Larger LNG carriers, larger risks?

Using sophisticated real-time simulation software and QRA, ports and terminals finally have answers

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In the last few years the size of the largest LNG carriers has increased dramatically, as illustrated in Figure 1.

With the increase in vessel size, the question is whether the risks associated with LNG carriers maneuvering in confined water also increase. To gain greater insight into those risks, recent studies executed for several new and existing LNG terminals throughout the world include a combination of quantitative risk assessment and real-time simulations. In general, these studies are executed for the largest LNG carriers sailing worldwide.

Quantitative risk assessment

A quantitative risk assessment (QRA) can be divided in two steps. In the first step the frequencies of accidents are determined. Accidents are divided in collisions, grounding, foundering, fire, and so on. In the second step the consequences of the accidents are determined. The most critical situations for the LNG carriers are grounding and the risk of collision with other vessels during maneuvers or while loading and unloading at the terminal.

Probabilities of such accidents involving an LNG carrier are calculated with the 'Safety Model for Shipping and Offshore in the North Sea' (the SAMSON model). Though the model was developed originally for the Dutch Ministry of Transport for the North Sea, the model is generic and can be used for any area.

This model has been developed over a period of 25 years. During this period, many studies have been executed for the Dutch Ministry of Transport, the European Commission and for various commercial projects.

Risk calculation with SAMSON consists of two steps. First the traffic flows in the area are defined. Nowadays we prefer to use Automatic Identification System (AIS) data, as stored by coastal or port authorities for this purpose. However, for a completely new port or terminal this data might not be available. In this case, it is possible to build up the traffic from available traffic data. Secondly, the probability on accidents is computed. In the SAMSON model, the traffic is composed from 36 ship types and eight ship size classes. For each ship class the probability on grounding and collision is computed.

To bridge the step from collision to ship damage, MARIN has developed the MARCOL tool, 'the maritime collision model of MARIN'. With this model, the penetration probability of the LNG tanks is determined. MARCOL solves this problem analytically. The model is capable of determining the penetration probability of the cargo tanks of one single scenario within seconds. Therefore it is possible to model millions of collision scenarios. The model describes the primary damage mechanism for typical structural components like shell plating and transverse webs.

The simplified analytical models have inherent limitations but are very suitable for Safety Assessment Studies. Presently the program can deal with different types of ships like container

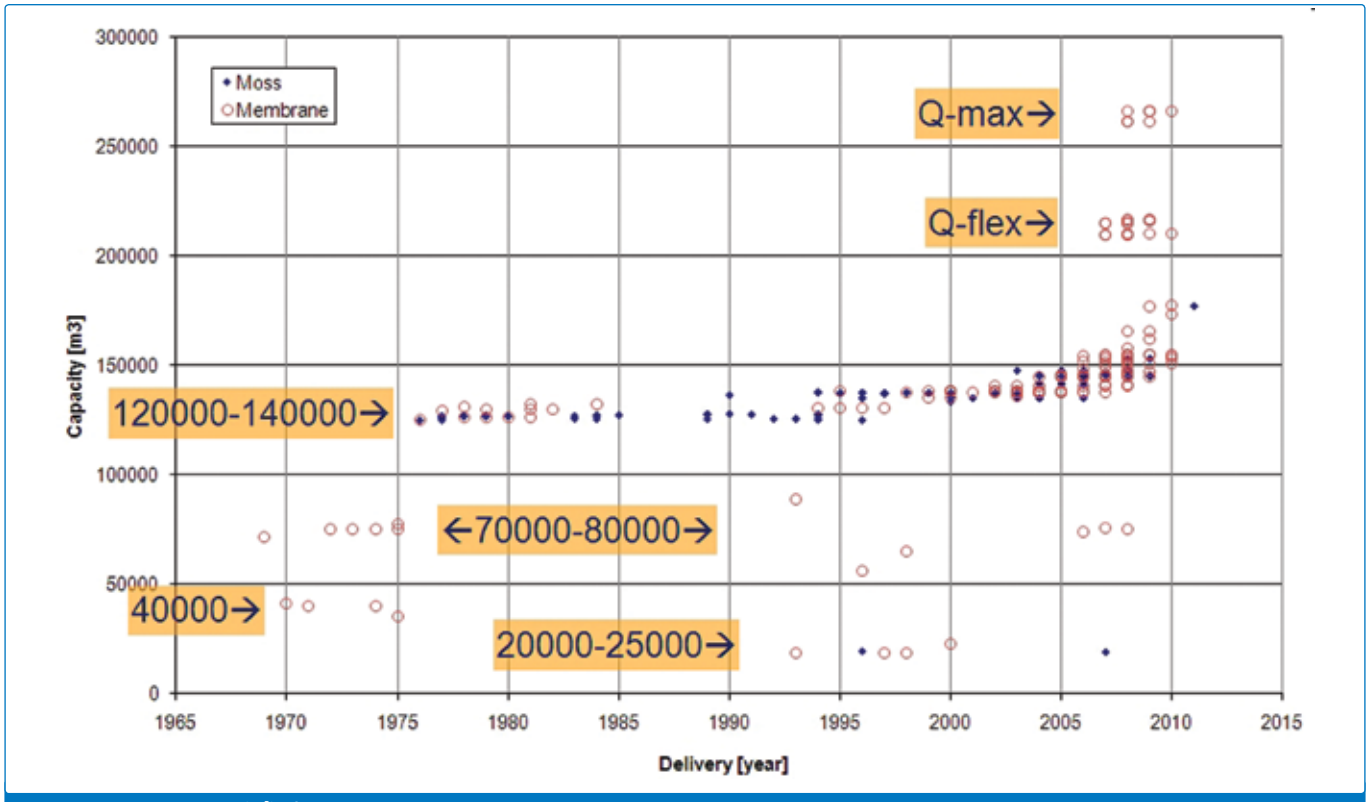
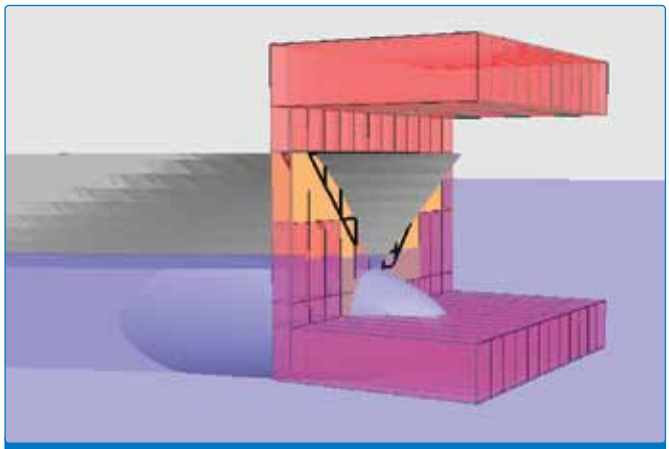


