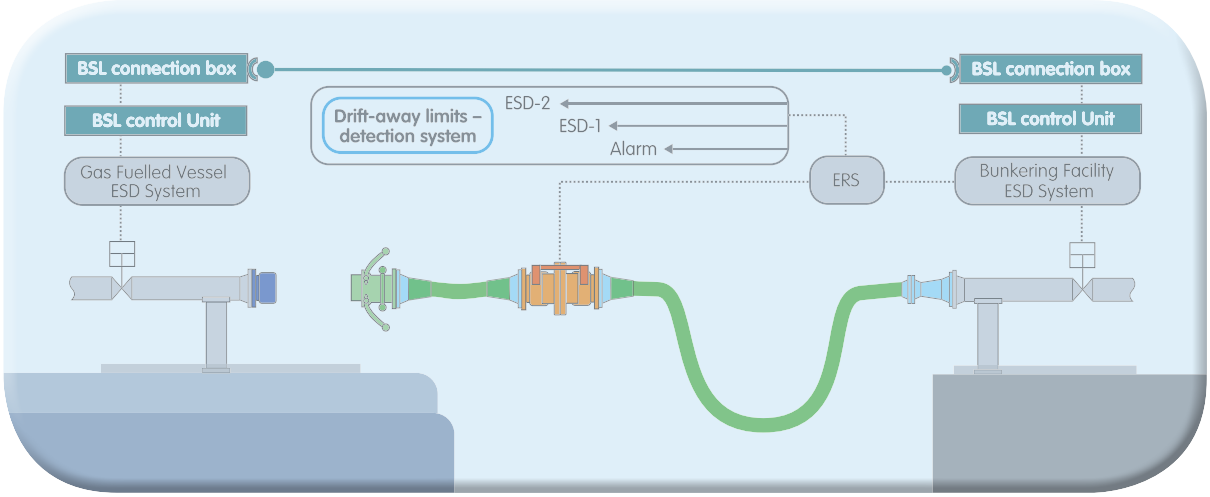
TGN06-06
version 1.0

gas as a marine fuel

LNG bunkering with hose bunker systems: considerations and recommendations



sgmf
the society for gas as a marine fuel

technical guidance note

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The Society for Gas as a Marine Fuel (SGMF)

The Society for Gas as a Marine Fuel (SGMF) is a non-governmental organisation (NGO) established to promote safety and industry good practice in the use of natural gas as a marine fuel. The society supports the wider use of gas as marine fuel by developing technical guidelines that encourage safe and responsible operations. More information on the society is available at: **https://www.sgmf.info**

Disclaimer

While the advice given in this Technical Guidance Note (TGN) is based on current good industry practices and available information, it is intended solely for guidance and use at the owner's/operator's own risk. No responsibility is accepted by SGMF – nor by any person, company or organisation related to SGMF – for any consequences resulting directly or indirectly from compliance with, or adoption of, any of recommendations or guidance contained herein.

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Foreword

The safety record of LNG bunkering operations has been exceptional, which the industry can be proud of. It can be attributed to guidelines published by the industry body, the Society for Gas as a Marine Fuel (SGMF), and adherence to mandatory port and ship regulatory requirements.

SGMF has been doing exemplary work to promote safety and industrial best practice in the use of gas as marine fuel, which is undergoing a rapid and unprecedented expansion. While this growth is very welcome, it raises many issues and challenges. To maintain its excellent safety record, the industry needs to respond to or pre-empt the challenges.

The LNG transfer hose is a vital component of the LNG bunkering system but consolidated guidance on hoses has not been available until now. This publication is intended to fill this gap. It is the result of an initiative by SGMF to gather LNG industry expertise from various bunkering stakeholders and to develop common hose functionality guidance to ensure LNG hose transfer operations are conducted safely.

The technical content has been developed by the SGMF's Working Group 6.3. It brings together information from: various hose technology OEMs on design and operational integrity; LNG bunker suppliers on operational excellence; LNG bunker receivers on operational experience; and regulatory bodies on design and operational safety.

There can never be a single type of hose suitable for all LNG bunkering operations. The guidelines have been written to highlight various hose designs and the key points that should be considered by buyers of transfer hoses and by LNG bunkering operators and receivers. The objective is to ensure that the crew handling the hose has all the necessary information to carry out LNG bunkering operations safely.

