Repair manual

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1. Introduction

This is the repair manual for Alamarin-Jet's Jet-245 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 Jet-245 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 cause a threat to 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 Two persons must carry out the procedure.
	INDICATOR ARROW
	ARROW DESCRIBING MOTION

Please note that this instruction uses the terms "jet" and "jet propulsion unit". They mainly refer to the same thing.

2. Main shaft and bearing

The power from the engine that runs the jet is transmitted to the main shaft using an intermediate shaft. The intermediate shaft is attached to the coupling flange in one end, and either the gear box or the engine flywheel adapter in the other end. The intermediate shaft is often acquired and installed by the manufacturer of the boat and can, therefore, not be discussed in detail in this document. However, some central issues related to it are described at a general level in the section 2.3. *Intermediate shaft*, page 25.

The main shaft of the jet is a direct shaft (figure 1, point A), supported at both ends with bearings. At the front end of the shaft is a coupling flange (figure 1, point B), to which the intermediate shaft is connected. The shaft is also equipped with an impeller (figure 1, point C), connected with friction and cotter joints. The impeller generates pressure as it rotates.

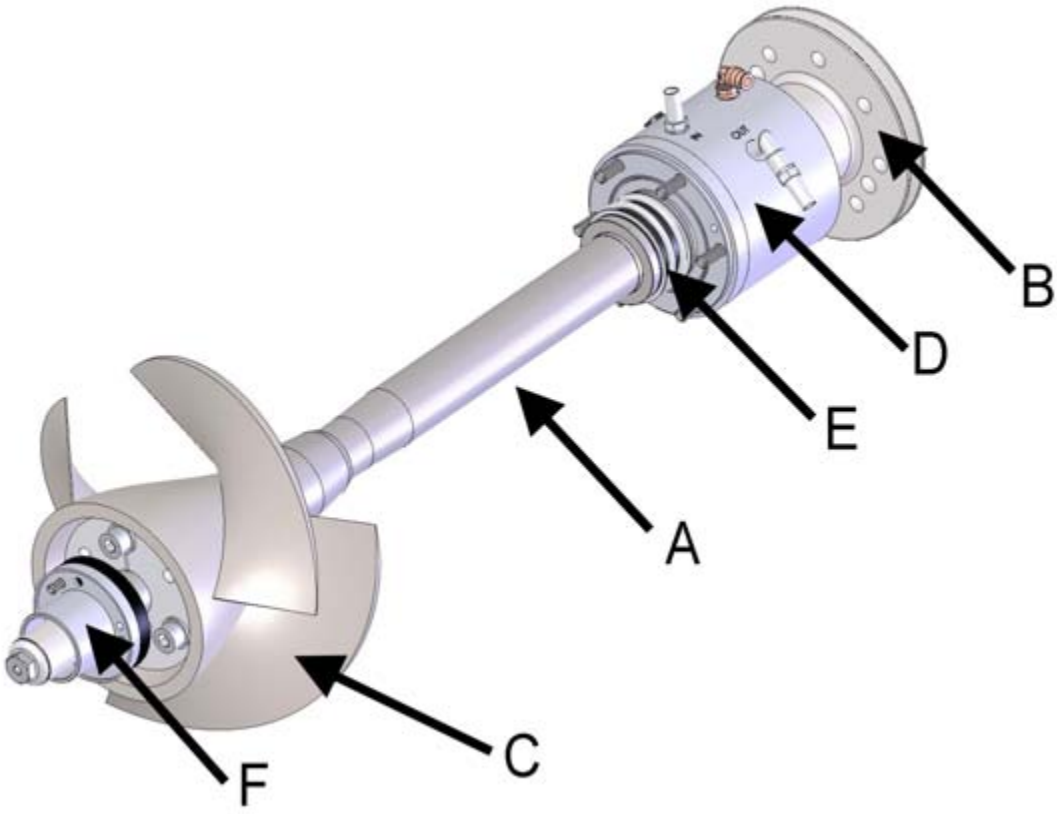

Figure 1. Main shaft and bearing

The front end has a double-cone angular contact ball bearing, receiving axial thrust and radial loads in every direction. The bearing is inside the housing (figure 1, point D), and it is oil-lubricated. The bearing housing seal on the intake duct side is a mechanical rotary seal (figure 1, point E). The shaft seal is on the engine room side.

The rear bearing (figure 1, point F) is attached to the stator. There is a needle bearing, which is lubricated from the engine room with petroleum jelly, within the housing. Alternatively, a water lubricated bearing can be used.

2.1. Front bearing

2.1.1. Front bearing disassembly

Before the bearing can be disassembled, remove

- the stator (section 6.1. *Removing the stator*, page 61).
- the impeller (section 3.2. *Removing the impeller*, page 29).

Then, remove the

- intermediate shaft from the coupling flange
- oil pump of the reversing deflector's actuating cylinder (section 4.3.1. *Removing the hydraulic pump*, page 49).

Make sure you also have a container into which you can drain the old oil from the system.

Front bearing disassembly:

1. Detach the lubricating oil reservoir connectors off of the bearing housing (figure 2) and drain the oil from the system.

   Drain the oil from the ends of the hoses into a suitable container. Depending on the length of the hoses, the oil reservoir and hoses contain approximately 1 to 2 litres of oil.

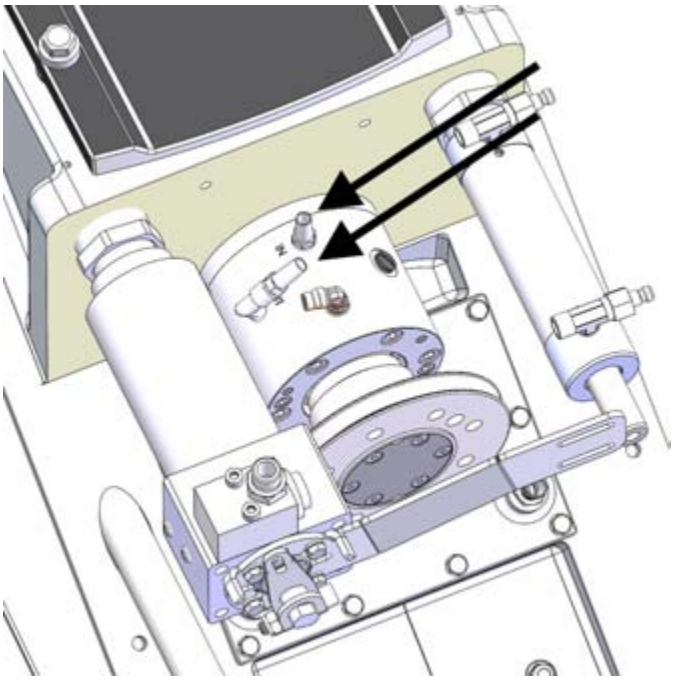

Figure 2. Lubricating oil reservoir connectors

2. Remove the coupling flange.

   If you need to replace the entire bearing, including the shaft, you can leave the coupling flange in place and the remove the bearing housing screws through the holes on the coupling flange (figure 4, point B). However, this is not an option with older models that do not have the holes on the coupling flange.

   First detach the cover plate, which is fastened to the coupling flange hub (figure 3).

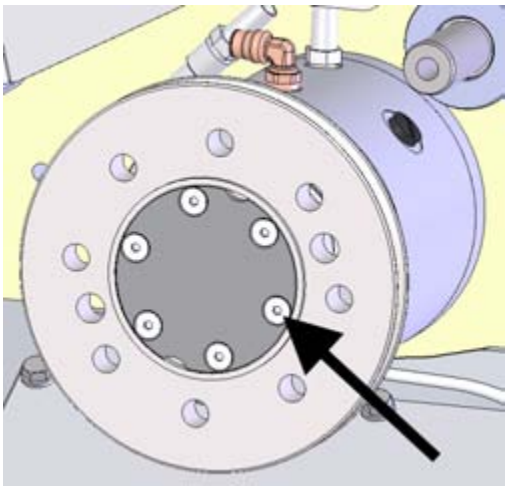

Figure 3. Coupling flange cover plate

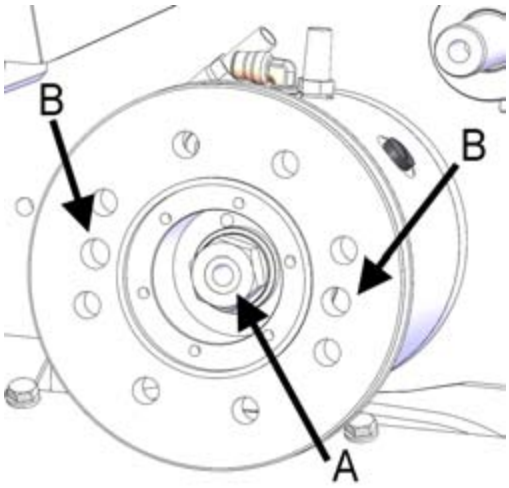

Figure 4. Coupling flange fastening nut

3. Unscrew the nut (figure 4, point A) and use pliers to remove the washer under the nut. Pull the coupling flange out of the cone with a sturdy extraction tool.

   There is a special tool available that covers and protects the end of the shaft when an extraction tool is used. The use of this tool is recommended in order to prevent damage to the end of the shaft.

4. Remove the wedge from the shaft (figure 5, point A).

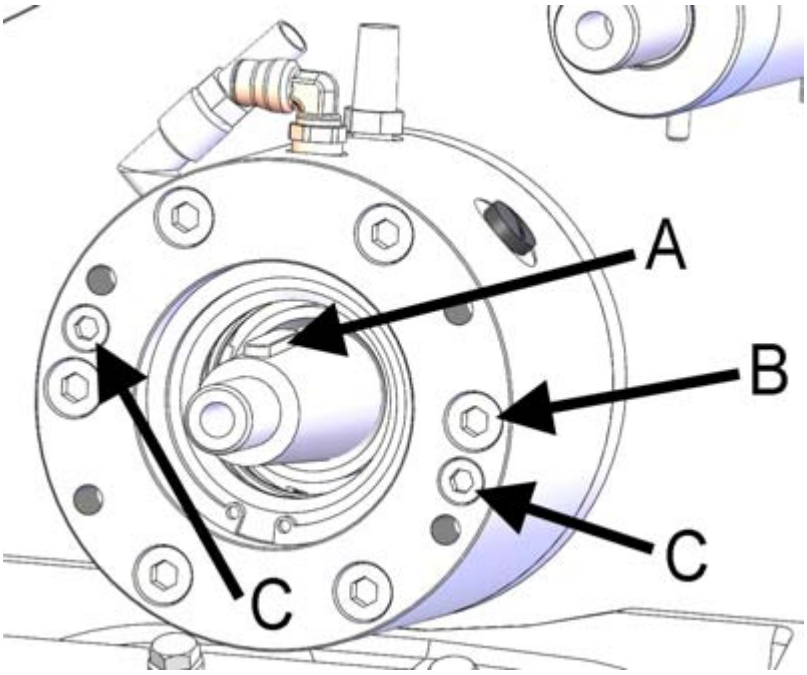

Figure 5. Removing the bearing housing

5. Open the bearing housing screws (6 in total, figure 5, point B).

6. Pull the shaft off the hull.

   Use the two M6 holes, from which the screws must first be removed (figure 5, point C). Replace the screws with longer screws or threaded rods, and tighten them until they bottom out. Tighten them evenly until the bearing housing comes loose from the hull.

   The bearing housing comes loose together with the shaft, bearings, and the mechanical seal. Pull the bearing housing off the bearings (figure 6).

Figure 6. Bearing housing, shaft, bearings, and mechanical seal

7. Turn the safety plate latch (figure 7, point A) up from the spinner nut groove, and unscrew the spinner nut (figure 7, point B).

   The safety plate comes loose when the nut is unscrewed.

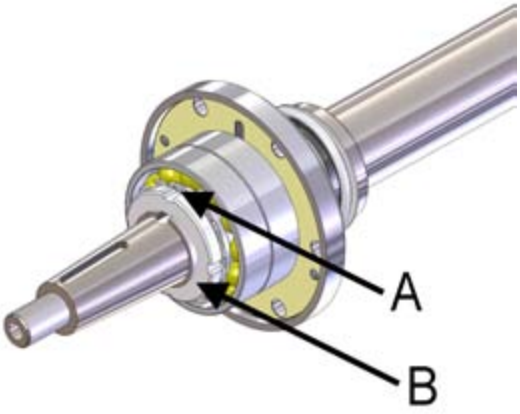

Figure 7. Removing the safety plate

8. Pull the bearing (figure 8, point B) off the shaft.

   The mechanical seal (figure 8, point D) can also be removed. However, it may be tight due to the pressure on the shaft that is caused by the rubber bellows.

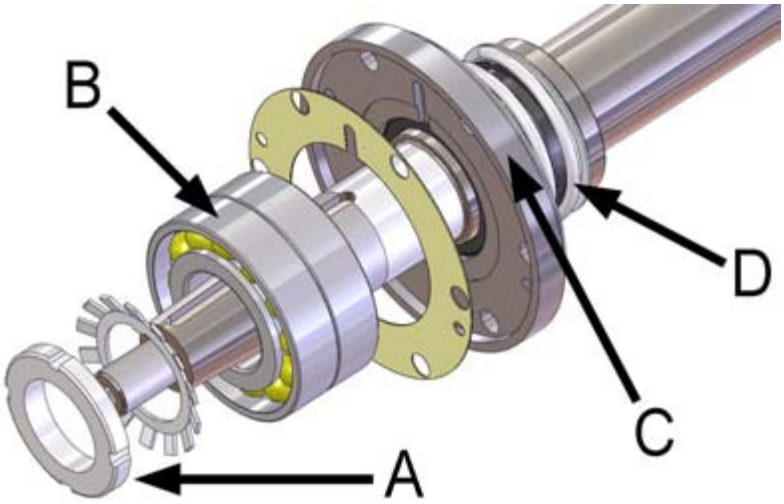

Figure 8. Removing the bearing from the shaft

Seals

Mechanical seal

The mechanical seal consists of several parts (figure 9).

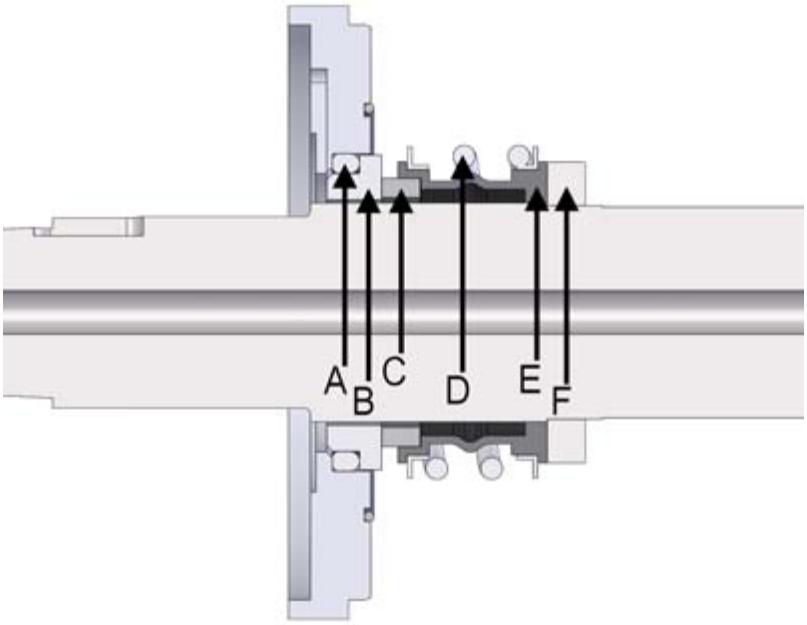

Figure 9. Mechanical seal

A	Static slip-ring seal
B	Static slip-ring, pressed to the bearing housing together with the seal
C	Rotating slip-ring
D	Spring for pressing the sealing faces against each other
E	Rubber bellows
F	Sealing support ring

The slip surfaces are of silicon carbide, which is an extremely durable material. In order to achieve a high level of sealing, the surfaces must be perfectly smooth. If the slip surfaces show signs of mechanical damage, the seal must be replaced.

The water on the outside and the oil in the bearing housing both lubricate and cool the slip surfaces.

Support ring F (figure 9) is attached to the shaft with a crimped joint. It can be removed by heating, for example. Parts A and B (figure 9) are removed by pushing them from the bearing side.

O-ring

An o-ring is used as sealing between the bearing housing and the jet's hull (figure 10).

Figure 10. O-ring

When opening the bearing housing, there may be small amounts of white oil in the rubber bellows of the mechanical seal and the joint surface of the slip-ring. This is a sign of water in the bearing housing. This is completely normal and will not cause any problems. When the shaft rotates, the oil circulates through the oil reservoir and the water gathers at the bottom of the reservoir.

Shaft seals

Two shaft seals that seal the front end of the bearing housing are attached to the bearing housing. The seal lip will rub against the surface of the coupling flange. The shaft seals come off in different directions and are locked in place with safety rings. The front seal can be replaced without detaching the bearing housing from the hull (figure 11).

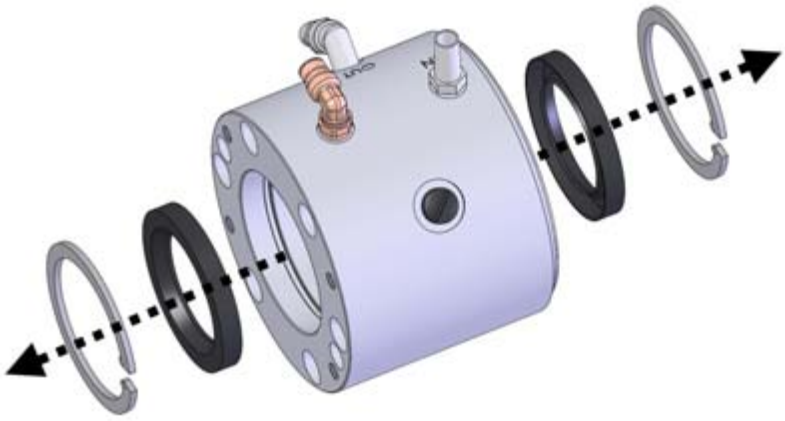

Figure 11. Shaft seal of the bearing housing

A shaft seal is also attached to the coupling flange to keep oil off of the cone joint surface. It can be removed with a screwdriver, for example (figure 12). As this seal does not move against the shaft, it will not wear like the others.

