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Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of Experts on the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) (ADN Safety Committee)

Twenty-fifth session
Geneva, 25-29 August 2014
Item 3 (b) of the provisional agenda
Special authorizations, derogations and equivalents

Proposed text of a derogation regarding the use of diesel and LNG for propulsion

Transmitted by the Government of the Netherlands

Attached is the proposed text of a possible derogation for the dry cargo vessel *Eiger* regarding the use of diesel and LNG for propulsion.

Decision of the ADN Administrative Committee relating to the dry cargo vessel *Eiger*

Derogation No. XX/2014 of 29 August 2014

The competent authority of the Netherlands is authorized to issue a trial certificate of approval to the dry cargo vessel *Eiger*, European Number of Identification (ENI) 02324957, for the use of diesel and liquefied natural gas (LNG) as fuel for the propulsion installation.

Pursuant to paragraph 1.5.3.2 of the Regulations annexed to ADN, the above-mentioned vessel may deviate from the requirements of 7.1.3.31 and 9.1.0.31.1 until 30 June 2017. The Administrative Committee has decided that the use of LNG is sufficiently safe if the following conditions are met at all times:

1. The vessel has a valid ship's certificate according to the Rhine Vessel Inspection Regulations, based on recommendation 2/2014 of the CCNR.
2. A HAZID study by the recognized classification society[1] shows that the safety level of the LNG propulsion system is sufficient. This study covered, but was not limited to, the following issues:
   - Interaction between cargo and LNG;
   - Effect of LNG spillage on the construction;
   - Effect of cargo fire on the LNG installation;
   - Different types of hazard posed by using LNG and diesel as fuel;
   - Adequate safety distance during bunkering operations.
3. The information that LNG is used as fuel is included in the dangerous goods report to traffic management and in emergency notifications;
4. All data related to the use of the LNG propulsion system shall be collected by the carrier. The data shall be sent to the competent authority on request;
5. An annual evaluation report shall be sent to the UNECE secretariat for information of the Administrative Committee. The evaluation report shall contain at least information on the following:

   (a) system failures;

   (b) leakages;

   (c) bunkering data (LNG);

   (d) pressure data;

   (e) abnormalities, repairs and modifications of the LNG system including the tank;

   (f) operational data;

   (g) inspection report by the classification society which classed the vessel.

[1] Report No. RTS/ENG/131548, d.d. 25 October 2013.

Attached documents:

- Annex 1: HAZID Study
- Annex 2: Deviations from IGF Code
- Annex 3: Bunkering procedure
- Annex 4: Crew Training
- Annex 5: Project description
- Annex 6: Report TNO
- Annex 7: CCNR Recommendations

Refit of IWW Container Vessel 'Eiger'

Danser Container Line

Technical Report RTS/ENG/131548 (Issue 1)

25 October 2013

Lloyd's Register

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Eiger-Nordwand: HAZID Dual Fuel Propulsion

Executive Summary

This report details the findings of a Hazard Identification (HAZID) Study on the design of the Dual-Fuel arrangements on the Inland Waterways Push Combination vessel 'Eiger-Nordwand'.

Representatives from Lloyd's Register EMEA, Danser, Wartsila, and the shipyard were present during the study which was facilitated by Lloyd's Register Marine over two days between the 1st and 2nd of October 2013.

The use of dual fuel (oil fuel and LNG) propulsion has been used on seagoing ships for many years and is becoming increasingly common on Inland Waterways vessels. The Push Combination vessel reported here has a conventional two main engine plus auxiliary engine machinery arrangement. The main engines have a double walled gas fuel piping system similar to that fitted on various seagoing ships. This system has been approved by Lloyd's Register for use in a conventional gas safe engine room.

The HAZID concentrated on the specific issues raised by the use of dual fuel on an Inland Waterways vessel. These issues are mainly concerned with the smaller scale and draft of Inland Waterways vessels and the collision risks and danger from falling objects and fixed structures.

The HAZID identified a number of possible scenarios that could endanger the vessel or be harmful to personnel. The main issues identified related to:

- Location and arrangement of the LNG tank.

  The LNG storage tank is arranged athwartships, at the aft end of the container carrying section and just in front of the accommodation. This provides good protection for the tank but because the tank is effectively in the hold of the vessel, air circulation around the tank is restricted. The tank and tank connection space are of a design that requires free circulation of air around the tank in order to disperse any possible leakages. Although the space in which the tank is mounted has openings to atmosphere at a high level on all sides the air circulation is unlikely to be equivalent to that on open deck. A forced ventilation system capable of circulating 12 air changes an hour in the hold is fitted and this complies with the IEC standard for ventilation requirements equivalent to those in the open. It was considered that a CFD analysis of the ventilation should be carried out to demonstrate good air circulation around the tank and in particular around the tank connection space, effective dispersion of gas from the vacuum drop off disc at the top of the tank, and establish that leakages from within the tank connection space and cooling of the bottom of the hold resulting from a failure within the tank connection space or annular space can be tolerated.

- Leak assessment

  A leak assessment of the pipes within the annular space is required to demonstrate that the design can accommodate a single leak in the pipes within the annular space and that the ventilation system can disperse the released gas and maintain the tank hold temperature at a safe level.

- Leaks in the tank connection space

  The tank connection space is fitted underneath the tank and of the same SS304 material as the tank. It is naturally ventilated into the hold space. There is a drip tray at the bottom of the tank of capacity 1000l. Gas and temperature detectors are fitted within the connection space to shut the system down if leakage is detected. The estimated amount of LNG in the pipework in the connection space is less than 500L. Providing the tank root valves are closed then the drip tray is of sufficient size to contain any leakages from the pipework. As the system relies on the automatic valve (ESD valve) on the liquid line closing in case of gas leak an FMEA of the valve is required to be submitted for approval.

  The vapour lines into the tank connection space are fitted with manual root valves. The root valves are to be accessible without entering the tank connection space.

- Containers falling onto storage tank.

  The storage tank is installed underneath the aftermost row of containers. The scenario of a container falling onto the tank and rupturing the shell of the tank was discussed. The tank is protected by a framework with a 50mm grid pattern between the primary members. The framework will be designed to resist a 20ft container of max. 30 tonnes falling from the crane or falling back from the front stack from a 5m height at an angle of 45 deg. It would be assumed that the container falls on one primary member but falling between primary memebers would also be considered. A full engineering analysis is to be submitted to LR for approval.

- Vent stack 3m high

  Cargo venting arrangements for Inland Waterway vessels are normally at a relatively low level because of the requirement for minimum air draft for passing under bridges. There is no ADN requirement for venting LNG systems. The proposed design uses a 3m high vent stack on the port side of the vessel. Dispersion of LNG is aided by the continuous flow of ventilation air from the GVUs into the vent stack. The arrangements were considered equivalent to venting systems generally used on Inland Waterway vessels. A hazardous area will exist on the port side of the vessel which will extend to the dock if alongside.

- Sizing of P/V valves

  The tank safety valves are to be sized for the maximum anticipated heat input under fire and fault conditions. The fault conditions are to include a runaway vapouriser and failure of the tank insulation.

- Collision protection

  For collision protection, according to ADN Rules for LPG and Type C & G tankers the tank must be located more than 1m from the ship side. The distance from the shear strake to the outer tank in the proposed design is 1.55m and this was considered acceptable for the LNG tank. For grounding protection there is a 500mm double bottom underneath the tank space. The distance from the base line of the ship to the bottom of the tank is 1.6m.(to the bottom of the tank connection space 800mm. This is more than the clearance required in the draft I.G.F. code and was considered acceptable.

- Removal of LNG

  In case of failure of the LNG tank, arrangements for pumping the contents of the tank ashore are to be provided.

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APPENDICES

1. Introduction

Danser Containerline is proposing to re-fit its Push Combination vessel 'Eiger-Nordwand' with dual fuel (diesel oil or LNG) engines.

The proposed design has the following overall features:

- LNG is stored in a single pressure vessel of IMO Type 'C' arrangement, designed in accordance with EN 13458/2.
- The tank is mounted athwartships in the aft container hold just in front of the retractable wheelhouse.
- The tank and tank connection space are of a design that requires free circulation of air around the tank in order to disperse any possible leakages. A forced ventilation system capable of circulating 12 air changes an hour in the hold is fitted and this complies with the IEC standard for ventilation requirements equivalent to those in the open.
- The LNG tank and associated tank connection space supplies methane gas to two gas valve units. There are two main engines, each engine with its own gas valve unit mounted in the tank hold. Each engine can run independently from the other engines.
- The main engines are LR Type Approved and have double walled gas supply piping. The existing auxiliary engines will not be converted to run on LNG.
- The main propulsion, apart from LNG related issues and the essential auxiliary systems are conventional Inland Waterways systems and did not form part of the HAZID.

The principle objective of the HAZID was to increase confidence that safety related aspects of the design are appropriate. The objectives are covered in Section 5 of this report and detailed in the Terms of Reference (ToR) Appendix 3.

2. Properties and Hazards associated with LNG

Before attempting to assess the risks with the use of LNG on board Inland Waterway vessels it is necessary to understand the characteristics and hazards associated with LNG as outlined below.

LNG Properties

LNG is a cryogenic liquid. It consists of methane with small amounts of ethane, propane and inert nitrogen. When used as a fuel, typically 94% or more is methane. Stored at ambient or near ambient pressure, its temperature approximates minus 162oC and its specific gravity is about 0.42. Hence, if released onto the sea/water LNG floats. When stored at pressures of up to 10 bar the temperature typically remains below minus 130oC with a specific gravity of approximately 0.4.

Released into atmospheric conditions, LNG rapidly boils forming a colourless, odourless and non-toxic gas. Although colourless, due to its very low temperature, water vapour in the air condenses forming a visible mist or cloud. The cold gas is initially heavier than air and it remains negatively buoyant until its temperature rises to about minus 100oC. At this stage the gas becomes lighter than air, and in an open environment it is thought that this coincides with a gas concentration of less than 5%. At this temperature and concentration the gas is still within the visible cloud. As the gas continues to warm to ambient conditions its volume is approximately 600 times that of the liquid with a relative vapour density of about 0.55, and so the gas is much lighter than air (air = 1).

As the gas disperses, its concentration in air reduces. At a concentration in air of between 5% and 15% the mix is flammable and can ignite in the presence of ignition sources or in contact with hot sources at or above a temperature of approximately 595oC (referred to as the auto-ignition temperature of LNG). Once below a concentration of 5% the mix is no longer flammable and cannot be ignited (and this is the case if the concentration remains above 15%). The 15% and 5% concentrations of LNG in air are commonly known as the upper and lower flammability limits, respectively. More recently, the limits are referred to as the upper and lower explosion limits, although ignition may not necessarily result in explosion.

LNG Hazards

Cryogenic Burns

Owing to its very low liquid temperature, in contact with the skin LNG causes burns. In addition, breathing the cold gas as it 'boils' can damage the lungs. The severity of burns and lung damage is directly related to the surface area contacted by the liquid/gas and duration of exposure.

Low Temperature Embrittlement

In contact with low temperature LNG, many materials lose ductility and become brittle. This includes carbon and low alloy steels typically used in ship structures and decking. Such low temperature embrittlement can result in material fracture, such that existing stresses in the contacted material cause cracking and failure even without additional impact, pressure or use. For LNG duty, materials resistant to low temperature embrittlement are used. These materials include stainless steel, aluminium, and alloy steels with a high-nickel content.

Asphyxiation

LNG is non-toxic and is not a known carcinogen. However, as it boils to gas it can cause asphyxiation as it displaces and then mixes with the surrounding air. The likelihood of asphyxiation is related to the concentration of gas in air and duration of exposure.

Expansion and Pressure

Released into the atmosphere LNG will rapidly boil with the volume of gas produced being hundreds of times that of the liquid (approximately 600 times at ambient conditions). Hence, if confined and unrelieved, the pressure will increase and this can damage surrounding structures and equipment.

Fire

Pool Fire

A 'small' release of LNG will rapidly boil and 'flash' to gas. However, given a 'large' and sudden release, a cold pool of LNG will form with gas boiling from the pool and mixing and dispersing with the surrounding air. If this mix is within the flammable range (i.e. 5% to 15% with air) and contacts an ignition source or a heated surface above the auto-ignition temperature (595oC) it will ignite and the resultant flame will 'travel back' to the pool resulting in a pool fire.

Jet Fire

If stored under pressure then a release of LNG may discharge as a jet of liquid, entraining, vapourising and mixing with air. If the mix disperses and reaches an ignition source or a heated surface (above the auto-ignition temperature) whilst in the flammable range it will ignite. The resultant flame will 'travel back' and may result in a pressurised jet fire from the release source. Similarly, where contained LNG has been heated to form gas, a pressurised release of this gas could ignite and result in a jet fire.

Flash Fire

Release of LNG to atmosphere and ignition within a few tens of seconds is likely to result in a pool fire or jet fire (as noted above) with no damaging overpressure. This is because the flammable part of the cloud is likely to be relatively small and close to the release point upon ignition. However, if ignition is delayed, the gas cloud will be larger and may have travelled further from the release point. Ignition will then result in a flash fire as the flammable part of the cloud is rapidly consumed within a few seconds. This ignition is likely to be violent and audible, and is often mistaken for an explosion, although there is little appreciable overpressure.

Thermal Radiation from a Pool Fire, Jet Fire and Flash Fire

Harm to people and damage to structures and equipment from fire is dependent upon the size of the fire, distance from the fire, and exposure duration. Within a metre of the fire, thermal radiation may approximate 170 kW/m2 but this rapidly falls with distance from the fire. As a rough guide:

- 18 kW/m2 results in unbearable pain of exposed skin within 2 seconds;
- 5 kW/m2 is potentially fatal after 5 to 20 seconds exposure;
- 37.5 kW/m2 is often considered as the onset of damage to industrial equipment and structures exposed to a steady state fire;
- industrial equipment and structures within a flash fire are unlikely to be significantly damaged;
- persons within a pool, jet or flash fire are likely to be fatally injured.

In short, an LNG fire on a ship could result in fatalities and damage to equipment and structures (including the hull).

Explosion

Release of LNG to atmosphere and delayed ignition of the resultant flammable cloud beyond a few tens of seconds can result in an explosion. This is because the cloud may have dispersed in and around equipment and structures causing a degree of confinement and increased surface area over which to increase flame speed as it travels (i.e. burns) through the flammable mixture. The resultant overpressure may be sufficient to harm individuals, and damage structures and equipment. Such an explosion is most likely to be a deflagration (rather than a detonation), categorised by high-speed subsonic combustion (i.e. the rate at which the flame travels through the flammable cloud).

3. DESIGN DETAILS

Details of the proposed design are shown in the reference documents listed in Table 1 below. The documents were made available to the study attendees prior to the study and were provided as hard copies during the study.

Table 1: Reference Documents

Plan no.	Description
Eiger -10	General arrangement – version II.
Eiger 11	Hazardous area plan
(13 sheets)	LNG Refit 'Eiger-Norwand' Specification
Eiger 12	GA LNG tank and pipeline ventilation v2
Eiger 16 (2 sheets)	Bunkerstation and ventstack
Eiger 20 (2 sheets)	Transverse section, version 1
Eiger 30	Side views, version 2
Eiger 40	Top views, version2
DAAF 036632 Rev A	Installation drawing
1302-1100-100 rev.0 (3 sheets)	LNG fuel system
1302 1000-100 rev.0	Heat and mass LNG system
400-230-24V (2 sheets)	Single line diagram

For reference purposes the vessel general arrangement, machinery arrangement and diagrammatic plan of the fuel gas arrangements are included as Appendix 4 of this report.

Additional information was made available to the attendees at the opening PowerPoint presentation.

The overall process design, based on details in the reference documents, is summarised below.

Gas supply system

The Gas supply system is a package for storing LNG, controlling the supply pressure in the tank, vaporizing the LNG into Methane Gas and supplying the gas to the engines at suitable pressure and quantity.

The system consists of an LNG storage tank, tank connection space (vaporizer & PBU), gas valve units, bunkering station, control & monitoring system and piping & instrumentation.

LNG Storage Tank

The LNG storage tank is a vacuum insulated pressure vessel with a double wall. Insulation fills the space between the two walls. Both walls are constructed from 304 austenitic-stainless steel. The outer vessel protects the inner tank from external impact and is designed as secondary containment in case of failure of the inner tank.

Tank connection space

The tank connection space is welded to the outer tank. It is mounted underneath the tank and contains the LNG vaporizer and PBU, all tank connections and all tank valves. This space is monitored to detect gas leakage using gas and temperature detectors. It is naturally ventilated by air circulating in the tank space.

PBU (Pressure Build-up Unit)

The pressure build up unit within the tank connection space pressurises the LNG storage tank, in order that LNG will flow to the vaporizer.

Vaporizer

The function of the vaporizer is to vaporize LNG into Methane gas. Heat is supplied from the engine cooling system via. the glycol system.

Gas valve units

Two gas valve units are fitted, one for each engine. They are located in separate gas tight enclosures within the tank space. The function of the gas valve units is to condition and control the methane gas supply to the engines. The methane supply pressure to the main engines is 4-6 bar.

Bunkering Station

The Bunkering Station is designed for receiving LNG from shore.

4. Approach and Workshop Team

4.1 HAZID Objectives

The objectives of the HAZID were to identify:

1. Hazards and how they can be realised (i.e. the accident scenarios – What can go wrong and how?);
2. The consequences that may result;
3. Existing measures/safeguards that minimise leaks, ignition and potential consequences, and maximise spill containment; and
4. Recommendations to eliminate or minimise safety risks.

4.2 Study Team and Attendance

The HAZID workshop was facilitated by LR at BCN Rotterdam, on 1 and 2 October 2013. The workshop team consisted of the participants noted in Table 2. Unless otherwise stated the participants were Subject Matter Experts (SMEs), collectively providing expertise on the design and operation of ships and gas as fuel.

The meeting room was adequately sized for the number of team members and was provided with the required equipment for undertaking the HAZID. Breaks for refreshments and Lunch were provided throughout the meetings.

Prior to commencing the Study a Terms of Reference (ToR) was produced by Lloyd's Register and issued to each of the team members. The ToR provided details of the HAZID approach and study schedule. (Appendix 3)

At the start of the meeting a short introductory presentation was given to the study team by the study facilitator providing an overview of the project and HAZID technique, respectively.

