*Z276-07*

# Liquefied natural gas (LNG) — Production, storage, and handling



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*Z276-07*
*July 2007*

**Title:** *Liquefied natural gas (LNG) — Production, storage, and handling*
**Pagination: 94 pages** (x preliminary and 84 text), each dated **July 2007**

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The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

| | |
|---|---|
| **Revised** | Clauses 2 and 9.1.1 |
| **New** | None |
| **Deleted** | None |

CSA Z276-07 originally consisted of **94 pages** (x preliminary and 84 text), each dated **July 2007**. It now consists of the following pages:

| | |
|---|---|
| **July 2007** | iii–x, 3, 4, 7–36, and 39–84 |
| **June 2008** | 1, 2, 5, 6, 37, and 38 |

- Update your copy by inserting these revised pages.
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# *Z276-07*
# *Liquefied natural gas (LNG) — Production, storage, and handling*

## 0 Introduction
This Standard establishes essential requirements and minimum standards for the design, installation, and safe operation of liquefied natural gas (LNG) facilities. It is not a design handbook, and competent engineering judgment is necessary for its proper use.

## 1 Scope

### 1.1
This Standard applies to the
(a) design;
(b) location;
(c) construction;
(d) operation; and
(e) maintenance
of facilities for the liquefaction of natural gas and facilities for the storage, vaporization, transfer, handling, and truck transport of LNG. It also contains requirements for the training of personnel.

### 1.2
For facilities that load or unload LNG from a marine vessel, this Standard contains requirements for the interconnecting piping between the loading/unloading arm flange and the storage tank(s), and other piping and appurtenances on the pier or jetty itself.

### 1.3
This Standard applies to all containers for the storage of LNG, including those with insulation systems applying a vacuum.

### 1.4
This Standard does not apply to refrozen ground containers.

### 1.5
This Standard includes non-mandatory guidelines for small LNG facilities (see the definition of "small facility" in Clause 3 and see Annex B).

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This Standard does not apply to the following:
(a) the transportation of refrigerants by any means;
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(d) facilities designed to allow the use of LNG as a fuel for highway vehicles, railroad locomotives, or marine vessels.

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All references to pressure throughout this document refer to gauge pressures unless otherwise specified.

### 1.8
All pipe sizes refer to nominal pipe sizes (NPS).

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CAN/CSA-G30.18-M92 (R2002)
*Billet-steel bars for concrete reinforcement*

G279-M1982 (withdrawn)
*Steel for prestressed concrete tendons*

**CGS (Canadian Geotechnical Society)**
*Canadian Foundation Engineering Manual,* 2006

**CGSB (Canadian General Standards Board)**
CAN/CGSB-24.3-92
*Identification of Piping Systems*

CAN/CGSB-48.9712-2006/ISO 9712:2005
*Non-destructive Testing — Qualification and Certification of Personnel*

**Government of Canada**
*Canada Labour Code,* Part II, 1985

**Government of the United States**
29 *Code of Federal Regulations,* Subtitle B, Chapter XVII, Part 1910.146

**GTI (Gas Technology Institute)**
GRI-89/0176 (1990)
*LNGFIRE: A Thermal Radiation Model for LNG Fires*

GRI-89/0242
*LNG Vapor Dispersion Prediction with the DEGADIS Dense Gas Dispersion Model*

GTI-04/0032 (2004)
*LNGFIRE3: A Thermal Radiation Model for LNG Fires*

**NACE International (National Association of Corrosion Engineers)**
RP 0169-2002
*Control of External Corrosion on Underground or Submerged Metallic Piping Systems*

**NFPA (National Fire Protection Association)**
10-2002
*Standard for Portable Fire Extinguishers*

11-2005
*Standard for Low-, Medium-, and High-Expansion Foam*

11A-1999
*Standard for Medium- and High-Expansion Foam Systems*

12-2005
*Standard on Carbon Dioxide Extinguishing Systems*

12A-2004
*Standard on Halon 1301 Fire Extinguishing Systems*

13-2002
*Standard for the Installation of Sprinkler Systems*

14-2003
*Standard for the Installation of Standpipe and Hose Systems*

15-2001
*Standard for Water Spray Fixed Systems for Fire Protection*

16-2003
*Standard for the Installation of Foam-Water Sprinkler Systems and Foam-Water Spray Systems*

17-2002
*Standard for Dry Chemical Extinguishing Systems*

20-2003
*Standard for the Installation of Stationary Fire Pumps for Fire Protection*

22-2003
*Standard for Water Tanks for Private Fire Protection*

24-2002
*Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

25-2002
*Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

30-2003
*Flammable and Combustible Liquids Code*

37-2006
*Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbine*

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57-2002
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58-2004
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72-2002
*National Fire Alarm Code®*

77-2000
*Recommended Practice on Static Electricity*

101-2006
*Life Safety Code®*

25[illegible]-2006
*Standard Method of Test of Surface Burning Characteristics of Building Materials*

[illegible]00-2005
*Standard on Industrial Fire Brigades*

750-2006
*Standard on Water Mist Fire Protection Systems*

### 8.3.4
The isolation of an idle manifolded vaporizer to prevent leakage of LNG into the vaporizer shall be accomplished with two inlet valves, or other double-block-and-bleed systems, and a safe means shall be provided to dispose of the LNG or gas that can accumulate between the valves. Ambient vaporizers having inlets of 60 mm (2 in) OD or less shall not be required to comply with this provision.

