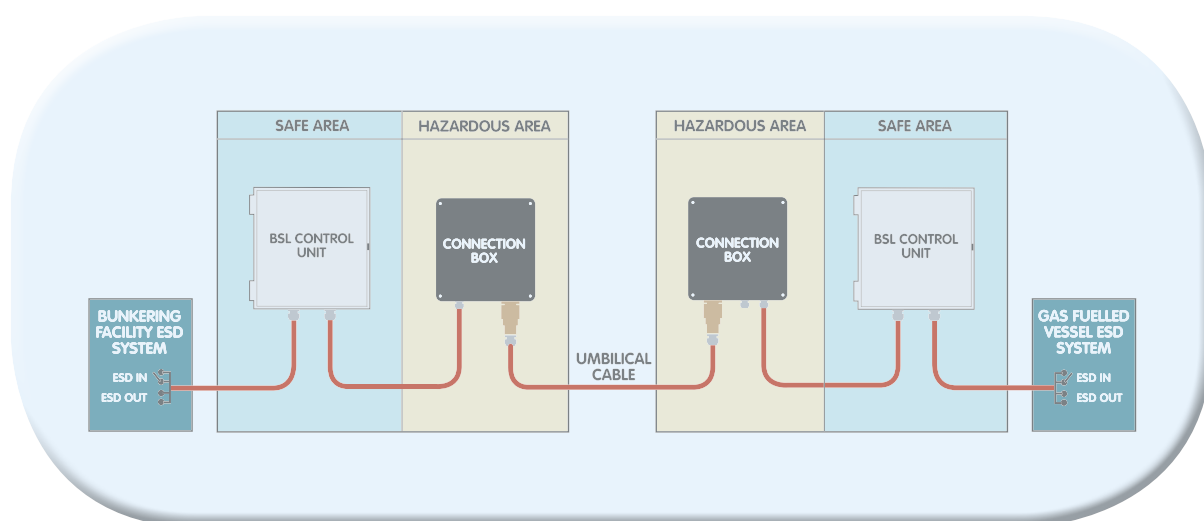


gas as a marine fuel

recommendations for linked emergency shutdown (ESD) arrangements for LNG bunkering





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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 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: www.sgmf.info

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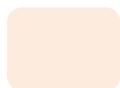
While the advice given in this TGN is based on current good industry practices and available information, it is intended solely for guidance and use at the owner's/operator's own risk.

Acknowledgements

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Reader key



Clarifications and
qualifications



Codes/standards
references

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Foreword

It is an honour to be part of the development of these guidelines. The Society for Gas as a Marine Fuel (SGMF) – both as an organisation and as a wider industry family – is striving to ensure that the fledgling gas bunkering sector gets off to the best possible start in life, without political or commercial prejudices.

The society ensures that all stakeholders are equally represented, with their views respected and taken account of. It actively seeks and heeds input from gas suppliers and receivers, vessel owners and operators, equipment manufacturers and suppliers, technical experts, engineering consultants and designers, regulators and class societies, and port and terminal operators. All have a voice.

No matter where we sit in the value chain, from super-major integrated energy companies to small and medium enterprise (SME) consultancies, there are common, unequivocal goals – to protect the safety of everyone involved in the business and to safeguard our environment by setting common standards and exchanging best practices.

Emergency Shutdown (ESD) systems are the most critical link in the safety chain. These guidelines are built on sound principles, both procedures and equipment standards, with operational excellence from existing LNG terminals and across the industry forming the best possible foundations.

It must be stressed that these are guidelines. As the industry evolves and builds its own experiences of operational excellence, so must these guidelines evolve. To ensure this happens, the guidelines must not only be used – suggested improvements and best practices must be recorded and fed back. It is the responsibility of all users to assume a leadership role in this.

Thank you to the work group members, for their participation in creating these guidelines and their ongoing development.

Neil Ferguson

Houlder Ltd

Chairman of SGMF WG6.2 Essential Functional Requirements for Control and Safety Systems



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Purpose

This Technical Guidance Note (TGN) provides recommendations for the Emergency Shutdown System arrangements, integration, data and voice communication and interfaces for the LNG bunkering of gas-fuelled vessels. It specifically addresses the functional safety principles of the linked ESD system to ensure a controlled shutdown of the bunkering operation in the case of an emergency.