Table 2: Workshop Participants

Name & Company	Position	Qualifications & Experience	Attendance
PA Stanney LR EMEA	Machinery Specialist	BSc Mech. Eng.DOT 2nd cert & 25 years plan approval experience of LNG systems. Facilitator for low flash point fuels.	Facilitator
V Shenoy LR EMEA	Specialist Machinery Department	BSc. Mech Eng. Experience: approval engineering systems (3 years)	Scribe Day 1
RP Verra LR EMEA	Specialist C&E Department	Mech. Engineering, 20 years elec. Design appraisal	Scribe Day 2
MP Breel LR EMEA	Senior Surveyor Machine TSO Rotterdam	BSc. Mech. Eng. Over 20 years' experience of diesel engines and marine plan approval. Two years plan approval of LNG fuelled ships for IWW.	Full-time
GJ Vromans LR EMEA	Lead Surveyor in Charge C&E Department	Approx. 35 years electrical design in the marine industry; experience of four LNG HAZIDs.	Full-time
B Joormann LR EMEA	IWW Product Manager	Naval Architect25 years inland waterways experience.	Full-time[1]
A Koedood Koedood Dieselservice B.V.	Ship design and construction supervisor.	Mechanical Engineering; 25 years experience Owner /Sales manager Koedood Dieselservice B.V.	Full-time
A Schroot Danser Container Line	Ship design and construction supervisor.	Ship building and technical 20 years experience of IWW transport and ship design/construction.	Full-time
CA Kruijt Wärtsil:a	Director IWW	Business; 30 years experience sales/business development	Full-time
J Nohl Wärtsil:a	Project manager– IWW.	HTS – technical management; 12 years project management.	Full-time
M Danzser-Duizendstra Danser Group	Director	Vessel owner	Full-time
RE Hamstra EMS Binnenvaart B.V.	Director, Electrical Marine Support.	Approx. 20 years' experience of inland waterways: electrical design, construction and building of inland vessels. and director EMS Binnenvaart B.V.	Full-time
U M Rommerts Rommert Ship Design B.V.	Ship Designer	Naval architect2001-2005 LR Plan Approval Surveyor. 2005-10 Manager technical design office-Rensen Shipbuilding.2011- Owner Rommerts Ship Design.	Full-time
S Kuijs Cryonorm Projects	Project/Process Engineer	HTS Mechanical Engineering. Engineering, design, construction, installation, commissioning and start-up of several cryogenic systems incl. Peters Yard and other LNG projects	Full-time
H Van Berkel Cryonorm Projects	Operations manager	Naval architect25 years business experience. 7 years exp.delivery and start-up of LNG systems.	Full-time

Notes

1: Did not attend at Node 2.

4.3 Study Methodology

The approach taken for the study was a 'Structured What If Technique' using guidance from the following sources on the requirements and best practice for conducting studies:

- BS ISO 31000: 2009, Risk Management – Principles and Guidelines
- BS ISO 31010: 2010, Risk Management – Risk Assessment Techniques

The two BS ISO Standards provide useful information on the overall techniques for hazard identification and risk assessment.

The HAZID technique adopted for this study is a checklist based approach used for identifying scenarios that may lead to releases of material or hazardous events. The technique involves the definition of discrete process sections, termed "Nodes", and the application of guidewords to these Nodes to identify deviations that may lead to a safety or operational problem (Scenario).

For each Node a checklist of possible hazards is used to identify possible scenarios. A study checklist, consisting of a list of HAZID guidewords, was developed prior to undertaking the HAZID, as shown below:

- Leakage
- Rupture
- Corrosion
- Impact
- Fire/Explosion
- Structural Integrity
- Mechanical failure
- Control/electrical failure
- Human error
- Manufacturing defects
- Material selection

These guidewords were based on previous experience and indicate the types of hazards that were thought to be applicable to the types of treatment systems being considered. The list is not exhaustive and the HAZID was not limited to these prompts.

For each item in the list of guidewords the team considered realistic scenarios that could lead to an accident and identified possible causes and outcomes from the accident. After evaluating the potential consequences of accident scenarios, measures that would be expected to be in place for prevention, control and mitigation were identified. If these were thought to be inadequate or insufficient information was available, items for further consideration were raised.

4.4 Risk Rating

Risks identified during the HAZID were rated in accordance with a risk matrix provided by Lloyd's Register as shown in Appendix 2.

It should be noted that the risk ranking is only based on the assessment of risk to personnel. Low severity consequences that could result in minor injury were excluded from the assessment. This approach helps to ensure that the study team only concentrated on significant risks, which is considered to be an appropriate approach for a HAZID at this stage of design.

4.5 Nodes

The gas system was split into the Nodes listed in Table for the study. Prior to considering each node a brief overview of the equipment and its operation was given. This ensured that the team were fully aware of the extent of the Node and its function.

The approximate time spent studying each Node is shown in the table. Times include breaks for refreshments but not the lunch breaks.

Table 3: Nodes

Node	Description	Study Details				
		Session	Date	Start Time	Finish Time	Duration (Minutes)
1.	LNG tank	1	01/10/2013	09:00	12:30	210
2.	LNG bunkering system	2	01/10/2013	15:30	17:00	90
3.	Hazardous areas	2	01/10/2013	13:30	15:00	90
4.	Fuel system from tank to GVU.	1	02/10/2013	09:00	12:30	210
5.	Engine room systems	2	02/10/2013	13:00	15:00	120
6.	External influences and control.	2	02/10/13	15.00	1700	120

5. Risk Assessment Results

Minutes of the HAZID discussions were recorded on a spreadsheet by the study Scribe and are shown in Appendix 1. During the meetings the minutes were projected onto a screen. This allowed team members to comment on the minutes.

For the major safety issues consequences that could have significant effects on people were rated in accordance with the risk matrix shown in Appendix 2. Scenarios that had no notable effects on personnel were not rated. This means that the ratings are only relevant to significant hazards related to the design

Overall HAZID Assumptions

The following overall assumptions were made for the HAZID :-

- Personnel involved with operation and maintenance of the LNG fuel system will be competent. It is therefore important that personnel have been trained in the use and maintenance of any new equipment.
- Safety systems will be designed to achieve an appropriate level of reliability. This includes any shutdown system or process alarm.
- Personnel will respond to alarms in sufficient time and will take appropriate action.
- Throughout the study it was assumed that any releases of LNG could find an ignition source and be ignited. The consequences of ignition could result in a number of outcomes, such as a pool fire, jet fire, or explosion. As the outcome will depend upon a number of factors such as release size, location, ventilation and duration before ignition it is not possible in a study of this nature to assess all possible outcomes. The overall assumption has been made that releases could result in a fire or explosion and the severity category of release has been based on the team's judgement.
- Rules, standards, codes and legislation for marine systems will apply where applicable. While a detailed review of applicable rules, standards, codes and legislation was not undertaken as part of the study it was recognised that these are relevant. Where relevant, reference was made to standards and codes during the meeting.

5.2 Main Safety Issues

The HAZID of the proposed LNG refit identified a number of possible scenarios that could harm personnel and these are detailed below. They concern structural failure of the inner/outer tank and release of LNG into the tank connection space. The likelihood of occurrence of these scenarios were considered remote, but fall into the medium risk category of the risk matrix by virtue of the consequences of the occurrence. These issues require further work and satisfactory resolution in order to reduce the risk to ALARP (as low as reasonably practicable).

The main issues identified related to:

- Location and arrangement of the LNG tank.

  The tank and tank connection space are of a design that requires free circulation of air around the tank in order to disperse any possible leakages. Although the space in which the tank is mounted has openings to atmosphere at a high level on all sides the air circulation is unlikely to be equivalent to that on open deck. A forced ventilation system capable of circulating 12 air changes an hour in the hold is fitted and this complies with the IEC standard for ventilation requirements equivalent to those in the open. It was considered that a CFD analysis of the ventilation should be carried out to demonstrate good air circulation around the tank and in particular around the tank connection space, effective dispersion of gas from the vacuum drop off disc at the top of the tank, and establish that leakages from within the tank connection space and cooling of the bottom of the hold resulting from a failure within the tank connection space or annular space can be tolerated.

- Leak assessment in annular space

  A leak assessment of the pipes within the annular space is required to demonstrate that the design can accommodate a single leak in the pipes within the annular space and that the ventilation system can disperse the released gas and maintain the tank hold temperature at a safe level.

- Leaks in the tank connection space

  The tank connection space is fitted underneath the tank and of the same SS304 material as the tank. It is naturally ventilated into the hold space. There is a drip tray at the bottom of the tank of capacity 1000l. Gas and temperature detectors are fitted within the connection space to shut the system down if leakage is detected. The estimated amount of LNG in the pipework in the connection space is less than 500L. Providing the tank root valves are closed then the drip tray is of sufficient size to contain any leakages from the pipework. As the system relies on the automatic valve (ESD valve) on the liquid line closing in case of gas leak an FMEA of the valve is required to be submitted for approval.

  In case of a leak in the tank connection space it will be necessary for personnel to go into the tank space and close the manual root valves. The root valves must be easily accessible without personnel having to enter into the tank connection space.

- Containers falling onto storage tank.

  The storage tank is installed underneath the aftermost row of containers. The scenario of a container falling onto the tank and rupturing the shell of the tank was discussed. The tank is protected by a framework with a 50mm grid pattern between the primary members. The framework will be designed to resist a 20ft container of max. 30 tonnes falling from the crane or falling back from the front stack from a 5m height at an angle of 45 deg. It would be assumed that the container falls on one primary member but falling between primary members must also be considered. A full engineering analysis is to be submitted to LR for approval.

- Vent stack 3m high

  Cargo venting arrangements for Inland Waterway vessels are normally at a relatively low level because of the requirement for minimum air draft for passing under bridges. There is no ADN requirement for venting LNG systems bur LNG vents should be led as high as possible to promote good dispersion of vented gas. The proposed design uses a 3m high vent stack on the port side of the vessel. Dispersion of LNG is aided by the continuous flow of ventilation air from the GVUs into the vent stack. The arrangements were considered equivalent to venting systems generally used on Inland Waterways vessels but a hazardous area will exist on the port side of the vessel which will extend to the dock if alongside and the effect of this must be recognised.

- Sizing of P/V valves

  The tank safety valves are to be sized for the maximum anticipated heat input under fire and fault conditions. The fault conditions are to include a runaway vapouriser and failure of the tank insulation.

- Collision protection

  For collision protection, according to ADN Rules for LPG and Type C & G tankers the tank must be located more than 1m from the ship side. The distance from the shear strake to the outer tank in the proposed design is 1.55m. and this was considered acceptable for the LNG tank. For grounding protection there is a 500mm double bottom underneath the tank space. The distance from the base line of the ship to the bottom of the tank is 1.6m.(to the bottom of the tank connection space 800mm. This is more than the clearance required in the draft I.G.F. code and was considered acceptable.

- Removal of LNG

  In case of failure of the LNG tank, arrangements for pumping the contents of the tank ashore are to be provided.

- Engine room bulkhead.

  The draft IGF code requires a cofferdam between the machinery space and a tank hold. The single bulkhead proposed for this vessel will be accepted provided the bulkhead is insulated to A60 standard and the tank is located more than 900mm from the engine room bulkhead.

5.2 Items for further consideration

Eleven items for further consideration or action were identified. The responses to these items along with details of potential failure scenarios and safeguards identified in the study will further improve the design from a safety risk perspective.

A synopsis is included at the end of the worksheets in Appendix 1.

No specific dates were set for completing these items and the items were assigned to companies rather than individuals. This approach was taken as all of the items should be considered immediately as part of the project schedule.

5.2 Conclusion

The current design requires improvements to gain LR approval and regulatory exemption to operate in inland waterways.

Provided the considerations recorded in this document are satisfactorily addressed, then alongside the normal rigors of classification and successful completion of the required studies summarised in Appendix 5, approval and exemption can be attained.

APPENDIX 1 HAZID WORKSHEETS AND SUMMARY OF ACTIONS

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
1. Rupture							
1.1. Rupture of inner tank.							
1.1.1.	High stress/fatigue	Release of LNG	Fire/explosion	Tank is designed to EN13458/2 and for ship motions/accelerations expected in IWW - 10deg roll, acceleration 2g horizontally & 1g vertically; Baffle plates will be fitted to prevent sloshing. EN13458 is an acceptable code under EU regulations. Inner and outer tank are 304L material.	Tank does not comply with IMO type C tank allowable stress levels. Plans will be submitted to LR for approval.	L1	C
1.1.2	Vessel collision/impact with jetty.	Release of LNG	Fire/explosion	According ADN Rules the tank must be located more than 1m from ship side, The distance from the shear strake to the outer tank is 1.55m. This complies with ADN requirements for LPG and type C & G tankers.	The IMO IGF code B/5 Rule is not applicable for IWW vessels. The draft IGF code also gives relaxation in respect of the compliance with B/5 for ships other than passenger ships.	L1/ L2	C
1.1.3.	Side/bottom impact.	Release of LNG	Fire explosion	A double bottom (DB) is located underneath the tank room. DB is 500mm deep, Distance from the bottom of the ship to the bottom of the gas tank is 1.6m Bottom of the ship to bottom of the cold box is 800mm.	Bottom clearance is more than B/15 (760mm) as required by IGF code.	L2	B
1.1.4	Vessel movement.	Release of LNG	Fire explosion	Tank is designed for 10deg roll, and to	Tank is designed for more than		

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
				2g horizontally & 1g vertically.	the expected vessel movements.		
1.1.5	Falling containers/dropped objects.	Damage to outer tank causes loss of vacuum. Damage to inner tank causes tank rupture.	Excessive pressure build up due to high heat transfer. Possible fire/explosion.	Tank is protected by framework with 50mm grid pattern. Framework is design to resist 20ft container falling from 5m height at 45 deg angle from the crane. Container weight max 30 tonnes falling from the crane or falling back from the front stack. Assume container falls on 1 primary member. Falling between members also to be considered.	The beam is strong enough to take up the load from the falling container. Calculations will be submitted to LR demonstrating that the container falling (in both cases) will not hit the gas tank.	L4	B
1.2 Rupture of outer tank.							
1.2.1.	Dropped objects	Damage to outer tank causes loss of vacuum.	Excessive pressure build up due to high heat transfer.	Protective framework.	See comment 1.1.5.	L3	A
1.2.2.	Side/bottom impact from jetty.	Damage to outer tank causes loss of vacuum.	Excessive pressure build up due to high heat transfer.	Safety valves are sized to relieve the maxim pressure build up.	See comment 1.1.5/1.1.3.		
.							
1.3 Rupture of connecting pipes in annular space.							

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
1.3.1.	Fretting/fatigue	Leakage of LNG into annular space	Pressure build up in annular space. Loss of insulation. Cryogenic temperatures on outer tank wall.	Vacuum drop disc will vent the annular space to atmosphere. Safety valves are sized for the increased boil off. Connecting pipes are all welded 304L SS material. Pressure relief valve by-pass can be opened to relieve tank pressure.	See comment 1.1.1. Tank is designed in accordance with EU statutory standards. Provision for unloading tank contents to shore is required.	L1	A
2. Leakage							
2.1 Leakage from inner tank							
2.1.1.	High stress fatigue	Leakage of LNG into annular space.	Pressure build up in annular space. Loss of insulation. Cryogenic temperatures on outer tank wall.	The tank is located in a space open to atmosphere. Vented gas will discharge direct to atmosphere. The tank space is also vented with 12 air changes an hour, which allows it to be considered as an open space for hazardous areas considerations. A cold break is provided before the tank connection to the ship's structure to prevent overcooling of ship structure. Saddle supports will also be low temp steels. Can use the fire fighting system of the vessel when there is a leakage of gas.	The vacuum disc will open and LNG/methane will fill the outer tank. Depending on leak size and vacuum disc area the outer tank may become pressurised. A leak assessment on the pipes inside the annular space is required to demonstrate the ability of the design to accommodate leakage. The tank hold temp. will be maintained by ventilation and circulation of air in the tank space. Calculations demonstrating acceptable heat	L1	A

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
					removal are to be submitted.		
2.2. Leakage into outer tank							
2.2.1.	Worn drop off disc/outer tank failure.	Loss of insulation	High heat ingress/low temperature in hold.	Safety valves to be sized for maximum heat ingress. Ventilation to be designed to maintain hold space temperature above the transition temperature.			
2.3. Leakage from connecting pipes							
2.3.1.	High stress fatigue	Leakage of LNG into annular space	Pressure build up in annular space. Loss of insulation. Cryogenic temperatures on outer tank wall.		See comment 2.1.1		
3. Corrosion/erosion							
3.1 Corrosion of inner tank							
3.1.1.				Inner and outer tanks and pipework are 304L stainless steel. No corrosion is expected provided vacuum is maintained in annular space.			
3.2 Corrosion of				See comment above			

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
outer tank							
3.3. Corrosion of tank connecting space.				See comment 3.1 .			
3.3.1.				Tank connecting space structure will be of 304 stainless steel.			
4. Impact							
4.1 Impact from external objects					See comment 1.1.5.		
5. Fire/explosion							
5.1 Fire in tank space							
5.1.1.	Leakage of LNG in tank connection space	Ignition of flammable vapour in tank connection space.	Fire explosion	Tank connection space is provided with gas detector. LNG system will shut down on gas or fire detection. Ventilation system evacuates any gas. Containers (non ADN & non refrig) are present on the top of the tank space (open space).		L2	A

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
				The tank has a drencher system to cool the tank.			
5.2 Fire in machinery space.							
5.2.1.	Oil fire.	Heat dissipates to the tank space.	Vapour in tank space may ignite.	Drencher system protects the tank. The safety valve will be sized for the fire condition.	IGF code requires a cofferdam between the machinery space and a tank hold. A single steel bulkhead is proposed between the machinery space and tank space. Provided the bulkhead is insulated to A60 standard and the tank is located more than 900mm from the bulkhead then the double wall of the tank can be accepted as a cofferdam and the arrangements are considered equivalent.		
5.3 Fire on deck.							
5.3.1.	Container fire	Fire spread	Fire affects LNG storage tank	Drencher system protects the tank. The safety valve will be sized for the fire condition.			
5.4 Fire on jetty/barges				Drencher system protects the tank.	Move the ship.		
6. Structural							

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
integrity							
6.1							
6.1.1.	Tank damage				See comment 1.1 and 1.2 above re. damage to tank.		
7.Mechanical failure							
7.1.							
7.1.1.	Damage to structure of tank				See comment 1.1 and 1.2 above re. damage to tank.		
8. Control electrical failure							
8.1 Control system failure							
8.1.1.				Two 24V independent power supplies are being provided. System will be shut down and engines will change over to diesel.			
8.2 Level alarm failure							
8.2.1.	Over pressurisation			Two level indicators are being fitted. A tri cock is fitted for a initial setup and calibration.			
8.3 Pressure alarm failure							
8.3.1.	Mechanical/control failure	Overpressure	Tank failure	PV valves are designed for full fire scenario.	Bypass valve (which is normally closed) is provided to		

System: LNG storage tank	Drawing: Various	HAZID sheet 1
Area: Node 1	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : LNG storage tank.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS/ COMMENT	FI	SI
				4 PV valves are being provided of which 2 work at one time (fully redundant). Filling limit of the tank 95%. Checked via Level Transmitter.	cool down the tank or when there is some problem with the tank. Vessel heel considered to be not more than 5deg.		
9. Human error							
9.1							
9.1.1.	Incorrect operation	Faulty operation		Crew will be trained for LNG opoerations. Incorrect operation will be detected by the automation. The system is fully automatic and designed to shut down in case of fault.			
10 Manufacturing defects							
10.1 Fault in tank manufacture.							
10.1.1.	Human error	Tank fails.	Release of LNG	Tank has a secondary barrier to contain leakage. (See comments 1.1 and 2.1 above.	Arrangements for emergency discharge of LNG are provided.		

