

Faxaflóahafnir sf

(Associated Icelandic Ports – Faxaports)

Safety manual on LNG bunkering procedures for Faxaports

A safety manual on LNG bunkering procedures for Faxaports have been developed by Faxaports Management Team. The safety manual outlines the safety regulations and demands that are required for safe handling in LNG bunkering operations, including ship-to-ship (STS) and truck-to-ship (TTS) operations within the operating area of the Faxaports Area.

The safety manual is valid in combination with [the Port Information Guide](#).

Summary and recommendations

Handling of LNG as fuel for ships in Faxaports is expected to increase in the near future. The use of LNG as fuel for ships contributes to almost no sulphur emissions and particles. It also considerably reduces emissions of nitrogen oxides and carbon dioxides. However, the physical properties of LNG introduce a number of hazards that must be considered when handling LNG. A safety manual on LNG bunkering procedures for Faxaports has therefore been developed to ensure safe LNG operations, as well as assuring harmonized procedures and regulations.

The safety manual outlines the safety regulations and demands that are required for safe handling in LNG bunkering operations, including ship-to-ship (STS) and truck-to-ship (TTS) operations within the operating area of Faxaports.

The safety manual is valid in combination with the Port Information Guide. In addition, international and national laws, regulations, and guidelines must be adhered to in all operations. The applicable rules and regulations are to be reviewed at regular intervals in order to keep the regulatory framework up-to-date.

Abbreviations

ADR – European Agreement Concerning the Transport of Dangerous Goods by Road

BLEVE - Boiling liquid expanding vapour explosion

EMSA - The European Maritime Safety Agency

ESD – Emergency shut-down

HAZID – Hazard Identification

IAPH – International Association of Ports and Harbours

IGC Code – International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (Gas Carrier Code)

IGF Code – International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels. *(Entry into force on 1 January 2017)*

IR – Individual Risk

ISM – International Safety Management Code

LFL – Lower Flammability Limit

LNG – Liquefied Natural Gas

PIC – Person in Charge

PPE – Personal Protective Equipment

QCDC - Quick Connect Disconnect Coupling

QualRA - Qualitative Risk Assessment

QRA - Quantitative Risk Assessment

RPT – Rapid Phase Transition

SIMOPS – Simultaneous Operations

SMS - Safety Management System

STCW - the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

STS – Ship To Ship

TTS – Truck To Ship

UFL – Upper Flammability Limit

WPCI – World Ports Climate Initiative

Table of contents

Summary and recommendations	1
Abbreviations	2
1 Introduction	5
1.1 Port-specific safety manual	6-7
2 General information on LNG including general considerations for LNG bunkering	7
2.1 Hazards when handling LNG	7
2.1.1 Leaks and accidental spills	8
2.1.2 Cryogenic hazards	8
2.1.3 LNG fire and explosion hazards	8-9
2.1.4 Other hazards	9
3 Regulatory framework	9
3.1 International	10
3.2 National	12
3.3 Port specific	12
4 Risk assessments	12
5 Safety guidance	14
5.1 Hazardous areas	14
5.2 Safety zones and security zones	14
5.3 Handling of LNG within Faxaports area	16
5.3.1 Simultaneous Operations (SIMOPS)	17
5.3.2 Weather restrictions	17
5.3.3 Personal Protective Equipment (PPE)	18
5.3.4 Emergency shut-down system (ESD system)	18
5.4 Distribution of responsibility.....	18
5.4.1 Faxaports general responsibility	19
5.4.2 Ship-to-ship	19
5.4.3 Truck-to-ship	19
5.4.4 Master	20
5.4.5 Person in Charge (PIC)	20
6 Bunkering procedures and requirements	20
6.1 Before bunkering	20
6.2 During bunker transfer	21
6.3 After bunker	22
7 LNG bunker supplier accreditation system	22
7.1 General requirements	22
7.1.1 Bunker vessel criteria	22
7.1.2 Truck criteria	23
7.1.3 Receiving vessel	23
8 Emergency procedures	23

8.1 Emergency response planning	24
9.0 LNG bunkering education and training	25
9.1 Education and training requirement	25
9.1.1 General requirements	25
9.1.2 Specific requirements	25
9.2 SGMF - Bunkering of ships with LNG competency guidelines	26
10 LNG Bunker Checklists – IAPH examples	27
10.1 LNG Bunker Checklist – Ship to Ship (IAPH example)	27
10.2 LNG Bunker Checklist – Truck to Ship (IAPH example)	27
List of references	28
Appendix 1 – Map of Sundahofn Harbour	
Appendix 4 – IAPH LNG Bunker Checklist Ship to Ship	
Appendix 5 – IAPH LNG Bunker Checklist Truck to Ship	

1 Introduction

As of today, the LNG fuelled Icelandic vessels do not exist but forecast for the demand for LNG as bunker fuel is expected. The processes and safety regulations to be agreed upon between the LNG suppliers, Faxaports and appropriate Administration.

Since the handling of LNG as fuel for ships in the Faxaports Area is expected to increase in the near future, there is a need of a safety manual on LNG bunkering procedures for Faxaports in order to ensure safe LNG operations, as well as assuring harmonized procedures and regulations.

Based on previous feasibility study regarding possibilities and alternatives for LNG bunkering in Faxaports, it was concluded that the most practical solution for LNG refuelling of ships is ship-to-ship (STS) bunkering. Another option is to perform LNG bunkering by truck-to-ship (TTS). Faxaports have no plans to establish an LNG terminal in the near future since the operations of the port are quite geographically widespread and the demand for LNG is assumed to be spread out in different parts of Faxaports.

Based on the above, the safety manual only includes STS bunkering and TTS bunkering within the operating area of Faxaports.

The different bunkering methods are illustrated in Figure 1 below.