The document responds to the demand for a common approach across the industry for emergency shutdown. It also addresses concerns regarding differing interpretations of emergency shutdown functional requirements, the functional safety principles, and the means of control between a gas fuel supplier and a receiver gas-fuelled vessel over the bunkering operation.

The application of this TGN will promote the development and deployment of compatible gas-fuelled vessel bunkering interfaces with differing bunkering facilities and installations. It will thereby facilitate flexibility of bunkering operations in different locations and from different suppliers.

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 technologies.

Furthermore, this document promotes and encourages the widespread use of linked ESD systems, as referred to in Chapter 8.5 of the IGF Code.

While this TGN has been based on information made available to SGMF, no responsibility is accepted by SGMF, 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.

In this TGN, “bunkering facility type(s)” means any technology or system designed to be used to transfer/bunker liquefied gas as fuel to a generic gas-fuelled vessel. This comprises floating, shore fixed or mobile fuel supply facilities – such as bunker vessels, terminals and road tankers.

1 Introduction

The growing use of natural gas as a marine fuel¹ 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 standardisation of the interfaces between the gas fuel supplier and the receiver.

While each bunker facility and gas-fuelled vessel will need to develop its own specific safety and operational processes, implementation of the recommendations in this TGN will facilitate compatibility between the different systems deployed across the industry. This TGN will assure flexibility of supply as well as a common minimum safety threshold.

To help standardise guidance, this TGN has been prepared by SGMF's Work Group 6.2, which consists of ship operators, naval architects, classification societies, ship builders and equipment manufacturers.

The document covers the following main topics:

- Linked ESD System: design and configuration, control and functional requirements
- Bunkering Safety Links: technology, type, selection and standardisation
- Emergency Shutdown function: initiators and actions

While this TGN has been written for both operators and system designers/manufacturers, it is not intended to constitute a detailed technical specification for the design of linked ESD systems. It only sets out recommendations and functional requirements such that a skilled design team can produce a detailed specification.

1.1 Applicability

This TGN and its recommendations are intended to apply to any IGF-compliant gas-fuelled vessel and bunkering facility.

Gas-fuelled vessels that are not formally required to comply with the IGF Code – for example, inland waterway and IGC vessels – may also benefit from the guidance in this TGN, ensuring a common and consistent approach across the industry.

While the primary intention of this TGN is to address the requirements of the receiver, the requirements may also serve the supplier's bunkering facility. However, in developing its safety and operational systems, the supplier must also reference the rules and standards applicable to its bunkering facility. These include: the IGC Code, ISO 28460 and ISO 20519.

This TGN currently addresses the specific requirements for natural gas used as a marine fuel. With appropriate limitations, its content might also be used as reference for some other low-flashpoint fuels and systems that are not currently specifically addressed.

1.2 Alternative Arrangements

Where existing receivers or suppliers are unable to adapt to the recommendations in this TGN, operational restrictions and incompatibilities may occur. All parties should be prepared to discuss these issues before a receiver utilises a new supplier for the first time.

Certain types of gas-fuelled vessel may be unable to comply with all the guidance in this TGN owing to the nature of their construction. Where possible, differences between vessel design and these recommendations should be minimised.

¹ In this TGN, "fuel" means natural gas in a liquefied or gaseous state.

When design solutions outside the guidelines in this TGN are agreed between vessel owners, designers and fuel suppliers, it is recommended that these follow a documented assessment process and preserve or enhance the minimum threshold safety principles in this TGN.

1.3 References and Further Reading

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

- 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
- ISO 20519: 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 28460: Petroleum and Natural Gas Industries – Installation and Equipment for Liquefied Natural Gas – Ship-to-shore Interface and Port Operations
- SGMF: Safety Guidelines – Bunkering – FP07-01 Ver2.0
- SGMF: Recommendation of Controlled Zones During LNG Bunkering – FP02-01 Ver1.0
- SIGTTO: ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers - 2009

Numerous guidelines and standards are available in the small-scale bunkering and large-scale LNG shipping industry. Table 1 below is a guide to the most relevant guidelines and standards and their main area of applicability:

Table 1: Guidelines & standards main areas of interest

	Assets & Facilities			
	Gas Fuelled Vessel	Shore Facility / Terminal	Mobile Facility (Trucks / Containers)	Bunker vessel / barge
IGF Code	✓			
IGC Code				✓
ISO 20519	✓ Bunkering	✓ Bunkering	✓ Bunkering	✓ Bunkering
ISO 18683	✓ Bunkering	✓ Bunkering	✓ Bunkering	✓ Bunkering
ISO 28460		✓ Cargo		✓ Cargo
SGMF Guidance	✓ Bunkering	✓ Bunkering	✓ Bunkering	✓ Bunkering
SIGTTO Guidance		✓ Cargo		✓ Cargo

While every effort has been made by SGMF to avoid discrepancies between the recommendations in this TGN and the statutory requirements in international standards and rules, if discrepancies are found the statutory requirements shall take precedence.

