Chiyoda's Experience in LNG / LPG Receiving Terminals

CHIYODA CORPORATION

Introduction

Chiyoda has been engaged in the engineering and construction of LPG/LNG receiving terminals, utilizing the technology and experience not only in cryogenic engineering but also in petroleum refining, gas processing, chemical, petrochemical, and other related industries.

To construct economical and reliable LPG/LNG receiving terminals and gasification plants for our clients, Chiyoda organizes a project team on a task force basis. This is to handle every aspect of the project systematically and smoothly, from initial planning to basic design, engineering, fabrication, procurement, construction, and commissioning, all under single responsibility.

With its expertise in cryogenic technology and its engineering capabilities, Chiyoda implements the project by mobilizing its corps of qualified and experienced engineers and specialists, all dedicated to providing an economical and reliable plant to meet the client's needs.

Cover photo : Tokyo Electric Power Co., Inc., Higashi Ohgishima

LPG / LNG Receiving Terminals

LPG Receiving Terminal

As for terminals for delivering imported LPG, Chiyoda has engineered and constructed the largest number of such terminals, over twenty facilities until now, with more under construction or in the planning stage. The imported LPG is loaded into lorries and coastal tankers, fed to power stations after vaporization by heating, or put in cylinders for use as industrial and domestic fuel.

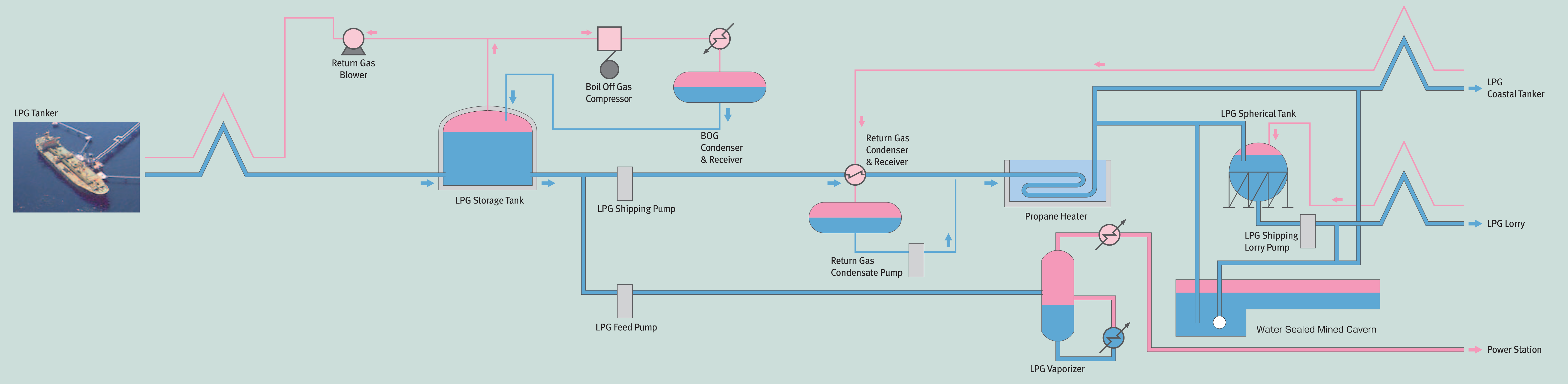
LNG Receiving Terminal

In 1969, Chiyoda constructed the first terminal for receiving LNG in Japan at the Negishi Works of the Tokyo Gas Co., Ltd. Since then, many more LNG receiving terminals have been constructed in Japan. This is in line with the Japanese policy of increasing the calorific value of city gas, and also of changing the feedstock for thermal power plants to pollution-free LNG. Because LNG itself is mainly consumed as a source of energy for city gas and electric power, the essentials for everyday life, naturally a very high level of reliability is required for LNG receiving terminals. Chiyoda which enjoys a reputation in meeting the severe standards required, is playing a major role in the planning, design and construction of such receiving terminals.

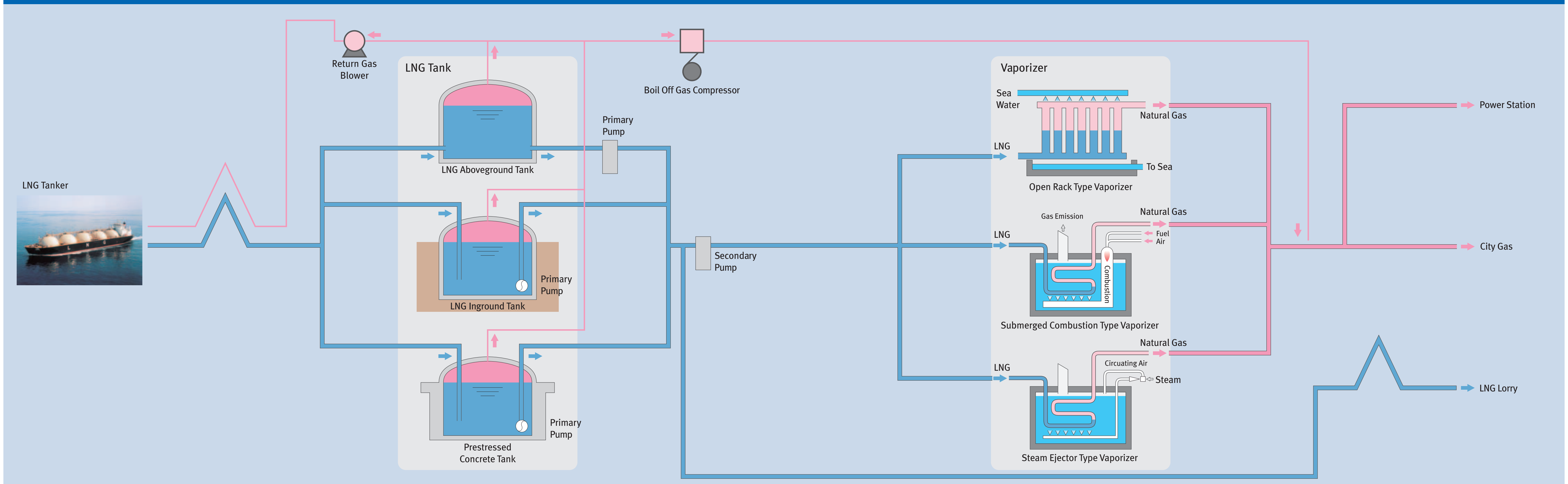
LNG Receiving terminal in Sodegaura, Japan
for Tokyo Gas Co., Ltd. and Tokyo Electric Power Co., Inc.

Process Flow

LPG Receiving Terminal



LNG Receiving Terminal



Features for LPG / LNG Receiving Terminals

The following presents a part of Chiyoda's capability in the technology related to LPG / LNG receiving terminals.

