

# LNG & Veiligheid in de binnenvaart

Kennis en Expertise Centrum LNG in de binnenvaart



# State-of-the-art publicaties

Relevante publicaties m.b.t. dit onderwerp zijn uitgegeven door:

## LNG Masterplan Consortium

- D 2.4.1 & D 2.4.2 Safety and Risk Assessment
- D 2.4.3 Case Study of Port of Rotterdam
- D 2.4.4 Emergency and incident response study

<http://lngmasterplan.eu/masterplan/activities/16-masterplan/97-technical-evidence-safety-and-risk-assessment>

## PGS Beheerorganisatie

- Aardgas - Afleverinstallaties van vloeibaar aardgas (LNG) voor vaartuigen

<http://www.publicatiereeksgevaarlijkstoffennl/publicaties/PGS33-2.html>

# LNG Masterplan Consortium

# D 2.4.1 & D 2.4.2 Safety and Risk Assessment

Suac 2.4 A: Operational Safety & Nautical Conditions

Suac 2.4 B: A risk comparison of different LNG bunker scenarios

Suac 2.4 C: Comparison of risk assessment tools

# Suac 2.4 A: Operational Safety & Nautical Conditions

## Findings and recommendations:

1. Harmonisation is important to make sure that bunker operations are standardised as much as possible while still incorporating the local conditions.
2. It is recommended that ports require that operational procedures are developed by the bunker company as part of the permitting and/or accreditation process for the specific bunker operation. All LNG bunkering operations will always need to be developed based on the operation and locationspecific characteristics of the operation.
3. A set of harmonised checklists is established. It is recommended that the checklists which will be issued by CCNR and made mandatory under the Rhine Police Regulations are used as a basis for all LNG bunkering activities on the Rhine Corridor in order to ensure consistency in operations.
4. It is recommended that port authorities publish their own LNG bunkering operating requirements in their port bye-laws which should reflect the local conditions, operations and procedures within the port area.
5. In order to simplify the operational differences between the different ports and riverside bunker locations along the Rhine Corridor, it is recommended to align the authority requirements as much as possible

# Suac 2.4 B: A risk comparison of different LNG bunker scenarios

## Risk levels involved with the different LNG bunker configurations:

### Truck-to-ship bunkering

TTS bunkering is a solution with a relative low risk level. The nearby risk is similar to that of mobile fuel tank operations. The nearby risk is predominantly determined by the scenario of a hose rupture. At larger distances the main risk driver is the scenario of damage to the on-board LNG fuel tank caused by a ship collision.

### Bunkering at a bunker station

For bunkering at a bunker station two cases were considered: bunkering with a bunker hose and bunkering with a bunker arm. For the application of bunker hoses, the nearby risk of bunkering at a bunker station is the highest of all considered configurations. This is due to the high flow rates associated with this bunker scenario. The distant risk is predominantly determined by the scenario of a collision with the LNG fuel tank as well as a failure of the onshore storage tank. When a bunker arm is applied instead of a bunker hose, the nearby risk is reduced significantly, as the likelihood of a release from the transfer system is reduced.

### Moored ship-to-ship bunkering

The nearby risk for STS operations is relatively high, because of the high flow rates. The risk at larger distances on the other hand is lower than that of the other configurations, as the only contributing scenario is a collision with the bunker barge cargo tank.

# Suac 2.4 B: A risk comparison of different LNG bunker scenarios

## Mobile fuel tank operations

The study has estimated the quantitative risk of mobile fuel tank operations based on a coarse methodology. It was found that the nearby risk is relatively low as the transfer scenarios, which are the dominating scenarios for the other configurations, do not apply to this particular configuration. For mobile fuel tanks both the nearby and distant risk levels are dominated by the hoisting scenarios.

## Sailing ship-to-ship bunkering

The risk for sailing STS operations has also been calculated based on a coarse methodology. As sailing STS operations are not conducted at a fixed location but along a trajectory, the risk is spread over a larger area. As a result the calculated *individual* risk is lower than that of the other configurations. This does however not mean that the risk of sailing STS operations is more *acceptable* than the risk of other configurations. The fact that this configuration is not bound to a single location introduces a series of risks related to the fact that the environment of the bunker activity cannot be controlled like in a fixed location.