1.4 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.

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".

Emergency Shutdown (ESD) – 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 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 drift away limit be exceeded, 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 typically 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 bunkering 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 time of disconnection. 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.

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

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 receiver bunkering and supplier discharging manifolds near the presentation flange. Governed by the ESD system, it is closed in an emergency shutdown event.

Fail-Safe – A design feature mitigating unsafe consequences of a component failure.

Fuel – Natural gas in liquefied or gaseous state.

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

Hazardous Area/Zone – A three-dimensional space in which there is a defined probability that a flammable atmosphere may be present. It is defined by national regulation and by the IGF and IGC codes.

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 – Liquefied 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.

Logic Solver – The Logic Solver (ESD Logic Solver – ERS Logic Solver) is generally an electronic programmable processor. However, it can consist of a discrete logic arrangement utilising, for example, safety relays.

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)

Person in Charge – Person In Charge should be suitably trained and qualified to fulfil the role; the regulating authority may have specific requirements.

Quick Connect / Disconnect Coupler (QC/DC) – Mechanical device, typically manually or hydraulically operated, used to connect the transfer system (e.g. loading arm) to the bunkering manifold presentation flange without employing bolts.

Receiver – Gas-fuelled vessel.

Safety-critical – A safety-critical or life-critical system or function is one whose failure or malfunction may result in one or more of the following outcomes: death or serious injury to people, loss or severe damage to equipment/property or harm to the environment.

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 – Bunkering facility.

Transfer System/Bunkering Transfer System – A loading arm made of articulated piping or transfer hose solution, or a combination of articulated piping and hose, enabling 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.

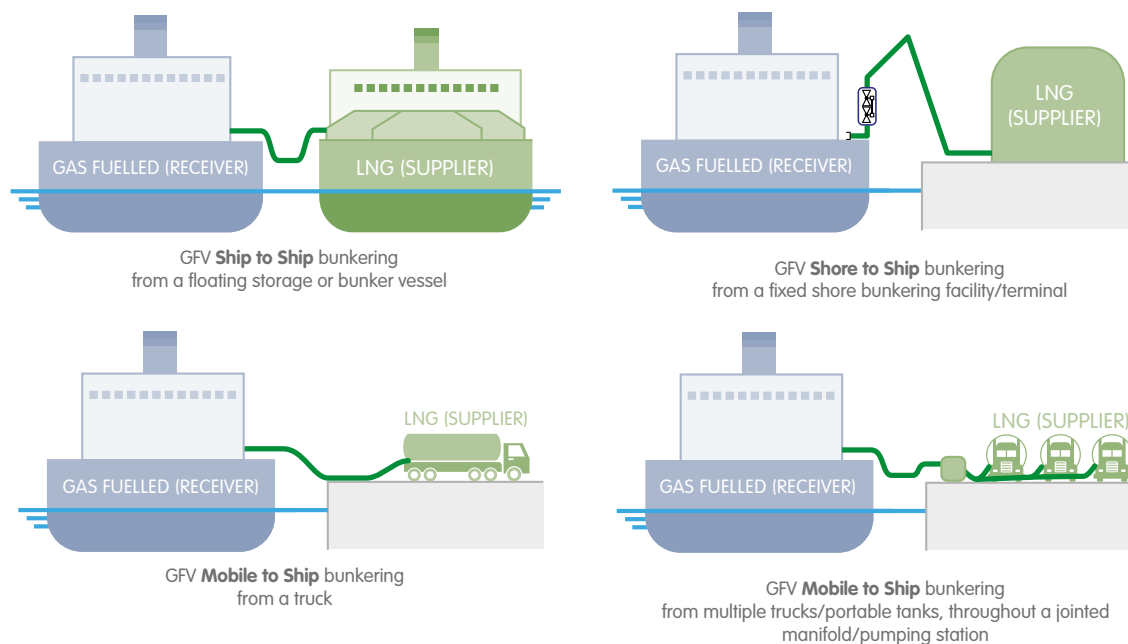


Figure 1 – Bunkering Supply Scenarios

1.5 Abbreviations

The following abbreviations are used in this document:

