



MAINTENANCE ROUTINES

The tunnel thruster equipment needs regular inspection and maintenance.

The inspection range depends on the following: If you suspect a fault, which requires dismantling of the propeller unit, the inspection work will be comprehensive. In other cases, the propeller unit can remain in the ship during inspection and checking.

An inspection which requires dismantling of the propeller unit should be carried out in the presence of a representative from Rolls Royce Marine AS.

After inspection, all loosened plugs and screws are to be locked in accordance with the instructions.

Weekly inspection

When the equipment is used, the following details are to be checked every week:

1. Inspection for noise and abnormal vibrations of the drive motor.
Check that the bearings, gaskets, electric apparatus and motors are not abnormally heated.
Observe also other abnormal phenomena,
2. Check that the oil level is normal and that there is no leakage in the hydraulic system.

Monthly inspection

1. Check the intermediate shaft, couplings and bearings.
2. If el driving motor, check and follow the lubrication instructions given on the lubrication schedule of the motor. Check brushes and slip rings on wound-rotor AC motors in order to discover any wearing down. The brushes are also to be cleaned in order to remove coal dust etc.
3. If hydraulically driven, follow the valid instruction for service and maintenance.

Yearly inspection

1. Take oil samples and have them analyzed by the supplier.
2. Change oil if needed, according to the results of the analysis.
3. Check the gear backlash.
4. Check and refill grease in the intermediate shaft bearing and gear couplings.



Inspection during normal docking and guarantee docking

Before docking, the propeller is to be carefully controlled with regard to noises, etc. If there are any remarks of observations, the propeller should be entirely dismantled. If no abnormal phenomena are discovered, the following control routines are to be carried out:

1. Turn the propeller by hand in order to check that bearings and gear do not jam.
2. Carry out a pressure testing of the propeller.
3. Take oil samples from the hydraulic oil system. If the oil contains water or other impurities, then it is to be changed.
4. Check the hull tunnel in order to find any corrosion damages. Check the condition of the anodes; see "Installation drawing". Replace any attacked anodes. Check the condition of the painting and renew when required.
5. Lubricate the driving motor in accordance with the instructions on the lubrication chart of the motor.
6. Lubricate the intermediate shaft and the bearing for the intermediate shaft (if exists) with grease.
7. Start the driving motor and pay attention to noise, overheating, vibration and so on. This is to be done, if possible, before docking is finished.

Attention! Apply to shipyard personnel and control that it is allowed to start the driving motor in the dock.

If any abnormal phenomena have been discovered during inspection, the propeller is to be dismantled so that a careful examination can be carried out.

Note: An inspection which requires dismantling of the propeller unit should be carried out in the presence of a representative from Rolls Royce Marine AS.

Pressure testing of the propeller

A pressure test of the propeller is to be carried out during the inspection work, in order to enable a discovery of any sealing damages. The pressure testing and control is carried out as follow:

1. Carry out the pressure testing of the propeller when the upper tank is connected and during repeated operations in the port and starboard directions. Check especially that there is no leakage of oil around the propeller shaft seal and the blade sealing rings.



2. Control the hydraulic equipment, including tubings.

Adjustment of oil pressure

The pressure relief valve, as well as the pressure switches are adjusted on delivery and in normal cases, no additional adjustment is needed. If the pressure is to be checked or adjusted, do as follows:

1. Actuate the control valve manually, so that the propeller gets into a limit position (starboard or port).
2. Check the oil pressure. If necessary, the pressure can be adjusted by means of the control screw on the relief valve.
3. Check that the operation is smooth and safe. An increased pressure does not mean a shorter operating time.
4. Set the pressure switches at values given in hydraulic diagram.



GEAR BACK LASH

When checking the gear backlash, do the following:

Lock the propeller blades by knocking in wooden wedges between the propeller blades and the tunnel. Do not forget to remove the wedges after the measurement!

Secure a lever on the upper end of the drive shaft (see drawing) or other suitable arrangement. The length of the lever should be more than the measure R in Table 1.

Measure by means of an indicator gauge, the movement which can be obtained on the drive shaft. Check that the backlash is within the limits given in Table 1.