### 8.3.5
Each heated vaporizer shall be provided with a device to shut off the heat source. The device shall be capable of being operated both locally and remotely. The remote location shall be at least 15 m (50 ft) from the vaporizer.

### 8.3.6
A shut-off valve shall be installed on the LNG line to a heated vaporizer at least 15 m (50 ft) from the vaporizer. If the vaporizer is installed in a building, the shut-off valve shall be installed at least 15 m (50 ft) from the building. This may be the valve specified in Clause 9.3.3.2. The shut-off valve shall be operable either at its installed location or from a remote location, and the valve shall be protected so that it does not become inoperable due to external icing conditions. Where the vaporizer is closer than 15 m (50 ft) to the container from which it is supplied (see Clause 5.2.5.4), the provisions of Clause 8.3.7 shall apply.

### 8.3.7
Any ambient vaporizer or a heated vaporizer installed within 15 m (50 ft) of an LNG container shall be equipped with an automatic shut-off valve in the liquid line. This valve shall be located at least 3 m (10 ft) from the vaporizer and shall close when loss of line pressure (excess flow) occurs, when abnormal temperature is sensed in the immediate vicinity of the vaporizer (i.e., due to fire), or when low temperature in the vaporizer discharge line occurs. At attended facilities, this valve may be operated remotely from a point at least 15 m (50 ft) from the vaporizer.

### 8.3.8
If a flammable intermediate fluid is used with a remotely heated vaporizer, shut-off valves shall be provided on both the hot and cold lines of the intermediate fluid system. The controls for these valves shall be located at least 15 m (50 ft) from the vaporizer.

## 8.4 Relief devices on vaporizers

### 8.4.1 Relief-valve capacity
Each vaporizer shall be provided with a safety relief valve sized in accordance with one of the following:
(a) the relief-valve capacity of heated or process vaporizers shall be such that the relief valve discharges 110% of the vaporizer's rated natural gas flow capacity without allowing the pressure to rise more than 10% above the vaporizer's maximum allowable working pressure; or
(b) the relief-valve capacity for ambient vaporizers shall be such that the relief valve discharges at least 150% of the vaporizer's rated natural gas flow capacity (as specified for standard operating conditions) without allowing the pressure to rise more than 10% above the vaporizer's maximum allowable working pressure.

### 8.4.2 Relief-valve location
Relief valves on heated vaporizers shall be so located that they are not subjected to temperatures exceeding 60 °C (140°F) during normal operation, unless designed to withstand higher temperatures.

## 8.5 Combustion air supply
Combustion air required for the operation of integral heated vaporizers or the primary heat source for remotely heated vaporizers shall be taken from outside a completely enclosed structure or building.

### 8.6 Products of combustion

Where integral heated vaporizers or the primary heat source for remotely heated vaporizers are installed in buildings, provisions shall be made to prevent the accumulation of hazardous products of combustion.

# 9 Piping systems and components

## 9.1 General

Δ **9.1.1**

All piping systems shall be in accordance with ASME B31.3. The additional provisions of Clause 9 shall apply to piping systems and components for flammable liquids and flammable gases. Requirements for fuel gas systems are set out in NFPA 54 or CAN/CSA-B149.1.

**9.1.2**

The piping seismic design forces shall be determined in accordance with Paragraph 4.1.8.17 of the *National Building Code of Canada*. Sentence (2) of Paragraph 4.1.8.17 shall not apply, and seismic design shall always be performed. The allowable stress for the piping shall be in accordance with the requirements of ASME B31.3.

**9.1.3**

Container-associated piping up to and including the first container shut-off valve in LNG lines shall be designed to meet the provisions of Item (b) of Clause 7.1.3.3. Piping seismic accelerations shall be taken as the container or container roof acceleration determined from the container dynamic analysis at the location of the pipe.

**9.1.4**

Piping systems and components shall be designed to accommodate the effects of fatigue resulting from the thermal cycling to which the systems are subjected. Particular consideration shall be given where changes occur in the wall thickness between pipes, fittings, valves, and components.

**9.1.5**

Provision for expansion and contraction of piping and piping joints due to temperature changes shall be in accordance with ASME B31.3, Section 319.

**9.1.6**

The maximum allowable working pressure shall be specified for all components.

## 9.2 Construction materials

### 9.2.1 General

**9.2.1.1**

All piping materials, including gaskets and thread compounds, shall be suitable for use with the liquids and gases handled throughout the range of temperatures to which the materials are subjected. The temperature limitations for pipe materials shall be as specified in ASME B31.3.

