

# gas as a marine fuel

Operation of ships with  
Liquefied Natural Gas (LNG)  
competency and  
assessment guidelines

## Training & Competence

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## Disclaimer

While the advice given in this *Operation of ships with Liquefied Natural Gas (LNG) – competency and assessment guidelines* document has been developed using the best currently available information, it is intended solely as guidance to be used at the user's own risk.

## Acknowledgements

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# Foreword



Within risk management, it is generally acknowledged that providing operatives with the information and skills they need to undertake a task safely and efficiently, lowers the perceived risk.

LNG has been carried at sea for over 50 years, with an enviable safety record – thanks to the design of the vessels used, the use of common standards and protocols, and the skilled personnel engaged in all stages of the process. The use of LNG as a fuel on marine vessels has introduced new challenges as we are now placing LNG onto vessels where the handling of hazardous liquids may not be common practice. When not handled correctly, LNG can be hazardous due to its very low temperature and its flammability. To ensure that vessels using LNG as a fuel are operated safely and efficiently it is important that crews are provided with training so that they fully understand the operating requirements and the risks.

This document focuses on all the activities relating to the preparation, storage, handling and use of gas as a fuel – from the storage tank through to delivery to the consumer – and the competencies required of those personnel engaged in undertaking the related tasks. It therefore covers the full scope of competencies that we believe a skilled engineer and supporting team need to have to be able to operate the gas fuel system through the complete voyage cycle (from dry-dock to dry-dock). It therefore goes beyond the scope of the IMO's *Standards of Training Certification and Watchkeeping (STCW)* and should be used accordingly.

The aim was to define a set of competencies that are simple to understand and interpret which may be used by any individual, operator, organisation or authority, to identify what tasks will be conducted by themselves, their personnel, or within their scope and the knowledge, understanding and competencies that they require. It is hoped that the document will also provide sufficient guidance to allow training organisations to develop training programmes that deliver the competencies effectively.

It has been a challenge to develop a scheme applicable to all the various parties that may be involved, but I believe this document meets that goal.

For that, I thank all the contributors to the working group for their hard work and also those who have provided comments separately.

The overall goal is to ensure that any operation conducted with LNG will be completed safely and effectively, no matter where or when.

The use of LNG as fuel is a new industry that will continue to develop and hence new knowledge, understanding and competence requirements will continue to be identified. So this document will be reviewed and updated accordingly on a regular basis. To this end, SGMF and its Working Group on Training and Competence welcome comments and suggestions for improvement.

**Ray Gillett**

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# Abbreviations and Definitions



**Ageing** – the effect on LNG composition and properties due to gas boiling off over a period of time (because lighter components evaporate more quickly than heavier ones)

**Apply** – in the context of this document means to apply concepts, general rules and knowledge to different but limited situations in a workplace

**Asphyxiation** – a medical condition in which the body is deprived of oxygen which can result in unconsciousness and death

**ATEX** – refers to the ATEX directives issued by the European Union which describes the minimum safety requirements of the workplace and equipment used in potentially explosive atmosphere.

**Auto-ignition point** – the temperature above which a fuel has sufficient energy to spontaneously ignite if sufficient oxygen is present

**BOG** – Boil-Off Gas, the vapour created by the evaporation of the LNG due to heat ingress; in this context, it is referred to as naturally produced BOG

**BLEVE** – Boiling Liquid Expanding Vapour Explosion, an explosion

resulting from over-pressurising a liquid gas storage tank, usually as the result of a fire beneath the tank

**CCTV** – Closed Circuit TeleVision, a means of monitoring an area remotely using cameras and TV screens

**CH<sub>4</sub>** – methane, the hydrocarbon that is the main constituent of natural gas

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

**Closed Question** – a question with a limited number of answers to choose from – for example, a multiple-choice test (see also Open Question)

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

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

**Competency** – the capability of undertaking a task and completing it successfully, with confidence and understanding

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

**DCS** – Distributed Control System, a microprocessor-based control system usually with multiple control loops, in which autonomous controllers are distributed throughout the system

**ESD** – Emergency Shutdown, a control system and its components that when activated stops operations in a controlled manner and returns the system to a safe state

An ESD system may have several sequential stages, with operation of each stage dependent on the potential consequences of the situation. During bunkering these stages are commonly designated ESD-1 and ESD-2.

