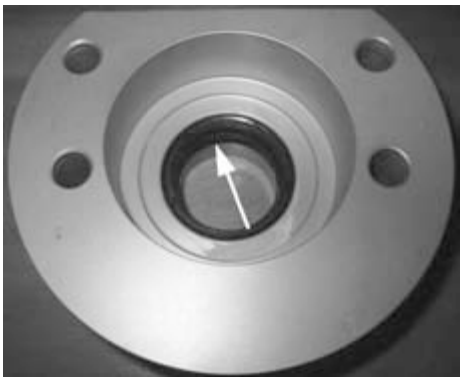


Figure 12. Shaft seals

4.1.2. Repairing the front bearing

A damaged or worn out front bearing must be replaced. The seals are also replaceable. They should be replaced when the bearing is replaced.

4.1.3. Installing the front bearing

Before beginning the procedure, make sure that the bearing housing and the support bearing housing are completely clean.

Front bearing installation:

1. Push the new shaft seals into the bearing housing (figure 13, point A).

   Pay attention to the direction of the lips! As the seal is being pushed into place, the lips must point away from the person doing the installation.

CAUTION!

If the shaft seal is installed the wrong way round, water will get into the bearing housing!

The ring supporting the seal lips must be made of rubber, as a steel spring will rust!

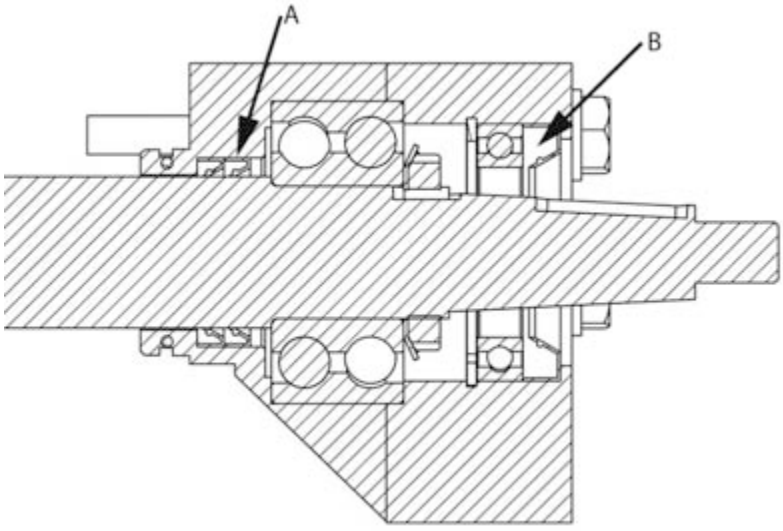


Figure 13. Shaft seal installation

2. Push the bearing into the shaft.

3. Fit the safety plate in place (figure 14).

Figure 14. Safety plate

4. Tighten the spinner nut with a special wrench or by carefully tapping the nut on the grooves of the outer rim, for example, with a screwdriver and hammer (figure 15).

Figure 15. Tightening the spinner nut

5. Bend one latch from the safety plate into the groove in the spinner nut (figure 16).

Figure 16. Safety plate latch

6. Push the shaft through the bearing housing, ensuring that the bearing goes right to the bottom of the bearing housing.

7. Place the shaft seals in the support bearing housing.

   Pay attention to the direction of the lip! The lip must point towards the person doing the installation. A correctly installed seal prevents grease from getting into the engine room.

8. Push the groove ball bearing into the support bearing housing and place the safety ring in the groove.

9. Add grease to the bearing housing.

   Check the recommended grease from appendix 1. *Grease recommendations*, page 59.

CAUTION!

An empty bearing housing takes around 50 injections with a grease gun. The bearing housing is full when excess grease comes out through the intake duct.

10. Reinstall the hydraulic pump (section 7.2.3. *Installing the hydraulic pump*, page 47).

11. Reinstall the coupling flange (section 3.3. *Installing the coupling flange*, page 8).

4.2. Rear-end bearing

The rear-end bearing housing is glued to the stator. The rear bearing is normally grease lubricated. In some cases the rear bearing is water lubricated. Disassemby and assembly is done the same way in both cases.

4.2.1. Rear-end bearing disassembly

The rear-end bearing housing can be removed. When the rear-end bearings are replaced, it is advisable to replace the entire bearing housing. When only changing the seals, they should be replaced without removing the bearing housing.

Before the rear-end bearing can be disassembled, remove

- the reversing deflector (section 6.1. *Removing the reversing deflector*, page 31)
- the steering nozzle (section 8.1. *Removing the steering nozzle*, page 51)
- the stator (section 10.1. *Removing the stator*, page 55).

Rear-end bearing disassembly:

- Remove the bearing housing from the stator by pushing the bearing housing from the back until it comes loose (figure 17).

Figure 17. Removing the bearing housing

4.2.2. Repairing the rear-end bearings

A damaged rear-end bearing must be replaced. The replaceable parts in the rear-end bearing are the shaft seals and the wear sleeve at the rear end of the shaft.

Changing the shaft seals

1. Remove the safety ring (figure 18).

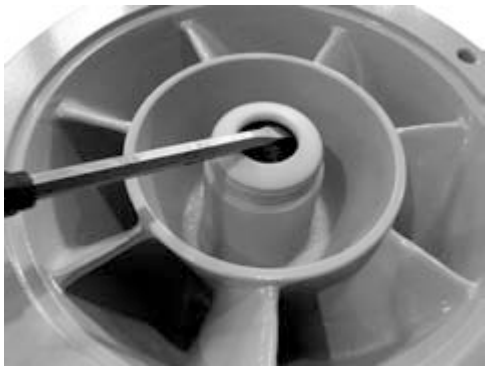


Figure 18. Removing the safety ring

2. Remove the shaft seals with a screwdriver, for example (figure 19).

Figure 19. Removing the shaft seals

3. Install the new shaft seals.

   Pay attention to the direction of the lips! They must point towards the person doing the installation.

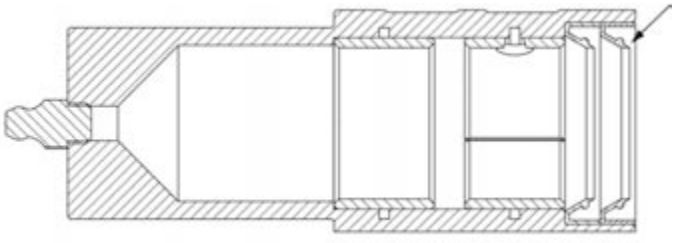


Figure 20. Direction of the shaft seal lips

CAUTION!

If the shaft seal is installed the wrong way round, water will get into the bearing housing!

The ring supporting the seal lips must be made of rubber, as a steel spring will rust!

Changing the wear sleeve:

1. Unscrew the wear sleeve nut (figure 21, point A) and the locking plate (figure 21, point B).

   Sealing compound has been applied between the wear surface and the shaft to prevent water flow. This is why force must be used to withdraw the sleeve.

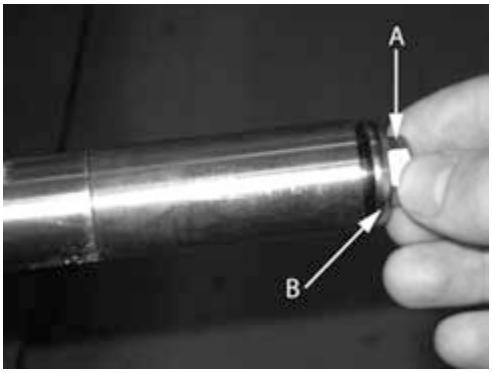


Figure 21. Wear sleeve

2. Replace the sleeve with a new one.
3. Position the locking plate and the nut at the end of the shaft.

   The tightening torque is 40 Nm.

4.2.3. Installing the rear-end bearing

Installing the rear-end bearing:

1. When assembling a new bearing housing or water-lubricated bearing, clean the stator carefully of old adhesive residues.
2. Spread sealing compound on the outer surface of the bearing housing (figure 22) and push the bearing housing into place.

Figure 22. Spreading sealing compound

3. Wipe any excess adhesive off the area of the bearing housing and stator seam.

4. Allow the adhesive to dry for 24 hours before installing the stator.

   Follow the adhesive manufacturer's recommendations.