**9.2.1.2**

Piping that can be exposed to the cold of an LNG or refrigerant spill or the heat of an ignited spill during an emergency, where such exposure can result in a failure of piping that can significantly increase the emergency, shall be

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*CSA Standard*

# *Z276-07*
# ***Liquefied natural gas (LNG) — Production, storage, and handling***




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***Technical Editor:*** *Sudi Kalra*

# Contents

# Technical Committee on Liquefied Natural Gas

| | | |
|---|---|---|
| **N.J. Trusler** | N.J. Trusler Pipeline Consulting Services,<br>Port Coquitlam, British Columbia | *Chair* |
| **G.W.N. Wassick** | Terasen Gas,<br>Surrey, British Columbia | *Vice-Chair* |
| **D.S. Alexander** | Union Gas,<br>Chatham, Ontario | |
| **G.M. Atkinson** | Carleton University,<br>Ottawa, Ontario | *Associate* |
| **S. Ballance** | Terasen Gas,<br>Delta, British Columbia | *Associate* |
| **S.M. Bates** | British Columbia Ministry of Energy and Mines,<br>Victoria, British Columbia | *Associate* |
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| **R.G. Charlwood** | Robin Charlwood & Associates,<br>Edmonds, Washington, USA | |
| **B.A. Chisholm** | Westport Innovations Inc.,<br>Vancouver, British Columbia | |
| **M. Donnelly** | M. Donnelly Enterprises Inc.,<br>Okotoks, Alberta | *Associate* |
| **B. Eisentrout** | CB&I,<br>Plainfield, Illinois, USA | |
| **W. Forbes** | Enbridge Pipelines Inc.,<br>Edmonton, Alberta | |
| **L.H. Gales** | Transportation Safety Board of Canada,<br>Gatineau, Québec | *Associate* |
| **D.W. Hein** | Union Gas Limited,<br>Hagar, Ontario | *Associate* |
| **M.S. Hnetka** | Natural Resources Canada,<br>Ottawa, Ontario | |

| | | |
|---|---|---|
| **R.A. Hoffmann** | Hoffmann & Feige Inc.,<br>Brewster, New York, USA | *Associate* |
| **J.-P. Lacoursière** | University of Sherbrooke,<br>Repentigny, Québec | *Associate* |
| **N.A. Legatos** | Preload Inc.,<br>Hauppauge, New York, USA | *Associate* |
| **J. Logan** | Irving Oil Limited/Canaport LNG,<br>Saint John, New Brunswick | |
| **W. MacLean** | Workplace Health, Safety and Compensation Commission of New Brunswick,<br>Saint John, New Brunswick | |
| **Z.M. Meratla** | CDS Research Ltd.,<br>Vancouver, British Columbia | |
| **P.W. Payzant** | Nova Scotia Utility and Review Board,<br>Halifax, Nova Scotia | |
| **J. Renaud** | Régie du bâtiment du Québec,<br>Montréal, Québec | |
| **H.J. Simoneau** | National Energy Board,<br>Calgary, Alberta | |
| **J. Stannard** | Stannard & Company,<br>Lawrenceville, Georgia, USA | *Associate* |
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| **J. Tseng** | Sandwell Engineering Inc.,<br>Vancouver, British Columbia | |
| **J.P. Van der Put** | TransCanada PipeLines Limited,<br>Calgary, Alberta | |
| **R.S. Wyman** | ICF International,<br>Houston, Texas, USA | |
| **S. Kalra** | Canadian Standards Association,<br>Mississauga, Ontario | *Project Manager* |

In addition to the members of the Technical Committee, the following person made valuable contributions to the development of this Standard:

| | |
|---|---|
| **J.P. Lewis** | ICF International,<br>Houston, Texas, USA |

# Preface

This is the eighth edition of CSA Z276, *Liquefied natural gas (LNG) — Production, storage, and handling*. It supersedes the previous editions published in 2001, 1994, 1989, 1981, 1978, 1973, and 1972.

The following significant changes have been introduced in this edition:

(a) Clause 4 contains additional requirements for safety and loss management systems;
(b) Clause 5 contains additional definitions and requirements for double and full containment containers and updated requirements for vapour dispersion limits;
(c) Clause 7 contains updated seismic design requirements;
(d) Clause 11 specifies additional requirements related to the design and installation of on-shore facilities for marine shipping and receiving and additional requirements for LNG pipelines;
(e) Clause 12 contains additional security requirements; and
(f) Clause 13 specifies additional requirements related to the operation of on-shore facilities for marine shipping and receiving and additional operational security requirements.

This Standard contains basic reference data relating to design, supplemented by specific requirements, where necessary, to establish a uniform interpretation of the design requirements.

This Standard was prepared by the Technical Committee on Liquefied Natural Gas, under the jurisdiction of the Strategic Steering Committee on Petroleum and Natural Gas Industry Systems, and has been formally approved by the Technical Committee. It will be submitted to the Standards Council of Canada for approval as a National Standard of Canada.

*July 2007*

**Notes:**

**(1)** *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

**(2)** *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

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*(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
*(b) provide an explanation of circumstances surrounding the actual field condition; and*
*(c) be phrased where possible to permit a specific "yes" or "no" answer.*

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