Figure 1. Changing capacity (m^3) of large LNG tankers since 1965.

Screenshot showing the safe transit of an LNG carrier into Port.



A ship bow penetrating a cargo tank, demonstrated using the MARCOL analysis tool.

vessels, car carriers and inland vessels. It has been validated against available full-scale collision experiments.

With the MARCOL model, a matrix is computed using the probability of a hole in the cargo tank for the various types of collisions. Analyzing the results can give insight in which mitigating measures can be effective in reducing the probability on damaging the cargo tank. This result is further used for the risk evaluation.

Real-time simulations

In the risk evaluation, the flow of traffic in to and out of the port is the basis for the analyses. Real-time simulations make it possible to look into the safety aspects of ship handling in more detail.

With the results of the risk evaluation in hand, we can look at the most risky parts of the maneuver and define mitigating measures to reduce these risks. To assure that the outcome of the simulations are realistic, the modeling of the ship's behavior and the environmental conditions are extremely important.

The real-time simulations can be divided into a number of batches. The focus of the first batch is on normal entries and departures under average and extreme environmental conditions. Simulations are executed to verify the channel dimensions and weather windows. The next batch will include one or more man-operated tugs. The combination of an LNG carrier assisted by tugs controlled by captains has huge added value. Operations become much more realistic; the limitations of tug operations, and the sensitivity for communication and possible errors all become clear.

This is also the ideal set-up to study emergencies during transit. These emergencies can result from mechanical failures, human error or unexpected weather changes. It is the aim of the simulations to keep the carrier sufficiently under control, and prevent groundings that damage the ship's hull.

Measures to reduce these risks include:

- Better bridge team performance
- Effective use of tugs
- Electronic chart systems (Portable Pilot Units)
- Information regarding the local environmental conditions during the transit
- Vessel Traffic Services (VTS)
- Training of all personnel involved.

The simulations can prove that specific measures are effective. As the QRA shows, these simulations will reduce risks. The combination of QRA and real-time simulations will give the answer to the question: Larger carriers, larger risks? MARIN has provided the answer to this question to various ports and terminals all over the world.

ABOUT THE COMPANY

For more than 75 years **MARIN** has been a reliable, independent and innovative service provider. The company has expanded the boundaries of maritime understanding with hydrodynamic research. MARIN has a dual mission: providing the industry with innovative design solutions, and carrying out advanced research for the benefit of the maritime sector as a whole. MARIN's nautical centre MSCN is active in shipping, safety, consultancy and training.

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