LNG INFORMATION PAPER

#4

2019 Update

Managing LNG Risks
Operational Integrity, Regulations, Codes, and Industry Organisations

contents

GIIGNL's Technical Study Group introduces a series of Information Papers that provide factual information about Liquefied Natural Gas (LNG). This paper describes the safety requirements for Liquefied Natural Gas (LNG) projects, which are established by regulations, classification societies, codes, standards, and industry associations. Cumulatively, they help assure the operational integrity of LNG facilities and ships and form one of the layers of protection to manage safety risks to facility workers and the public.

INTRODUCTION

The most important safety requirement for the industry is to safely process, store, and transport LNG. There are a number of guidance documents and requirements which are intended to assure the safe operation of onshore and offshore LNG facilities, personnel and ships. Strict adherence to government regulations, codes, and standards has led to the LNG industry's exemplary safety record. Sharing best practices through non-profit trade organisations has also served to strengthen the safety culture of the entire industry.

LNG ships must comply with all relevant local and international regulatory requirements including those of the International Maritime Organisation (IMO), International Gas Carriers Code (IGC) and the US Coast Guard (USCG). For additional information on the regulations, codes and standards which apply to LNG ships, please refer to **Information Paper No. 3**.

Small scale LNG Terminals (satellite plants and road or marine bunkering stations) must also comply with all relevant, national and international regulatory requirements such as those quoted in the GIIGNL Retail LNG handbook.

There are 148 LNG import terminals (regasification plants) located worldwide in 2018. In 2018, the largest importers of LNG were Japan, China, South Korea, India and Taiwan on the Asian continent, Mexico and Chile on the American continent, Kuwait and Jordan in the Middle East as well as a number of European countries such as Spain, France, Turkey, Italy, the UK and the Netherlands.

Offshore (floating) import terminals are an alternative to onshore facilities. Offshore regasification facilities are currently operational in Argentina, Bangladesh, Brazil, China, Columbia, Egypt, Indonesia, Israel, Italy, Jamaica, Jordan, Kuwait, Lithuania, Malaysia, Malta, Pakistan, Turkey, UAE and the US.

GOVERNMENT REGULATIONS

The intent of regulatory authorities is to reduce the risk of adverse environmental consequences, damage to equipment, facilities or ships and – most importantly – human casualties. This is achieved by various means in different parts of the world but with a common basis fixed by international standards such as ISO16901 : "Guidance on performing risk assessment in the design of onshore LNG installations including the ship/shore interface"

In Europe, project applicants are required to conduct a safety risk assessment according to accepted methodologies and submit the results of these studies to the permitting agencies for review. European regulations usually focus on the outcomes, rather than the specific ways to achieve the desired level of safety.

European Union Directive 2012/18/EU (SEVESO-III) is aimed at the prevention of major accidents involving dangerous substances, including LNG, and the limitation of their consequences. The provisions contained within the Directive were developed on the basis of an analysis of major accidents which had been reported to the Commis-

sion since the implementation of the original SEVESO I directive in 1976. One such area is management policies and systems. Failures of the relevant management system were shown to have contributed to the cause of over 85% of the accidents reported. The Directive sets out basic principles and requirements for policies and management systems which are suitable for the prevention, control and mitigation of major accident hazards.

US regulations do not prescribe formal methodologies for risk assessments. Rather, risk is evaluated by both the project applicant and regulatory authorities, using government guidance to target the specific issues which risk assessments should address. The US government's oversight of LNG facilities is provided by three federal agencies, which are under an Interagency Agreement:

- Federal Energy Regulatory Commission (FERC). FERC grants federal approval for the siting and the construction of new facilities and implements its authority over LNG terminals through the agency's regulations. FERC has the responsibility to issue a certificate to the facility and is the lead federal agency for review of environmental and safety concerns, including public comment meetings and review procedures
- U.S. Department of Homeland Security (DHS). USCG within DHS exercises regulatory authority over LNG facilities which affect the safety of port areas and navigable waterways. The USCG also establishes review criteria for evaluating a proposed deepwater port. A prime regulation governing the marine portion of an LNG terminal is 33 CFR Part 127, Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas. Individual terminals operate under site-specific USCG Operating Plans (OPLANS). The OPLANS require pre-arrival boarding and inspection including ship certificates, crew licenses, safety equipment, ship condition, ship's log and procedures. The USCG can deny entry to any US port or terminal at their discretion.
- U.S. Department of Transportation (DOT). The Pipeline and Hazardous Materials Safety Administration (PHMSA) within DOT has the authority to promulgate and enforce safety regulations and standards both for the transportation and storage of LNG and for interstate or foreign commerce under the pipeline safety laws. The Maritime Administration (MARAD), also within DOT, has licensing authority for the construction and operation of deepwater ports, including offshore (floating) import terminals. PHMSA regulations, contained in 49 CFR Part 193, Liquefied Natural Gas Facilities: Federal Safety Standards, are applicable to LNG import terminals and storage facilities.