System: Bunkering system.	Drawing: Various	HAZID sheet 2
Area: Node 2	Revision: 0	Operating Mode: Alongside.
Equipment/Systems : Bunkering system		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
1. Rupture							
1.1. Rupture of bunker pipework							
1.1.1	Supply hose failure.	Leak of LNG on dock	Fire/explosion on dock.		The supply hose will be the responsibility of the bunker supplier. It should be rated for the maximum pump discharge pressure.		
1.1.2.	Overpressure of bunker pipework.	Leak of LNG	Fire explosion	Pipes are designed to PN25 (bunkering line) and the rest is PN16.	The supply pressure must be less than 25 barg and this should be written down in the bunkering procedure.		
1.1.3	Quick release coupling fails	Release of LNG	Fire/explosion.		Bunkering should be a manned operation. The bunker connection should be visible at all times during bunkering.		
1.1.4.	Expansion/contraction causes pipe fatigue.	Release of LNG	Fire/explosion	Bunker line is designed with due regard to flexibility when cooling down.	No flexible hoses are used in bunker line.		
1.2 Tank rupture due to high pressure							
1.2.1.	Overfilling.of tank	Tank fails due to overpressure	Fire/explosion	High level alarm gives warning. Separate high high level alarm shuts down the bunkering line in case of over filling. High pressure alarm will cause shut			

System: Bunkering system.	Drawing: Various	HAZID sheet 2
Area: Node 2	Revision: 0	Operating Mode: Alongside.
Equipment/Systems : Bunkering system		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
				down of bunker valve.			
1.2.2.	Failure of pressure relief	Tank fails due to overpressure	Fire/explosion	Tank relief valves are duplicated.			
2. Leakage							
2.1 Leakage from bunker connection							
2.1.1.	Leakage from coupling due to cooldown	Release of LNG	Fire/explosion	SS drip tray are provided on the side of the ship that drain overboard. overboard.	A small amount of leakage during cooldown is expected. Coupling may need to be retightened. Fire and explosion risk is minimal.		
2.1.2 Leakage from bunker pipe.	Expansion/contractio n causes pipe fatigue,	Leak of LNG	Fire explosion.	Bunker pipes are butt welded w/o any flanges. Pipes will be purged with nitrogen to the first valve from the bunker connection flange.(1.5 ms from the ship side). Gas trap will be on the one side of the bunker cross over pipe.			
3. Corrosion /erosion							
3.1 Corrosion of bunker line							

System: Bunkering system.	Drawing: Various	HAZID sheet 2
Area: Node 2	Revision: 0	Operating Mode: Alongside.
Equipment/Systems : Bunkering system		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
3.1.1.				The bunker pipework will be single walled 304 SS. This int susceptible to corrosion.			
5.Mechanical failure							
.							
5.1Quick release coupling							
5.1.1.	Coupling seals fail	Release of LNG	Fire/explosion	Spill tray is provided to protect ship side. LNG will vaporise and disperse.			
5.1.2.	Breakaway coupling fails	Release of LNG	Fire explosion.	Bunkering is a manned operation. If coupling is ruptured due to movement of vessel then bunker supplier will stop the supply pump.			
6. Control /electrical failure							
6.1 Control system failure					Two power supplies provided.		
6.1.1.	Blackout during bunkering - Loss of alarms and safety functions.	Release of LNG	Fire explosion	Two 24V power supplies provided for the control system.			
7. Human error	Faulty operation	Release of LNG/overpressure	Fire/explosion.	Bunkering is automatic and will stop on high level and pressure.	Needs to follow the written down procedure and it's a manned procedure. Automatic shut dwn of the tank inlet valve on high pressure.		

System: Bunkering system.	Drawing: Various	HAZID sheet 2
Area: Node 2	Revision: 0	Operating Mode: Alongside.
Equipment/Systems : Bunkering system		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
7.1. Incorrect operation							
7.1.1.	System not purged.	LNG remains in bunker lines after bunkering	Overpressure in bunker lines after bunkering has finished.	Relief valves are fitted to relieve the pressure build up.			

System: LNG systems	Drawing: Various	HAZID sheet 3
Area: Node 3	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Ventilation and Hazardous areas.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
1. Leakage							
1.1 Leakage from inner tank							
1.1.1.	Failure of inner tank	Leakage of LNG. Reduction in insulation – heat ingress-excessive boil-off.	Leakage of LNG into tank hold. Lifting of safety valves. Decrease in outer tank and hold temperature.	Initial leakage will be through the drop disk of the outer tank into the tank hold. Gas detection in the tank hold. LNG system will shut down. Forced ventilation of tank space will evacuate the gas to atmosphere. All equipment in tank space is Ex rated. All local containers are ADN and non refrig.	Tank leakage is readily obvious -can be seen from outside what has happened inside the tank space. Arangements to discharge the tank to shore or overboard to be provided.		
1.2 Leaks from safety valve							
1.2.1.	Feathering due to wear.	Small leakage of methane gas	Methane gas leakage from vent stack. A hazardous area exists around the vent stack.	Gas is vented to vent stack on port side. Vent stack is 3m high and has continuous flow of ventilation air from GVUs to help disperse the gas. There is no ADN requirement for methane venting.	SB side of the vessel in this respect is a safe area. A 10ms hazardous area exists around the vent stack outlet. This hazardous area will extend to an adjacent vessel or onto the dock.		
1.2.2.	Relief valve opens on high pressure.	Large leakage of methane gas.	Large volumes of methane gas released from vent stack.	As per 1.2.1.above except larger volumes of methane released. Gas being released will have a higher exit speed and will be dispersed more easily.			
1.3							

System: LNG systems	Drawing: Various	HAZID sheet 3
Area: Node 3	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Ventilation and Hazardous areas.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
Leakage from connecting pipes in annular space							
1.3.1.	Failure of pipes in annular inner tank	Leakage of LNG. Reduction in insulation – heat ingress-excessive boil-off.	Leakage of LNG into tank hold. Loss of insulation and lifting of safety valves. Decrease in outer tank and hold temperature.	Initial leakage will be through the drop disk of the outer tank into the tank hold. Gas detection in the tank hold. LNG system will shut down. Forced ventilation of tank space will evacuate the gas to atmosphere. All equipment in tank space is Ex rated. All local containers are ADN and non refrigerated.	Tank leakage is readily obvious -can be seen from outside what has happened inside the tank space. Arangements to discharge the tank to shore or overboard to be provided.		
1.4 Leakage into outer tank.							
1.4.1.	Air enters outer tank	Loss of insulation.	Increased boil off.	P/V valves to be sized for maximum boil off in case of insulation failure.	See comment 1.3.1. above.		
1.5 Leaks in tank connection space.							
1.5.1.	Failure of pipes or components in tank connection space	Leakage of LNG or methane.	Fire/explosion	Tank connection space is naturally ventilated into the hold space. Hold space is open to atmosphere and permanently ventilated by 12 air changes/hr. Hazardous area of 3m around the	The manual root valves are to be located close to the tank connection space access. An FMEA is required for the LNG shut off valve.		

System: LNG systems	Drawing: Various	HAZID sheet 3
Area: Node 3	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Ventilation and Hazardous areas.		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
				ventilation outlet. No inlet to accommodation, no source of ignition, no hot surfaces. All gas connections from tank have manual root valves. The LNG connection has a remotely operated shut off valve to isolate the tank.			
1.6 Leaks in GVU room.							
1.6.1.	Leaks in GVU.	Release of LNG	Fire/explosion	Air is drawn in from aft of the accommodation. It then passes though the outer wall of the double wall m/c space piping to the GVU located in the hold space. It is then vented through the exhaust fan (only one) via the vent stack. If the fan fails the systems stops working.	The air inlet for double wall ventilation is to be 1.5 m from the air inlet to the engine room/accommodation.		
1.7 Leaks in engine room				No possibility of leakage since the all the piping is double walled and the annulus space is ventilated.			
1.7.1.	Leaking gas pipe.	Release of LNG	Fire explosion	All gas pipes in the machinery space are double walled. Any leak will be detected and ventilated to the vent stack.			

System: Pressure build up and gas distribution.	Drawing: Various	HAZID sheet 4
Area: Node 4	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Tank connection space and GVU		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
1. Rupture							
1.1. Rupture of pipework in connection space.							
1.1.1.	Stress/fatigue	Leakage of LNG/methane	Fire/explosion	Gas and temperature detectors are fitted. System will shut down. Automatic shut off valve is fitted on the liquid lines. Gas lines have manually controlled root valves. On gas detection automatic shut off valves will close, and system will shutdown. It is necessary to open the tank connection space to close the gas root valves. Root valves are accessible without entering the cold box. Cold box access arrangements are not yet defined. A drip tray is fitted on bottom of tank connection space, minimum drip tray capacity 1000L. The drip tray is part of the structure of the cold box.	Easy access to manual root valves required. The probability of a rupture in the cold box is considered low. No flexible hoses or expansion pieces are fitted. A leak will be detected prior to the rupture. Estimated amount of LNG released after tank valves close: <500L. Content of drip tray from a small leak will evaporate. Root valve to be as closed to where the pipe exits the tank. The piping in the cold box is stainless steel 316L all welded		
1.1.2.	Side/bottom impact from jetty.	Release of LNG	Fire/explosion	Bottom of cold box is located 800mm above base line (B/15 is 760mm)			
1.1.3.	Vessel collision				See comments on Node 1.(1.1.2.)		
1.2 Rupture of pipe in GVU.							
1.2.1.	Side/bottom impact damage.	Release of gas	Fire/explosion	GVU has low pressure and limited volume of gas. Gas leak will be detected			

System: Pressure build up and gas distribution.	Drawing: Various	HAZID sheet 4
Area: Node 4	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Tank connection space and GVU		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
				and system shuts down.			
2. Leakage							
2.1 Leakage into tank connection space.							
2.1.1.	Pipe failure	Release of gas	Fire/explosion	-gas detection will be activated -soap testing for leakage. -small leakage can be rectified by trained crew -crew will be trained in procedures for maintenance for LNG.	See comments re. Node 2.		
2.2 In line leakage through valves							
2.2.1.	Valve seal worn	Cannot shut of LNG.	System cannot be shut down.	The valves have a facility for checking the sealing of the main valves. Sections of pipe work are pressurised to check for leaks.	FMEA for main LNG shut off valves to be submitted.	L4	A
2.3. Internal leakage through heat exchangers.							
2.3.1.	Corrosion/fatigue	LNG enters ship system.	Fire/explosion	leakage in the heat exchanger will be from LNG site to glycol because of pressure difference.. Leakage will be detected by rising / under pressure in glycol system. The system will shut down on high / low pressure.			

System: Pressure build up and gas distribution.	Drawing: Various	HAZID sheet 4
Area: Node 4	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Tank connection space and GVU		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
3. Corrosion/erosion							
3.1 Corrosion							
3.1.1.	Corrosion of heat exchangers	LNG leaks.	Leak of LNG into ship systems.	heat exchanger is all 316L stainless steel. No corrosion is expected.	See 2.3.1. above		
4. Fire				-			
4.1 Fire in tank connection space.							
4.1.1.	LNG leak	Fire/explosion	Components may be damaged.	A fire in the space is considered unlikely. There is no source of ignition. A fire will be detected and the system will shut down. The source of flammable material will be stopped and the fire will extinguish. -All cryogenically valves in the cold box are fire tested. -personal protection			
5. Control/ electrical failure							
5.1 Control system failure							
5.1.1.	Blackout	Loss of control of system	Immediate change over to fuel oil.	All valves close if air/24V fails. Gas supply to engines stops on failing	The master valve delivering gas to the GVUs and engines shuts		

System: Pressure build up and gas distribution.	Drawing: Various	HAZID sheet 4
Area: Node 4	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Tank connection space and GVU		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
				air/24V Solenoid's are located in engine room. If pressure build-up valve fails open PV valves are sized to take the max evaporation rate. Valve 5150NG is a slam shut valve and acts as master control valve. This valve shuts on pre determent fault conditions.	on predetermined fault conditions. The master gas valve is not at the engine room bulkhead but at the inlet to the GVU. This was considered acceptable.		
6. Human error							
6.1							
6.1.1.	Source of ignition in hazardous areas		Fire/explosion	Use of non sparking devices within the zone. Personnel will be trained in ADN procedures.			
7. Manufacturing defects							
7.1					See previous comments		
8. Material selection				Only use materials suitable for LNG / gas			

System: Engine room systems.	Drawing: Various	HAZID sheet 5
Area: Node 5	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Dual fuel/Main engines		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
Main engines							
1. Rupture							
1.1. Rupture of pipework							
1.1.1	Vibration/fatigue	Leak of LNG	Fire/explosion	All gas pipework in the machinery is double walled. The outer wall is ventilated with air. Any leakage will be detected and the gas to the engine will be shut off. The engine will continue to run on oil fuel.The other dual fuel engine will continue to run. The Wartsila 6L20DF is LR Type Approved.	The pressure in the inner pipe while the engine is running is around 6bar.		
2. Leakage							
2.1 Leakage from inner pipe							
2.1.1.	Vibration/fatigue	Leak of LNG	Fire/explosion	See comment 1.1.1. above	See comment 1.1.1. above		
2.2. Leakage in gas gas admission valve.							
2.2.1.	Damaged/worn valve	Gas leaks into engine manifold	Engine maloperation.	Engine management will detect worn valve. Engine changes over to oil fuel.			

System: Engine room systems.	Drawing: Various	HAZID sheet 5
Area: Node 5	Revision: 0	Operating Mode: Normal continuous.
Equipment/Systems : Dual fuel/Main engines		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
3. Control electrical failure							
3.1 Control system failure							
3.1.1.	Blackout/loss of power	Loss of engine control system.	Engine maloperation.	Engine control system is LR type Approved. Control system failure will cause the engine to change to oil fuel and continue running.			

System: External influences	Drawing: Various	HAZID sheet 6
Area: Node 6	Revision: 0	Operating Mode: Normal continuous/docking.
Equipment/Systems : External influences		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
1.Fire							
1.1. ER fire.					See Node1. 5.2.1.		
1.2 Fire in tank connection space.					See Node4.4.1.1.		
1.3 Fire in tank space/ deck					See Node1.5.3.1.		
1.4 Fire on berth					See Node1. 5.4.1.		
2. Flooding							
2.1 Tank room flooding				Tank structure will be welded to hull.	No flooding/anti flotation calculations are required.		
3. Alongside /maintenance				Annual periodical maintenance scheme will be implemented. Safety valves will be checked by using stand-by valves.	Ventilation outlet of tank space is on PS of the vessel. This will cause a hazardous area on the dock side when vessel is berth on PS.		
4. Commisioning and trials					A full commissioning procedure will be developed and submitted to LR for approval.		
5. Blackout					See comments on individual nodes.		

System: External influences	Drawing: Various	HAZID sheet 6
Area: Node 6	Revision: 0	Operating Mode: Normal continuous/docking.
Equipment/Systems : External influences		

ITEM	CAUSE	HAZARD	POTENTIAL EFFECTS	SAFEGUARDS	RECOMMENDATIOS	FI	SI
6.Deadship				For docking periods in order to empty or fill the LNG tank after discharging, purging with nitrogen is required. An external battery charger is required to start up after dead ship period.	A written procedure for gas freeing the tank prior to docking and for refilling the tank after docking is required		

Eiger-Nordwand: HAZID Dual Fuel Propulsion

Summary of Actions /Recommendations

No.	Worksheet ref.	Remarks/considerations	Responsibility
1.	Node1/ 1.1.1.	Tank plans to be submitted to LR for approval.	Cryonorm
2.	Node1/1.1.5.	Container falling calculations to be submitted	Shipyard
3.	Node1/1.2.2.	Calculations of sizing of safety valves for fire/worst case single failure scenario to be submitted.	Cryonorm
4.	Node1/2.1.1	A leak assessment on the pipes inside annular space is to be submitted to LR for approval.	Cryonorm
5.	Node1/2.1.1.	A CFD analysis demonstrating satisfactory air circulation for conditions in report to be submitted for approval.	Shipyard
6.	Node1/5.2.1.	A single steel engine room bulkhead with A60 insulation will be accepted. Details to be approved by LR.	Shipyard
7.	Node2/1.1.2.	A bunkering procedure is to be written and submitted for approval.	Cryonorm
8.	Node3/1.5.1.	An FMEA is required for the LNG liquid line tank isolation valve.	Cryonorm
9.	Node3/1.5.1.	The manual root valves are to be located close to the tank connection space access door.	Cryonorm
10.	Node3/1.6.1.	The air inlet for double wall ventilation is to be 1.5m from e/r air inlet	Shipyard
11.	Node6/5.	A written procedure for gas freeing the tank and refilling after docking is required.	Cryonorm

APPENDIX 2 RISK RATINGS

Eiger-Nordwand: HAZID Dual Fuel Propulsion

Severity

Severity	Description	Likelihood				
		L1	L2	L3	L4	L5
C	Multiple fatalities					
B	Single fatality or multiple major injuries					
A	Major injury					

Likelihood

Code	Description	Chance Per Year	Chance Per Vessel Lifetime
L1	Remote	<10E-6	> 1 in 40,000
L2	Extremely Unlikely	10E-6 to 10E-5	1 in 40,000 to 1 in 4,000
L3	Very Unlikely	10E-5 to 10E-4	1 in 4,000 to 1 in 400
L4	Unlikely	10E-4 to 10E-3	1 in 400 to 1 in 40
L5	Likely	10E-3 to 10E-2	1 in 40 to 1 in 4

Risk Ranking

Code	Description
	Low
	Medium
	High

APPENDIX 3 TERMS OF REFERENCE

Eiger-Nordwand: HAZID Dual Fuel Propulsion

Terms of Reference (ToR) for a Hazard Identification Study (HAZID)
of the proposed LNG fuel refit for the Inland Waterways Push Combination vessel 'Eiger-Nordwand'

Introduction

Lloyd's Register has been contracted to carry out a Hazard Identification Exercise (HAZID) on an Inland Waterways Push combination vessel with dual fuel (diesel oil or LNG) engines. The use of LNG as a fuel for Inland Waterways Vessels is relatively new and novel for this type of boat.