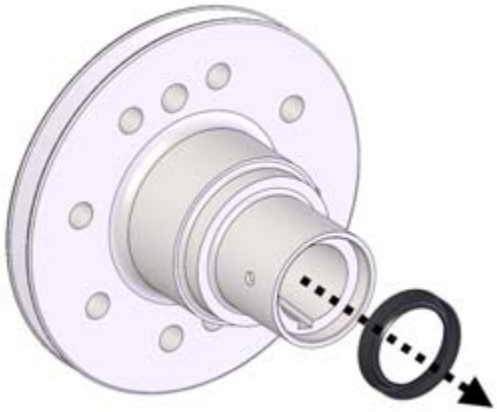

Figure 12. Coupling flange shaft seal

2.1.2. Repairing the front bearing

Under normal circumstances, the operating life of the front bearing is thousands of driving hours. However, if the lubrication weakens due to, for example, the failure of the seal or dirty oil, the operating life of the bearing will decrease rapidly. Using a worn rear bearing also shortens the life span of the front bearing. A worn bearing will make noise and may cause the bearing housing to overheat.

The bearings must be replaced after 3,000 driving hours, except when used with a low load on the jet, i.e. mainly running at low engine speeds.

The wearing parts of the front bearing include the bearings, mechanical seal, and front shaft seal. All of the wearing parts and the coupling flange seal should be replaced every time the bearing replaced.

When replacing the bearings, check the following issues:

- straightness of the shaft
- location of the mechanical seal on the shaft (the surface must be free of scratches)
- external condition of the bearing housings
- external condition of the coupling flange (particularly where the shaft seal rubs against the coupling flange).

Measuring the straightness of the shaft

The straightness of the shaft is measured from three points (figure 13).

Figure 13. Measuring the straightness of the shaft

A	Supporting point 1
B	Supporting point 2
C	Measuring point

The maximum permissible deviation measured from the surface of the shaft is 0.15 mm, in which case the dislocation of the centre line is 0.075 mm.

NOTE!

Measure the straightness carefully.

Excessive deviation in the straightness will cause several problems, the most significant being the excessive wearing of the impeller and bearings.

2.1.3. Assembly of the front bearing

The front bearing must be assembled before it can be reinstalled. Clean all parts of old lubricants and dirt before assembly. Old grease must also be removed from the hole that runs through the shaft.

Assembly of the front bearing:

1. Install the mechanical seal.

   Be careful not to damage the slip-ring (figure 14, point B) during installation. If the seal is pressed into its place in a slanted position, and the slip-ring can scratch the surface of the shaft, the slip-ring may be damaged.

   1.1. Heat the sealing support ring (figure 9, point F) until it slips into its place unobstructed.

   1.2. Let the parts cool down.

   1.3. Lubricate the surface of the shaft where the rubber bellows rest (figure 14, point A).

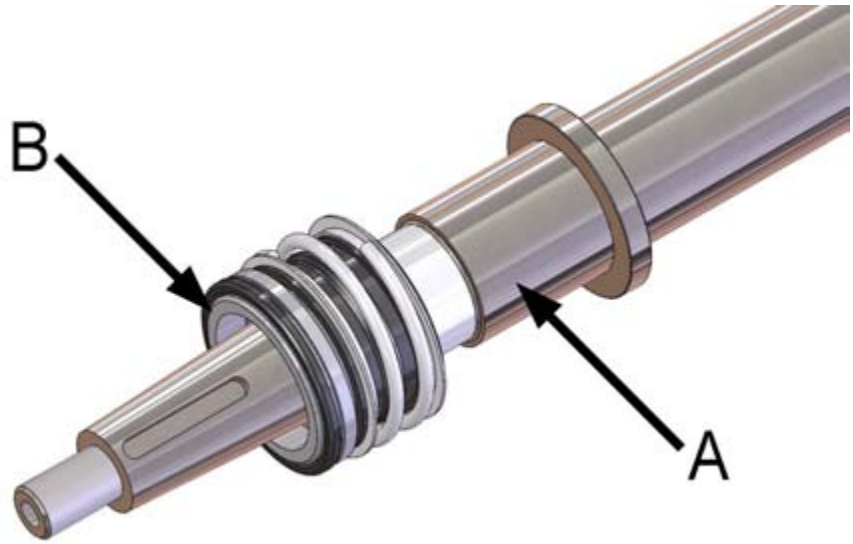

Figure 14. Installing the mechanical seal

The rubber bellows will not move on the shaft surface if it is not lubricated.

CAUTION!

Only special lubricating gel that vaporises between the rubber and shaft may be used for the lubrication.

If the lubricant used for the rubber bellows contains oil, the bellows might rub against the shaft surface and thereby cause insufficient sealing.

If the gel is not available, the bellows may be lubricated with a small amount of water.

The rubber bellows is pressed tightly against the support ring.

1.4. Push the rotating part of the mechanical seal (figure 9, points C, D, and E) into their places against the support ring.

2. Push the static part of the mechanical seal into the bearing housing spacer together with the seal (figure 9, points A and B).

   Figure 15 shows the static ring in its correct position.

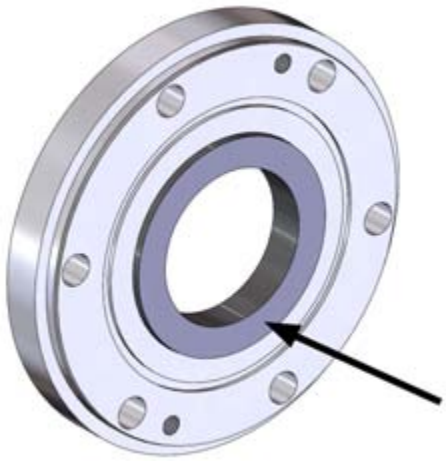

Figure 15. Static ring

3. Place the paper seal against the bearing housing spacer. Make sure that the screw holes and oil duct are positioned correctly (figure 16, point A). Push the bearing pair into the shaft. Please note that the bearings must be installed in the correct way. See figure 17.

4. Install the safety plate and screw the spinner nut in place.

   Tighten the nut by first tightening it against the bearings by hand and then use a spinner nut wrench to tighten it enough to make one of the safety plate wedges connect with the groove in the nut. Finish by turning the safety plate wedge into the shaft nut groove (figure 16, point B).

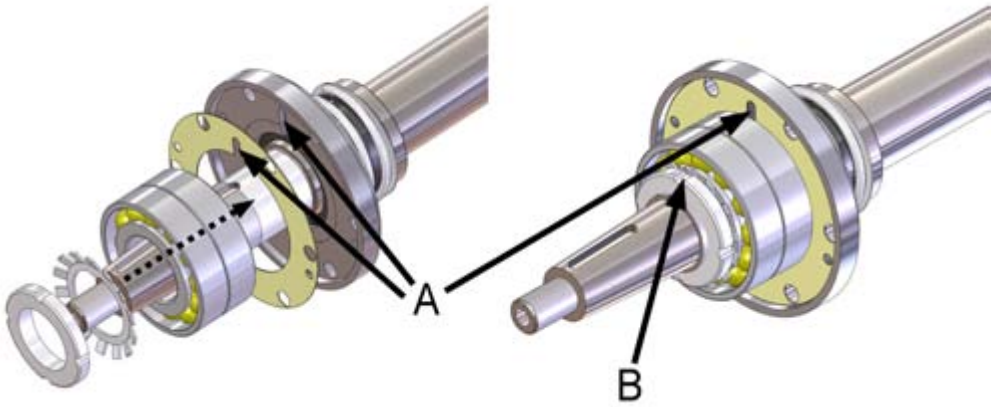

Figure 16. Pushing the bearings onto the shaft

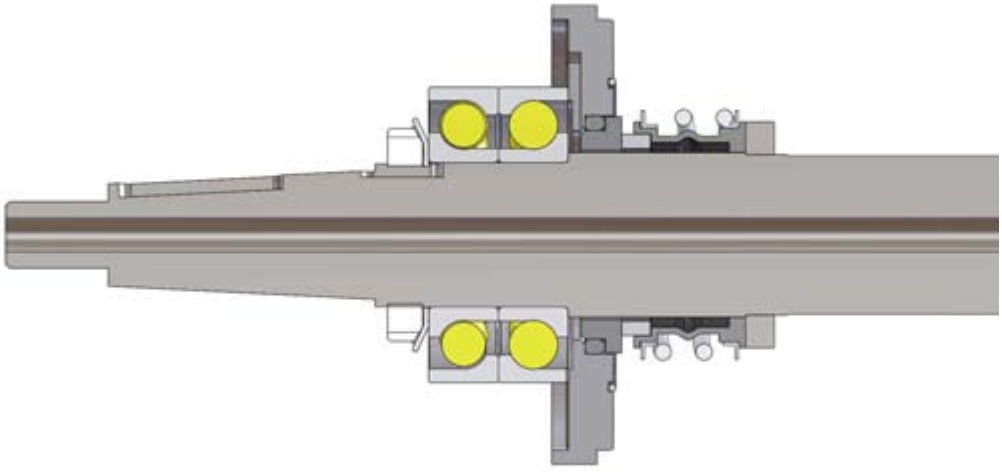

Figure 17. Bearings (cross-section)

5. Lubricate the inner rims of the bearing housing and press the shaft seals into the bearing housing, right side up (figure 18). If they are not the right way up, the rear shaft's lubrication grease will be mixed with the lubrication oil on the front bearing (figure 19). Install the safety rings in their grooves to keep the shaft seals in place. In other words, the shaft seals seal the rear shaft lubrication channel.

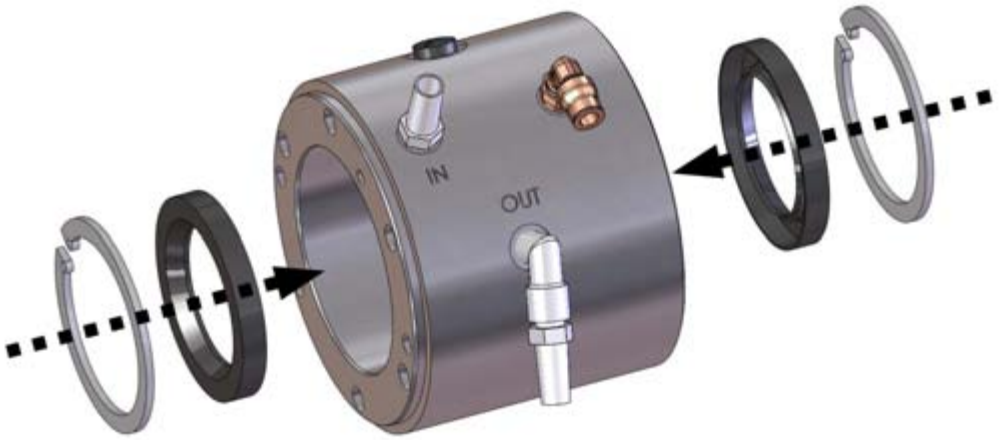

Figure 18. Installing the shaft seals in the bearing housing

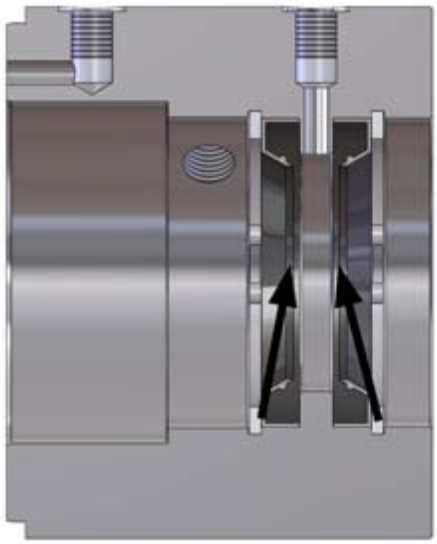

Figure 19. Rear shaft lubrication channel

6. Push the bearing housing onto the bearings. Make sure that the oil channel and screw holes are positioned correctly (figure 19). Fasten the bearing housing with two M6 screws to a tightness of 9 Nm (figure 20).

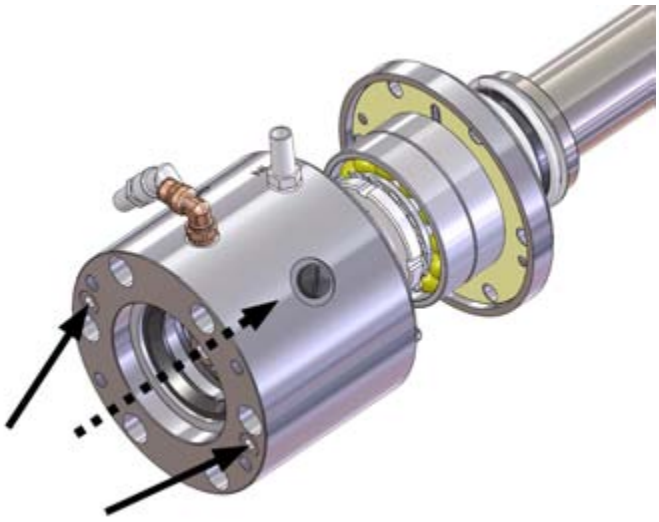

Figure 20. Installing the bearing housing

7. Replace the seal in the rear section of the coupling flange. This seal does not necessarily wear since it is static, but when the bearing housing is opened, it is a good idea to replace it. Ensure that the seal is inserted in the correct way (figure 21).

Figure 21. Installing the coupling flange shaft seal

8. Open the bearing housing's fastening screws (six in total, figure 22, point A) in the holes and install the coupling flange.

   8.1. Place the wedge in the wedge groove (figure 22, point B).

   8.2. Press the coupling flange against the cone at the end of the shaft. The shaft seal in the coupling flange contacts the wedge, but if you lift the rear edge of the coupling flange slightly, it will clear the wedge. The tightening torque for coupling flange nut is 125 Nm. Use a thread locking compound (such as Loctite 242).

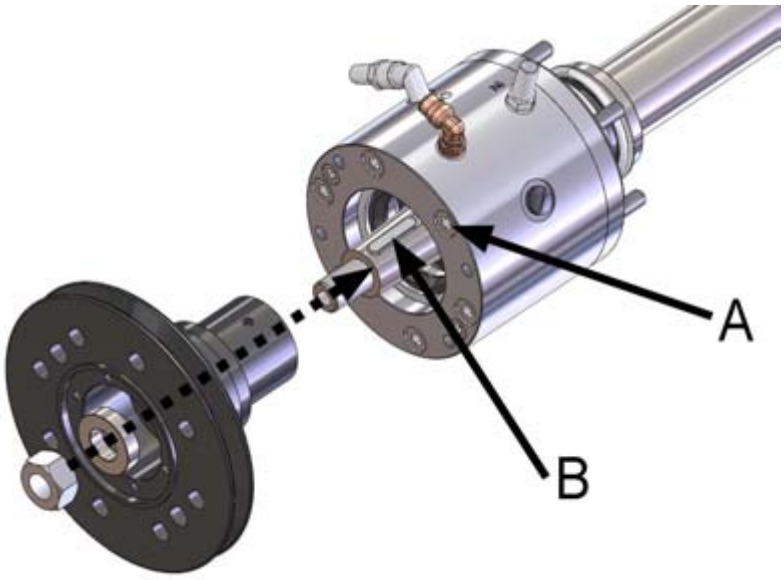

Figure 22. Installing the coupling flange

   8.3. Install the cover ring on the front surface of the coupling flange. Please note the o-ring in the ring (figure 23).

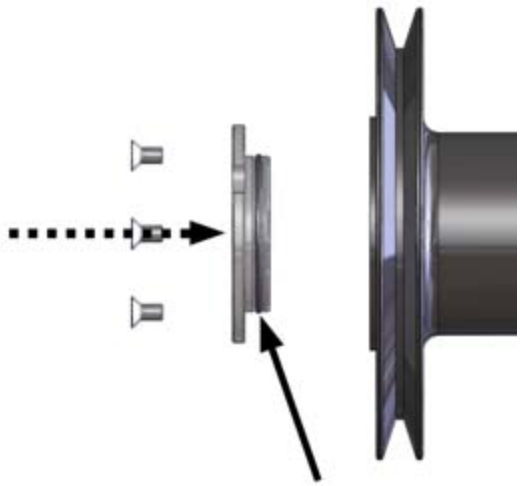

Figure 23. Cover ring of the coupling flange front surface

It is recommended to check the tightness of the bearing housing during this phase. Use connector A (figure 24) to apply enough grease into the rear bearing's lubrication channel for the grease to discharge through the rear end of the shaft. This means that the lubrication channels are full of grease. The rotation of the shaft will become heavier as the seals press against the coupling flange surface. Do not feed grease in too quickly to avoid excessive pressure peaks. If the C seals leak, grease will pour out from the neck of the coupling flange or through connector B. This means that reassembly is required.

Connector B is for the oil lubrication of the front bearing (IN connector). Fill the housing with oil. The OUT connector must have a piece of hose turned upwards to prevent overflow.

Rotate the shaft in different directions several times in order to expose the possible leak points in the mechanical seal.

