

Some Notes on Safety Measures when Approaching Port of Świnoujście

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ABSTRACT: The paper describes new directions in which the safety of navigation in Pomeranian Bay (Poland) became into a new era since the LNG Terminal in port of Świnoujście begun to attend to a large gas tankers at around 320 meters length, 50 meters breadth, and draught of 12.5 meters. For the safety of navigation in Pomeranian Bay, the Maritime Administration has modified the traffic regulations, directing the ship's traffic to the zones outside the main approaching channel. For some of the ships navigating in to Świnoujście the new regulations mean the necessity of passing the shallow waters, with all consequences of that. The most important effect, being predominating in shallow waters, it is the squat effect. This effect is causing the ship's speed reduction and the increase of fuel consumption. It is very difficult to select the influence of the squat effect from others, like weather conditions, waves high and direction, and sea keeping qualities for ships of different type. This paper is giving the contribution to deep analysis of the above, and is presenting the test re-sults done for passenger/cargo Ferries, travelling as per regular service to the port of Świnoujście: M/F "Gryf" and M/F "Wolin".

1 INTRODUCTION

First commercial delivery 206 000 m³ of LNG to the port of Świnoujście was made by tanker „Al-Nuaman” on 17th of June 2016. Sea channel for LNG tankers entering port of Świnoujście is presented in Figure 1. It has been dragged to the draught 14.5 meters and width of 220 meters for safe navigation by a large gas tankers.

According to the Maritime Administration safety regulations, the highest admissible dimensions of LNG tankers (see Figure 2) entering Świnoujście are:

Length = 320 meters, Breadth = 51 meters., Draught = 12.5 meters. Two pilots embark the ship at the anchorage No 3 or in position of N-1 buoy. Four tugs: two – per 80 tons each, and two of minimum 45 tons each, are necessary for help in manoeuvring the

vessel in LNG terminal. VTS gives the permission for berthing LNG tanker during the day time only. The other restrictions are as follows:

The wind speed has to be less than 10 knots, the wave high has to be less than 1.5 m., the visibility has to be more than 1 n.mile.

When LNG tanker navigates in the channel any other vessel can navigate in Pomeranian Bay or Port of Świnoujście as per the VTS permission given on VHF ch. 12. All ship's traffic is accepted only outside the deep sea channel.

Presented paper is dedicated to the ships which are navigating outside the main channel, as per Maritime Administration regulations.

2 SHIPS GOING OUTSIDE THE CHANNEL

When ships are navigating outside the main channel, inbound going vessels are proceeding west side of the channel, when outbound vessels are proceeding east side of the channel. The outbound going vessels with the draught less than 7 meters should leave the channel when passing the pair buoys no. 15 -16 and further navigate between the line lying 0.5 n. mile off the east side of the channel and the western boundary line of anchorages 1B, 2A, 2B and quarantine anchorage. Vessels proceeding to the east are navigating between the anchorages 1B and 2A and further by the recommended HELCOM ship's route. The outbound vessels with the draught less than 9 meters should leave the channel when passing the pair buoys no. 11-12, as it has been shown in Figure 1.

On the other hand, the vessels approaching Świnoujście from the North are navigating between the line lying 0.5 n. mile off the west side of the channel and eastern boundary line of anchorage 1A.

The vessels cannot crossing the channel between the parallels 53°57.5'N and 53°59.6'N.

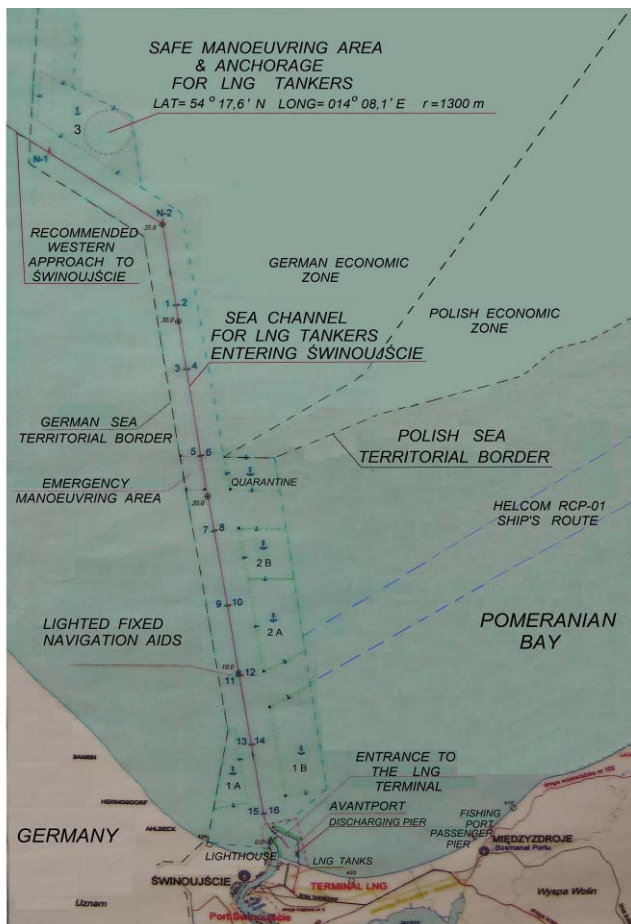


Figure 1. Approaching channel to LNG terminal in Świnoujście (by author)