# Suac 2.4 C: Comparison of risk assessment tools

## Findings and recommendations:

### External safety

- Each country has adopted different methodological approaches in their legislation to determine and assess external safety (distances) in land use planning due to their own implementation of the Seveso directive. Harmonisation of the methodological approach for LNG installations covered by the Seveso directive seems therefore not feasible.
- For non-Seveso LNG establishments and activities, however, harmonization could be achieved easier because no specific approaches or guidance has been adopted in national legislation or port regulations. In addition, for non-Seveso LNG bunkering activities inside port limits, approval would be required from the port authority. This would allow the port authorities to develop their own (harmonized) method for assessing the acceptability of risk of LNG bunkering and set requirements for land-use planning restrictions. It must be stressed that the port regulators are not always the port authorities. Especially the LNG shore-ship LNG activities are (or will be) mostly covered in national regulations. Therefore, part of the harmonization has to be done on national or EU level. For the LNG activities (e.g. Ship-to-ship bunkering) that are not governed by other regulators than the port authorities, harmonization can be achieved in port regulations.

# Suac 2.4 C: Comparison of risk assessment tools

- A comparison of the external safety distance for an example scenario (Truck-to-ship bunkering operation) revealed that similar external safety distances would be applicable for the Netherlands, Belgium (Flanders) and Germany. The fact that the safety distances are roughly the same is probably more of a coincidence than due to the similarities in the approach and criteria as there are some fundamental differences identified.

## **Safety and security zoning**

- The concept and requirements for safety zoning for LNG bunkering are not well-defined in all the port regulations of the Rhine ports. The Ports of Rotterdam, Antwerp, Mannheim do specify minimum requirements for safety zoning. In some cases the requirements are more or less the same (e.g. for truck-to-ship bunkering), although full harmonization between all the Rhine ports is lacking. Also, reference to a common approach to determine a safety zone is missing.

- A clear concept and specific requirements for security zoning for LNG bunkering are missing in the port regulations.

## **Risk assessment - tools and methodologies**

- There is no common approach in requesting risk assessments (e.g. HAZID, HAZOP, QRA) for LNG bunkering operations. The requirements to determine under which circumstances a specific risk assessment should be requested by the regulator are unclear.

# Suac 2.4 C: Comparison of risk assessment tools

## Recommendations:

- 1)** Consider to develop a harmonized (Rhine state) LUP-approach for non-Seveso small scale LNG establishments and activities to establish required external safety distances and to address societal risk. It must be noted that this recommendation is touching the sovereignty of the EU nations and is in fact a political issue. Although desirable in terms of EU-wide harmonization, the recommendation may therefore not be feasible to implement.
- 2)** Consider prescribing minimum recommended safety zones for various bunkering configurations based on a clear approach provided in ISO/TS 18683 to define the limits. Specific requirements for safety zoning should be adopted in port regulations or relevant bunkering checklists.
- 3)** Specify regulatory implementation and sizing requirements for security zones in LNG bunkering. Consider using the guidance and approach provided in ISO/TS 18683 and outlined in this report. It must be stressed that the meaning of ‘security zone’ intended in this report and in ISO/TS 18683 is not the same as the term ‘security zone’ conform the International Ship and Port Facility Security Code (ISPS).

# Suac 2.4 C: Comparison of risk assessment tools

**4)** Specific requirements under which circumstances a risk assessment (e.g. HAZOP, HAZID) should be performed by the operator should be adopted in regulations or other relevant documentation for the regulator.

Implementation of these recommendations would be the first step in realization of a harmonized approach for the use of risk assessment tools, methodologies and criteria in the determination of safety & security zones, the external safety area and the assessment of risk in general for LNG bunkering activities in the Rhine corridor.

# D 2.4.3 Case Study of Port of Rotterdam

- Part A - Gap study on regulations for LNG activities in a seaport
- Part B - LNG bunkering map
- Part C - Incompatibility of inter-modal LNG activities
- Part D - Impact on terminals
- Part E - Impact on passing vessels

# Part A - Gap study on regulations for LNG activities in a seaport

## **This report (A) analysis whether all foreseen LNG bunker activities in a seaport are covered with safety regulations or best practice guidelines**

Truck-to-ship, ship-to-ship and bunker station-to-ship bunkering of seagoing as well as inland vessels are well covered by guidelines. At the international level the ISO/TS 18683:2015 now provides a goal based guidance document for the equipment, systems, procedures and training for parties engaged in the delivery of LNG as fuel to ships. At a national level, PGS 33-2 gives more prescriptive requirements regarding the construction and operations of bunker stations-to-ship and truck-to-ship and covers requirements to equipment, safety systems, training and organizational aspects. Furthermore several other relevant guidelines have been published by individual industry players or other institutions.

