
0.0.1 DP 4 Corner tests

In order to compare the existing thruster configuration with the retrofit, a manoeuvre called DP 4 corner was performed. This is to compare responsiveness of the thrusters, position accuracy, thrust usage, and power consumption. This manoeuvre is illustrated in Figure (1), and it consists of four parts:

- 1. Ahead, heading same: From DP steady state with heading north, change desired position 50 m ahead, keeping same heading,
- 2. Crab port, heading same: At the instant the vessel reach the operating circle of the new setpoint, position setpoint is changed to 50 m port (west) of the vessel,
- 3. Astern, heading change: At the instant the vessel reach the operating circle of the new setpoint, the new desired setpoint is 50m eastern (south) and heading set to -90° (west),
- 4. Astern, heading same: AS the instant the vessel reach the operating circle of the new setpoint, new setpoint is set to be 50 m astern (east, back to original position), with heading still -90° (west).

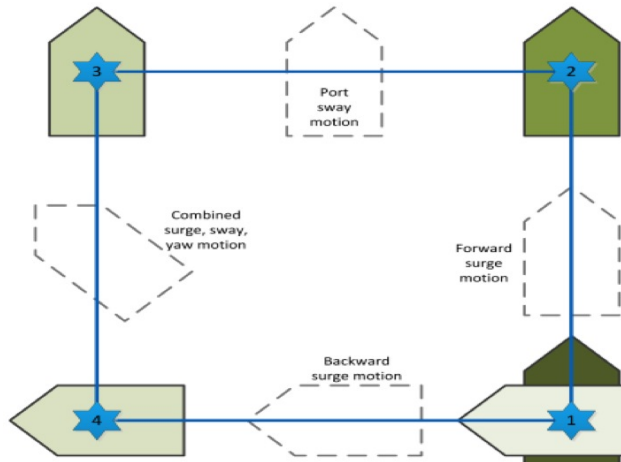


Figure 1: DP 4 corner, illustration

DP 4 corner - calm sea

During the sea trials in calm sea (August) one DP 4 corner was performed. The log from the DP system is available, but MARINTEK's log contains only half of the maneuver. The DP data is used to find the duration. The setpoints in position error are available, so the duration estimates are quite accurate. However, a lot of measurements are unavailable for the first half of the maneuver. Even though the DP system logged shaft speed, and

thrust force for the sea trials in August, these values were collected by MARINTEK as the trial was ongoing. Because of this, thrust force for the first half of this maneuver is unavailable, but power consumption is available for the entire maneuver, since this was collected from the DP system log. See Table (1) for the environmental conditions, and Table (2) for the thrust and power consumption.

Table 1: DP 4 corner - environmental conditions, calm sea - 3035

Environment	
Wind, speed [m/s]	
<i>Average</i>	<i>Std.</i>
5.3	0.3
Wind, direction [°]	
<i>Average</i>	<i>Std.</i>
42.2	2.2
Waves	
<i>H_s [m]</i>	<i>Direction [°]</i>
0.2	N
Current	
<i>Speed [m/s]</i>	<i>Direction [°]</i>
0.3	147

Table 2: DP 4 corner maneuver - calm sea - 3035

Maneuvre	Duration [s]	Accumulated thrust force [kNs]				Accumulated power [kJ]			
		<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>	<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>
<i>Ahead, heading same</i>	134	—	—	—	—	690	600	—	1290
<i>Crab port, heading same</i>	214	—	—	—	—	4750	4380	—	9130
<i>Astern, heading change</i>	142	770	1230	1080	3080	3230	4520	—	7750
<i>Astern, heading same</i>	134	600	1100	960	2660	3620	3790	—	7410
Total	624	—	—	—	—	12290	13290	—	25580

DP 4 corner - november

Two DP 4 corner tests were performed in the November sea trials, and only MARINTEK logged (no logs from the DP system itself). MARINTEK performed extensive logs containing quite good North and East position measurements, shaft speed measurements of all thruster, and a calculated power consumption of the two main thrusters. Setpoints are therefore unavailable, but in order to find the duration of each maneuver, the North-East plot is used in combination with the plots of North position, East position and heading. The duration is not very accurate, but should be correct to within some seconds of margin.

The N-E plot of the first test is shown in Figure (3). Please note that at the last maneuver there is an overshoot in East-position before the vessel returns to desired East position.

For the logs in Table 3, and 4, the duration is stopped when the correct east value is reached the first time (neglecting the overshoot), to get a better estimate of the power consumption as if there were no overshoot. It should also be noted that the vessel does not perfectly track the square as it was supposed to do.

