MAINTAINING HIGH-LEVEL SAFETY IN CITY GAS PRODUCTION IN JAPAN
– THE CONSTRUCTION, MAINTENANCE AND OPERATION OF LNG FACILITIES APPROPRIATELY DESIGNED IN CONSIDERATION OF BUSINESS SCALE AND OTHER FACTORS –

Shigeru Matsuda
Manager
Production Technology Sec.
Gas Technology Dept.
The Japan Gas Association
1-15-12, Toranomon, Minatoku, Tokyou, 105-0001, Japan

1. Introduction

Even though one or two accidents at city gas production sites are still reported each year in Japan, all such accidents in the last five years occurred during inspections or dismantling of facilities, and had no effect on the city gas production.

This paper describes, with specific examples, how the city gas utilities of Japan are raising safety levels and how the efforts of the industry as a whole are coordinated by the Japan Gas Association (JGA) from the three viewpoints of: construction of LNG facilities, management of operation and maintenance of LNG facilities, and earthquake disaster prevention.

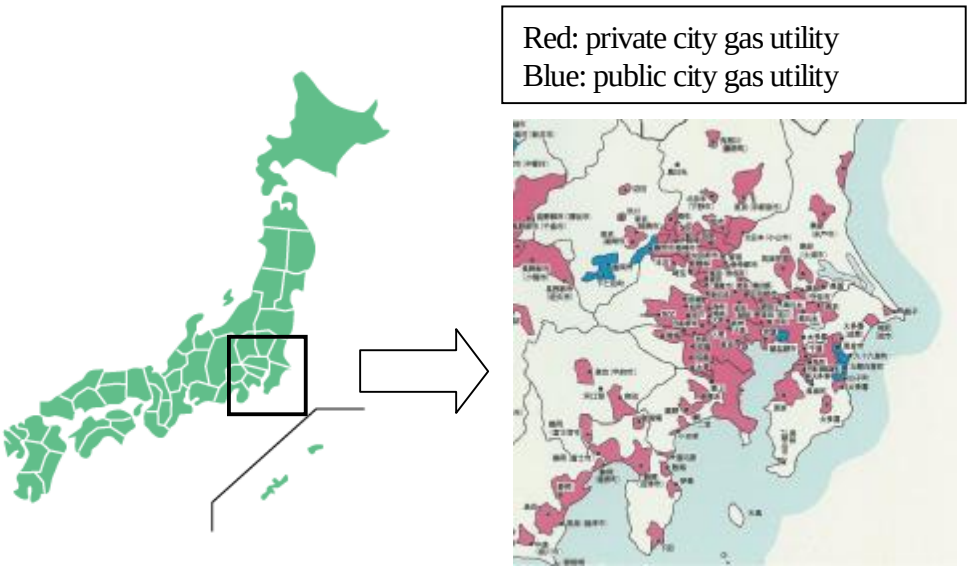
2. The City Gas Industry in Japan

As shown in Table 1, there are more than 200 city gas utilities in Japan of various sizes, with the number of consumer contracts ranging from several thousand to ten million. As shown in Figure 1, there is a scattering of city gas utilities with a small service area.

Table 1 Number of city gas utilities by scale (number of consumer contracts)
(End of March 2007)

Number of consumer contracts	Number of city gas utilities [1)]	
- 2,000	17	(2)
2,001 - 4,000	35	(11)
4,001 - 5,000	13	(5)
5,001 - 10,000	35	(11)
10,001 - 50,000	75	(19)
50,001 - 100,000	16	(5)
100,001 - 300,000	12	(7)
300,001 - 500,000	4	(4)
500,001 -	6	(5)
Total	213	(69)

Note 1:
Figures in parentheses show the number of city gas utilities that have their own LNG facilities. There are many city gas utilities that do not own LNG facilities but purchase gasified LNG from an LNG base owned by another utility.



Source: Gas Energy News

Figure 1 Example of service area distribution of city gas utilities

In the past, LNG was introduced mainly by large city gas utilities. However, since the IGF21 Plan[2)] encourages all city gas utilities to switch over to high calorie gases (mostly natural gas) by the target year of 2010, LNG is being introduced by an increasing number of smaller city gas utilities.