Most states in the US also have regulations and permit requirements which are similar to the federal regulations. Some states have LNG-specific regulations. The state permitting and review activities are undertaken independently and tend to address local concerns. County and municipal governments also have jurisdiction in these matters, with broad discretion vested in the county fire marshal, city fire chief and town council. For marine operations, port authorities also have jurisdiction. In most cases, the various regulatory agencies and bodies issue pronouncements and regulations which are consistent and correlative, often reflected by cross-referencing between documents and/or incorporation of "pronouncement a" by reference in "pronouncement b".

In Japan, the regulatory agency involved in LNG terminal siting and operation is the Ministry of Economy, Trade and Industry (METI) which enforces the Gas Utility Industry Law, the Electricity Utility Industry Law and the High Pressure Gas Regulation Law. LNG terminal siting and operation must comply with one of these laws. For example, under the Gas Utility Industry Law, gas utility companies:

- Maintain a gas facility in accordance with an adopted technical standard,
- Define, submit and observe their companies' own security regulations, in order to ensure the safety of construction, maintenance, and operation of gas facilities,
- Assign a gas-licensed engineer to ensure the safety of construction, maintenance and operation of a gas facility.

CODES AND STANDARDS

The LNG industry adheres to an international network of codes and standards which specify safe technologies, materials and designs for the construction of an import terminal. Codes and standards enable the industry to implement generally-approved technologies and ensure a high level of safety. The development and implementation of these codes and standards promotes sharing state-of-the-art technologies and research. Some of them, mainly European and American standards, are widely used throughout the world. The primary codes and standards are described in this paper. Compliance with additional codes and standards may be required in specific countries. It is important to note that an international working group called TC67/SC9: "LNG installations and equipment" was formed in 2015 and succeeded TC67/WG10 which had been created in 2006 under the ISO (International Organisation for Standardization). This group's objective is compatibility and harmonisation of LNG codes in order to raise the existing codes and standards among countries to an international level.

Some codes address specific safety risks to LNG import terminals from earthquakes in certain parts of the world. The main codes, NFPA 59A or EN1473, provide robust construction requirements to assure another rigorous level of protection against earthquake forces. Under these codes, for example, all companies must perform a site-specific investigation to determine ground motion risks and define seismic characteristics. This site-specific investigation will identify the probabilistic "maximum considered earthquake" (MCE). The LNG tanks and impounding system are then designed for two levels of seismic motion: (1) the "safe shutdown earthquake"; and (2) the "operating basis earthquake", both of which are defined in the main codes.

Europe

European Committee for Standardisation (CEN)

CEN is a private non-profit organisation whose mission is to "contribute to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes and public procurement."

In Europe, the codes and regulations specific to LNG import facilities include:

- **European Union Seveso-III Council Directive** 2012/18/EU of 4 July 2012 - Control of Major-Accident Hazards involving Dangerous Substances. For the European Union all operation and maintenance activities are under the control of a Safety Management System required by Directive Seveso-III 2012/18/EU, which includes requirements relating to safety management systems, emergency planning and land-use planning and provisions on inspections to be carried out by Member States.
- **EN 1473:** "Installation and equipment for LNG – Design of onshore installations" for storage capacities over 200 tones. The European code **EN 1473** is based on a risk assessment approach with fewer explicit prescriptive standards, compared to US regulations or US standards.
- **ISO 16903** : "Installation and equipment for Liquefied Natural Gas – Characteristics of LNG, influencing the design and material selection. This standard contains guidance on properties of materials that may come in contact with LNG in the facility.
- Additional codes include: **EN 14620**[1] ("Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0°C and -165°C"), ISO 16904-2016 ("Design & testing of LNG marine transfer arms for conventional onshore terminals. – Design and testing of LNG loading/unloading arms"); ISO 28460 ("Installation and equipment for LNG – Ship to shore interface and port operations"); and **EN 13645** ("Design of onshore installations with a storage capacity between 5 tonnes and 200 tonnes").