Lloyd's Register has Rules for Methane Gas (LNG) fuelled ships. These Rules require a HAZID to be carried out on the LNG arrangements. The object of this HAZID is to ensure that all hazards associated with LNG and methane gas and in particular those relevant to inland waterways vessels are considered and that an acceptable level of safety is achieved.

The HAZID report will form part of the approval documentation required for Classification of the vessel by Lloyd's Register and acceptance of the vessel by the National Authorities for use on Inland Waterways.

The HAZID will take the form of a round the table discussion by all stakeholders involved in the project. The discussions will be led by a project facilitator using guidewords as detailed below.

Project team

Project facilitator from Lloyd's Register.
Representatives from :-
Lloyds Register.
Ship owner/operator.
Shipyard.
Subcontractors.

A full list of attendees will be included in the HAZID report.

Applicable codes and standards

LR Rules for Inland Waterways vessels
LR Rules and Regulations for Ships
LR Rules for Methane Gas Fuelled Ships
IEC 60092: Electrical installations in Ships
IEC 60079-1: Electrical apparatus for explosive atmospheres
IMO MSC86(26) Interim Guidelines for gas fuelled ships
IMO MSC Circ 285.
Draft IGF code as applicable.
ADN 2013.
Rhine Vessels Inspection Regulations (RVIR).

Novel or alternative design

The novel design features for this vessel are concerned solely with the LNG storage, processing and distribution systems. The propulsion engines are duel fuel. If the LNG system fails, propulsion and steering can be maintained by switching over to diesel fuel. Similar dual fuel engines to those proposed for the Eiger-Nordwand have been approved by Lloyd's Register and installed in various other ships. The engines are not considered novel and will not form part of this study.

Risk management

The HAZID is scheduled for 2 days and will address the following :-

a) The safety of the shipboard LNG machinery and systems.
b) The safety of shipboard personnel

c) The reliability of essential machinery and systems.
d) The environment.

The procedure will consider the hazards associated with installation, operation, maintenance and disposal, both with the machinery system functioning correctly and following any reasonably foreseeable failure. A single failure of any piece of equipment will be considered.

Procedure for the HAZID

The approach taken for the study is based on LR's experience of this type of study and guidance from the following sources on the requirements and best practise for conducting studies:

- HAZOP Guide to Best Practise, 2nd Edition I.Chem.E (2008)
- BS ISO 3100: 2009, Risk Management – Principles and Guidance
- BS ISO 31010:2010, Risk Management – Risk Assessment Techniques

The technique adopted for the HAZID involves the definition of discrete process sections termed 'Nodes'. These nodes are considered in turn to identify deviations from the prescriptive requirements and conventional arrangements.

Before the HAZID it is necessary to establish the specific areas and systems that are considered outside the scope of existing Rules, non-compliant with existing Rules or that are required to be addressed by stakeholders. An initial assessment of the plans indicates that these areas are:

a) Tank design and arrangement.
b) Pressure build up and evaporator systems.
c) Bunkering arrangements.
d) Tank venting and ventilation of hazardous areas.
e) Gas valve unit arrangement.
f) Engine room gas related systems.

The following operating modes and ship conditions will be considered:

a) Underway
b) Docking
c) Alongside and maintenance
d) Commissioning and trials.

For the purpose of analysis the systems will be divided into the following Nodes :

Node 1. Storage tank and bunkering arrangement.
Node 2. Ventilation and hazardous areas.
Node 3 Pressure build up and gas distribution systems.
Node 4 Engine room systems
Node 5 External influences e.g. Fire/flooding

Ship conditions :

a) Normal operation
b) Blackout
c) Deadship
d) Fire in a single compartment
e) Flooding in a single compartment

Modes of operation :

a) Start-up
b) Running
c) Shutdown
d) Automatic

e) Reversionary
f) Emergency

To structure the discussions the following guidewords will be applied :

Leakage
Rupture
Corrosion/erosion
Impact
Fire explosion
Structural integrity
Mechanical failure
Control/electrical failure
Human error
Manufacturing defects
Material selection.

The guidewords will be applied in a systematic manner to the relevant plans and all comments, mitigating measures e.t.c. will be recorded in accordance with the following preliminary schedule.

Day 1 :

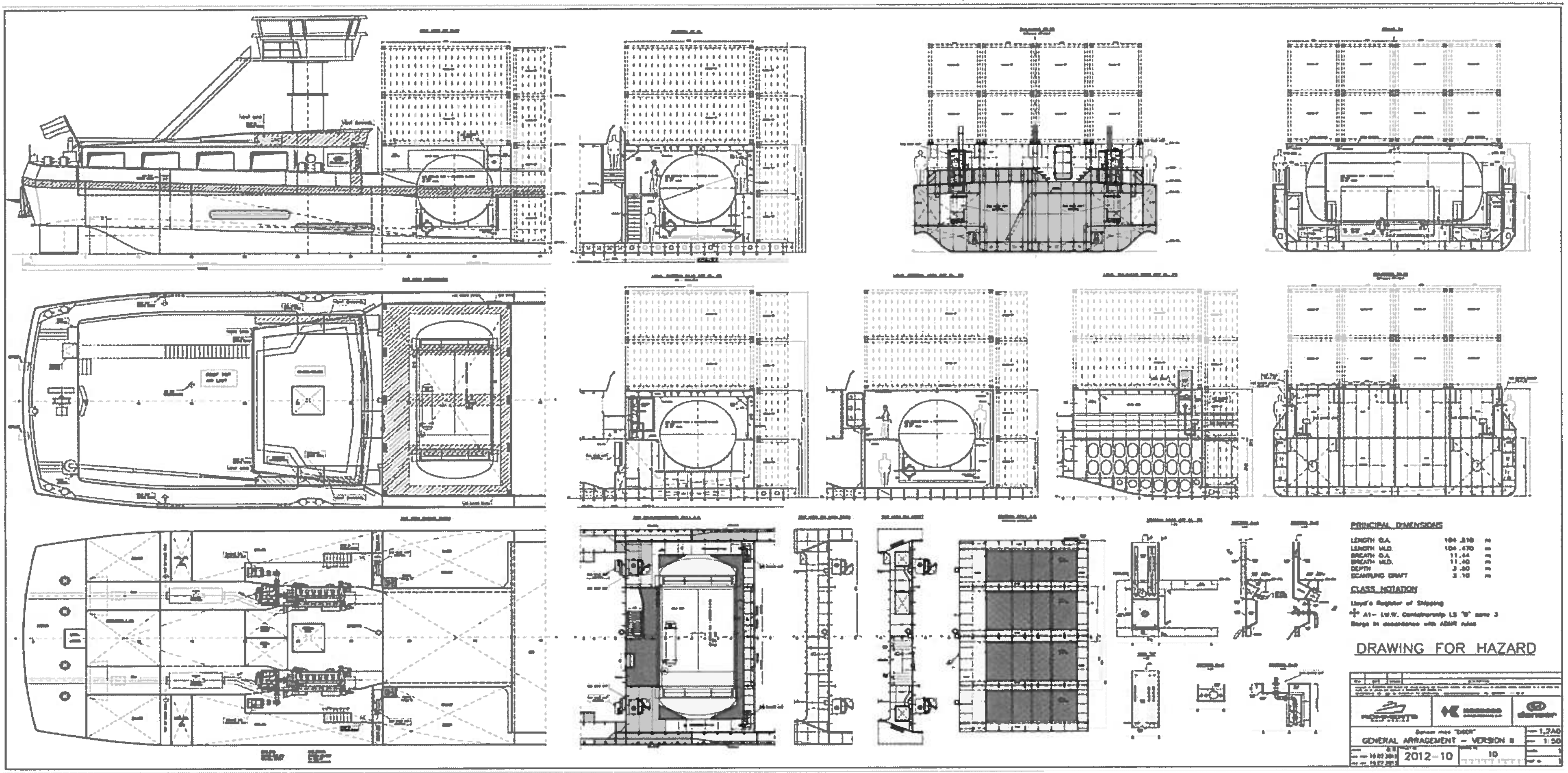
Node 1.
Node 2.

Day2 :

Node 3.
Node 4.
Node 5.

This schedule may need to be amended during the session depending on comments and issues raised.

APPENDIX 4 GENERAL ARRANGEMENT EIGER-NORDWAND


PRINCIPAL DIMENSIONS
CLASS NOTATION
DRAWING FOR HAZARD
GENERAL ARRANGEMENT – VERSION 8
2012-10
10
1:50

APPENDIX 5 RISK BASED STUDIES REQUIRED FOR LR APPROVAL

Risk Based Studies Required for LR Approval

Study Name	Requirements
System Safety Risk Assessment (HAZID)	3.2.1 A system safety risk assessment is to be undertaken. The objectives of the assessment are to: (a) evaluate safety risks associated with the use of gas that are application specific, such as the specific location of tanks, machinery, equipment and accommodation; (b) evaluate safety risks associated with the use of gas where it is proposed to deviate from the requirements of these Rules; and (c) demonstrate that an appropriate level of safety is achieved that is commensurate with conventional oil-fuelled propulsion and auxiliary machinery. 3.2.2 Where the risks cannot be eliminated, an inherently safer design shall be sought in preference to operational/procedural controls. This shall focus on engineered prevention of failure (e.g., a minimised number of connections, increased reliability, and redundancy). Where this cannot be achieved or is insufficient, protection of occupants should focus on: (a) firstly, passive means (e.g., physical barriers, separation, absence of ignition sources); (b) secondly, active means (e.g., detection, isolation, ventilation and extinguishment). Both passive and active means may be required to demonstrate an appropriate level of safety. 3.2.3 The assessment may identify the need for additional safety measures in addition to those specifically stated in these Rules (e.g., a Failure Modes and Effects Analysis of the Tank Master Isolation Valve). 3.2.4 As a minimum, the scope of the assessment is to consider: (a) normal operation, start-up, normal shutdown, non-use, and emergency shutdown of the system; (b) physical tank, machinery and equipment layout, arrangements and location; (c) foreseeable mechanical failures, electrical failures and human errors. 3.2.5 The assessment is to be undertaken to a recognised standard (e.g., ISO 31010, Risk management – Risk assessment techniques) and in accordance with LR's ShipRight procedure Assessment of Risk Based Designs and associated annexes.
System Dependability Assessment	3.3.1 A system dependability assessment is to be undertaken. The objectives of the assessment are to: (a) demonstrate the dependability of the system during all normal and reasonably foreseeable abnormal conditions where essential services are reliant upon the system for their intended operation; and (b) demonstrate that an appropriate level of dependability is achieved that is commensurate with conventional oil-fuelled machinery. 3.3.2 Essential services include but are not limited to propulsion and electrical power. 3.3.3 As a minimum, the scope of the assessment is to consider: (a) the redundancy of fuel storage and supply; and (b) the reliability and availability of machinery, equipment and components to maintain essential services. 3.3.4 The assessment is to be undertaken to a recognised standard (e.g., IEC 60300-3-1, Dependability management Part 3-1: Application guide – Analysis techniques for dependability – Guide on methodology).
Failure Modes and Effects Analysis (FMEA) of the tank master isolation valve	3.4.1 An FMEA is to be undertaken on the tank master isolation valve. The objectives of the analysis are to identify: • potential failures; • consequences of failure; • means to eliminate or prevent failure; and • means to eliminate or minimise consequences. 3.4.2 The analysis may identify the requirement for safety measures in addition to those specifically stated in these Rules. 3.4.3 As a minimum, the scope of the analysis is to consider the 'fail safe' condition, location and arrangement of the valve. 3.4.4 The analysis is to be undertaken to a recognised standard (e.g., as outlined in ISO 31010, Risk management - Risk assessment techniques).
Hazardous Areas Classification Study	3.5.1 A hazardous areas classification study is to be undertaken. The objective of the study is to identify areas or spaces in which a flammable/explosive atmosphere is present or may be expected to be present, such that potential sources of ignition can be eliminated or controlled, and access to such areas restricted. 3.5.2 The scope of the study is to consider all machinery and equipment which could represent a source of release of flammable/explosive gas in: (a) normal operation, start-up, normal shutdown, non-use, and emergency shutdown of the fuel-gas system; (b) equipment intended for recovery from unintended releases of gas (e.g., venting systems). 3.5.3 The study is to be undertaken to a recognised standard, for example: (a) to identify and categorise areas in which a hazardous atmosphere is present or may occur -

Study Name	Requirements
	International Standard IEC 60079-10-1, Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres; (b) to identify mechanical equipment appropriate for use in a hazardous area – International Standard EN 13463-1, Non-electrical equipment for use in potentially explosive atmospheres. 3.5.4 To facilitate the selection of appropriate electrical apparatus, mechanical equipment and the design of electrical and mechanical installations, hazardous areas are to be identified and divided into Zones 0, 1 and 2.
System Hazard & Operability Study (HAZOP)	3.6.1 A HAZOP study is to be undertaken. The objectives of the study are to: (a) identify potential deviations from the intended operation of the fuel-gas system; (b) identify the causes of each deviation, and the consequences for safety (see 3.2 and 3.4) and dependability (see 3.3); (c) list safeguards to minimise causes and consequences; and (d) determine and recommend if further safeguards should be considered. 3.6.2 Using a detailed piping and instrumentation diagram (P&ID) and supporting information and plans, the scope of the study is to consider normal operation, start-up, normal shutdown, non-use, and emergency shutdown of the fuel-gas system. 3.6.3 The study is to be undertaken to a recognised standard (e.g., ISO 31010, Risk management – Risk assessment techniques) in accordance with LR's ShipRight procedure Assessment of Risk Based Designs and the associated annexes.
Bunkering Safety Study	3.7.1 A bunkering safety study is to be undertaken. The objectives of the study are to review the bunkering equipment and arrangements, so as to: (a) identify causes and safety consequences of potential gas releases during connection, preparation and disconnection of bunkering equipment, and during transfer of gas; (b) list safeguards to minimise causes and consequences; and (c) determine and recommend if further safeguards or procedural changes should be considered. *3.7.2* The study is to be undertaken to a recognised standard (e.g., ISO 31010, *Risk management – Risk assessment techniques*) in accordance with LR's ShipRight procedure *Assessment of Risk Based Design*' and the associated annexes.
The above numbering refers to: Rule Amendment (Marine), For the consideration of the Technical Committee, Proposal No. 2013/GP06/0.2.4, Proposal for amendments to: Rules and Regulations for the Classification of Natural Gas Fuelled Ships July 2012	

Applicable Rules, Regulations, Standards and Codes

- Lloyd's Register Rules and Regulations for the Classification of Inland Waterways Ships, November 2008 and notices.
- Lloyd's Register Rules and Regulations for the Classification of Ships, July 2012.
- Lloyd's Register Rules and Regulations for the Classification of Natural Gas Fuelled Ships, July 2012.
- Rule Amendment (Marine). For the consideration of the Technical Committee Proposal No. 2013/GP06/0.2.4. Proposal for amendments to: Rules and Regulations for the Classification of Natural Gas Fuelled Ships July 2012. November 2013.
- IED 60079-1: Electrical Apparatus for Explosive Gas Atmospheres – Part 10 – Classification of Hazardous Areas.
- IMO Resolution MSC. 285(86). Interim Guidelines for Natural Gas-Fuelled Engine Installations in Ships, June 2009.
- Draft IGF Code, July 2013 – Draft International Code of Safety for Ships Using Gases or other Low-flash Point Fuels.

Synthèse des dérogations au Code IGF (IMO-Résolution MSC.285(86)

Le présent document est applicable pour la transformation GNL du bateau à cargaison sèche « Eiger »

Code IGF	**« Eiger-Nordwand » LR 9148386**	**Spécifications et conception de la construction**
1.1.2 Renvoi à SOLAS	Un bateau de la navigation intérieure doit satisfaire aux exigences SOLAS.	
2. Exécution du réservoir de GNL : réservoir OMI type C	Le réservoir de GNL est construit conformément aux prescriptions et règles de classification EN 3458-2 et conçu pour une gîte du bateau de 2g dans le sens horizontal et 1g dans le sens vertical.	Voir paragraphe 5.3.1 Réservoir de GNL
2.8.1.2 Branchements de tuyaux sur le réservoir normalement installés au-dessus du niveau de remplissage maximal	Les branchements de tuyaux sur le réservoir ne se trouvent pas tous au-dessus du niveau de remplissage maximal	La conception du réservoir suppose un branchement sur le fond afin de pouvoir établir de la pression pour la consommation. De plus, le niveau de remplissage est défini à partir du branchement sur le fond. Cette conception est analogue à celle du modèle déjà mis en service.
2.8.1.4 L'échappement via les vannes de surpression se trouve au moins à 6 m ou largeur/3 au-dessus du pont exposé aux intempéries (la plus grande des deux dimensions étant retenue)	Du fait du faible tirant d'air du bateau au passage des ponts, l'ouverture de la tuyauterie dans le puits d'aération se trouve en fait à 3170 mm au-dessus du pont principal. Ce point correspond à la face supérieure des supports de conteneurs au niveau de la cloison de chargement arrière.	Voir paragraphe 5.9 Puits d'aération Une ventilation supplémentaire est prévue dans le puits d'aération ; le passage en toute sécurité du personnel vers l'avant du bateau est assuré via l'autre côté du bateau.
2.8.3 Stockage sur le pont découvert	Le réservoir de GNL se trouve sur la surface découverte entre la cale et la salle des machines. Une ventilation forcée est prévue.	Voir paragraphe 5.6.1 Séparation du réservoir de GNL
2.8.3.4 Gatte de réception en dessous du réservoir (et station de remplissage du réservoir)	Le réservoir est réalisé à double paroi. Le réservoir extérieur en acier inoxydable sert de protection secondaire pour le réservoir intérieur. Une gatte de réception d'une capacité de 1000 litres est prévue en dessous de la boîte froide (cold box) pourvue des vannes de raccordement du réservoir.	