As chairman of the working group, I would like to thank SGMF and the members of the group for their exemplary contributions in delivering these comprehensive guidelines on the technicalities of LNG transfer hoses to the fast-evolving LNG bunkering industry.

Syed Asadulla Ahmed Mareel
Shell
LNG Marine Fuel Project Advisor and Working Group Chairman

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1 Purpose

This Technical Guidance Note (TGN) provides recommendations for the safe handling and operation of hose bunker systems utilising cryogenic flexible hoses as the main means for LNG transfer. It specifically addresses hose selection and its handling and functional safety principles.

Application of this TGN will promote development of standardised and safe practices during the deployment of compatible gas-fuelled vessel bunkering interfaces with differing bunkering facilities and installations.

This TGN also addresses the differences between the requirements and capabilities of differing bunkering facility "suppliers" – such as bunker vessels, shore terminals and road tankers – with generic gas-fuelled vessel "receivers", considering the basic philosophy of their systems, differing supply methods and bunkering capabilities.

Notes:

1. This document provides only recommendations. They are not intended to constitute a detailed technical specification and apply only to the bunkering of Liquefied Natural Gas (LNG) to a gas-fuelled vessel.
2. "Bunkering facility type(s)" refers to any technology or system designed and intended to be used to transfer/bunker liquefied gas as fuel to a generic gas-fuelled vessel. These comprise floating, shore-fixed or mobile fuel-supply facilities such as bunker vessels, road tankers and terminals.
3. The term "hose" refers to any type/technology of flexible pipe used to bunker LNG. This might be a composite or metal hose, or a flexible pipe designed to be repetitively bent to accommodate the static and dynamic misalignments between a bunkering facility and a gas-fuelled vessel.

2 Introduction

The growing use of natural gas as a marine fuel in recent years, and the concurrent development of the regulatory framework for safe gas handling and operations, has resulted in demand from the industry for guidance on the safe handling and operation of bunkering equipment used for LNG transfer between a gas fuel supplier and a receiver.

This TGN specifically addresses the use of hose bunker systems in different bunkering scenarios, from any type of LNG bunkering facility. It provides guidelines on hose selection, safe handling, and hose bunker system manoeuvring and operations – including lessons learned and good practices gathered from the industry.

While each bunker facility and gas-fuelled vessel will need to develop its own specific safety and operational procedures, implementation of the recommendations in this TGN will facilitate standardisation of operations between the different systems deployed across the industry and standardisation of operations – assuring efficiency and flexibility of supply as well as maximising safety.

This TGN has been prepared by SGMF's Working Group 6.3, which comprises ship operators, naval architects, classification societies, ship builders and equipment manufacturers. It covers the following main topics:

- A basic knowledge of hose bunker systems.
- Hose selection principles.
- Safe handling and manoeuvring principles.
- Hose technologies and typical failure modes.
- The safe operation of hose bunker systems and lessons learned.

Notes:

1. This TGN provides general guidance for the correct use of hose bunker systems and LNG bunkering hoses. It is not intended to constitute a detailed operational procedure or technical specification for the design or operation of hose bunker systems.
2. It is the responsibility of the owner/operator to develop appropriate operational guidance for specific equipment, based on the manufacturer's instructions and these recommendations, and to ensure that the design specification of equipment meets the actual operational conditions to which the hose bunker system will be subjected over its lifetime.
3. This document should be read in combination with these SGMF publications:
   a. *Safety Guidelines – Bunkering – FP07-01 Ver2.0*, which presents the different stages of the bunkering operation and their rationale.
   b. *Technical Guidance Note – manifold arrangements for gas-fuelled vessels – TGN 06-04 Ver1.0*, which sets out the requirements for the gas-fuelled vessel manifold to which the hose bunker system is connected.
4. This guidance is based on information made available to SGMF. No responsibility is accepted by SGMF – nor by any person, company or organisation related to SGMF – for any consequences resulting directly or indirectly from compliance with, or adoption of, any of recommendations or guidance contained herein.

2.1 Applicability

This TGN and its recommendations are intended to be applicable to any LNG bunkering scenario.

While the primary intention of this TGN is to address the requirements for safe handling and operation of hose bunker systems, its considerations and recommendations can also serve suppliers and manufacturers of bunkering equipment and systems. However, in developing their procedures and equipment, suppliers and manufacturers should also refer to applicable rules and standards, including, but not limited to, the IGF Code, EN1474 and ISO 20519.