Applying their own regulations derived from the Seveso-III Directive, national authorities of each European country have the responsibility to issue a certificate to the facility and are the lead agency for review of environmental and safety concerns, including public comment meetings and review procedures.

The following US standards may also be applied in Europe:

- NFPA 59A - Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG); and
- 33 CFR Part 127 - Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas.

US

American Petroleum Institute (API)

API maintains some 500 standards covering all segments of the Oil and Gas industry. One API standard that the LNG industry frequently uses is: API 620.

This standard is not applicable to all tank types because it contains rules for the design and construction details for double-walled, metal tanks. **Information Paper No. 5** describes types of LNG tanks in use today.

National Fire and Protection Association (NFPA)

NFPA is an international non-profit organisation which specialises in fire prevention and serves as an authority on public safety practices.

One NFPA standard that is frequently used in the LNG industry is:

- **NFPA 59A**: "Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)".

The **NFPA 59A** requirements are, for the most part, prescriptive as to the siting and design of an LNG facility.

NFPA 59A and **API 620** are widely used in the LNG industry.

Asia

- In Asia, specific standards have been developed for each area. The codes and regulations specific to LNG import facilities include:
- Gas Industry law, and
- Electricity Power Industry law.

Japan

The Japan Gas Association (JGA) is an organisation consisting of city gas utilities. One of the missions of JGA is to research the development of technical standards. JGA provides several recommended practices also used in other Asian countries:

- Recommended Practice for LNG In-ground Storage (JGA-107-RPIS,2012)
- Recommended Practice for LNG Aboveground Storage (JGA-108-RPAS,2012)
- Recommended Practice for LNG Facilities(JGA-102,2015)
- Recommended Practice for Safety and Security in Gas Production Facilities (JGA-103,2017).

These recommended practices have been developed using references from JIS (Japanese Industrial Standards) and API codes, among others. JGA-107-RPIS was developed by and is unique to Japan.

1. EN 14620 This standard originates from BS7777 (British Standard: "Flat-bottomed, vertical, cylindrical storage tanks for low temperature service". Specification for the design and construction of single, double and full containment metal tanks for the storage of liquefied gas at temperatures down to -165°C").

China

The Chinese LNG industry is currently using the international codes NFPA 59A, EN 1473 and NFPA 30. Terminals incorporate some additional Chinese codes and standards, but these are largely limited to equipment and building specifications.

India

India has its own high-level code: "**OISD2 STANDARD 194** – Storage & Handling of LNG", which is primarily based on the US standard **NFPA 59A**, with references to other OISD Standards. Elements are also taken from European LNG standards such as **EN1473**, as well as some British standards, and **API 620 Appendix Q**.

Taiwan

NFPA and API standards are used for the design of LNG terminals, along with British standards, **EN 1473**, and the JGA Recommended Practices for Liquefied Natural Gas.

South Korea

Korea Gas Corporation (KOGAS) mainly uses international standards, as well as some Korean Industrial Standards.

In addition to the codes and standards, the regulations of onshore plants, and the classification of LNG carriers, a number of international organisations exist to ensure a high level of safety.

INDUSTRY ORGANISATIONS

GIIGNL – International Group of Liquefied Natural Gas Importers

GIIGNL is a non-profit organisation, founded in 1971. GIIGNL's operational focus is the import terminal – those marine facilities which receive LNG by LNG ships. It is composed of more than 80 member companies involved in the importation of Liquefied Natural Gas, from over 26 different countries (in Asia, Europe and North America). GIIGNL provides its members with overviews of the general economic condition of the LNG industry and the most current state-of-the art LNG technology. This information enhances facility operations, strengthens the breadth and depth of contractual techniques, and supports industry positions with international agencies. GIIGNL members share information about commercial and technical developments in LNG, including safety incidents at member facilities. Activities of shared interest to GIIGNL members include the handling, importing, processing, purchasing, regasification, transportation and uses of LNG around the world.