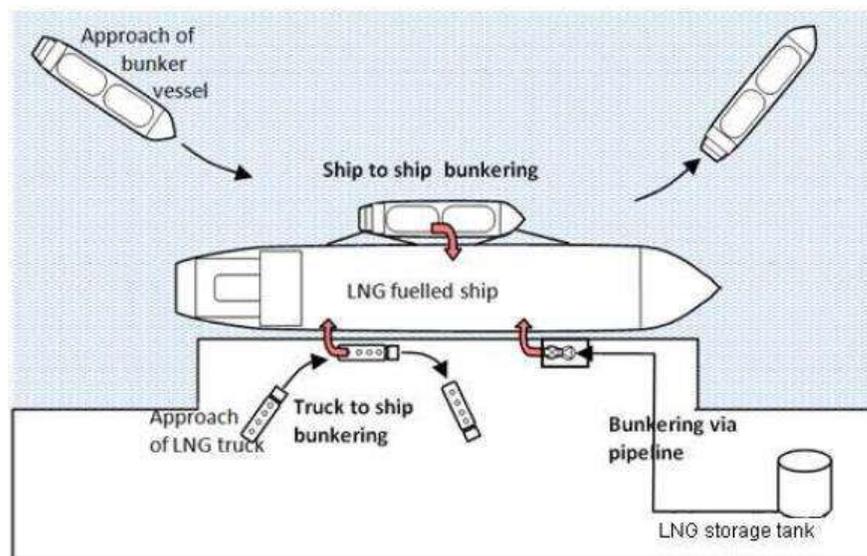


Fig No. 1 - Possible bunkering stations

1.1 Port-specific safety manual

The safety manual is valid in combination with the Port Information Guide. at <https://www.faxafloahafnir.is/en/port-information-guide/>

In addition to the harbour regulations and the safety regulations that is outlined in this safety manual, international and national laws, regulations, and guidelines must be followed in all operations.

This safety manual outlines the safety regulations and demands that are required for safe handling in LNG bunkering operations, including ship-to-ship (STS) and truck-to-ship (TTS) operations within the operating Faxaports area.

A typical arrangement of an LNG bunker vessel and an LNG fuelled vessel equipped with type C tanks is illustrated in Figure 2 below.

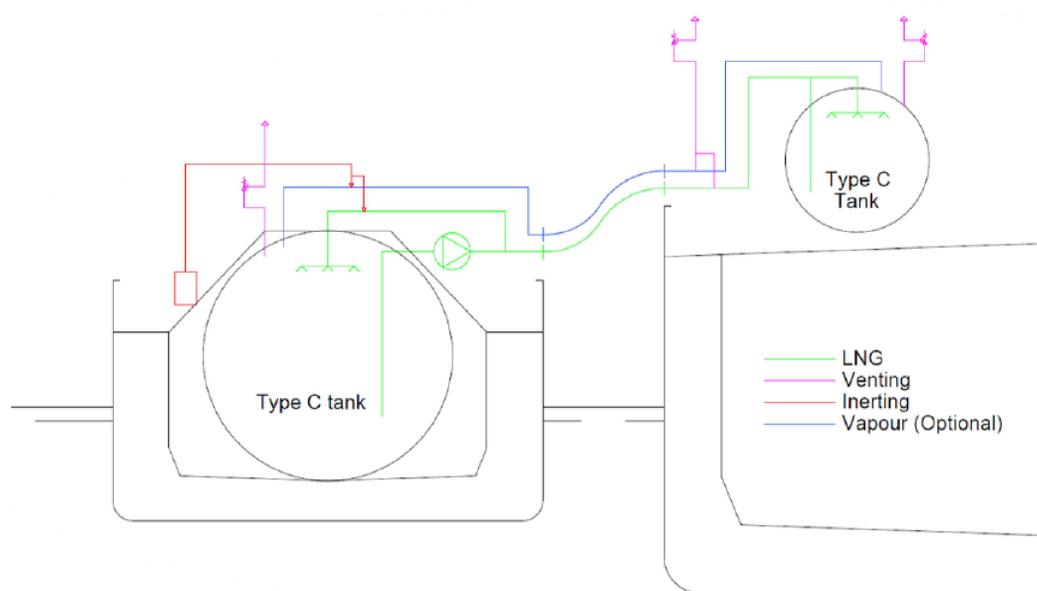


Figure 2 Typical arrangement of bunkering ship and LNG fuelled ship with type C tank.

A typical arrangement of an LNG tank truck and an LNG fuelled vessel equipped with type C tanks is illustrated in Figure 3 below.

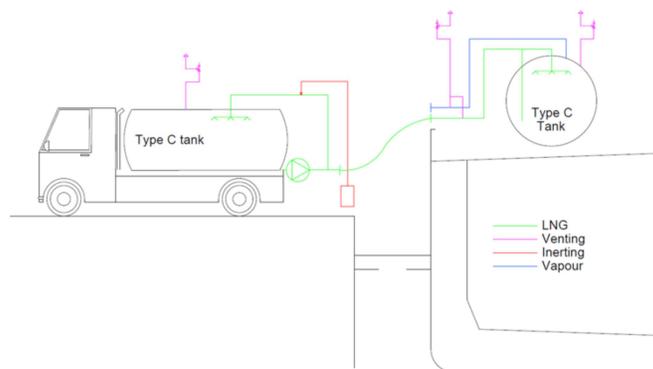


Figure 3 Typical arrangement of LNG tank truck and LNG fuelled ship with type C tank.

2.0 General information on LNG including general considerations for LNG bunkering

Liquefied natural gas, LNG, is natural gas that at atmospheric pressure has been cooled into a liquid state at about -162°C . The liquefaction process of the natural gas into LNG reduces the volume of the gas with a factor of about 600 times, making it easier and more effective to transport and store. LNG is a mixture of substances, predominantly methane (CH_4), which constitutes about 80 – 95% of the mixture. Methane is a colourless, odourless gas, lighter than air at ambient temperatures. However, it is heavier than air until it warms to approximately -110°C . Other LNG components include ethane, propane, butane and small quantities of nitrogen. The proportion of the mixture is varying depending on the source of LNG and for how long it has been ageing.

2.1 Hazards when handling LNG

The use of LNG as fuel for ships contributes to almost no sulphur emissions and particles. It also considerably reduces emissions of nitrogen oxides and carbon dioxides. However, the physical properties of LNG introduce a number of hazards that must be considered when handling LNG.

According to 5.3 Potential hazardous situations associated with LNG transfer in the ISO/TS 18683:2015, *“the risks and hazards related to the LNG bunkering are closely linked to the potential rate of release in accidental situations and factors such as transfer rates, inventories in hoses and piping, protective systems such as detection systems, ESD, and spill protection are essential”* (ISO, 2015). This is important considerations which should be taken into account in when designing the bunkering system.

2.1.1 Leaks and accidental spills

Several causes can lead to leaks and accidental spills, such as operational and technical failure. Therefore, due care should be taken during bunkering operations in order to avoid unfavourable events.

