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# An analysis of the LNG tanker Al Nuaman's speeds during its first voyage to the LNG terminal in Świnoujście (route sections Arkona–Świnoujście–Arkona)

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**Key words:** safety of navigation, LNG tanker, LNG terminal, ships' safety routes, ship's speed

**Abstract**

When a transport vehicle is put into service on a new route, all safety aspects of its movement should be comprehensively examined. In maritime transport, such situations arise especially when new sea ports are built, intended to handle selected types of vessels with specific characteristics. The construction of the LNG terminal in Świnoujście made it necessary to carry out an extensive analysis of the safety of LNG tanker passage. This was related to the shipping route from the Danish Straits to the berth. This article compares the routes planned at the design stage with the actual track of the tanker Al Nuaman during its first voyage. The tanker speeds on key route sections have been examined, i.e. in the approach channel from Cape Arkona to Świnoujście.

## Introduction

The first arrival of a Q-flex class gas carrier at Świnoujście's LNG Terminal on 11 December 2015 is now history. The tanker's berthing and discharge of liquefied gas required a complex installation, comprising the siting, design and construction of a new outer port in Świnoujście, which now accommodates LNG carriers. At the stage of terminal site selection, two options were considered. One general location was in a port in the Gulf of Gdańsk, the other was the port of Świnoujście. Each of these locations has advantages and disadvantages. As we know today, Świnoujście was chosen (Gucma et al., 2005; 2006a; 2006b ).

Skipping over the arguments for and against, and focusing on the safety of shipping, we should state that the adopted solution was a challenge in terms of the necessary assumptions, analyses and preparation of navigational infrastructure to be accepted by stakeholders. The work included an analysis of possible LNG routes, required aids to navigation, navigational equipment and systems and tanker maneuvering in the approach channel to Świnoujście and in the newly built Outer Port accounting for the existing restrictions. This phase has been completed, published and implemented: the layout, location and physical dimensions of the Outer Port were specified, aids to navigation were adjusted, new types of tug were put into operation, and general conditions for safe LNG terminal operation were adopted (Gucma et. al., 2007a; 2007b; Gucma, 2007; 2011; 2012; 2013; Gucma & Gucma, 2009; Gucma, Gucma & Ślączka, 2007; Hajduk, 2006; 2009; 2012; Hajduk & Montewka, 2007a; 2007b).

Some events that occurred during the terminal construction might have affected the safety of navigation of LNG tankers on shipping routes to Świnoujście. The most spectacular occurrence was the construction of the gas pipeline Nord-Stream, linking Russia and Germany. This gas pipeline crosses the shipping route near Rügen Island. There were three aspects to cope with: depth of the pipes, possible trenching of the pipeline and the consequent restrictions leading to a blockade of the port of Świnoujście for vessels currently sailing to or planning to call at the port. Finally, the gas pipes crossing the main shipping route to the port of Świnoujście were trenched in the sea floor and today do not obstruct LNG tankers heading for the LNG terminal in Świnoujście.

The shipping route through the Danish Straits to Cape Arkona, North of Rügen Island is established, adapted to Balticmax ships drawing up to approximately 15.3 meters. In the planning phase, talks were held with the Danish Maritime Administration on the safety of LNG tankers. The Danish party indicated the need to apply Resolution MSC 138 (76) of 2002, which recommends that ships with a draft of over 11 meters should proceed with a pilot onboard through the Danish Straits. The resolution is a recommendation, but Danish authorities consider it a binding regulation. From Cape Arkona, the shipping route leads through the territorial waters of Germany, with the closest point at Cape Kollicker, running less than 3 Nm from the shore of Rügen Island. Natural depths along this route permit ships drawing 13.5 meters to reach the roadstead of Świnoujście. Currently, the approach channel to Świnoujście has been dredged to 14.5 meters, which ensures safe entry to the LNG Terminal and the whole seaport by ships with a maximum draft of 13.5 meters, although some temporary restrictions may exist (Przepisy Portowe, 2017).

