SAFE OFFSHORE LNG OPERATIONS

PREVENTION AND PROTECTION

Over many years, TNO has built up wide-ranging experience and expertise in emergencies. Our consultancy and research projects involve hazard analyses, structural thermal stability and runaway reactions, safety during the production, transport, storage and use of hazardous materials, reactivity and compatibility, gas explosions, fires and emergency studies, and mitigation and evacuation behaviour.

SHIP STRUCTURAL INTENSITY

Our experts use special applications of fluid element analysis for the structural assessment of LNG carriers in case of ship collision. Future models are based on both laboratory measurements as well as on unique full-scale experiments on tank parts, such as liquid sloshing and containment.

We offer a qualitative approach to the evaluation of the load transfer, which is based on cost-effective calculation models. Combined safety information on the ship and terminal environment, e.g. ship type and tank movements in the area, is a formal risk analysis of LNG spills can be provided. In addition we involve the operator in the study of working in particular risk areas.

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It is important to be able to quantify risks in order to determine LNG behaviour and to ensure its containment. This facilitates comprehensive safety management. Quantitative risk assessments are necessary to enable the selection of preventive and protective measures that suit the situation. Every situation demands a different measure in terms of preventive and protective measures.

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Knowledge-transfer and cooperation can make development faster, better and less expensive. With its position between universities and industry, it is TNO’s nature to position itself at the right place in the value chain for any type of service. In the LNG sector, it is evident that the operational requirements for offshore terminals are similar to those of onshore situations. This makes TNO an ideal player in the development of LNG technology.

SAFETY OFFSHORE LNG OPERATIONS

The development of LNG as an alternative fuel for heavy-duty transport is growing globally. The increasing global demand for gas has also increased the interest in using LNG as a substitute for liquid transportation fuels.

COLLABORATIVE LNG RESEARCH AND DEVELOPMENT

EXAMPLE RESEARCH JP: IMPACT OF BALLING LIQUID ON FLOODED-VAPOURS (FLUVENT)

New experimental techniques and methods have to guarantee maximum availability without implying concessions to safety, reliability and safety in flaring LNG vessels. LNG is a stored and transported at near to boiling conditions (–162° C) and an atmospheric pressure. Pressure and temperature fluctuations can cause the so-called vapour-walls.

The interaction between the wall and the boiling fluid makes the boiling liquid is not well understood. Also the effects and influence of the interaction between a liquid and heat will be of additional relevance to the safety in LNG technology.

The objective of the project FLUVENT is to develop a predictive model of the impact of boil-off in LNG transfer on the pressure loss of multi-compartment hoses and corrugated piping. Pressure loss prediction can be based on boiling, transition boiling and condensation boiling testing as performed by TNO.

A combined numerical/experimental study will be carried out on the effect of boiling in pipe flow with both smooth and corrugated walls. This will allow the model to suit the test, considering the on-site experts in observing gas bubble in wall structures and in investigating multiphase flow in pipes. The effect of gas bubbles on the flow in smooth and corrugated pipes will be investigated both by measuring the pressure drop and distribution of gas bubbles in pipes under various operating conditions (gas volume fraction, bubble size, etc.), and by means of detailed experiments on the un-reacting elements.

The main goal of the project is to obtain a validated prediction model for gas formation in LNG transfer and the impact on pressure loss in corrugated hoses and pipes, throughout the operating spectrum.

The 4-year project, which has been started in 2010, is a joint cooperation of TNO, the Dutch Ministry of Technology and industrial partners.

FUELLING THE FUTURE WITH LNG

LNG will be playing an increasing role in the coming years to meet the global demand for energy. Taking into account the increased regulations in Europe, it will be necessary for the import of LNG to supplement the European natural gas grid. With the Global availability of LNG and the planned production growth in mind, the interest in using LNG as a substitute for liquid transportation fuels has significantly increased.

The development of LNG as an alternative fuel for heavy-duty transport such as ships and trucks is mainly driven by the rising oil prices and increasingly stringent emissions regulations for marine and road transport.

