OUTLINE OF CHITA-MIDORIHAMA WORKS AND PROGRESSIVE DESIGNS TO A NEXT-GENERATION LNG TERMINAL

L'USINE DE CHITA-MIDORIHAMA ET CONCEPTION D'UN TERMINAL NOUVELLE GENERATION DE GNL

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ABSTRACT

Toho Gas is currently constructing its third LNG receiving terminal – the Chita-Midorihama Works – with the aim of starting operations in November 2001. This facility will supply natural gas as raw material for city gas and fuel for electricity production. In the initial phase of construction, the main equipment will consist of one 200,000 kl inground LNG storage tank, two 60 t/h LNG vaporizers, and two 180 t/h LNG vaporizers.

In the construction of this terminal, following have been taken into consideration to make it befitting for the 21st century.

- Adoption of inground LNG storage tank together with the provision of green zone and planning of the facility to harmonize with the environmental surroundings and people working in the facility.
- Smooth linkage with the existing terminal and facilities in the surrounding of this terminal.
- Introduction of various advanced technologies for labor saving monitoring and control.

RESUME

Toho Gaz est actuellement dans la phase de construction de son troisième terminal pour *gaz naturel liquéfié* (GNL) – Le site de Chita-Midorihama – avec pour objectif d'être opérationnel en novembre 2001. Ce site permettra la fourniture du gaz naturel en tant que matière première pour le gaz de ville et combustible pour la production d'électricité. Dans la phase initiale de construction, les installations principales seront constituées d'un réservoir de stockage enterré, d'une capacité de 200 000kl, de deux (2) vaporisateurs GNL de 60 t/h ainsi que de deux (2) vaporisateur GNL de 180 t/h.

Les initiatives suivantes ont été prises en considération pour en faire un site industriel parfaitement adapté au XXI^{ème} siècle.

- La mise sous terre des réservoirs GNL, agrémentée d'espaces verts et d'une planification des installations, pour permettre l'harmonisation entre le contexte environnemental et les opérations du site.
- Liaison efficace avec les terminaux existant et les installations alentour.
- Introduction de technologies de pointe concernant le contrôle, la surveillance et la simplification des opérations.

1. INTRODUCTION

Toho Gas Company is situated in Nagoya City, roughly in the central Japan, and supplies city gas to the surrounding cities, towns and villages. In order to provide a stable supply to meet increased gas demands in the future, Toho Gas is now constructing the "Chita-Midorihama Works" in Chita City's Midorihama-cho(The South Reclamation Area No.5 of Nagoya Port) in Aichi prefecture. The Chita-Midorihama Works is the 3^{rd} LNG receiving terminal for Toho Gas, following the existing Chita LNG Joint Terminal, and the Yokkaichi Works, and will be the leading LNG terminal for Toho Gas in the future.

As shown in Figure 1, the Chita-Midorihama Works is located approximately 30 km south from Nagoya, and is being built on an artificial island along Ise Bay in the South Reclamation Area No.5 of Nagoya Port. The total reclaimed area is about 1,100,000 m^2, of which this facility accounts for about 300,000 m^2. The rest of the site contains an existing seaside green park of 180,000 m^2 in addition to the reclamation construction work now being carried out by Nagoya Port Authority for the planned cryogenic energy utilization facility and seaside green zone.