5. Reinstall the stator (section 10.3. *Installing the stator*, page 57).

6. Grease the rear bearing.

   Check the recommended grease from appendix 1. *Grease recommendations*, page 59.

7. Reinstall the steering nozzle (section 8.3. *Installing the steering nozzle*, page 52).

8. Reinstall the reversing deflector (section 6.3. *Installing the reversing deflector*, page 33).

5. Impeller

The impeller is fixed to the main shaft using a plastic fastening part with a contracting cone. Torque transmission takes place with a wedge.

Checking the impeller type

The impeller type used is determined by engine power and maximum revolutions. When changing the impeller, it is important to know the impeller type. A type marking is stamped on each impeller, which makes it easy to recognise the type (figures 23 and 24).

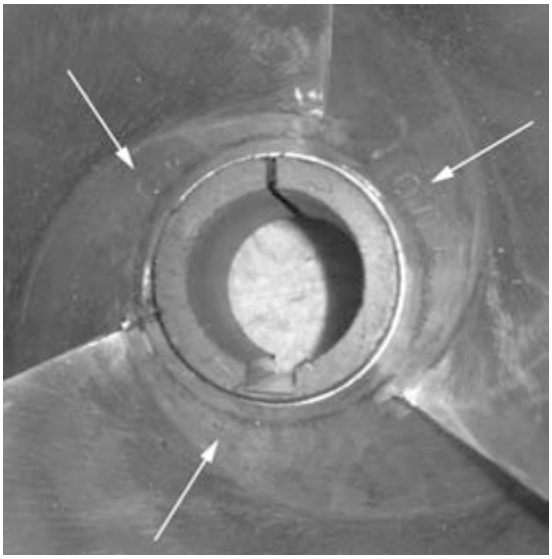


Figure 23. Impeller type marking on the blades

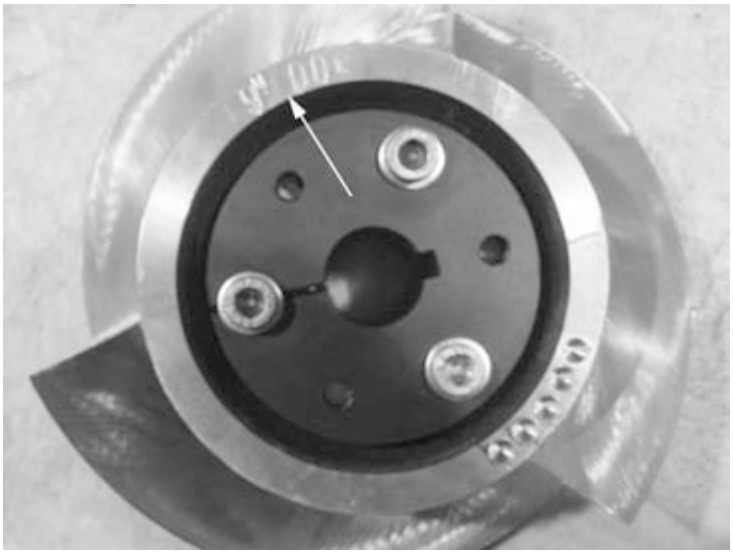


Figure 24. Impeller type marking on the body

If there are no markings or they are worn, the easiest way to check the impeller type is by measuring: Appendix 4. *Impeller data*, page 62 includes a figure showing all measurements defining the impeller size.

Checking the impeller type:

1. Loosen the adjuster sleeve.

2. Push the impeller into the impeller duct as deep as it will go.
3. Place a straight ruler against the rear edge of the cone (figure 25) and measure the distance from the rear edge of the impeller duct to the rear edge of the impeller. This measurement is 2 mm at the smallest.

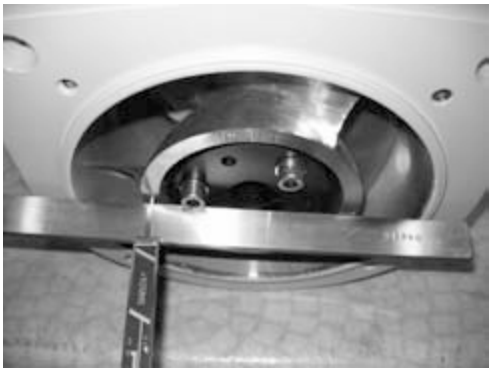


Figure 25. Impeller dimensions

4. Measure the impeller blade span (figure 26).

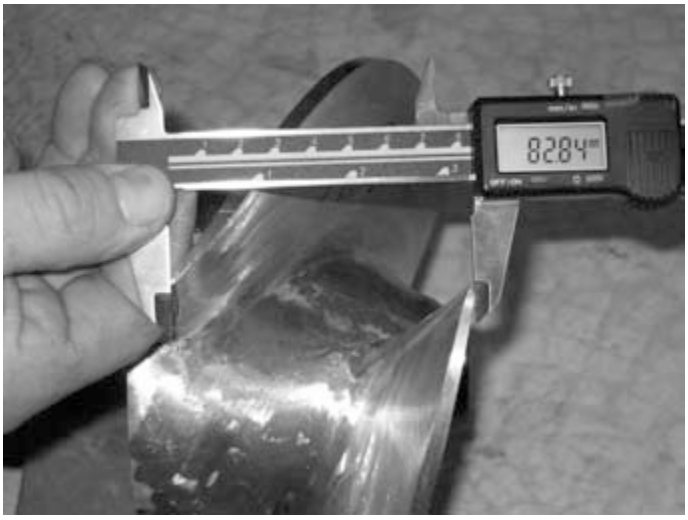


Figure 26. Measuring the impeller blade span

5.1. Removing the Impeller

Before removing the impeller, remove

- the reversing deflector (section 6.1. *Removing the reversing deflector*, page 31)
- the steering nozzle (section 8.1. *Removing the steering nozzle*, page 51)
- the stator (section 10.1. *Removing the stator*, page 55).

Removing the impeller:

1. Loosen the impeller fastening screws (figure 27) and remove one completely.

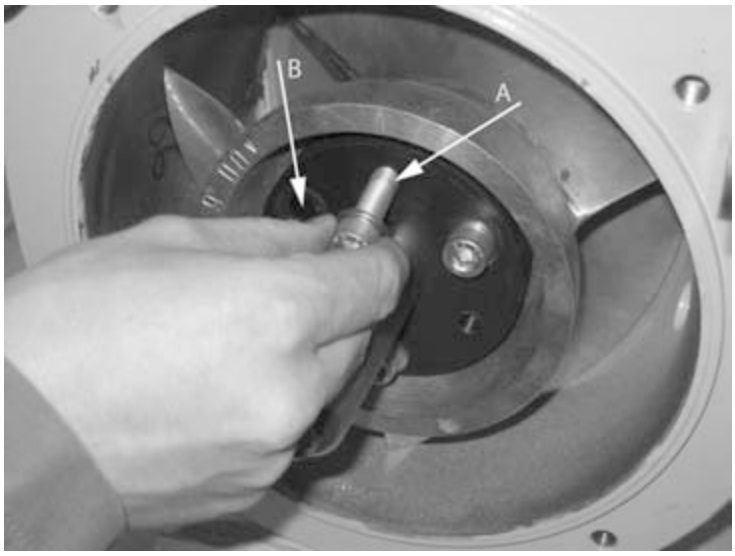


Figure 27. Removing the impeller

2. Screw the removed screw into the threaded hole in the plastic cone (figure 27, point A) and tighten it carefully until the cone loosens.
3. Take the screw out of the threaded hole and spin it loosely back into its original place (figure 27, point B).
4. Pull the impeller off the shaft.

   If the plastic cone is still sitting tightly on the shaft, preventing the removal of the impeller, you can loosen it by pushing a screwdriver into the opening in the cone and forcing the cone open (figure 28).

Figure 28. Impeller plastic cone

5.2. Repairing the impeller

Faults with the impeller that require repair are slight bending and cracking of the blades.

Bent blade repair:

1. Tap the bent blade carefully back to its original position.

   The front edge can be repaired by carefully hammering the marks caused by bigger stones and grinding them smooth. The front edge must not be sharpened, it must be left about 2 mm (approx. 0.08") thick and rounded r = 2 mm (approx. 0.08").

   Compare the position of the blade to the other blades.

2. Make sure that there are no cracks at the bending point.

   If there are any visible cracks, they must be repaired by welding or the impeller must be replaced.

