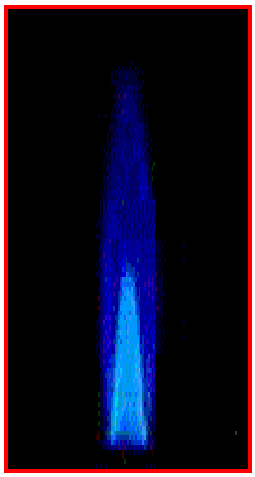
GROUPE INTERNATIONAL DES IMPORTATEURS DE GAZ NATUREL LIQUÉFIÉ

THE INTERNATIONAL GROUP OF LIQUEFIED NATURAL GAS IMPORTERS

LNG Information Paper No. 4



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

GIIGNL's Technical Study Group has overseen the development of this Information Series of 7 papers to provide factual information about Liquefied Natural Gas (LNG). In French, Spanish, Portuguese, or Italian speaking countries, the abbreviation GNL is used in place of 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. For more information on these topics, additional references and weblinks are provided at the end of this paper.

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**. This Information Paper focuses primarily on the import terminal.

There are 63 LNG onshore import terminals (regasification plants) located worldwide in 2009. In 2007, the largest importers of LNG were India, Japan, South Korea and Taiwan on the Asian continent, the United States in theAmericas and a number of European countries such as Belgium, France, Italy, Portugal, Spain and the UK. Argentina, Brazil, Chile, China and Mexico also now import LNG. Offshore (floating) import terminals, also described in **Information Paper No. 3**, are an alternative to onshore facilities. Offshore regasification facilities are currently operational in Argentina, Brazil, the UK, and the US.

Government Regulations

The intent of regulatory authorities is to reduce the risk of adverse environmental consequences, damage to the equipment, facilities or ships and – most importantly – human casualties. This is achieved by various means in different parts of the world. 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 Council Directive 96/82/EC (SEVESO II) 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 following a fundamental review of the implementation of Council Directive 82/501/EEC (SEVESO I). In particular, certain areas were identified in which new provisions seemed necessary on the basis of an analysis of major accidents which had been reported to the Commission since the implementation of SEVESO I. 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.

The 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 onshore facilities and implements its authority over onshore 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 work group called **TC67 Work Group 10:** "Standardisation for Installations and Equipment for Liquefied Natural Gas, Excluding Product or Testing" was formed in 2006 under the ISO organisation (International Organisation for Standardisation). 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 II Council Directive** 96/82/EC of 9 December 1996 - *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 II 96/82/EC. This pronouncement includes a revision and extension of the scope of Seveso I, the introduction of new requirements relating to safety management systems, emergency planning and land-use planning and a reinforcement of the 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 tonnes. The European code **EN 1473** is based on a risk assessment approach with fewer explicit prescriptive standards, compared to US regulations or US standards.
- **EN 1160**: "Installation and equipment for Liquefied Natural Gas – General characteristics of liquefied natural gas" 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"), **EN 1474** ("Installation and equipment for LNG – Design and testing of LNG loading/unloading arms"); **EN 1532** ("Installation and equipment for LNG – Ship to shore interface"); 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 II 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

[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").

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. For example, this standard requires any LNG container to have an impoundment able to contain the volume which meets one of the following criteria:

- For an impoundment serving a single tank, the volume equals 110 percent of the LNG tank's maximum liquid capacity, or
- For an impoundment serving more than one tank, the volume equals 100 percent of all tanks or 110 percent of the largest tank's maximum liquid capacity, whichever is greater, or
- If the dike is designed to account for a surge in the event of catastrophic failure, the volume equals 100 percent.

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)
- Recommended Practice for LNG Aboveground Storage (JGA-108-RPAS)
- Recommended Practice for LNG Facilities (JGA-102)
- Recommended Practice for Safety and Security in Gas Production Facilities (JGA-103).

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.

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: "**OISD**[2] **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.

Korea

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

These organisations provide and share overviews of the state-of-the-art technologies, best practices and high standards to support the development of the LNG industry. Indeed, if one company suffers from a poor public image because of an LNG incident, the entire industry's reputation will be impacted. It is therefore in the general interest of all companies within the industry to promote and achieve a high level of safety.

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[2] Oil Industry Safety Directorate

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 Associations

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 56 member companies involved in the importation of Liquefied Natural Gas, from over 18 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 has been updated twice. 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 LNG Europe (GLngE), Center for LNG (CLNG) and Eurogas. The GIIGNL website is www.giignl.org.

SIGTTO – Society of International Gas Tanker and Terminal Operators

Founded in 1978, SIGTTO is a non-profit international society composed of more than one 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 and produces information papers and works of reference for the guidance of industry members.