**Figure 1. The gas tanker Al Nuaman berthing at the LNG terminal in Świnoujście (Gospodarka Morska, 2015)**

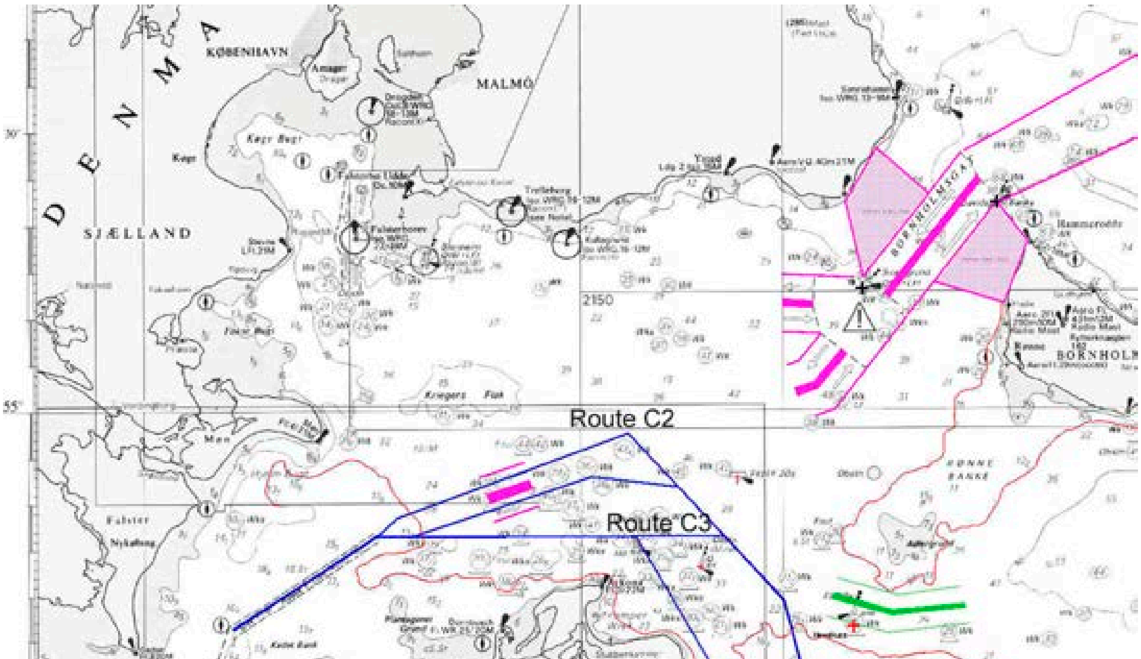


**Figure 2. Shipping routes to/from the ports of Szczecin and Świnoujście (Hajduk & Montewka, 2007b)**

## The gas tanker Al Nuaman

The gas tanker Al Nuaman was built in 2009 in the shipyard Daewoo Shipbuilding & Marine Engineering Co. Ltd. for the Nakilat Company. It was chartered by the Quatar Liquefied Gas Company Limited. It is a membrane type Q-Flex class gas tanker with a tank capacity of 210,100 cubic meters. Its overall length is 315 meters, breadth 50 meters and maximum draught 13.6 meters. The ship can call at the LNG terminal in Świnoujście in practically any conditions. The ship is shown in Figure 1.

## Recommended routes

Recommended routes to Świnoujście were examined for their safety of navigation. Practically, at present, the only safe route for ships drawing over 10 meters is a marked shipping route crossing the territorial waters of Germany (Route C in Figure 2). The alternative routes, due to their natural depths, cannot be used today by vessels of that size. Routes C2 and C3 lead through the North approach channel, then run outside the German territorial sea. Natural depths in the northern fairway restrict safe shipping to vessels with a draft less than 10 meters. The northern fairway may be used in the future by vessels with draft to 15.3 meters (Balticmax), when it is dredged to approximately 17.0 meters. Aside from the financial aspect of such a project, dredging in that region requires bilateral political arrangements with Germany (Gucma et al., 2005; 2006a; 2006b; Hajduk, 2006; 2009; 2012; Hajduk & Montewka, 2007a; 2007b; IMO, 2002).

