
## An invaluable resource both now and in the future

# Safety Assessment Studies for new LNG terminals

**Liquefied natural gas is certainly set to make an even greater contribution towards the generation of electricity in the coming decade and much of this gas will be transported by LNG carriers. As demand for LNG surges, MARIN is carrying out a number of Safety Assessment Studies, which recently included two studies for the port of Rotterdam.**

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Here is an update of a study covering nautical safety, which is defined as the probability that an LNG carrier will be involved in a collision or other incident during the transport of LNG to the terminal, or that it is struck by a ship during the stay at the terminal.

A Quantitative Risk Assessment was carried out to determine the risk exposure for the surroundings of the terminal and the fairway leading to it. Frequencies of incidents based on a traffic analysis (present and forecasted traffic) were examined and the consequences. These included the penetration probability of the cargo tanks and an assessment of external risks in terms of loss of life, based on the distribution for the expected penetration sizes. The external risk assessment was carried out by a consulting company and then risk-reducing measures were put forward.

### Incident frequencies

For the two studies for the port of Rotterdam, the safety of the LNG transport was calculated for five different trajectories of the arriving LNG carrier: the anchorage area, approach to the harbour, within the harbour to the manoeuvring location in front of the terminal, the manoeuvring location just in front of the terminal and the berthing location.

Probabilities of an accident with the LNG carrier were calculated using the Safety Model for Shipping and Offshore in the North Sea (SAMSON) model. In the last 20 years, this model has been developed, extended, validated and improved continuously in studies performed for DGSM (now DGTL), the European Commission and for commercial projects.

Initially, the risk was calculated for the present traffic levels and lay-out of the port. After that the risk was calculated for forecasted traffic scenarios for 2010, 2020 and 2035 and for the future port-extension Maasvlakte II, including expected changes to the traffic separation schemes.

### Special collision model developed

The specification for the penetration probability of the cargo tanks calls for the determination of the structural failure response of the vessels involved in the collision event. This determination is generally specified by the conventional nonlinear finite element method. However, the conventional method demands a high amount of modelling and calculating time and as a consequence, results in a time-consuming investigation.

MARIN tackled this problem by developing an analytical collision model. This, in contrast to the conventional method is capable of determining the penetration probability of the cargo tanks in a time span of just seconds. In order to achieve this reduction in calculating time, the model is based on simplified Wang models. These analytical models describe the primary damage mechanics 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. At the moment, MARIN is further extending the capabilities of the collision model, including an allowance for inland vessels which have a large variety of bow forms.

### Risk-reducing measures

The two studies found that traffic rules can largely reduce the collision risk. Stopping all other traffic during the arrival of LNG carriers results in lower collision frequencies and the consequences of collisions can further be reduced by limiting the speed.

By combining the results of all incident scenarios with the results of the penetration calculations, the distribution of the expected penetration size on a geographical base was delivered for the additional calculation of the external risk.

The collision probabilities of an LNG carrier for different trajectories are shown. The penetration probability of the cargo tanks is calculated from these probabilities. At sea, in the anchorage area and in the approach, the penetration probability of the cargo tanks is much higher than within the harbour because passing ships at sea sail with higher speeds than ships within the harbour. The probability that the cargo tank of an LNG carrier is penetrated at berth is small because the carrier cannot be hit by another large ship from the side.

In addition, MARIN has performed studies for the safe approach of LNG carriers, such as a feasibility study on the full-scale bridge simulator, optimising terminal lay-out. The optimal approach of the carrier can be determined and training can be provided for the approach and mooring. Certainly, as LNG demand continues, these studies will continue to provide an invaluable aid for the industry. MARIN