In case of an eventual spill or leakage, the large temperature difference between the cold LNG and the ambient air implies that the natural gas will evaporate quickly. The evaporating gas will then form a vapour cloud that cools surrounding air. Humidity in the air will be condensed and form a mist that together with the vapour cloud can affect the visibility. Certain mist formation also develops around cold pipes and hoses during normal activities. As the gas is lighter than air at temperatures above -110°C , it will rapidly start to rise and be mixed and diffused with air. The quick dispersion is of advantage with regard to safety in case of leakage in open air

2.1.2 Cryogenic hazards

The so called cryogenic properties linked to LNG are due to the extremely low temperature of LNG, typically around -162°C . Contact with LNG can result in severe cryogenic burns and frostbite on human tissues. Appropriate Personal Protective Equipment (PPE), should be worn at all times. It is essential to wear correct gloves for cryogenic protection. Deliberate contact with cryogenic pipework should be avoided.

Brittle fracture and damage to equipment can be caused by embrittlement when material not designed for cryogenic temperatures, such as standard ship steel, gets in contact with LNG. Drop trays of stainless steel are used to avoid structural damages. Material such as stainless steel and aluminium should be used wherever cryogenic temperatures are expected. Water curtains can be used to protect steel structures from small leaks of LNG.

2.1.3 LNG fire and explosion hazards

Natural gas can only be ignited in a gaseous phase, when the concentration of natural gas vapour is within its flammable range: mixed with air in the range of 5% to 15% by volume. At a concentration less than 5%, the lower flammability limit (LFL), there is insufficient natural gas as fuel to burn. At a concentration greater than 15%, the upper flammability limit (UFL), there is not enough oxygen in the mixture to support combustion. Fires can start in different ways and act with different characteristics:

- *Flash fire* – occurs when a cloud of gas burns in an open area without generating any significant overpressure. An ignited cloud will “flash back” and burn its way back to the LNG spill source.
- *Pool fire* – occurs when LNG spills evaporate and the gas, in a combustible gas-air concentration, above the pool ignites and burns, either on water or on land. If LNG is spilled on water the heat exchange and evaporation is quick and the fire intensive. Land spills have a slower evaporation rate, hence, less intensive fire.
- *Jet fire* – can occur due to gas or liquid release from a pressurised system. The flow velocity in a jet fire will be very high and are likely to cause damage to structure and equipment.

- *Boiling liquid expanding vapour explosion (BLEVE)* – is a vapour explosion which can occur if LNG in a closed containment is heated up. If the tank collapses, the sudden decompression produces a blast resulting in drastic lowering of pressure. This results in rapid boiling of liquid creating large quantities of vapour which is ignited if in its flammability range.

2.1.4 Other hazards

- *Rapid phase transition (RPT)* – is a rapid physical phase transition of LNG to vapour. This process can occur when LNG comes into contact with a heat source, such as during an LNG spill into water where the water heats up the LNG and regasification is instant.
- *Rollover and stratification* – LNG in a storage tank could be stratified into layers of different densities. If the layers are suddenly mixed (known as “rollover”), a rapid and potentially dangerous release of vapour occurs.
- *Contamination of the bunker lines and/or connections* – If moisture, dust or CO₂ is present in bunker lines being cooled, it will form ice which may block or damage important equipment such as sensors, seals and dry-break couplings. This could be prevented by the use of filters and purging with nitrogen.
- *Trapped volume* – If LNG remains in pipes that is trapped between closed valves after bunkering, it will boil and expand to fill the space available. The expanding vapour leads to a pressure build up that will increase to dangerous levels and cause the pipes to burst or valves to be damaged. This should be prevented by pressure relief valves provided at appropriate locations.
- *Oxygen deficiency* – could occur due to LNG spills that vaporises to natural gas and air is displaced. It can cause asphyxiation due to lack of oxygen if the concentration of gas develops in an unventilated, confined area.

3.0 Regulatory framework

In this section a list of applicable rules, regulations, guidelines as well as industry standards and recommendations related to LNG and LNG bunkering is presented, divided into international, national and Port Information Guide. In addition, a list of relevant national and port specific authorities is included as applicable.

There is a rapid global development of rules and regulations for LNG bunkering. Hence, the list should be reviewed at regular intervals in order to keep the regulatory framework up-to-date ensuring latest editions being followed as well as to comprise new rules and regulations.

3.1 International

IMO (2016) IGC Code – International Code for the Construction and Equipment for Ships Carrying Liquefied Gases in Bulk

IMO (enters into force 01 Jan 2017) IGF Code – International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels

IMO (2010) STCW – International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended and Manila Amendments

Amendments to the STCW Code, entering into force on 1 January 2017, includes new mandatory minimum requirements for the training and qualifications of masters, officers, ratings and other personnel on serving on ships subject to the IGF Code. The amendments are found in a new regulation V/3 in Chapter V of the STCW code.
ISO 20519:2017 Ships and marine technology – Specification for bunkering of liquefied natural gas fuelled vessels

ISO/TS 18683:2015 Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships

ISO/TS 16901:2015 Guidance on performing risk assessment in the design of onshore LNG installations including the ship/shore interface

ISO 28460:2010 Petroleum and natural gas industries – Installation and equipment for liquefied natural gas – Ship-to-shore interface and port operations

ISO 16903:2015 Characteristics of LNG, influencing the design, and material selection

- *IEC 60079-10-1:2015 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres*
- *Directive 89/686/EEC – Personal Protective Equipment*
(To be replaced with effect from 21 April 2018 by the new Regulation (EU) 2016/424)
- *Directive 2014/94/EU on the deployment of alternative fuels infrastructure*
- *EU ATEX Directives (Directive 99/92/EC or “ATEX137” or “ATEX Workplace Directive” AND Directive 94/9/EC or “ATEX95” or “ATEX Equipment Directive”)*
- *ADR 2017 – European Agreement Concerning the Transport of Dangerous Goods by Road*
- *IACS Rec 142 LNG bunkering guidelines*
- *IACS Rec 146 Risk assessments as required by the IGF Code*
- *IAPH (2015) LNG Bunkering Safety Checklists (Ship to Ship, Truck to Ship, Shore to Ship)*
- *SGMF (2014) Gas as a Marine Fuel – An Introductory Guide*
- *SGMF (2015) LNG Bunkering – Safety Guidelines*
- *SGMF (2015) Quality and Quantity – Contractual Guidelines*

- *SGFMF (2016) Bunkering of Ships with LNG – Competency Guidelines*

SIGTTO (2009) ESD arrangements & linked ship/shore systems for liquefied gas carriers

- *SIGTTO (2013) Ship-to-Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases*
- *SIGGTO (2003) LNG Operations in Port Areas*
- *EMSA (2018): The European Maritime Safety Agency (EMSA) – Guidance on LNG Bunkering to Port Authorities and Administrations*

3.2 National

- Environment Agency of Iceland (Umhverfisstofnun)
- Regulation no. 124/2015 (Sox content).
- Regulation no. 960/2016 (fuel quality).
- ICETRA – Icelandic Transportation Administration (Samgöngustofa)

