

# gas as a marine fuel

Work practices for  
maintenance, repair  
and dry-dock operations

## safety

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This book is dedicated to the memory of Marcel LaRoche who, while at British Columbia Ferries, pioneered many of the basic tenets of this new industry.

His contribution to the early stages of this group was very important in giving this publication its form and direction, his guidance was sorely missed during the later stages.

# Foreword

Firstly it was an honour and a privilege to chair this particular working group. The quality, experience and technical knowledge of the team contributed in developing this new guidance for dry-docking vessels which select to use methane gas as a fuel from LNG storage facilities on board the vessel.

With more focus on the environment and addressing emissions the marine industry has embraced the challenge under direction of the International Maritime Organization (IMO) to tackle emissions. The IMO has enforced a new 0.5% global sulphur cap on fuel. MARPOL Annex VI Regulation 14 limits the fuel oil sulphur content to any fuel oil used onboard all ships, new and existing, to 0.50% m/m as of 1 January 2020.

This is a strong move towards reducing harmful emissions from vessels of all types which forces the maritime industry to look for more efficient environmentally suitable fuels that comply with the new IMO legislations. Hence why gas as a marine fuel is part of the emissions solution.

Shipping companies who undertake the use of LNG storage and gas as a marine fuel will need to be ready for first dry dock. This guidance will provide the required detail and direction to the ship owner in selecting the prequalified yards and the yards will be able to use the guidance to prepare and be LNG ready.

The guidance offers a risk assessment approach and covers all aspects of LNG fuel management while preparing for the docking and during the docking process.

LNG as a marine fuel will continue to grow and more vessels will switch to gas as the preferred fuel to meet the IMO legislation on emissions. It is important that prior to any docking both vessel and yard fully understand the preparation and the fuel management during the docking period. This guidance will give the majority of detail, but it is advised to fully understand the LNG handling methodology and appoint an LNG specialist within the fleet and the yard.



It only remains for me to thank the SGMF and the participants of the working group whose efforts and time was shared to put this guidance together.

Thank you.

**Andrew Brown**  
*Smit Lamnalco*  
*Chairman, SGMF WG10*

# Abbreviations and Definitions

**ALARP/ALARA** – As Low as Reasonably Practicable/Achievable without incurring excessive cost

**Asphyxia** – a condition arising when the body is deprived of oxygen that may result in impairment and ultimately death

**Asphyxiant** – a gas that displaces or replaces oxygen in the atmosphere, thus posing the threat of asphyxiation – for example, nitrogen and methane vapour

**ATEX** – Appareils destinés à être utilisés en Atmosphères EXplosibles. (Equipment destined for use in potentially explosive atmospheres.) The European Union ATEX Directive 2014/34/EU covers equipment and protective systems intended for use in potentially explosive atmospheres

**bara/barg** – pressure stated as absolute/gauge pressure, meaning the pressure zero-referenced to that of a perfect vacuum or ambient atmospheric pressure

**BOG** – Boil-Off Gas. The vapour created by evaporation from the surface of a volume of LNG

**Chemist** – a skilled and qualified

person who works with chemicals to define their behaviours and reactions and their effects on humanity and the environment

**Class(ification) Society** – an organisation that establishes and maintains technical standards for construction and ongoing operations to ensure the safety of ships

**CNG** – Compressed Natural Gas is natural gas stored at high pressure (up to 300 bar)

**CO<sub>2</sub>** – carbon dioxide, a combustion product and a major greenhouse gas

**Competence** – the capability to undertake a task and complete it successfully with confidence and understanding

**Competent Authority** – any national, regional or local authority empowered, alone or together with other authorities, to act as the regulatory body on the use of LNG onboard ships

**Cryogenic** – temperatures below -101°C (NFPA)

**Dew Point** – the temperature, at a specified pressure, at which a vapour condenses its first drop



of liquid and will continue to condense if cooled further

**Dry air** – air, at atmospheric pressure, with a dew point of  $-70^{\circ}\text{C}$  (about  $-100^{\circ}\text{F}$ ) and containing less than 2.6 parts per million of water by volume

**EN** – European (Standard) Norm

**ESD** – Emergency Shut-Down, a control system and associated components that, when activated, stop operations in a controlled manner, returning a system to a safe state

**ESSF** – European Sustainable Shipping Forum, an EU consultative body for LNG as a marine fuel

**EU** – European Union, a political and economic alliance of 27 countries in Europe

**EX** – equipment classified as safe to operate in hazardous areas where a flammable gas may be present

**Flag (state)** – the place where a vessel is registered and whose rules a ship must be operated to. The rules are normally the interpretation of IMO regulations which can be implemented

directly or via Class Societies

**GaN** – Gaseous nitrogen

**Gas** – a fluid above its critical point that cannot be turned into a liquid by pressure alone

**Gas Doctor** – see Chemist

**Gas free** – when a vessel, container or area has concentrations of flammable gases below a prescribed limit.

**Gassed up** – a piece of equipment or pipework where a flammable gas is or may be present. By extension, where a liquid such as LNG is present which may vaporise to create a flammable gas