On its first voyage to Świnoujście, the gas tanker Al Nuaman, on 11.12.2015, had a maximum draft of 12.3 meters. On the return voyage under ballast its draft was 9.4 meters. The ship proceeded along the standard route both to and from Świnoujście, intended for ships drawing more than 10 meters (Route C in Figure 2).

## Analysis of vessel speeds (SOG – speed over ground)

Between Cape Arkona and buoy SWIN-N, in the initial section abeam Cape Kollicker, natural depths are above 20 meters. Once the Cape is abaft, the 20 meters depth contour is crossed and minimum natural depths oscillate around 14 meters. The average speed of the loaded ship, $v_{av}$ = 9.59 knots. Temporary speeds of around 14 knots were reduced to 6.8 knots, then, increased to 10 knots, settling at 8 knots before buoy SWIN-N (Figure 5). On the return trip under ballast the ship covered this part of the route at an average speed of 15.6 knots, keeping more or less steady throughout (Figure 6).

Minimum depths between buoys SWIN-N and N-2 are 14.8 meters. The ship should make a remarkable turn at buoy SWIN-N as sailing too far South of the shipping route is dangerous due to numerous shoals 11 to 12 meters deep, while single rocks lie on

**Figure 3. A route of the gas tanker Al Nuaman, recorded during its passage with cargo on 11.12.2015 along the coast of Rügen Island (Maritime Office in Szczecin, 2015]**

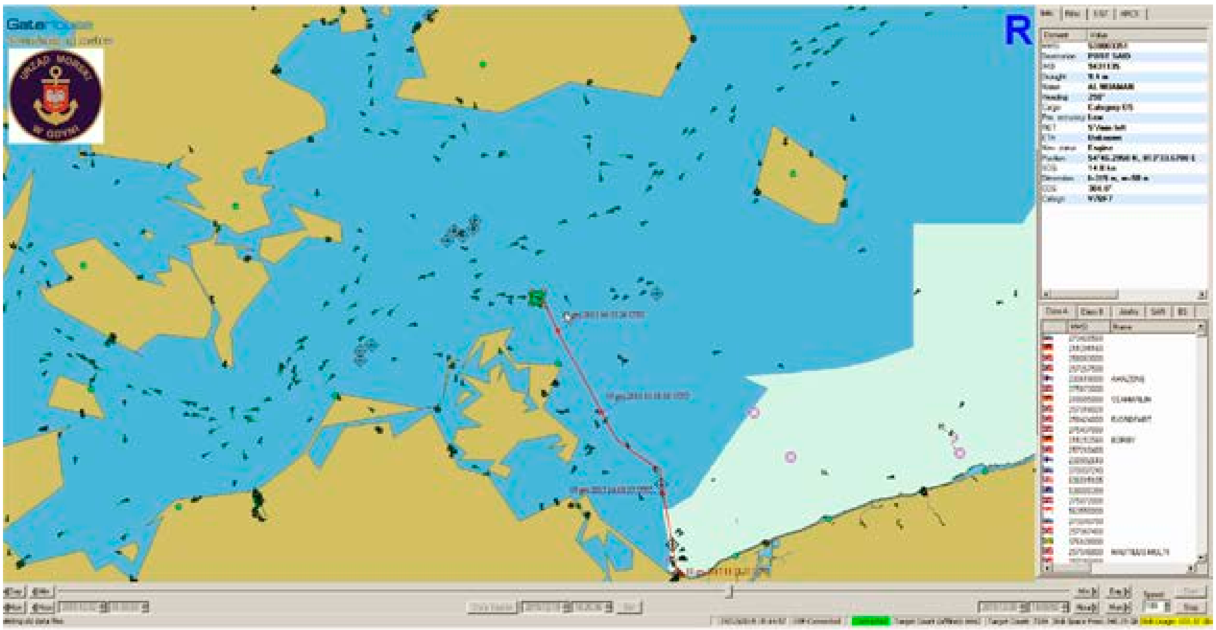

**Figure 4. A recorded route of the gas tanker Al Nuaman proceeding under ballast on 19.12.2015 from Świnoujście to Cape Arkona (Maritime Office in Szczecin, 2015)**