If a piece has broken off the blade, it can be repaired by welding filler metal into the crack. However, repairing a broken blade is not recommended due to the risks involved. If the impeller blade has broken, it is best to replace the entire impeller.

CAUTION!

Welding can create heat stress, which may cause the impeller to break when used. This is why the manufacturer is not responsible for the breakdown of a repaired impeller.

Impeller material: GTp10

Filler metal: EL-CuSn7 (ESAB OK 94.24)

NOTE!

If the impeller has been repaired with filler metal, it should be machined if necessary, and it must be balanced!

5.3. Installing the impeller

New and repaired impellers are fitted in the same way.

Installing the impeller:

1. Screw the adjuster sleeve (figure 29, point A) and the possible additional ring onto the shaft.

   The sleeve has a left-hand thread, but the additional ring is unthreaded. The sleeve must be screwed onto the shaft all the way down the threading.

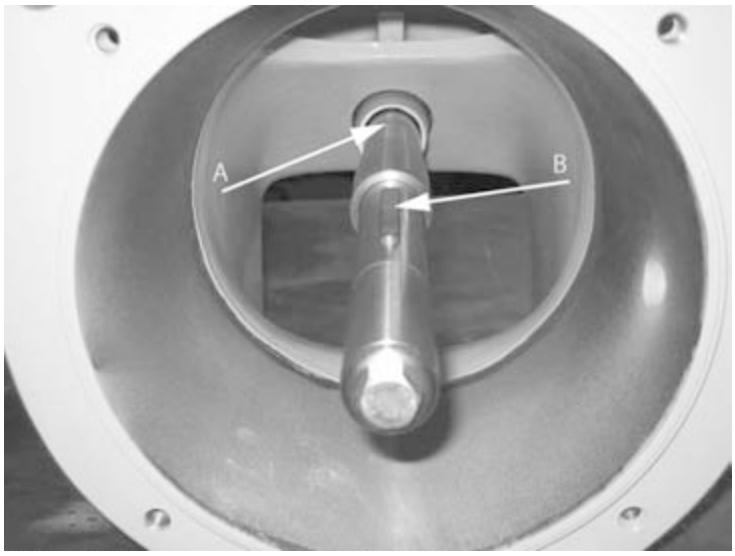


Figure 29. Adjuster sleeve

2. Position the wedge (figure 29, point B) in the appropriate groove.

3. The place for the wedge groove (figure 30, point A) on the mounting cone is marked on the impeller with a line (figure 30, point B). Set the cone so that the wedge groove is aligned with the line.

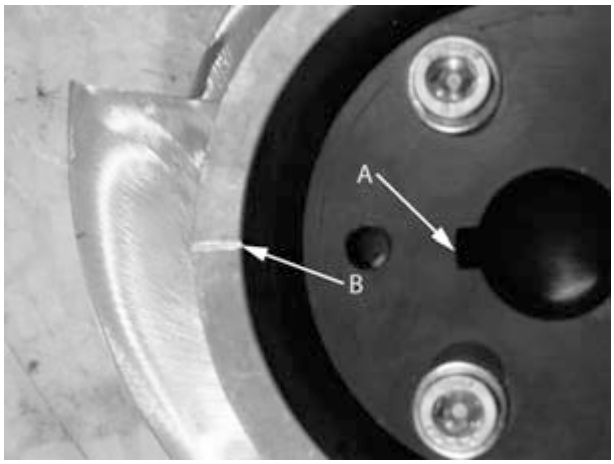


Figure 30. Wedge groove

4. Screw the screws loosely in place.

5. Position the impeller with the cone onto the shaft, but do not push it into the duct.

6. Tighten the screws so they are finger-tight and push the impeller as far into the impeller duct as it will go (figure 31).

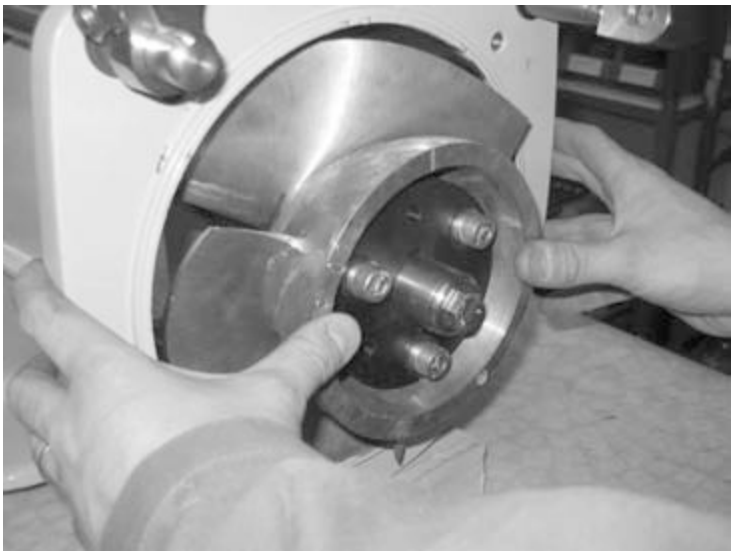


Figure 31. Pushing the impeller into place

CAUTION!

When installing the impeller, be careful not to leave your fingers between the impeller blade and the impeller duct wall! Use the working position shown in figure 31!

7. Tighten the screws to a torque of 20 Nm.

   During tightening, the impeller moves slightly outwards in the duct, which causes the gap to adjust to the correct size automatically.

8. Tighten the impeller adjuster sleeve (figure 32, point A) as tight as possible using manual force through the inspection hatch.

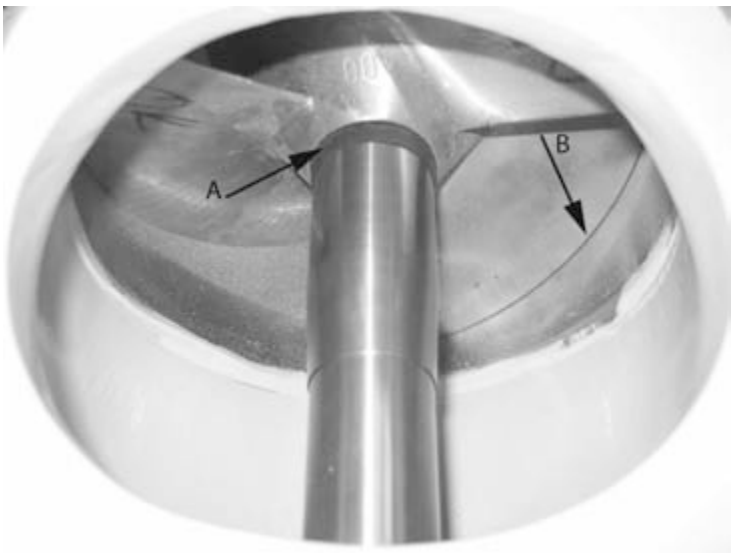


Figure 32. Tightening the adjuster sleeve

Note that the sleeve has a left-hand thread. The sleeve must be tight against the plastic fastening cone of the impeller.

There can be a gap of 0.2–0.4 mm between the impeller blade and the impeller duct (figure 32, point B).

During installation, the lower edge touches the cone, and there may be a slightly bigger gap in the upper part of the impeller due to the weight of the shaft and the impeller. This gap disappears when the stator finally centres the shaft.

NOTE!

Too wide a gap between the cone and the impeller blade causes loss of power.

9. Check that the impeller rotates correctly.

   If it does not, open the impeller screws, pull the impeller out a little and tighten the screws again.

   Note! This phase cannot be implemented if there is no gearbox, as the motor stops the free rotation of the shaft in direct drive operation. The inspection of impeller rotation in direct drive installation can only be done by removing the intermediate shaft.

10. Tighten the adjuster sleeve on the front of the impeller through the inspection hatch as tightly as possible using manual force (figure 32).

11. Close the inspection hatch cover.

12. Install the reversing deflector, the steering nozzle and the stator as a complete unit (section 10.3. *Installing the stator*, page 57).

13. Attach the reversing deflector joint to the hydraulic cylinder (section 6.3. *Installing the reversing deflector*, page 33).

14. Attach the loop joint on the steering nozzle to the lever at the end of the control shaft (section 8.3. *Installing the steering nozzle*, page 52).

15. Apply grease to the rear bearing.

    Check the recommended grease from appendix 1. *Grease recommendations*, page 59.