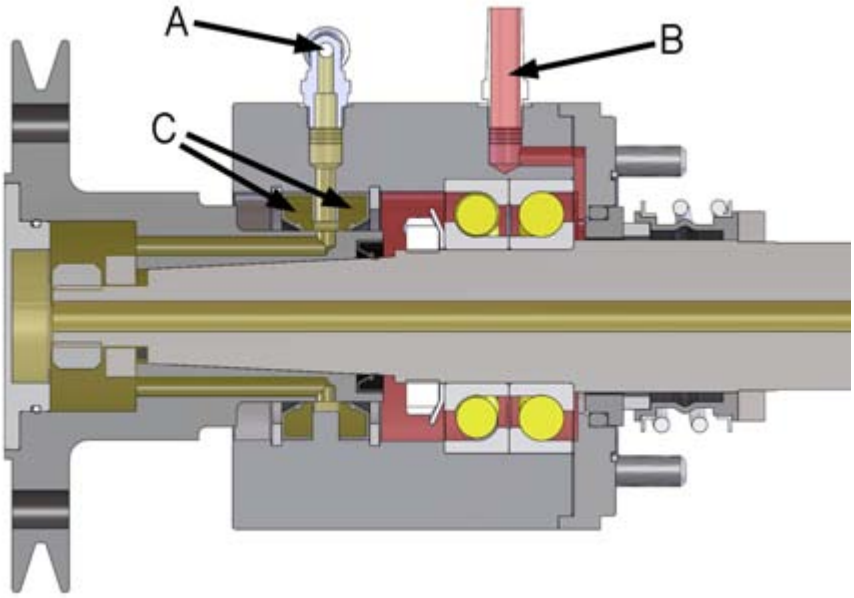

Figure 24. Lubricating the bearing housing

2.1.4. Installing the front bearing

Assemble the front bearing before installing (section 2.1.3. *Assembly of the front bearing*, page 11).

Front bearing installation:

1. Clean the part of the jet's hull where the bearing housing is to be installed.

   The installation surface must be free of any old sealing compound or other impurities and be straight.

2. Make sure the seal is tight by spreading sealing compound (such as Sikaflex 291i) on the shoulder (figure 25) at the o-ring.

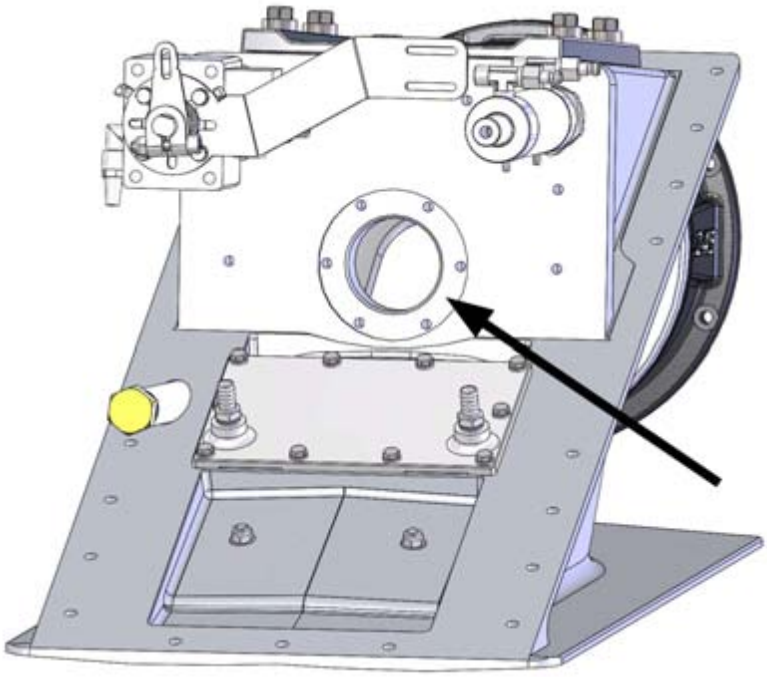

Figure 25. Shoulder

3. Push the shaft bearing into place through the hole in the jet's hull (figure 26, point A), and tighten the bearing housing fastening screws (six in total, figure 26, point B) through the holes in the coupling flange using a long Allen key (figure 26, point C). Use a thread locking compound (such as Loctite 242).

   The tightening torque of the screws is 25 Nm.

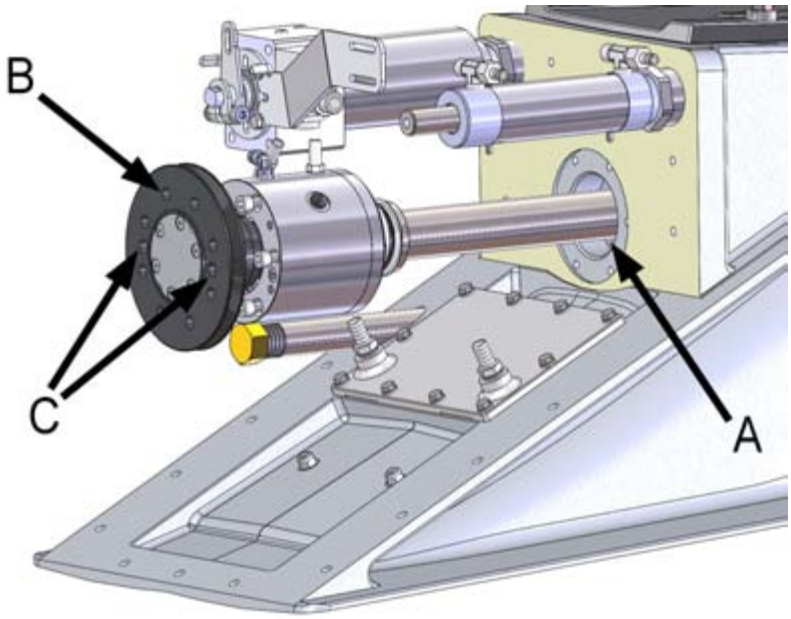

Figure 26. Attaching the bearing housing

4. Install the impeller (section 3.4. *Installing the impeller*, page 30).

5. Install the stator (section 6.3. *Installing the stator*, page 65), steering nozzle (section 5.1.3. *Installing the steering nozzle*, page 57), and reversing deflector (section 4.1.3. *Installing the reversing deflector*, page 37).

6. Install the hydraulic pump (section 4.3.3. *Installing the hydraulic pump*, page 51).

2.2. Rear-end bearing

2.2.1. Rear-end bearing disassembly

Rear-end bearing disassembly:

1. Remove the stator (section 6.1. *Removing the stator*, page 61).

2. The rear bearing housing is attached to the stator with three screws (figure 27). Undo the screws and remove the plastic cover.

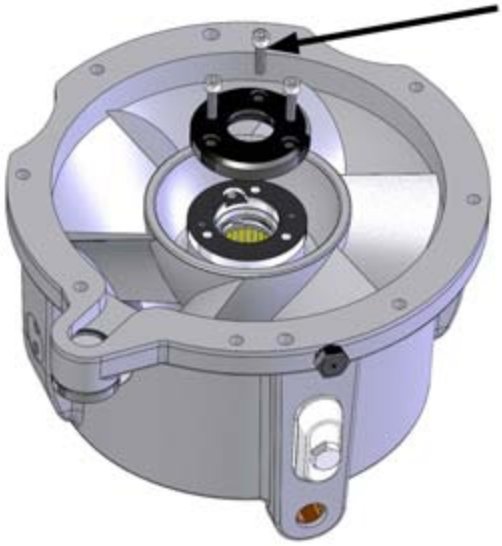

Figure 27. Rear bearing housing screws

3. Screw one or, if necessary, two of the fastening screws into the threaded holes in the bearing housing flange.

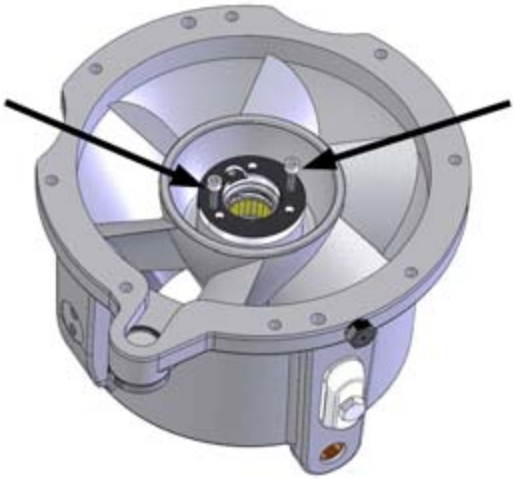

Figure 28. Detaching the rear bearing housing from the stator

4. Tighten the screws carefully until the bearing housing comes loose.

5. Pull the bearing housing off the stator.

2.2.2. Repairing the rear-end bearings

Repair operations on the rear bearings are limited to replacing worn parts. The wearing parts include the bearing, seals, and shaft sleeves, replaced as necessary. The wearing speed varies according to the load on the jet.

CAUTION!

If the seals are worn, they may allow water to flow into the bearing housing, in turn weakening the lubrication of the bearing and shortening its operating life.

Please note that the greatest permissible radial clearance in the rear bearings is 0.1 mm.

Seals

NOTE!

A removed sealing must always be replaced with a new one, never reinstalled.

Changing the seals:

1. Remove the seals with a screwdriver, for example (figure 29).

Figure 29. Removing the rear bearing seals

The second seal is attached to the plastic cover.

2. Replace the old seals with new ones.

Bearing

Replacing the bearing:

1. Push the bearing out of the housing from the front side.

   There are holes on the housing race (figure 30) to allow pushing the bearing with a mandrel, for example.

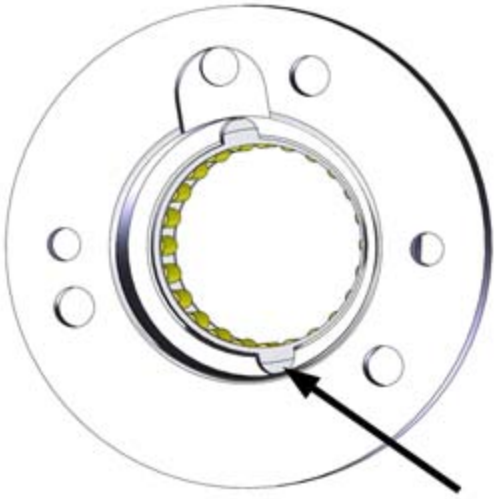

Figure 30. Recess allows for the easy removal of the bearing

Shaft sleeves

There is a sleeve at the rear end of the shaft. The sleeve consists of two parts: the short (figure 31, point A) and long sleeves (figure 31, point B). A worn sleeve can be replaced. There is a plate (figure 31, point C) at the end of the shaft, pressing the sleeves into their places.

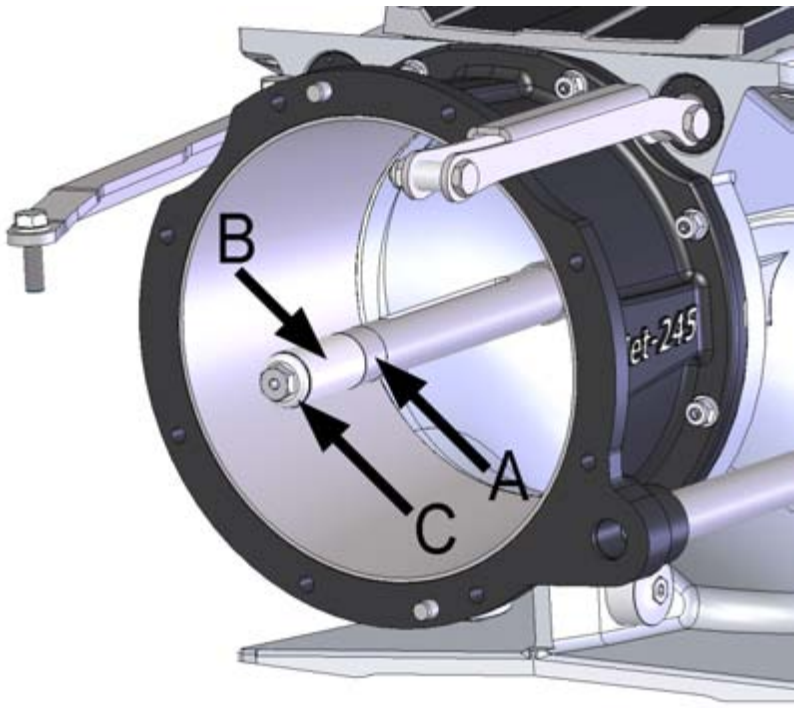

Figure 31. Shaft sleeves

Removing the shaft sleeves:

Open the bolt at the end of the shaft and pull the sleeves off the shaft.

Please note that there are o-rings between the sleeves.

2.2.3. Assembly of the rear-end bearing

Assembly of the rear bearing:

1. Push the bearing into the bearing housing from the back (figure 32).

   Use a bearing retaining compound to ensure that the bearing stays in place (such as Loctite 648 or similar).

Figure 32. Assembly of the rear bearing

2. Push the seal into place from the front of the bearing housing.

   The second seal is attached to the plastic cover. Ensure that the seals are inserted in the correct way (figure 33).

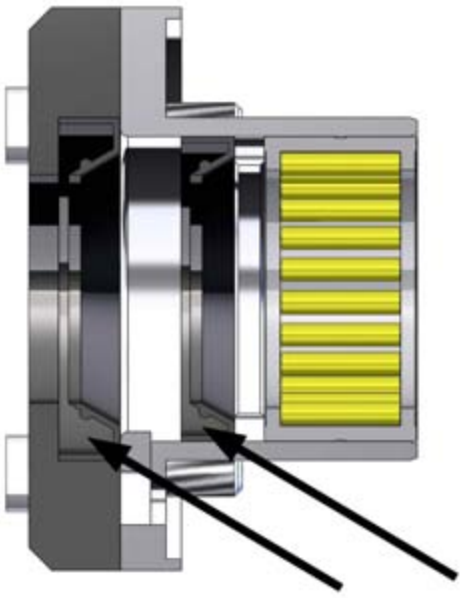

Figure 33. Installation direction of the seals

2.2.4. Installing the rear-end bearing

Before installation, ensure that the bearing housing hole in the stator is clean and intact.

Installing the rear-end bearing:

1. Spread adhesive sealing compound around the bearing housing on the area indicated in figure 34.

Figure 34. Spreading area of the adhesive compound

2. Push the bearing housing into the hole on the stator (figure 35, point A).

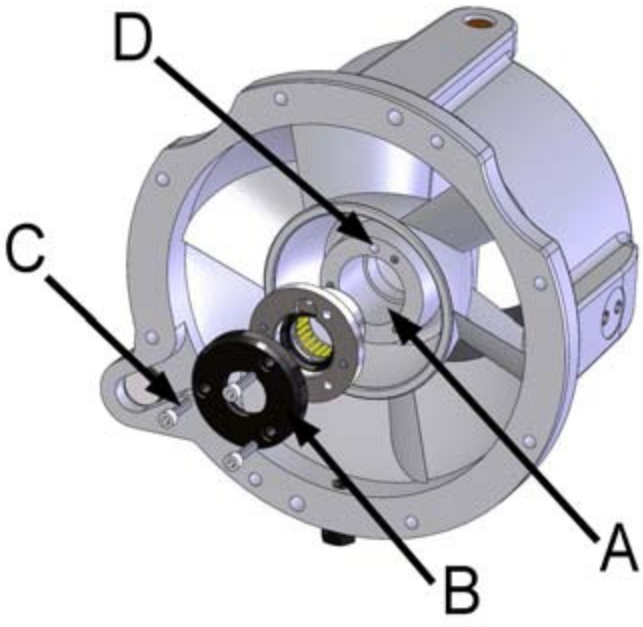

Figure 35. Installing the blanking plate

3. Press the bearing housing into the stator hole in the correct position so that the three fastening screw holes (figure 35) are aligned. This is when

the housing is in the correct position. Install the cover (figure 35, point B) in place and tighten the fastening screws. Use a thread locking compound (such as Loctite 242).

The tightening torque of the screws is 10 Nm.

4. Remove excess adhesive compound from the hole (figure 35, point D).
5. Install the sleeves at the end of the shaft onto the shaft together with the o-rings.

   The correct installation sequence is illustrated in figure 36.

   Use thread locking compound (such as Loctite 243) on the fastening screw in order to prevent any unintentional loosening of the screw.

Figure 36. Installation sequence of the sleeves

6. Install the stator (section 6.3. *Installing the stator*, page 65).

2.3. Intermediate shaft

The intermediate shaft is the transmission shaft between the motor and jet. Usually, the intermediate shaft has been acquired and installed by the boat manufacturer.

The most common types of intermediate shaft are the constant speed shaft and the cardan shaft. In addition, various flexible shaft couplings are used.

The intermediate shaft is attached to the jet's coupling flange and the flywheel or gearbox. An adapter flange can be used between the jet and the shaft.

The manufacturer's instructions must always be followed in the maintenance, repair, and installation of the intermediate shaft.

3. Impeller

The impeller (figure 37, point A) is attached to the jet's main shaft. As the impeller rotates, it generates pressure that is then transformed into the flow rate.