Storage Tanks

Design and Construction

LPG/LNG storage tanks are subject to extremely low temperatures. To ensure safe storage of the liquefied gas, the project begins with careful selection of the material and structural design based on in-depth analyses. At the construction site, the tanks are subjected to exacting construction standards and careful inspection at each stage of the work.

Chiyoda's more than 40 years of experience in the engineering and construction of cryogenic storage tanks, and 60 years of experience in the petroleum refining, gas processing, chemical, petrochemical and other related industries permits its dedicated engineers to construct these tanks to the most stringent specifications of the client.

Seismic Analysis and Structural Analysis

LPG and LNG stored in tanks are extremely volatile, therefore, even the slightest accident cannot be allowed to occur. This requires careful seismic analysis, as well as analyses of various types of stresses, by considering the foundation and the tank as an integral whole.

Chiyoda's group of specialists has developed one of the world's most extensive setups of analytical procedures and computer programs in seismic and structural analyses. These procedures and programs have already been used in designing storage tanks, pressure vessels, piping systems, and other facilities. Furthermore, the Chiyoda-developed lever-and-pendulum earthquake isolating device has made it possible to construct spherical tanks and other similar structures highly resistant to earthquakes.

LPG Shipping Facility

Return Gas Condensation System

Low-temperature propane is pressure-boosted as it is pumped from the cryogenic tank and sent to a heater where it is warmed to ambient temperature and then loaded into a coastal tanker for shipping.

Normally, low-temperature butane is pressure-boosted as it is pumped from the cryogenic tank and loaded directly into a coastal tanker. Propane and butane can be blended in-line at highly accurate mixing ratios. This permits the shipment of the propane and butane mixture to be loaded directly from tank to ship while being blended.

Chiyoda's proprietary process has been adopted, where, return gas from the coastal tanker during cargo loading is condensed by using the cold energy of the LPG being shipped, and the condensate is shipped together with the LPG.

LPG Shipping System

Coastal shipments are benefiting from a high level of automation. After the loading arm is connected, the amount of delivery and the blend ratio are set on a control panel and the pump is started.

The heater and the blender, as well as the flow rate are automatically controlled according to preset values. When the specified amount of LPG cargo has been loaded, operation stops automatically and the system returns to stand-by mode.

Propane Heater

Seawater is the cost economical heat source for propane heaters. There are several types of propane heaters which utilize seawater. Even with its increased capacity, the propane heater developed by Chiyoda is compactly designed and does not require an especially large space for installation. This features low construction cost and ease of operation and maintenance.

LPG cavern storage system

LPG cavern storage system, in which underground water pressure around cavern is made over LPG vapor pressure, is the most economical and safe system for huge volume LPG storage.

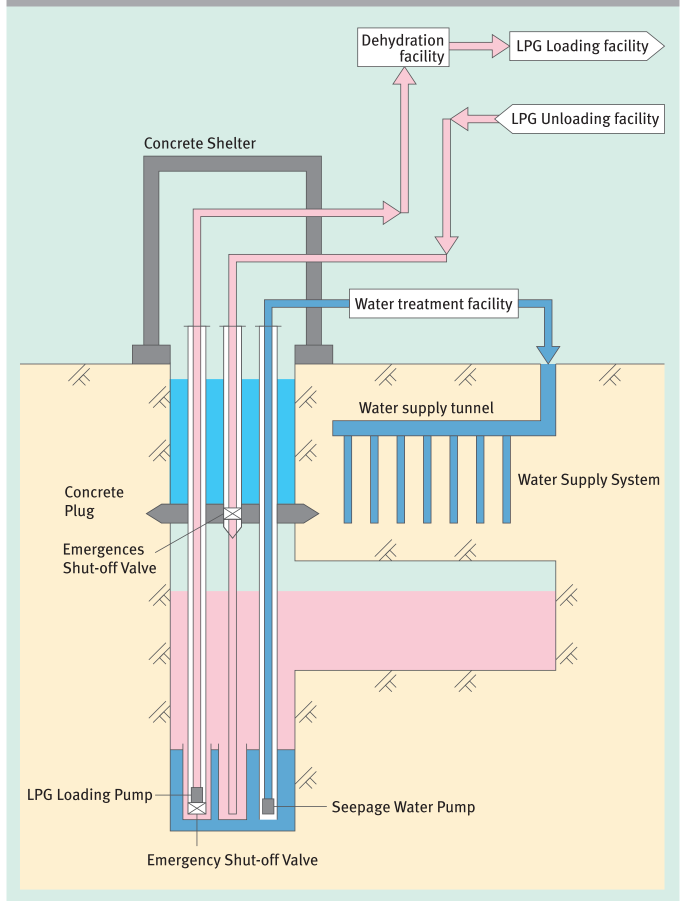
The design for safety in cavern LPG storage system is excellent, because the installation depth of cavern is very deep,such as App. 200m for propane, App.90m for butane, and also emergency shut-off valve installed in cavern prevents to leak LPG,and the shelter above piping shaft protects piping.

For LPG user, another merit is in being able to construct cavern storage system in a small area, at such sites where it is not able to construct aboveground cryogenics tanks system. Safety space between other facilities can be minimized in cavern storage system.

From economical viewpoint, construction cost and operation cost for liquefying boil off gas for aboveground cryogenics tanks, are not needed for LPG cavern storage system.

Therefore LPG cavern storage system is the most economical and safe system for huge LPG storage.

LPG cavern storage system



On-board Boil-off Gas Reliquefaction Plant for LNG Carrier

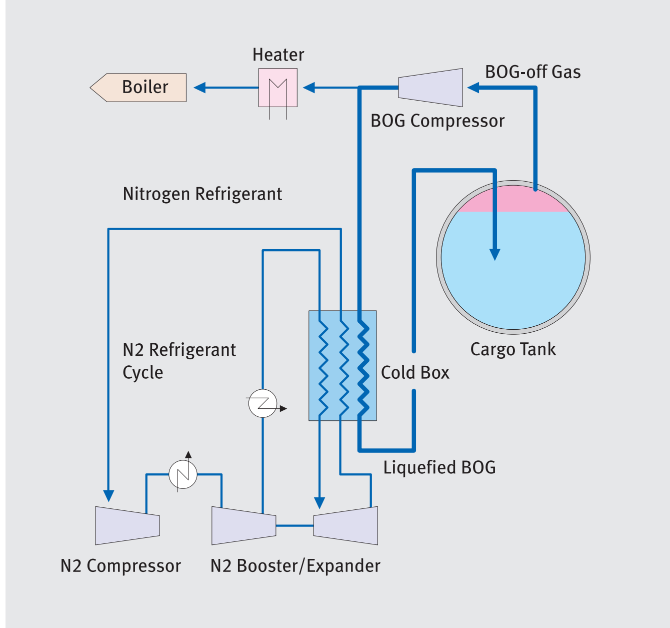
Boil-off Gas (BOG) generated in the LNG ship cargo during its voyage is burned in the boiler on conventional LNG carriers. On-board BOG reliquefaction plant had been studied for over a decade, because it is a key technology for LNG carriers in order to employ a new and more efficient propulsion system in the future.