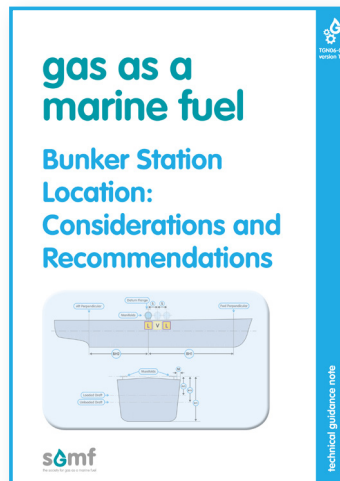
- BOG** – Boil-Off Gas
- BSL** – Bunkering Safety Link
- CCTV** – Closed-circuit television
- ESD-1** – Emergency shutdown stage 1
- ESD-2** – Emergency shutdown stage 2
- ERC** – Emergency Release Coupler
- ERS** – Emergency Release System
- FAT** – Factory Acceptance Test
- FMEA** – Failure Mode and Effects Analysis.
- GFV** – Gas Fuelled Vessel
- HAZOP** – Hazard and Operability Analysis
- IEC** – International Electrotechnical Commission
- IGC** – International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk
- IGF** – International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels
- ISO** – International Organization for Standardization
- IP Rating** – Ingress Protection rating
- LNG** – Liquefied Natural Gas
- PIC** – Person in Charge
- SIGTTO** – The Society of International Gas Tanker and Terminal Operators
- SIL** – Safety Integrity Level
- SIF** – Safety Instrumented Function
- SSL** – Shore-to-Ship Link
- TGN** – Technical Guidance Note

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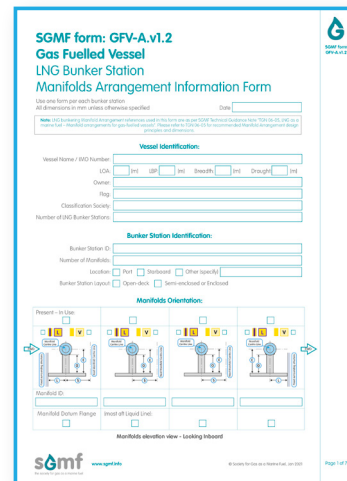
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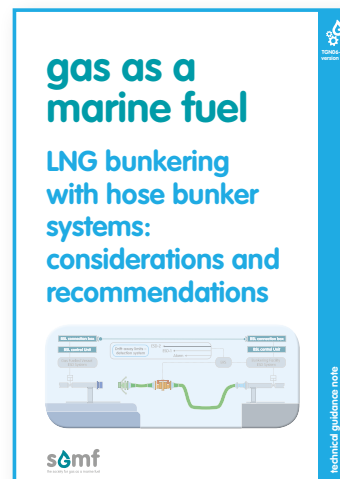
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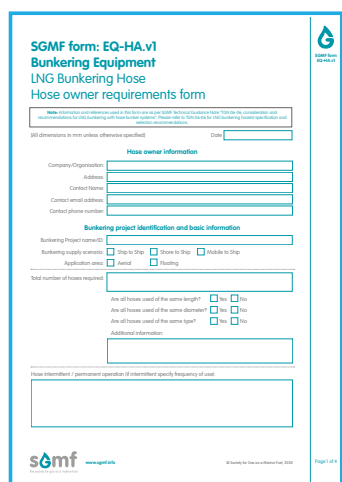
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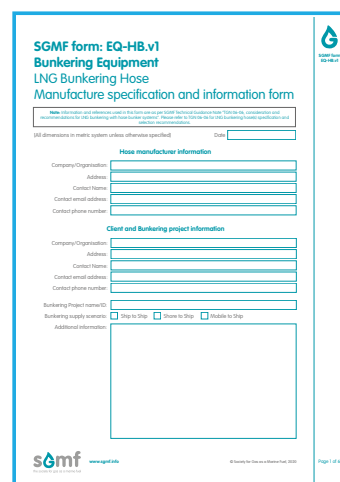
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