DYNAMIC POSITIONING CONFERENCE
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Thrusters

Service Experience with 4 x 4,500 kW Thrusters

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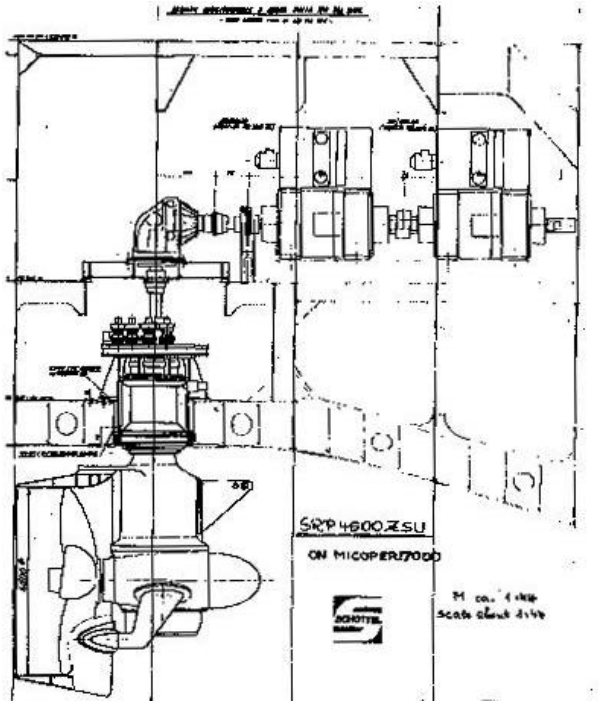
General
In 1986 the semi-submersible crane vessel SSCV "Micoperi 7000" was built by Fincantieri, Cantiere Navale Italiana SPA, in Monfalcone, Italy.

The owner of the vessel was firstly Messrs. Micoperi, they were taken over later by Saipem and the name of the vessel is now "Saipem 7000".

The vessel was commissioned in 1987 and is in service since as one of the world biggest crane vessel equipped with 2 x 7000 tons revolving cranes.

The vessel did crane service in following locations:
· Brasil 1987 - 1989
· North Sea 1989 - 1998

From October 1998 until April 1999 the vessel was converted into a combined crane vessel and pipelay vessel. Since then it is working as a pipelayer in the North Sea.



Main propulsion and propulsion for dynamic positioning (among other smaller retractrable thrusters and bow thrusters) are No. 4 SCHOTTEL Rud derpropellers type SRP 4500 ZSU. Each Rudderpropeller has a power of 4500 kW/720 rpm. These thrusters are the main propulsion of the vessel for a speed of about 9,5 knots and they are part of the dynamic positioning propulsion.

The total DP power is 35.000 kW and the DP system is layed out for North Sea condition, i. e.:
· wind force upto bft. 8
· currence upto 2 knots
· sea state upto 6 m wave height

Except of the period where the pipe-laying equipment was installed the vessel is in uninterrupted service and the thrusters SRP 4500 are used in transit cases and during crane operations or pipe-laying for DP.

The base of the vessel is Rotterdam, the Netherlands, and the vessel return to the base almost every 6 to 12 months.