LNG carrier, "LNG JAMAL", owned by Osaka Gas International Transport, Inc. (OGIT), Nippon Yusen Kabushiki Kaisha (NYK Line), Mitsui O.S.K. Lines, Ltd. and Kawasaki Kisen Kaisha, Ltd., has become the world's first ship equipped with on-board BOG reliquefaction plant. The achievement has been made jointly by Osaka Gas CO., Ltd. OGIT, NYK Line, Mitsubishi Heavy Industries, Ltd., and Chiyoda Corporation.

Chiyoda was responsible for the basic design of the reliquefaction plant. Refrigeration cycle, employing the Brayton cycle with nitrogen coolant, was designed to liquefy all the BOG generated during the voyage to return to cargo tanks. Chiyoda optimized the system to fit the limited on-board space and to achieve the efficiency required for the economic operation. Control schemes are crucial to the reliable and safe operation since BOG generation rate is likely to change during the voyage. Chiyoda established the liquefaction control system through the verification with dynamic simulation.

The plant has demonstrated its performance and effectiveness successfully in the voyage between Oman and Osaka, Japan starting from November 2000.

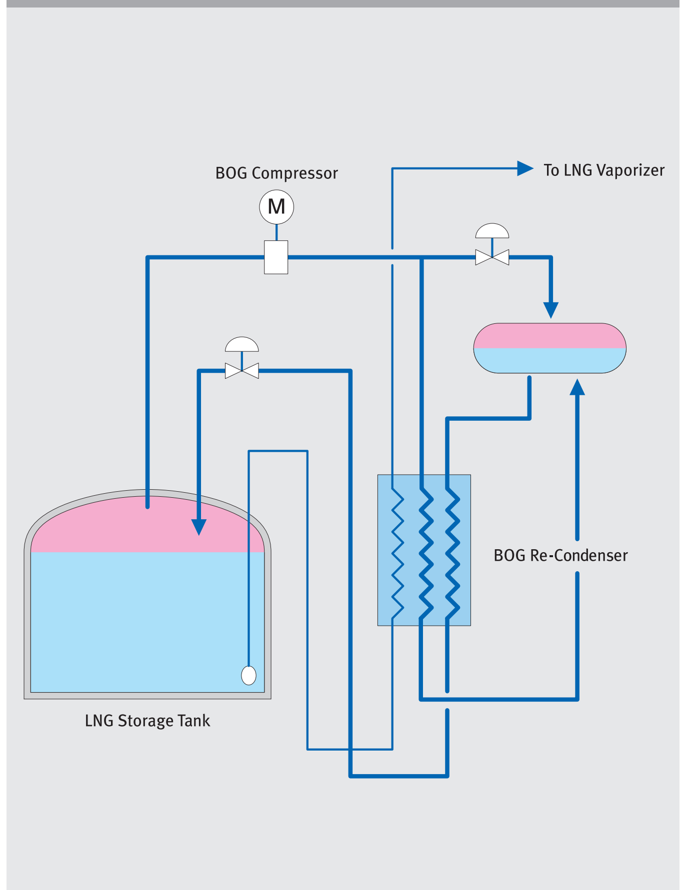
Overview of the BOG Reliquefaction Plant



LNG BOG Re-Condensing Process

Chiyoda has developed LNG-BOG re-condensing process with Tokyo Electric Power Co., Inc. which is named as "Hot Gas Bypass Control". Conventionally, BOG is compressed to send-out pressure by a high-pressure compressor in order to maintain a tank pressure of several kPa, and is sent out along with LNG vaporized by a LNG vaporizer. In the newly developed system, however, BOG is re-condensed at about 0.5MPa in the plate-fin heat exchanger by utilizing cryogenic energy of LNG which is supplied to LNG Vaporizer, and is sent back to LNG tank.
This Process unit enables us to keep BOG compressor discharge pressure constant without controlling both LNG and BOG flow rate. This process unit can also maintain a constant LNG composition in LNG Tank without concentration over the long period.
This BOG re-condensing process is economical compared with conventional system, when gas send-out pressure from the LNG terminal is over 2.0MPa.

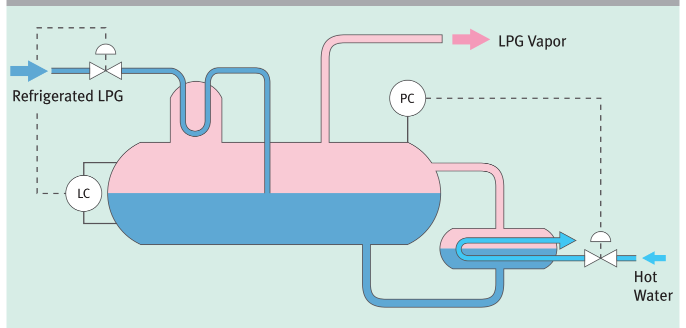
BOG Re-Condensing Process Flow



Vaporization Unit

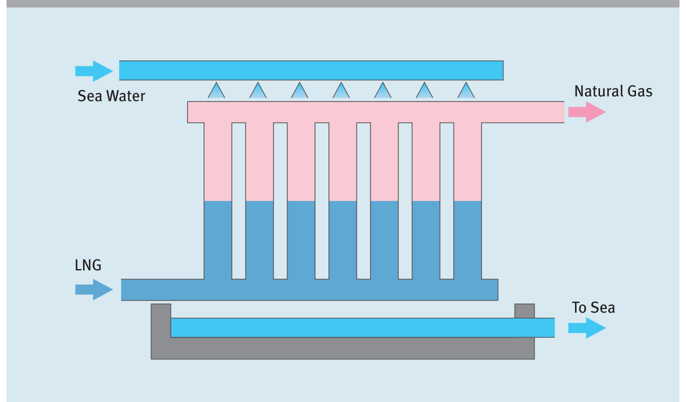
LPG/LNG stored in low-temperature storage tanks, is vaporized by heating and then sent to the power plant as fuel or to the utility company to make city gas. LPG/LNG is also used in steel plants which consume considerable amounts of fuel. Accordingly, a very high level of reliability is required for the LPG/LNG vaporization unit. Vaporizers are classified into the kettle type, the vertical thermosiphon type, the horizontal thermosiphon type for LPG,and the open rack, submerged combustion and steam ejector types for LNG. Chiyoda has designed and supplied various types of vaporizers, choosing the one most suited for each case. Electric power companies require LPG/LNG vaporization units having a quick response to the rapid fluctuations in load of the generators. To meet this requirement, Chiyoda has designed and constructed fully automated vaporization units which have met with full satisfaction of the clients.