With the expected adoption of LNG as fuel in CCNR regulation and the formalization of draft IGF in June 2015, the regulatory framework will be in place for truck-to-ship, ship-to-ship and bunker station-to-ship bunkering of seagoing and inland vessels in the Port of Rotterdam. In the port of Rotterdam, LNG bunkering is allowed only at designated locations by companies that hold an environmental permit (shore-to-ship) or a port authority accreditation (ship-to-ship). In all other circumstances, a bunkering activity is only allowed by Port Authority by exemption and after quantitative risk analysis. In this way the port authority prevents that bunker activities are taking place at uncontrolled locations.

The only bunker configuration where regulations and guidelines will not be in place in the near future is for mobile fuel tanks. While draft IGF does specify requirements for a mobile LNG fuel tank on board of a seagoing vessel, the draft amendments to CCNR regulation do not consider this option for inland vessels. Furthermore, there is no regulation for the activity of transferring and connecting a mobile fuel tank to a LNG fuelled seagoing or inland vessel. This means that, for the time being, the activity of transferring mobile fuel tanks to inland or seagoing vessels in the Port of Rotterdam can only be allowed by Competent Authority by exemption and it is not possible to refer to a standard, best practice or guideline when requesting permission for mobile fuel tank transfer operations because they are currently not available.

## Part B – LNG bunkering map

### **This report (B) describes an analysis of the suitability of different locations in the Rotterdam port area for LNG bunkering activities**

The bunker location suitability is evaluated based on two safety factors: external safety and nautical safety. The analysis regarding external safety aspects is divided into two steps: one related to the port areas which are covered by the three safety contours and one related to the port areas located outside these zones.

For the port areas outside the safety contours a zoning system (“zoning regulations”) is applicable. The purpose of this activity is to indicate which bunker activities could be conducted in each of the zones and how often such activities can be conducted without requiring additional mitigation measures based on additional risk assessment.

Even though the risk of LNG bunkering might be acceptable from an external safety perspective, it could still be that the location is not suitable for LNG bunker activities as the risk of a nautical incident is high. The analysis of nautical aspects has addressed the nautical traffic conditions and how these conditions affect the suitability of locations for LNG bunkering activities.

By combining the results of both analyses a GIS map is established for the area within the three safety contours. The map shows the areas with an increased nautical risk level as well as the most critical areas in terms of external safety for each of the four considered configurations. The results will be used by the Port of Rotterdam to develop a location policy for LNG bunkering.

It is emphasized that the conducted analyses have a high level nature and that the map is intended only to compare the suitability of locations throughout the port area. For the actual development of LNG bunkering activities a location-specific risk assessment should be conducted to determine whether the risk of a specific activity at a particular location is acceptable.

# Part C - Incompatibility of inter-modal LNG activities

**This report (C) focusses on the identification of possible hurdles in LNG bunkering due to incompatibility of or a lack of information exchange on supplier/receiver connections**

While LNG fuelled vessels have been in operation for some time, most of these vessels operate within small defined areas using LNG bunkering connections compatible for that particular vessel service. This report shows that regulations and guidelines give functional requirements for ESD and bunker couplings without referring to a standard. Currently different technical solutions are being used by companies for different bunker configurations. For LNG fuelled vessels to be able to safely bunker at different locations and to be supplied by different bunker suppliers, from a bunker station, by a truck or a bunker vessel, it is desired that a standard for the bunker coupling and ESD connection are developed. Because the LNG bunker market is just developing it is expected that standardization will still take several years and will substantiate as the LNG bunker market grows. Until that time, LNG fuelled vessel operators and bunker suppliers will need to communicate and agree on the connections upfront to prevent technical incompatibility issues.

Although various standards and regulations exist that try to govern the organizational compatibility issues (for example hazardous or training and safety awareness), the harmonization across configurations and/or geographies is not common (yet). In the absence of harmonized regulations, guidelines or standards for organizational compatibility issues, it is recommended that comprehensive procedures and checklist systems are used to deal with these potential organizational compatibility issues.