Table 1

Size	Backlash	R (mm)
1100	0.20 + 0.05	49.8
1300	0.20 + 0.05	54.5
1650	0.30 + 0.05	56.6
2000	0.30 + 0.05	67.2
2200	0.30 + 0.05	79.4
2400	0.40 + 0.05	84.6
2650	0.50 + 0.05	98.7
2800	0.60 + 0.05	103.7
3000	0.60 + 0.05	114.4
3300	0.60 + 0.05	120.0

Figures are valid at +20°C

When the backlash is increased to 1.5 times the maximum value given above, we recommend an overhaul of the unit, or contact Rolls-Royce Marine AS for a recommendation.



DISMANTLING OF THE PROPELLER BLADES

When replacing the O-ring, the propeller blade (the blade sealing ring), or when replacing a damaged propeller blade, it is not necessary to dismantle the whole propeller unit from the tunnel. The distance between the blade tip and the tunnel allows the blade to be lifted from its seat and taken away. A blade of a smaller propeller can be lifted away manually by two men; larger propellers may sometimes require a special lifting arrangement, depending on tunnel length and the yard's facilities. Such special tools are not included with the Rolls Royce Marine AS delivery.

Dismantling of propeller blades:

1. Drain the oil from the gear housing and the upper tank by removal of the plugs in the gear housing.
2. Cut away the locking plates for the blade bolts by means of a chisel and remove the bolts.
3. Lift the blade from its position.
If it is necessary to use lifting points, lifting eyes can be welded in the tunnel. If the tunnel is equipped with a stainless strip (optional), do not weld in that area.
4. Pull out the blade from the tunnel.
5. The open blade pocket should be covered as soon as the blade is taken away.
6. Clean under the blade foot and the blade pocket before the blade is remounted. Lubricate the O-ring and the bearing surface. Do not lubricate the surface of the crank pin ring.



DRIVE SHAFT SEAL

During operation, some oil drops from the sealing may be seen. This is normal and not considered to be leakage.

Drive shaft seal on version I, II, III and IV:

If a leakage occurs from the seal ring, the drive shaft coupling can easily be removed without removing the electric motor, and the seal ring can be replaced.

Drive shaft seal on version I, II, III and IV:

The drive shaft seal is arranged with two sealings, a white metal seal ring and a radial seal ring.

The white metal seal ring has a constant leakage towards the radial seal ring. The oil is drained from the space between the two seal rings to a separate tank mounted below the gravity tank. The oil is pumped from the separate seal tank and back to the gravity tank.

If a leakage occurs from the seal ring, the drive shaft coupling can easily be removed without removing the electric motor, and the seal ring can be replaced.



CHANGE AND REFILLING OF OIL

The hydraulic / lubrication oil is to be changed if an oil analysis indicates that the oil is impure or in bad condition.

Take oil samples at least once a year and have them analysed by the oil supplier.

Oil used must fulfil our "Requirements for hydraulic oil" (11867-E).

For required oil volume, see chapter 6.

Drain of oil

The installed pump (P53) is to be used for drainage.

- Close valve V54 and open valve V53
- Drain the oil

Refilling of oil

- Close valve V53 and open valve V54
Note: the valve V54 is to be locked in open position.
- Refill the system via the filling connection, Z, on the valve manifold. (See drawing "Hydraulic pump unit")
Note: cleanliness is essential.
- Check the oil level in the oil tank.



1. OIL FILLING

- 1.1 Immediately upon arrival, the propeller unit shall be filled with oil and air vented according to the following instructions:
- 1.2 The oil type and viscosity to be used has to be according to Rolls Royce Marine As instruction No 11867-E, load step FZG12 shall be passed (FZG 12+)
- 1.3 The cleanliness of the oil should be according to ISO 4406, Grade 16/13 or better
- 1.4 For filling up, use a pump with a filter, 10 micron or better, in the discharge line

2. HUB, HIGH PRESSURE CHAMBER

- 2.1 Turn the propeller so that the hub venting holes are in upward direction.
Loosen the two plugs.
Note! Plugs located in hub cylinder and coupling flange.
- 2.2 The oil to be filled slowly through connections **AA** and **BB** at the top of the propeller unit. Air is vented via the two holes.
- 2.3 The high pressure chambers are filled and vented when air free oil appears at the holes. The plugs to be mounted and secured by welding as per separate instruction.
- 2.4 If the piping is installed at this stage, the filling must be carried out through connections **A** and **B** at the pump unit.
- 2.5 During fitting of pipes at a later stage, oil has to be filled into these pipes and air has to be vented at the connections **AA** and **BB** respectively, before final tightening of these pipe connections to the propeller unit.