Horizontal Thermosiphon Type Vaporizer

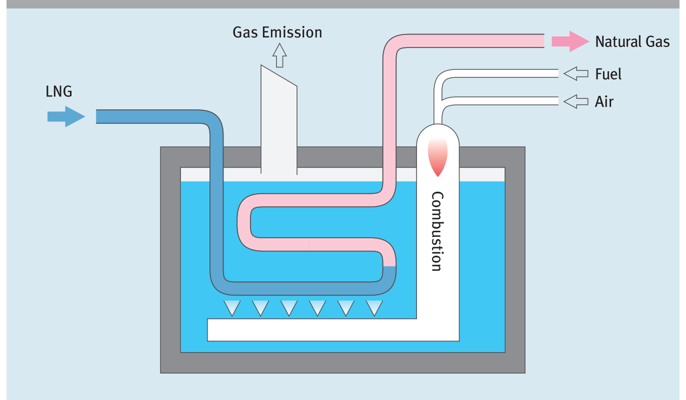


PC : Pressure Control LC : Level control

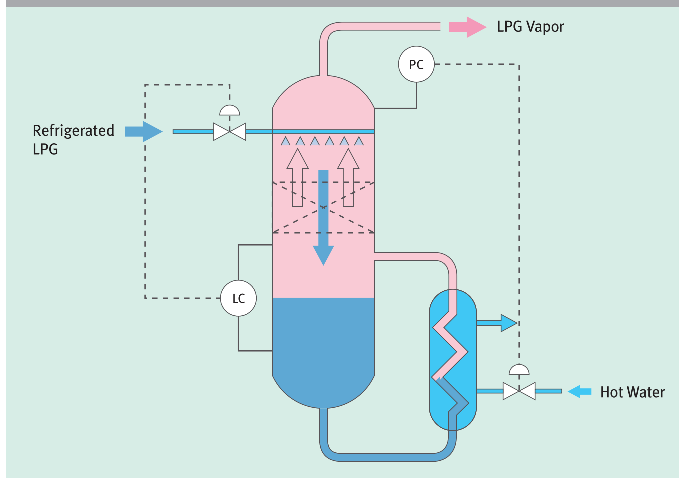
Open Rack Type Vaporizer



Submerged Combustion Type Vaporizer

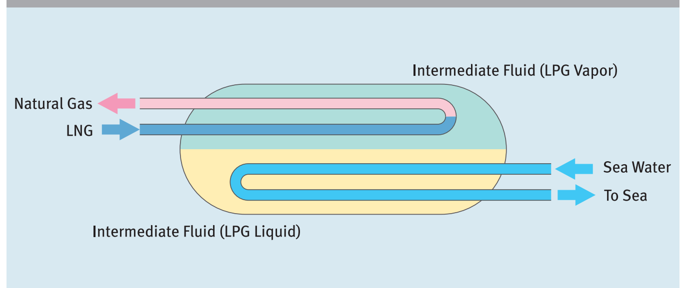


Vertical Thermosiphon Type Vaporizer

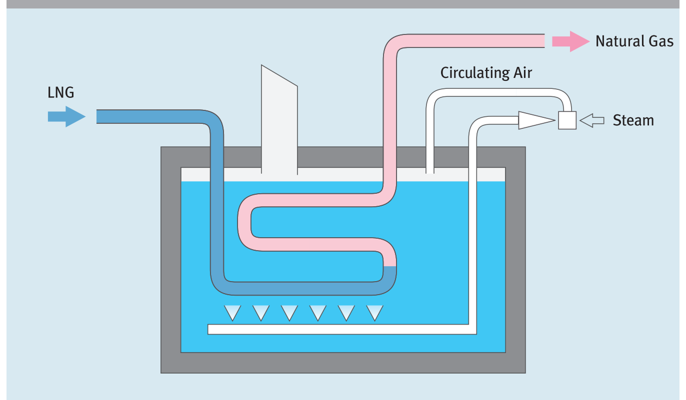


PC : Pressure Control LC : Level control

Intermediate Fluid Type Vaporizer



Steam Ejector Type Vaporizer



Calorific Value Adjustment System

The calorific value of vaporized natural gas is maintained within a specified narrow range when it is used as city gas, and essentially adjusted by adding LPG (Propane or Butane), since LNG calorific value is normally less than the required range.
In general, required LPG flow rate is calculated based on the flow rate of natural gas, calorific value of natural gas, LPG and target product gas.
Several methods of adding LPG has been developed as follows,

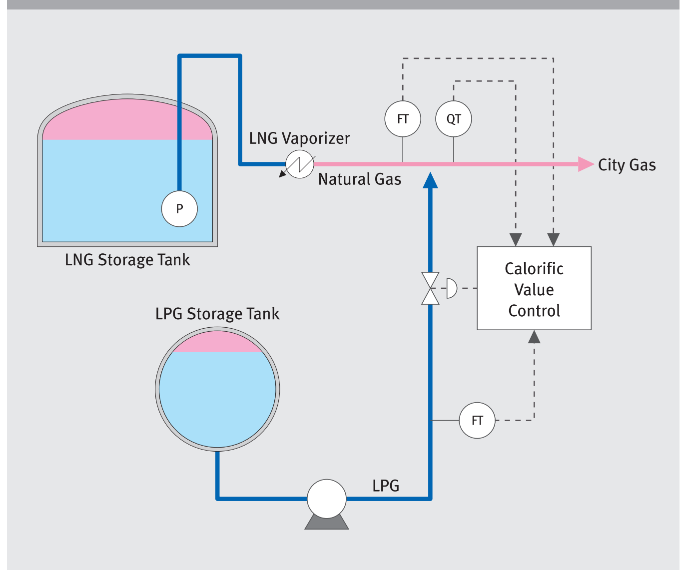
•Liquid / Gas calorific value adjustment
Natural gas and LPG are mixed by spraying LPG inside of a venturi type mixer or a drum. A natural gas heater needs to be installed at upstream of the mixer or the drum to completely vaporize LPG.

•Gas / Gas calorific value adjustment
LPG is vaporized before it is added to send out gas. An LPG vaporizer is necessary.

•Liquid / Liquid calorific value adjustment
Both LNG and LPG are mixed in the liquid phase. LNG is vaporized after calorific value adjustment.

Optimum method is selected through the consideration of LPG composition, availability of the heat source, such as steam or hot water, plot plan and facility investment costs.

Calorific Value Adjustment System (Liquid / Gas calorific value adjustment)



Operation and Maintenance

Piping

The following points are taken into account in the design and installation of LPG/LNG piping systems.

a) Special considerations in design

- Safety requirements
- High cost of piping and insulation materials
- Vapor generation by heat penetrating through insulation
- Rise in pressure (liquid expansion) due to change in liquid temperature
- Piping flexibility analysis
- Insulation for extremely low temperatures

b) Special considerations in construction

- Welding procedures
- Highly qualified welders
- Procedures for material handling and material control
- Inspection procedures

In both of these aspects, Chiyoda has established its own standard specifications based on abundant experience. Thanks to its extensive technology and experience, Chiyoda is enjoying a reputation as one of the foremost fully integrated engineering companies for the LPG/LNG industry, both domestically and overseas.