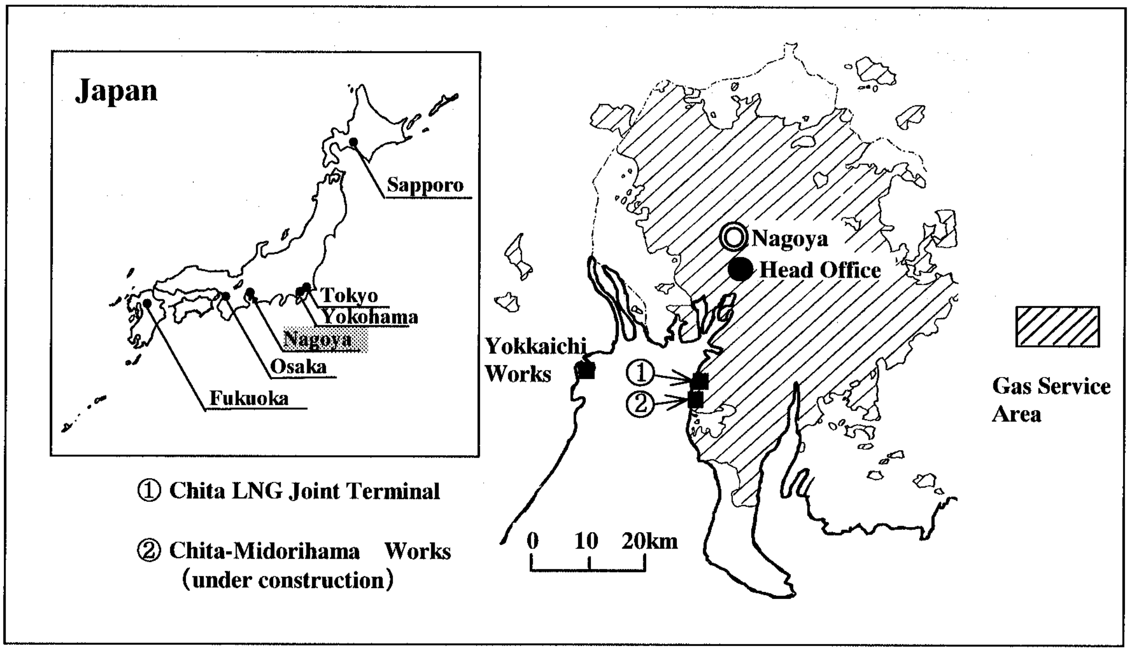

Figure 1. LNG Receiving Terminals and Gas Service Area of Toho Gas

As shown in Figure 2, the Chita-Midorihama Works is being built on a site south of the neighboring existing Chita LNG Joint Terminal, separated by about 250 m of open sea. The Chita-Midorihama Works is an L shape site, approximately 500 m from north to south, and about 700 m from west to east. The LNG storage tank area is about 300 m in length on the west side, and will initially consist of a single 200,000 kl inground LNG storage tank. The vaporized LNG gas from the Chita-Midorihama Works will be sent to the Chita Works as raw material for city gas via the Chita LNG Joint Terminal. It will also be sent via Chita LNG Co. Ltd., as a fuel for power generation at the thermal power plant operated by Chubu Electric Power Co., Inc.

A bridge loaded with LNG receiving and sending pipes will be constructed between the existing LNG receiving berth and the Minamihama pier, and will connect with the existing LNG receiving pipes. This will enable LNG receiving using the LNG receiving berth jointly managed and operated by the previously constructed LNG receiving terminals of Chita LNG Joint Terminal and Chita LNG Co., Ltd. In addition, by connecting the gas sending pipes from the Chita-Midorihama Works with the various gas supplying pipes within the two existing LNG receiving terminals, the new terminal will be able to share the existing facilities with regard to their respective sending piping systems.

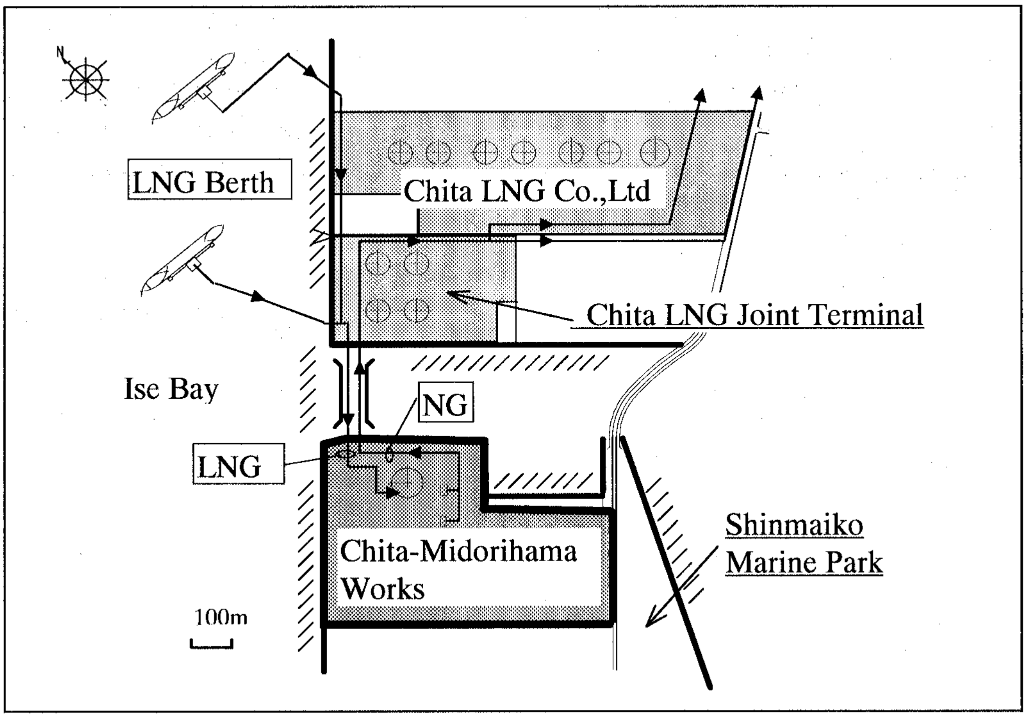

Figure 2. Environment of Chita-Midorihama Works

Under the site conditions and surrounding environment described above, the key design concepts for fulfilling the functions of this LNG facility, the first in the world to commence operation in the 21st century are :