6. Reversing deflector

There are three reversing deflector models: Round-type and two tube-type deflectors.

The round type is used when the installation width of the jet's reversing deflector is limited (for example, when the jet is installed within the boat's hull).

The tube-type reversing deflector is the best option when installation width is not an issue. The tube type has higher reversing power.

6.1. Removing the reversing deflector

All reversing deflector types are removed in the same way. Three fastenings must be removed to take off the reversing deflector.

Removing the reversing deflector:

1. Remove the joint of the reversing deflector's actuating cylinder (figure 33, point A). Note that the joint is slightly different in tube-type model GT2 (figure 34).

   Remove the loop from the reversing deflector side.

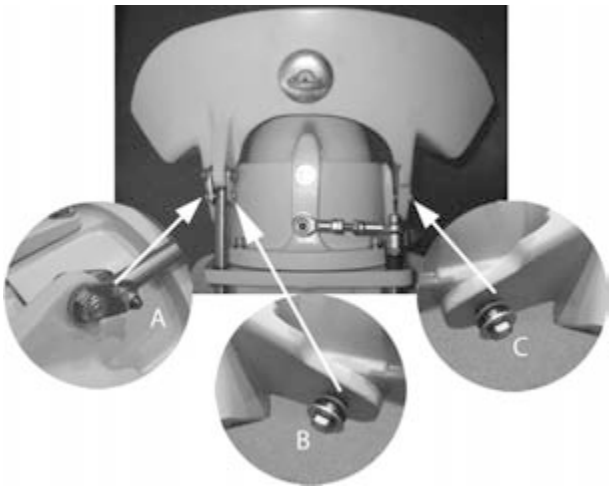


Figure 33. Reversing deflector

Figure 34. Tube-type GT2 joints

2. Open the sleeves and hex screws in the stator (figure 33, point B and point C).

   Take note of the order of the spacers. Note that the free threading on the stator is of the locking type and thread locking has been used in installation, so the screw will not open by hand.

6.2. Repairing the reversing deflector

The wearing parts of the reversing deflector are plastic bearings, hard plastic spacer plates and zinc anode. The parts must be replaced if they have cracks or they are very worn.

Small cracks on the reversing deflector can be repaired by welding. If the deflector's fastening screw bracket or cylinder bracket have broken, they must not be welded, but instead the deflector must be replaced.

Changing the plastic bearings:

1. Remove the plastic bearings with an appropriate sleeve.
2. Install new plastic bearings using sealing compound (such as Sikaflex 221).

Repairing cracks:

1. Weld filler metal into the notches.
2. Abrade the welded parts carefully.
3. Paint the bare aluminium with appropriate paint.

Deflector material and other casting parts: AlSi7Mg

Welding filler metal: AlMg5.

6.3. Installing the reversing deflector

The reversing deflector is installed in the reverse order to which it is removed.

Installing the reversing deflector:

1. Attach the deflector to the stator with two hex screws using thread locking compound.

   The appropriate thread locking compound type is given in appendix 3. *Tightening torques*, page 61.

   Remember the correct order of the spacers and sleeve. Note that the GT2 reversing deflector is attached with two socket screws.

   The tightening torque of the screws is 70 Nm.

2. Attach the actuating cylinder joint.

7. Operating hydraulics

The operating hydraulics of the reversing deflector consist of a hydraulic pump, a pressure relief valve, an actuating cylinder and a cooler (figure 35). The oil used in the system is automatic transmission oil (appendix 2. *Oil recommendations*, page 60).

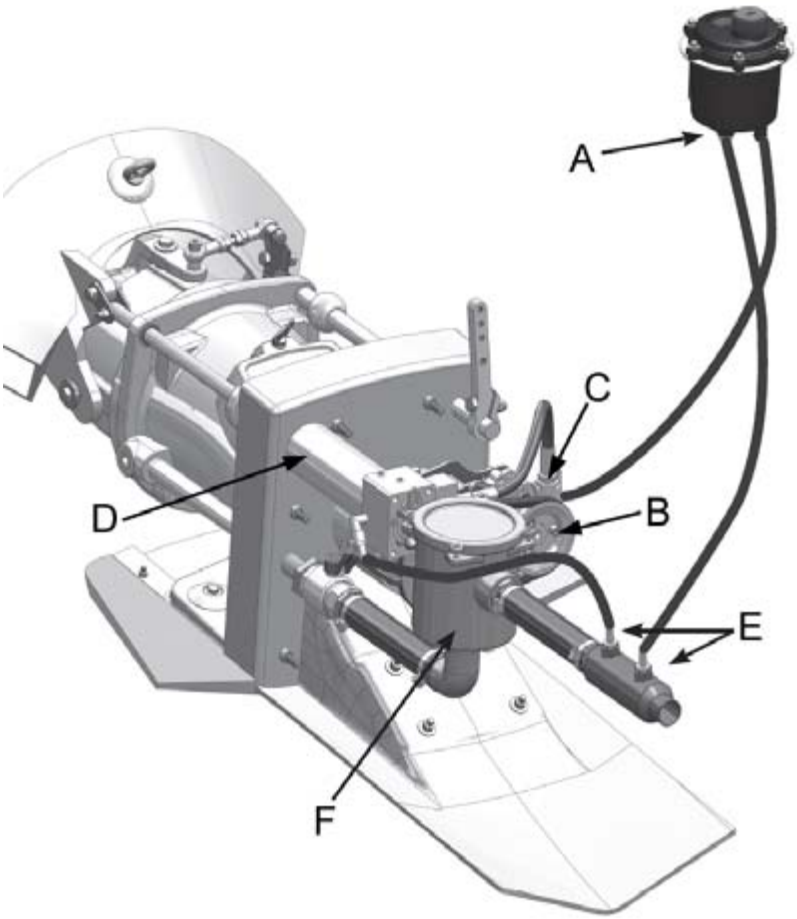


Figure 35. Operating hydraulics

A	Oil reservoir	D	Hydraulic cylinder
B	Hydraulic pump	E	Cooler
C	Pressure relief valve	F	Cooling water system raw water filter

It is extremely important that the system has these parts. For example, the absence of a cooler can lead to the system breaking down. The cooler (E) must be installed after the raw water filter (F).

WARRANTY!

If the line has no cooler or filter, or they are installed in the wrong order, the manufacturer is not liable for any damage caused by overheating of the system.

The pressure relief valve in the system prevents the other components from breaking in fault situations.

7.1. Actuating cylinder

The cylinder using the deflector is installed in the jet's body. The operation is mechanical. The cable from the cabin's control lever can be installed to go from either the left or the right. In standard installation, the cable goes from the right (starboard). The cable holder in figure 36 is in the standard state, pointing to the starboard side.

Figure 36. Actuating cylinder

7.1.1. Removing the actuating cylinder

Before removing the actuating cylinder, empty any water from the bilge. This makes it easy to remove any oil leaking there during the work.

Removing the actuating cylinder:

1. Open the quick-release locking of the cable end and detach the cable from its holder (figure 37, point A).

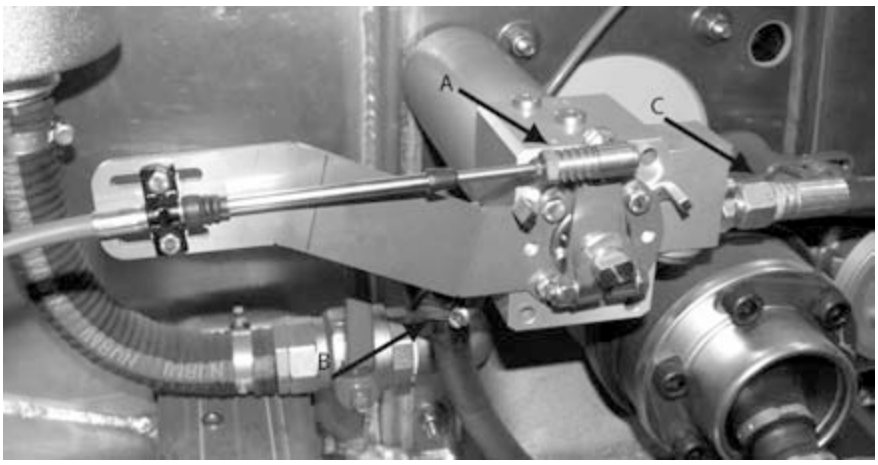


Figure 37. Actuating cylinder cable

2. Reserve two containers for the spilling oil and first open the connection on the return side of the cylinder (figure 37, point B).