- Slökkvilið Höfuðborgarsvæðisins BS (112)
- Icelandic Coast Guard (Landhelgisgæslan)

3.3 Port specific

- Faxaports Safety Guidelines
- Port Information Guide
- Environmental Permits of Faxaports
- City of Reykjavik
- Slökkvilið Höfuðborgarsvæðisins (SHS) (Fire Engines)

4.0 Risk assessments

A risk assessment of the bunkering operation including risk to personnel and environment shall be conducted in accordance with ISO/TS 18683:2015 (ISO, 2015). The risk assessments shall be carried out by a team of suitably qualified and experienced individuals representing different disciplines including adequate expertise and experience in risk assessment techniques for LNG applications. Participants from each of the following organisations shall be involved in the risk assessment:

- Faxaports
- ICETRA – Icelandic Transportation Administration (Samgöngustofa)
- Slökkvilið Höfuðborgarsvæðisins BS (Fire Engines)
- Bunker supplier
- Bunker receiver

It is recommended that both the qualitative and the quantitative risk assessments, as described below, should be conducted with professional guidance of an external risk assessment expert in order to ensure an appropriate quality and outcome of the risk assessment.

The main steps in the risk assessment as per ISO/TS 18683:2015 shall be to:

- identify what can go wrong (hazard identification (HAZID)),
- assess the effect (consequence and impact assessment),
- assess the likelihood (frequency assessment), and
- decide if the risk is tolerable, or identifying risk reducing measures.

If bunkering is carried out without simultaneous cargo operations and without passengers on-board, a *Qualitative Risk Assessment* (QualRA) shall be carried out as a minimum.

The main steps in a *qualitative risk assessment* consist of the following:

- Definition of a study basis (*see ISO TS 18683 7.2.2 for reference*).

- Hazard identification (HAZID) review, normally performed as a workshop with the purpose of identifying hazards and assess the risks using a risk matrix (see *ISO TS 18683 7.2.3 for reference*).

Determination of safety zones and security zones (see *ISO TS 18683 7.2.4 and 7.2.5 for reference*).

- Documentation of the HAZID and qualitative risk assessment in a report (see *ISO TS 18683 7.2.6 for reference*).

Risk levels in a qualitative risk assessment are estimated in relative terms such as high or low or ranked on a scale, for example from 1 to 5. The risk levels are usually shown by a risk matrix which indicates a level of risk associated with a specific combination of probability and consequence.

In case of bunkering during cargo operations, bunkering with passengers on-board or passengers embarking/disembarking, a dedicated and comprehensive *Quantitative Risk Assessment* (QRA) shall be performed (as a supplement to the QualRA), which shall address the effects of the simultaneous operation (SIMOP).

A QRA is a formalised statistical risk assessment method where risk levels are calculated in absolute quantitative terms. The risk levels are compared with defined risk acceptance criteria as per ISO TS 18683 Annex A Table A.1. The risk acceptance criteria is expressed as individual risk (IR), i.e. the probability of being killed (or harmed at a certain level) on an annual basis from all hazards.

The QRA shall demonstrate that the risk is acceptable. In addition, acceptance is required by all parties (such as authorities, terminal, ship and bunkering operator, and supplier operator).

The QRA shall be conducted by usage of recognized modelling tools where frequencies and consequences of each modelled event can be calculated and combined to measure the overall risk

The main objective in a *quantitative risk assessment* is to:

- Confirm safety zones
- Demonstrate that overall safety targets are met
- Evaluate and select safeguards and risk reducing measures

Instructions given in ISO/TS 18683:2015 should be used for detailed guidance on the requirement and application of risk assessments for LNG bunkering.

The bunkering concepts that are included in this manual, Truck-to-Ship (TTS), and Ship-to-Ship (STS), should be evaluated individually in order to address the risks associated with each bunkering concept

5.0 Safety guidance

5.1 Hazardous areas

Hazardous area, as per *IEC 60079-10-1:2015*, is a three-dimensional area in which an explosive gas atmosphere is or may be expected to be present in quantities such

as to require special precautions for the construction, installation and use of equipment.

Hazardous areas are classified into three zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as per below:

- Zone 0 – an area in which an explosive gas atmosphere is present continuously or for long periods or frequently.
- Zone 1 – an area in which an explosive gas atmosphere is likely to occur in normal operation.
- Zone 2 – an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only.

The hazardous area zones are defined for:

- The *receiving ship* in accordance with the IGF Code, regulation 12.5 (IMO, 2016a);
- The *bunkering ship* in accordance with the IGC Code, regulation 1.2.24 (IMO, 2016b) and where gas may be present as a result of the bunkering operation; and
- The *bunkering truck tanker facility* in accordance with IEC 60079-10-1:2015.

5.2 Safety zones and security zones

According to ISO/TS 18683:2015 a safety zone and security zone should be established around the bunkering station/facilities. These zones are in addition to the hazardous areas. Both the safety and security zones should be enforced and monitored at all times during bunkering.

Prior to all LNG bunkering operations, a safety zone shall be established around the bunkering station/facilities to control ignition sources and ensure that only essential personnel and activities are allowed in the area that could be exposed to a flammable gas in the event of an accidental release of LNG or natural gas during bunkering. The safety zone shall never be zero and never be less than the hazardous areas and/or the minimum distance defined by authorities from any part of the bunkering installation.

In ISO/TS 18683:2015 there are two different approaches to determine the safety zone distance:

- *deterministic approach* - calculating the distance to LFL based on a maximum credible release.
- risk-based approach (also referred to as *probabilistic approach*).

If using a *deterministic approach*, the safety zone, as per ISO/TS 18683:2015, is defined as the area within the distance to LFL as determined by a recognised and validated dispersion model for the maximum credible release as defined as part of

the HAZID performed in the QualRA. The maximum credible release scenario shall take into account at least the following:

- the characteristics of the bunkering facility
- factors specific to the bunkering operation such as transfer rate and inventory in the bunkering facilities, properties of the LNG in the bunkering system (temperature, pressure), weather conditions etc.
- mitigation measures that are implemented.

If using the *probabilistic approach* by performing a quantitative risk assessment (QRA) as per ISO/TS 18683:2015, a smaller safety zone may be the result compared to using the deterministic approach. The risk assessment shall address all hazard and release scenarios as identified in the HAZID performed in the QualRA. It is important that appropriate risk acceptance criteria are used.