There are several ways of procuring LNG depending on the size of business. Large city gas utilities owning a large LNG terminal such as the one shown in Figure 2 import LNG from overseas by LNG tanker. Small city gas utilities with only small LNG bases such as the one shown in Figure 3 receive LNG by truck from an LNG terminal in Japan. In addition, several city gas utilities receive LNG by small LNG tanker from an LNG terminal in Japan.

Note 2:
In response to the Integrated Gas Family 21 Plan proposed in January 1990 by the Agency for Natural Resources and Energy of the then Ministry of International Trade and Industry, the JGA and the Japan Industrial Association of Gas and Kerosene Appliances drew up the IGF21 Plan, with the aim of decreasing the number of gas groups from 13 to 7 by 1995 and integrating them into the high calorie gas group (mainly natural gas) by 2010.

Max. LNG storage capacity: 1,610,000 kL

Max. Gas production capacity: 1,100,000 m^3/h

Figure 2 Example of a large LNG terminal

Max. LNG storage capacity: 300 kL

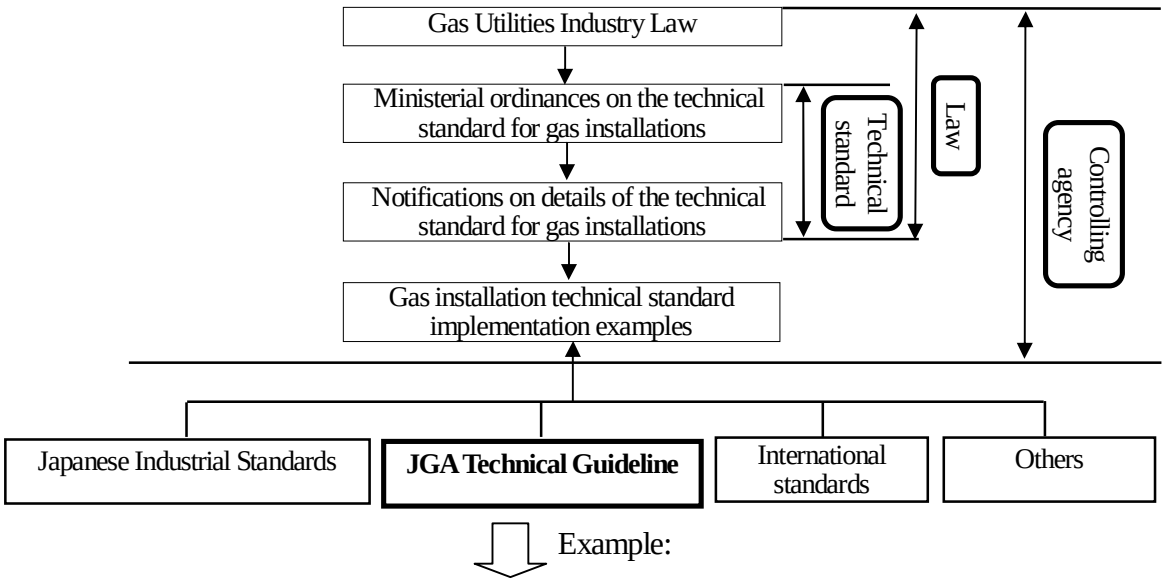
Max. Gas production capacity: 9,600 m^3/h

Figure 3 Example of a small LNG base

3. Construction of LNG Facilities

The Government has established a technical standard for LNG facilities, which city gas utilities must comply with when constructing an LNG facility.

Figure 4 shows the system of the technical standard, private guidelines and the like applicable to LNG facilities used by the city gas industry:



Example:

Title	Description
Guideline on LNG In-ground Storage Tanks	Comprehensive technical guidelines covering the planning, designing, construction and maintenance of facilities
Guideline on LNG Above-ground Storage Tanks	
Guideline on LNG Receiving Terminal Facilities	
Guideline on Small LNG Base Facilities	

Figure 4 System of technical standard

The Government's policy is that the city gas utilities are primarily responsible for safety. The Governmental technical standard comprises ministerial ordinances on the technical standard for gas installations, which simply describe performance requirements while examples of gas installations that meet the technical standard are illustrated in the gas installation technical standard implementation examples.

For LNG facilities such as LNG tanks and vaporizers, the JGA has prepared technical guidelines for the industry describing specific technical requirements.

Since these guidelines are referenced in the gas installation technical standard implementation examples, as shown in Figure 4, city gas utilities following these technical guidelines can be assured that the facilities they build comply with the Governmental technical standard.