Advantages in Adopting 36% Nickel Alloy Steel

For facilities involving cryogenic temperatures (-160℃ or lower),18-8 stainless steel has typically been used because of the excellent properties of austenite in withstanding ultra-cold temperatures. However, because applications using 18-8 stainless steel piping that are constructed in ambient temperatures experience substantial thermal contraction when subsequently exposed to cryogenic temperatures, loops are usually installed to absorb the thermal contraction. In the case of adopting 36% nickel alloy steel piping, however, the following significant advantages become possible.

(1)Cutting the costs of piping work

a.Reducing the number of required loops makes it possible to:
- reduce the number of elbows;
- reduce the pipe diameter (thereby narrowing the bore due to the reduction in pipe pressure losses);
- reduce the number of welding points.

b.Cutting the costs of thermal insulation work (diameter and elbow sections).

c.Cutting the costs of pipe-rack construction.

(2)Cutting the costs of civil work due to the narrowing of shield tunnel cross-sections, etc., and scaling down the width of pipe racks.

(3)Achieving more effective land utilization by reducing the occupied area.

Utization of LNG Cold Potential

To meet energy-saving requirements, Chiyoda has developed an effective method of recovering LNG cold potential. Called the MFR Cycle, this method employs the Rankine Cycle which uses a multi-component fluid as the working medium.

A pilot plant developed with Tokyo Gas Co., Ltd. was constructed to generate electricity using the MFR Cycle and it has successfully demonstrated the feasibility of using this cycle commercially.

Following the successful pilot plant, the first commercial plant was constructed and operated at Negishi Works of Tokyo Gas Co., Ltd. in 1985, with an electrical output of 4,000 kW using 100 t/h of LNG.

Chiyoda has designed the frozen food distribution center, including food-processing works and frozen warehouse. Then, Chiyoda has constrcuted the cold energy supply facility in LNG Receiving Terminal, for that center.

■LNG Consumption : 4 t/h
■Refrigeration Capcity : 90 refrig. ton
■Temperature level : -35℃(-31℉)
■Frozen Warehouse volume : 2,200m3(net)

Power Generation Plant

Training Simulator for LNG Receiving Terminal

The operation and maintenance training simulator for LNG receiving terminals was designed and constructed by Chiyoda at the Shinagawa Training Center of Tokyo Electric Power Co., Inc. in 1987 to improve operating techniques and to provide training in the appropriate actions to be taken in emergency situations.

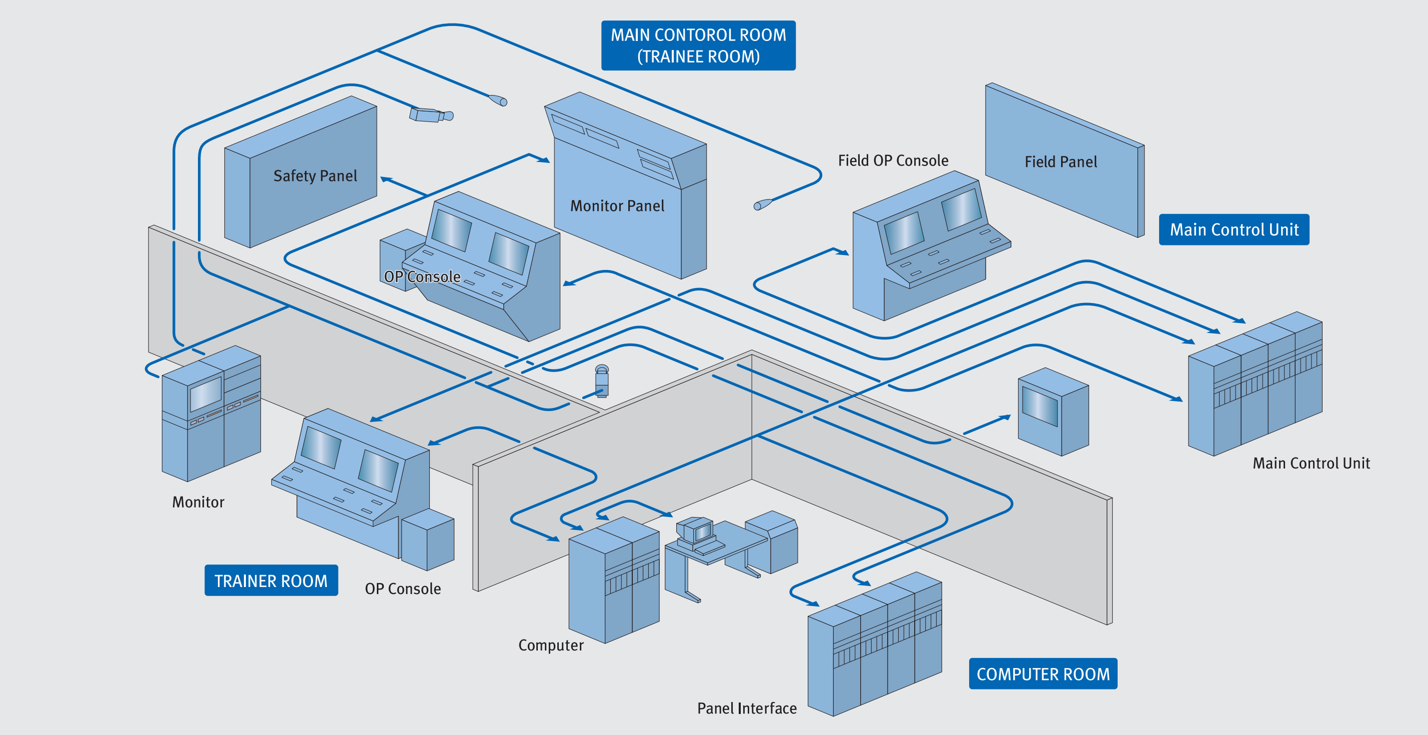
The simulator was developed based on the identical DCS control system and actual equipment configuration with the two existing terminals. The capabilities of the simulator include the following:

1. Training for start-up - normal-shutdown operation for each operation mode such as unloading, sending out to vaporizer, and loading operations.
2. Training for cooldown and heat-up operation.
3. Training for shift operation of LNG between tanks and rollover phenomena.
4. Training for emergency operation at the failure of major equipment such as LNG pumps, BOG compressors and LNG vaporizers.
5. Training for Safety equipment.

The operating phenomena in the above operations are simulated by a computer program based on the actual composition of receiving LNG. This Simulator was replaced recently by Chiyoda as seen in the pictures.