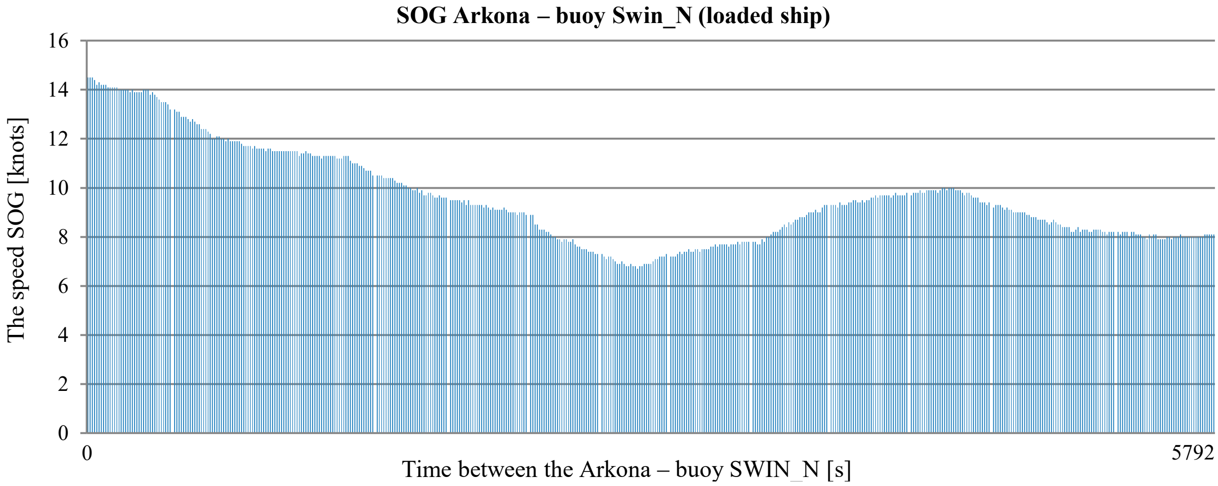


**Figure 5. The speed of the Al Nuaman in the loaded state between Arkona and buoy SWIN-N (author's research based on recorded AIS data)**

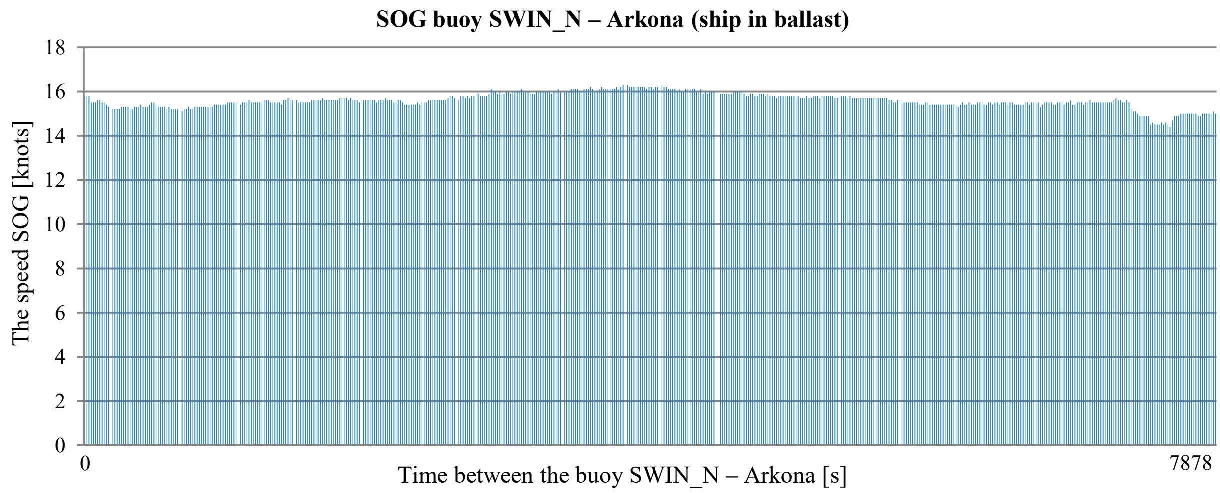


**Figure 6. The speed of the Al Nuaman under ballast between buoy SWIN-N and Arkona (author's research based on recorded AIS data)**

the sea bed further South. This section was covered by the laden ship at average speed of 6.99 knots. The initial speed of 8 knots was reduced to about 5 knots, while approaching buoy N-2 the vessel sped up to around 10 knots (Figure 7). These changes in speed were not necessitated by lesser depths, but by the need to adjust to the time arranged for a pilot boat to transfer a pilot on board. Returning under ballast, the Al Nauman steamed along that section at an average speed of 12.71 knots. After disembarking the pilot, the ship developed speed to a steady 16.0 knots (Figure 8).