   Plug the end of the hose immediately so that no oil leaks out unnecessarily. Keep a container under the connector in the cylinder.

3. Open the connector on the pressure side of the cylinder and let the oil leak into the other container (figure 37, point C).

4. When no more oil comes from the system, go outside the boat and open the connector between the reversing deflector and the piston. Also open the nut of the cylinder.

   Move the nut and the plastic spacer to the rod. If the jet is installed deep in the hull, the nut must be removed with a special wrench (figure 38).

Figure 38. Actuating cylinder nut

5. Remove the cylinder by pushing it from the back in the direction of the engine room.

   The bushing is sealed with sealing compound, so sufficient power must be used to remove it.

CAUTION!

Note that the position of the cylinder is locked with a wedge hidden in the lead-through of the body (figure 39). For this reason, never try to remove the cylinder by rotating it.

Figure 39. Actuating cylinder wedge

7.1.2. Repairing the actuating cylinder

Only a person with appropriate training is allowed to carry out the maintenance and repair of the cylinder.

The wearing parts of the actuating cylinder are, for example, seals and the bearing. The metallic valve parts can also wear if the oil used is unclean. Normally, the valve parts do not need replacing due to wearing.

A repair kit is available for the cylinder including seals and a bearing.

7.1.3. Actuating cylinder installation

Installing the actuating cylinder:

1. Clean the hole in the hull carefully of old adhesive residues.

   The hole must be clean before installing a new cylinder. Figure 40 shows hole that has not been cleaned.

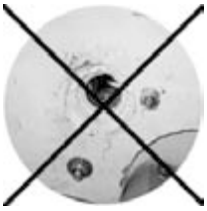


Figure 40. Unclean actuating cylinder hole

2. First make sure that the cylinder fits in place without sealing compound.

   Note that the position of the cylinder is defined by a wedge at the lead-through (figure 41).

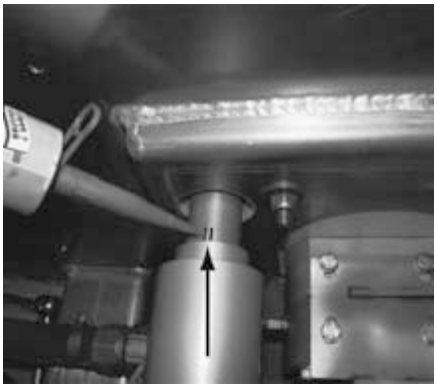


Figure 41. Wedge

NOTE!

The cylinder must go all the way to the bottom, against the jet's body (figure 42)!

Installing the cylinder so that it presses on the stern will result in adjustment issues.

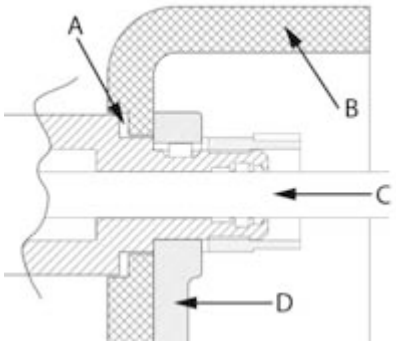


Figure 42. Actuating cylinder installation

A Embedding for the cylinder in the laminate

B Mounting template laminate

C Piston rod

D Jet body

3. Push the piston rod through the hole in the body.

   The person helping you must position the plastic spacer and the fastening nut on the piston rod before the rod goes in through the further lead-through of the body (figure 43).

Figure 43. Actuating cylinder piston rod

4. Fit the wedge in place.

5. Spread sealing compound (such as Sikaflex 221) onto the cylinder lead-through collar.

The sealing must be done carefully so that no water can leak into the boat (figure 44).

Figure 44. Spreading sealing compound

6. Push the cylinder into place and screw the nut in place from the outside.

   The tightening torque is 100 Nm.

7. Install the pressure and return hoses to the cylinder.

8. Install the cable to the cable holder with a fastener.

9. Add oil to the system.

> **NOTE!**
>
> The oil must be automatic transmission oil (appendix 2. *Oil recommendations*, page 60).

7.1.4. Adjusting the actuating cylinder

When you start the engine for the first time, make sure that you have oil available to add to the reversing deflector control hydraulic system. Fill the reservoir with oil before you start the engine. After you start the engine and put it into forward gear, the oil is transferred from the reservoir into the system and the pump automatically removes air from the system. If the oil level decreases in the reservoir, add some oil through the oil reservoir cap. There is a dipstick in the reservoir that you can use to check the oil level (figure 45). Every now and then, move the hydraulic cylinder's operating lever back and forth (figure 46, point A) so that the cylinder fills with oil.

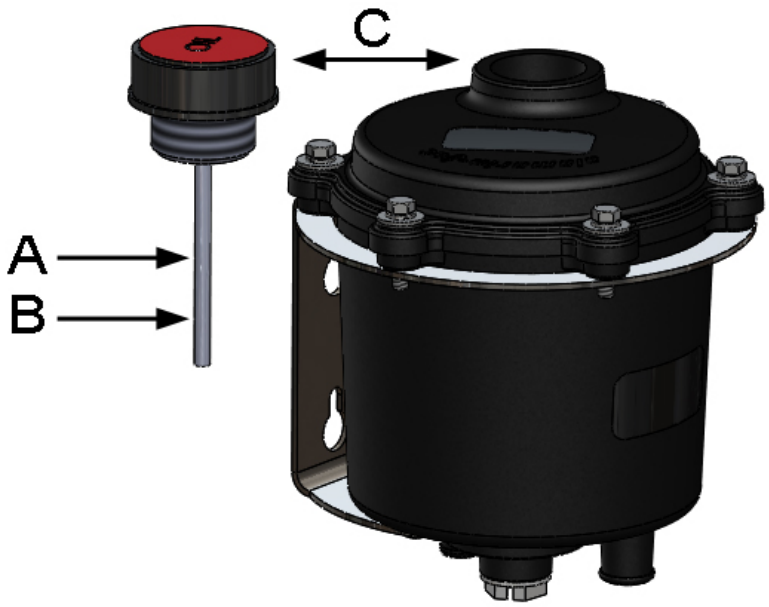


Figure 45. Checking the oil level

A	Maximum level
B	Minimum level
C	Cap

A new cylinder will have been preadjusted at the factory, so the reversing deflector should move normally from one extreme to the other after installation.

Actuating cylinder adjustment:

1. Detach the control cable from the end of the cylinder operating lever (figure 46, point A).

Figure 46. Operating lever cable and screw

2. Loosen the operating lever screw (figure 46, point B) but do not pull the lever off the shaft yet.

3. Place the lever against the limiter on the shaft (figure 47, point A).

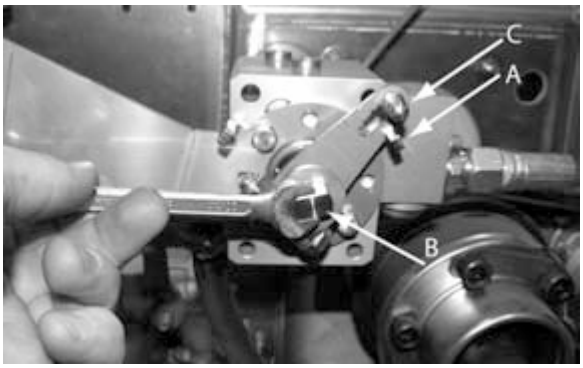


Figure 47. Adjusting the cylinder

4. Using a wrench, turn the operating shaft (figure 47, point B) 13 mm (0.4") clockwise so that the reversing deflector is down, blocking the jet flow.

   If you turn the shaft too much, it will no longer move smoothly, indicating that the cylinder has reached the end of its movement range. If this happens, turn the shaft back slightly.

5. Attach the operating lever to the shaft with a screw. Tighten the screw to a torque of 10 Nm. Do not tighten the screw too much!

6. Attach the control cable to the screw at the end of the operating lever (figure 47, point C).

7. Use the control system in the cabin to check that the deflector can move to the up and down positions. The positions are illustrated in figures 48–51.

Tube-type reversing deflector

The down position is correct when the entire jet flow enters the deflector (figure 48, point A). When viewed from the outside, the steering nozzle and the reversing deflector must be level (figure 49, point B).