Übersicht über die Abweichungen vom IGF-Code (IMO-Resolution MSC.285(86)

Dieses Dokument gilt für die LNG-Umrüstung des Containerschiffs „Eiger-Nordwand“

IGF-Code	„Eiger-Nordwand“ LR 9148386	Spezifikation und Konstruktionskonzept
1.1.2 Verweis auf SOLAS	Ein Binnenschiff muss den SOLAS-Anforderungen nicht entsprechen.	
2. LNG-Ladetank-ausführung: IMO Typ C Tank	Der LNG-Tank ist in Übereinstimmung mit den Klassifikationsvorschriften und -regeln EN 13458-2 konstruiert und für eine Krängung des Schiffes ausgelegt: längs 2G und senkrecht 1G.	Siehe Absatz 5.3.1 LNG-Tank
2.8.1.2 Rohranschlüsse am Tank normalerweise über dem höchsten Füllstand angebracht	Nicht alle Rohranschlüsse am Tank befinden sich über dem höchsten Füllstand	Das Tankkonzept setzt einen Bodenanschluss voraus, um für den Verbrauch Druck aufbauen zu können. Zudem wird der Füllstand über den Bodenanschluss bestimmt. Dieses Konzept ähnelt dem bereits in Betrieb genommenen Modell.
2.8.1.4 Auslass aus den Überdruckventilen befindet sich mindestens 6 m oder B/3 über dem Wetterdeck (das größere Maß ist maßgeblich)	Wegen der geringen Brückendurchfahrtshöhe des Schiffes befindet sich die Rohrleitungsöffnung im Lüftungsschacht tatsächlich 3170 mm über dem Hauptdeck. Dieser Punkt entspricht der Oberseite der Containerauflagen am hinteren Ladungsschott.	Siehe Absatz 5.9 Lüftungsschacht Im Lüftungsschacht ist eine zusätzliche Belüftung vorgesehen; der sichere Durchgang des Personals zum Vorschiff wird über die andere Seite des Schiffs sichergestellt.
2.8.3 Speicherung auf offenem Deck	Der LNG-Tank befindet sich auf offener Fläche zwischen Laderaum und Maschinenraum. Es ist eine Zwangsbelüftung vorgesehen.	Siehe Absatz 5.6.1 LNG-Tankabteilung
2.8.3.4 Auffangwanne unterhalb Tank (und Tankfüllstation)	Der Tank wird doppelwandig ausgeführt. Der Außentank aus Edelstahl wird als Sekundärschutz für den Innentank dienen. Unter der Cold Box mit den Anschlussventilen des Tanks ist eine Auffangwanne mit einer Kapazität von 1000 Litern vorgesehen.	

Annexe 3 au RV (14) 17 = RV/G (14) 33 = JWG (14) 28

Procédure pour l'avitaillement de gaz naturel liquéfié

1. OBJET

Afin de remplir le(s) réservoir(s) de GNL sans danger, les procédures qui suivent seront suivies de façon rigoureuse :

2. CADRE GÉNÉRAL

Avant de pouvoir procéder à l'avitaillement en GNL, l'autorité compétente doit avoir été informée. Celle-ci peut demander des précautions de sécurité additionnelles. L'accord de l'autorité pour les opérations d'avitaillement doit être donné avant le début de ces opérations.
En l'absence de règlementations gouvernant l'avitaillement au GNL, les règles qui suivent peuvent servir de règles de base :

- procédures générales d'avitaillement en vigueur pour les produits pétroliers
- précautions et procédures pour l'embarquement et le débarquement de marchandises dangereuses par les bateaux de navigation intérieure.

3. PRÉ-AVITAILLEMENT

Avant de commencer l'avitaillement au GNL, des panneaux d'avertissement devront être mis en place, et la liste de contrôle pour l'avitaillement contenue dans l'annexe A doit être signée tant par le responsable du bateau que par le responsable du camion d'avitaillement.
Une fois que toutes les questions de la liste de contrôle pour l'avitaillement ont reçu une réponse positive et que le responsable du camion d'avitaillement est en possession de l'ensemble de la documentation requise, l'avitaillement peut commencer.

4. AVITAILLEMENT

Tout au long de l'avitaillement, les points suivants seront surveillés en permanence :

- absence de fuites des tuyaux à gaz et des raccords,
- les aussières de mouillage,
- les forces exercées sur le tuyau d'avitaillement,
- la pression dans le réservoir, qui peut être contrôlée par le recours à l'équipement d'avitaillement aérosol par le haut (auquel cas un circuit de retour vapeur n'est pas nécessaire).

5. POST-AVITAILLEMENT

Après l'avitaillement du GNL, et la déconnexion du tuyau d'avitaillement, les panneaux d'avertissement posés sur la berge peuvent être retirés. À ce moment le responsable du bateau devra informer l'équipage et les autorités compétentes de la fin des opérations d'avitaillement.

Appendice A (formulaire de base)

Liste de contrôle pour l'avitaillement au GNL	
Précautions prises et répartition des tâches en vue d'un avitaillement au GNL	
- Identification du bateau .... (Nom du bateau)	.... (Numéro européen unique d'identification des bateaux)
- Identification du camion .... (Nom de la société)	.... (Numéro d'immatriculation)
- Localisation de l'avitaillement .... (Adresse) .... (Date)	.... (Localité) .... (Heure)
Données relatives au GNL	
Quantité en m^3 :	
Procédure d'urgence	
Interruption immédiate de l'avitaillement en présente d'une fuite quelconque. Toutes vannes en position de sécurité. Le bateau arbore un feu clignotant rouge signalant la situation anormale spécifique. Le chauffeur du camion arrête immédiatement le transfert de GNL. L'ensemble du personnel évacue la zone d'avitaillement en observant le plan de sécurité.	

Il n'est permis de commencer l'avitaillement au GNL qu'après que chacune des questions de la liste de contrôle suivante a reçu la réponse "Oui" et que les deux responsables ont signé cette liste.
Si une de ces questions n'a pas reçu une réponse positive, l'avitaillement au GNL n'est **PAS** permis.

Liste de contrôle pour l'avitaillement au GNL			
		Bateau	Camion
1.	L'accord de l'autorité compétente pour l'avitaillement au GNL dans la zone prévue a-t-elle été donnée ?	o	--
2.	Est-il satisfait aux exigences des réglementations locales et de l'autorité compétente?	o	--
3.	L'autorité compétente a-t-elle été informée de l'imminence du début de l'avitaillement de GNL?	o	--
4.	L'amarrage du bateau est-il correct?	o	--
5.	L'éclairage est-il suffisant et en bon état de fonctionnement, tant sur le camion que sur le bateau (collecteur de soute et issues de secours)?	o	o
6.	Les panneaux délimitant la zone de sécurité autour du camion-citerne sont-ils en place sur la berge?	--	o
7.	Y a-t-il en place des bacs de récupération en suffisance pour toute fuite possible, et l'installation de vaporisation d'eau est-elle prête pour utilisation immédiate?	o	--
8.	Le tuyau souple d'avitaillement GNL est-il correctement soutenu et est-on assuré de l'absence de sollicitations extrêmes sur ce tuyau?	o	o
9.	Le tuyau d'avitaillement GNL et le raccord autodétachable sont-ils en bon état?	o	o
10.	Le branchement à la terre est-il convenablement connecté?	--	o
11.	Les systèmes de communication entre le camion, le collecteur d'avitaillement et la timonerie sont-ils tous vérifiés et en ordre de marche?	o	o
12.	Les équipements de contrôle et de sécurité de l'installation GNL sont-ils tous vérifiés et en ordre de marche?	o	--
13	La quantité de GNL à transférer est-elle convenue?	o	o
14.	Les spécifications du GNL qui a été livré correspondent-elles à celles du GNL commandé?	o	o
15.	La procédure d'urgence a-t-elle été discutée avec le chauffeur, et l'a-t-il assimilée?	o	o
16.	Un certificat de qualité du GNL est-il disponible?	o	o
17.	L'équipage a-t-il été informé du commencement de l'avitaillement GNL?	o	--
18.	Une surveillance continue par les responsables du bateau est-elle assurée durant toute la durée du remplissage ou de la vidange du réservoir de stockage de gaz naturel liquéfié du bateau et du camion-citerne ?	o	o
19.	Des moyens appropriés sont-ils disponibles pour l'évacuation du bateau en cas d'urgence ?	o	

Vérifié et signé :

Responsable du bateau :	Responsable du camion-citerne :
....	....
(Nom en majuscules)	(Nom en majuscules)
....	....
(Signature)	(Signature)

Anlage 3 zu RV (14) 17 = RV/G (14) 33 = JWG (14) 28

Verfahren für das Bunkern von Flüssigerdgas

1. ZWECK

Für ein sicheres Befüllen des bzw. der Flüssigerdgas-Vorratstank(s) ist eine strenge Einhaltung der folgenden Verfahren notwendig:

2. ALLGEMEINES

Bevor eine Befüllung der Flüssigerdgas-Vorratstanks möglich ist, muss die zuständige Behörde informiert werden. Von der Behörde können zusätzliche Sicherheitsvorkehrungen verlangt werden. Vor dem Beginn des Bunkerns muss die Genehmigung der Behörde für das Bunkern vorliegen.
Solange es für das Bunkern von Flüssigerdgas keine Vorschriften gibt, können wo anwendbar die folgenden Handlungsempfehlungen genutzt werden:

- Allgemeine Verfahren für das Bunkern von Ölbrennstoffen
- Vorsichtsmaßnahmen und Verfahren für die Be- und Entladung von Binnentankschiffen mit gefährlichen Gütern

3. VOR DER BEFÜLLUNG

Vor dem Beginn der Übergabe des Flüssigerdgases sind Warnschilder aufgestellt worden, die Bunker-Prüfliste in der Anlage A muss vervollständigt und sowohl vom Verantwortlichen des Schiffs als auch vom Verantwortlichen des Lastkraftwagens mit der Ladung unterzeichnet worden sein.
Nachdem alle Fragen auf der Bunker-Prüfliste bejaht wurden und der Verantwortliche des Lastkraftwagens mit der Ladung alle erforderlichen Dokumente erhalten hat, kann die Übergabe beginnen.

4. BEFÜLLUNG

Während der Übergabe müssen die folgenden Punkte ununterbrochen kontrolliert werden:

- Die Gasrohre, -schläuche und -anschlussstücke auf Leckage,
- die Festmacher,
- die auf den Übergabeschlauch einwirkenden Kräfte,
- Tankdruck, der durch den Einsatz einer Sprühvorrichtung für die Obenbefüllung kontrolliert werden kann (bei dieser Befüllung ist eine Dampfrückleitung nicht erforderlich).

5. NACH DER BEFÜLLUNG

Nach der Übergabe des Flüssigerdgases und nachdem der Übergabeschlauch abgeschlossen wurde, können die Warnschilder am Ufer entfernt werden. Zu diesem Zeitpunkt muss der Verantwortliche des Schiffs die Besatzung und die zuständigen Behörden darüber in Kenntnis setzen, dass die Übergabe abgeschlossen wurde.

Anhang A (Vorlage)

<table>
<tr><td colspan="2" align="center">Prüfliste für das Bunkern von Flüssigerdgas</td></tr>
<tr><td colspan="2">Ergriffene Vorsichtsmaßnahmen und Beauftragungen für die Übergabe von Flüssigerdgas</td></tr>
<tr><td>- Angaben zum Schiff
....
(Schiffsname)</td><td>..
(Einheitliche europäische Schiffsnummer)</td></tr>
<tr><td>- Angaben zum Lastkraftwagen
....
(Firmenname)</td><td>..
(Kennzeichen)</td></tr>
<tr><td>- Bunkerstandort
....
(Adresse)
....
(Datum)</td><td>..
(Ort)
....
(Zeit)</td></tr>
<tr><td colspan="2">Angaben zum Flüssigerdgas: ....</td></tr>
<tr><td colspan="2">Menge in Kubikmetern (m^3): ....</td></tr>
<tr><td colspan="2">Notfallverfahren</td></tr>
<tr><td colspan="2">Im Falle einer Leckage muss die Befüllung sofort beendet werden. Sämtliche Ventile müssen in ihre Sicherheitsstellung gebracht werden.
Ein rotes Blinklicht am Schiff zeigt die beschriebene Ausnahmesituation an.
Der Fahrer des Lastkraftwagens beendet die Übergabe des Flüssigerdgases sofort.
Sämtliches Personal räumt den Bunkerbereich unverzüglich nach Maßgabe der Sicherheitsrolle.</td></tr>
</table>

Der Beginn der Übergabe des Flüssigerdgases ist nur zulässig, wenn sämtliche Fragen auf der folgenden Prüfliste mit „Ja“ beantwortet wurden und die Liste von beiden verantwortlichen Personen unterzeichnet wurde.
Wenn eine der Fragen nicht mit „Ja" beantwortet werden kann, ist die Übergabe des Flüssigerdgases **NICHT** erlaubt.

Prüfliste für das Bunkern von Flüssigerdgas			
		Schiff	Lastkraft-wagen
1.	Ist die Genehmigung der zuständigen Behörde für die Übergabe des Flüssigerdgases im ausgewiesenen Bereich vorhanden?	o	--
2.	Werden die Anforderungen der lokal geltenden Vorschriften und der zuständigen Behörde eingehalten?	o	--
3.	Besitzt die zuständige Behörde Kenntnis vom Beginn der Übergabe des Flüssigerdgases?	o	--
4.	Ist das Schiff gut festgemacht?	o	--
5.	Ist die Beleuchtung am Lastkraftwagen und am Schiff (Bunkerverteiler und Fluchtwege) ausreichend und funktionstüchtig?	o	o
6.	Sind die Schilder aufgestellt, mit denen der sichere Bereich am Tanklastkraftwagen am Ufer ausgewiesen wird?	--	o
7.	Sind alle für mögliche Lecks erforderlichen Auffangwannen aufgestellt und steht die Wassersprühvorrichtung zur sofortigen Verwendung zur Verfügung?	o	--
8.	Wird der Schlauch für die Übergabe des Flüssigerdgases ordnungsgemäß abgestützt und wirken keine extremen Kräfte oder Belastungen auf den Schlauch ein?	o	o
9.	Befinden sich der Schlauch für die Übergabe des Flüssigerdgases und die Nottrennkupplung in einem guten Zustand?	o	o
10.	Ist das Erdungskabel richtig angeschlossen?	--	o
11.	Wurden alle Kommunikationsmittel für die Kommunikation zwischen dem Lastkraftwagen, dem Bunkerverteiler und dem Steuerhaus kontrolliert und sind diese funktionstüchtig?	o	o
12.	Wurden alle Sicherheits- und Kontrollvorrichtungen des Flüssigerdgassystems geprüft und sind diese funktionstüchtig?	o	--
13	Wurde vereinbart, wie viel Flüssigerdgas umgefüllt werden soll?	o	o
14.	Stimmen die Spezifikationen des bestellten Flüssigerdgases mit den Spezifikationen des gelieferten Flüssigerdgases überein?	o	o
15.	Wurde das Notfallverfahren mit dem Lastkraftwagenfahrer besprochen und versteht der Lastkraftwagenfahrer das Notfallverfahren?	o	o
16.	Ist für das Flüssigerdgas ein Qualitätszertifikat vorhanden?	o	o
17.	Ist die Besatzung darüber informiert, dass die Übergabe des Flüssigerdgases beginnt?	o	--
18.	Ist während der gesamten Dauer des Befüllens oder Entleerens des Flüssigerdgas-Vorratstanks eine stetige Überwachung durch die Verantwortlichen des Schiffes und des Lastkraftwagens sichergestellt?	o	o
19.	Sind geeignete Mittel zum Verlassen des Schiffes im Notfall vorhanden?	o	

Geprüft und unterzeichnet:

Verantwortlicher des Schiffs:	Verantwortlicher des Tanklastkraftwagens:
....	....
(Name in Großbuchstaben)	(Name in Großbuchstaben)
....	....
(Unterschrift)	(Unterschrift)

Annexe 4 au RV/G (13) 104 rev. 1 = JWG (13) 73 rev. 1

Description de la formation des équipages à bord de bateaux de la navigation intérieure dont la propulsion est assurée par du GNL

A. Introduction

L'objectif central de cette formation est de familiariser l'équipage des bateaux de navigation intérieure avec les caractéristiques et les risques présentés par le GNL et lui apprendre la façon de travailler avec le GNL utilisé comme combustible à bord de leur bateau; par exemple pour la manœuvre du bateau, l'avitaillement et la maintenance.

La formation devra comprendre une partie théorique, portant sur les matières mentionnées dans l'annexe B, et une partie pratique à bord du bateau, durant laquelle les points de théorie seront mis en application.

La sélection d'une institution de formation adéquate et la détermination de l'étendue de la formation seront effectuées conformément aux exigences de l'autorité compétente. La formation sera répétée tous les deux ans et demi.

Après y avoir participé avec succès, l'équipage recevra un certificat de l'institut de formation.