3. PROPELLER UNIT AND HUB LOW PRESSURE SPHERE

- 3.1 The oil is filled through connection **FF** and air vented through connection **VV**. One of the plugs for the hub low pressure sphere to be in upward position. Loosen the plug for air venting.
Note! These plugs are diametrically positioned in the spherical part of the hub body.

The hub is air – vented when air free oil appears at the hole.

If the hydraulic system is installed, instructions below must be followed.

- 3.2 Connect the filling device to connection **ZZ** (see Appendix 1)
- 3.3 Close the shut off valve (V54), open the valve (V56) and connect a test hose to **VT** on the hydraulic pump unit. Loosen the air-venting plug in the hub low pressure sphere.
- 3.4 Start to fill oil into the propeller unit.
- 3.5 When air free oil appears in **VT** and in the hole in the hub low pressure sphere, close the air venting hole in the hub and disconnect the test hose at **VT** and open the shut off valve V54.
- 3.6 Continue to fill oil into the system until the oil tank is filled up.

The above given instruction is valid for new installations and for installations after reconditioning.

- 3.7 When topping up the oil tank from a low level (not empty), the oil can be filled via connection **Z** at the pump unit.



4. START-UP INSTRUCTION

Valid for new units and units after reconditioning.

The pitch setting system must be final air vented according to following procedure below, before starting up the drive motor.

- 4.1 Adjust 0-pitch on the feedback device.
Set the remote control system to local control mode.
- 4.2 Start the hydraulic pump and set the pitch in end position by means of local manual control of the control valve on the pump unit.
- 4.3 Relief valve setting value (V64) to be adjusted to 6 M Pa.
- 4.4 The pitch is to be manoeuvred 10 times to each end position. The relief valve pressure is to be kept for 5 seconds at each end position.
- 4.5 The relief valve pressure to be set to value stated on hydraulic diagram. The pitch to be set to 0-pitch.
- 4.6 When the air venting procedure is finished, the oil tank is to be filled up to max oil level.
- 4.7 Close shut-off valve (V56) and disconnect the filling pump.
(Connection ZZ can alternatively be permanently connected to an oil filling system)
- 4.8 Valve V54 to be secured in fully open position.
Set the control in remote control position.
- 4.9 The hydraulic system is now ready for operation.