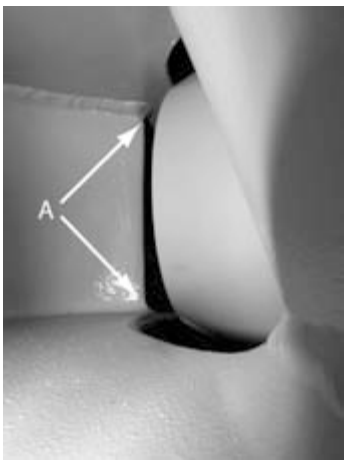


Figure 48. The correct position of the tube-type deflector

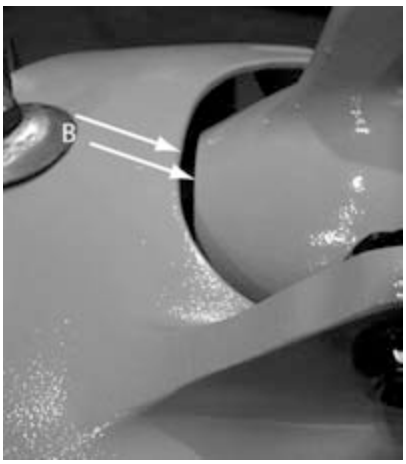


Figure 49. Correct position of the tube-type deflector from outside

Round-type reversing deflector

The top of the deflector must be almost on the same level as the steering nozzle (figure 50, point A). The deflector will then turn the water flow

efficiently (figure 51). If necessary, adjust the ball screw height on the control lever (figure 47, point C) so that the entire movement range of the lever is in use.

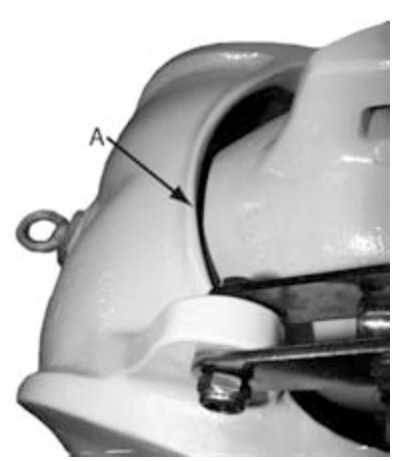
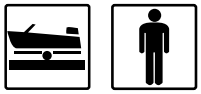


Figure 50. Correct position of the round-type deflector

Figure 51. Movement range of the round-type deflector

7.2. Hydraulic pump

7.2.1. Removing the hydraulic pump



The hydraulic pump is easiest to remove from the bearing housing with the rack.

Before removing the hydraulic pump, empty any water from the bilge. This makes it easy to remove oil leaking there during the work. Make sure you also have a container into which you can drain the old oil from the system.

Removing the hydraulic pump:

1. Loosen the 4 screws that hold the pump in its rack (figure 52).

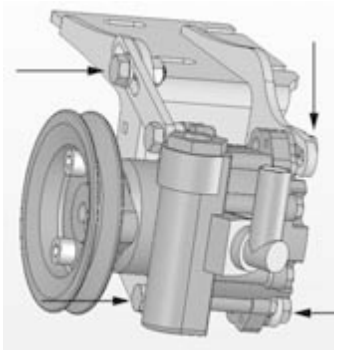


Figure 52. Hydraulic pump

2. Move the pump closer to the bearing housing and remove the wedge belt.

3. Open the connector between the pressure hose and the pressure relief valve (figure 53, point A).

   You can plug both open ends of the connector if you do not wish to empty the system of oil.

   DO NOT OPEN THE RETURN-SIDE HOSE OF THE PUMP YET!

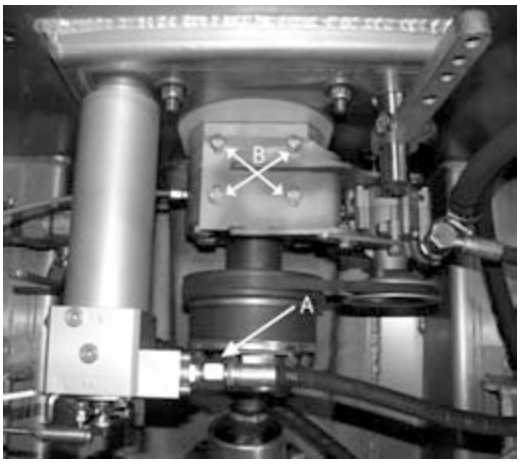


Figure 53. Connector between the pressure hose and the pressure relief valve

4. Open the 4 screws that hold the rack in the bearing housing (figure 53, point B).

5. Lift the pump with the rack off the bearing housing.

6. Open the return-side hose of the pump and drain the oil into the container (figure 54, point A).

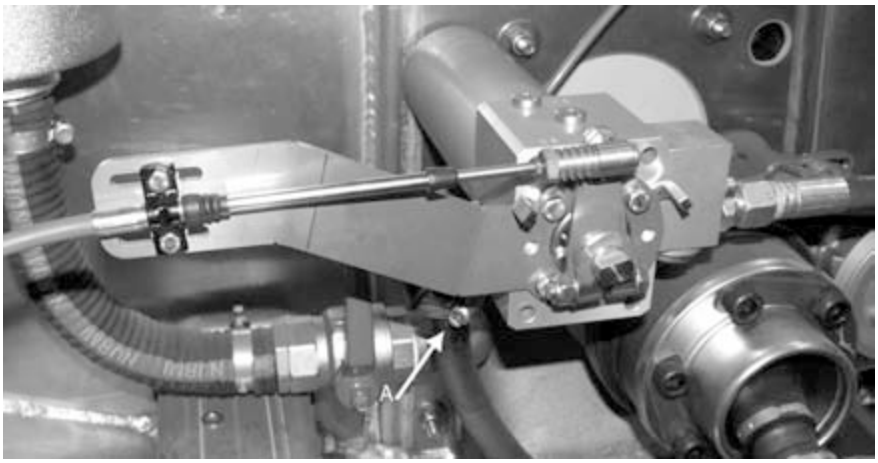


Figure 54. Return-side hose of the hydraulic pump

7. If you wish to replace the entire pump, remove it from its rack. Also remove the tightening plate and the intermediate sleeves.

   The plate screw (figure 55) is locked in place using thread locking compound. This is meant to make moving the pump easier when tightening the belt (section 7.2.3. *Installing the hydraulic pump*, page 47, step 4).

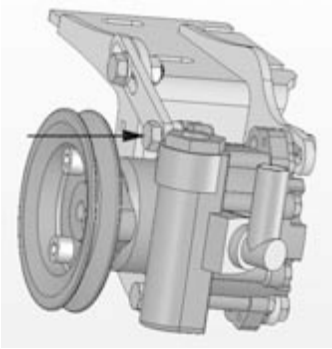


Figure 55. Tightening plate screw of the hydraulic pump

7.2.2. Repairing the hydraulic pump

Broken parts of the hydraulic pump cannot be fixed, but they must be replaced with new parts. However, repairing individual parts is not usually possible. Instead, the entire hydraulic pump must be replaced.

A worn belt pulley in the hydraulic pump can be replaced. It can also be replaced with the pump attached to the rack.

The pump's pressure relief valve may get clogged up with debris, which may cause the pump to malfunction. The pressure relief valve can be checked and cleaned even when the pump is attached to its rack.

Replacing the belt pulley

1. Loosen the fastening screws of the hydraulic pump rack.

2. Open the three screws that attach the belt pulley to the rack (3 pcs, figure 56).

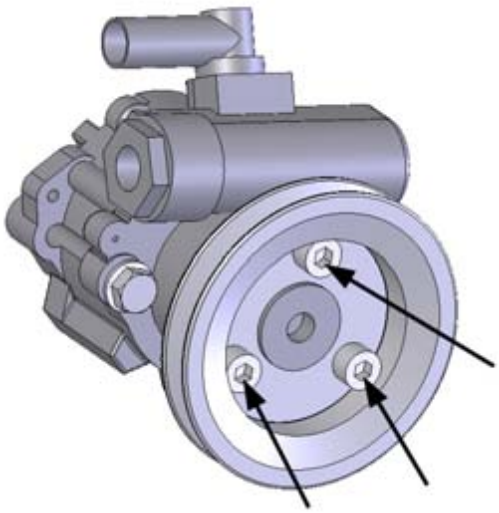


Figure 56. Belt pulley fastening screws

3. Remove the old belt pulley.

4. Fit in the new belt pulley.

5. Tighten the screws.

   The tightening torque is 25 Nm. Use thread locking compound.