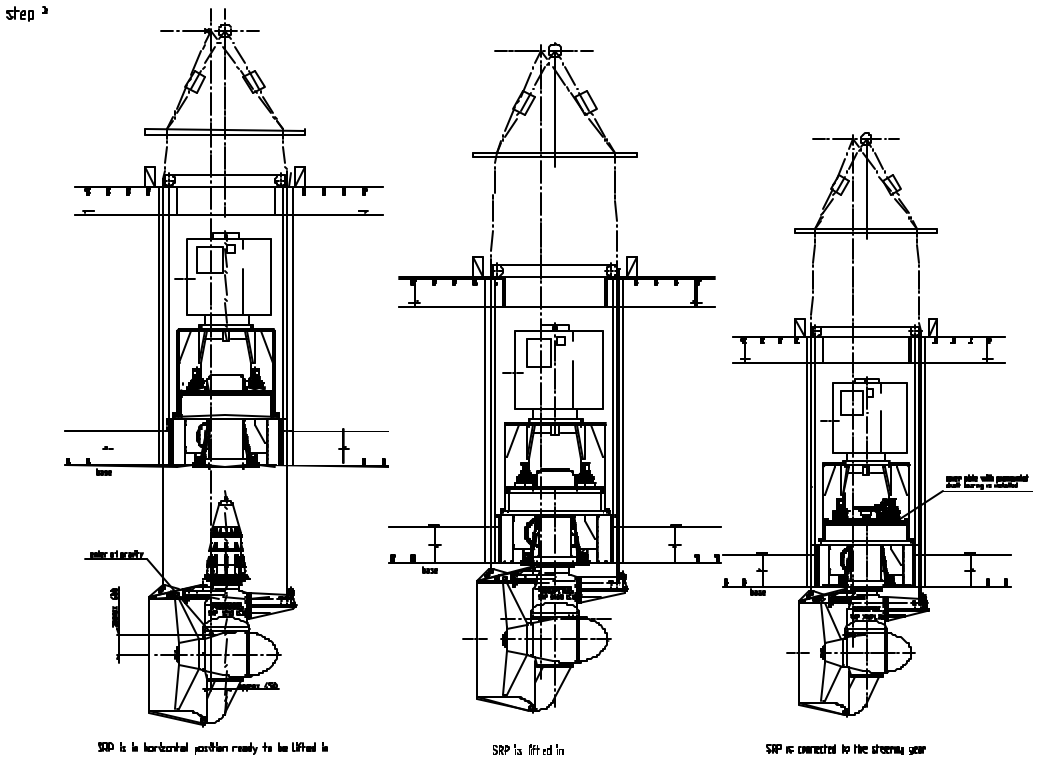
Since 1987 the propulsion units are operating for 4000 - 5000 hours annually and the thrusters are now for 60.000 operation hours in service.

At the time of vessel's construction the Rudderpropellers type SRP 4500 ZSU were the largest steerable thrusters world-wide.

Thrusters are foreseen for underwater mounting. Underwater mounting is provided through a receptacle with visual and mechanical position control of the thruster. The thrusters are moved by a winch system with fine adjustment device. Mounting and dismounting of the thrusters is diver-assisted.

Before underwater dismounting the power transmission shaft to the upper right angle gear which is connected to the driving motor is removed and the vertical power input is sealed by covers. The lower part of the thruster is attached to the steel wires and after the locking pins are released, the unit is lowered by the winch system.

The crew of the vessel has a good experience is underwater mounting and dismounting and for one thruster this procedure takes about 12 hours.



Operation and Service Experience

As the thrusters SRP 4500 were the first steerable thrusters of 4500 kW in operation world-wide, small start of problems were solved between owner, motor supplier and ourselves.
This was done during the first year of operation.

Start-up problems were related to:
- lubrication problems at the power input bearing (problem solved by modification of lubrication system)
- too fast acceleration of electric prime mover (up to 2 sec. from 0 to full rpm), so risk of gear damage (problem solved by reducing acceleration of motor to about 12 seconds from 0 - full rpm)
- monitor pumps for temperature monitoring failed (solution: installation of more reliable monitoring pumps)

However generally after one year of operation (in Brasil) all four thrusters were working satisfactorily.