At this time, this TGN addresses the specific requirements for natural gas used as a marine fuel. Its content might, with appropriate limitations, be used as a reference for some other low-flashpoint fuels and systems not currently addressed by the guidance in this TGN.

2.2 References and Further Reading

The following standards and guidelines are referred to in this document:

IMO codes:

- *IGF Code: International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels*
- *IGC Code: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*
- *ISM Code: The International Safety Management Code*

International Standards:

- *ISO 20519:2017 Ships and Marine Technology – Specification for Bunkering of Liquefied Natural Gas-Fuelled Vessels*
- *ISO/TS 18683: 2015 – Minimum Requirements on Design & Operations for Safe LNG Bunkering [Seagoing & Inland Navigation Vessels]*
- *ISO 21593:2019 Ship and Marine Technology – Technical requirements for liquefied natural gas bunkering dry-disconnect/connect coupling*
- *EN 1474-2:2008 – Installation and Equipment for Liquefied Natural Gas. Design and testing of marine transfer systems. Design and testing of transfer hoses*
- *EN 1474-3:2008 – Installation and Equipment for Liquefied Natural Gas. Design and testing of marine transfer systems. Offshore transfer systems*

Industry Guidelines:

- *SGMF: Safety Guidelines – Bunkering – FP07-01 Ver2.0*
- *SGMF: Recommendation of Controlled Zones During LNG Bunkering – FP02-01 Ver1.0*
- *SGMF: Recommendations for linked Emergency Shutdown (ESD) arrangements for LNG bunkering – TGN 06-05 Ver1.0*
- *SGMF: Manifold Arrangements for Gas-Fuelled Vessels – TGN 06-04 Ver1.0*

Every effort has been made by the SGMF to avoid discrepancies between the recommendations in this TGN and the statutory requirements in international standards and class rules. If discrepancies arise, the statutory requirements shall take precedence.

2.3 Definitions

The following definitions are used throughout this document:

Bunkering Facility/Supplier – The bunkering facility – also referred as the "supplier" – is any technology or system designed to be used to transfer/bunker liquefied gas as fuel to a gas-fuelled vessel. It may consist of a floating, shore-based, fixed or mobile fuel-supply facility, such as a bunker vessel, road tanker or terminal (see Figure 1).
Bunkering Safety Link (BSL) – The Bunkering Safety Link (BSL) connects the suppliers' and receivers' ESD systems. It may be pneumatic, electric, fibre-optic or wireless.

Note that the BSL is sometimes referred to as the "ESD link" or "Ship-to-Shore Link" (SSL). This terminology was adopted from large-scale LNG transfer applications; this document uses the term BSL to clearly define the bunkering application of the link.

Bunker Station – The location(s) on board a vessel where non-cargo fluids are loaded from and discharged to a bunkering facility.

Connection Flange – The part of the bunkering transfer system that connects to the gas-fuelled vessel's manifold. It can be a flange type or a dry-disconnect/connect coupling nozzle.

Coupling Nozzle – The half part of the dry-disconnect/connect coupling, bolted to the bunkering facility's transfer system, which permits quick connection and disconnection to the receptacle installed on the gas-fuelled vessel's manifold. It includes an internal valve to seal the nozzle/transfer system when disconnected and will be opened by manual operation after connection.

Coupling Receptacle – The half part of the dry-disconnect/connect coupling bolted to the gas-fuelled vessel's manifold to which the nozzle installed on the transfer system will be connected. It includes an internal valve to seal the receptacle/manifold when disconnected and will be opened by manual operation of the nozzle after connection.

Dry-Disconnect/Connect Coupling (DD/CC) – A mechanical device enabling quick and safe connection and disconnection of the hose bunkering system of a bunkering facility to the manifold of the receiving vessel without employing bolts. The coupling consists of a nozzle and a receptacle. These couplings are also known as "Dry-Disconnect Couplings" or "Dry-Break Couplings".

Notes:

1. Quick Connect/Disconnect Coupler (QC/DC) is generic definition of couplers. the Dry-Disconnect/Connect Coupling (DD/CC) is a type of QC/DC.
2. Reference should be made to Coupling Nozzle and Coupling Receptacle definitions with requirement for an internal seal valve as per ISO 21593.

Emergency Shutdown (ESD) (bunkering) – The emergency shutdown is the event, signal or process initiated in case of an emergency to shut down the bunkering operation.