## Part D - Impact on terminals

**This report (D) addresses the impact on and preparedness of Rotterdam terminal operators, who can be confronted with LNG bunkering activities at their quays**

Ship-to-ship bunkering is the dominant configuration for conventional bunkering of seagoing vessels and is generally seen as the most feasible bunkering solution for larger LNG volumes and in particular for bunkering of vessels at terminals in the Port of Rotterdam. Currently, LNG bunker vessels are being developed, which are expected to be operating in the Port of Rotterdam. Requirements with respect to safety and exclusion zoning, SIMOPS and training are considered as the main aspects that can have a significant impact on existing terminal operations. It can be concluded that terminals were not yet fully aware of the impact that these requirements can have on their existing operations. Furthermore, the workshop showed that several requirements and issues still need to be clarified, respectively resolved, before LNG bunkering can be implemented at terminals:

- The establishment of a safety zone which comes on top of any existing ATEX zoning around the bunkering area can have considerable impact on the terminal operations. Currently, different methods can be applied to determine safety zone and the size depends on parameters which can differ per vessel and type of bunkering operations. It will be challenging for terminals to comply with different safety zone requirements for different vessels. Terminals suggest that the practical feasibility of safety zones in terminals should be determined at an early stage (e.g. contracting phase) and that any resulting operational restrictions, requirements or investments should be critically examined on their effectiveness.
- Depending on the location and lay-out of a terminal, the nautical safety distances (defining the exclusion zone) defined in the Port bye-law can limit terminal accessibility when LNG bunkering takes place.
- Safety requirements for simultaneous LNG bunkering and (un)loading are determined on a case-by-case basis. This can result in different SIMOPS requirements for different vessels. It is recommended that a common approach is established to assess whether SIMOPS can be allowed and if yes, under what conditions and provisions.

## Part D - Impact on terminals

- Rules and regulation specify training requirements for personnel directly involved with the bunkering activity. In the IAPH bunkering checklist, it is required that all personnel involved in the LNG bunker operation have the appropriate training and have been instructed on the particular LNG bunker equipment and procedures. This check also needs to be signed off by terminal personnel, which are usually involved to a lesser degree. It is unclear if terminal personnel should be considered involved or if they should be considered as 2nd party personnel, e.g. not directly involved and may therefore not be subject to the same training requirements as for 1st party personnel.

Given potential impact on terminal operations, it is recommended that operators deal with this issue proactively. First of all terminal companies are recommended to enhance their knowledge about LNG bunkering in general and to initiate discussions on the identified issues with relevant stakeholders early DNV GL – Report No. PP122088-4, Rev. 1 – [www.dnvgl.com](http://www.dnvgl.com) Page 2 (e.g. shipping company, bunker company and competent authority) if LNG bunkering operations are foreseen.

On a positive note, current applicable regulations and guidelines such as Rotterdam port bye-laws, the IAPH bunker checklist and ISO/TS 18683 already provide a sound framework for the establishment of operational safety procedures, but DNV GL expects that the above mentioned terminal specific implementation issues will have to be solved on a case-by-case basis initially. Once practical experience has been built up by the early adopters, it is possible and recommendable for terminals to jointly develop and agree on a best practice guideline for safe LNG bunkering at a terminal.

## Part E - Impact on passing vessels

**This report (E) verifies whether the adopted safety distances in the Port bye-laws, for vessels passing or mooring near LNG fueled vessels which are bunkering LNG, are in line with the applicable national and international legislation and regulations**