There are some other restrictions for the vessels in the vicinity of LNG tanker. Any vessel not to be closer than:

- 1 n. mile off the LNG tanker when she is in the anchorage No. 3;
- 0.5 n. mile off the LNG tanker when she is in emergency manoeuvring area;

- 0.5 n. mile off the LNG tanker when she is navigating in the channel and other vessel - with pilot on board - is passing by east or west side of the channel;
- 5 n. miles ahead of LNG tanker navigating in the channel to the pair of buoys No. 9-10;
- 4 n. miles ahead of LNG tanker navigating in the channel closer than the pair buoys No. 9-10;
- 3 n. miles astern the LNG tanker approaching the port;
- 2 n. miles off the LNG in the entrance the port.



Figure 2. LNG tanker in Świnoujście (photo by author)

3 HYDRODYNAMIC EFFECTS IN SHALLOW WATER WHEN NAVIGATING OFF THE CHANNEL

The passage through the deep sea channel of Pomeranian Bay has been analysed in details by several authors (Chwesiuk, et al, 2007; Rutkowski, 2012)

When the exploitation of LNG terminal has begun, Maritime Administration brought new traffic regulations into effect. As it has been described above - in section 2, the vessels approaching or leaving the port of Świnoujście are obliged to navigate, respectively in west or east side of the main channel. Navigation through the approaching channel is reserved only for LNG tankers, vessels with draught more than 9 meters or vessels which has got the VTS permission.

Navigating west or east side of the approaching channel the vessels are exposed to several effects typical in shallow water. The above said effects are define when the clearance of water under the keel is being analysed for safety of navigation. Authors (Barras C.B., Rutkowski G., Jurdziński M.) have been described several effects influential on clearance "C" of water under the keel for vessels navigating in shallow waters:

$$C = C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9$$

where:

- C1 - accuracy of draught determination;
- C2 - reaction on different kind of sea bed;
- C3 - influence of sea level;
- C4 - influence of rolling;

- C5 – influence of pitching;
- C6 – influence of yawing;
- C7 – effect of surge;
- C8 – effect of sway;
- C9 – effect of heave;
- C10 – influence of squat effect.

The experience of exploitation the fast going passenger/cargo Ferries or Container vessels in shallow waters of Pomeranian Bay, allows to state that the squat effect is predominant when the vessel approaching Świnoujście harbour out of the main approaching channel.

Passenger/cargo Ferries or Container vessels are sailing in this area with speed of around 14-15 knots. Theory for hydrodynamic effects in shallow waters shows, that squat effect is usually felt more when the depth/draft ratio is less than four (Barras, 1978). Ship's velocity increasing interaction of a low-pressure area so that ship is pulled down as shown in Figure 3. This squat effect results from a combination of vertical sinking and a change of trim that may cause the vessel to dip towards the stern or towards the bow.

Squat effect is approximately proportional to the square of the speed of the ship (Barras, 1978, Rutkowski, 2012, Jurdziński, 2013). Thus, by reducing speed by half, the squat effect is reduced by a factor of four.

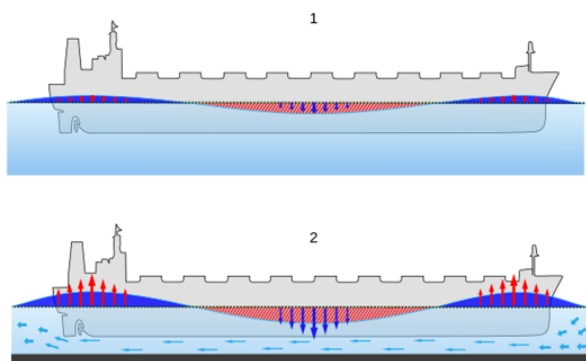


Figure 3. The hydrodynamic effects in deep sea (1) and in shallow waters (2). (authors Walke, Semhur Wikipedia)

Due to the predominant influence of squat effect in the resistance of ship's hull navigating in shallow waters of Pomeranian Bay, the consequences of the above are described below. Figure 4 shows how much the increase of the resistance of ship's hull is producing an effect of reduction of ship's speed and increase of fuel consumption.