The section between buoy N-2 and buoys 15–16 requires a pilot on board a ship of that size. The fairway is dredged to 14.5 meters. The average speed for that section was 6.99 knots. Initially, the speed was approximately 8 to 9 knots, then it was gradually reduced and, near buoys 15–16, stabilized at 4 knots (Figure 9). On the way back, after the ship had passed buoys 15–16, the initial range of 6 to 7 knots rose to a steady 12 knots. The average speed along this section in the ballast condition was 9.7 knots.

The section from buoys 15–16 to the berth requires tugs to assist the gas tanker, which is first turned in order to berth along its starboard side. The initial speed of about 4 knots is gradually reduced during turning and berthing to 1–1.5 knots, so that contact with the berth occurs at the ship's minimum transverse and rotary speeds. The average speed in this section was 1.19 knots (Figure 11). On the way back, the tanker sailed faster in this section of the channel. After unberthing, the speed increases quite fast, and after passing buoys 15–16 stabilizes at 7 knots. The average speed in this section was 4.64 knots (Figure 12).

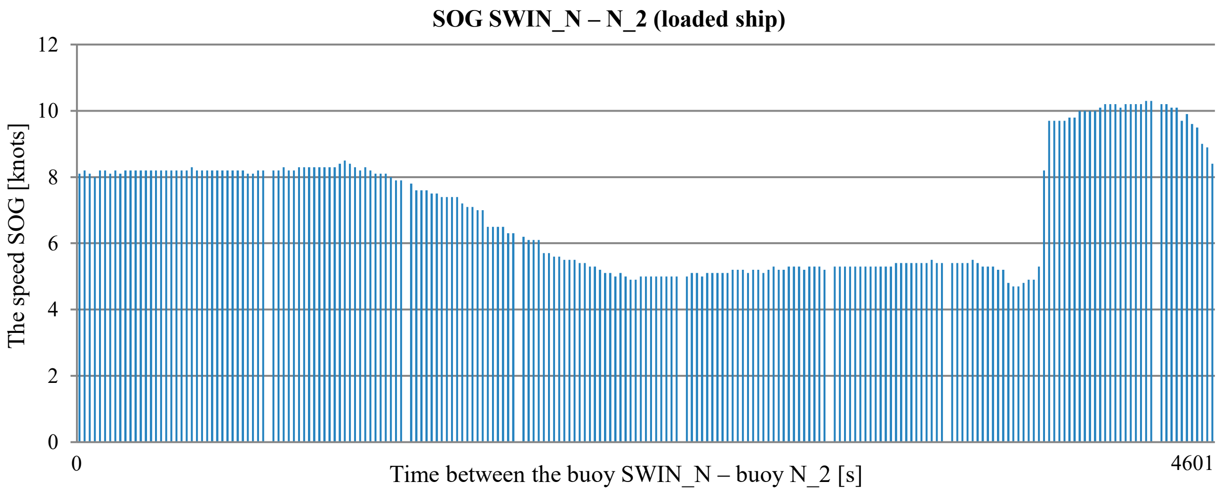


**Figure 7. The speed of the Al Nuaman under ballast between buoys SWIN-N and N-2 (author's research based on recorded AIS data)**