SIGTTO maintains working relationships with other industry bodies, governmental and intergovernmental agencies, including the IMO, to better promote the safety and integrity of gas transportation and storage schemes. For twenty-five 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, founded in 1931, is a worldwide non-profit organisation. IGU has a very broad scope across the whole gas industry, including LNG export and import. The members of IGU are various associations and entities of the gas industries in 67 countries. IGU cooperates with many global energy organisations, and covers all the domains of the industry from exploration and production of natural gas on- or offshore, pipeline and piped distribution systems to customers' premises, and combustion of the gas at the point of use. The objective of IGU is to promote the technical and economic progress of the gas industry. The IGU website is www.igu.org.

CLNG – Center for Liquefied Natural Gas

The Center for Liquefied Natural Gas is another association of LNG producers, shippers, terminal operators and developers, energy trade associations and natural gas consumers. Based in the US, CLNG's purpose is to enhance the exchange of educational and technical information, and to facilitate the discussion of issues and the development of public policies which support the growth and operation of the LNG industry. CLNG also promotes public education and understanding about LNG by serving as a clearinghouse for related information. A number of recent LNG research reports can be downloaded from the site, www.lngfacts.org.

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 reader should remember the key points of this information paper:

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 Work Group 10** (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. **GIIGNL** (the International Group of Liquefied Natural Gas Importers, founded in 1971), which is composed of 56 member companies in over 18 different countries, and focuses on the import terminal operations. **SIGTTO** (Society of International Gas Tanker and Terminal Operators, founded in 1978), which comprises more than 100 members, represents the operators of (LNG and LPG) tankers and liquefied gas marine loading or receiving terminals. **SIGTTO**'s focus is on shipping and its interface with marine terminal operations. The **IGU** (the International Gas Union, founded in 1931), spans the entire spectrum of the gas industry in 67 countries around the world. The **CLNG** (Center for Liquefied Natural Gas) is a broad association of LNG producers, shippers, terminal operators and developers in the US, as well as energy trade associations and natural gas consumers. Its purpose is to advance the exchange of educational and technical LNG information.
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.

Next, in **Information Paper No. 5**, we will discuss how LNG is contained in import terminals, which is essential to assuring LNG safety. As reflected in the illustration on the last page, 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.

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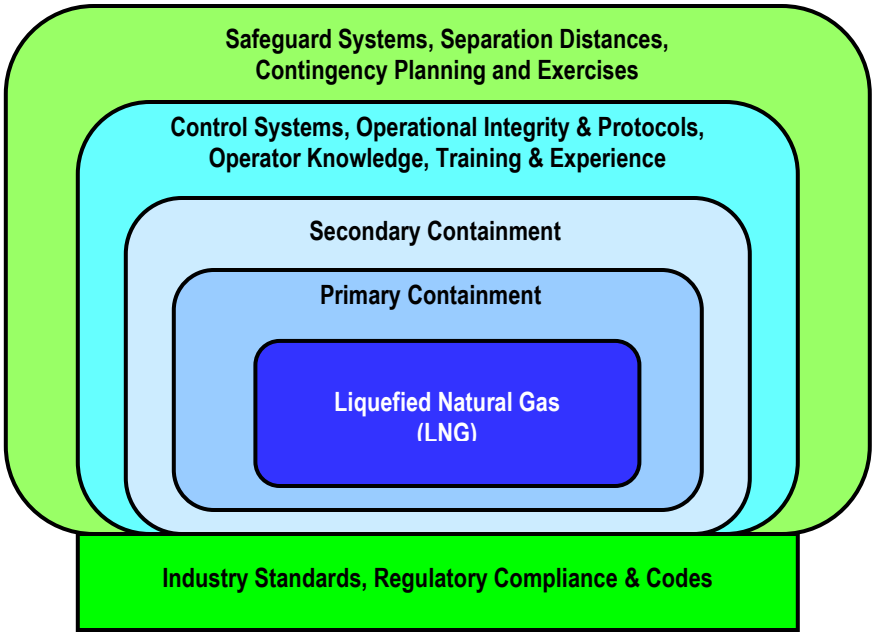
Multiple Safety Layers Manage LNG Risk



The GIIGNL Technical Study Group has developed this 7-paper series to provide public readers with factual information about the LNG industry's multiple layers of safety, as illustrated in the figure to the left.

The GIIGNL Information Papers include:

- No. 1 – Basic Properties of LNG
- No. 2 – The LNG Process Chain
- No. 3 – LNG Ships
- No. 4 – Managing LNG Risks – Operational Integrity, Regulations, Codes, and Industry Organisations
- No. 5 – Managing LNG Risks – Containment
- No. 6 – Managing LNG Risks – Industry Safeguard Systems
- No. 7 – Questions and Answers (Q&A's)

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