- Harmony with the surrounding environment and people concerned with the facility operations;
- Smooth linkage with the existing terminals and facilities in the surroundings of this terminal;
- Introduction of various advanced technologies for laborsaving monitoring and control.

These various new approaches which have been made without adherence to conventional concepts are described below.

2. OVERVIEW OF PLANS FOR THE CHITA-MIDORIHAMA WORKS

2.1 Construction Progress

Reclamation work for the Chita-Midorihama Works, located in The South Reclamation Area No.5 of Nagoya Port, began in 1989. After completion of reclamation of the facility site in 1994, foundation improvement construction was implemented. Construction of the inground LNG storage tank was launched in 1996. While inspections and adjustments proceed, the first LNG carrier will be received in June 2001 and after half a year of trial operations, regasifying should begin in November of the same year.

2.2 Main Facilities

The specifications of the main facilities, which will be ready for operation in 2001, are described below in Table 1.

Table.1 Outline of Main Facilities(first phase)

Facilities	Name	Specification
Storage	LNG storage tank	Inground 200,000kl1 x 1
LNG regasification	LNG vaporizer	Open-rack type 60t/h x 2(for city gas) 180t/h x 2(for power generation)
Sending out	Primary pump Secondary pump	190t/h x 4 60t/h x 2(for city gas) 90t/h x 4(for power generation)
Boil-off gas treatment	BOG compressor	18,000m^3/h x 3
Sea water inlet	Sea water pump	4,800m^3/h x 1 6,850m^3/h x 2

3. HARMONY WITH THE SURROUNDINGS AND FACILITY OPERATIONS

The landscape architecture that has been implemented to cover the entire terminal strives for harmony between the peripheral access roads and adjoining park. In addition, the Control Center has been designed to be in harmony with the residents involved in the facility operations. These approaches are explained below.

3.1 LNG Storage Tank

The LNG storage tank which is the main equipment of the Chita-Midorihama Works will be the first inground tank the company has adopted ever. Compared to the aboveground tanks, the inground tank enables its overwhelming effects on the surroundings to be reduced while helping the whole facility to blend with its surroundings and contributing to effective use of the site with improved safety.

Further, the use of ring plate structure as the outer roof (traditionally, knuckle ring structure have been the mainstream) according to computer-assisted design has made it possible to:

Conserve resources due to a reduction in the volume of steel used; and improve the landscape by reducing the height of the roof.

3.2 Terminal Layout and Green Zone Planning

Figure 3 shows the ground plan of the terminal. The LNG storage tank area is on the west side, running north to south, where a 200,000 kl inground tank will be constructed in the initial phase. The LNG vaporizer area is in the center, running north to south, and will comprise an open rack type vaporizers. The east side is allocated for utility facilities and the Control Center.

In order to minimize the overwhelming effects of the external portion of the terminal facilities, a green zone 100 m wide and 10 m high on the eastern edge of the terminal will be provided. While preventing the facilities within the terminal from being easily seen from the outside, the green zone will also harmonize with the landscape of the public seaside park situated on the east side of the terminal. In addition, the soil excavated in the construction of the inground LNG storage tank can be used effectively for the earth required for the creation of the green zone.