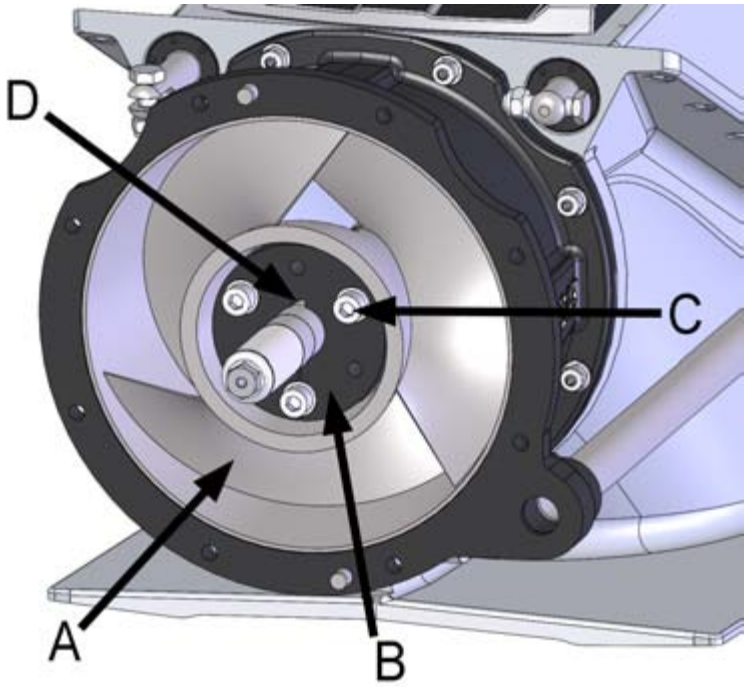

Figure 37. Impeller

The impeller is attached to the shaft using a plastic cone (figure 37, point B), tightened between the impeller and shaft using three screws (figure 37, point C). The torque is transmitted to the shaft using a wedge (figure 37, point D).

The impeller is located in the cone duct, which allows the gap between the blade and the duct wall to be quite small.

There is an adjuster sleeve (figure 38, point A) on the front of the impeller and at least one plastic ring (figure 38, point B). In addition to this, there may be steel rings. The adjuster sleeve features a left-handed thread, and it transmits the impeller thrust to the shaft. The plastic ring is between the adjuster sleeve and the impeller, galvanically insulating the impeller from the rest of the structure.

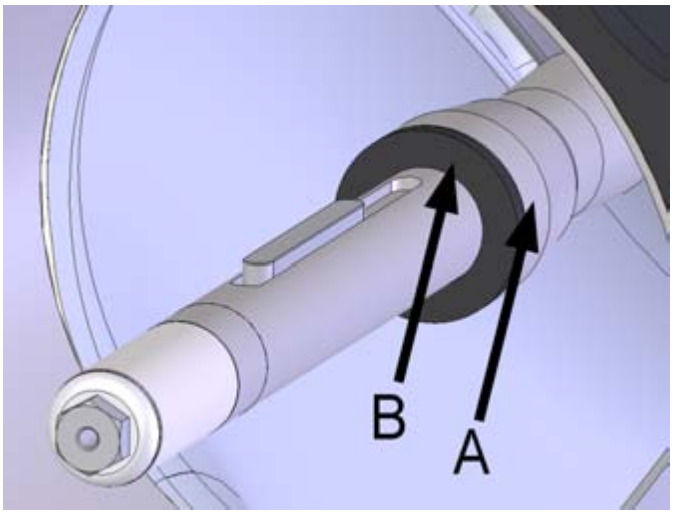

Figure 38. Impeller rings

3.1. Impeller type

The type of the impeller is defined according to the number, pitch, and surface area of the blades. The number and total pitch of the blades are unambiguous, but the surface area may vary according to the diameter and length of the blades.

The impeller type that is used varies according to the situation because the Jet-245 can be attached to various types of motors. Therefore, each impeller must be type-marked. The type marking has been punched into the rear of the impeller hub (figure 39). The type of the impeller must be declared, for example, when ordering a new impeller. The format of the type marking is "245-X/N+T.

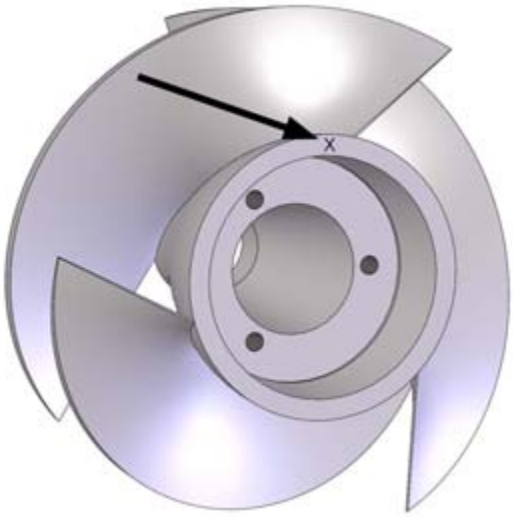

Figure 39. Impeller type marking

3.2. Removing the impeller

Before removing the impeller, remove the stator (section 6.1. *Removing the stator*, page 61).

Removing the impeller:

1. Open the impeller fastening cone screws (3 pcs, figure 37, point C).
2. Insert one of the screws into the threaded hole (figure 40) and tighten until the cone comes loose.

   If the cone is stuck, insert and tighten a screw in another threaded hole.

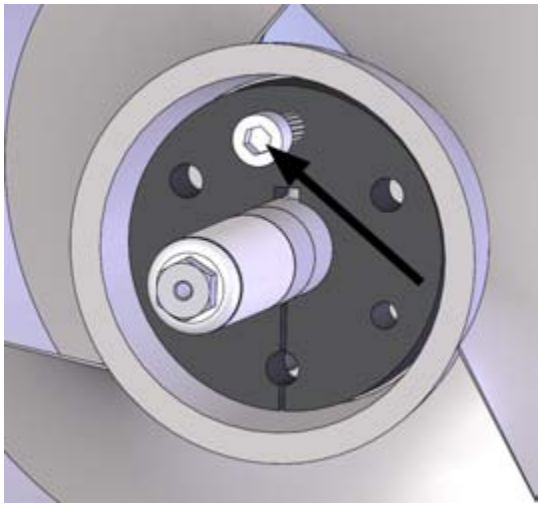

Figure 40. Removing the impeller

3. Pull the impeller off of the shaft and remove the wedge from the groove.

3.3. Repairing the impeller

Minor damages on the impeller can be repaired, Examples of this are dents to the front edge that can be ground out, and slightly bent blades that can be hammered back into their original position.

NOTE!

The impeller must be balanced after any repair operations.

If the diameter of the impeller becomes too small, the impeller must be replaced.

The impeller is manufactured from acid-proof steel 1.4460 (AISI329).

Sanding the front edge

If necessary, a worn front edge can be sanded down. Please note that the front edge may not be too sharp or too round. A suitable rounding is approximately r = 1 mm (figure 41).

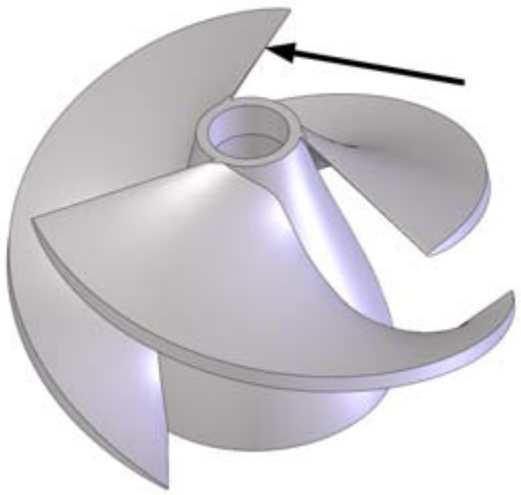

Figure 41. Front edge

Repairing bent blades

Bends in the blades can be carefully tapped back into their original shape with a hammer.

3.4. Installing the impeller

Installing the impeller:

1. Set the fastening cone to the impeller hub and tighten the three screws (figure 42, point A) so that they are finger-tight.

   The mounting cone wedge groove must line up with the mark stamped on the impeller hub (figure 42, point B).

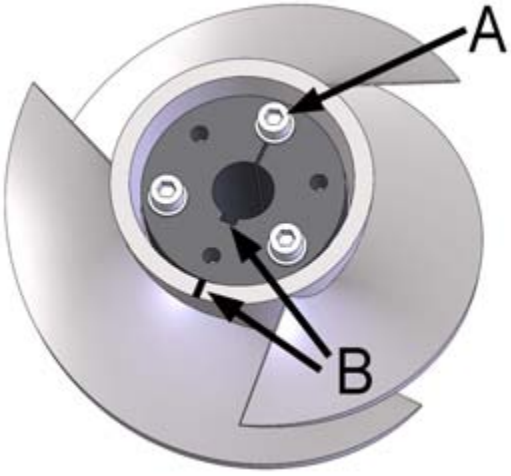

Figure 42. Attaching the mounting cone

2. Lubricate the inner rim of the adjuster sleeve and especially the o-rings, as they cause friction.

   We recommend lubricating the thread with tar to prevent it from seizing up.

3. Push the adjuster sleeve onto the shaft and screw it all the way to the bottom (please note the left-handed thread).

   Also place the insulating ring onto the shaft.

4. Push the impeller onto the shaft until it almost comes into contact with the duct walls so that a small clearance remains at the top or bottom (0.2–0.5 mm).

   This should be done by placing a feeler gauge between the impeller blade and wall (figure 43). It is enough for the feeler gauge to be in the position of a single blade; the rest can touch the duct wall.

5. Tighten three screws of the impeller cone evenly to a torque of 25 Nm.

   At this point, the clearance should increase slightly as tightening the screws pulls the impeller back.

6. Measure the clearance.

   The clearance should be 0.6 mm...1 mm. The easiest way to perform the measurement is to allow the impeller to come into contact with the duct wall at the bottom, which will leave the entire clearance at the top. In this way, once the impeller has been centred, the final clearance will be an even 0.3...0.5 mm.

7. Tighten the adjuster sleeve against the impeller through the inspection hatch.

   It is enough to tighten it by hand. The adjuster sleeve has been correctly tightened when the ring between the impeller and sleeve cannot move.

8. Install the stator (section 6.3. *Installing the stator*, page 65).

9. If possible, rotate the shaft by hand through the inspection hatch or from the engine room (if the marine gear has been installed).

   If the impeller chafes significantly against the duct wall, increase the clearance of the impeller. Minor contact is OK.

10. Complete the adjustment by closing the inspection hatch.

3.5. Impeller duct

The impeller spins in a duct with an aluminium exterior surface (figure 43, point A) and inner ring made of acid-proof steel (figure 43, point B). The inner ring is not an actual wearing part as the cone shape enables the impeller to be adjusted more deeply, in order to maintain a small clearance. However, if the ring is damaged, the entire duct can be replaced.

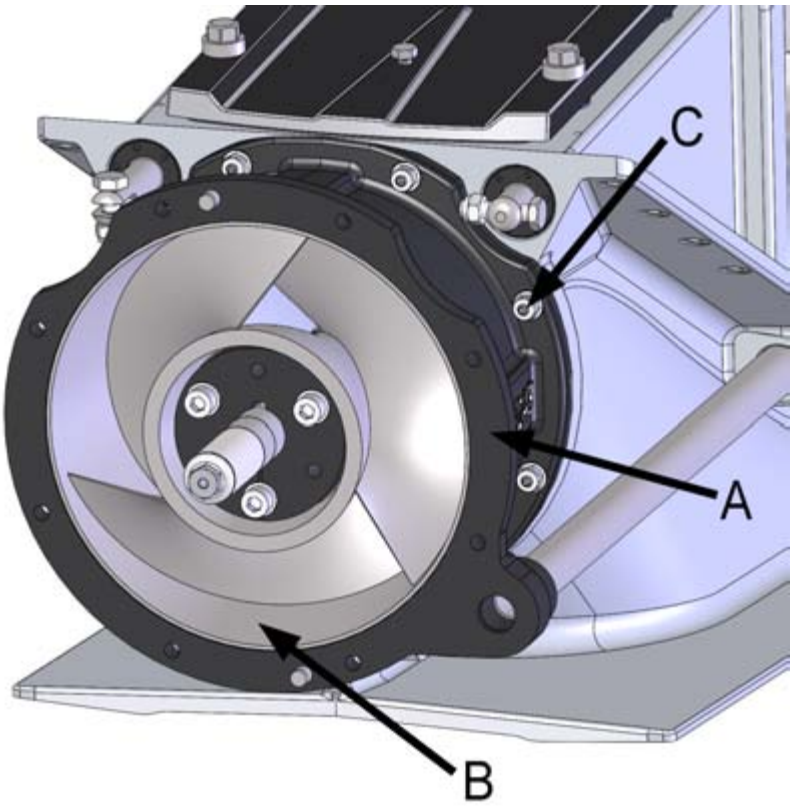

Figure 43. Impeller duct

Removing the impeller duct

Before removing the impeller duct, detach the stator (section 6.1. *Removing the stator*, page 61) and the impeller (section 3.2. *Removing the impeller*, page 29).

1. Open the connection to the raw water line at the pipe end on the engine room side (figure 44, point A).
2. Screw the raw water pipe to disconnect it from the rear end (figure 44, point B). However, you can leave it attached to the hull.

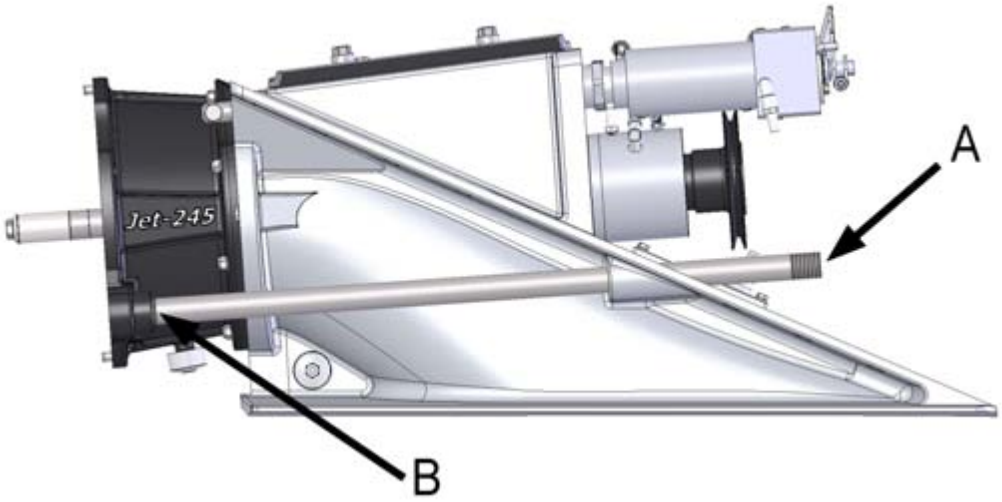

Figure 44. Raw water line

3. Open the duct fastening nuts (8 pcs, figure 43, point C).

4. Pull the duct off the hull.

   You can assist the detachment by inserting a blunt wedge in the holes included for this purpose (figure 45).

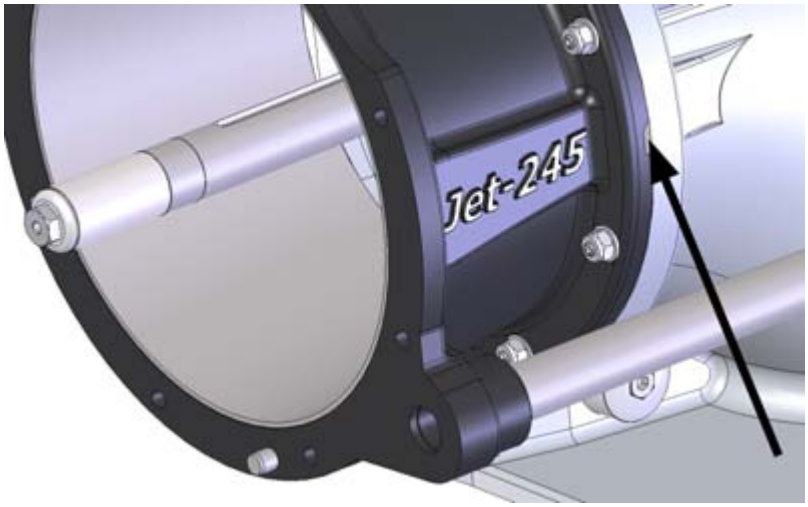

Figure 45. Removing the impeller duct from the hull

Installing the impeller duct

1. Ensure that the o-ring between the impeller duct and hull is in place. Apply waterproof petroleum jelly onto the connecting surface (such as Shell Gadus S2 V220AC or similar) (figure 46, point A).

2. Ensure that the clamping screws (8 pcs) are in their correct places in the hull. If they have come loose, they must be reinstalled with thread locking compound (such as Loctite 242) (figure 46, point B).

3. Ensure that the centring rods of the impeller ducts are in place (figure 46, point C).

4. Press the impeller duct into place.

5. Tighten the nuts and the washers (8 kpl) into place to a torque of 25 Nm.

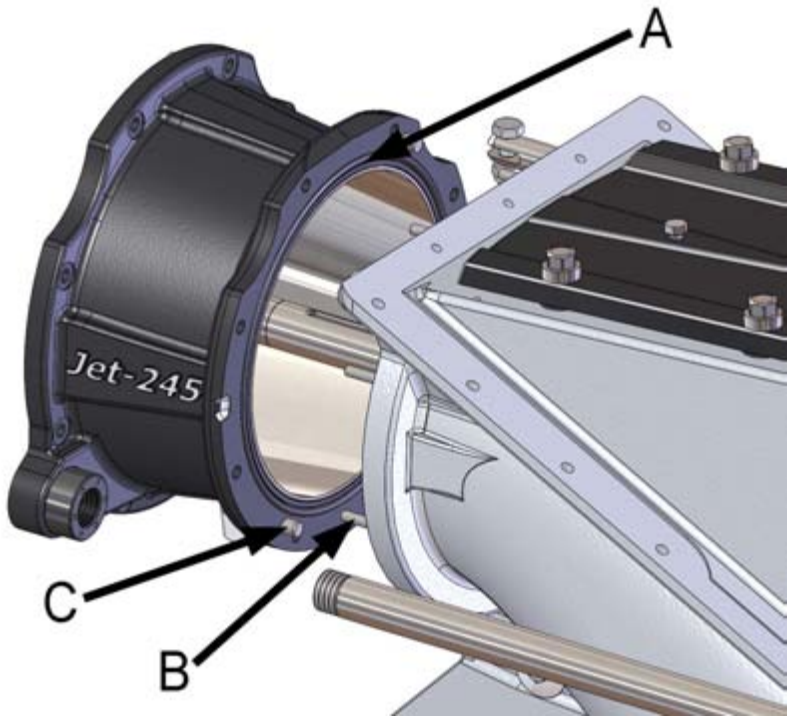

Figure 46. Installing the impeller duct

4. Reversing deflector and operating hydraulics

The purpose of the reversing deflector is to create sufficient reverse thrust for reversing the boat. When the deflector (figure 47, point A) is lowered in front of the jet flow, it will turn the jet flow entirely or partially towards the bow, creating thrust. The operating principle allows for stopping even from high speeds because the deflector can be lowered even at full speed.