One important example of proprietary information, shared only among industry members, is GIIGNL's LNG Incident Identification Study. This study began in 1992 and was last updated in 2017. To promote information-sharing among the industry, data is analysed without company names. The main aims of the study are to:

- Identify actual incidents of LNG or vapour release for possible inclusion in the hazard analysis of new, modified or existing facilities.
- Advise on the severity of the identified LNG incidents to assist in evaluation of their importance and potential consequences.
- Provide information on the circumstances under which the identified LNG incidents have occurred (and their frequency where possible) to assist in the evaluation of their relevance to the particular LNG facility under review.

In order to be as comprehensive as possible, the incident study aims to include all incidents known in the LNG Industry with the potential to cause damage to equipment or injury to personnel. GIIGNL members share this information to improve operational safety within the industry.

GIIGNL also coordinates and exchanges information on relevant studies with other organisations in the LNG industry, such as the International Gas Union (IGU), the Society of Gas Tanker and Terminal Operators (SIGTTO), Gas Infrastructure Europe (GIE), Center for LNG (CLNG),Eurogas, Marcogaz, NGVA, SEA-LNG and SGMF.

The GIIGNL website is https://giignl.org.

SIGTTO – Society of International Gas Tanker and Terminal Operators

Founded in 1978, SIGTTO is a non-profit international society composed of close to two hundred members representing liquefied gas (LPG, LNG and others) tankers or liquefied gas marine loading or receiving terminals, or the operators of such tankers or terminals. While GIIGNL is concerned with import terminals, SIGTTO's focus is on shipping and its interface with marine terminal operations. The purpose of the organisation is to specify and promote high standards and best practices, and in so doing to maintain confidence in the level of safety achieved by the LNG industry.

This Society is an international body established for the exchange of technical information and experience, between members of the industry, to enhance the safety and operational reliability of gas tankers and terminals. To that end, the Society publishes studies, produces information papers and works of reference for the guidance of industry members and manages a shipping incident data base similar to the GIIGNL database.

SIGTTO maintains working relationships with other industry bodies, governmental and intergovernmental agencies, including the IMO and the IGC, to better promote

the safety and integrity of gas transportation and storage schemes. For fourty years, the Society has produced a steady flow of information, including recommendations and guidelines for industry members. These documents and reports represent SIGTTO's accumulated intellectual property, much of which has been adopted by regulatory authorities for the governance of gas shipping and terminal activities. It represents a compendium of reference work universally acknowledged as embodying de facto standards virtually throughout every niche within the liquefied gas transportation industry. SIGTTO's publications are listed on their website, www.sigtto.org. Some are downloadable but the majority are printed volumes available for purchase.

IGU – International Gas Union

The International Gas Union (IGU) was founded in 1931. It is a worldwide non-profit organisation registered in Vevey, Switzerland with the Secretariat currently located in Barcelona, Spain.

The mission of IGU is to advocate gas as an integral part of a sustainable global energy system, and to promote the political, technical and economic progress of the gas industry. The more than 150 members of IGU are associations and corporations of the gas industry representing over 97% of the global gas market. The working organisation of IGU covers the complete value of gas chain from exploration and production, transmission via pipelines and liquefied natural gas (LNG) as well as distribution and combustion of gas at the point of use.

IGU encourages international trade in gas by supporting non-discriminatory policies and sound contracting principles and practices, promoting development of technologies which add to the environmental benefits of gas and further enhance safe production, transmission, distribution and utilisation of gas. IGU has the vision of being the most influential, effective and independent non-profit organisation, serving as the spokesperson for the gas industry worldwide. The website of IGU is www.igu.org.

NGVA – International Association for Natural Gas Vehicles

The Natural & bio Gas Vehicle Association (NGVA Europe) is a European association that promotes the use of natural and renewable gas as a fuel in vehicles and ships. Founded in 2008, its 135 members from 31 countries include companies and national associations from across the entire gas and vehicle manufacturing chain.

NGVA Europe is a platform for the industry involved in producing and distributing vehicles and natural gas, including component manufacturers, gas suppliers and gas distributors. It defends their interests to European decision-makers to create accurate standards, fair regulations and equal market conditions. NGVA Europe creates networks among interested stakeholders to reach consensus on positions and actions to expand the market for the natural gas transport system. It also collects, records and communicates reliable facts and significant developments in the market. The website of NGVA is www.ngva.eu.