B. La formation sur le GNL couvrira les sujets suivants :

1. Réglementation

- 1.1 Réglementation d'ensemble / meilleurs pratiques pour l'ADN, le Règlement de visite des bateaux du Rhin, la Directive 2006/87/CE et tous développements ultérieurs
- 1.2 Les règlements internationaux en vigueur concernant le GNL (pour la navigation maritime / les meilleures pratiques) OMI, IMDG et tous développements ultérieurs
- 1.3 Les règles de la société de classification qui a classé le bateau.
- 1.4 Réglementation sur la sécurité et la protection sanitaire
- 1.5 Réglementations et permis locaux
- 1.6 Recommandations relatives à l'ADN et au Règlement de visite des bateaux du Rhin

2. Introduction au GNL

- 2.1 Définition du GNL, températures critiques, risques liés au GNL, conditions atmosphériques
- 2.2 Composition et qualités du GNL, certificats de qualité du GNL
- 2.3 MSDS (Fiches de données de sécurité des matériaux dangereux) : caractéristiques physiques / du produit
- 2.4 Caractéristiques environnementales

3. Sécurité

- 3.1 Dangers et risques
- 3.2 Gestion du risque
- 3.3 Utilisation des protections individuelles

4. Aspects techniques du système GNL

- 4.1 Configuration d'ensemble
- 4.2 Explication des effets du gaz naturel liquide
- 4.3 Températures et pression
- 4.4 Vannes et contrôles automatisés, ATEX
- 4.5 Alarmes
- 4.6 Matériaux (tuyauteries, vannes de surpression)
- 4.7 Ventilation

5. Entretien et vérifications du système GNL

5.1 Entretien quotidien
5.2 Entretien hebdomadaire
5.3 Entretien périodique
5.4 Pannes
5.5 Trace écrite des opérations d'entretien

6. Avitaillement de GNL

6.1 Procédure d'avitaillement en GNL
6.4 Dégazage / injection de gaz dans le système GNL
6.5 Listes de contrôle et certificat de livraison

7. Préparation du système GNL pour les travaux d'entretien du bateau

7.1 Certificat de dégazage
7.2 Dégazage / injection de gaz dans le système GNL avant le séjour au chantier naval
7.2 Inertage du système GNL
7.3 Procédure de vidange du réservoir de stockage de GNL
7.4 Premier remplissage du réservoir de stockage de GNL (refroidissement)
7.5 Redémarrage après le séjour au chantier naval

8. Scénarios d'urgence

8.1 Plan d'urgence
8.2 GNL répandu sur le pont
8.3 Contact de GNL avec la peau
8.4 Rejet de GNL sur le pont
8.5 Rejet de GNL en espace clos (stations de production d'électricité)
8.6 Incendie sur le pont à proximité du réservoir de GNL
8.7 Incendie dans la salle des machines
8.8 Risque spécifique lié au transport de marchandises dangereuses
8.9 Échouage / collision du bateau

C. La formation à bord sur le GNL couvrira les sujets suivants :

9. Formation pratique à bord :

9.1 Familiarisation avec le contenu du système de gestion du bateau, et plus précisément des parties relatives au système GNL.
9.2 Vérification de la prise de conscience des questions de sécurité et de l'utilisation des équipements de sécurité GNL.
9.3 Connaissance des installations de suivi, contrôle et alarme du système GNL à bord.
9.4 Connaissance des procédures d'entretien et de contrôle du système GNL.
9.5 Connaissance de la procédure d'avitaillement et familiarisation avec celle-ci (de préférence en pratique).
9.6 Connaissance des procédures d'entretien pour le séjour au chantier naval
9.7 Connaissance des scénarios d'urgence

Anlage 4 zu RV (14) 17 = RV/G (14) 33 = JWG (14) 28

Beschreibung der Schulung von Besatzungen an Bord von Binnenschiffen mit Flüssigerdgasantrieb

A. Einleitung

Der Hauptzweck des Kurses besteht darin, die Besatzungen von Binnenschiffen mit den Eigenschaften und Gefahren von Flüssigerdgas vertraut zu machen und Wissen über die Arbeit mit Flüssigerdgas als Brennstoff an Bord von Schiffen zu vermitteln, beispielsweise im Zusammenhang mit dem Betrieb, der Bunkerung und der Instandhaltung.

Der Kurs wird einen theoretischen Teil beinhalten, der sich auf die unter B aufgeführten Themen erstreckt, sowie eine praktische Schulung an Bord des Schiffes, bei der das theoretische Wissen in der Praxis umgesetzt wird.

Die Auswahl eines geeigneten Schulungsinstituts und der Umfang der Schulung werden den Vorgaben der zuständigen Behörde entsprechen und von ihr festgelegt. Alle 2,5 Jahre muss die Schulung wiederholt werden.

Nach der erfolgreichen Teilnahme wird für die Besatzung von der Schulungseinrichtung ein Zertifikat ausgestellt.

B. Der Kurs zum Flüssigerdgas behandelt die folgenden Themen:

1. Gesetzgebung

1.1 Allgemeine Gesetzgebung / beste Vorgehensweisen nach ADN, RheinSchUO, Richtlinie 2006/87/EG und neue Entwicklungen

1.2 Vorhandene internationale Gesetzgebung für Flüssigerdgas (für die Seefahrt / beste Vorgehensweisen) IMO, IMDG und neue Entwicklungen

1.3 Vorschriften der Klassifikationsgesellschaft, die die Klassifikation des Schiffs vorgenommen hat

1.4 Gesetzgebung für Gesundheit und Sicherheit

1.5 Lokale Vorschriften und Genehmigungen

1.6 Empfehlungen gemäß ADN und RheinSchUO

2. Einführung zu Flüssigerdgas

2.1 Definition für Flüssigerdgas, kritische Temperaturen, Gefahren im Zusammenhang mit Flüssigerdgas, atmosphärische Bedingungen

2.2 Zusammensetzungen und Eigenschaften von Flüssigerdgas, Qualitätszertifikate für Flüssigerdgas

2.3 SDBI (Sicherheitsdatenblatt): Physikalische und Produkteigenschaften

2.4 Umwelteigenschaften

3. Sicherheit

3.1 Gefahren und Risiken

3.2 Risikomanagement

3.3 Verwendung von persönlicher Schutzausrüstung

4. Methodik des Flüssigerdgassystems

4.1 Allgemeine Anordnung

4.2 Erläuterung der Wirkungsweise von Flüssigerdgas

4.3 Temperaturen und Drücke

4.4 Ventile und Automatiksteuerungen, ATEX

4.5 Warnanlagen

4.6 Materialien (Schläuche, Druckentlastungsventile)

4.7 Lüftung

5. Wartung und Prüfung des Flüssigerdgassystems

5.1 Tägliche Instandhaltung
5.2 Wöchentliche Instandhaltung
5.3 Regelmäßige wiederkehrende Instandhaltung
5.4 Fehler
5.5 Dokumentation der Instandhaltungsarbeiten

6. Bunkern von Flüssigerdgas

6.1 Verfahren für das Bunkern von Flüssigerdgas
6.4 Gasentleerung und Spülung des Flüssigerdgassystems
6.5 Prüflisten und Auslieferungszertifikat

7. Vorbereitung des Flüssigerdgassystems für Instandhaltungsarbeiten des Schiffes

7.1 Gasfreiheitszertifikat
7.2 Gasentleerung und Spülung des Flüssigerdgassystems vor dem Werftaufenthalt
7.2 Inertisierung des Flüssigerdgassystems
7.3 Verfahren zum Entleeren der Vorratstanks
7.4 Erste Befüllung des Flüssigerdgas-Vorratstanks (Abkühlung)
7.5 Inbetriebnahme nach dem Werftaufenthalt

8. Notfallszenarien

8.1 Notfallplan
8.2 Verschüttung von Flüssigerdgas auf dem Deck
8.3 Hautkontakt mit Flüssigerdgas
8.4 Freisetzung von Flüssigerdgas auf dem Deck
8.5 Freisetzung von Flüssigerdgas in geschlossenen Räumen (Antriebsstationen)
8.6 Brand auf dem Deck in der Nähe des Flüssigerdgas-Vorratstanks
8.7 Brand in den Maschinenräumen
8.8 Spezifische Gefahren beim Transport von Gefahrgütern
8.9 Auf-Grund-Laufen oder Kollision des Schiffes

C. Die Schulung an Bord zum Flüssigerdgas behandelt die folgenden Themen:

9. Praxisschulung an Bord:

9.1 Vertrautmachen mit dem Inhalt des Managementsystems des Schiffs, insbesondere der Teile zum Flüssigerdgassystem.
9.2 Kontrolle des Sicherheitsbewusstseins und der Verwendung der Sicherheitsausrüstung für Flüssigerdgas
9.3 Kenntnisse der Überwachung, der Steuerungen und der Warnmeldungen des Flüssigerdgassystems an Bord
9.4 Kenntnisse der Instandhaltung und der Verfahren zur Kontrolle des Flüssigerdgassystems
9.5 Kenntnisse des und Vertrautmachen mit dem Bunkerverfahren (vorzugsweise in der Praxis)
9.6 Kenntnisse der Instandhaltungsverfahren für Werftaufenthalte
9.7 Kenntnisse zu den Notfallszenarien

LNG Refit "Eiger-Nordwand"

SPECIFICATION AND DESIGN CONCEPT

1. GENERAL

1.1 General Description

The "Eiger-Nordwand" is a push combination transporting containers and sailing under Dutch flag. The vessel was built in 2000.
The "Eiger" is a twin screw vessel and will be refit in Q1 2014 by Koedood to meet the expected environmental requirements of the CCR (Centrale Commisie Rijnvaart) for Fase IV engines to become effectuated in 2019 - 2021.
NOx emissions: max. 1,8 g/kW/h
Particles emissions: max. 0.045g/kWh

1.2 General Description Design Approval Procedure

The "Eiger" has to meet the rules and regulations for Inland Water Way Vessels as been given by R.O.S.R and A.D.N.
As R.O.S.R as well as A.D.N do not allow fuels with a flame point below 55° C (like LNG) , these installations should be proposed to CCR and ECE/VN and can be approved if the alternative installations are proven to be at least as safe as the conventional installations that do meet the R.O.S.R. regulations.
Lloyd's Register and the Dutch Ministery of Infrastructure and the Environment agreed upon a procedure to check the LNG installation with existing rules and legislation as far as practical. (like IGF code IMO- resolution MSC. 285(86) and Lloyd's rules and regulations for the classification of LNG fuelled ships.

As part of the approval of the LNG installation, the safety of the LNG systems and ships design Concept will be judged in a Hazid Study (Oct. 2013) in which the if- than technique is followed as mentioned in the IMO-Resolution MSC.392 appendix 3 part 5.
This has brought us to the following stages of the design and approval program.

1. Koedood's Design and Concept proposal for the refit is submitted to Class and checked by Lloyds.
2. Design and concept proposal worked out into a more detailed design to meet the requirements of Owner, Class, Regulatory bodies. The hazardous situations possibly able to occur in relation with the design and installations will be investigated by a hazard identification (HAZID study executed by Lloyds register).
3. The recommendations out of the Hazid study will be incorporated in the final design which will be submitted in detail to Lloyds Plan Approval department for final approval. (Procedures for use and maintenance of ship systems will be part of the approval procedures).
4. The vessel will be refit and equipped under supervision of Lloyds Register and Class will be maintained during ships life time.
5. The crew and technical staff will be trained to operate the vessel and its installations in a safe and efficient way using the approved procedures.
6. After commissioning vessels operations and performance will be monitored and reported.

1.3 Main Particulars

Overall length	: 105 metres "Eiger"/ 178 metres as push combination
Beam	: 11,45 metres
Draught max.	: 3,55 metres
Max container capacity (4 layers)	: 348 TEU, of which a possibility for 22 reefers

1.4 Classification, Government and Other Regulations

- Rhine Vessels Inspection Regulations (ROSR) (1 man radar operation)
- Lloyds Registers Rules and Regulations for the Classification of Inland Waterways Ships.
- Lloyds Registers Rules and Regulations for the Classification of Natural Gas Fuelled Ships.
- Interim Guidelines on Safety for natural gas-fuelled engine installations in ships (Resolution MSC.258(86) as adopted on 1 June 2009)
- Rhine Police Regulations (RPR)
- Regulations Binnenschifffahrts Berufsgenossenschaft (BSBG)
- European Agreement Concerning the International Carriage of Dangerous Goods by Inland Water Ways (ADN) – Volume I & II, issued 01-01-2013.

The vessel will meet the Stability regulations (damaged and intact conditions) as given in Part 9: 9.1.0.93-94 and 95 IWW ADN rules for the construction of dry cargo vessels containing ADN goods.

1.5 Operational area and ship speed.

Operational area is inland water ways, mainly Rotterdam→Basel→Antwerp→Rotterdam.
The vessel also has stops in Straasbourg and Weil am Rhein.
The vessel sails approx 63.000 km./year and is always loaded with containers during sailing (Rotterdam→Basel and vice versa).

Sailing speed through water:

Maximum	18 km/hr.	(fully loaded)
Minimum	13 km/hr.	for any convoy sailing the Rhine

1.6 Crew

The vessel is built and equipped to sail 24 hours continuously. The crew consists of qualified employees in accordance with Dutch law. The crew changes normally every 2 weeks.
The crew will be properly trained for sailing a LNG fuelled vessel. Moreover, part of the crew is also ADN (basis) certified.

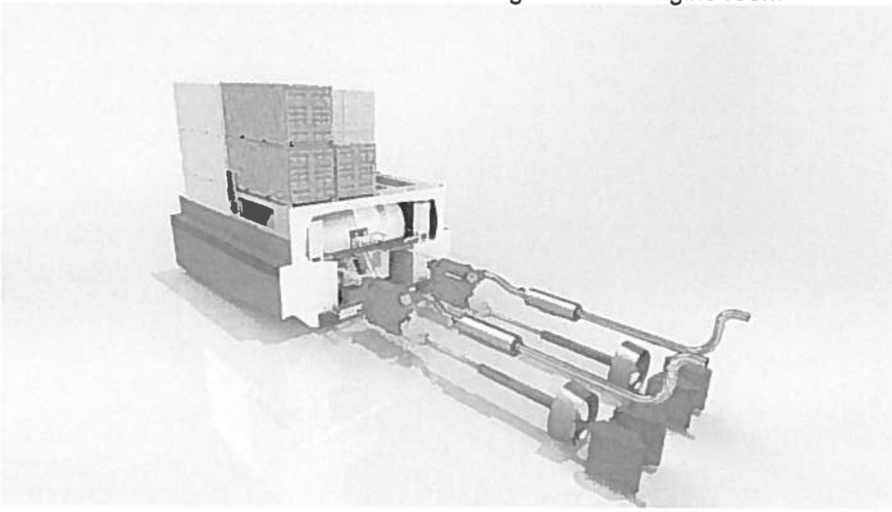
2. HULL AND DECK HOUSE

2.1 General

Looking from forward to aft the "Eiger" is compartmentalized as follows:

Below deck level:
Fore peak
Bow thruster and generator room
Loading area
Wheelhouse (which can hydraulically be adjusted in height)
Engine room
Living area
Sterndeck

The LNG tank will be located between loading area and Engine room



3. PROPULSION SYSTEM

3.1 Main Engines – current situation

2x Caterpillar 3508B, 756 KW each
Reverse reduction gears: ZF 461

3.2 Main Engines – after refit

2x Wärtsilä 6L20DF, 900 kW each at 1200 rpm
Reverse reduction gears: Masson W8000

3.2 Auxiliaries

1x van Tiem grid bow thruster (350 pk)

3.3 Propulsion / Power Concept

Sailing upstream the required propulsion power will be established by the 6 cyl. Dual Fuel powered Wärtsilä engines.
The bow thruster unit will only be operational during harbour manoeuvres and emergency stop situations.
In case of emergency, power supply is assured by means of 2 separate generator sets
(1 in front bowthruster / generator room and 1 in engine room).

4. FIRE FIGHTING SYSTEM

4.1 General fire fighting systems.

The vessel will be equipped with all required firefighting systems and equipment. Moreover, a sprinkler installation will be added above the LNG tank.
The crew will be trained to operate the ship systems and regular roles and practical training shall be planned to maintain the skills of the crew.

5. VESSELS SAFETY CONCEPT AND GENERAL INFO LNG RELATED ITEMS.

5.1 Rules and regulations

The following rules and regulations are used to define the layout of the vessel and its systems:

- Lloyds Rules and regulations for the Classification of Inland Waterways Ships August 2011
- Lloyds Rules and regulations for the Classification of Natural Gas Fuelled Ships July 2012
- Interim Guidelines on Safety for Natural Gas-Fueled Engine Installations in Ships Resolution MSC.285(86) adopted on 1 June 2009. (IGF code)
- Lloyds Requirements for Machinery and Engineering Systems of Unconventional Design (Part 7 Chapter 15)
- Rhine Vessels Inspection Regulations; Central Commission Navigation on the Rhine (CCNR)
- Cryogenic vessels – Static vacuum insulated vessels Part 2 design, fabrication inspection and testing (European Standard EN 134582:2002)
- European Agreement Concerning the International Carriage of Dangerous Goods by Inland Water Ways (ADN) – Volume I & II, issued 01-01-2013.

5.2 Approval and survey

The concept design and its compliance to the rules will be evaluated by Lloyd Register in a Hazid study.
Plan approval for final design and engineering will be done by Lloyds Register.
On site surveys at the refit location of the vessel will also be executed by Lloyds Register.
The vessel will be classed and certified by Lloyd's Register.
At weekly basis, the LNG system and components will be inspected visually by ships chief engineer according instructions formalized in the safety manual. Also bi-weekly surveys will be performed by the ship's supervisor.
During all LNG operations functioning of the systems and procedures will be evaluated and reported.
Annual reporting and evaluation will be shared with the CCNR as stated in the recommendation. Procedures and systems on board will be actualized by the result of these evaluations.

5.3 General LNG systems

5.3.1 LNG Tank

The LNG tank is a tank placed between the engine room and loading area of the ship.
The LNG tank can contain 60 m3 LNG at 100% filling level
The cryogenic LNG tank is an independent tank, designed in accordance with the EN 13458-2 classification rules & regulations and calculated for heeling of the vessel: longitudinal 2G and vertical 1G.
The cryogenic tank does not need any regular maintenance or because of the usage of non-corrosive materials for both inner and outer tank, as well as the internal piping in annular space. As the annular space is drawn to vacuum, there is no need for maintenance inspection of the annular space. All welds on inner tank, as well as all welded internal piping connections are X-rayed according to classification requirements.

Inner tank design pressure .... 10 bar g
tank design temperature...-196 / +20 °C

5.3.2 Gas piping

All piping containing gaseous natural gas will be double walled.

5.3.3 LNG bunker manifold

The bunker manifold (2) are situated at port and starboard side of the tank room approx. 1m above superstructure deck level.
The manifold consists of a cryogenic valve a connection flange for the bunker connection and a purge connection.
Under the connection flange, a drip tray will be constructed made of stainless steel. The length of the drip tray is, in case of a leakage, long enough to assure that the leaking liquid gas will go directly overboard into the water.
The manifold also has a break-away coupling connection which will break first in case of an emergency during bunkering.

5.3.4 Gas detection

Gas detection is arranged as per class requirements.

5.3.5 Ventilation, safety distances

All ventilation intakes and outlets, openings and entrances to enclosed spaces are located outside the hazardous areas as defined in above mentioned rules and regulations as well as all hot spots like engine exhaust pipes are.

5.3.6 Purging of gas equipment

A limited N2 supply is permanently connected for the purpose of purging GVU and/or engine gas feed systems for the purpose of maintenance or in case of emergency.
The LNG fill pipe from filling manifold to filling shut off valves will be purged by N2 delivered from the bunker station.

5.4 Accommodation & wheelhouse

5.4.1 Ventilation

An over pressure is maintained on the accommodation and wheelhouse to prevent hazardous substances from entering these spaces.