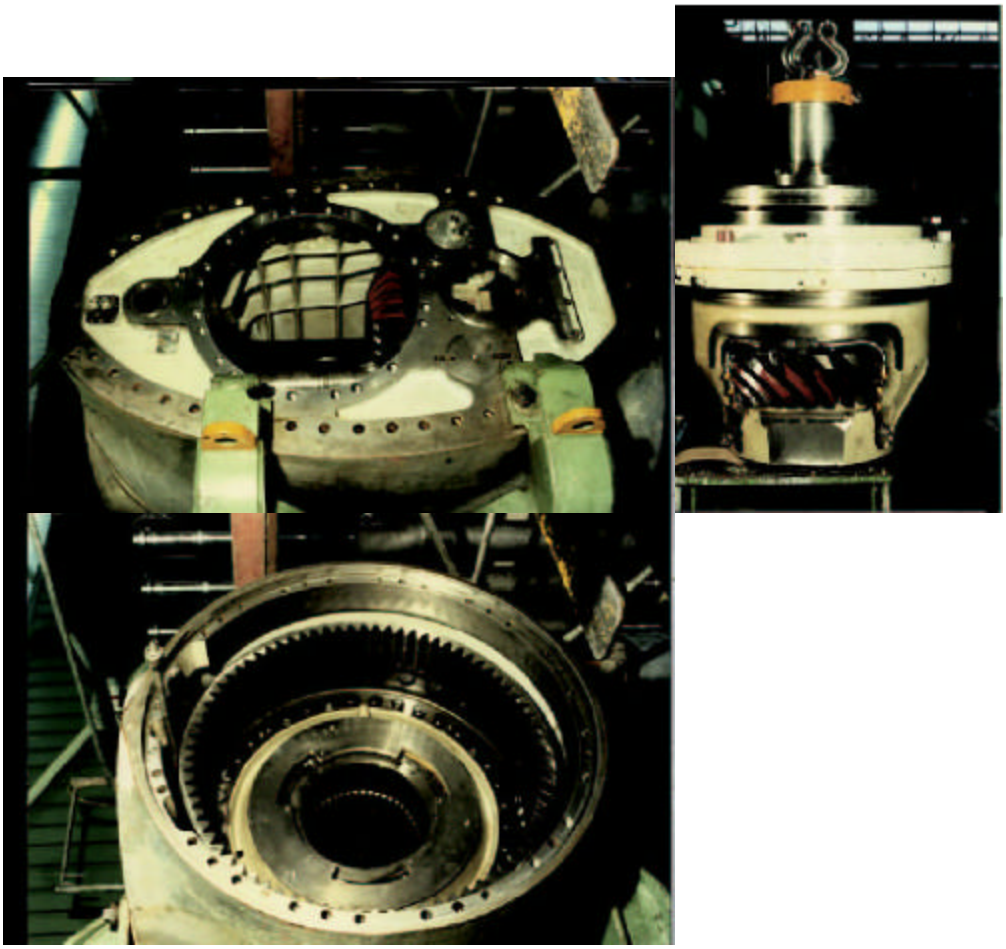
In 1992 after five years of operation the ship owner started to set-up a regular maintenance program for the thrusters.

As one spare lower part of thruster, i. e. the complete underwater mountable part, was purchased with the four complete thruster sets, there was a possibility to change unit by unit with a spare and to carry out complete service in SCHOTTEL's workshop thruster by thruster.

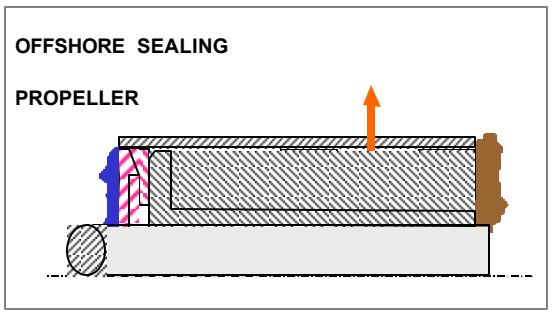
After underwater dismounting the lower part was taken to deck of vessel, propeller and nozzle were dismounted and the remaining part was sent to SCHOTTEL's workshop and serviced.

This maintenance and service sequence is in operation since 1992 and maintained in that way that after 16.000 - 20.000 service hours the lower gears arriving in our work shop and basically following service and check-up is made:

- complete dismounting of thruster
- check of parts together with the customer and classification society
- replacement of all sealing components exposed to wear
- ball blasting of bevel gears to keep the tooth surface even and to restore hardness (amount abt. USD 1.500,00 per thruster)
- assembling of the thruster
- leakage test and lubrication test



Special alteration was given to the propeller shaft seal as we were using the first time and finally very successful a friction type deep sea seal - type Burgmann with excellent results. The seal is designed to work at drafts between 9.5 and 43.5 m.



This check was made for all four thrusters and the costs per thruster were about USD 20.000,00. This has to be compared with the value of a new thruster which is about US 500.000,00.