Training Simulator

System Configuration



LPG Receiving Terminal


Namikata Terminal Co., Ltd., Namikata


Oita LPG Joint Stockpiling Co., Ltd., Oita


Tohoku Oil Co., Ltd., Sendai


Idemitsu Kosan Co., Ltd., Aichi


Iwatani & Co., Ltd., Sakai


Kashima LPG Joint Stockpiling Co., Ltd., Kashima


Japan National Oil Corp.
Water Sealed Mined Cavern Storage (Pilot)


BP Ningbo Huadong LPG Co., Ltd., Ningbo, China

LPG Vaparizer


Vertical Thermosiphon Type Vaporizer


Horizontal Themosiphon Type Vaporizer

LNG Receiving Terminal

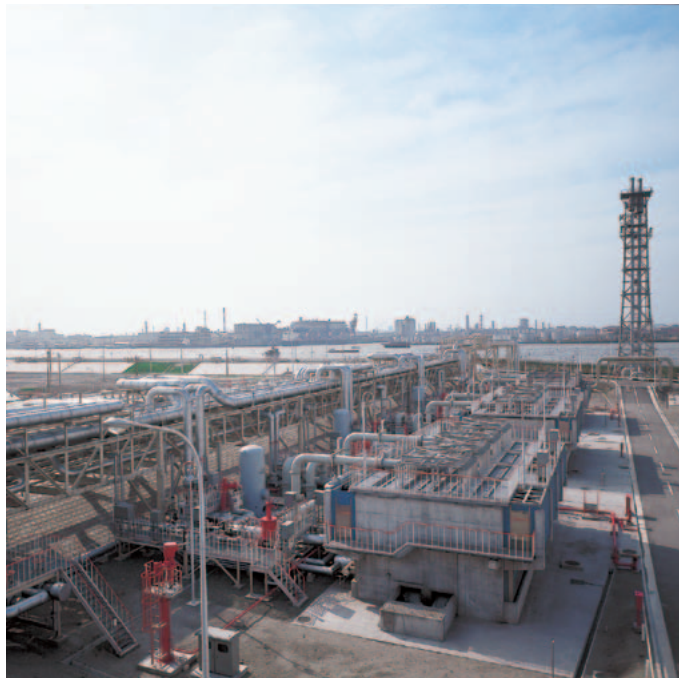

Tokyo Electric Power Co., Inc., Futtsu


Tokyo Gas Co., Ltd., Ohgishima


Tokyo Gas Co., Ltd., Negishi


Toho Gas Co., Ltd., Chita


Nihonkai LNG Co., Ltd., Niigata


Tokyo Electric Power Co., Inc., Higashi Ohgishima


Oita Liquefied Natural Gas Co., Inc., Oita


Chugoku Electric Power Co., Inc., Yanai


Mizushima LNG Co., Ltd., Mizushima

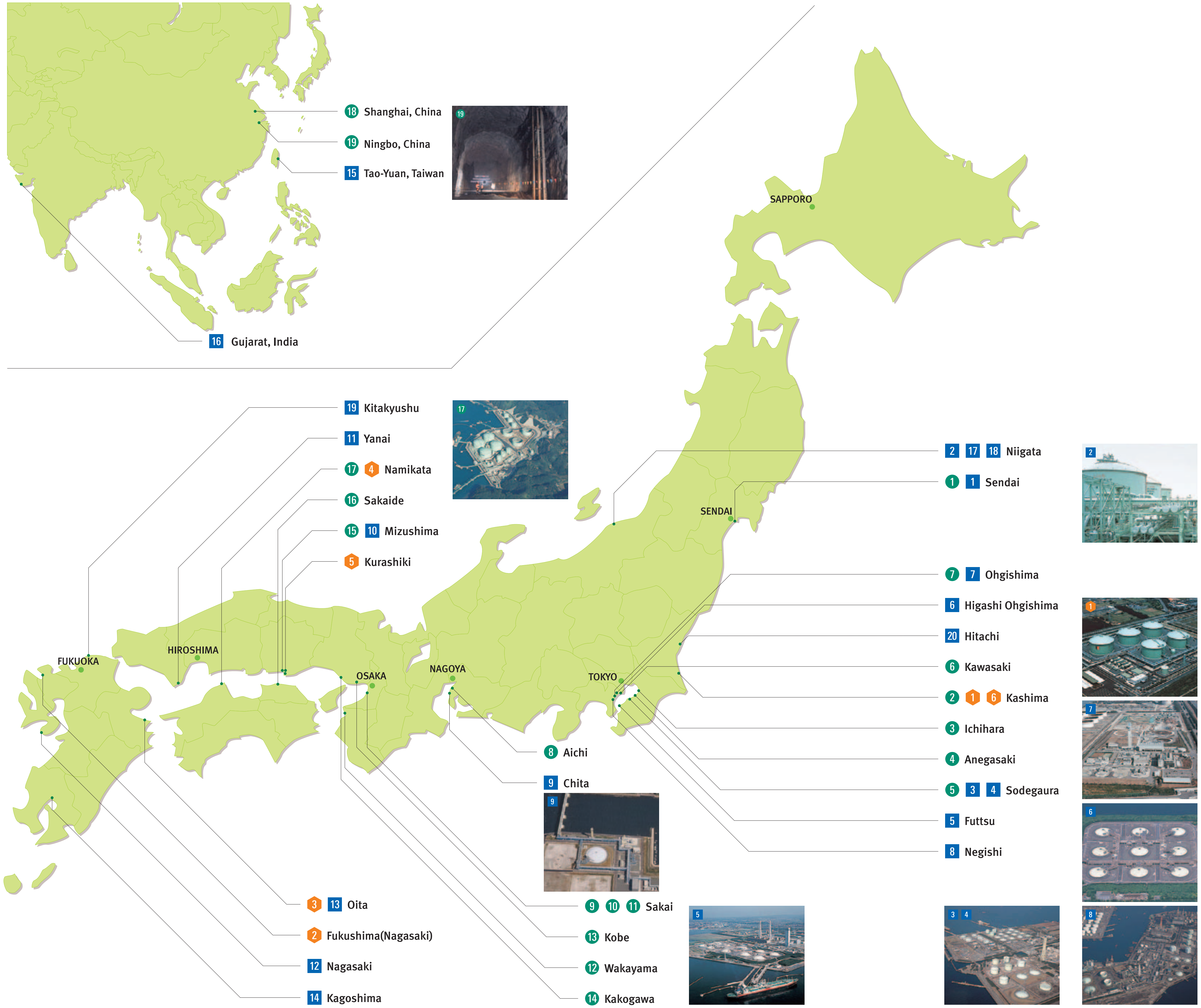

Sendai City Gas Bureau, Sendai

LNG Vaporizer


Open Rack Type Vaporizer (ORV)


Submerged Combustion Type Vaporizer (SMV)