**ESD1** – where transfer of LNG to the bunkering vessel is stopped

**ESD2** – where the transfer system is disconnected from the bunkering ship

In some ship types there may be additional definitions to the ESD system but these are outside the scope of this document.

**Ex** – electrical equipment certified for safe operation when gas is present – for example, in a hazardous area

**Flag (state)** – the place where a vessel is registered and whose rules a ship must comply with. The rules are normally the interpretation of IMO regulations which can be implemented directly or frequently via class societies

**Flammable range** – describes the minimum (see LFL) and maximum (see UFL) concentrations at which a given vapour can ignite or combust when mixed with air

**Flashpoint** – the temperature above which a fuel generates sufficient vapour to allow combustion to occur if an ignition source is present

**GCU** – Gas Combustion Unit, equipment that thermally oxidises fuel gases when supply exceeds demand

**GVU** – Gas Valve Unit, the valves that isolate and protect a gas consumer from the gas supply

**Hazardous Area Classification / Zoning** – hazardous areas are classified into zones based on assessing the likelihood of an explosive gas atmosphere occurring, as follows:

Zone 0: An area in which an explosive gas atmosphere is



present continuously or for long periods

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 and, if it occurs, will exist only for a short time

**Holding time** – The time taken to reach the maximum allowable pressure in an LNG tank with the tank completely isolated and no BOG being removed

**HSSE** – common acronym for Health, Safety, Security and Environment

**Hypothermia** – a medical condition in which the human body loses heat, resulting in a dangerously low core body temperature (<35°C)

**IEC** – International Electrotechnical Commission, an international standards body for electrical equipment

**IGC Code** – *The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*, published by the IMO, is an international

standard for ships engaged in the carriage of liquefied gases and certain other substances

**IGF Code** – *The International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels*, published by the IMO, is an international standard for ships, other than vessels covered by the IGC Code, operating with gas or low-flashpoint liquids as fuel

**IMO** – The International Maritime Organization, the United Nations' specialised agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships

**Interpret** – in this document means to critically examine information to make judgements, plan procedures and troubleshoot events

**Intrinsically Safe** – a protection concept for the design of safe electrical equipment for operation in hazardous areas by limiting the electrical and thermal energy available for ignition

**ISM Code** – *The International Safety Management Code*, published by the IMO, is an international standard for the safe management and operation of ships and for pollution prevention

**ISO** – International Organization for Standardization, a standard-setting body composed of representatives from various national standards organisations

**Know** – in this document means to recall learned information, particularly underpinning knowledge, on request

**Knowledge** – indicates possession of information relating to an event or operation that gives the individual the capability to safely take part in that operation (see also Understanding)

**LEL/LFL** – Lower Explosive Limit/Lower Flammable Limit, the lowest concentration of a flammable hydrocarbon in air that can be ignited and burnt; similarly, UEL/UFL represents the upper limit of the flammable range

**LNG** – Liquefied Natural Gas, natural gas that has been cooled to the point where it is liquid at the current pressure. GNL in French, Spanish and Italian (the French translation is Gaz Naturel Liquefié)

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

**MARPOL** – *The International Convention for the Prevention of Pollution from Ships*, published by the IMO, is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes

**Mechanical handling** – the method and/or equipment used to manoeuvre LNG transfer systems into place; may consist of a crane or simpler devices such as block and tackle, chain hoists, and so on

**N<sub>2</sub>** – nitrogen, an unreactive gas that is the main constituent of air

**Natural Gas (NG)** – a mixture of hydrocarbon gases, mostly methane, used as a fuel or chemical feedstock; may refer to natural gas in liquid or gaseous phase; methane is a potent greenhouse gas

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

**NO<sub>x</sub>** – nitrogen oxides, products of combustion processes that are harmful to humans and also potent greenhouse gases



**NPSH** – Net Positive Suction Head, the absolute pressure at the suction port of the pump.

**O<sub>2</sub>** – oxygen, a highly reactive oxidising agent and one of the main constituents of air

**OCIMF** – 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

**Open Question** – a question with no defined answers; requires candidates to consider and compare/contrast, for example, an essay (see also Closed Question).