Following restrictions applies during the bunkering operations in the safety zone if not otherwise agreed with the port authority:

- Smoking is strictly prohibited.
- Naked lights, mobile phones, cameras and other non-certified portable electrical equipment are strictly prohibited.
- Cranes and other lifting appliances not essential to the bunkering operation are not to be operated.
- Other possible sources of ignition should be eliminated.
- No vehicle (except the tank truck) should be present in the safety zone.
- No ship or craft should enter the safety zone, except if authorized by the Port Authorities.

Only authorized personnel should have access to the safety zone, provided they are fitted with appropriate personal protective equipment (PPE) and portable gas detector.

The security zone is site dependent and is set based upon ship/port specific operations. The size and location of the security zone is established based on the findings from the qualitative and/or quantitative risk assessment.

The security zone, as per ISO/TS 18683:2015, is an area where movement such as ship traffic and other activities such as shore-side operations need to be monitored and controlled during bunkering to prevent possible incidents. The security zone will always be larger than the safety zone. The security zone may also be referred to as the “exclusion zone”.

Figure 4 below illustrates an example of possible location of the hazardous areas, safety zone and security zone. Physical barriers such as breakwaters and ISPS border could affect the size and layout of the security zone.

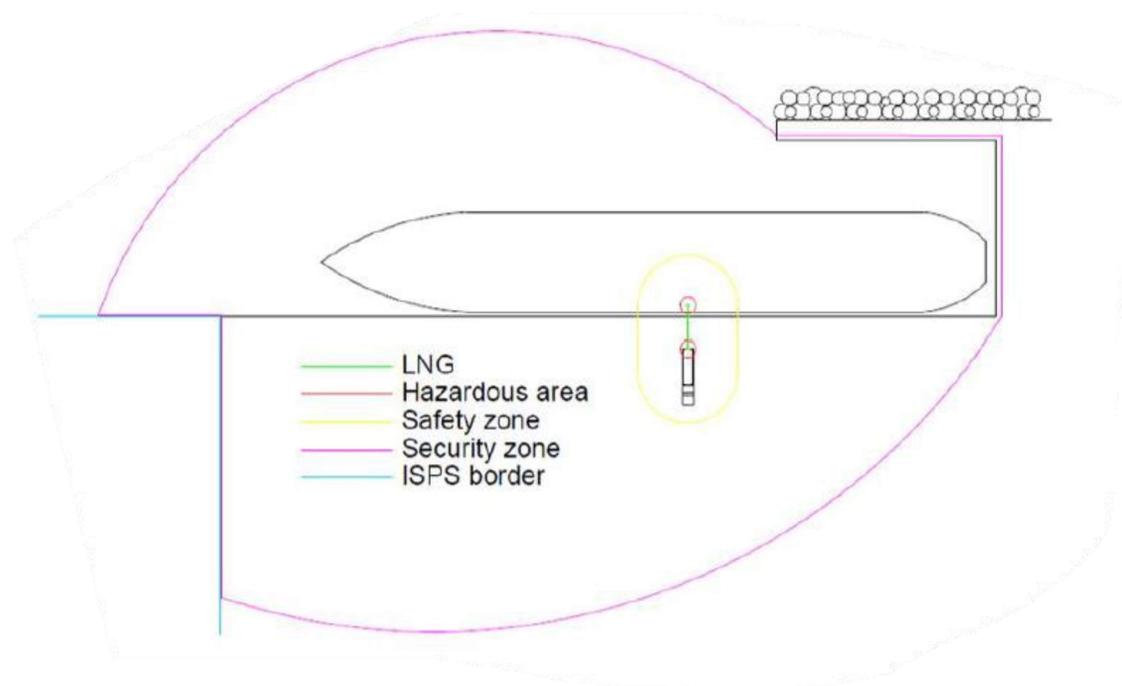


Figure 4 Possible example of location of hazardous area, safety zone and security zone.

5.3 Handling of LNG within the operating area of Faxaports

LNG bunkering may only take place at a facility, or with an LNG bunker vessel or LNG tank truck which has a permit to undertake the operation. Please refer to Chapter 7 for a description of the requirements to be fulfilled

Notification of LNG bunkering to Faxaports should be performed prior to any LNG bunkering operation by the LNG bunker vessel (or the receiving vessel in case of LNG tank truck bunkering). The pre-notification time is to be determined and agreed on, on a case by case basis. The notification should at least include:

- The location/berth where the LNG bunkering will take place
- The quantity of LNG which will be bunkered
- The time of commencement of the LNG bunkering

During LNG bunkering, the receiving vessel shall fly the international signal flag “B” between sunrise and sunset, and an all-round red light between sunset and sunrise. Information signs in English or a picture with similar meaning, that smoking, naked flame and access by unauthorised persons are prohibited should be placed clearly visible when LNG transfer operations are in progress.

The safety distance at sea side for passing vessels during LNG bunkering operation is to be determined and agreed on, on a case by case basis. LNG bunkering must be stopped if a vessel or craft interferes with the safety distance.

It is the responsibility of the Master(s) to ensure that the vessel(s) is/are securely moored in accordance with agreed mooring plans. It is forbidden to have more than

one LNG bunker vessel alongside the receiving vessel. It is forbidden to berth alongside vessels which are bunkering LNG ship-to-ship. LNG must be bunkered without release of LNG or natural gas in normal operation. As per the IGF Code section 8.5.2 (IMO, 2016a), the bunkering system shall be arranged so that no gas is discharged to the atmosphere during filling of storage tanks.

Appropriate PPE for the LNG bunkering operation shall be used by all involved personnel, see 5.3.3.

5.3.1 Simultaneous Operations (SIMOPS)

Simultaneous operations such as cargo handling, bunkering other fuels or lubricants, passenger embarkation/disembarkation, cleaning and repairing etc. can create risks if carried out at the same time as LNG bunkering. As stated in Chapter 4 Risk assessments, if simultaneous operations are to be undertaken, a QRA shall be performed which shall address the effects of the simultaneous operation according to ISO/TS 18683:2015.

The simultaneous operations are only allowed if the risk assessment can demonstrate that the risk is acceptable. In addition, acceptance is required by all parties (such as authorities, terminal, ship and bunkering operator, and supplier operator). The risk assessment should state whether and under which conditions other activities can be carried out simultaneously in a safe and responsible manner.

Simultaneous operations should be in accordance with the LNG fuelled vessel's operational documentation approved by the flag state, as required by the IGF Code.

5.3.2 Weather restrictions

Weather restrictions (including wind force and sea state) for ship to ship and truck to ship LNG bunkering is to be determined and agreed on, on a case by case basis. If the weather conditions exceed the agreed weather restrictions, the hoses and arms must be drained, purged and disconnected.