Experience at a Glance



LNG RECEIVING TERMINAL

1	Sendai City Gas Bureau	Sendai
2	Nihonkai LNG Co., Ltd.	Niigata
3	Tokyo Gas Co., Ltd.	Sodegaura
4	Tokyo Electric Power Co., Inc.	Sodegaura
5	Tokyo Electric Power Co., Inc.	Futtsu
6	Tokyo Electric Power Co., Inc.	Higashi Ohgishima
7	Tokyo Gas Co., Ltd.	Ohgishima
8	Tokyo Gas Co., Ltd.	Negishi
9	Toho Gas Co., Ltd.	Chita
10	Mizushima LNG Co., Ltd.	Mizushima
11	Chugoku Electric Power Co., Inc.	Yanai
12	Saibu Gas Co., Ltd.	Nagasaki
13	Oita Liquefied Natural Gas Co., Inc.	Oita
14	Nippon Gas Co., Ltd.	Kagoshima
15	Tung Ting Gas Corp. *1	Tao-Yuan, Taiwan
16	BG plc. *1	Gujarat, India
17	Chubu Electric Power Co.,Inc.	Niigata
18	Inpex Corporation	Niigata
19	Hibiki LNG Co., Ltd.	Kitakyushu
20	Tokyo Gas Co., Ltd.	Hitachi

LPG RECEIVING TERMINAL

1	Tohoku Oil Co., Ltd.	Sendai
2	Kashima Oil Co., Ltd.	Kashima
3	Kyokuto Petroleum Industries, Ltd. *1	Ichihara
4	Tokyo Electric Power Co., Inc.	Anegasaki
5	Tokyo Gas Co., Ltd.	Sodegaura
6	Japan Energy Corp.	Kawasaki
7	Tokyo Gas Co., Ltd.	Ohgishima
8	Idemitsu Kosan Co., Ltd.	Aichi
9	Tonen General Sekiyu K.K.	Sakai
10	Sakai LPG Terminal Co., Ltd.	Sakai
11	Iwatani International Corp.	Sakai
12	Sumitomo Metal Industries, Ltd.	Wakayama
13	Mitsubishi Corporation	Kobe
14	Kobe Steel, Ltd.	Kakogawa
15	Nikko LPG Co., Ltd.	Mizushima
16	Zen-noh Fuel Terminal Corp. *1	Sakaide
17	Namikata Terminal Co., Ltd.	Namikata
18	Continental Grain Co./Shanghai Petrochemical Co., Ltd. *1	Shanghai, China
19	BP Ningbo Huadong LPG Co., Ltd.	Ningbo, China

LPG STORAGE TERMINAL

1	Kashima LPG Joint Stockpiling Co., Ltd.	Kashima
2	Japan Oil, Gas and Metals National Corporation	Fukushima(Nagasaki)
3	Oita LPG Joint Stockpiling Co., Ltd.	Oita
4	Japan Oil, Gas and Metals National Corporation	Namikata
5	Japan Oil, Gas and Metals National Corporation	Mizushima
6	Japan Oil, Gas and Metals National Corporation	Kashima

*1 Basic Design/FEED

LNG/LPG Receiving Terminal Projects

LNG Receiving Terminal

Client	Storage Capacity (Kl)	Project	Location	Year of Completion
Tokyo Gas Co., Ltd.	160,000	Grass-Roots	Negishi	1969
Tokyo Gas Co., Ltd.	10,000	Expansion	Negishi	1971
Tokyo Gas Co., Ltd.	70,000	Expansion	Negishi	1971
Tokyo Gas Co., Ltd.	60,000	Expansion	Negishi	1972
Tokyo Gas Co., Ltd.	90,000	Grass-Roots	Sodegaura	1973
Tokyo Electric Power Co., Inc.	90,000	Grass-Roots (Piping Work)	Sodegaura	1973
Tokyo Gas Co., Ltd.	180,000	Expansion	Sodegaura	1974
Tokyo Gas Co., Ltd.	300,000	Expansion	Sodegaura	1976
Tokyo Electric Power Co., Inc.	300,000	Expansion (Piping Work)	Sodegaura	1976
Tokyo Gas Co., Ltd.	95,000	Expansion	Negishi	1977
Tokyo Gas Co., Ltd.	120,000	Expansion	Sodegaura	1977
Tokyo Gas Co., Ltd.	95,000	Expansion	Negishi	1978
Tokyo Gas Co., Ltd.	120,000	Expansion	Sodegaura	1979
Tokyo Gas Co., Ltd.	95,000	Expansion	Negishi	1980
Tokyo Gas Co., Ltd.	95,000	Expansion	Negishi	1982
Tokyo Gas Co., Ltd.	260,000	Expansion	Sodegaura	1983
Nihonkai LNG Co., Ltd.	320,000	Grass-Roots	Niigata	1983
Tokyo Gas Co., Ltd.	130,000	Expansion	Sodegaura	1984
Tokyo Electric Power Co., Inc.	420,000	Grass-Roots	Higashi Ohgishima	1984
Tokyo Gas Co., Ltd.	4,000 kw	Power Generation Plant	Negishi	1985
Tokyo Electric Power Co., Inc.	360,000	Grass-Roots	Futtsu	1985
Tokyo Gas Co., Ltd.	30,000 Ton	LPG Facility for Calorie Adjustment	Sodegaura	1986
Tokyo Electric Power Co., Inc.	-	Training Simulator	Shinagawa	1987
Tokyo Electric Power Co., Inc.	120,000	Expansion	Higashi Ohgishima	1987
Oita Liquefied Natural Gas Co., Inc.	240,000	Grass-Roots	Oita	1990
Chugoku Electric Power Co., Inc.	240,000	Grass-Roots	Yanai	1990
Tokyo Electric Power Co., Inc.	180 T/H	Vaporizer (expansion)	Higashi Ohgishima	1991
Tokyo Electric Power Co., Inc.	250,000	Tank (expansion)	Futtsu	1991
Tokyo Gas Co., Ltd.	for 130,000 kl Tanker	Unloading Facility (expansion)	Negishi	1991
Chugoku Electric Power Co., Inc.	80,000	Tank/Vaporizer (expansion)	Yanai	1991
Tokyo Electric Power Co., Inc.	720 T/H	Gas Blower for Conduit Pipe	Futtsu	1993
Tokyo Gas Co., Ltd.	-	Expansion	Sodegaura	1993
Tokyo Gas Co., Ltd.	170,000	Expansion	Negishi	1994
Oita Liquefied Natural Gas Co., Inc.	80,000	Tank (expansion)	Oita	1994
Nihonkai LNG Co., Ltd.	-	Vaporization Facility (expansion)	Niigata	1995
Tokyo Electric Power Co., Inc.	-	Control System (replacement)	Higashi Ohgishima	1995
Chugoku Electric Power Co., Inc.	160,000	Tank/Vaporizer (expansion)	Yanai	1996
Tokyo Gas Co., Ltd.	200,000	Tank (expansion)	Negishi	1996
Nippon Gas Co., Ltd.	36,000	Grass-Roots	Kagoshima	1996
Tokyo Electric Power Co., Inc.	540 T/H	Gas Blower for Conduit Pipe	Futtsu	1996
Tokyo Electric Power Co., Inc.	810 T/H	Vaporizer (expansion)	Higashi Ohgishima	1997
Sendai City Gas Bureau	80,000	Grass-Roots	Sendai	1997
Tokyo Gas Co., Ltd.	200,000	Grass-Roots (Unloading Facility)	Ohgishima	1998
BG plc.	-	FEED work	Gujarat, India	1998
Nihonkai LNG Co., Ltd.	200,000	Tank (expansion)	Niigata	1998
Tokyo Gas Co., Ltd.	100 kg/Y	C13 Methane Plant	Negishi	1999
Oita Liquefied Natural Gas Co., Inc.	140,000	Tank/Vaporizer (expansion)	Oita	1999
Tokyo Electric Power Co., Inc.	-	Control System (modification)	Futtsu	1999
Tokyo Electric Power Co., Inc.	-	Control System (Replacement for CRT Operation)	Futtsu	2000
Tokyo Gas Co., Ltd.	200,000	Expansion	Ohgishima	2000
Tokyo Electric Power Co., Inc.	-	Training Simulator (replacement)	Shinagawa	2001
Tokyo Electric Power Co., Inc.	540 T/H	Vaporization Facility (expansion)	Futtsu	2001
Toho Gas Co., Ltd.	200,000	Grass-Roots	Chita	2001
Tung Ting Gas Corp.	420,000	Grass-Roots (Basic Design)	Tao-Yuan, Taiwan	2002
Tokyo Electric Power Co., Inc.	405 T/H	Vaporizer (expansion)	Higashi Ohgishima	2002
Saibu Gas Co., Ltd.	-	LNG Lorry Facility	Nagasaki	2003
Chugoku Electric Power Co., Inc.	-	LNG Lorry Facility	Yanai	2005
Mizushima LNG Co., Ltd.	160,000	Grass-Roots	Mizushima	2004
Tokyo Electric Power Co., Inc.	-	Vaporization Facility (expansion)	Higashi Ohgishima	2005
Tokyo Electric Power Co., Inc.	-	Control System (replacement)	Futtsu	2005
Tokyo Electric Power Co., Inc.	-	Control System (replacement)	Futtsu	2007
Tokyo Electric Power Co., Inc.	-	Control System (modification)	Higashi Ohgishima	2009
Mizushima LNG Co., Ltd.	160,000	Expansion	Mizushima	2011
Chubu Electric Power Co.,Inc.	-	Grass-Roots	Niigata	2013
Inpex Corporation	-	Grass-Roots	Niigata	2013
Hibiki LNG Co., Ltd.	180,000×2	Grass-Roots	Kitakyushu	2014
Tokyo Gas Co,. Ltd.	-	Grass-Roots	Hitachi	(2016)