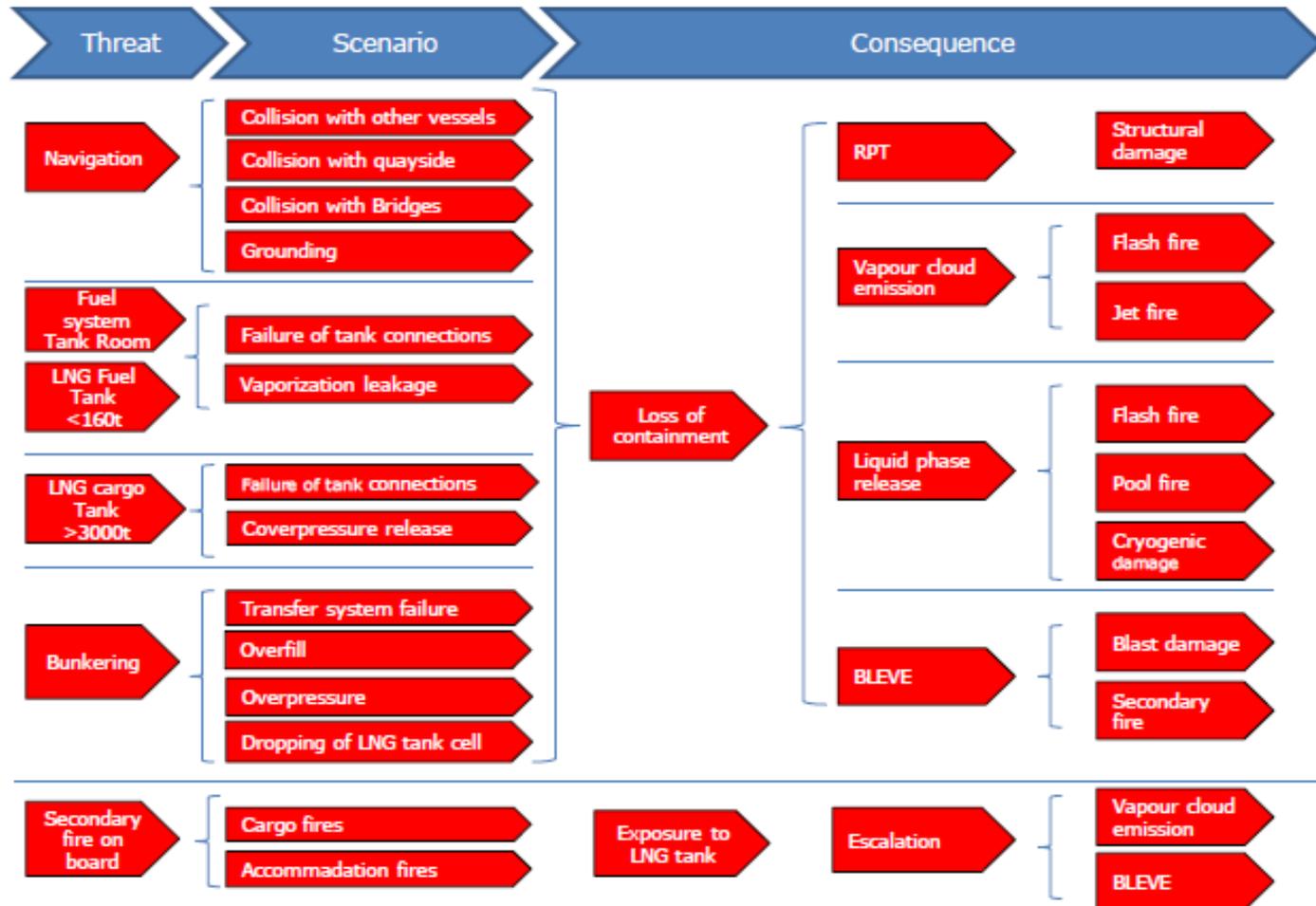
Following the regulatory assessment in relation to this article the following conclusions can be drawn:

- Based on the assessment of regulatory instruments, it is concluded that there is no regulatory basis to compare the set safety distances to requirements in the relevant regulatory documents. In other words, it is left up to the port authority to determine what is deemed safe, in consultation with other authorities, and define safe distances
- The safety distances of 10 and 25 m, are of a similar order of magnitude of safe passing distances to vessels carrying dangerous goods. Various international documents for LNG bunkering specify a minimum safety zone for ships of 10 m or 25 m around the bunkering manifolds. However, as described in the previous chapter, the comparison with these distances is not straightforward.
- As such it can be concluded that the distances are not in conflict with any of the current regulations, as none of the regulatory documents contains specific guidance of how these distances should be established. This is left up to the judgement of the responsible authorities.
- And as there are no guidelines with regards to safety distances for passing traffic during in both applicable regulations and international standards, it is concluded that there exists no conflict between the minimum safety distances enforced by the Port of Rotterdam and existing

It is however highlighted that, in line with ISO/TS 18683, risk studies should be conducted for each individual bunker activity, which should include the establishment of a safety and a security zone. The enforced minimum safety distances should therefore not be seen as a measure which is sufficient for all possible bunker operations. Distances as defined by PoR are minimum passing distances. These might not be sufficient for all cases and conditions. Especially at locations with high risks of ship collisions, larger passing distances could be required.