SGMF – Society for Gas as a Marine Fuel

The Society for Gas as a Marine Fuel (SGMF) is a non-governmental organisation established to promote safety and industry best practice in the use of gas as a marine fuel. Governed by a representative board and driven by two principal Committees, SGMF has several working groups at any one time solving issues and producing outputs such as guidelines and checklists for the industry. The Society has over 130 international members ranging from oil majors, port authorities, fuel suppliers through to equipment manufacturers and classification societies. The website of SGMF is www.sgmf.info.

Ship Classification Societies

Classification societies are independent technical organisations. Their classification of ships assures all interested parties that each vessel is structurally and mechanically fit to carry crew and cargo. Another level of approval is certification by the societies, which provides assurance that at the time of certification the ship is fit for service.

Ship classification has long influenced the design, construction and maintenance of ship structures and engineering systems. The main classification societies for the LNG carriers are the American Bureau of Shipping (ABS), Bureau Veritas (BV), Det Norske Veritas (DNV), Lloyd's Register (LR), and Nippon Kaiji Kentai Kyokai (NKKK). More discussion of ship classification can be found in **Information Paper No. 3**.

KEY POINTS AND CONCLUSIONS

In closing, the key points of this information paper are:

1. The safe processing, storage and transportation of LNG is an essential condition for the continued existence, growth and sustenance of the entire industry.

2. Companies within the industry, governmental bodies and professional trade associations are all committed to the continued issuance of codes, guidance, regulations and standards intended to assure the safe operation of onshore and offshore LNG facilities, personnel and ships.

3. There are a number of international authorities which are instrumental to the creation, maintenance and dissemination of the diverse database, broadly defined, of LNG knowledge. Included most prominently among them are the International Maritime Organisation (IMO), International Gas Carriers Code (IGC) and the US Coast Guard (USCG). Each country with an LNG presence tends to have one or more governmental agencies monitoring, in varying fashion, their own LNG industry. By way of example for the US, such agencies include the Federal Energy Regulatory Commission (FERC), the Department of Homeland Security (DHS) and the Department of Transportation (DOT).

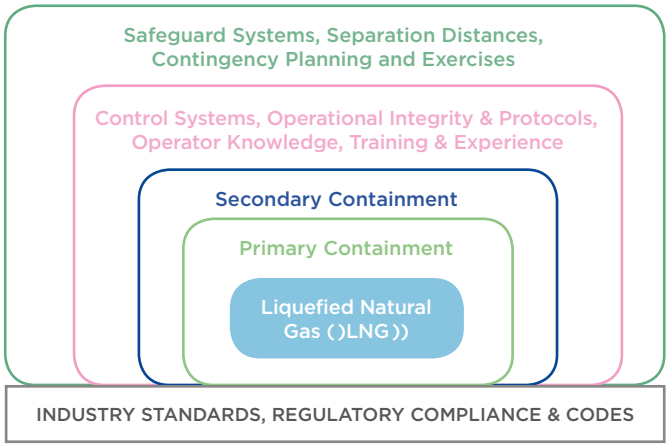
4. An extensive network of international work groups and associations includes, among other entities, TC67 /SC9 (which addresses LNG equipment and installation standards); the European Committee for Standardisation (CEN), which has addressed or is addressing, among other things, the control of major accident hazards, equipment/installation design for onshore installations, and tank design and manufacture; and the American Petroleum Institute (API), which maintains some 500 standards covering all segments of the Oil and Gas Industry.

5. International gas industry associations serve, in various ways, to codify and disseminate LNG information and safeguards, including best practices.

6. Ship Classification Societies review various aspects of ship quality, including mechanical fitness, security and safety of cargo capacity and structural integrity, as well as the professional competence and training of the crew. The Ship Classification process has long influenced the design, construction and maintenance of ship structures and related engineering systems.

As reflected in the illustration below the Multiple Safety Layers for LNG are all firmly based on a foundation of solid Industry Standards, Regulatory Compliance and Codes, many of which are developed by the foregoing associations and regulatory bodies. These "safety layers" include several key components of the industry's Risk Management framework. Included among them are Primary and Secondary Containment, Control Systems which promote Operational Integrity; Protocols, Operator Knowledge and Experience (which are reinforced by comprehensive and ongoing training). A protective umbrella of Safeguard Systems, Separation Distances, and Contingency Planning further enhances the safe management of LNG.

Multiple Safety Layers Manage LNG Risk



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