LPG Receiving Terminal

Client	Storage Capacity (Ton)	Project	Location	Year of Completion
Nippon Mining Co., Ltd.	60,000	Grass-Roots	Mizushima	1965
Mitsubishi Corporation	59,000	Grass-Roots	Kobe	1966
Kyodo Oil Co., Ltd.	40,000	Grass-Roots	Kawasaki	1966
Maruzen Oil Co., Ltd.	52,000	Grass-Roots	Sakai	1966
Idemitsu Kosan Co., Ltd.	60,000	Grass-Roots	Aichi	1969
General Gas Co., Ltd.	81,000	Grass-Roots	Sakai	1969
Idemitsu Kosan Co., Ltd.	21,000	Expansion	Aichi	1971
Nippon Mining Co., Ltd.	34,000	Expansion	Mizushima	1972
Tohoku Oil Co., Ltd.	105,000	Grass-Roots	Sendai	1972
Idemitsu Kosan Co., Ltd.	100,000	Expansion	Aichi	1972
Kashima Oil Co., Ltd.	107,000	Grass-Roots	Kashima	1972
Kobe Steel, Ltd.	60,000	Grass-Roots & Vaporization Plant	Kakogawa	1973
Sumitomo Metal Industries, Ltd.	48,000	Grass-Roots	Wakayama	1974
Tokyo Electric Power Co., Inc.	108,000 / 260 T/H	Grass-Roots & Vaporization Plant	Anegasaki	1976
Sumitomo Metal Industries, Ltd.	40 T/H	Vaporization Plant (expansion)	Wakayama	1976
Iwatani & Co., Ltd.	80,000	Grass-Roots	Sakai	1980
Tokyo Electric Power Co., Inc.	93,000	Expansion	Anegasaki	1980
Kyokuto Petroleum Industries, Ltd.	180,000	Grass-Roots (Basic Design)	Ichihara	1981
Chugoku Electric Power Co., Inc.	100 T/H	Vaporization Plant	Iwakuni	1982
Tohoku Electric Power Co., Inc.	80 T/H	Vaporization Plant	Sendai	1982
Zen-noh Fuel Terminal Corp.	130,000	Grass-Roots (Basic Design)	Sakaide	1983
Tohoku Oil Co., Ltd.	90,000	Expansion	Sendai	1983
Namikata Terminal Co., Ltd.	180,000	Grass-Roots (incl. Chemicals)	Namikata	1983
Tokyo Gas Co., Ltd.	35,000	Grass-Roots	Sodegaura	1986
Chubu Electric Power Co., Inc.	48 T/H	Vaporization Unit	Yokkaichi	1988
Continental Grain Co./ Shanghai Petrochemical Co., Ltd.	100,000	Grass-Roots (FEED Work)	Shanghai, China	1994
Tokyo Gas Co., Ltd.	35,000	Grass-Roots	Ohgishima	1998
BP Ningbo Huadong LPG Co., Ltd.	1,600,000 T/Y	Grass-Roots (Water Sealed Mined Cavern)	Ningbo, China	2002

LPG Storage Terminal

Client	Storage Capacity (Ton)	Project	Location	Year of Completion
Oita LPG Joint Stockpiling Co., Ltd.	215,000	Grass-Roots	Oita	1986
Japan Oil, Gas and Metals National Corporation	400 kl	Pilot (Water Sealed Mined Cavern)	Mizushima	1993
Kashima LPG Joint Stockpiling Co., Ltd.	225,000	Grass-Roots	Kashima	1994
Japan Oil, Gas and Metals National Corporation	200,000	Grass-Roots	Fukushima(Nagasaki)	2005
Japan Oil, Gas and Metals National Corporation	200,000	Grass-Roots	Kamisu	2005
Japan Oil, Gas and Metals National Corporation	450,000	Grass-Roots (Water Sealed Mined Cavern)	Namikata	2012
Japan Oil, Gas and Metals National Corporation	400,000	Grass-Roots (Water Sealed Mined Cavern)	Kurashiki	2012
Japan Oil, Gas and Metals National Corporation	450,000	Grass-Roots (Water Sealed Mined Cavern)	Namikata	(2015)

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