The reversing deflector is used through a hydraulic cylinder, controlled mechanically (figure 47, point B). A cable runs from the handle in the cabin to the operating lever of the cylinder (figure 47, point C). The hydraulic cylinder receives its power from a pump integrated in the jet (figure 47, point D), rotated from the coupling flange with a V belt.

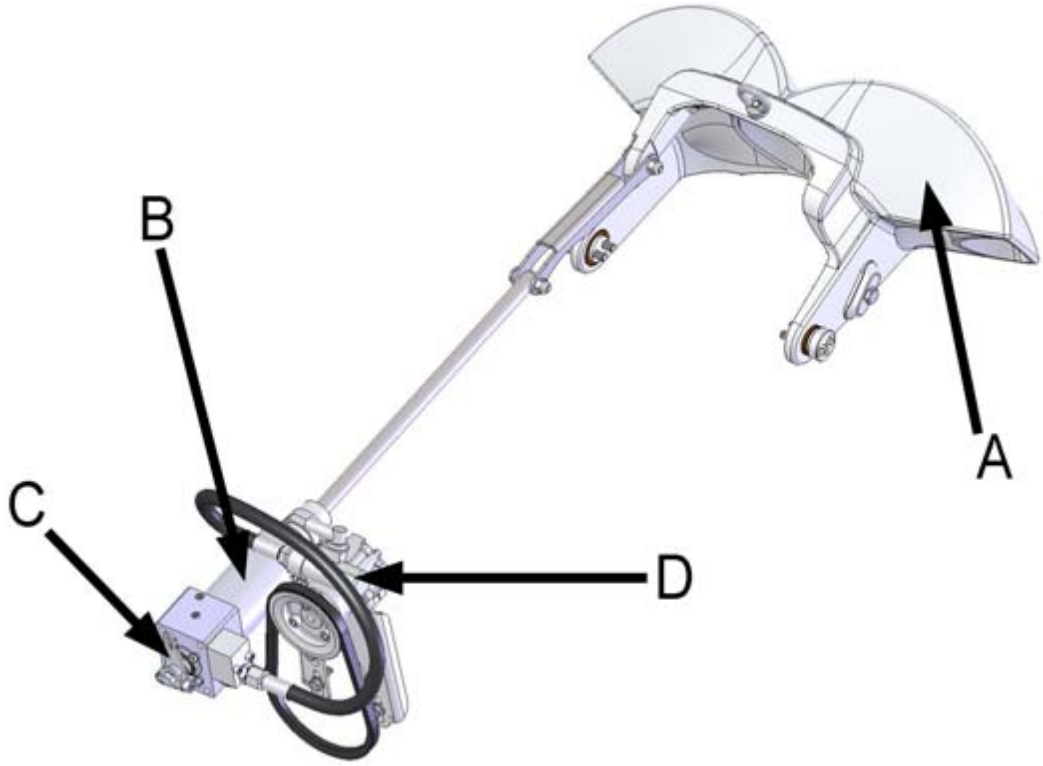

Figure 47. Reversing deflector and operating hydraulics

4.1. Reversing deflector

4.1.1. Removing the reversing deflector

Removing the reversing deflector:

1. Open the knee bolt of the connecting rod between the hydraulic cylinder and the reversing deflector (figure 48, point A).

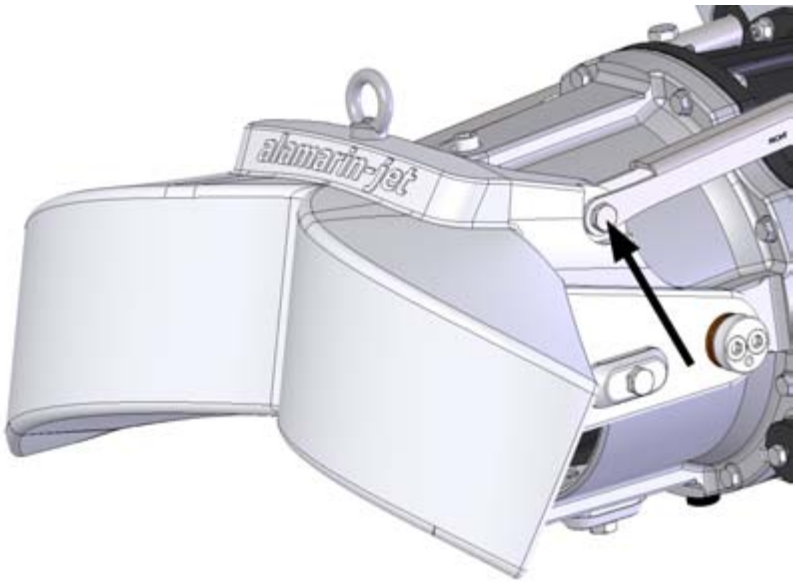

Figure 48. Removing the reversing deflector

2. Open the four joint peg screws (2 pcs, figure 49).

WARNING!

Be careful not to drop the deflector.

The deflector weighs approximately 10 kg.

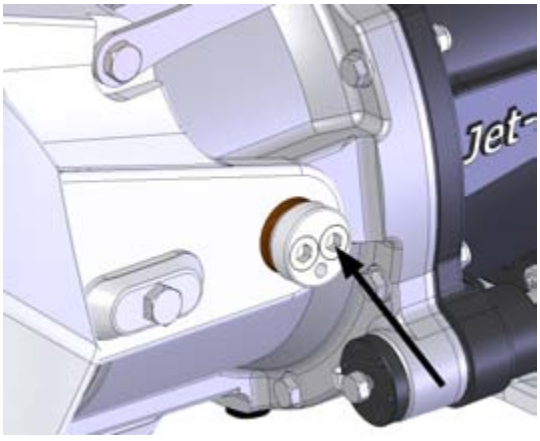

Figure 49. Joint peg screws

3. If you must replace the plastic bearings on the joint pegs, they can be removed with a suitable mandrel.

   The plastic bearings are pushed to their place and can be removed by pushing (figure 50).

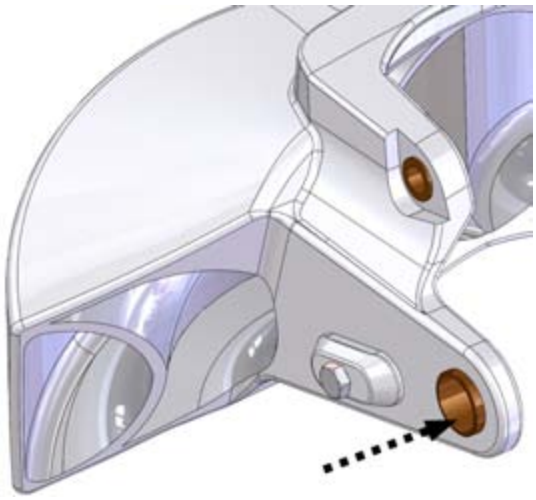

Figure 50. Removing the plastic bearings

4.1.2. Repairing the reversing deflector

The wearing parts of the reversing deflector are the plastic bearings and anodes. When the gap in the plastic bearings of the joint pegs expands too much, the bearings must be replaced. The greatest permissible radial clearance is +1 mm. The articulation bearing of the hydraulic cylinder connecting rod must also be replaced as necessary. The greatest permissible radial clearance is +1 mm.

The reversing deflector is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5. If the arms show breakages, the deflector must be replaced, not repaired.

NOTE!

Bare aluminium areas must be painted when welding the deflector. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

4.1.3. Installing the reversing deflector

Installing the reversing deflector:

1. Push the plastic bearings of the joint peg and the hydraulic cylinder connecting rod into their places.

   Take note particularly of the direction of the joint peg bearing flange (figure 51).

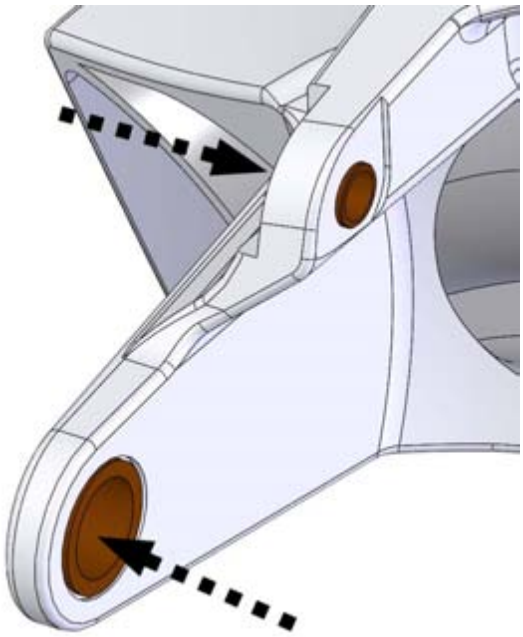

Figure 51. Direction of the plastic bearing flange

2. Lift the reversing deflector in place and push the joint pegs in the holes.
3. Tighten the fastening screws (2 on each side) (figure 52).

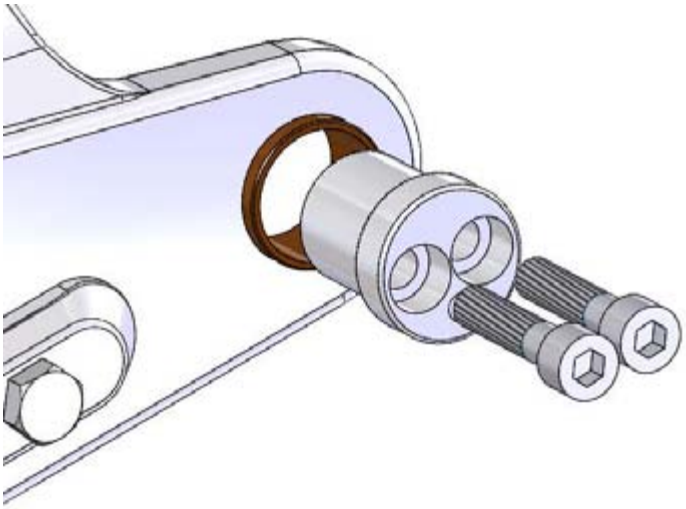

Figure 52. Attaching the joint pegs

4. Attach the knee bolt of the hydraulic cylinder connecting rod (figure 48, point A).

   Please note that there must be a sleeve in the reversing deflector's hole.

4.2. Operating hydraulics

4.2.1. Removing the cylinder

Before you remove the cylinder, make sure you have a container for draining the oil from the hoses. Please note that it may not be necessary to completely drain the system: you can also put plugs at the ends of the hoses.

Removing the cylinder:

1. Remove the cable from the cylinder.

   1.1. Remove the cable angle joint (figure 53, point A) from the control lever.

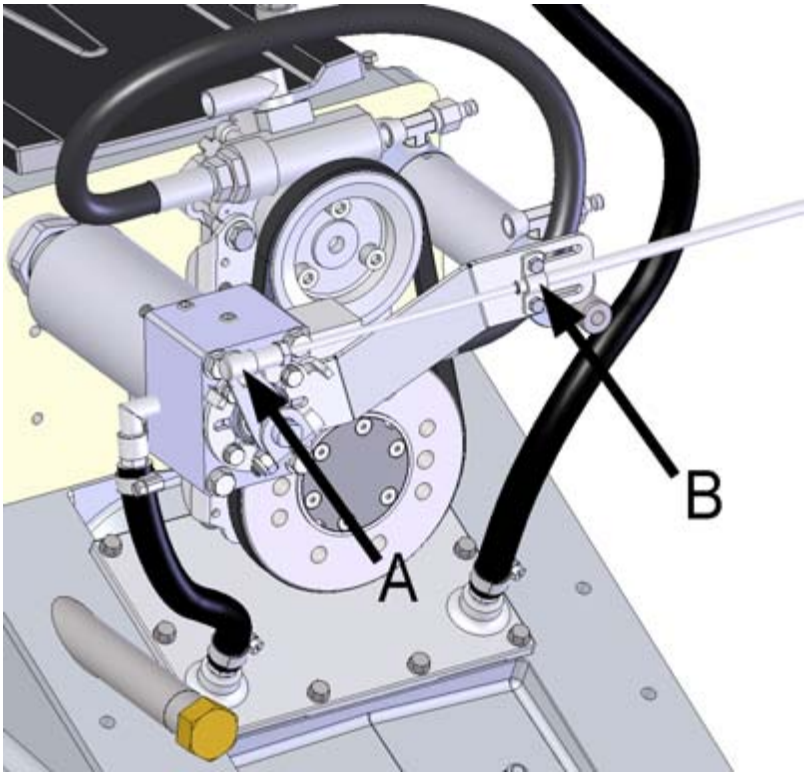

Figure 53. Removing the cable

   1.2. Remove the saddle mounting from the cable clamp (figure 53, point B).

2. Remove the cylinder pressure hose (figure 54, point A) and return hose (figure 54, point B) from the valve and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

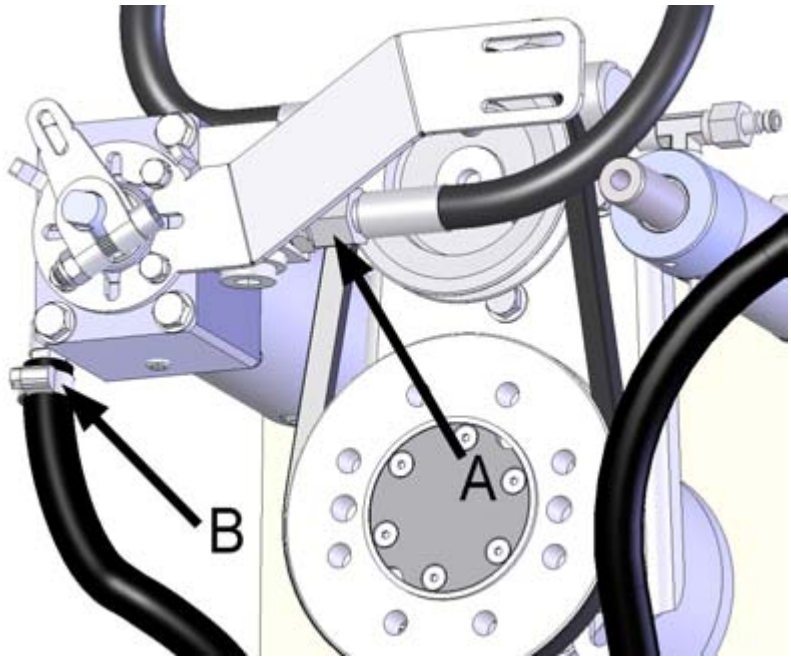

Figure 54. Removing the hoses

3. Open the knee bolt of the connecting rod between the hydraulic cylinder and the reversing deflector (figure 55, point A).

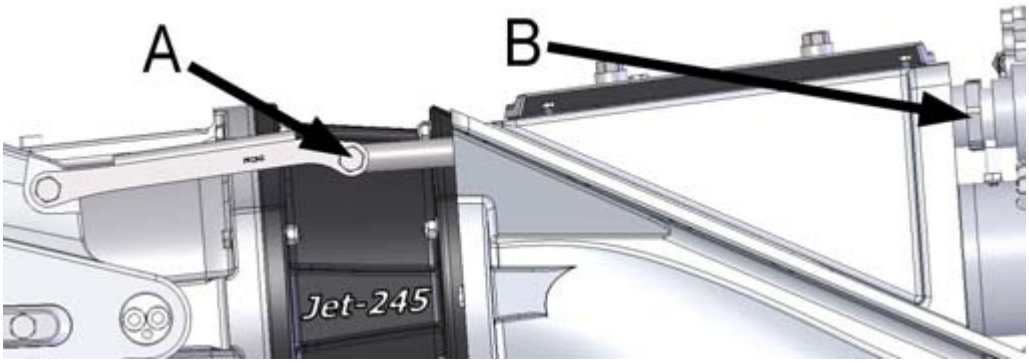

Figure 55. Removing the cylinder

4. Open the fastening nut of the hydraulic cylinder (figure 55, point B).

   If the opening is not possible with conventional tools, you can use special tools 10718.

5. Unscrew the cylinder from the jet's hull towards the engine room.

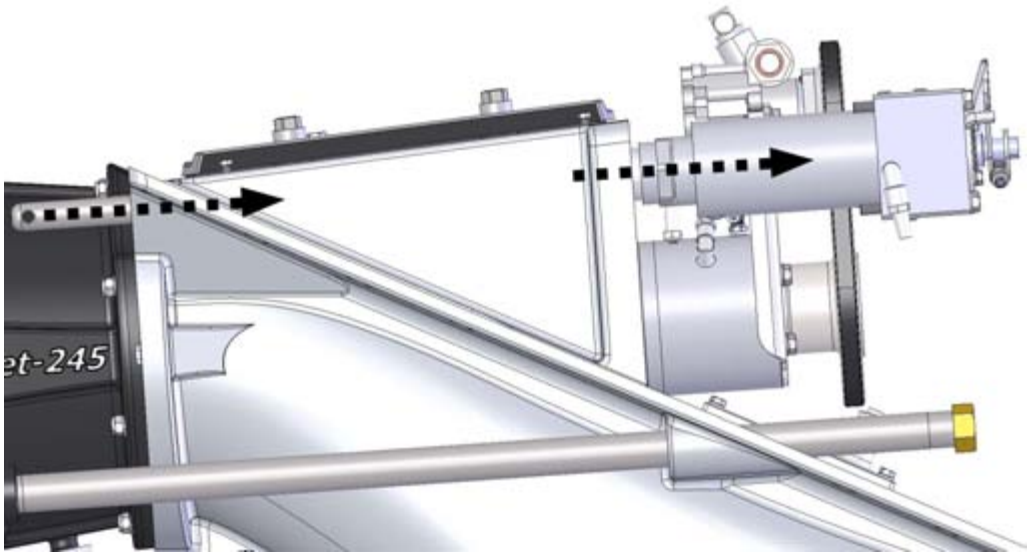

Figure 56. Pushing the cylinder

4.2.2. Repairing the cylinder

Worn or damaged parts of the cylinder can be replaced.