5.4.2 Gas detection

Gas detection is arranged at the accommodation ventilation air intakes. In case of gas detection the ventilation system is stopped and quick closing arrangements prevent further gas entry into the accommodation and wheelhouse.

5.5 Engine room

5.5.1 Dual fuel engines

The engine room is a non-hazardous (gas safe) area because the LNG fuel lines to the main engines are double walled from engine to the Gas Valve Units integrated in the tank room.
The double walled piping is ventilated from outside the engine room through the engines and the gas valve unit compartments and this ventilated system has an outlet beside the vent stack of the LNG tank.
Each of the two engines has a separate ventilated piping system and GVU box
(ref.: Project Guide Wärtsilä 20DF engine).

5.6 Tank compartment

5.6.1 LNG tank compartment

The LNG storage tank is located in an open area between loading area and engine room.
Moreover, extra ventilation will be arranged as well.

5.8 GVU compartments

Two independent gas tight GVU compartments will be located on starboard and port side from the tank. Each GVU compartment can be isolated from the rest of the gas system and independently purged for the purpose of inspection and/or maintenance whilst the gas tank system and the other GVU's remain in operation. The appropriate procedure is to be followed.

5.9 Vent stack

The outlets of the pressure release valves, ventilation and purging of the engine gas feed systems are independently piped to the vent stack. These pipes are arranged at the tip of the vent stack to promote mixing of the outflows with the purpose of dissipating temperature differences, nitrogen concentrations, LNG concentrations and/or local pockets of gas with a density greater than ambient. Extra ventilation will be foreseen as well.

5.10 Bunkering

During bunkering, access is regulated by the bunkering procedure.

Memorandum

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To
DCL Bargebv, attn. A. Schroot

From
A.W. Vredeveldt

Subject
HAZID, LNG refit ms Eiger-Nordwand

Date
January 14th 2014

Our reference
TNO-2013-M02643, 052.03406

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Contents

Introduction

Danser Containerline is considering to refit their push combination 'Eiger-Nordwand' with an LNG duel fuel propulsion system. This implies a conversion of the motor vessel from a marine fuel oil (MFO) propelled vessel to a dual fuel propelled vessel where the 2nd fuel is natural gas, stored as liquefied natural gas (LNG). Current regulations do not allow the use of fuels with a flashpoint below 55° C (Chapter 8, Article 8.01, [3]). No consolidated regulations are available with respect to the use of cryogenic storage facilities. It is noted that LNG is carried at a temperature of -162 ° C (minimum).
Fortunately authorities, i.e. IWW shipping inspectorates and the Central Commission for the Navigation of the Rhine (CCNR, CCR, ZKR) are willing to grant exemptions when satisfactory technical evidence is available as regards the safe carriage and use of natural gas on board.
The current practice with regard to providing such evidence is following, at least partially, requirements from existing regulations on the carriage of liquefied gasses in sea going tankers (IGC [4]) which have been included in a code under development at IMO, known as the International code on safety for Gas-Fuelled ships (IGF) [5]. Often a vacuumed double walled pressure tank is used for the carriage of the LNG bunger fuel. For the design of this tank usually, in Europe, a European standard on cryogenic vessels static vacuum insulated vessels is referred to (EN13458 [6]). The IGF code is under development and intended for sea going vessels. The other codes, IGC and EN 13458 are not intended for LNG bunker fuel installation on board inland waterway (IWW) vessels, although many requirement are applicable to IWW ships as well.

Clearly a new technique is introduced in IWW shipping. Therefore authorities require a safety assessment to be carried out. It is noted that in IWW shipping this assessment is often referred to as the hazard identification study (HAZID), which is formally only a part of risk assessment.
It is also noted that it is the intention to lift this requirement as soon as regulations on the use of LNG bunker fuel installations have been adopted by the competent authorities and have come in to force.
The results of a risk assessment rely heavily on the competence and skills of the people involved. Since the authorities have no staff to assess the results of a risk assessment from a technical point of view, TNO is invited to study the available material and formulate a position.
This memorandum reflects the opinion of TNO about the technical evidence currently available on the LNG refit of MV 'Eiger'. The memo has been written on the request of DCL Barge bv, part of the Danser Group.

Technical documentation

A picture of the general lay out of the system is given in Figure 1.

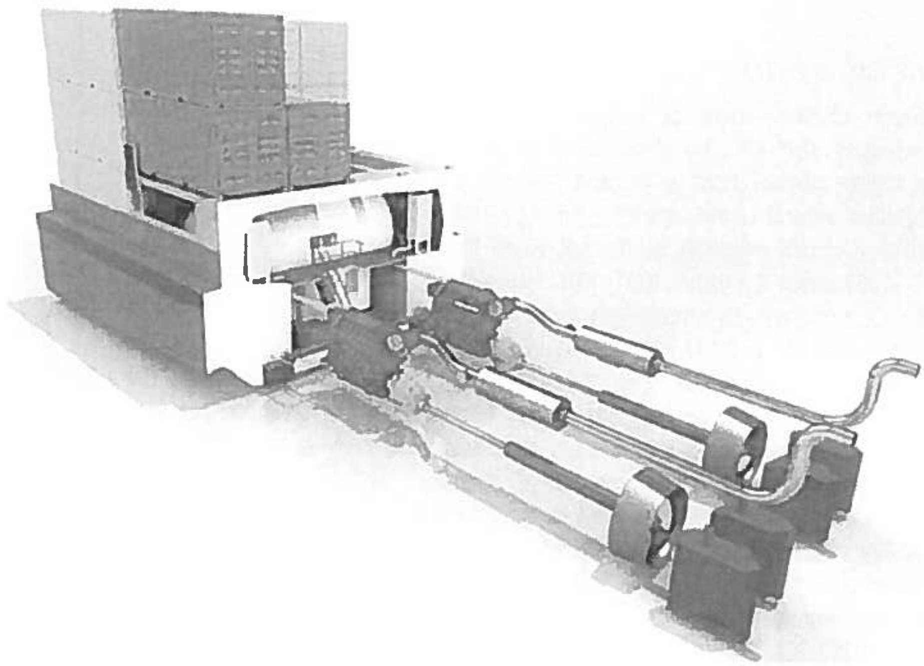


Figure 1 General lay out LNG/NG fuel system

As can be seen the LNG fuel tank is situated in front of the engine room, in a space which is currently cargo hold.

Danser has tabled technical documentation related to the refit toward LNG/ MGO (Liquefied Natural Gas/ Marine GasOil) as listed below:

Table 1 Technical documentation from [1]

Plan no.	Description
Eiger -10	General arrangement – version II
Eiger 11	Hazardous area plan
(13 sheets)	LNG Refit 'Eiger-Norwand' Specification
Eiger 12	GA LNG tank and pipeline ventilation v2
Eiger 16 (2 sheets)	Bunkerstation and ventstack
Eiger 20 (2 sheets)	Transverse section, version 1
Eiger 30	Side views, version 2
Eiger 40	Top views, version2
DAAF 036632 Rev A	Installation drawing
1302-1100-100 rev 0 (3 sheets)	LNG fuel system
1302 1000-100 rev 0	Heat and mass LNG system
400-230-24V (2 sheets)	Single line diagram

These documents have been used in a HAZID carried out by Lloyds Register [1]. The report on the HAZID states that the design may attain approval, provided the 'items for further consideration' are properly addressed. A list of these items is given in Table 2.

Table 2 List of Items for Further Consideration

Summary of Actions /Recommendations

No.	Worksheet ref.	Remarks/considerations	Responsibility
1.	Node1/ 1.1.1.	Tank plans to be submitted to LR for approval.	Cryonorm
2.	Node1/1.1.5.	Container falling calculations to be submitted	Shipyard
3.	Node1/1.2.2.	Calculations of sizing of safety valves for fire/worst case single failure scenario to be submitted.	Cryonorm
4.	Node1/2.1.1	A leak assessment on the pipes inside annular space is to be submitted to LR for approval.	Cryonorm
5.	Node1/2.1.1.	A CFD analysis demonstrating satisfactory air circulation for conditions in report to be submitted for approval.	Shipyard
6.	Node1/5.2.1.	A single steel engine room bulkhead with A60 insulation will be accepted. Details to be approved by LR.	Shipyard
7.	Node2/1.1.2.	A bunkering procedure is to be written and submitted for approval.	Cryonorm
8.	Node3/1.5.1.	An FMEA is required for the LNG liquid line tank isolation valve.	Cryonorm
9.	Node3/1.5.1.	The manual root valves are to be located close to the tank connection space access door.	Cryonorm
10.	Node3/1.6.1.	The air inlet for double wall ventilation is to be 1.5m from e/r air inlet	Shipyard
11.	Node6/5.	A written procedure for gas freeing the tank and refilling after docking is required.	Cryonorm

Discussion

The items identified during the HAZID are relevant and valid and should therefore be resolved.
Some additional remarks may be appropriate.
Loss of gas tightness of the LNG storage tank is referred to in item no. 4. The background of this item is that visual inspection of a vacuum tank is impossible once it has been built. This implies that, unlike any other item on board, the LNG vacuum type fuel tanks cannot be brought under the usual inspection regime of a classification society, i.e. inspections every 2.5 years and survey every 5 years.

Fortunately the material used is not sensitive to corrosion (provided the outer tank is manufactured from stainless steel as well) and the substance in the tank, i.e. LNG, is non-corrosive. Hence the only remaining mechanism is fracture due to fatigue.
It should be demonstrated that, when fracture occurs and in the worst case a pipe is entirely detached from the inner tank, the consequential events, such as evaporation, pressure build up in vacuum space, venting, icing, etc. are still manageable.
It is also noted that the technical evidence does currently not refer to the ADN [7], which contains regulation on the carriage of liquefied gasses in IWW ships, albeit that LNG is not on the list of allowed cargos. ADN does not allow tank penetrations below deck (section 9.3.1.11.4[1], ADN [7]). Which is however, to some extent, the case in this design.
The bunkering procedure as such need not be a complicated one. The main danger here is a lack of understanding on the part of the daily operators and consequential 'taking shortcuts' behavior, e.g. 'temporarily' overfilling. Therefore we advocate a training which is concluded with an examination which must be passed in order to qualify as crew on a LNG fuelled vessel. See also issue d. in this section.

A few additional issues have been identified which we propose for further consideration:

a. Full burst of containment system,
b. Effect analysis LNG spill from conditioning system on deck,
c. LNG spill from a fractured bunkering hose,
d. Education and awareness.

ad. a.
Although the probability of this event may be extremely remote, the consequences are not well understood and hard to predict. Therefore it is recommended to assume the worst. From a safety point of view this still need not be a problem, provided it is demonstrated that the probability of tank burst is acceptably low. The IGF code implies that this is the case when a 1/5 B distance between ship side and the tank is observed. Currently there is an investigation on-going, which aims at verifying this implicit assumption. Preliminary results seem to indicate that a typical vacuum LNG tank is unlikely to burst in a collision or dropped object event. However it still needs to be investigated whether piping penetration in the inner tank are likely to come off and what the consequences may be.

1

9.3.1.11.4 The bulkheads bounding the hold spaces shall be watertight. The cargo tanks and the bulkheads bounding the cargo area shall have no openings or penetrations below deck.
The bulkhead between the engine room and the service spaces within the cargo area or between the engine room and a hold space may be fitted with penetrations provided that they conform to the requirements of 9.3.1.17.5.

ad. b.
This may typically occur when there is a malfunctioning. It is very likely that the coldbox itself is capable of dealing with this event, it is however recommended to conduct an analysis.
ad. c.
This may typically happen when a mistake is made in the bunkering procedure or a material failure occurs. It is very likely that the drip tray and discharge channels are capable of dealing with this event, it is however recommended to conduct an analysis.
ad. d.
This issue is considered a real worry. Currently there are two (in the near future three) IWW tankers which use LNG as bunker fuel. A weighty argument for supporting the request for an exemption is that these vessels as tankers, subject to the ADN requirements [7]. This implies that the crew is already aware of the dangers of hazardous cargos and is therefore expected to behave in a responsible and competent fashion toward LNG bunker fuel as well.
Moreover ADN vessels are subject to restrictions with respect to where (and when) they are allowed to sail. Moreover they have an obligation to communicate their sailing plans with traffic control and follow traffic control instructions. For the vessel discussed in this document, this is not the case.
Therefore an explicit investigation into education, enforcement and mores is recommended. This issue is probably the most likely show stopper with regard to the use of LNG as bunker fuel.
In the particular case of the requesting party, Danser Container Line, there are no doubts with respect to this issue because of their good reputation and track record. However, the real fear is that parties with a less favorable reputation and track record will also apply for an exemption. At the moment it is unclear how authorities intend to handle this issue.

Conclusion/ recommendation

The HAZID/Risk assessment ([2]), reports eleven recommendations as shown in Table 2. TNO supports these recommendations.
In addition we recommend to investigate the following issues:

- Full burst of containment system due to collision or dropped object and effect analysis for fracture of piping and piping connections in vacuum space in case of a collision or a dropped object,
- effect analysis for fracture of piping and piping connections in vacuum space, under long term operational conditions,
- analysis LNG spill from conditioning system (cold box) or bunkering hose,
- crew training, qualification and enforcement.

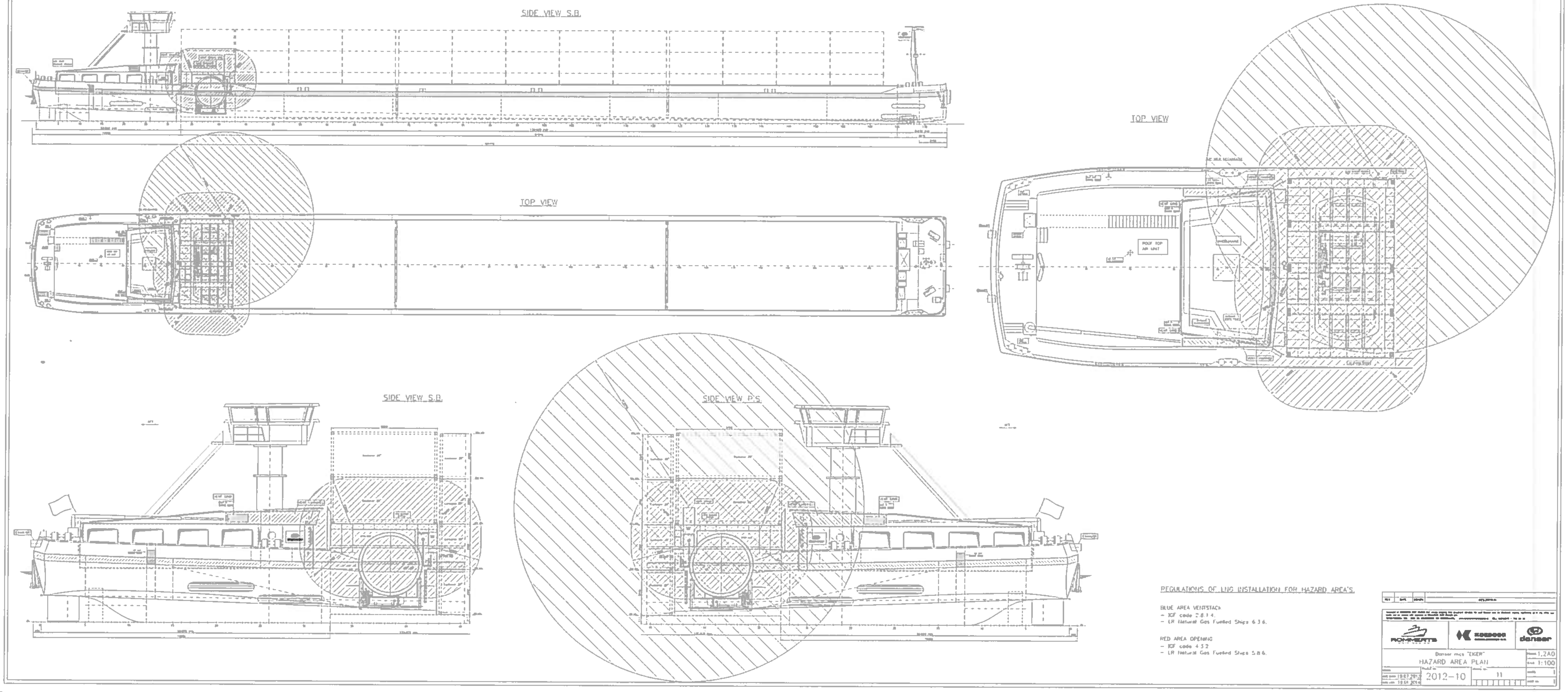
We acknowledge that some of these recommendations are generic to all IWW ship designs featuring LNG fuel. We therefore recommend that these issues are dealt with in a joint industry effort. For ad. a. such an effort is currently being made, results are expected early 2014.

TNO is of the opinion that a sufficient safety level is attainable for the use of LNG as fuel on mv 'Eiger'. We therefore recommend that when additional answers are given and documented, with respect to the issues as indicated, to grant the request for an exemption allowing the use of LNG as fuel on board mv 'Eiger'.

It is noted that the majority of issues raised, is generic to most LNG fuelled ships and hence not specific for mv 'Eiger'.

References

[1] Annex 5 to the recommendation of the dry cargo vessel 'Eiger', Danser 02-10-2013
[2] Refit of IWW Container Vessel 'Eiger', Danser Container Line, Technical Report RTS/ENG/131548 (Issue 1), Lloyds Register, 25 October 2013
[3] Besluit van 23 januari 1996, houdende het van kracht zijn voor de Rijn in Nederland van het Reglement betreffende het onderzoek van schepen op de Rijn 1995, CCNR Strassburg.
[4] IGC, International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, 1993 Edition, IMO
[5] IGF, draft International code on safety for Gas-Fuelled ships, IMO
[6] Cryogenic vessels-Static vacuum-insulated vessels, European Standard EN 13458-2:2002
[7] European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), United Nations Economic Commission for Europe, Geneva 2011.



REGULATIONS OF LNG INSTALLATION FOR HAZARD AREA'S.

BLUE AREA VENTSTACK
- IGF code 2.8.1.4.
- LR Natural Gas Fuelled Ships 6.3.6.

RED AREA OPENING
- IGF code 4.3.2
- LR Natural Gas Fuelled Ships 5.8.6.