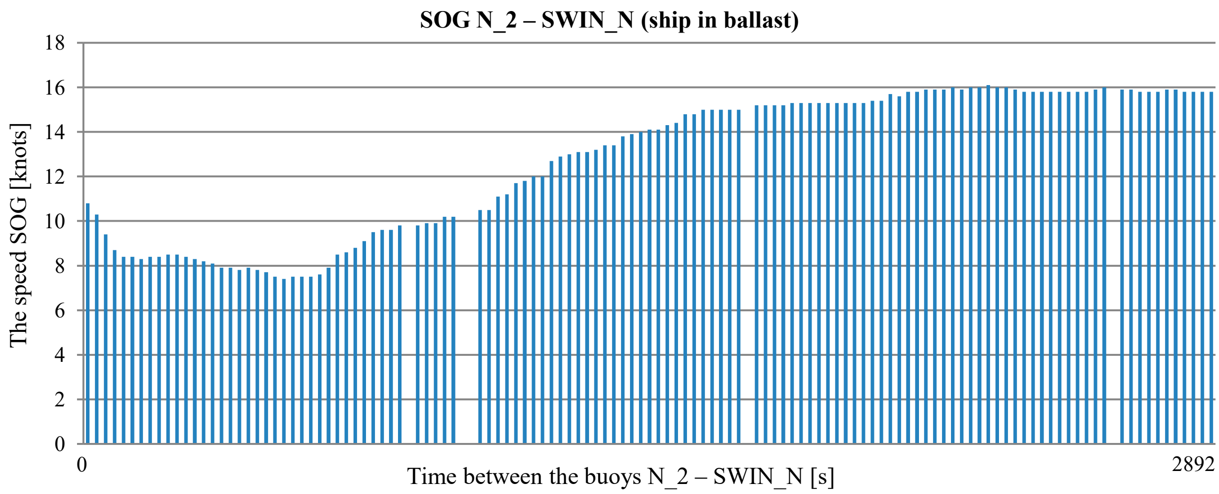


**Figure 8. The speed of the Al Nuaman under ballast between buoys N-2 and SWIN-N (author's research based on recorded AIS data)**

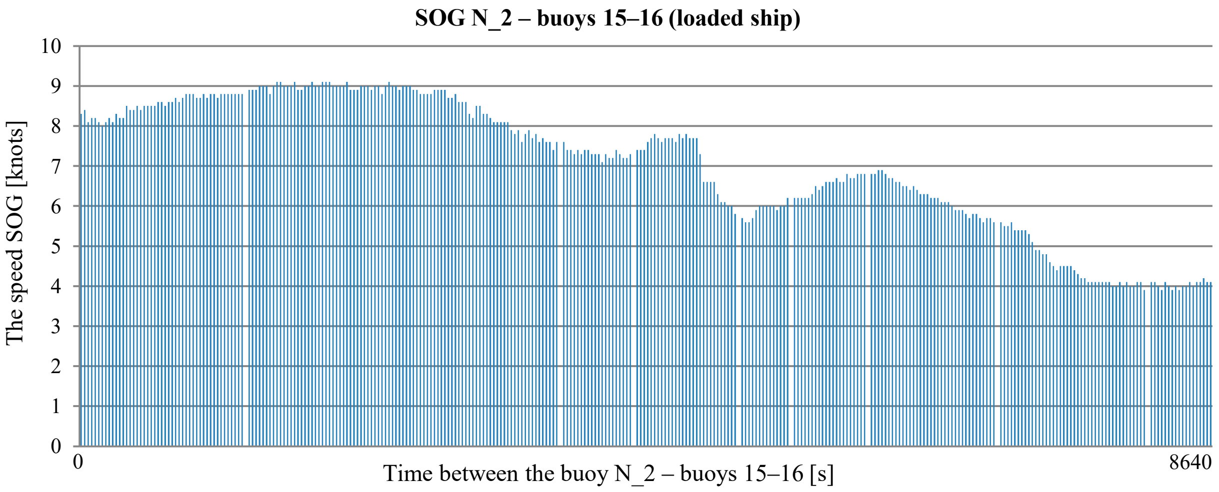


**Figure 9. The speed of the Al Nuaman in the loaded condition between buoys N-2 and buoys 15–16 (author’s research based on recorded AIS data)**