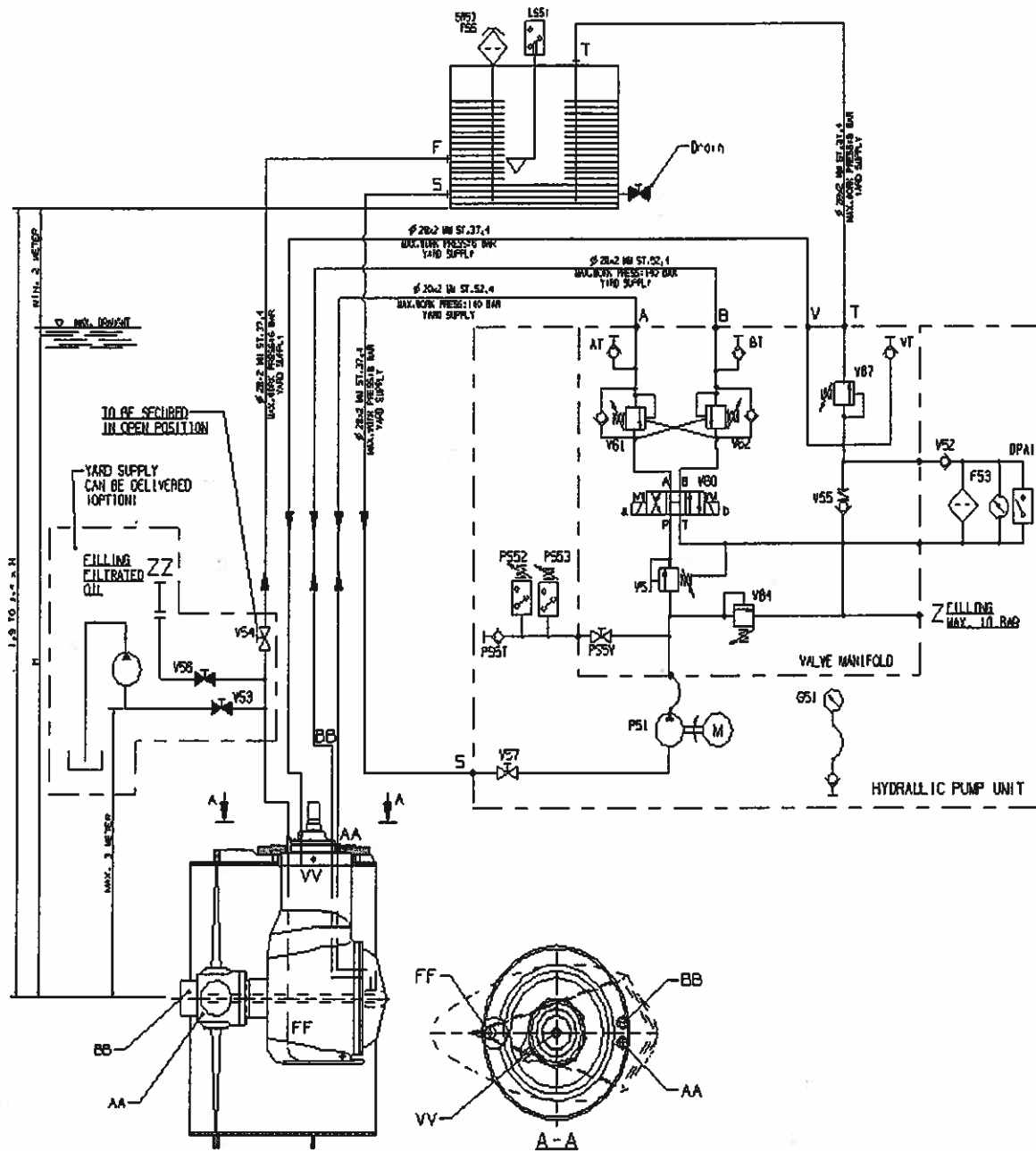
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TUNNEL THRUSTER INSTRUCTION MANUAL

Yard: PORT WELLER

Hull no.: 68

Sign:KOK
Page 50 of 52
Unit no.: T8276
47451-E



Revis	Zone	Revision comprises	Date	Drawn	Approved
a		Text completed	801010	Deb	
b		KaMeWa-propeller removed	860428	BL1w	
B	c	Text changed + drawn by CAD	920613	ALg	JnH
B	d	Dim. 1000 was wrong.	940829	ALg	JnH
B	e	Text changed	950228	ALg	JnH
B	f	Removed swedish text	000719	BEK	DB

Use of tools for torque tightening

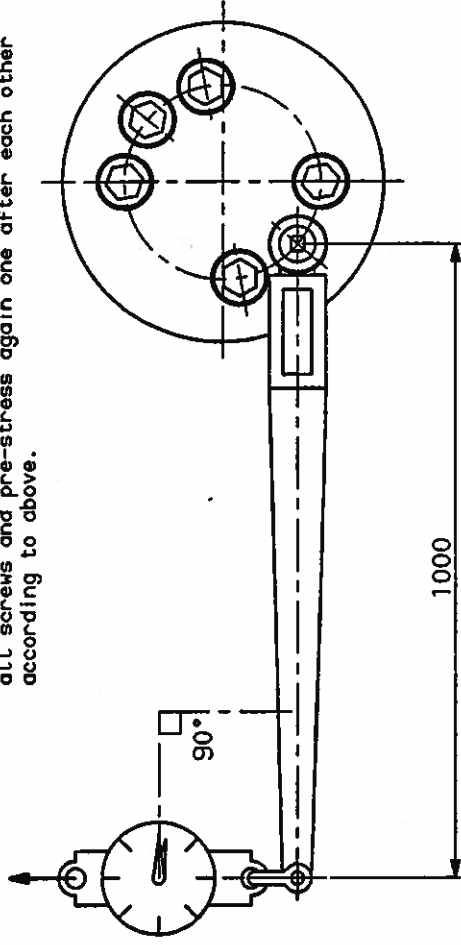
Tools for torque tightening are to be used pre-stressing of blade-, shaft flange- and hub cylinder screws.