# D 2.4.4 Emergency and incident response study

## Gevaarlijke scenario's LNG



# Geloofwaardige LNG incidentbestrijdings-scenario's

Op basis van 3 criteria zijn 4 geloofwaardige incidentbestrijdingsscenario's opgesteld

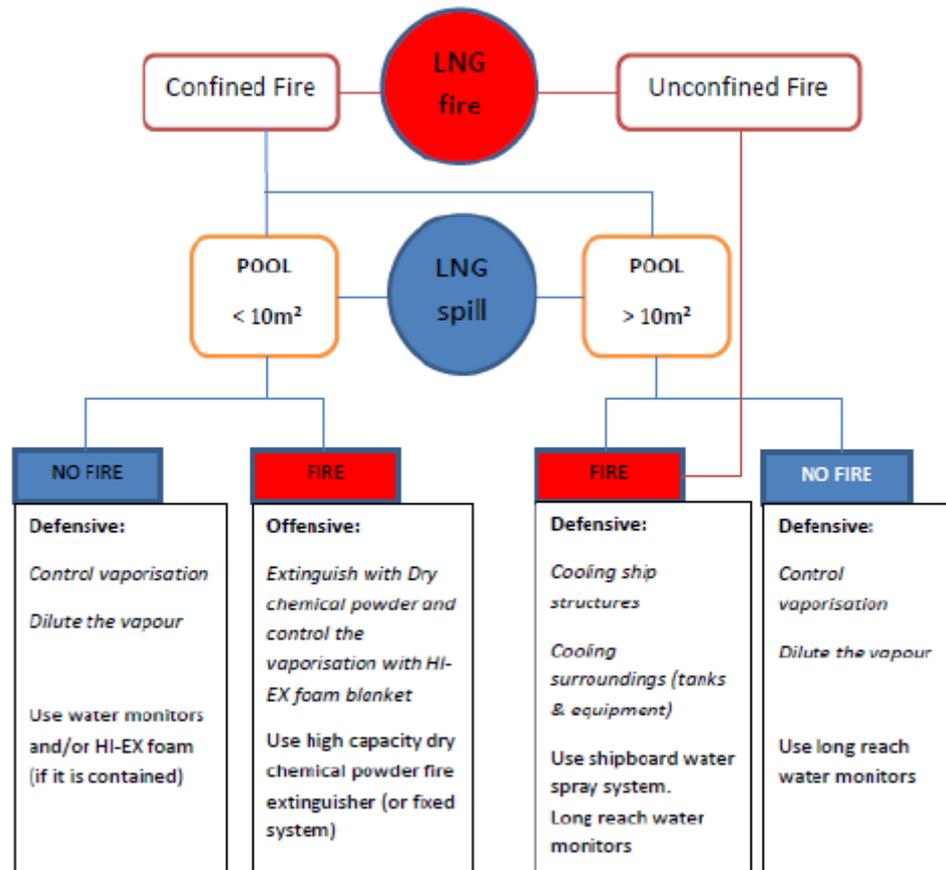
## Criteria:

1. Is het scenario realistisch en kenmerken?
2. Kan het scenario relevante schade toebrengen aan bezittingen of personen in de omgeving?
3. Kan interventie van het scenario een duidelijk effect hebben om escalatie te voorkomen?

## Incidentbestrijdingsscenario's:

Type Insluitingssysteem		Oorzaak	Effect
LNG aangedreven schepen	Brandstoftank(s) op het dek	Botsing met brug	Plasbrand
LNG aangedreven schepen	Brandstoftank(s) op het dek	Secundaire brand (bijv. vracht)	Domino/(meer) secundaire brand(en)
LNG aangedreven schepen	Brandstoftank(s) onder het dek	Defecte tankaansluiting	Plasbrand
LNG aangedreven schepen	Brandstoftank(s) onder het dek	Defect overdrachtssysteem	Cryogene schade

# LNG incidentbestrijdingsstrategie



# Tekortkomingen LNG-incidentbestrijding

De volgende tekortkomingen zijn geïdentificeerd m.b.t. LNG-incidentbestrijding:

## Planning

- Er is geen bestaande specifiek gevalideerde op maat gemaakte operationele voorbereiding voor small-scale LNG in de binnenvaart.

## Mensen

- Er zijn geen bestaande specifiek gevalideerde op maat gemaakte opleidings- en trainingsprogramma's voor optreden bij incidenten met LNG in de binnenvaart.

## Uitrusting

- Er is geen bestaand specifiek gevalideerd materieel en apparatuur voor incidentbestrijding t.a.v. small scale LNG in de binnenvaart.