The bunkering Emergency Shutdown process is divided into two consecutive stages: ESD-1 and ESD-2.

- The ESD-1 and ESD-2 processes are independent. However, the ESD-1 process should always be initiated before ESD-2; initiation of an ESD-1 process does not imply that an ESD-2 process will be initiated soon after.
- The second stage ESD-2 process is primarily intended to protect the bunkering transfer system, equipment and ship's manifold should the vessel drift out of a predetermined operating envelope, which will typically be detected by sensors. The ESD-2 release may also be manually initiated from the bunkering facility. It is not designed to be initiated from the gas-fuelled vessel.

Depending on the context, the terms Emergency Shutdown, ESD-1 and ESD-2 may apply to a process, trip signal, event or condition. SGMF uses the terms Emergency Shutdown, ESD-1 and ESD-2 in this TGN to distinguish clearly between the various trip functions and actions in the overall linked ESD system.

Emergency Release Coupler (ERC) – A coupling installed on LNG and vapour lines, as a component of the Emergency Release System (ERS), enabling quick physical disconnection of the transfer system from the unit to which it is connected. It is designed to prevent leakage and damage to loading/unloading equipment if the transfer system's operational envelope and/or parameters are exceeded.

- An active controlled ERC is an emergency release coupler whose activation can be manually or automatically triggered by a control system and associated control switch/signal.
- A passive ERC "dry break-away" is an emergency release coupler the activation of which can be triggered only by applying a set "break-away" load to the ERC itself. Break-away load is typically a mechanical tension applied at the ERC collar in response to either the gas-fuelled vessel or the bunkering facility drifting away from the other.

Emergency Release System (ERS) – An ERS is a system that provides safe shutdown, transfer system isolation and quick release of hoses or transfer arms between the supplier and receiver to prevent product release at disconnection time.

It typically consists of an emergency release coupling (ERC) and interlocked isolating valves which automatically close on both sides, thereby containing the LNG or vapour in the lines (dry disconnect) and, if applicable, the associated control system.

In this TGN the ERS is considered to be part of the bunkering facility/supplier equipment to which is connected. This may not be the case in some applications.

ESD-1 (bunkering) – ESD-1 is the first stage of the bunkering emergency shutdown process. (see Emergency Shutdown)

ESD-2 (bunkering) – ESD-2 is the second stage of the bunkering emergency shutdown process. (see Emergency Shutdown)

ESD System (bunkering) – An ESD system safely and effectively ends the bunkering operation/process by stopping the transfer of LNG and vapour between the supplier and receiver.

It takes inputs from critical instruments – for example, LNG tank overfill alarms – and from manual pushbuttons to initiate trips which stop the transfer operation to prevent gas/LNG release and potential risks from escalating.

It is the combination of system/s and controller/s that governs the emergency shutdown process. An ESD system should be found onboard the gas-fuelled vessel and at the bunkering facility.

ESD Manifold Valve – The ESD manifold valve is a remotely operated shutdown valve typically located at the bunkering and discharging manifolds near the presentation flange. Governed by the ESD system, it is closed in an emergency shutdown event.

Fuel – In the context of the recommendations in this document, "fuel" means natural gas in its liquid or gaseous state.

Gas-Fuelled Vessel (GFV)/Receiver – The gas-fuelled vessel – also referred to as the "receiver" – is an IGF-compliant vessel using gas as marine fuel.

Hazardous Area/Zone – The three-dimensional space where there is a defined probability that a flammable atmosphere is present. The probability is defined by national regulations and both the IGF and IGC codes.

Hose Bun/Hose Slings – A device designed for safe lifting and manoeuvring of hoses while maintaining a minimum bending radius to ensure they are not overstressed.

Hose Bunker System – A hose bunker system allows the transfer of liquefied gas between a fuel supplier and a gas-fuelled vessel primarily using a flexible hose to transfer liquid or vapour.

Hose String – A hose string consists of two or more hoses, of identical type, joined together via their end fittings to reach a specified total length.

Linked ESD System – The Linked ESD System is the combined and connected arrangement of the bunkering facility's ESD system, the gas-fuelled vessel's ESD system, and the Bunkering Safety Link (BSL).

Liquid – Fuel gas in the liquid phase.

LNG Bunkering/LNG Bunker – The process of re-fuelling an LNG-powered vessel from a trailer, bunker vessel or terminal.