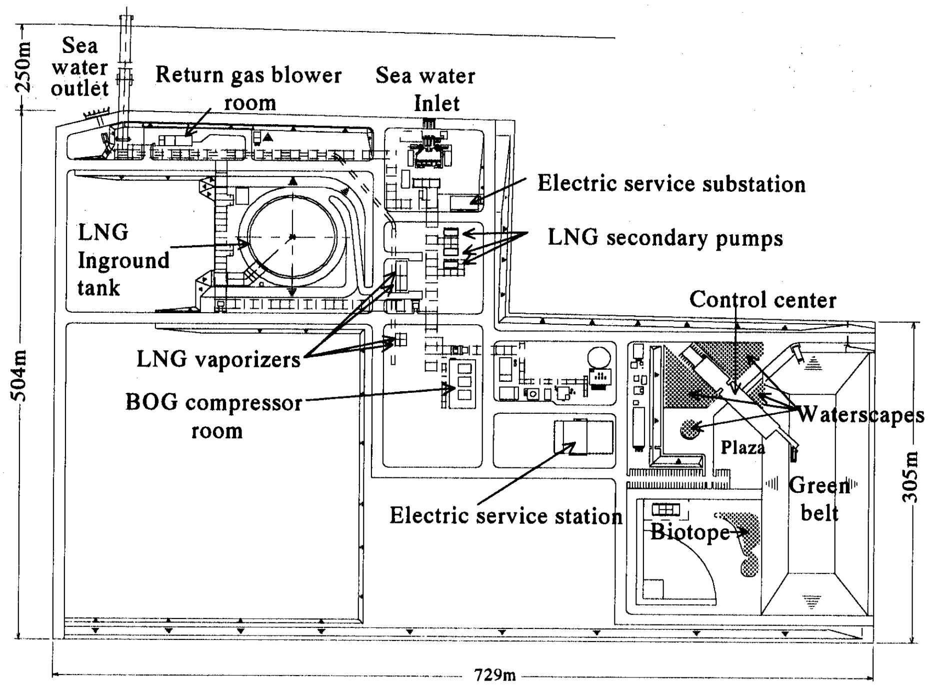

Figure 3. Terminal Layout

The Control Center- the nerve center of operation control – has become the symbol of the “environmentally-friendly natural gas” production terminal, and its layout gives a sense of unity with the green zone within the terminal.

Waterscapes have been provided at 4 locations around the buildings. With the image of the buildings reflected on the water surface, a sense of a landscape that merges into the natural environment could be obtained. On the southwest side of the building is a plaza paved with flat stones. Such architectural considerations provide a sense of ease and serenity to visitors and employees.

In addition, a BIOTOPE [a made-up word consisting of BIO (Biological) + TOPE (Space)] as shown in Figure 4, has been provided within the green zone of the terminal site. A natural environment consisting of a pond (850 m^2) and so forth has been created using earth and wood. Plants have been placed around this, creating an ecological system where local birds, small animals, insects and so on can live, thus making it possible to preserve the natural environment.

Figure 4. Photograph of the BIOTOPE

4. LINKS TO THE EXISTING TERMINAL

In the process of producing city gas, it is necessary to have calorific value regulating equipment to ensure the calorific value and combustibility of the gas produced.

However, in the initial phase, the Chita-Midorihama Works will not have such facility. Instead, the existing equipment at the Chita Works will be used. As mentioned above, the vaporized gas produced by the Chita-Midorihama Works will flow together with the vaporized gas of the adjoining existing Chita LNG Joint Terminal and will be sent to the previously constructed calorific value regulation equipment of the Chita Works. To change the vaporized gas into city gas with the appropriate calorific value and combustibility at the Chita Works, LPG will be added and then be piped to customers.

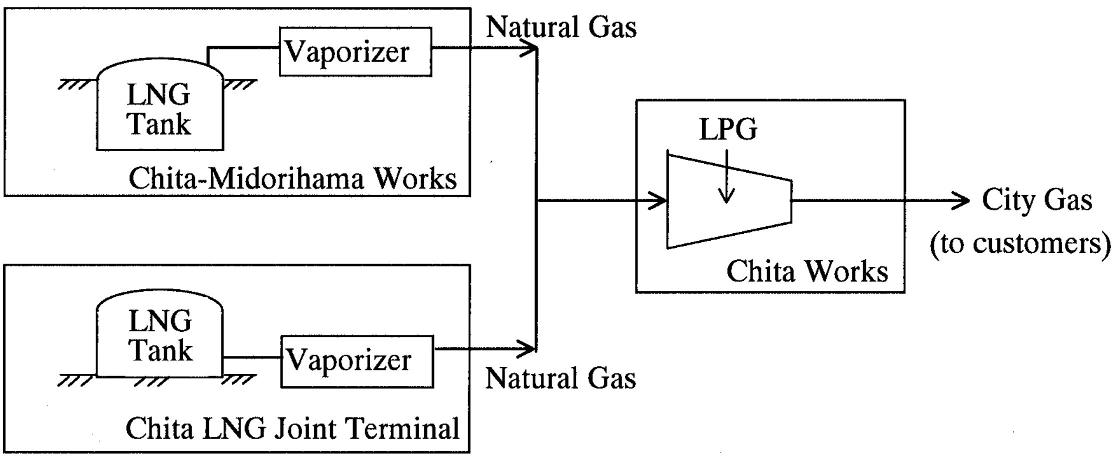

Figure 5. Gas Flow Sheet

Figure 5. shows the gas flow sheet. Accompanying the start of operations at the Chita-Midorihama Works there will be a change from the present 1:1 ratio between a single