**P&ID** – Process and Instrumentation Diagram, a drawing that shows all the main pipework, valves and instruments and how they are connected to each other

**PBU** – Pressure Build-up Unit, an installed system that enables the gas fuel storage tank pressure to be increased

**PIC** – Person-In-Charge, sometimes also called the Person in Overall Advisory Control (POAC)

**Pilot fuel** – a small quantity of liquid fuel injected into gas-burning equipment to initiate combustion

**PM** – Particulate Matter, small particles of solid material created by combustion of fuels; harmful to humans and a contributor to pollution – for example, smog

**PPE** – a common abbreviation for Personal Protective Equipment

**Q & Q** – an abbreviation for Quality and Quantity, used to refer to specialist measurements taken as part of the transfer process

**Q-H** – flow rate to head (pressure) characteristics for pumps and compressors

**Rollover** – the rapid mixing of layers of different compositions of LNG (see stratification) that may develop within a fuel tank; such mixing may result in the generation of large volumes of gas

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

**SGMF** – Society for Gas as a Marine Fuel, a London-based association for companies involved in the use of LNG as a marine fuel

**SIGTTO** – the Society of International Gas Tanker and Terminal Operators, an association representing operators of gas tankers and import and export terminals dealing with all liquefied gases in bulk

**SIMOPs** – abbreviation referring to **SIM**ultaneous **OP**erations; typically, operations carried out on or close to a vessel at the same time as LNG bunkering

**SOx** – sulphur oxides, products of combustion processes resulting from sulphur in the fuel; harmful to humans and damaging to the environment (as a cause of acid rain)

**STCW** – *Standards of Training Certification and Watchkeeping*, an IMO publication detailing the standards and training for mariners on different ship types

**Stratification** – differences in density between two or more layers within a tank filled with LNG

**Training** – indicates teaching a particular skill or way of doing something

**UEL/UFL** – Upper Explosive Limit/Upper Flammable Limit, the highest concentration of a

flammable hydrocarbon in air that can be ignited and burnt; similarly, LEL/LFL represent the lowest limits of the flammable range

**Underpinning Knowledge** – the minimum level of technical or other appropriate knowledge and understanding required to be able to carry out a task safely and efficiently, without undue risk or delay

**Understand** – in this document means to understand the meaning and interpretation of instructions and problems based on the knowledge learnt

**Understanding** – indicates possession of sufficient breadth and depth of knowledge and experience to be able to make appropriate decisions about the preparation for, and conduct of, an operation, without compromising the safety or efficiency of that operation (see also Knowledge)

**Weathering** – see Ageing

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# 1. Purpose and Scope



This document is a guide for those involved in training, assessing and monitoring people who operate vessels that use gas as a fuel and which are covered by *The International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code)*, published by the IMO. It provides additional training elements to those described in Tables A-V/3-1 and A-V/3-2 of the IMO's Standards of Training Certification and Watchkeeping (STCW) and focuses on LNG marine fuel operations and technical details.

Used in conjunction with the SGMF's *Training and Competency Guidelines for Bunkering (FP04-02)*, it is intended – along with other resources such as the IMO Model Course guide – to provide guidance for the development of training courses for marine personnel concerned with the storage and use of gas as fuel onboard vessels other than gas carriers and bunker vessels.

Some basic and essential information – including definitions, abbreviations and the underlying ethos regarding training and competence – may be repeated to avoid continual cross-referencing to other SGMF publications.

The information in this document is current at the time of publication. There are a number of different fuel storage and handling systems in service, using a wide range of equipment, and advances are being made rapidly. Whilst every effort has been made to make this document as comprehensive as possible, it is inevitable that new equipment and configurations will develop which may require additional competencies to be defined.



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