Before commencement of LNG bunkering, the weather conditions for the duration of the entire operation should be estimated in order to consider whether the LNG bunkering can be carried out safely.

Weather forecasts can be obtained from the Icelandic Metrological Institute, **www.vedur.is**

The LNG bunker operation should immediately be suspended and all systems secured on the approach of an electrical storm.

5.3.3 Personal Protective Equipment (PPE)

All personnel involved in handling of LNG and cryogenic equipment shall use appropriate personal protective equipment (PPE) for the LNG bunkering operation. It shall be ensured that all personnel is trained in the proper use of PPE.

The PPE shall include but not be limited to:

- Protective cryogenic gloves
- Tightly fitting safety goggles and safety face shield with side protection
- Clothing should be fully body comprehensive, flame resistant, cryogenic retardant and have visibility markings.
- Safety shoes
- Safety helmet
- Life jacket must be worn when working on berths or piers or where there is a risk of falling into the water.
- Hearing protections (to be easily accessible)

The European Union has issued the PPE Directive 89/686/EEC which covers the manufacture and marketing of PPE. The CE marking affixed to PPE provides evidence of high level of protection against hazards.

5.3.4 Emergency shut-down system (ESD system)

The functions of the emergency shutdown system (ESD system) are to stop liquid and vapour transfer in the event of an emergency and to bring the cargo/bunker transfer system to a safe condition.

The emergency shutdown process are divided into two stages as per SIGTTO (2009):

- **ESD-1 emergency shutdown stage 1** - shuts down the transfer operation in a quick controlled manner by closing the shutdown valves and stopping the transfer pumps and other relevant equipment in ship and shore systems. The activation of ESD-1 shall give both visual and audible alarms.
- **ESD-2 emergency shutdown stage 2** – shuts down the transfer operation (ESD-1) and uncouples the bunker hose/loading arms after closure of both the emergency release system (ERS) isolation valves.

A **linked ESD system** transmits ESD signals from the receiver to the supplier or vice versa via a compatible system. As per SIGTTO (2009), the primary function of a linked ESD system is that the receiving party can shut down the transfer process in a safe and controlled manner, avoiding the risk of ending up in a situation where the only option is to shut valves against an incoming flow of liquid.

It is required that both the bunkering facility (bunker vessel/bunker truck) and the receiving vessel are equipped with an emergency release system (ERS) and a linked ESD system, as per ISO 20519:2017, in order to perform LNG bunkering operations within the operating area of Faxaports.

5.4 Distribution of responsibility

5.4.1 Faxaports general responsibility

The Faxaports general responsibility includes, but are not limited to:

- Accreditation of the bunker supplier as per the requirements outlined in Chapter 7.
- Approval of all bunkering operations and its locations.

Qualification criteria of the person in charge (PIC)

- Approval of simultaneous operations
- Setting conditions criteria in which LNG bunkering operations are allowed: weather conditions, sea state, wind speed and visibility.

5.4.2 Ship-to-ship

As per the LNG Bunker Checklist Ship to Ship guidelines given by the International Association of Ports and Harbours (IAPH, 2014);

The responsibility and accountability for the safe conduct of operations while a ship is performing an LNG bunkering is shared jointly between the ship's masters and, if applicable, the terminal representative if the ships are moored alongside a terminal. Before LNG bunker operations commence, the masters and, if applicable, the terminal representative should:

- Agree in writing on the transfer procedures, including the maximum loading or unloading rates;
- Agree in writing on the action to be taken in the event of an emergency, and
- Complete and sign the IAPH (*or equivalent, to be approved by Faxaports*) LNG bunker checklist Ship to Ship, see IAPH checklist example in Appendix 4.

5.4.3 Truck-to-ship

As per the LNG Bunker Checklist Truck to Ship guidelines given by the International Association of Ports and Harbours (IAPH, 2014);

The responsibility and accountability for the safe conduct of operations while a ship is performing an LNG bunkering is shared jointly between the ship's master, the LNG bunker truck operator and, if applicable, the terminal representative if the ships are moored alongside a terminal. Before LNG bunker operations commence, the master, the LNG bunker truck operator and, if applicable, the terminal representative should:

- Agree in writing on the transfer procedures, including the maximum loading or unloading rates;
- Agree in writing on the action to be taken in the event of an emergency, and
- Complete and sign the IAPH (*or equivalent, to be approved by Faxaports*) LNG bunker checklist Truck to Ship, see IAPH checklist example in Appendix 5.

5.4.4. Master

The master of the receiving ship retains control for the safe operation of the ship throughout the bunkering operation. The master has the right to terminate the process if the bunkering operation deviates from the planned and agreed process.

5.4.5 Person in Charge (PIC)

It is required that a designated person in charge of the bunkering operation (PIC) to be agreed by the receiving ship and the bunkering facility, and approved by Faxaports.

As per SGMF Safety Guidelines – Bunkering 4.1.1 (SGMF, 2015), the PIC should be adequately trained and have an appropriate level of competence to ensure safe bunkering operations. The PIC should be responsible for the bunkering operation and the personnel involved, ensuring that agreed bunkering operating procedures are followed and that operations comply with all applicable regulatory requirements. The PIC shall be present at all times during the bunkering operation.

6.0 Bunkering procedures and requirements

The functional requirements for LNG bunkering systems as defined in ISO/TS 18683:2015 Chapter 8 shall be adhered to. The bunkering operations shall be conducted under the control of a recognised Safety Management System (SMS).

6.1 Before bunkering

A compatibility assessment which takes into account the compatibility of the physical connections as well as bunker control and safety systems, of the bunkering facility and receiving ship should be performed prior the bunkering operation in order to identify any aspect that require particular attention and management.

According to ISO/TS 18683:2015 section 8.3, the compatibility between supplier and ship shall be checked and documented prior to bunkering operations. The check shall include the following:

- a) agreement on quantity and properties of supplied LNG;
- b) safe and effective mooring/immobilising of the trucks;
- c) compatibility of ESD and communication systems;
- d) compatibility of manifold flanges; Could be replaced by Quick Connect Disconnect Coupling (QCDC) or similar
- e) operational window (motions, weather, visibility);
- f) compatibility of hazard zoning and ventilation;
- g) spill protection systems;
- h) compatibility of safety management systems;
- i) compatibility of communication procedures and protocols.

The compatibility check should be signed off by both parties prior to the operation.