Mobile-to-Ship – An LNG bunkering operation to a gas-fuelled vessel from a mobile bunkering facility located onshore. Mobile bunkering facilities can consist of a truck, rail car or other mobile device (including portable tanks) used to bunker LNG. (see Figure 1)

Presentation Flange – The part of the gas-fuelled vessel's manifold to which the transfer system is connected. It can be a flange type or a dry-disconnect/connect coupling receptacle.

Quick Connect / Disconnect Coupler (QC/DC) – Manual or hydraulic mechanical device used to connect the transfer system (e.g. loading arm) to the bunkering manifold presentation flange without employing bolts.

Receiver – See gas-fuelled vessel.

Reducer/spool piece – A short section of pipe bolted outboard of the manifold flange.

Shore-to-Ship – An LNG bunkering operation to a gas-fuelled vessel from a fixed bunkering facility or terminal (see Figure 1).

Ship-to-Ship – An LNG bunkering operation to a gas-fuelled vessel from a floating storage or bunker vessel (see Figure 1).

Supplier – See Bunkering Facility.

Transfer System/Bunkering Transfer System – A loading arm made of articulated piping or a transfer hose solution, or a combination of articulated piping and hose, allowing the transfer of liquefied gas between a fuel supplier and a gas-fuelled vessel.

It comprises all the equipment between the bunkering manifold flanges of the bunker facility and the receiving gas-fuelled vessel, including, but not limited to: transfer arms or hoses; Emergency Release System (ERS); insulation flanges; dry-disconnect/connect coupling; and the bunkering safety link used to connect the supplying and receiving ESD systems.

Truck-to-Ship – See Mobile-to-Ship

Vapour – The gaseous phase of liquefied gas.

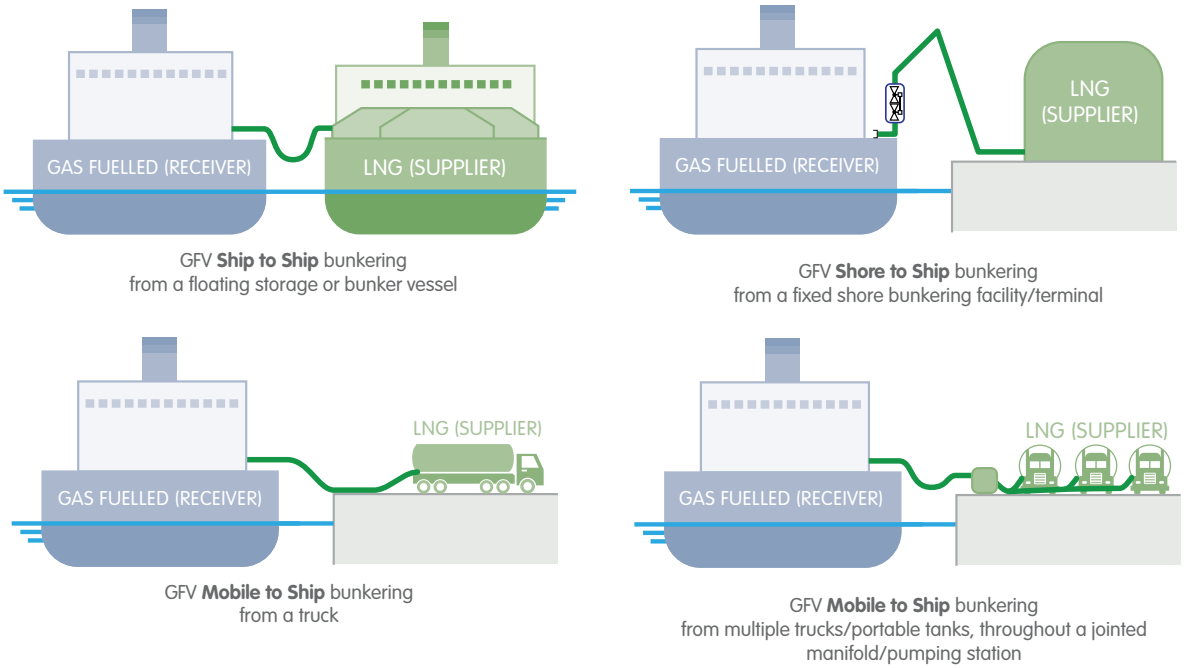

Figure 1: Typical bunkering supply scenarios

2.4 Abbreviations

The following abbreviations are used in this document:

BOG – Boil-Off Gas

BSL – Bunkering Safety Link

DD/CC – Dry-Disconnect/Connect Coupling

ESD-1 – Emergency shutdown stage 1

ESD-2 – Emergency shutdown stage 2

ERC – Emergency Release Coupler

ERS – Emergency Release System

FMEA – Failure Mode and Effects Analysis.