Since city gas utilities differ greatly in size as mentioned in Section 2, LNG facilities of various scales are required. Taking the example of the industry's technical guidelines on LNG storage tanks, large LNG storage tanks with a capacity exceeding 100,000 kL are covered by the Guideline on LNG In-ground Storage Tanks and the Guideline on LNG Above-ground Storage Tanks, while the small and medium size storage tanks of a smaller capacity are covered by the Guideline on Small LNG Base Facilities. Thus, each city gas utility can construct LNG facilities of an optimum size for their business.

Table 2 lists the numbers of LNG storage tanks of different sizes owned by city gas utilities:

Table 2 Number of LNG storage tanks by size
(End of September 2007)

Capacity (kL)	Number
- 100	113
101 - 1,000	65
1,001 - 10,000	6
10,001 - 50,000	16
50,001 - 100,000	49
100,001 -	16
Total	265

When constructing an LNG facility, each city gas utility establishes a management system headed by a chief gas engineer[3)], and practices appropriate management during the construction process to ensure compliance with the Governmental technical standard.

At the end of construction, the city gas utility performs a self-inspection, the results of which must be inspected by a third-party agency (an inspection agency authorized by the Government). Thus, the inspection system is highly transparent.

When issuing a technical guideline for the industry, the JGA organizes an orientation meeting for city gas utilities to promote better understanding and wider use of the technical guidelines by them.

Note 3:
The Government requires each business location of each city gas utility to appoint a chief gas engineer responsible for supervising safety during the construction, maintenance and operation of gas installations.

4. Management over the Operation and Maintenance of LNG Facilities

To ensure that LNG facilities maintain their integrity during operation, it is important that city gas utilities appropriately manage their operation and maintenance.

Figure 5 shows the safety management organization and the system of standards, etc.

Each city gas utility follows their safety regulations[4)] that have been established to ensure that all their facilities comply with the Governmental technical standard and to define standard work procedures for operation, examination and inspection activities under specific situations depending on the operation status, for example.

In addition, each city gas utility has prepared various manuals such as inspection procedures for different facilities to ensure the safety and appropriateness of maintenance activities.

Each of the industry's technical guidelines has specific provisions on desirable inspection intervals and procedures for each type of LNG facility. City gas utilities decide inspection intervals and procedures by referring to these guidelines and in consideration of unique factors such as the operation status.

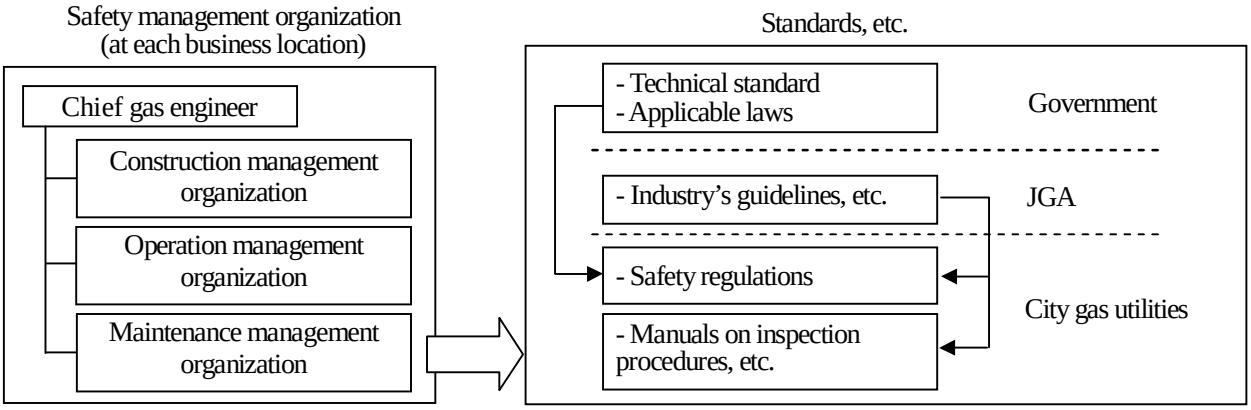


Figure 5 Safety management organization and the system of standards, etc.

Moreover, each business location has a safety management organization under the supervision of a chief gas engineer[3)], which ensures careful management at each stage in the construction, operation and maintenance of LNG facilities.