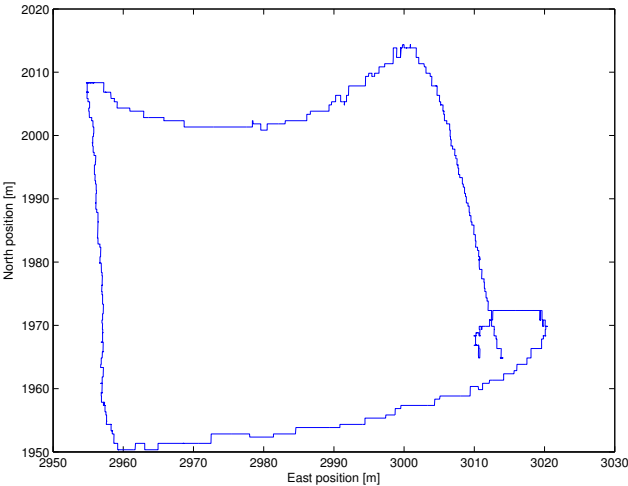


Figure 2: NE-plot of DP 4 corner test 1, at sea

Table 3: DP 4 corner - environmental conditions, calm sea - test 1

Environment	
Wind, speed [m/s]	
<i>Average</i>	<i>Std.</i>
2.9	0.5
Wind, direction [°]	
<i>Average</i>	<i>Std.</i>
178.0	7.5
Waves	
<i>H_s [m]</i>	<i>Direction [°]</i>
1.5	345
Current	
<i>Speed [m/s]</i>	<i>Direction [°]</i>
0.2	N/NW

Table 4: DP 4 corner - maneuver, at sea - test 1

Maneuvre	Duration [s]	Accumulated thrust force [kNs]				Accumulated power [kJ]			
		<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>	<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>
<i>Ahead, heading same</i>	117	310	290	—	600	630	410	—	1040
<i>Crab port, heading same</i>	180	1430	1910	—	3340	4960	6720	—	11680
<i>Astern, heading change</i>	163	530	570	—	1100	1510	1190	—	2700
<i>Astern, heading same</i>	85	1850	2270	—	4120	8770	12630	—	21400
Total	545	4120	5040	—	9160	15870	20950	—	36820

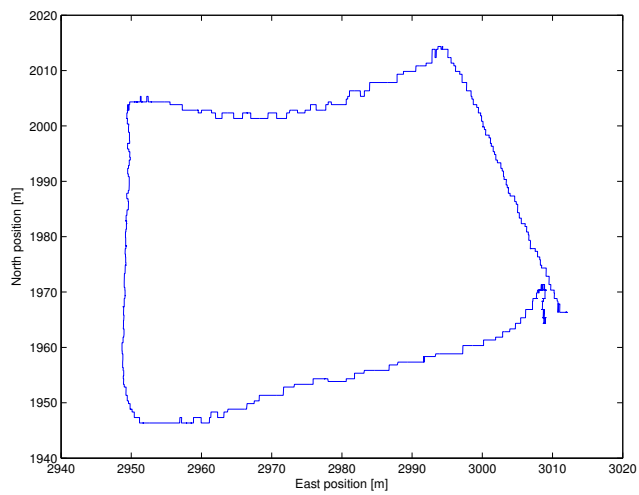


Figure 3: NE-plot of DP 4 corner test 2, at sea

Table 5: DP 4 corner - environmental conditions, at sea - test 2

Environment	
Wind, speed [m/s]	
<i>Average</i>	<i>Std.</i>
2.8	0.4
Wind, direction [°]	
<i>Average</i>	<i>Std.</i>
174.3	6.8
Waves	
<i>H_s [m]</i>	<i>Direction [°]</i>
1.5	345
Current	
<i>Speed [m/s]</i>	<i>Direction [°]</i>
0.4	N/NW

Table 6: DP 4 corner - maneuver, at sea - test 2

Manoeuvre	Duration [s]	Accumulated thrust force [kNs]				Accumulated power [kJ]			
		<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>	<i>SB</i>	<i>Port</i>	<i>Tunnel</i>	<i>Total</i>
<i>Ahead, heading same</i>	101	310	370	—	680	660	850	—	1510
<i>Crab port, heading same</i>	207	1050	1300	—	2350	3500	3670	—	7170
<i>Astern, heading change</i>	120	640	460	—	1100	1800	900	—	2700
<i>Astern, heading same</i>	118	2890	3240	—	6130	13820	18600	—	32420
Total	546	4890	5370	—	10260	19780	24020	—	43800

Conclusive remarks

A DP 4 corner for the new thruster configuration could give good indications on power consumption, and total (accumulated) thruster force. It is a drawback that so much data for the tunnel thruster is lacking. The pure DP tests of Section ...REF should give some indication of how much thrust the tunnel thruster generate, and how much power it consumes. However, because of this the DP 4 corner would only give a rough performance comparison. Also, the thrust mapping used is somewhat simple, and does not take loss effects into account. This means that the thrust force calculated is more accurate under normal (no significant thrust losses), and zero speed conditions. For the November sea trials the weather was quite calm, so the basis for comparison could be satisfactory, if the DP 4 corner tests for the new thruster system is also conducted under similarly calm conditions.