Pressure relief valve disassembly

Reserve a container for this procedure into which you can drain the oil from the partially dissembled system.

1. Open the cylinder-side end of the pressure hose and disconnect the pressure hose from the pump.

   If the pump-side end of the hose is equipped with a banjo connection, the cylinder-side connector does not need to be detached.

2. Open the adapter nut (figure 57)

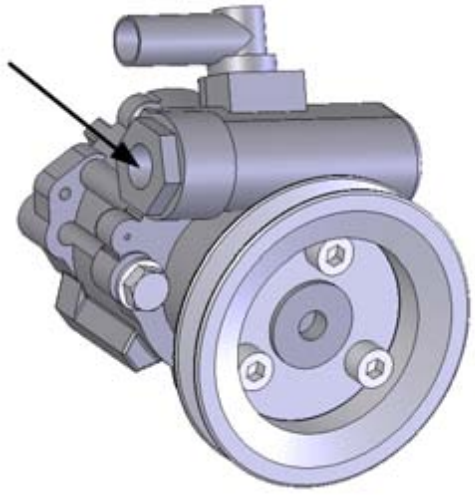


Figure 57. Hydraulic pump pressure relief valve

3. Lift out the pressure relief valve (figure 58) and clean it of any debris and impurities.

Figure 58. The hydraulic pump and the pressure relief valve

4. Set the cleaned pressure relief valve back in the pump.

5. Tighten the adapter nut.

   The tightening torque is 40 Nm.

7.2.3. Installing the hydraulic pump

If the pump is fixed to a rack, go to step 3.

Hydraulic pump installation:

1. Put the tightening plate in place with an intermediate sleeve.

   Use thread locking compound in the thread of the screw (figure 59, point A).

   The appropriate thread locking compound type is given in appendix 3. *Tightening torques*, page 61.

   The tightening torque is 20 Nm.

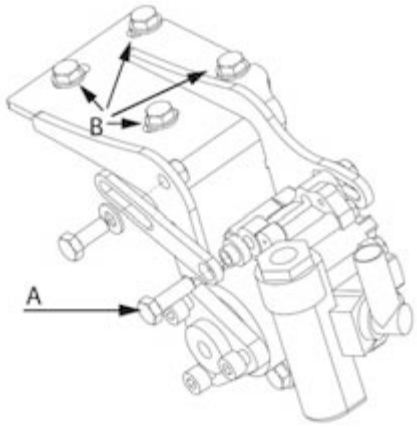


Figure 59. Hydraulic pump tightening plate

2. Install the pump to the rack using 4 screws (figure 52).

   Screw the screws so they are finger-tight.

3. Install the pump with the rack onto the bearing housing using 4 screws (figure 59, point B).

   Screw the screws so they are finger-tight.

4. Put the wedge belt in place and tighten it slightly.

   This can be done easily with a fork wrench from the screw depicted in figure 60.

Figure 60. Tightening the wedge belt

5. Align the wedge belt pulley on the pump with the wedge belt groove and tighten the bearing housing screws to their final tightness.

   The tightening torque is 23 Nm.

6. Tighten the belt to its final tightness and also tighten the screws that hold the pump in the rack.

   You can verify the correct tightness of the belt by turning it between the wheels with your fingers. The belt must turn 90 degrees when turned using your fingers (figure 61).

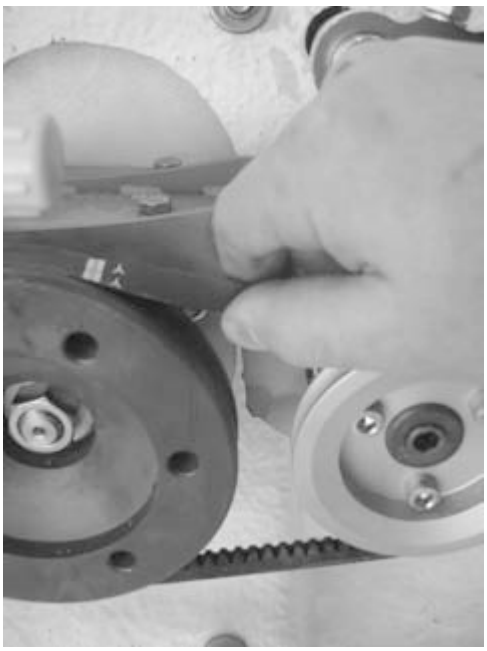


Figure 61. Checking the tightness of the wedge belt

7. Put the pressure and return hoses in place and add oil to the system.

8. Turn on the engine, put it into forward gear and move the deflector back and forth.

   At the same time, monitor the amount of hydraulic oil and add oil to the hydraulics system if necessary.

NOTE!

The oil must be automatic transmission oil (appendix 2. *Oil recommendations*, page 60).

8. Steering nozzle

8.1. Removing the steering nozzle

Before removing the steering nozzle, remove the reversing deflector (section 6.1. *Removing the reversing deflector*, page 31).

The steering nozzle is pivoted to the stator with sleeves and hex screws (figure 62, point A). The steering shaft is attached to the nozzle with loop joints (figure 62, point B).

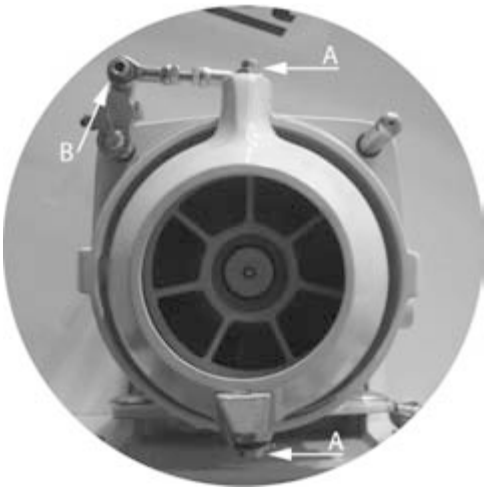


Figure 62. Steering nozzle fastening

Removing the steering nozzle:

1. Remove the loop joint from the steering shaft side.
2. Open the hex screws and take note of the order of the spacers.

   Note that the free threading on the stator is of the locking type and thread locking has been used in installation, so the screw will not open by hand.

8.2. Repairing the steering nozzle

The wearing parts of the steering nozzle are the hard plastic spacer plates, loop joints and zinc anodes. The parts must be replaced if they have cracks or they are very worn. The loop does not require lubrication.

Small cracks in the steering nozzle can be repaired by welding. If the steering nozzle's bracket or operating lever has broken, it must not be welded, but instead the nozzle must be replaced.

Changing the plastic bearings:

1. Remove the plastic bearings with an appropriate sleeve.

The plastic bearings are attached to the stator (figure 63).

Figure 63. Steering nozzle plastic bearings

2. Install new plastic bearings using sealing compound (such as Sikaflex 221).

Repairing the cracks:

1. Weld filler metal into the notches.
2. Abrade the welded parts carefully.
3. Paint the bare aluminium with appropriate paint.

Steering nozzle material and other casting parts: AlSi7Mg

Filler metal: AlMg5

8.3. Installing the steering nozzle

The steering nozzle is installed in the reverse order to which it was removed.

Installing the steering nozzle

1. Attach the nozzle to the stator with two hex screws.
2. Attach the loop to the steering shaft.

   Use thread locking compound. The appropriate thread locking compound type is given in appendix 3. *Tightening torques*, page 61.

   The tightening torque of the screws is 40 Nm.

9. Steering shafts

The steering shaft goes through two points of support, or lead-throughs: One is in the flange against the stern (front steering device, figure 64, point A) and the other is in the rear flange of the jet's body (rear steering device, figure 64, point B).

Figure 64. Steering shafts

9.1. Removing the steering shafts

Removing the steering shafts:

1. Remove the front steering device from the support point against the stern (figure 64, point A).
2. Remove the rear steering device lever (figure 65, point A).

Figure 65. Rear steering device lever

3. Push the shaft into the boat.
4. Remove the rear steering device bearing.

9.2. Repairing the steering shafts

In the support point of the flange against the stern (front flange), there is a plastic sleeve screwed into the aluminium casting, as well as a shaft seal. The rear flange only has a slide bearing. These parts may wear over the course of time and should be replaced when necessary.

