Liquefied Natural Gas: Properties and Reliability[1]

INTRODUCTION

Liquefied Natural Gas: Properties and Reliability is the final report in a series of three that discuss liquefied natural gas (LNG). The LNG industry uses advanced LNG safety technologies and procedures. These are enforced and maintained through numerous standards, codes and regulatory supervision, which support safe and reliable LNG operations. This report describes the properties of LNG, the history and reliability of LNG operations, and concludes with a discussion of LNG industry standards, best practices, and regulatory supervision.

LNG PROPERTIES

Liquefied natural gas, or LNG, is natural gas that has been cooled to minus 160° C (minus 260° F) at atmospheric pressure and reduced to a liquid state that is 1/600th its original volume. LNG is clear, colourless, and odourless. LNG is non-corrosive and non-toxic.

The potential hazards of LNG are the result of its basic properties including its cryogenic nature and dispersion and flammability characteristics. Due to its cryogenic nature, LNG will freeze any material it contacts. As a liquid, LNG cannot explode and is not flammable. Only when LNG is warmed and returns to its gaseous state (i.e., natural gas), is mixed with air, and comes into contact with an ignition source, does the mixture become flammable or explosive (in a confined environment). Before any of these hazards can be realized, a release of LNG would need to occur.

LNG OPERATIONS: HISTORY AND RELIABILITY

LNG is not a new technology. The first LNG plant was built in West Virginia in 1912 and began operations in 1917. In January 1959, the world's first LNG vessel, the *Methane Pioneer*, delivered an LNG cargo from Lake Charles, Louisiana to the United Kingdom.

Worldwide (as of February 2005), there were 22 LNG export (liquefaction) terminals, 46 LNG import (re-gasification) terminals, and more than 150 LNG vessels in operation. Since the industry's inception in 1959, there is no record of fatalities, loss of cargo containment, or major accidents or safety problems either in port or on the high seas. In that time, LNG vessels, which are double-

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[1]Sources of the material used in the development of this report include:
(a) Center for Energy Economics, Bureau for Economic Geology, The University of Texas at Austin, http://www.beg.utexas.edu/energyecon/lng;
(b) United States Department of Energy, http://www.fossil.energy.gov;
(c) Federal Energy Regulatory Commission, http://www.ferc.gov/industries/gas/indus-act/lng-what.asp; and,
(d) Center for LNG, http://www.lngfacts.org/.

hulled and specially designed so that LNG is stored in special containment systems, have made more than 80,000 LNG shipments worldwide, spanning more than 160 million kilometres.

LNG INDUSTRY BEST PRACTICES

The LNG industry has safeguards and mitigation measures in place to ensure the safety and security of LNG facilities and operations, as well as the protection of the public and the environment. The LNG industry is required to adhere to multi-layer protection requirements with respect to primary containment (e.g., steel alloys and other materials for the storage tanks which contain the LNG); secondary containment (e.g., dikes or impoundments around storage tanks to retain the full capacity of a tank in the event of a tank rupture); safeguard systems (e.g., fire protection systems, emergency shut down systems); and, separation distances to protect people and property.

LNG REGULATIONS, STANDARDS AND CODES

In addition to the safety procedures and best practices employed by industry, the LNG industry must meet a broad set of standards, codes and regulations. The LNG industry has made significant advances in the safe and secure transport and storage of LNG since it was first produced in 1917. Design, construction, operation and safety standards and regulations have been made increasingly stringent over the last four decades to prevent LNG accidents and minimize their impacts if they occur.

Industrial facilities built in Canada are subject to numerous regulations to ensure that the health, safety, and security of the environment and the Canadian public is protected. LNG facilities are classified as industrial sites and must meet all standards, codes, and regulations enforced by federal, provincial and municipal jurisdictions.

The Canadian Standards Association (CSA), a national standards organization for developing public safety standards in Canada, has a specific standard for LNG Production, Storage and Handling (*CSA Standard CAN/CSA Z276-01*). The Standard establishes essential requirements and minimum standards for the design, installation, and safe operation of LNG facilities.[2]

The LNG industry follows additional codes, rules, regulations and standards established by organizations such as, but not limited to, the Society of International Gas Tanker and Terminal Operators, the Gas Processors Association, the National Fire Protection Association, and the International Maritime Organization (IMO).

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[2]There are three peak-shaving LNG storage facilities in Canada: Union Gas LNG facility near Sudbury, Ontario; Gaz Metro LNG facility in Montreal, Quebec; and, Terasen Gas LNG facility in the Lower Mainland of Vancouver, B.C.. All three existing LNG storage facilities comply with *CSA Standard CAN/CSA-Z276-01*. The Standard has been adopted into the legislation of the Technical Standards and Safety Authority in Ontario, le Regie du Batiment in Quebec, and the British Columbia Oil and Gas Commission.

For example, all vessels and ports worldwide that engage in international trade are to comply with the International Ship and Port Security Code (ISPS) administered by the IMO. Transport Canada has implemented the ISPS Code through the Marine Transportation Security Regulations. The regulations require that the port, LNG facility and vessel have an approved Security Plan in place and the designation of security officers prior to operation.

LNG RESEARCH

A significant amount of research is devoted to understanding the behaviour of LNG. For example, to address LNG safety issues, the United States Department of Energy commissioned its Sandia National Laboratory (Sandia) to examine LNG safety issues, particularly those related to LNG transportation. Sandia's report *'Guidance on Risk Analysis and Safety Implications of a Large LNG Spill Over Water'* was released in December 2004, and is available at the following website: http://www.fe.doe.gov/programs/oilgas/storage/lng/sandia_lng_1204.pdf.

USEFUL LNG WEBSITES

- Center for Energy Economics, Bureau for Economic Geology, The University of Texas at Austin (http://www.beg.utexas.edu/energyecon/lng)
- United States Department of Energy (http://www.fe.doe.gov/)
- Federal Energy Regulatory Commission (http://www.ferc.gov/industries/gas/indus-act/lng-what.asp)
- Center for LNG (http://www.lngfacts.org/)
- Canadian Standards Associations (http://www.csa.ca)