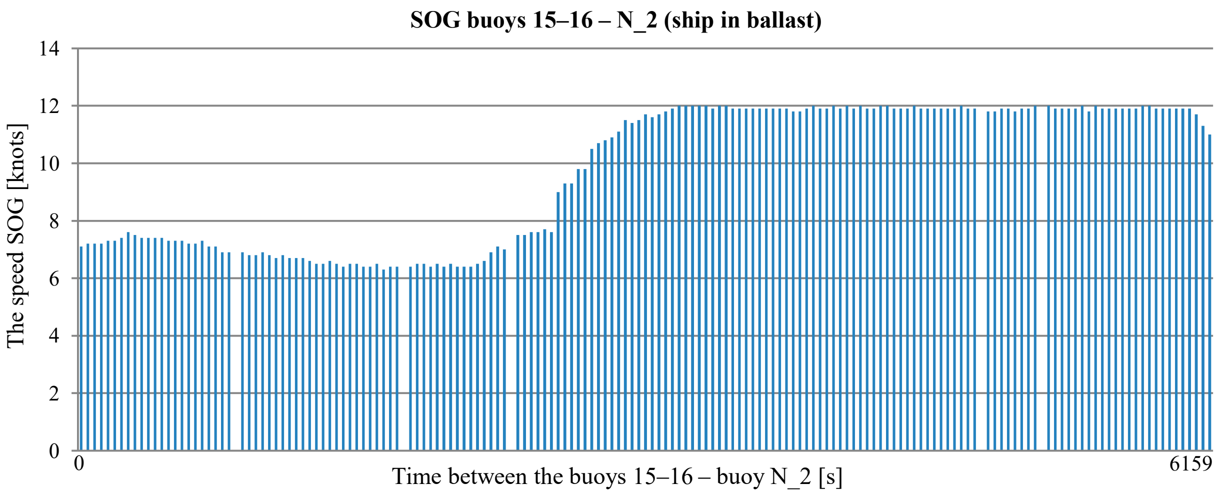


**Figure 10. The speed of the Al Nuaman under ballast between buoys 15–16 and N-2 (author’s research based on recorded AIS data)**

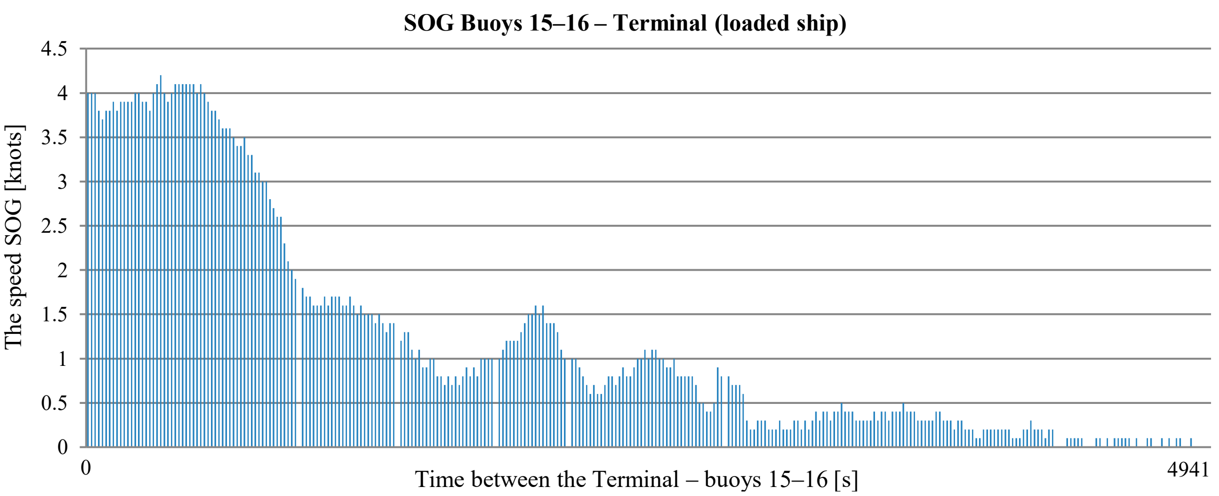


**Figure 11. The speed of the Al Nuaman in the loaded condition between buoys 15–16 and the terminal (author’s research based on recorded AIS data)**