**GCU** – Gas Combustion Unit, a way of disposing of methane and other hydrocarbons by catalytically burning them into  $\text{CO}_2$  and water

**Hazardous area/zone** – the three-dimensional space in which a combustible or explosive atmosphere can be expected to be present frequently enough to require special precautions for the control of potential ignition sources. Defined by national regulations and both the IGF and IGC codes

# Abbreviations and Definitions

## **HAZID** – HAZard IDentification.

There are a number of recognised methods for the formal identification of hazards. For example, a brainstorming exercise using checklists where the potential hazards in an operation are identified and gathered in a risk register to be addressed and managed

## **HAZOP** – HAZard and OPERability

study, a safety process that reviews how systems react to changes in their operating parameters that may cause additional hazards

## **HSEQ** – Health, Safety, Environment and Quality

**IACS** – International Association of Classification Societies, a technically based non-governmental organisation that consists of the 12 main Classification Societies aiming to produce consistent standards for marine ships

**IAPH** – International Association of Ports and Harbours, the global trade association for ports and harbours

**ICS** – International Chamber of Shipping, the international trade association of merchant ship

owners and operators including all ship types

**IGF** – The International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels

**IMO** – The International Maritime Organization. The United Nation's maritime regulatory body

**ISGOTT** – International Safety Guide for Oil Tankers and Terminals, published jointly by IAPH, ICS and OCIMF

**ISM** – The International Safety Management Code published by the IMO

**ISO** – The International Organization for Standardization. An international standard-setting body composed of representatives from various national standards organizations

**ISPS** – IMO's International Ship and Port Security Code, describing minimum security requirements for the maritime sector

**LFL** – Lower Flammable Limit. The low end of the concentration range over which a flammable mixture of gas and vapour in air can ignite at a given temperature and pressure





**LIN** – Liquid nitrogen, normally below  $-196^{\circ}\text{C}$  at ambient conditions. Also known as LN2

**LNG** – Liquefied Natural Gas. Natural gas in a liquid state. GNL in French, Spanish and Italian (the French is Gaz Naturel Liquefié)

**LNG-ready dry-dock** – A shipyard that has plans, skills, equipment and management systems in place to handle competently gas/LNG-fuelled vessels with fuel (gas/LNG) on-board during maintenance

**LPG** – Liquid Petroleum Gas, a mixture of propane and butane used as fuel and chemical feedstock

**LSHFO** – Low-Sulphur Heavy Fuel Oil, a residual fuel oil whose sulphur content is below 0.5%

**Maintainer** – members of the vessel's crew, a shipyard and any subcontractors/OEMs employed by the owner or the yard to perform maintenance or repair work

**MAP** – the Maximum Acceptable Pressure allowed by competent authorities as part of a gas-management plan. The MAP will be an agreed percentage of the MARVS

**MARVS** – Maximum Allowable Relief Valve Setting, the pressure at which a relief valve used to protect a pressurised system opens to control and reduce pressure

**MGO** – Marine Gas Oil

**Natural gas (NG)** – A mixture of hydrocarbon gases, mostly methane, used as a fuel or chemical feedstock. Also used to refer to regasified LNG

**NDT/NDE** – Non Destructive Testing/Examination, techniques that allow a system or component to be examined and proven without damage

**NFPA** – The National Fire Protection Association, a US-based standards body for fire, electrical and related hazards

**OCIMF** – The Oil Companies International Marine Forum, an association representing operators of oil tankers and terminals, dealing with safety and environmental issues and specifically associated with mooring and berthing guidelines

**OEM** – Original Equipment Manufacturer

# Abbreviations and Definitions

**ORA (Operational Risk Assessment)** – Risk assessments resulting from operations and maintenance activities to ensure levels of safety are not compromised while activities continue

**PPE** – Personal Protective Equipment

**ppm** – parts per million, a measure of concentration

**PRV (Pressure-Relief Valve)** – a mechanical device used to prevent pressure rising above a predetermined level

**QRA** – Quantitative Risk Assessment, a formalised, numerical risk assessment methodology for calculating a risk level for comparison with defined risk criteria

**QSHE** – see HSEQ

**Risk** – A combination of the likelihood of an event occurring and the consequences of the event occurring

**Risk Assessment** – a term used to describe the overall process or method whereby hazards and risk factors that have the potential to cause harm are identified,

analysed and evaluated so that appropriate mitigations – both physical and managerial – can be put in place to reduce risks to acceptable levels

**RPT** – Rapid Phase Transition, the rapid – potentially explosive – vaporisation of LNG into vapour through contact with a heat source, typically water