ROMMERTS | KOEDOOD | damen

Damen mcs "TIGER"
HAZARD AREA PLAN

1,2A0
1:100
2012-10
11

COMMISSION CENTRALE POUR LA NAVIGATION DU RHIN

RV (14) 17
RV/G (14) 33
JWG (14) 28
25 mars 2014
Or. de fr/de/nl/en

COMITE DU REGLEMENT DE VISITE
GROUPE DE TRAVAIL DU REGLEMENT DE VISITE
GROUPE DE TRAVAIL COMMUN

Recommandation bateau à cargaison sèche « Eiger »

Communication du Secrétariat

Le Secrétariat a l'honneur de distribuer en annexe pour information la recommandation formulée par le groupe de travail du règlement de visite conformément à l'article 2.19 du RVBR.

COMMISSION CENTRALE POUR LA NAVIGATION DU RHIN

RECOMMANDATIONS AUX COMMISSIONS DE VISITE
RELATIVE AU RÈGLEMENT DE VISITE DES BATEAUX DU RHIN

RECOMMANDATION N° 2/2014
du 20 février 2014

Bateau à cargaison sèche EIGER

Le bateau à cargaison sèche « Eiger », numéro européen unique d'identification 02324957, est autorisé par la présente à utiliser du diesel et du gaz naturel liquéfié (GNL) en tant que combustible pour son installation de propulsion.

Conformément à l'article 2.19, chiffre 3, le bâtiment est autorisé à déroger aux dispositions des articles 8.01, chiffre 3 et 8.05, chiffres 6, 9, 11 et 12 jusqu'au 01/04/2019. L'utilisation du GNL est réputée suffisamment sûre sous réserve que les conditions ci-après soient respectées à tout moment:

1. Le bâtiment est transformé et classé conformément aux règles et sous le contrôle d'une société de classification agréée ayant établi des règles spécifiques pour les installations fonctionnant au GNL. La classe doit être maintenue.

2. Le système de propulsion au GNL doit être inspecté annuellement par la société de classification qui a classé le bateau.

3. Une étude HAZID exhaustive doit avoir été réalisée par la société de classification qui a classé le bateau (voir **annexe 1**).

4. Le système de propulsion au GNL doit être conforme au code IGF (Résolution MSC.285(86) du 1er juin 2009) à l'exception des points mentionnés en **annexe 2**.

5. Le système de propulsion au gaz naturel liquéfié est conçu de manière à limiter autant que possible les émissions de méthane.

6. Le réservoir de stockage de GNL doit être conforme aux exigences applicables aux réservoirs cryogéniques selon la norme EN 13458-2. Outre ces exigences, il doit pouvoir résister à des forces d'au moins 2g dans le sens horizontal et 1g dans le sens vertical avec un angle de gîte de 10 degrés. Le réservoir doit être fixé à bord du bateau de manière à garantir qu'il y demeure fixé en toutes circonstances. À l'extérieur du local du réservoir figure un marquage indiquant clairement la présence d'un réservoir de gaz naturel liquéfié.

7. Au-dessus et dans la première rangée en avant du local du réservoir, ne peuvent être placés des conteneurs avec des marchandises dangereuses ou des conteneurs réfrigérés.

8. L'avitaillement au GNL doit être réalisé conformément aux procédures figurant à l'**annexe 3.**

9. L'entretien du système de propulsion au GNL doit être assuré conformément aux instructions du fabricant. Ces instructions doivent être conservées à bord. Préalablement à toute remise en service et à la suite d'une réparation substantielle, le système de propulsion au GNL doit être examiné par la société de classification qui a classé le bateau.

10. Tous les membres d'équipage doivent avoir suivi une formation sur les dangers, l'utilisation, l'entretien et l'inspection du système de propulsion au GNL conformément aux procédures figurant en **annexe 4**.

11. Un dossier de sécurité doit être prévu à bord du bâtiment. Le dossier de sécurité doit décrire les tâches de l'équipage et doit comporter un plan de sécurité.

12. Toutes les données relatives à l'utilisation du système de propulsion au GNL doivent être conservées par le transporteur durant au moins cinq ans. Ces données doivent être communiquées à l'autorité compétente sur demande.

13. Un rapport annuel d'évaluation comportant l'ensemble des données collectées doit être adressé au Secrétariat de la CCNR pour distribution aux Etats membres. Ce rapport d'évaluation doit comporter au minimum les informations suivantes :
    a) panne du système;
    b) fuites;
    c) données relatives à l'avitaillement (diesel et GNL);
    d) données relatives à la pression;
    e) réparations et modifications subies par le système GNL, réservoir compris;
    f) données de fonctionnement;
    g) données relatives aux émissions, y compris les émissions de méthane;
    h) rapport d'inspection de la société de classification qui a classé le bateau.

Annexes :

Annexe 1 : No. RTS/ENG/131548 daté du 25 octobre 2013

Annexe 2 : Synthèse des dérogations au Code IGF (IMO-Résolution MSC.285(86)

Annexe 3 : Procédure pour l'avitaillement de gaz naturel liquéfié

Annexe 4 : Description de la formation des équipages à bord de bateaux de la navigation intérieure dont la propulsion est assurée par du GNL

Annexe 5 : Description du projet EIGER

Annexe 6 : Rapport TNO (TNO-201 3-M02643, 052.03406 du 14 janvier 2014)

Annexe 7 : Croquis (espaces dangereux et distances)

Annexes are located on website under and	**RV 2014 EN/FR** **RVG 2014 EN/FR** **JWG 2014 EN/FR**	**rv14_17en_2 and rv14_17fr_3** **rvg14_33en_2 and rvg14_33fr_3** **jwg14_28en_2 and jwg14_28fr_3**
Les annexes sont enregistrées sur le site sous et	**RV 2014 EN/FR** **RVG 2014 EN/FR** **JWG 2014 EN/FR**	**rv14_17en_2 et rv14_17fr_3** **rvg14_33en_2 et rvg14_33fr_3** **jwg14_28en_2 et jwg14_28fr_3**
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ZENTRALKOMMISSION FÜR DIE RHEINSCHIFFFAHRT

RV (14) 17
RV/G (14) 33
JWG (14) 28
25. März 2014
Or. de fr/de/nl/en

UNTERSCHUNGSAUSSCHUSS
ARBEITSGRUPPE UNTERSUCHUNGSORDNUNG
GEMEINSAME ARBEITSGRUPPE

Empfehlung Trockengüterschiff „Eiger“

Mitteilung des Sekretariats

Das Sekretariat übermittelt zur Information anliegend die von der Arbeitsgruppe Untersuchungsordnung nach § 2.19 RheinSchUO ausgesprochene Empfehlung.

ZENTRALKOMMISSION FÜR DIE RHEINSCHIFFFAHRT

EMPFEHLUNGEN AN DIE SCHIFFSUNTERSUCHUNGSKOMMISSIONEN ZUR RHEINSCHIFFSUNTERSUCHUNGSORDNUNG

EMPFEHLUNG Nr. 2/2014
vom 20. Februar 2014

Trockengüterschiff EIGER

Das Trockengüterschiff „Eiger“, einheitliche europäische Schiffsnummer 02324957, wird hiermit für den Einsatz von Diesel und Flüssigerdgas (LNG) als Brennstoff für die Antriebsanlage zugelassen.

Gemäß § 2.19 Nr. 3 ist für das Fahrzeug eine Abweichung von den §§ 8.01 Nr. 3, 8.05 Nr. 6, 8.05 Nr. 9, 8.05 Nr. 11 und 8.05 Nr. 12 bis zum 01.04.2019 zulässig. Der Einsatz von LNG gilt als hinreichend sicher, wenn folgende Bedingungen zu jeder Zeit erfüllt sind:

1. Der Umbau und die Klassifikation des Schiffes sollen unter der Aufsicht und Einhaltung der zu befolgenden Regeln einer anerkannten Klassifikationsgesellschaft erfolgen, welche besondere Regeln für Flüssigerdgas-Antriebssysteme hat. Die Klassifikation ist beizubehalten.

2. Das Flüssigerdgas-Antriebssystem muss jährlich von der Klassifikationsgesellschaft, welche das Schiff klassifiziert hat, inspiziert werden.

3. Von der Klassifikationsgesellschaft, die die Klassifikation des Schiffs vorgenommen hat, wurde eine umfassende HAZID-Studie (siehe **Anlage 1**) vorgenommen.

4. Das Flüssigerdgas-Antriebssystem erfüllt den IGF-Code (IMO Resolution MSC.285(86), 1. Juni 2009) mit Ausnahme der in **Anlage 2** aufgelisteten Punkte.

5. Das Flüssigerdgas-Antriebssystem ist so ausgeführt, dass Methan-Emissionen auf ein Minimum reduziert werden.

6. Der Flüssigerdgas-Vorratstank erfüllt die Anforderungen an kryogene Tanks gemäß der Europäischen Norm EN 13458-2. Zusätzlich zu diesen Anforderungen muss der Tank mindestens auf eine Belastung von 2g in der Horizontalebene und eine vertikale Belastung von 1g ausgelegt sein und einem Krängungswinkel von 10 Grad standhalten. Der Tank muss auf dem Schiff so angebracht sein, dass er unter jeglichen Umständen mit dem Schiff verbunden bleibt. Die Außenseite des Tankraumes ist mit Zeichen zu versehen, die eindeutig angeben, dass sich dort ein Flüssigerdgas-Tank befindet.

7. Über und in der ersten Reihe vor dem Tankraum dürfen keine Container mit Gefahrgut und keine Kühlcontainer plaziert werden.

8. Das Bunkern des Flüssigerdgases muss unter Einhaltung der in **Anlage 3** aufgeführten Verfahren erfolgen.

9. Die Instandhaltung des Flüssigerdgas-Antriebssystems muss unter Einhaltung der Anweisungen des Herstellers erfolgen. Die Anweisungen sind an Bord mitzuführen. Nach jeder erheblichen Reparatur muss das Flüssigerdgas-Antriebssystem vor der erneuten Inbetriebnahme von der Klassifikationsgesellschaft untersucht werden, die die Klassifikation des Schiffs vorgenommen hat.

10. Alle Besatzungsmitglieder sind zu den Gefahren, zum Einsatz, zur Instandhaltung und Inspektion des Flüssigerdgas-Antriebssystems nach den in **Anlage 4** festgelegten Verfahren zu schulen.

11. Eine Sicherheitsrolle ist an Bord des Schiffes vorzusehen. Die Sicherheitsrolle beschreibt die Pflichten der Besatzung und enthält einen Sicherheitsplan.

12. Alle Daten zum Einsatz des Flüssigerdgas-Antriebssystems sind vom Betreiber zu erfassen und müssen mindestens fünf Jahre lang aufbewahrt werden. Die Daten sind der zuständigen Behörde auf Anfrage zuzuschicken.

13. Ein jährlicher Auswertungsbericht, der alle erfassten Daten enthält, wird zur Verteilung an die Mitgliedstaaten an das Sekretariat der ZKR gesandt. Der Auswertungsbericht soll wenigstens die folgenden Informationen enthalten:
    a) Systemausfall;
    b) Leckage;
    c) Bunkerdaten (Diesel und Flüssigerdgas);
    d) Druckdaten;
    e) Abweichungen, Reparaturen und Änderungen des Flüssigerdgassystems einschließlich des Tanks;
    f) Betriebsdaten;
    g) Emissionsdaten, einschließlich Methan-Emissionen
    h) Prüfbericht der Klassifikationsgesellschaft, die die Klassifikation des Schiffs vorgenommen hat.

Anlagen:

Anlage 1: Bericht Nr. RTS/ENG/131548 vom 25. Oktober 2013

Anlage 2: Übersicht über die Abweichungen vom IGF-Code (IMO-Resolution MSC.285(86)

Anlage 3: Verfahren für das Bunkern von Flüssigerdgas

Anlage 4: Beschreibung der Schulung von Besatzungen an Bord von Binnenschiffen mit Flüssigerdgasantrieb

Anlage 5: Projektbeschreibung EIGER

Anlage 6: TNO Bericht (TNO-201 3-M02643, 052.03406 vom 14. Januar 2014)

Anlage 7: Zeichnung (Gefahrenbereiche und Abstände)

Annexes are located on website under and	**RV 2014 EN/DE** **RVG 2014 EN/DE** **JWG 2014 EN/DE**	**rv14_17en_2 and rv14_17de_3** **rvg14_33en_2 and rvg14_33de_3** **jwg14_28en_2 and jwg14_28de_3**
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CENTRALE COMMISSIE VOOR DE RIJNVAART

RV (14) 17
RV/G (14) 33
JWG (14) 28
25 maart 2014
Or. de fr/de/nl/en

COMITÉ REGLEMENT VAN ONDERZOEK
WERKGROEP REGLEMENT VAN ONDERZOEK
GEMEENSCHAPPELIJKE WERKGROEP

Aanbeveling droge lading schip "Eiger"

Mededeling van het secretariaat

Het secretariaat heeft het genoegen u hierbij ter informatie de door de Werkgroep Reglement van onderzoek overeenkomstig artikel 2.19 van het ROSR geuite aanbeveling te doen toekomen.

CENTRALE COMMISSIE VOOR DE RIJNVAART

AANBEVELINGEN AAN DE COMMISSIES VAN DESKUNDIGEN MET BETREKKING TOT TOEPASSING VAN HET REGLEMENT ONDERZOEK SCHEPEN OP DE RIJN

AANBEVELING Nr. 2/2014 van 20 februari 2014

Droge lading schip EIGER

Voor het droge lading schip “Eiger”, Europees scheepsidentificatienummer 02324957, wordt bij deze de vergunning afgegeven voor het gebruik van diesel en vloeibaar aardgas (LNG, Liquefied Natural Gas) als brandstof voor de voortstuwingsinstallatie.

Op grond van artikel 2.19, derde lid, mag bij genoemd schip worden afgeweken van de artikelen 8.01, derde lid, 8.05, zesde lid, 8.05, negende lid, 8.05, elfde lid en 8.05, twaalfde lid, tot en met 01.04.2019. Het gebruik van LNG wordt geacht voldoende veilig te zijn indien te allen tijde aan de volgende voorwaarden wordt voldaan:

1. Het schip wordt verbouwd en geklasseerd onder toezicht en overeenkomstig de van toepassing zijnde voorschriften van een erkend classificatiebureau dat specifieke voorschriften voor LNG-installaties hanteert. De klasse blijft gehandhaafd.

2. Het LNG-voortstuwingssysteem wordt jaarlijks gekeurd door het classificatiebureau dat het schip heeft geklasseerd.

3. Een volledige HAZID-keuring door het classificatiebureau dat het schip heeft geklasseerd (zie **bijlage 1**) is uitgevoerd.

4. Het LNG-voortstuwingssysteem voldoet aan de IGF-Code (IMO-Resolutie MSC 285(86) van 1 juni 2009), behoudens de in **bijlage 2** vermelde onderdelen.

5. Het LNG-voortstuwingssysteem is zodanig uitgevoerd dat uitstoot van methaan maximaal wordt beperkt.

6. De LNG-opslagtank voldoet aan de voorschriften voor cryogene tanks overeenkomstig de EN 13458-2 standaard. Afgezien van deze eisen, moet de tank minimaal bestand zijn tegen een kracht van 2 *g* in het horizontale vlak, 1 *g* in de verticale richting en een helling van 10°. De tank is dusdanig op het schip aangebracht dat verzekerd is dat deze onder alle omstandigheden aan het schip bevestigd blijft. Aan de buitenzijde van de tankruimte zijn tekens aangebracht die duidelijk weergeven dat er zich daar een LNG-opslagtank bevindt.

7. Boven de tankruimte en in de eerste rij voor de tankruimte mogen geen containers met gevaarlijke goederen en geen koelcontainers worden geplaatst.

8. Bunkeren van LNG wordt uitgevoerd conform de in **bijlage 3** vermelde procedures.

9. Het onderhoud van het LNG-voortstuwingssysteem wordt uitgevoerd overeenkomstig de instructies van de fabrikant. De instructies worden aan boord bewaard. Voordat het voortstuwingssysteem opnieuw in bedrijf wordt genomen en tevens na een omvangrijke reparatie, moet het door het classificatiebureau dat het schip heeft geklasseerd, onderzocht worden.

10. Alle bemanningsleden zijn opgeleid in de bestrijding van gevaren alsmede in het gebruik, het onderhoud en de inspectie van het LNG-voortstuwingssysteem overeenkomstig de in **bijlage 4** vermelde procedures.

11. Een veiligheidsrol is beschikbaar aan boord van het schip. De veiligheidsrol beschrijft de taken van de bemanning en bevat tevens een veiligheidsplan.

12. Alle gegevens betreffende het gebruik van het LNG-voortstuwingssysteem worden verzameld door de vervoerder en moeten minstens vijf jaar worden bewaard. Deze gegevens worden op verzoek naar de bevoegde autoriteit verzonden.

13. Er wordt jaarlijks een evaluatierapport, waarin alle verzamelde gegevens zijn opgenomen, opgesteld en naar het secretariaat van de CCR gezonden, ter uitdeling onder de lidstaten. Dit evaluatierapport bevat ten minste de volgende informatie:
    a) systeemuitval;
    b) lekkage;
    c) bunkergegevens (diesel en vloeibaar aardgas);
    d) drukgegevens;
    e) afwijkingen, reparaties en wijzigingen van het LNG-systeem, de tank hieronder begrepen;
    f) functioneringsgegevens;
    g) uitstootgegevens, methaan hieronder begrepen;
    h) verslag van het onderzoek opgesteld door het classificatiebureau dat het schip heeft geklasseerd.

Bijlagen:

Bijlage 1: Rapport Nr. RTS/ENG/131548, d.d. 25 oktober 2013

Bijlage 2: Overzicht van de afwijkingen van de IGF-code (IMO-Resolutie MSC.285(86)

Bijlage 3: Procedure voor het bunkeren van vloeibaar aardgas

Bijlage 4: Beschrijving van de opleiding van bemanningen aan boord van binnenschepen die met vloeibaar aardgas worden aangedreven

Bijlage 5: Project beschrijving EIGER

Bijlage 6: Verslag TNO (TNO-201 3-M02643, 052.03406 van 14 januari 2014)

Bijlage 7: Tekening (gevaarlijke ruimten en afstanden)

Annexes are located on website under	**RV 2014 EN/NL**	**rv14_17en_2 and rv14_17nl_3**
and	**RVG 2014 EN/ NL**	**rvg14_33en_2 and rvg14_33nl_3**
	JWG 2014 EN/ NL	**jwg14_28en_2 and jwg14_28nl_3**
Les annexes sont enregistrées sur le site sous	**RV 2014 EN/NL**	**rv14_17en_2 et rv14_17nl_3**
et	**RVG 2014 EN/ NL**	**rvg14_33en_2 et rvg14_33nl_3**
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