**Hierbij moet vermeld worden dat deze tekortkomingen betrekking hebben op professionele hulpverleningsorganisaties zoals brandweer, politie en geneeskundige diensten, de haven- en rivierautoriteiten. De genoemde tekortkomingen hebben geen betrekking op de bemanning, officieren, technici of walpersoneel.**

# PGS Beheerorganisatie

# Aardgas afleverinstallaties van LNG voor vaartuigen (PGS 33-2)

Richtlijn PGS 33-2 geeft aanvullende voorschriften voor PGS 33-1 *Aardgas: Afleverinstallaties van vloeibaar aardgas (LNG) voor motorvoertuigen* die als uitgangspunt dient. Het beschrijft het ontwerpen, realiseren en beheren van LNG-bunkerinstallaties op het land en op een drijvende inrichting. Hieronder vallen o.a. de ontwerpeisen die worden gesteld aan de installatie, de toegepaste componenten en de gebruiksomstandigheden. Hierdoor wordt een aanvaardbaar beschermingsniveau voor mens en milieu gerealiseerd.

Een groot deel van de eisen danwel voorschriften die aan het gebruik van gevaarlijke stoffen worden gesteld, zijn vastgelegd in wetgeving, al dan niet gebaseerd op Europese richtlijnen of volgen rechtstreeks uit Europese verordeningen. De PGS-publicaties beogen een zo volledig mogelijke beschrijving te geven van de wijze waarop bedrijven kunnen voldoen aan de eisen die uit wet- en regelgeving voortvloeien.

Toezicht, handhaving en vergunningverlening zijn geregeld in de desbetreffende wetgeving. Bedrijven moeten aan de beschreven stand der techniek voldoen, wanneer vanuit een bindend document wordt verwezen naar de PGS. Een bindend document is bijvoorbeeld het Activiteitenbesluit of een omgevingsvergunning. Voor de werknemersbescherming kan de beschreven stand der techniek in een Arbo catalogus zijn opgenomen, waarmee het voor de desbetreffende branche (of doelgroep) het referentiepunt voor toezicht is. Een andere mogelijkheid is dat PGS-voorschriften via een eis tot naleving door de Inspectie SZW worden opgelegd aan een bedrijf.

# Toepassingsgebied PGS 33-2

PGS 33-2 is van toepassing op LNG-bunkerinstallaties op het vaste land en op een drijvende inrichting.

PGS 33-2 is van toepassing op het bunkeren van schepen met een totaal netto brandstoftankvolume van maximaal 500 m<sup>3</sup> LNG. Inrichtingen met een vergunde hoeveelheid van 50 ton of meer vallen onder het Brzo '99. Bij het bepalen van de vergunde hoeveelheid wordt de totale inhoud van alle gekoppelde systemen (tanks en leidingen) meegerekend.

Het afleveren aan losse wisseltanks is niet opgenomen in PGS 33-2.

PGS 33-2 heeft geen betrekking op het overladen van LNG als cargo (lading) voor schepen.

PGS 33-2 heeft geen betrekking op het bunkeren van LNG van vaartuig naar vaartuig ('ship to ship' bunkeren).

# Conclusie

Anno 2016 zijn er vier relevante publicaties m.b.t. LNG en veiligheid in de binnenvaart:

## LNG Masterplan Consortium

- D 2.4.1 & D 2.4.2 Safety and Risk Assessment
- D 2.4.3 Case Study of Port of Rotterdam
- D 2.4.4 Emergency and incident response study

<http://lngmasterplan.eu/masterplan/activities/16-masterplan/97-technical-evidence-safety-and-risk-assessment>

## PGS Beheerorganisatie

- Aardgas - Afleverinstallaties van vloeibaar aardgas (LNG) voor vaartuigen

<http://www.publicatiereeksgevaarlijkstoffennl/publicaties/PGS33-2.html>

Uit de publicaties blijkt dat er een behoefte is naar een geharmoniseerd Europees reguleringskader voor LNG als brandstof en cargo en het promoten van de introductie van LNG als brandstof en cargo in de binnenvaart.

## Team EICB

Expertise- en InnovatieCentrum Binnenvaart

Vasteland 12e

3011 BL Rotterdam

Tel: 010 798 98 30

E-mail: [secretariaat@eicb.nl](mailto:secretariaat@eicb.nl)

Dit project werd mede mogelijk gemaakt door:



provincie **HOLLAND**  
**ZUID**