Before LNG bunker operations commence, the master(s) and/or the LNG bunker truck operator should:

- Agree in writing on the transfer procedures, including the maximum loading or unloading rates;
- Agree in writing on the action to be taken in the event of an emergency, and
- Complete and sign the IAPH (*or equivalent, to be approved by Faxaports*) LNG Bunker Checklists, *Chapter 1 Part A-D* (see IAPH checklist example in Appendix 4 and 5).

Note: Part A (*“Pre Operations Checklist”*) should be completed during the planning stage of the LNG bunker operations, i.e. before the LNG fuelled ship arrives on the bunker location.

Once the pre-bunker checklists are completed and signed, they are considered to be a permit to commence the bunkering operation. The operation may need to be suspended or stopped if conditions change.

6.2 During bunker transfer

Agreements on items to be re-checked at appropriate intervals in the bunker checklists should be followed by all parties and the record of repetitive checks should be signed accordingly. See Appendix 4 and 5 for IAPH checklist example (*equivalent checklist are to be approved by Faxaports*).

The bunker operation should be safely and continuously monitored by supervision of dedicated personnel, including but not limited to:

- Mooring arrangement
- Transfer rate, topping up rate, vapour management
- Tank conditions (temperature, pressure, level)
- Leaks
- Safety and security zone (only essential authorised personnel to be allowed in the safety zone during bunkering)
- Simultaneous operations (only authorised simultaneous operations to be undertaken)

If any problems are detected during the bunker transfer, the transfer should be stopped immediately and not resumed until satisfactory checks and any necessary corrective actions have been completed.

6.3 After bunker transfer

The final part of the LNG Bunker Checklist, *Chapter II – After LNG Transfer Checklist* (see Appendix 4 and 5 for IAPH checklist example), contains the considerations to be made after the LNG bunker operations for the disconnecting of the bunker connections and finishing the total operations.

7.0 LNG bunker supplier accreditation system

All bunkering operations within the port area are subject to the Harbour Guidelines and the Instructions for Vessels and must be in line with the Environmental Permit for the Faxaports. The bunker vessel/truck must have accreditation from Faxaports. All bunkering operations must be approved by Faxaports.

The permit process will, in addition to Faxaports, include Icelandic Transportation Administration, City Rescue Department.

7.1 General requirements

Faxaports shall approve each site/berth where LNG bunkering is performed. An application for a bunkering location must include a risk analysis for the intended location, with surrounding areas, and the types of ships referred to be bunkered. Risk assessment for the LNG bunker operation must be performed according to ISO/TS 18683:2015 (*or equivalent, to be approved by Faxaports*).

All equipment and systems used for the LNG transfer has to fulfil the requirement in Ch. 5 of ISO 20519:2017 (*or equivalent, to be approved by Faxaports*).

7.2 Bunker vessel criteria

In order for an LNG bunker vessel to be approved to perform LNG bunkering, the following conditions must be met:

- The bunker vessel must be designed and built according to the IGC Code.
- Equipped with a linked ESD system (*designed to conform to the requirements specified in Appendix D or H of ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers, as per ISO 20519:2017*).
- The vessel must have a safe bunkering procedure, which is carried out according to the approved International Safety Management (ISM) manual on-board.
- The bunkering vessel shall have defined hazardous zone(s).
- Training of personnel in accordance with Ch. 9
- The vessel shall be inspected (SIRE) at least every six months and have no large deviations.

7.3 Truck criteria

In order for an LNG truck/Truck company to get permission to perform LNG bunkering, the following requirements must be met:

- Must have an operations and emergency manual approved by Faxaports and relevant authorities.
- The truck must be built and operated according to applicable European rules and regulations – ADR 2017.
- The truck shall have defined hazardous zone(s).

- Procedures and instructions according to ISO/TS 18683:2015.
- Training of personnel in accordance with Ch. 9
- The truck is not allowed to have any remarks from the last inspection.
- Equipped with a linked ESD system (*designed to conform to the requirements specified in Appendix D or H of ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers, as per ISO 20519:2017*).

7. 4 Receiving vessel criteria

To approve an LNG fuelled vessel for LNG bunkering the following requirements must be met:

- The vessel must fully comply with the IGF Code, given that below conditions are met;

The IGF Code applies to ships contracted for construction on or after 1 January 2017 (in the absence of a building contract, ships keel laid on or after 1 July 2017), ships delivered on or after 1 January 2021 or ships converted to use gaseous or other low-flashpoint fuels on or after 1 January 2017.

- Ships with keel laid before 1 July 2017 to be approved by the flag state and the Faxaports
- Equipped with a linked ESD system (*designed to conform to the requirements specified in Appendix D or H of ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers, as per ISO 20519:2017*).
- The vessel must have a safe bunkering procedure, which is carried out according to the approved ISM manual on-board.
- The receiving vessel shall have defined hazardous zone(s).
- Training of personnel in accordance with Ch. 9

8.0 Emergency procedures

In the event of an emergency during bunkering, emergency communication shall take place by contacting:

- Faxaports pilots at VHF channel 12
- Or dialling Faxaports pilots by phone number +354 525 8900

If dialling directly to the national emergency number 112, Faxaports pilots shall be informed as well.

Following information should be included in the emergency call:

- The name of the ship(s)
- What has happened

- Where has it happened
- The number of persons injured and the nature of the injuries
- The type of assistance required

Measures to be taken in case of fire or emergency on board:

- Make an emergency call immediately
- Cease all cargo/bunker operations
- Start firefighting measures
- Disconnect loading arms/bunker connections
- Stand by for unberthing

Measures to be taken in case of fire or emergency at the terminal or another vessel:

- Make an emergency call
- Stand by to cease all cargo/bunker operations
- Wait for additional instruction from port authorities
- Stand by for unberthing

8.1 Emergency response planning

Emergency response planning should include provisions to ensure that local authorities and emergency services are aware of the potential risks associated with LNG bunkering.

According to ISO/TS 18683:2015, a contingency plan shall be in place outlining the requirements for the following:

- evacuation of personnel and third parties;
 - mobilising fire-fighting;
 - mobilising first aid, hospitals and ambulances;
 - communication to authorities and third parties.
-
- In addition to the above, following emergency situations should be covered:
 - LNG leakage and spill
 - Emergency evacuation of LNG in tanks and systems
 - Gas detection
 - Fire in the bunkering area

Unexpected movement of the vessel(s)

- Unexpected moving of the truck
- Unexpected venting on the receiving ship or on the bunkering facility
- Loss of power

The contingency plan shall be communicated to all parties involved in the bunkering operation including the planned emergency response team. The role and responsibility of the respective actors should be clearly stated. Practice drills shall be carried out at regular intervals with the participation of all actors involved. Relevant personnel should have undergone training in fighting gas fires, treatment of cryogenic burns etc.