The growing global demand for gas has also increased the interest in using LNG as an alternative fuel for heavy-duty transport, which were previously not economically attractive. The need of the hour is accurate structural gas fields are scarce. Scouring the gas cycle, gas fields is seen as an on-side most feasible solutions to develop these fields. Scouring on-side LNG technology towards offshore fields poses many technological challenges and will trigger further development of medium size LNG production.

All these developments are bringing new dynamics to the traditional LNG industry. The combination of innovation, qualification and innovation making it a challenging environment for TNO. TNO combines knowledge and experience from over 30 years of research contractor in the oil and gas production and exploration with world leading expertise in the area of state of the art technology. This makes TNO an independent partner in the development of LNG technology.
The ship-to-ship transfer of LNG is crucial for the development of an offshore LNG supply chain. Offloading from a floating storage and unloading (FSU) and loading into the ship tanks. For this reason, TNO is capable of proposing more than just executing specified tests, for example testing of flexible pipes and hoses. This results in a higher confidence in the system, thus to secure the supply of gas. TNO offers expertise on the development of offshore transfer systems by independently proving the reliability of offshore transfer systems by independently proving the reliability of offshore transfer systems.

Flexible pipes and hoses for ship-to-ship transfer need to be qualified to EN1474-2. Although this standard EN1474 specifies the baseline for qualification, many issues need to be covered to qualify different hose configurations. EN1474 specifies the baseline for qualification, many issues need to be covered to qualify different hose configurations. New ground needs to be broken, focusing on mechanical behaviour: static, fatigue and damage tolerance tests at ambient (water) and cryogenic (LNG) temperature. Pressure losses across the flexible hose, maximum allowable flow, multi-analysis and a pulsation and vibration measurement are included in the test. Based on a series of test programmes, a performance of composite flexible hoses has been developed to assess the mechanical behaviour.

Offshore LNG transfer systems have to fulfil very strict conditions. Systems should be flexible to deal with the ships moving relative to each other. The offshore transfer system has to transfer LNG in the highest possible quality, which means that the equipment has to withstand high flow velocities and pressures and fatigue and damage tolerance tests should be safeguarded efficiently to show that a spill of LNG is not taking place. A ship-to-ship transfer water hammer can occur when the flow is suddenly stopped, which can result in damage of the system and equipment. The combination of a high transfer rate, which means a high flow velocity and high flow stresses, may lead to high amplitude shock waves. TNO has investigated the mechanical behaviour of flexible hoses and other system components in the absence of compressors and pumps. The well-known phenomena like flow excites acoustic or mechanical modes, which can be important to consider in the evaluation of the insulation value of the equipment.

The LNG industry has had an excellent safety record for decades. Even in severe upsets in the planned offshore LNG supply chain, components must be able to perform continuously, reliably and safely. Expertise on material behaviour, structural behaviour, flow-dynamics and safety are valuable to further development of the offshore chain. TNO’s expertise and experience in measuring, modelling, testing and optimising installations gives back even more. The LNG industry is considered to be a very safe fuel for heavy transport over long distances. Using clean LNG as a shipping fuel fits in with the picture as a transport fuel among the Netherlands; there is almost no infrastructure for LNG supply in smaller quantities for the use of LNG as a transport fuel. TNO helps to get the small scale LNG supply chain off the ground by transfer of technology, investigating the environmental and economic effects. As an independent party and in collaboration with the industry, TNO offers the possibility of removing the legal and safety barriers to develop the small scale LNG supply chain. The selection of legal options for LNG in the Netherlands; there is almost no infrastructure for LNG supply in smaller quantities for the use of LNG as a transport fuel. TNO helps to get the small scale LNG supply chain off the ground. LNG as fuel for shipping

In February 2011 TNO started a joint industry project called LEWSH with the aim to assist in assessing the feasibility of LNG as fuel for different types of ship. The study was supported by the Dutch Marine Innovation Program (DP) and the Inland Environmental risks. The investigation focused on case studies for different types of ships (contain carrier, feeder, bulk carrier and very large oil carrier). The fuel system and the environmental impacts were covered in detail.