The code for the seal kit is P9904.

NOTE!

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

The cylinder rear end seal (figure 57, point A) is a wearing part and must be replaced regularly. The replacement can be performed with the cylinder in place.

The seal sleeve must be replaced as an assembly, as removing the seal damages the seal groove. The sleeve is also subjected to wear when the cylinder is operated.

The code for the seal sleeve kit is P9909.

Replacing the cylinder rear end seal:

1. Open the cylinder's connecting rod screw if the cylinder is closed (figure 57, point B)

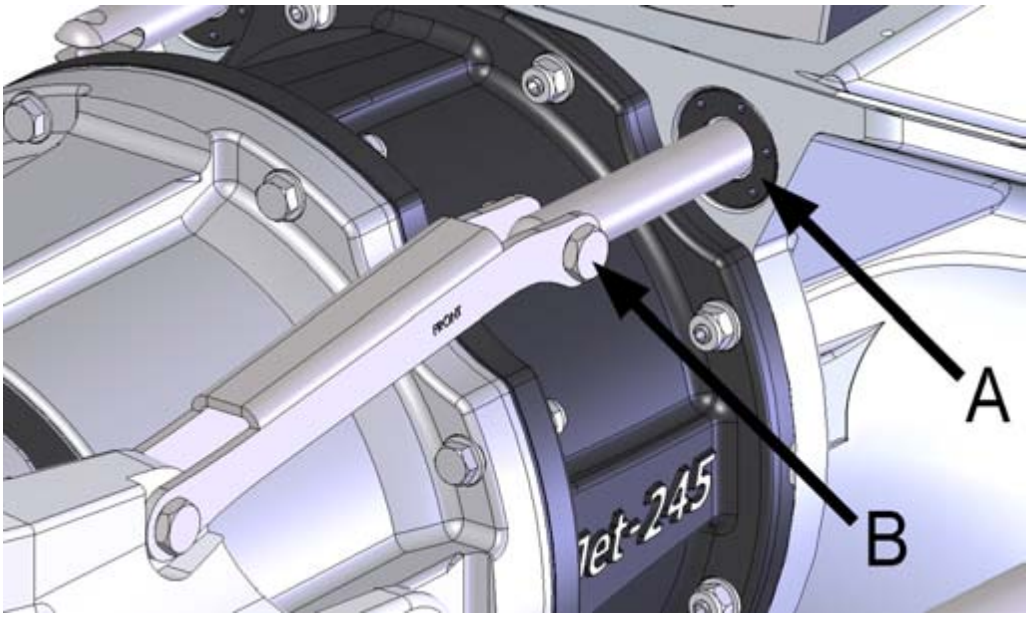

Figure 57. Cylinder rear end seal

2. Unscrew the seal sleeve using the holes in the sleeve.
3. Install the new sleeve using sealing compound (such as Sikaflex 291i).
4. Attach the cylinder's connecting rod screw if the cylinder is installed in place (figure 57, point B)

4.2.3. Installing the cylinder

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

1. Clean the cylinder attachment hole and thread in the hull (kuva 58, kohta A).
2. Screw the locking nut on the thread onto the end of the cylinder in the correct position (figure 58, point B).
3. Screw the cylinder onto the threads in the hull. It is a good idea to apply lubricant on the thread (figure 58, point C).

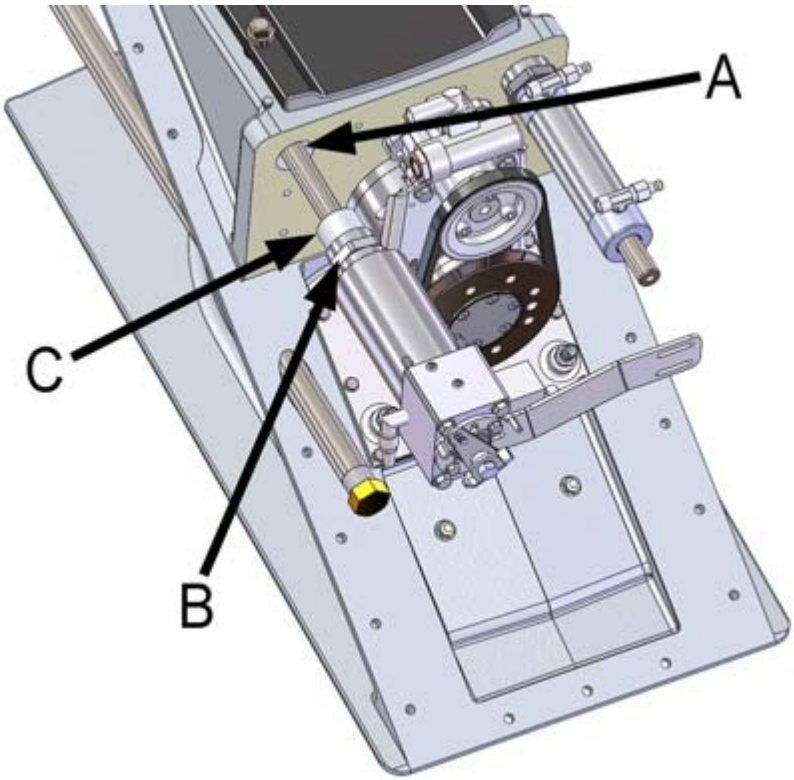

Figure 58. Installing the cylinder

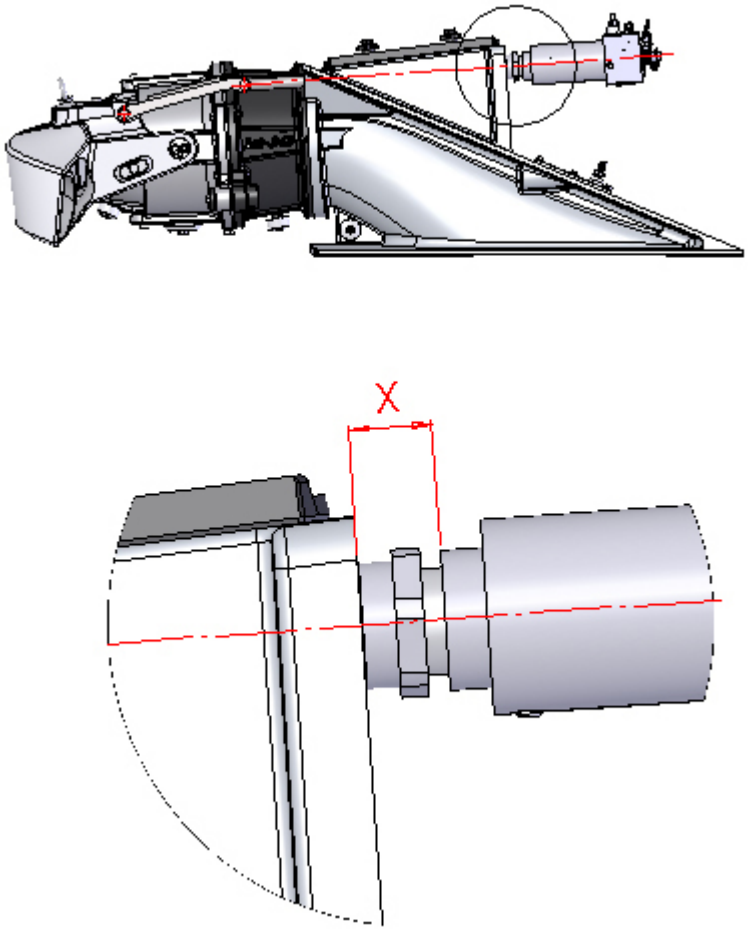

Figure 59. Cylinder dimensions

4. When the correct measurement X ~31 mm is met (figure 59), apply some sealing compound (such as Sikaflex 291i) on the thread, and tighten the nut. You can turn the cylinder slightly if you want the cable clamp to point directly in the cable's direction of entry (figure 60).

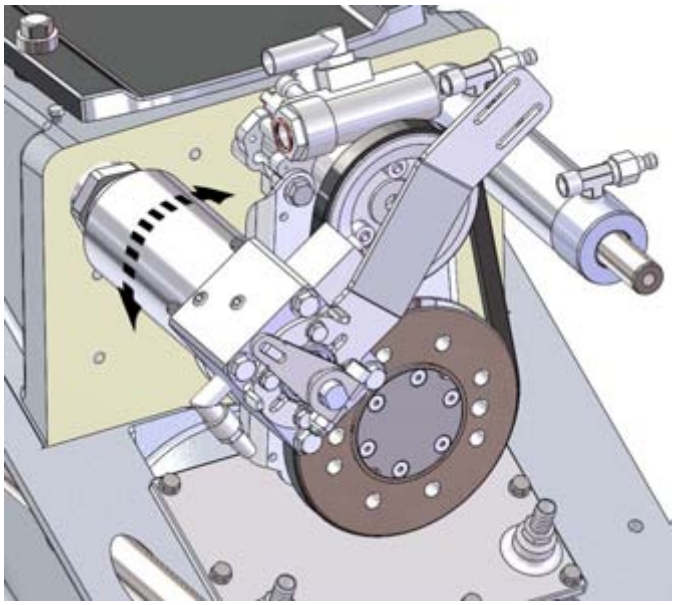

Figure 60. Adjusting the cylinder's position

If the nut cannot be tightened with a normal wrench, special tool 10718 is available.

5. Install the rod between the cylinder and the deflector.

   Check the correct alignment of the rod (figure 61).

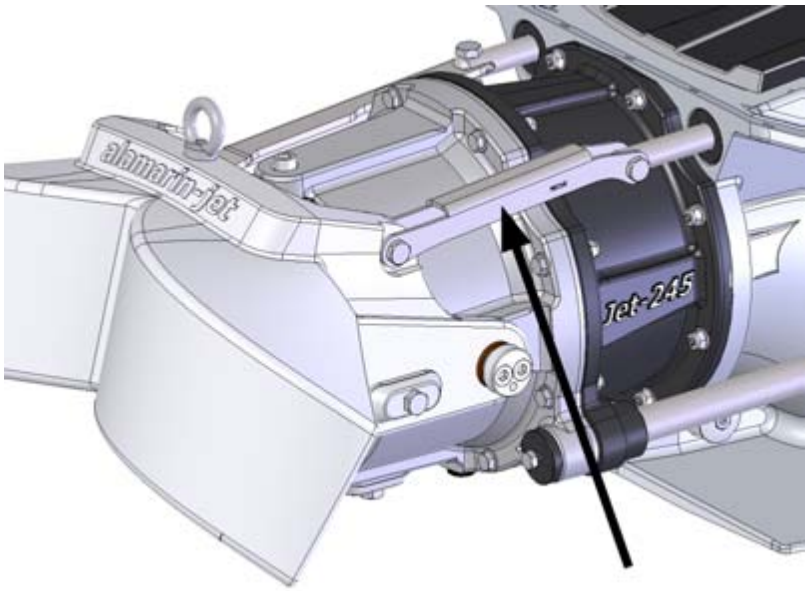

Figure 61. Installing the cylinder's connecting rod

4.2.4. Cylinder adjustment

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 to the reservoir through the cap. There is a dipstick in the reservoir that you can use to check the oil level (figure 62). Every now and then, move the hydraulic cylinder's operating lever back and forth (figure 63, point A) so that the cylinder fills with oil.

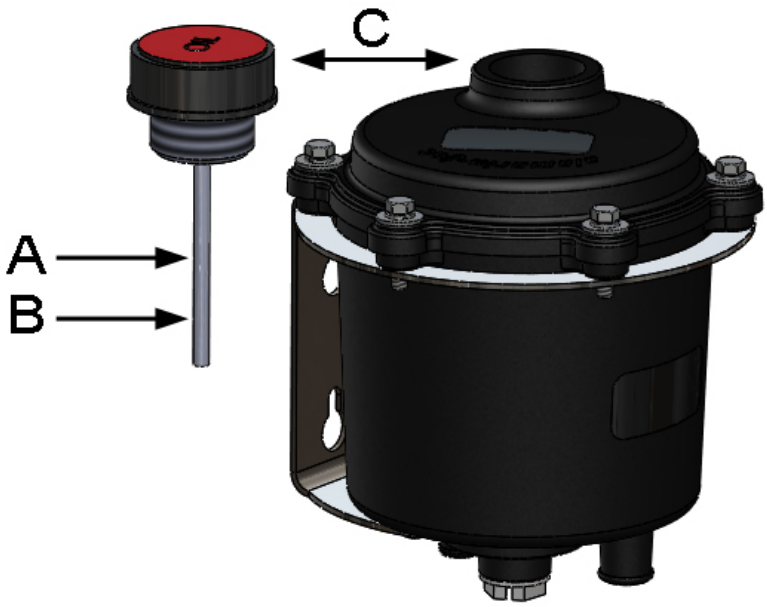

Figure 62. Checking the oil level

A	Maximum level
B	Minimum level
C	Cap

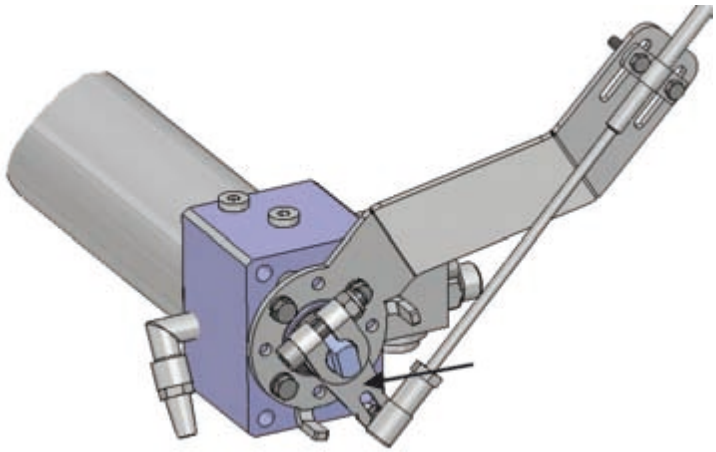

Figure 63. Operating lever

Adjusting the cylinder:

1. Detach the control cable from the end of the cylinder operating lever (figure 64, point A).

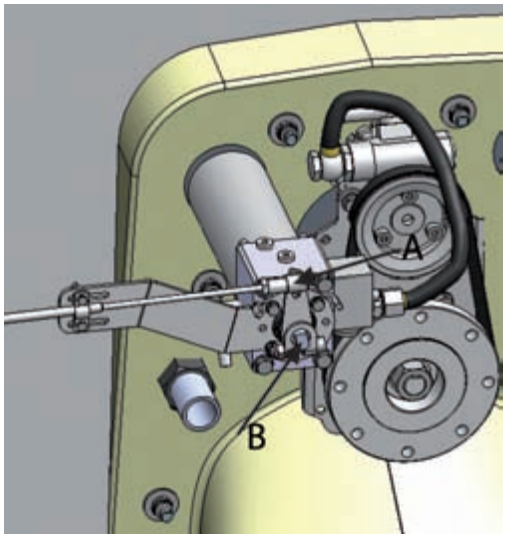

Figure 64. Removing the control cable

2. Loosen the operating lever screw (figure 64, point B) but do not pull the lever off the shaft yet.

3. Place the lever against the limiter on the shaft (figure 65, point A).

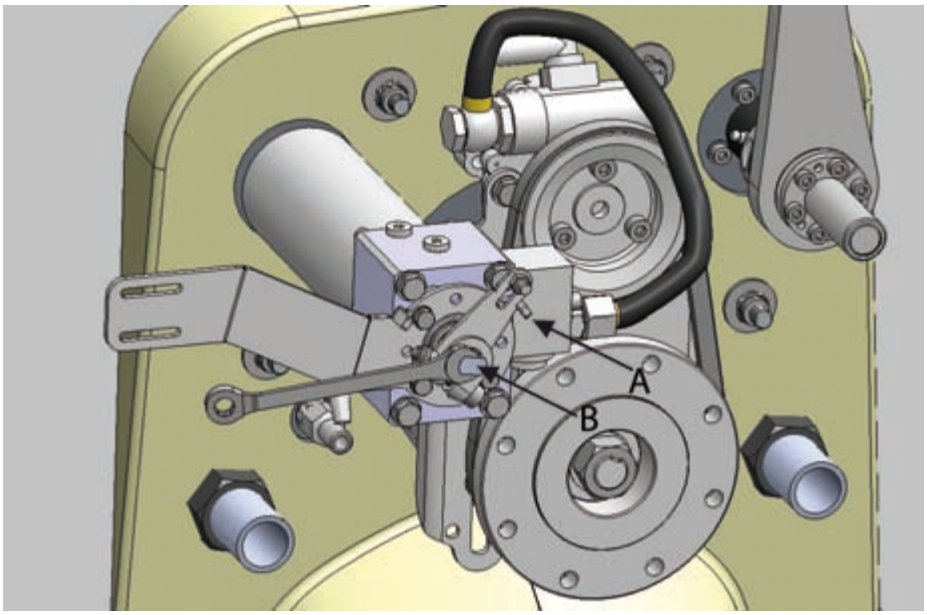

Figure 65. Operating shaft and limiter

4. Turn on the engine and put it into gear.
5. Using a wrench, turn the operating shaft (figure 65, point B) 13 mm 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.
6. Attach the operating lever to the shaft with a screw, and tighten the screw.