9.0 LNG bunkering education and training

Education and training regarding LNG and LNG bunkering are needed on different levels for the parties who may be involved, directly or indirectly, in the bunkering process when LNG is introduced as an alternative to traditional marine fuels. If an incident or accident occurs, all staff must be familiar with what is expected of them.

9.1 Education and training requirement

9.1.1 General requirements

The crew of the bunker vessel shall be trained according to the STCW convention. The crew of the receiving vessel shall be trained according to the STCW convention. For vessels not complying to the IGF code the crew shall be trained according to requirements by the flag state.

The crew operating the truck shall be trained according to the ADR rules.

9.1.2 Specific requirements

In addition to the general requirements all personal involved in the bunker operations shall be properly trained. The training scheme shall be approved by Faxaports. As per ISO/TS 18683:2015, the training shall, as a minimum, cover the following:

- Properties and hazards of LNG relevant to the LNG bunkering operations
- Potential effects of mixing LNG with different properties
- Risk reducing measures
- International or national regulations and guidelines regarding LNG fuel transfer operations
- First aid specific to frost-bite and asphyxiation
- Safe operation of LNG fuel transfer equipment
- Procedures to be followed during normal LNG bunkering operations:
- Understanding of non-standard operations and emergencies during LNG bunkering operations with respect to recognition of different types of incidents and specific actions for each type of incident:
- Immediate action to be taken in response to emergency situations that can occur during LNG fuel transfer operations including liquid and/or vapour leakage, fire, or emergency breakaway
- Management of vapour and/or liquid leaks to minimise risk to personnel and assets due to cryogenic temperatures and flammable atmospheres

9.2 SGMF - Bunkering of ships with LNG competency guidelines

The Society for Gas as Marine Fuel (SGMF) published their *“Bunkering of ships with Liquefied Natural Gas (LNG) competency guidelines”* in 2016. The guidelines only cover the bunkering/transferring operation and aims to supplement existing industry training schemes such as:

- **STCW training for mariners serving on board IGF-compliant vessels**
- **STCW training for mariners serving on board IGC-compliant vessels**
- **ADR training for LNG road tanker drivers**

SGMF has proposed four levels of competences; **RESPOND**, **ASSIST**, **DO** and **MANAGE** as described below:

RESPOND training – for individuals who need to be familiar with, and understand the hazards associated with, LNG and the actions that need to be implemented in an emergency situation.

ASSIST training - for individuals that support the activities required in the transfer of LNG/gas but are under the direct supervision and direction of the DO level.

DO training - for individuals engaged directly in the LNG/gas transfer and who may supervise other individuals engaged in the activity (for example, a PIC).

MANAGE training - for individuals responsible for the people engaged in the operation or the area where this operation takes place, along with the administration, regulation, planning, and implementation of the supply of LNG, on behalf of the receivers, suppliers or port authority/regulatory bodies.

Roles, as suggested by SGMF, corresponding to the different levels of competence is listed below:

Public:

- Emergency services, local/national authority representative, truck driver and other port visitors – RESPOND
- Passengers – RESPOND/no specific training

Port employees:

- Port security, port worker – RESPOND
- Port manager or supervisor – MANAGE

LNG supplier (road tanker, bunker vessel, terminal etc.)

Hose watch – ASSIST

- PIC, loading master – DO
- LNG supplier’s manager or master – MANAGE

LNG receiver (gas fuelled ship)

- Manifold watch – ASSIST
- PIC – DO
- Vessel’s master – MANAGE
- Vessel’s engineer – MANAGE/DO
- Other crew – RESPOND/ASSIST

10.0 LNG Bunker Checklists – IAPH examples

It is required to use the LNG Bunker Checklists developed by the “International Association for Ports and Harbours World Ports Climate Initiative” (IAPH’s WPCI) LNG working group for Ship to Ship and Truck to Ship as included in the Appendices 4 and 5 (*or equivalent checklists, to be approved by Faxaports*).

Before LNG bunkering commence, it should be ensured by the LNG receiving ship and the LNG bunker ship or LNG supplying tank truck, that the LNG bunker checklist

has been completed fully, positively and truthfully, and signed by the persons responsible for the LNG bunkering of the involved parties.

The parties involved in the LNG bunkering must comply with the provisions of the LNG bunkering checklist. The LNG bunkering shall be stopped immediately if the provisions in the LNG bunkering checklist for each party involved in the LNG bunkering are not observed.

The LNG bunker checklist shall be kept on board the ships involved in the LNG bunkering during and up to twenty-four hours after the end of the LNG bunkering.

10.1 LNG Bunker Checklist – Ship to Ship (IAPH example)

See Appendix 4.

10.2 LNG Bunker Checklist – Truck to Ship (IAPH example)

See Appendix 5.

Note: The Ship to Ship Chapter 1 Part B Checklist “*Planned Simultaneous Activities*” is to be used for Truck to Ship operations when applicable.

List of references

IACS (2016). *Recommendation No.142. LNG Bunkering Guidelines*. International Association of Classification Societies. Available at <http://www.iacs.org.uk/> (Last retrieved 2017-01-23)

IAPH-WPCI (2014a). *Bunker checklists*. Available at <http://www.lngbunkering.org/lng/bunker-checklists> (Last retrieved 2016-12-21)

IAPH-WPCI (2016). *LNG bunker supplier accreditation model*. Available at <http://www.lngbunkering.org/lng/bunker-checklists/lng-bunker-supplier-accreditation-model> (Last retrieved 2016-12-21)

IEC (2015). *IEC 60079-10-1:2015 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres*.

IMO (2016a). *International Code of Safety for Ships using Gases or other Low Flashpoint Fuels (IGF Code)*. 2016 Ed. London: IMO.

IMO (2016b). *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)*. 2016 Ed. London: IMO.

ISO (2015). *ISO/TS 18683:2015 Guidelines for systems and installations for supply of LNG as fuel to ships*. Geneva: ISO.

ISO (2017). *ISO 20519:2017 Ships and marine technology – Specification for bunkering of liquefied natural gas fuelled vessels*. Geneva: ISO

SGMF (2015). *Safety Guidelines – Bunkering*. London: SGMF

SGMF (2016). *Bunkering of ships with Liquefied Natural Gas (LNG) Competency Guidelines*. London: SGMF

SIGTTO (2009). *ESD arrangements & linked ship/shore systems for liquefied gas carriers*. Available at <http://www.sigtto.org/media/7201/esd-arrangements-and-linked-ship-shore-systems.pdf> (Last retrieved 2017-02-01)