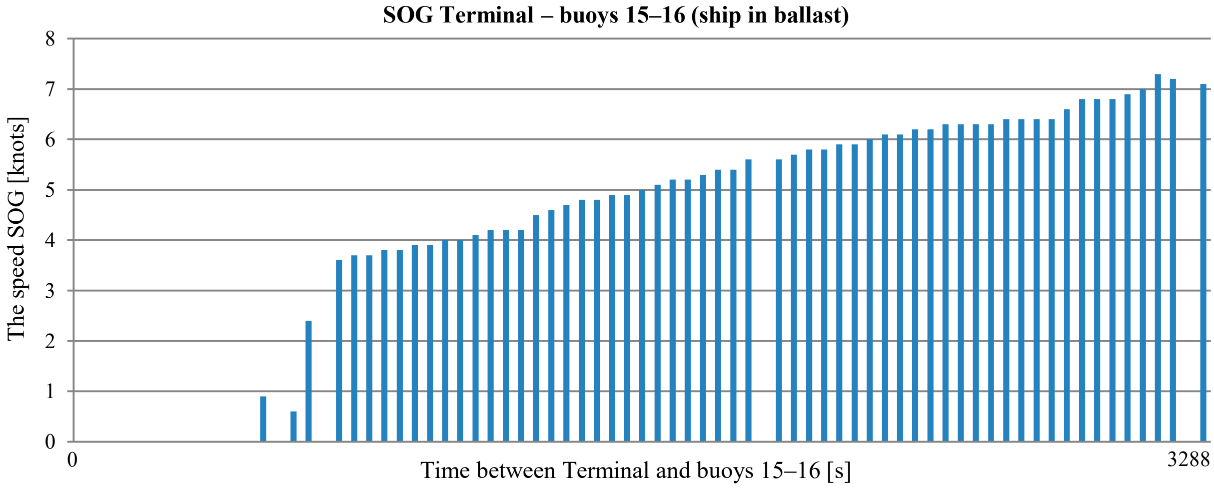


**Figure 12. The speed of the Al Nuaman under ballast between the terminal and buoys 15–16 (author's research based on recorded AIS data)**

## Conclusions

The construction of a new port or terminal is always a big technical challenge. The outcomes of scientific research at planning and design stages, including experiments, are then verified in practice. This applies, especially, to the safety of operations. Hydrotechnical structures are capital-intensive. Putting an LNG terminal in a port involves a hydrotechnical structure as well as highly specialized shore structures for complex infrastructure and equipment. A terminal like this can only operate if the tanker of previously estimated and designed-for size, carrying liquefied gas, can safely berth and discharge the cargo.

The Maritime University of Szczecin, its Marine Traffic Engineering team in particular, conducted extensive research that resulted in appropriate assumptions, guidelines and requirements for the then planned operation of the LNG Terminal in Świnoujście. The scope of the research was very wide. The empirical and simulation studies focused mainly on the safety of LNG tankers on the approach channel to Świnoujście and inside the newly built Outer Port. The results provided a basis for the determination of safe dimensions for the fairway and the area of the outer port, changes of the aids to navigation, maneuvering tactics, including the number and capabilities of the tugs, and required safety procedures. In addition, model courses and actual programs have been developed for training pilots and captains of LNG tankers.

The first arrival of a ship, as big as the one previously planned for, is a test not only for the builders and operators, but also for scientists who contributed to the project. Safety should not be underestimated. On the other hand, any navigational or operational accident, however small, casts a shadow on the future safe operation of the newly built port and reduces opportunities for lucrative contracts.

The analysis of navigational safety, although in a selected part of the route of the Q-flex class gas carrier, of the size that was assumed as a maximum for the LNG terminal in Świnoujście, positively and fully verifies the design assumptions and time-consuming simulation-based research preceding project completion. The presented routes and speeds of the gas tanker are consistent with the guidelines ensuring the required level of navigational safety. Up to September 2017, 20 LNG tankers, mostly of Q-flex class, called at Świnoujście LNG Terminal. No navigational or technical accidents or failures were noted in that time. This has confirmed the results of research in the area of marine traffic engineering, simulation tests in particular.

## Acknowledgments

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