**Safety-Sensitive Area** – Locations where heightened work control is required because they border on hazardous areas or include systems essential to safe vessel operation

**SBTT** – Secondary Barrier Tightness Test, a process whereby the continuing integrity of a (GTT) membrane type fuel tank is assured

**SGMF** – The Society for Gas as a Marine Fuel, an international organisation providing guidance on the safe and responsible use of low-flashpoint fuels in a marine context

**Shipyards** – a controlled area where ships are built and repaired

**SIGTTO** – The Society of International Gas Tanker



and Terminal Operators, an organisation representing operators of gas tankers and import and export terminals, covering all liquefied gases in bulk

**SIMOP** – SIMultaneous OPeration. Defined in this document as “an activity where LNG or its vapour is transferred or has the potential to escape containment plus one, or more, other activity and/or operation conducted at the same time where their interaction may adversely impact safety, ship integrity and/or the environment”

**Special steel** – a steel not typically used for a vessel hull and structures such as a high alloy steel, for example stainless steel (or an alternative material such as aluminium) required to contain LNG and gaseous fuels.

**STCW** – Standards of Training

Certification and Watchkeeping, an IMO publication detailing standards and training for mariners on different ship types

**Training** – the teaching of a particular skill or method of doing something

**TRV (Thermal-Relief Valve)** – used to relieve pressure caused by the thermal expansion of process fluids in vessels and lengths of pipework

**ULSHFO** – Ultra Low Sulphur Heavy Fuel Oil, a residual fuel oil with a sulphur content below 0.1%

**Vapour** – a fluid which appears to be a gas but can be turned into a liquid by a change of pressure

**VIT** – Vacuum-Insulated Tank, a Type C tank with a vacuum jacket for insulation

# Disclaimer

While this document is specifically about LNG, much of the discussion applies to other fuels allowed by the IGF Code. However, each fuel has its own peculiarities – for example, the cryogenic nature of LNG or the toxic hazard associated with methanol – so this guidance should be used in its entirety only for LNG.

LNG and natural gas behave differently from traditional fuel oils when released into the air or onto water or land. Safety precautions should be assessed differently than for traditional maintenance operations. This guide explains how to assess these differences.

This publication is a technical book which primarily provides the necessary information for individuals and organisations to start developing maintenance and safety guidance. It does not provide rules or definitive practices but the framework on which to base more detailed rules and procedures.

Parts of these guidelines talk about the mitigation of LNG/gas hazards. This does not include emergency response (including firefighting). Once a hazardous event has occurred, risk assessments are overtaken by emergency service protocols. Guidance for the emergency services is being developed or has been covered elsewhere by other industry bodies (such as SIGTTO, CCNR and OPITO).

These guidelines do not address the following:

- equipment-specific maintenance required by certain equipment models, OEMs or manufacturers/vendors
- maintenance frequencies required by OEMs, Class Societies or Flag states
- the commercial impacts of maintenance activities

It is up to the ship-owner, yard, and/or competent authority to assess each situation and, if necessary, to apply alternative measures.

While the advice given in this Guide is based on current good industry



practices and available information, it is intended solely for guidance and use at the owner's/operator's/Maintainer'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 the recommendations or guidance contained herein.

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# 1. Purpose and Scope

## 1.1. Aim

This document provides guidance on how to maintain vessels using LNG/gas as fuel. Maintenance covers all the activities that keep a vessel operating safely to its specifications. It can range from maintenance by a ship's crew through to major repairs and inspections requiring a dry dock. The guidance concerns techniques and precautions that can be applied to minimise the hazards of LNG/gaseous fuels – in many cases, allowing the use of traditional maintenance techniques. Where this is not possible, the guidance discusses alternative methods.

These guidelines were created collaboratively by industry members of the SGMF. The guidance assumes that gas-fuelled vessels are designed according to relevant and applicable codes, regulations and guidelines.

These guidelines emphasise and advise some new concepts. These include:

- LNG remaining on board a vessel during maintenance may become the norm – requiring additional risk assessment and precautions.
- where there is a risk that gas may be present, a technique called hazardous areas classification is used as one mitigation.
- this guidance also defines a “safety-sensitive area” where enhanced safety performance is required. Safety-sensitive areas are locations that border on hazardous areas or include systems essential to safe vessel operation and where heightened work control is required.
- safe systems of work – both procedures and methods of working – are essential within hazardous zones and safety-sensitive areas to preserve the integrity of these locations, even if the LNG system itself is not being maintained.
- a “LNG-ready dry dock” will have developed systems of safe working and the necessary procedures which have been approved by the appropriate regulators.

Minimum safety requirements are defined by International, national and/or local regulating bodies. Competent authorities will define procedures for compliance and enforce the regulations. This guidance will assist in streamlining and standardising these procedures.



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