Lubricant is to be used on the threads of the screw and sealing compound under the screw head when pre-stressing (see hub assembly drawing).
The screws are to be pre-stressed twice.

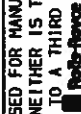
- 1 Check that the screw runs easily in the thread.
Tighten all the screws with a hand tool.
Note! Wrench (pneumatic, hydraulic or electric) may not be used!
torque tightening according to instructions.

- 2 Pre-stress the screws crosswise and read on the dynamometer the torque stated on the hub assembly drawing.

- 3 Wait in 15 minutes
Then begin untightening the screw first pre-stressed and pre-stress this again to the torque stated on the hub assembly drawing and then untighten all screws and pre-stress again one after each other according to above.



THIS DRAWING MUST NOT BE COPIED NOR USED FOR MANUFACTURING PURPOSES WITHOUT OUR WRITTEN PERMISSION NEITHER IS TO BE HANDED OVER TO NOR IN OTHER WAY COMMUNICATED TO A THIRD PARTY. INFRINGEMENT WILL LEAD TO PROSECUTION.



Basic size	Tolerance	Basic size	Tolerance
(3) - 6	$\pm 0,1$	(1000) - 2000	$\pm 1,2$
(6) - 30	$\pm 0,2$	(2000) - 4000	± 2
(30) - 120	$\pm 0,3$	(4000) - 8000	± 3
(120) - 315	$\pm 0,5$	(8000) - 12000	± 4
(315) - 1000	$\pm 0,8$	(12000) - 16000	± 5
		(16000) - 20000	± 6

Use of tools for torque tightening

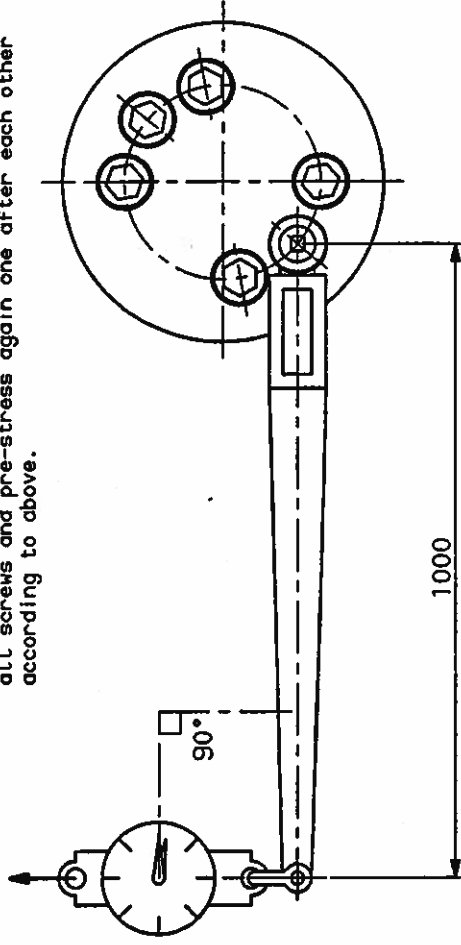
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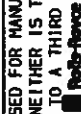
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Item no.	Description	Reference	Material	Remark
Plant		Order No./Prod. No.		Total weight by
Drawn	Deb	Checked	Approved	Surface texture ISO/R 1302 Ra μm \checkmark
PROPELLER HUB				Scale A3 19800312
Instr. for tightening of screw				Sheet of 1 1 577077
Rolls-Royce				Design 586431
60001				f