   The tightening torque is 10 Nm. Do not tighten the screw too much!
7. Attach the control cable to the screw at the end of the operating lever (figure 64, point A).
8. Use the control system in the cabin to check that the deflector can move to the up and down positions.

   In the up position, the deflector does not block the jet flow (figure 66). In the down position, the top of the reversing deflector nearly touches the steering nozzle (figure 67).

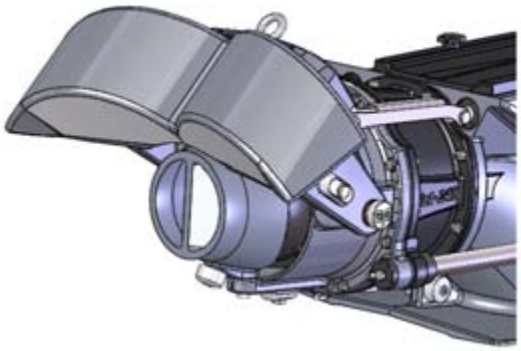

Figure 66. Deflector in the up position

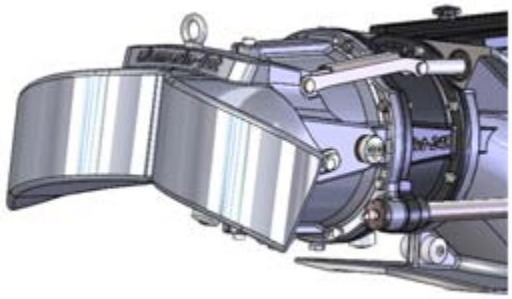

Figure 67. Deflector in the down position

4.3. Hydraulic pump

4.3.1. Removing the hydraulic pump

Before you remove the hydraulic pump, ensure that you have a container for draining the oil from the hoses. Please note that it may not be necessary to completely drain the system: you can also put plugs at the ends of the hoses.

Removing the hydraulic pump:

1. Remove the hydraulic pump pressure hose (figure 68, point A) and suction hose (figure 68, point B) and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

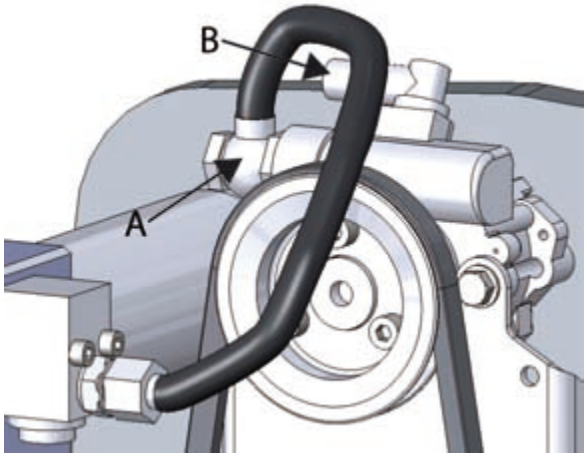

Figure 68. Hoses of the hydraulic pump

2. Remove the hydraulic pump rack by opening its fastening screws.

   The rack is attached to the front surface of the bearing housing with fou screws, two on each side of the pump (figure 69).

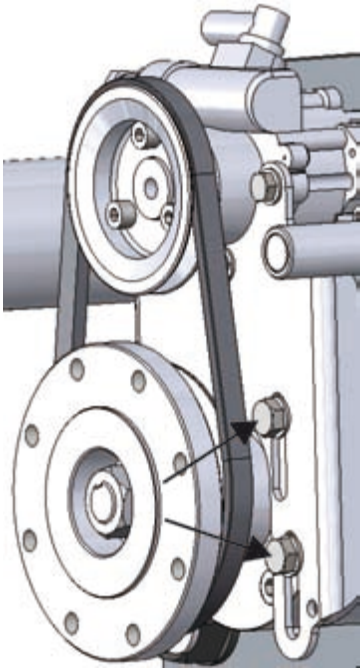

Figure 69. Hydraulic pump rack fastening screws

3. Remove the hydraulic pump from the rack by opening its three fastening screws (figure 70).

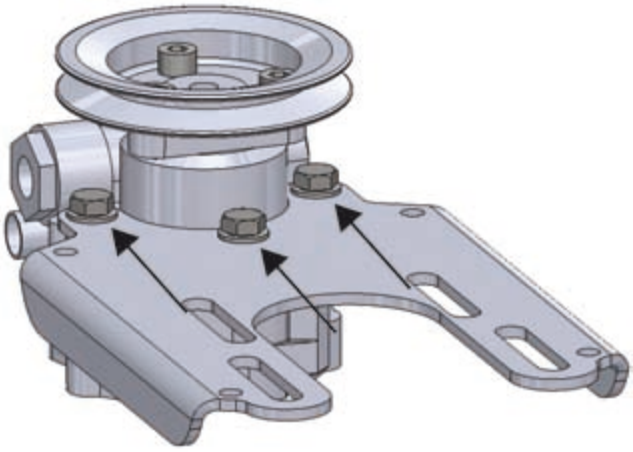

Figure 70. Hydraulic pump fastening screws

4.3.2. Repairing the hydraulic pump

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

Replacing the belt pulley:

1. Loosen the fastening screws of the hydraulic pump rack (figure 69).
2. Open the three screws that attach the belt pulley to the rack (figure 71).

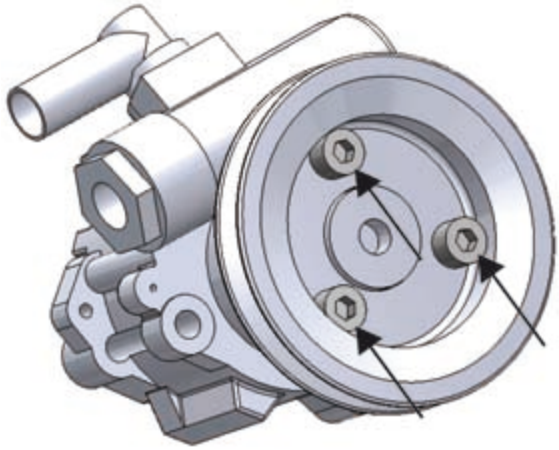

Figure 71. Belt pulley fastening screws

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.

4.3.3. Installing the hydraulic pump

Installing the hydraulic pump:

1. Mount the hydraulic pump in the rack using fastening screws (figure 70).

   The tightening torque is 25 Nm. Use thread locking compound.
2. Set the rack against the front surface of the bearing housing and tighten the fastening screws (figure 69) loosely.

   Use thread locking compound.
3. Set the belt in its place and lift the rack until the belt tightens.
4. Tighten the rack fastening screws at the same time.

   The tightening torque is 25 Nm.
5. Install the pressure hose (figure 68, point A) and return hose (figure 68, point B).
6. Fill the oil reservoir with oil and use the system (motor running, in forward gear), moving the reversing deflector up and down several times.

   This removes air from the system.

4.3.4. Replacing the oil filter

The oil filter in the oil reservoir must be replaced after every 500 operating hours.

Replacing the oil filter:

1. Open the six cover screws (figure 72)

Figure 72. Oil reservoir cover screws

The filter is located under the cover and has a spring on top of it that keeps the filter in place (figure 73).

Figure 73. Oil filter spring

2. Remove and replace the spring and the filter.

   It is not necessary to replace the spring unless it is damaged.

3. Put the cover back into place.

Make sure that the cover seal is correctly positioned in the groove (figure 74, point A). The cover must also be positioned correctly so that the spring is in line with its support (figure 74, point B).

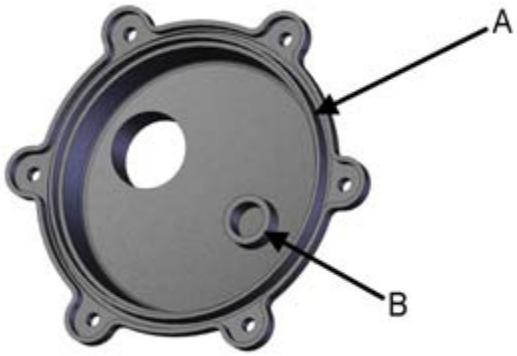

Figure 74. Oil reservoir cover

4. Reattach the six cover screws (figure 72)

5. Steering nozzle and actuating cylinder

The steering nozzle (figure 63, point A) is used to turn the direction of the water from the jet, causing the boat to turn. The steering nozzle is turned with a hydraulic cylinder (figure 63, point B).

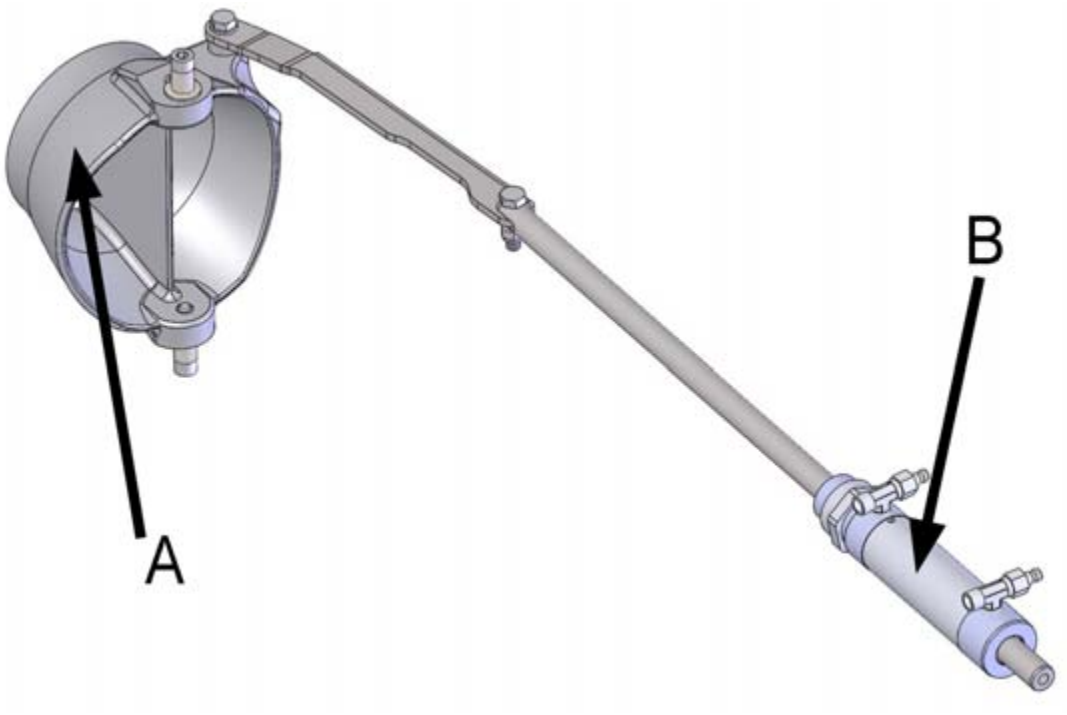

Figure 75. Steering nozzle and actuating cylinder

5.1. Steering nozzle

The steering nozzle can also be removed when the boat is in water, but it is easier if the boat is out of the water.

5.1.1. Removing the steering nozzle

1. Open the connection of the reversing deflector connecting rod (figure 76) and lower the deflector.

   Please note that the steering nozzle must be straight when the deflector is lowered.

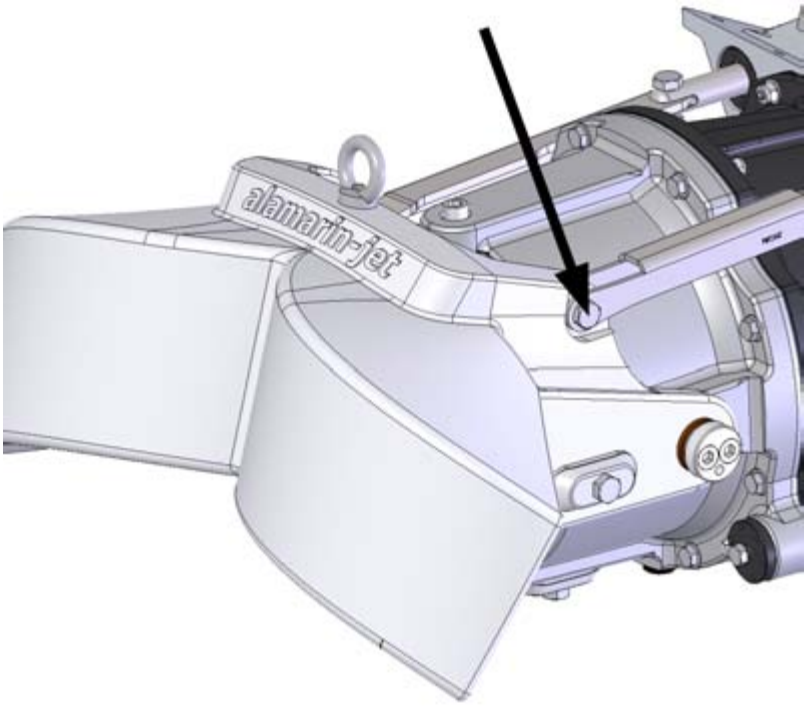

Figure 76. Connecting the reversing deflector connecting rod

2. Detach the control cylinder connection from the steering nozzle (figure 77, point A).

3. Open the steering nozzle joint screws (figure 77, point B).

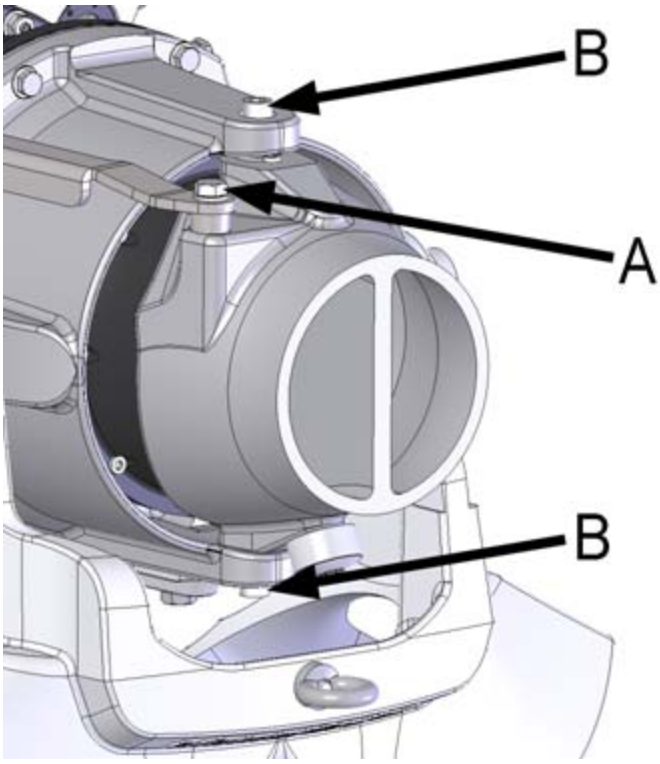

Figure 77. Removing the steering nozzle

5.1.2. Repairing the steering nozzle

A worn or damaged connecting rod 10823, joint peg 10825 and joint pegs 10616 (2 pcs) and anode can be replaced from the steering nozzle.

The steering nozzle is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5. If the swinging arm or shaft holes show breakages, the steering nozzle must be replaced, not repaired.

NOTE!

Bare aluminium areas must be painted when welding the steering nozzle. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

5.1.3. Installing the steering nozzle

1. Place the joint pegs in the stator holes (figure 78, point A) and install the steering nozzle.

   The upper peg must be held in place while guiding the steering nozzle in place. The screws in the joints of the steering nozzle go in the joint peg holes (figure 78, point B)

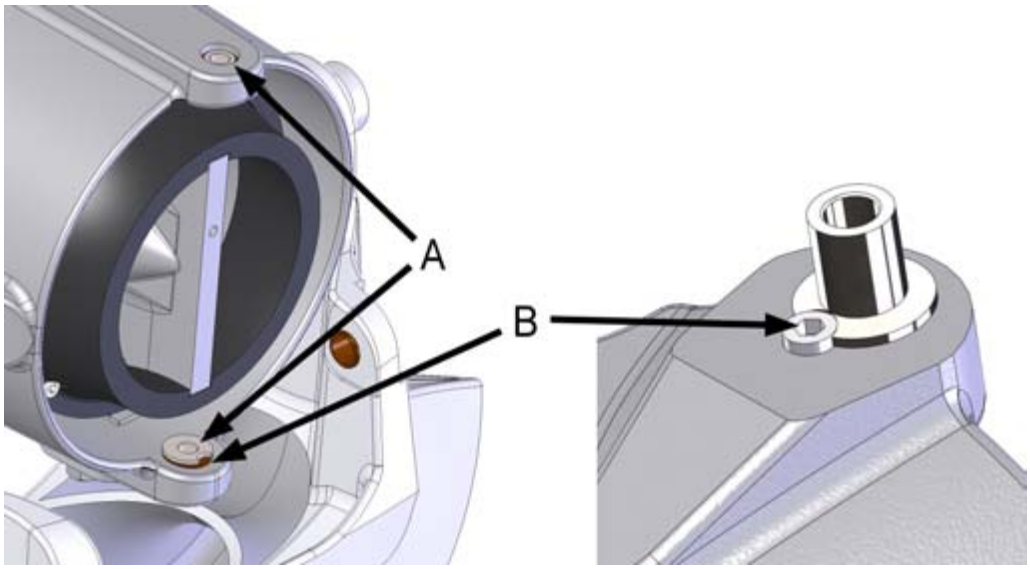

Figure 78. Nozzle joint pegs

2. Screw the joint screws in place and tighten them to a torque of 50 Nm.

   Use a thread locking compound (such as Loctite 242).