GFV – Gas Fuelled Vessel

HAZOP – Hazard and Operability study

IGC Code – International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (LNG carrier vessels)

IGF Code – International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels

IMO – International Maritime Organization

LNG – Liquefied Natural Gas

SIGTTO – The Society of International Gas Tanker and Terminal Operators

SIMOPS – Simultaneous Operations

SWL – Safe Working Load

TGN – Technical Guidance Note

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Essential Functional Requirements for Bunkering

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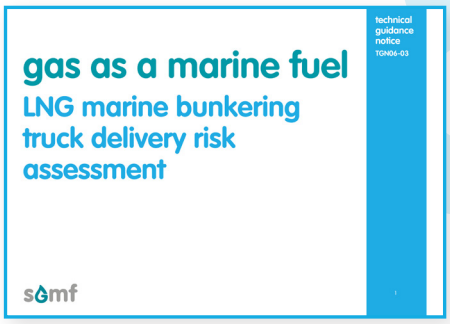

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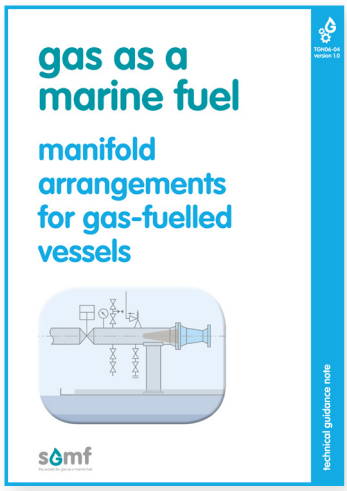

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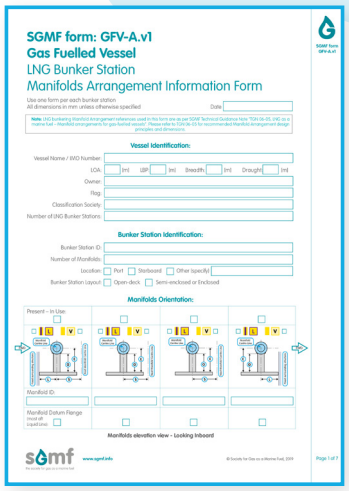

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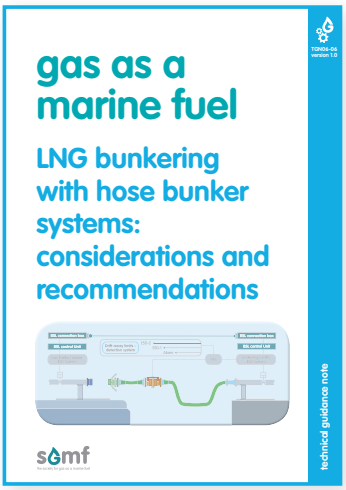

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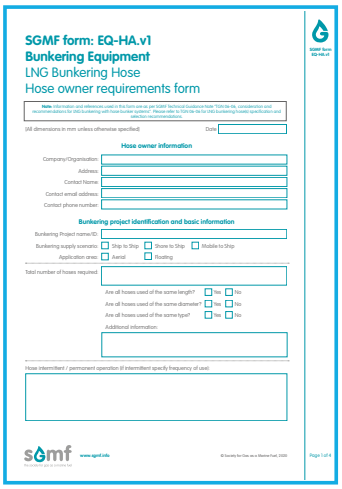

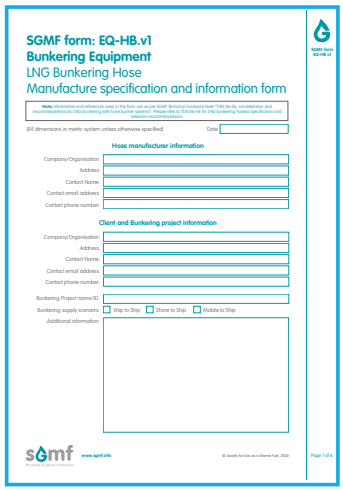

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