On board of the ship the thrusters do have the numbers 7 - 10 and the sequence of service was:

December 1992	thruster no. 9	after 16.000 hours
July 1993	thruster no. 10	after 19.000 hours
September 1994	thruster no. 7	after 24.000 hours
June 1996	thruster no. 8	after 30.000 hours

At all thrusters also the bearing system was checked but it was not necessary to change a single bearing.

In 1998 the service sequence started again and all four thrusters were serviced the second time in following sequence:

June 1998	thruster no. 9	after 35.000 hours
March 1999	thruster no. 10	after 38.000 hours
January 2001	thruster no. 7	after 52.000 hours
March 2002	thruster no. 8	after 58.000 hours

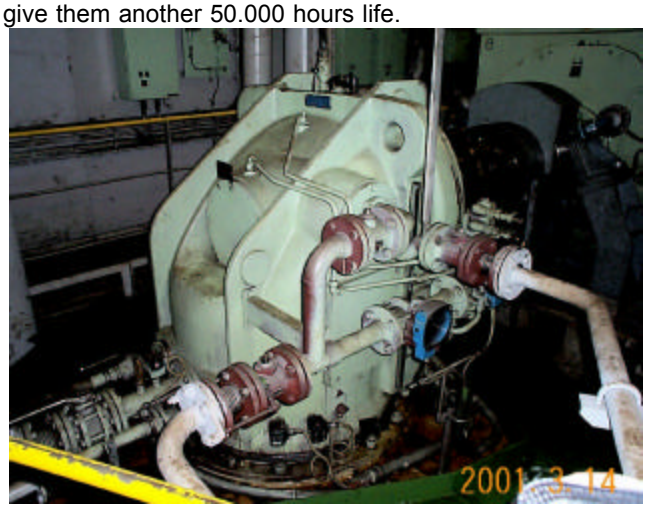
The service procedure was the same as about five years before, however during these last services, all bearings were carefully analysed and indeed the first traces of wear at the input shaft bearings were found.

So to guarantee a safe operation the owner decided to replace all bearings below a shaft diameter of 250 mm by new ones and to repair all bearings above a shaft diameter of 250 mm. This repair of larger bearings is by far less expensive than new bearings and as there was the spare underwater part of thruster available, also the time frame was at hand to do a repair instead of an exchange.

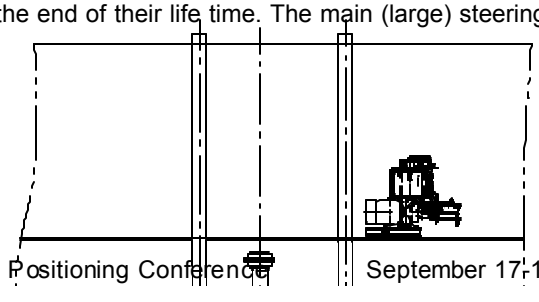
Now after the second round of scheduled service, the situation is that all four thrusters can start a new live of around 50.000 service hours again (basic requirement of bearing lifetime was 40.000 hours).

The cost per thruster for this second main service including 650 working hours per thruster is about USD 80.000,00.

Of course the service of lower gears in SCHOTTEL's workshop left out any shop service for the upper gears which are mounted on a separate foundation above the underwater-mountable parts of thrusters. These gears were also served in 5 year intervals, but only seals were changed, gears and bearings are still untouched and as per owner and classification remarks they are still in a condition to give them another 50.000 hours life.



For the steering gears which are slow moving parts a provisionally change was made after 9 years of operation (on board). This change normally was made when the hydraulic motors driving the steering were at the end of their life time. The main (large) steering bearing is still on board and is working well.



Conclusion

This procedure of planned service demonstrates that it is possible to provide a very reliable operation of high-powered steerable thrusters. In all 15 years of operation now the main thrusters of the vessel "Saipem 7000" never had an operational breakdown and due to the spare lower part of thruster also the planned down-time to change a thruster is very small. The service of thrusters in a workshop instead at a shipyard in a dry-dock has the advantage that always a very careful and detailed examination of the system was possible. This finally resulted into an excellent and safe operation record. It had been proven that the design time of bearing system = 40.000 service hours was correctly met, even nearly 60.000 hours were reached at one thruster without changing bearings.