CAUTION!

The lead-through seal in the front flange must be checked regularly because if it leaks, it allows water to flow into the engine room.

9.3. Installing the steering shafts

The steering shafts are installed in the reverse order to which they were removed.

Installing the steering shafts:

1. Attach the rear steering device bearing.
2. Push the shaft back into place from the boat side.
3. Attach the rear steering device lever.
4. Attach the front steering device to the support point against the stern.

10. Stator

10.1. Removing the stator

The stator can be removed as a complete unit with the reversing deflector and steering nozzle or one part at a time.

Detachment one part at a time:

1. Remove the reversing deflector and the steering nozzle (sections 6.1. *Removing the reversing deflector*, page 31 and 8.1. *Removing the steering nozzle*, page 51).

2. Open the fastening screws of the stator, 4 in total (figure 66).

Figure 66. Stator fastening screws

3. Remove the stator carefully using a screwdriver (figure 67).

Figure 67. Removing the stator

Removing the stator as a complete unit:

1. Remove the joint between the reversing deflector and the hydraulic cylinder as well as the loop joint of the steering nozzle.
2. Open the stator's fastening screws.
3. Remove the stator carefully using a screwdriver.
4. Pull the stator, the steering nozzle and the reversing deflector out as a single assembly (figure 68).

Figure 68. Pulling out the stator

10.2. Repairing the stator

The wearing parts of the stator are the steering nozzle plastic bearings (section 8.2. *Repairing the steering nozzle*, page 51), rear-end bearing (section 4.2. *Rear-end bearing*, page 18) and zinc anode.

Small cracks on the stator can be repaired by welding filler metal into the notches. However, at the ends of the blades this is practically impossible, and there are no guarantees that the result will last.

Repairing cracks:

1. Weld filler metal into the notches.
2. Abrade the welded parts carefully.
3. Paint the bare aluminium with appropriate paint.

Deflector material and other casting parts: AlSi7Mg

Filler metal: AlMg5

10.3. Installing the stator

The stator is installed in the reverse order to which it was removed.

Installing the stator

1. Carefully push the end of the shaft inside the rear bearing housing and push the stator against the body of the jet.
2. Screw the tightening screws (4 in total) so they are finger-tight, then tighten them evenly to a tightening torque of 40 Nm.

   A small gap is left between the stator and the body because the end of the propeller duct extends further out than the other parts and fits against the stator.
3. If the deflector and the steering nozzle are attached, attach the loop joint to the steering shaft and the reversing deflector joint to the hydraulic cylinder.

   If the deflector and the steering nozzle are not attached, install them (sections 6.3. *Installing the reversing deflector*, page 33 and 8.3. *Installing the steering nozzle*, page 52).
4. Add grease to the rear bearing housing.

   The recommended grease can be found from appendix 1. *Grease recommendations*, page 59.

Appendix 1. Grease recommendations

The grease used for lubricating the propulsion unit bearing must meet the following requirements:

- lithium soap and a thickener with EP additives
- mineral oil as a base oil
- NLGI class 2
- operating temperature range -25 to 130°C (-13–266 °F)
- continuous operating temperature min. 75 °C (167 °F)

Recommended grease brands:

- Würth Multi-Purpose Grease III
- FAG Multi2
- FAG Load 220
- Mobil XHP 222
- Neste Allrex EP2
- Shell Retinax Grease EP2

A grease that has equivalent properties to those mentioned above can also be used for lubrication.

Appendix 2. Oil recommendations

The operating hydraulic system of the reversing deflector and the lubrication of the front bearing are designed to use oil that is specifically intended for automatic transmission systems. The oil must meet the following requirements:

Kinematic viscosity 40℃	33-36 mm^2/s
Kinematic viscosity 100°C	7.1-7.7 mm^2/s
Viscosity index	min. 170
Density 15°C	0.835–0.890 g/cm^3
Pour point	max. -42 ℃
Flashpoint	min. 180 ℃

Recommended oil brands:

- Mobil ATF 320
- FormulaShell ATF DEXRON III
- Neste ATF-X
- BP Autran DX III

Appendix 3. Tightening torques

Use the tightening torques from the table 3 when tightening the propulsion unit screws. The strength grade of an acid-proof A4-80 screw is equivalent to a class 8.8 screw.

Table 3. Tightening torques of the screws

	Strength grade		
	8.8	10.9	12.9
Thread	Tightening torque (Nm) (*)		
M5	5.5 (4)	8.1 (6)	9.5 (7)
M6	9.6 (7)	14 (10)	16 (12)
M8	23 (17)	34 (25)	40 (30)
M10	46 (34)	67 (49)	79 (58)
M12	79 (58)	115 (85)	135 (100)
M16	145 (107)	215 (159)	250 (184)

(*) The tightening torque in pound-feet (approximate value) is marked in the table in parentheses after the corresponding value in Nm.

A suitable thread locking compound that is good for all purposes is one of medium strength, for example. Loctite 242 or similar.

Appendix 4. Impeller data

If the impeller has become unfit for use, it must be replaced with a new one. In order to be able to manufacture a replacement impeller, Alamarin-Jet Oy needs information on the type of the broken impeller. If no type markings are visible on the impeller, fill in table 5 and provide it when making the order. Also give information on the engine used (table 4).

Table 4. Engine data

Type:	
Drive (gasoline/diesel):	
Output kW/hp:	
Number of cylinders:	
Litre volume:	
Gearbox:	

Table 5. Data of current impeller

Number of blades:	
A*:	
S*:	
K*:	
T*:	
D*:	

* in millimetres. See the clarification of required dimensions in figure 69.

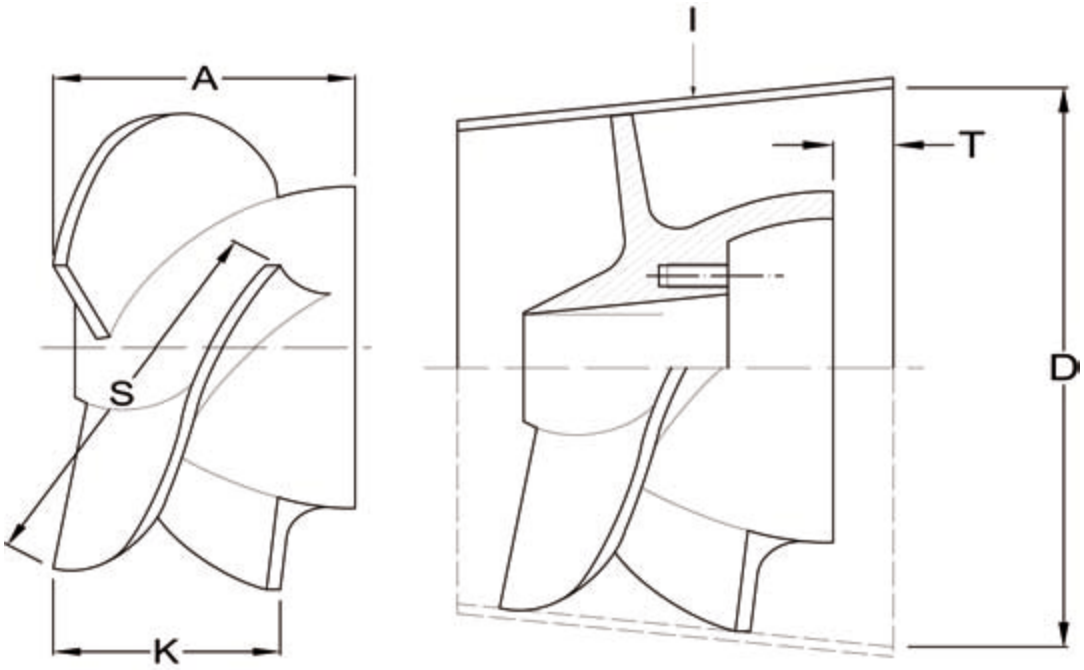


Figure 69. Impeller dimensions

A Distance between the blade front edge and the rear of the impeller hub

S	Length of the blade from the tips measured with a straight gauge
K	Blade span measured from the front tip to the back tip of the preceding blade
I	Impeller duct
T	Distance of the impeller rear surface from the impeller duct rear edge.
D	Maximum diameter of the impeller duct