In nominal exploitation conditions the curve of propeller K_s , shown in figure 4, makes the power requirement dependent on ship's speed. At the same time the fuel setting h_N is giving a nominal quantity of fuel per time unit. Point A in figure 4 corresponds to the nominal power conditions N_N at the nominal fuel setting h_N , and nominal ship's speed V_N .

Point E in figure 4 corresponds to the economical power conditions. In conditions, when the resistance of ship's hull is raising, the power N and speed V are falling down, reaching the heavy curve of propeller K_C . At the same time the fuel adjuster is giving more fuel per time unit to attain a nominal setting h_N . New

conditions of sailing correspond to the point C in figure 4. In nominal quantity of fuel distribution per time unit we have the reduced power and speed of ship.

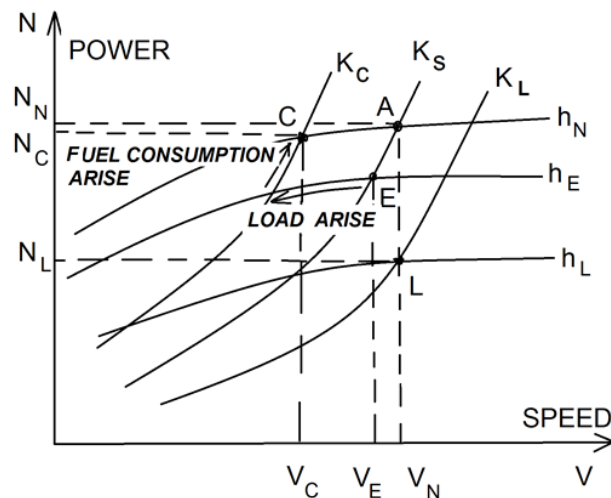


Figure 4. The propeller K and fuel h setting curves (by author)

where

K_C corresponds to the heavy curve, arising in case of increased resistance of ship's hull.

K_L corresponds to the reduced resistance. Curves h_N , h_E , h_L correspond to the fuel settings: nominal, economic, and low, respectively.

It is not possible to set more fuel per time unit than characterized by the nominal curve h_N . It means, that in case of increased resistance of the ship's hull, the full power of the engine is not to use: $N_C < N_N$.

Tables 1 and 2 display the results of trial tests of main engines, made on board the passenger/cargo Ferries, serving on regular lines between ports of Świnoujście and Trelleborg, M/F "Wolin" and M/F "Gryf". Ferry M/F "Wolin" is supplied with four main engines MAN B&W, type 6L40/45 with nominal power of 3300 kW of each. The total accessible power is 13 200 kW. Ferry M/F "Gryf" is supplied with two main engines Wartsila-Sulzer, type ZA40S with nominal power of 3960 kW of each. The total accessible power is 7 920 kW.

Time schedule of such regular service is very restricted, and any break load causing the increase in fuel consumption, as it was displayed in Tables 1 and 2.

Table 1. M/F "Wolin", MAN B&W engine, type 6L40/ 45

Power (%)	25	50	75	85	100	110
Power (kW)	825	1650	2475	2805	3300	3630
Brake load (kN)	18.75	27.5	41.75	46.75	55	60.5
Fuel consumption (Kg/Hr)	201.3	342.1	487.4	551.0	646.7	714.9

(test results for M/F "Wolin")

Table 2. M/F "Gryf", Wartsila-Sulzer engine, type ZA40S

Power (%)	25	50	75	85	100
Power (kW)	990	1980	2970	3366	3960
Break load (kN)	27.5	48.9	64.1	69.7	77.6
Fuel consumption (Kg/Hr)	215.0	406.0	591.0	670.0	910.0

(test results for M/F "Gryf")

4 CONCLUSIONS

The general safety navigation regulations for Pomeranian Bay ship's traffic, done by the Maritime Administration, and caused by the beginning of the large LNG tankers service in gas terminal of Świnoujście has been presented. As the result of these new regulations implementation, the commercial ships which are navigating to, or from the port of Świnoujście, are travelling outside the main approaching channel. They are losing the fuel and time passing the shallow sea waters of Pomeranian Bay. Tests made for passenger/cargo Ferries M/F "Gryf " and M/F "Wolin" are introducing the scale of fuel losses.

Per one year, one regularly serving Ferry ship is consumming around 330 metric tons of fuel more due

to shallow water effects of squat. Four such ships are giving to the owner the loss 1320 metric tons of fuel per year. These values are not to ignore taking into account the scale of ship's traffic in Pomeranian Bay.

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