Furthermore, the Guideline on the Inspection, Evaluation and Repair of the Corrosion and Fatigue Cracking of Pressure Vessels and Pipes[5)], which introduces a new concept called "fitness for service", addresses the issues of external corrosion and fatigue cracking for pressure vessels and pipes, and specifies evaluation, inspection and repair procedures.

City gas utilities are expected to enhance the integrity and safety of their LNG facilities by making use of this guideline.

Note 4:
Safety regulations are an important part of the framework for the industry's self-actions for safety, stipulating how city gas utilities should establish organizations for managing the construction, maintenance and operation of gas installations under specific situations, and how to conduct safety patrols, examinations and inspections. The Government requires each city gas utility to establish and observe safety regulations.

Note 5 :
This Guideline addresses external corrosion and fatigue cracking at the weld line for pressure vessels and pipes at production facilities, and establishes procedures for evaluating the integrity of such components. This is a comprehensive technical guideline complete with systematic descriptions of the inspection procedures for evaluation and of the procedures for repair after the evaluation.

5. Earthquake Disaster Prevention

In consideration of legal obligations under the Gas Utilities Industry Law, the Disaster Countermeasures Basic Act and the like, and also of suggestions from the Governmental panels on earthquake preparedness established in response to major earthquakes such as the Kushiro Offshore Earthquake and the Hyogo-ken Nanbu Earthquake, the JGA has revised the industry's technical guidelines.

LNG facilities and other production facilities adopt antiseismic design features based on the Guidelines for Seismic Design of Production Facilities, etc.

Table 3 lists major earthquakes since 1995 and the damages to city gas production facilities. As shown, these major earthquakes did not cause significant damage to any LNG facility or production facility.

Table 3 Major earthquakes and damages to city gas production facilities

Earthquake name and date	Magnitude	Damage to production facility
Hyogo-ken Nanbu Earthquake (Jan. 1995)	7.2	None
Tottori-ken Seibu Earthquake (Oct. 2000)	7.3	None
Geiyo Earthquake (Mar. 2001)	6.7	None
Tokachi Offshore Earthquake (Sept. 2003)	8.0	None
Niigata-ken Chuetsu Earthquake (Oct. 2004)	6.8	None
Fukuoka-ken Western Offshore Earthquake (Mar. 2005)	7.0	None
Niigata-ken Chuetsu Offshore Earthquake (July 2007)	6.8	None
Miyagi/Iwate Inland Earthquake (June 2008)	7.2	None

This record suggests that the efforts of the city gas utilities of Japan such as designing facilities based on the Guideline for Seismic Design of Production Facilities, etc., have resulted in excellent antiseismic performance of their production facilities.

In addition, the city gas utilities of Japan are well prepared for taking relief action (emergency measures) following an earthquake for preventing secondary disasters. For example, the utilities have established seismic intensity criteria for taking emergency measures and criteria for judging whether employees must report to the office, thus ensuring that sufficient manpower is automatically mobilized following an earthquake. Moreover, the emergency measure procedures specify key points for facility inspection, inspection routes and inspectors, thus enabling facility inspections to be conducted quickly after an earthquake.

Furthermore, to ensure that the inspections specified in the emergency measure procedures can be carried out, staff go through training programs to ensure that specific procedures and the roles of each team and individual are fully understood.

Complementing the drills performed internally, city gas utilities participate in comprehensive disaster prevention drills organized by municipalities or jointly organize disaster prevention drills with municipalities, thus enhancing preparedness for implementing emergency measures.

In addition to the disaster relief headquarters set up by the city gas utility affected by an earthquake, the JGA may, if required, set up its own disaster relief headquarters for organizing support from the city gas industry of Japan as a whole.

The JGA disaster relief headquarters, while helping to clarify the damage, assist the affected utility by responding to requests to dispatch rescue teams organized by the city gas utilities from all over Japan, for example.

After the Niigata-ken Chuetsu Offshore Earthquake in July 2007, rescue teams organized by city gas utilities mainly from Kanto area, center part of Japan, involving 60,000 persons in total, were dispatched to support the utilities affected by the earthquake, thus enabling the early restoration of gas pipes.

6. Conclusion

This paper described the efforts of the city gas utilities of Japan in terms of the construction of LNG facilities, management over the operation and maintenance of LNG facilities, and earthquake disaster prevention.

The city gas utilities of Japan are committed to maintaining a high safety level by continuing their efforts and by introducing new concepts such as fitness for service.

Key Word

LNG, The Japan Gas Association, Gas production, Technical guideline, Safety