3. Attach the cylinder connecting rod with the steering nozzle's joint peg and screw.

   Use a thread locking compound (such as Loctite 242) and tighten the screw to 50 Nm.

4. Attach the connection of the reversing deflector connecting rod (figure 76).

5.2. Control cylinder

5.2.1. Removing the control cylinder

1. Remove the hydraulic hoses from the cylinder (figure 79, point A).

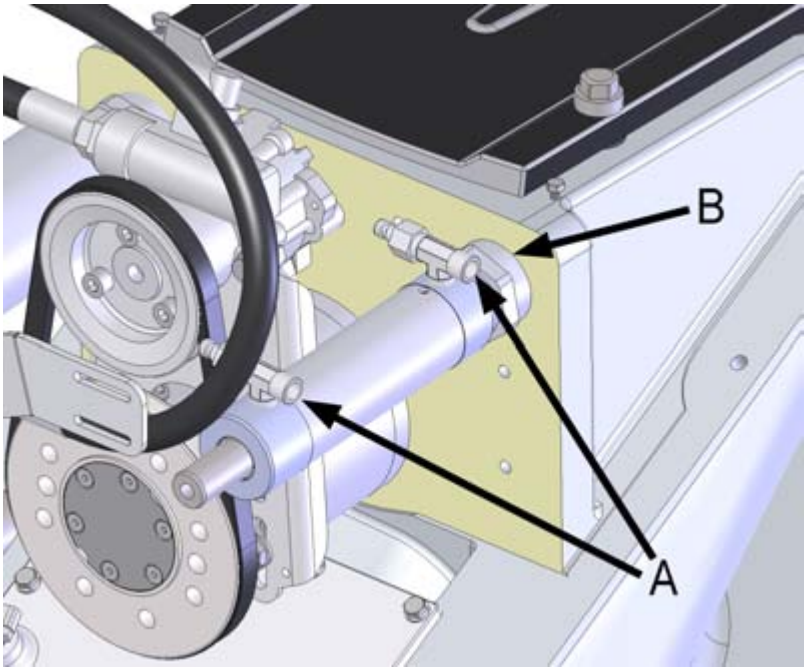

Figure 79. Cylinder hydraulic hoses

2. Remove the connection between the control cylinder connecting rod and piston rod (figure 80).

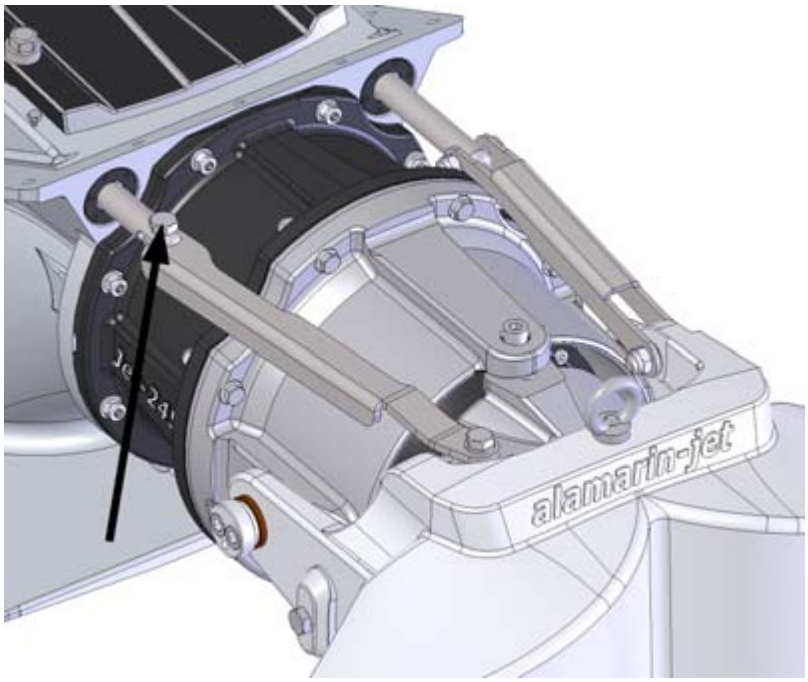

Figure 80. Connection between the control cylinder connecting rod and piston rod

3. Open the fastening nut of the cylinder (figure 79, point B).

   If the opening is not possible with normal tools, you can use special tools 10718.

4. Unscrew the cylinder from the jet's hull towards the engine room.

5.2.2. Repairing the control cylinder

Worn or damaged parts of the cylinder can be replaced.

The code for the seal kit is P9908.

NOTE!

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

The cylinder rear end seal (figure 57, point A) is a wearing part and must be replaced regularly. The replacement can be performed with the cylinder in place.

The seal sleeve must be replaced as an assembly as disconnecting the seal damages the seal groove. The sleeve is also subjected to wear when the cylinder is operated.

The code for the seal sleeve kit is P9909.

Replacement is described in section 4.2.2. *Repairing the cylinder*, page 41.

5.2.3. Installing the control cylinder

The control cylinder is installed in the same way as the reversing deflector cylinder. This is described in section 4.2.3. *Installing the cylinder*, page 42).

6. Stator

6.1. 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 4.1.1. *Removing the reversing deflector*, page 35 and 5.1.1. *Removing the steering nozzle*, page 55).

2. Open the six fastening screws of the stator (8 pcs, figure 81).

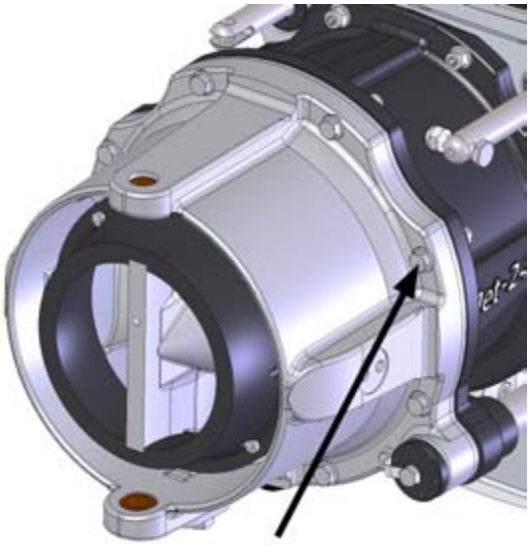

Figure 81. Stator fastening screws

3. Pull the stator off.

   If the stator cannot be detached easily, you can use a screwdriver by inserting it between the stator and impeller duct (figure 82). Please note that this will damage the seal between the parts, which means that it must be replaced.

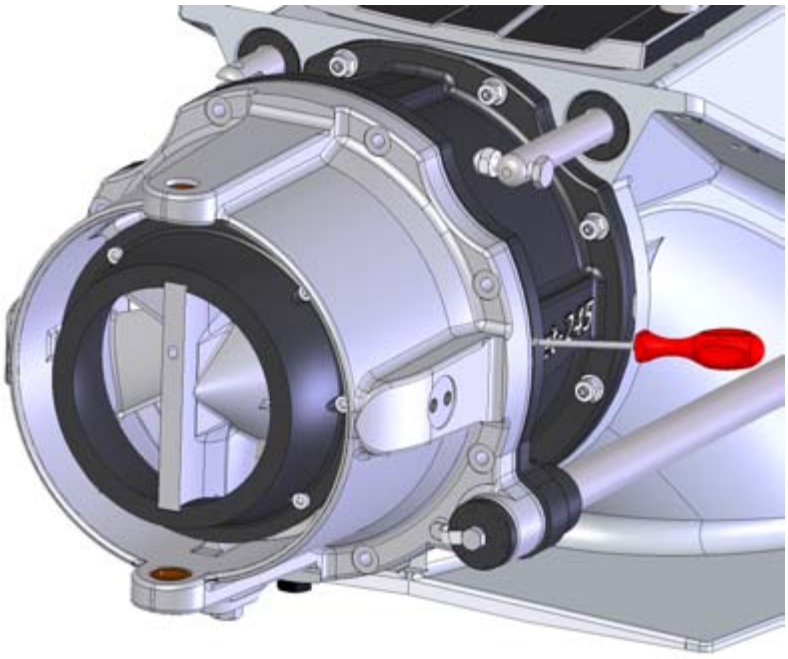

Figure 82. Removing the stator

Removing the stator as a complete unit:

1. Detach the joint between the reversing deflector and hydraulic cylinder (figure 76) and the joint between the steering nozzle and control cylinder (figure 77, point A).
2. Open the six fastening screws of the stator (8 pcs, figure 81).
3. Remove the stator carefully using a screwdriver (figure 82).
4. Pull the stator, the steering nozzle and the reversing deflector out as a single assembly (figure 71).

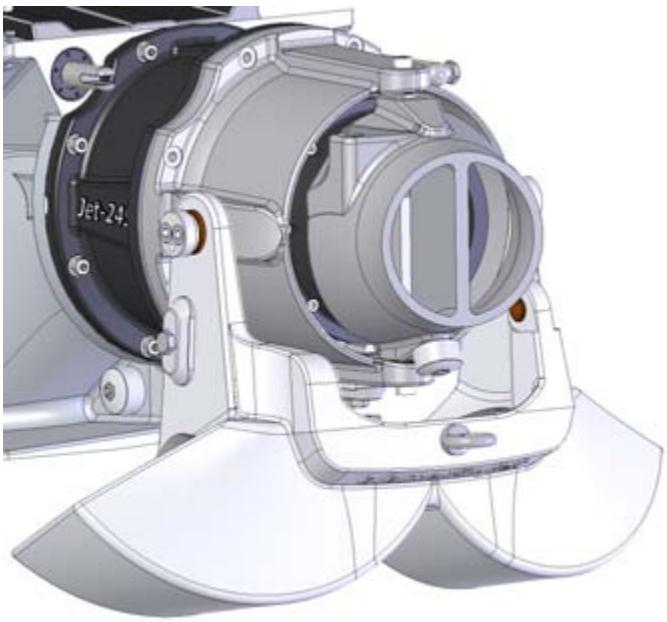

Figure 83. Removing the stator as a complete unit

6.2. Repairing the stator

Replaceable parts in the stator include:

- seals (figure 84, points A and B), seal B is between the choker and the stator
- choker (figure 84, point C)
- anodes (figure 84, points D and E)
- steering nozzle plastic bearings (figure 84, point F)

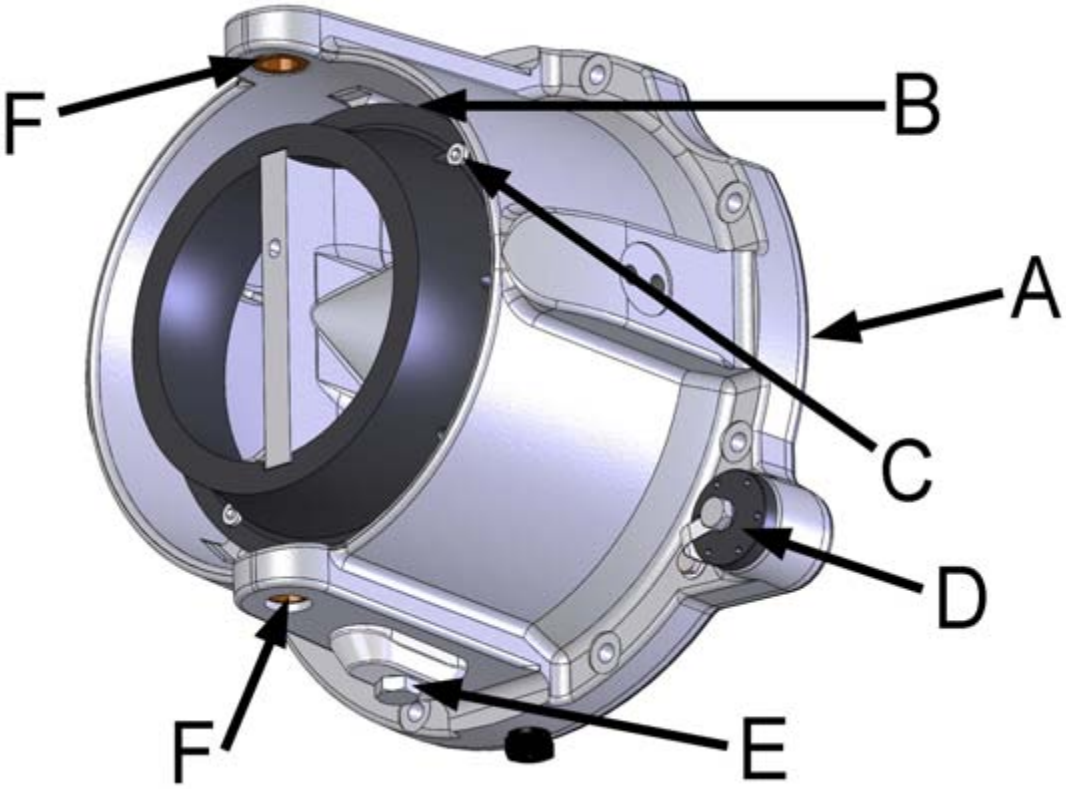

Figure 84. Stator's replaceable parts

The stator is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5.

Typically the tips of the blades suffer most damages in the stator (figure 85). These kinds of damage can be prevented by repair painting any minor damage.

If the steering nozzle pivots show breakages, the part must be replaced, not repaired.

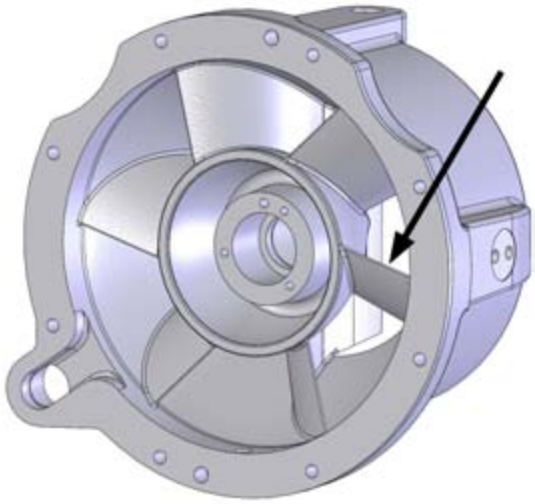

Figure 85. Stator blades

> **NOTE!**
>
> Bare aluminium areas must be painted when welding the stator. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

Seals

Leaking seals must be replaced.

Changing the choker seal:

1. Remove the choker (figure 84, point C) fastening screws (6 pcs).
2. Pull the choker off.
3. Remove the old seal (figure 86).

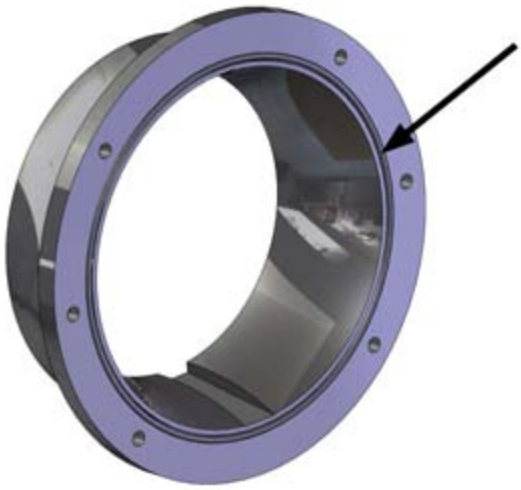

Figure 86. Choker seal

4. Place the new seal in the groove with waterproof petroleum jelly (such as Shell Gadus S2 V220AC).

5. Fasten the choker back into place.

   The tightening torque of the fastening screws is 10 Nm. Use a thread locking compound (such as Loctite 242) for the fastening.

6.3. Installing the stator

1. Ensure that the stator seal is undamaged and the centring rods are in place either in the stator or the impeller duct (figure 75).

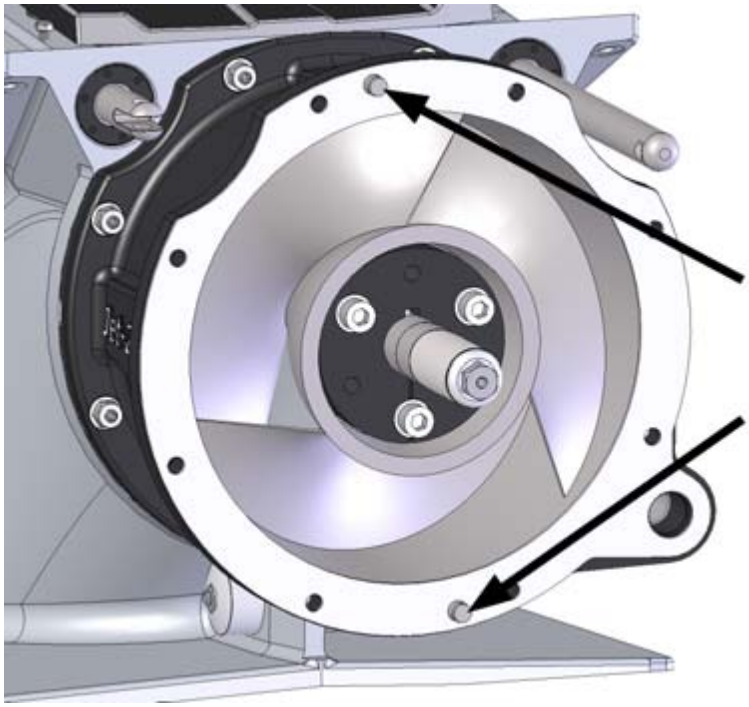

Figure 87. Installing the stator

2. Clean the end of the impeller shaft and push the stator into place so that the shaft end enters the rear bearing housing and the centring rods enter the holes that are intended for them.

3. Tighten the screws evenly to a torque of 25 Nm.

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 2 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 2. 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.