LNG receiving terminal and a single calorific value regulating equipment to a 2:1 ratio in which there will be 2 LNG receiving terminals for a single calorific value regulating equipment plant leading to greater complexity in the link between the terminals. This will demand greater cooperation between the terminals than ever before in order to maintain safety and to increase the efficiency between the terminals. Consequently, an optical fiber and multiplex wireless network system connecting terminal control equipment for monitoring and control, for transmittinng necessary data and for supporting cooperative operations between each of the terminals has been built in conjunction with the construction of the Chita-Midorihama Works.

The key functions of the system are described below:

(1) Load distribution and mutual monitoring functions

The volume of gas produced must be adjusted to match fluctuations in the demand for city gas in the supply area. Once operations begin at the Chita-Midorihama Works, this function will ensure total sending gas volumes from the 2 LNG receiving terminals and decide how much vaporized gas should be produced and by which terminal (i.e. "load distribution") in a unified manner. In addition, a mechanism has been constructed to enable the mutual monitoring of the operation conditions of each terminal to accurately and efficiently implement interlinked operations between the LNG receiving terminals and the equipment that adjusts the calorific values.

(2) Operation guidance functions

The operations of each terminal are carried out in synchronization with changes in the operating conditions and control of the other terminals. In order to carry out these operations smoothly, a mechanism has been created to capture the changes in operating conditions and the timing of operations, and to communicate the actions necessary to respond to these details to the appropriate terminal. This mechanism fulfills a vital role during a normal situation and during an emergency as well by quickly and accurately carrying out the necessary actions

(3) LNG stock simulation

In order to continue the stable sending gas, each terminal draws up a plan (stock operation plan) of the volume of LNG that has been sent and received in response to demand projections. However, differences occur in the planned and actual sending in response to the demand. To compensate for these differences, adjustments of the LNG stock operation plan between terminals are required. These adjustments however cannot be smoothly made unless each of the terminal has a grasp of the other's stock operation plan and the shifts in its stock volumes. For this reason, a program that predicts the shifts in LNG stock volumes has been created as a support function for stock operation plan.

5. INTRODUCTION OF NEW TECHNOLOGY FOR ADVANCED, LABORSAVING MONITORING AND CONTROL

Giving consideration to the role of this terminal, the assurance of safety and reliability is being secured by the maintenance of backup equipment and the duplication of the pipelines and power system, similar to the fundamental ideas when designing conventional LNG receiving terminals. Additionally, practical use has been made of advanced, laborsaving monitoring and control by introducing new technology. Among these, the ones with special features are described below.

5.1 Pressure Control System for Receiving Pipes

Figure 6 shows the receiving piping flow diagram of the Chita-Midorihama Works. This terminal utilizes an inground LNG storage tank in which the ends of the receiving pipes are opened in the gas phase part of the LNG storage tank. Consequently, in the case of the inground LNG storage tank, the head pressure does not get trapped as the backpressure. As a result when the tank receiving valve is maintained in an open state when receiving begins , the LNG inside the receiving pipes escapes to the tank. This results in the pressure falling at the highest part of the receiving pipes (the junction bridge), generating gas inside the pipes and hindering receiving operations and the maintenance of cooling. Additionally, even when receiving is not being carried out, a reduction in pipe pressure can occur due to a disturbance in valve operation, and so on, making it possible for the same phenomenon to occur. Hence, it becomes necessary to carry out a series of receiving operations while maintaining the pipe pressure above the usual fixed values of a pipe bridge where gasification occurs most easily. Carrying out these operations manually increases the operator's responsibilities with increased risk of operational errors, delayed responses, and so on. Thus, a system to automate the series of receiving operations has been created.

For a detailed study of the control system, a feasibility study was made theoritically by as well as with computer simulation and the feasibility along with the optimum settings were decided. In the simulation, an extrapolation of the optimum pipeline pressures and circulation coolant volumes, shown in Table 2, corresponding to each process during receiving was carried out. Since it is necessary to control disparate LNG quantities, including during receiving, multiple sizes of LNG receiving control valves were combined and changed according to the circumstances. The valve sizes and optimum control patterns for open/close timing to deal with these were assessed by simulation.

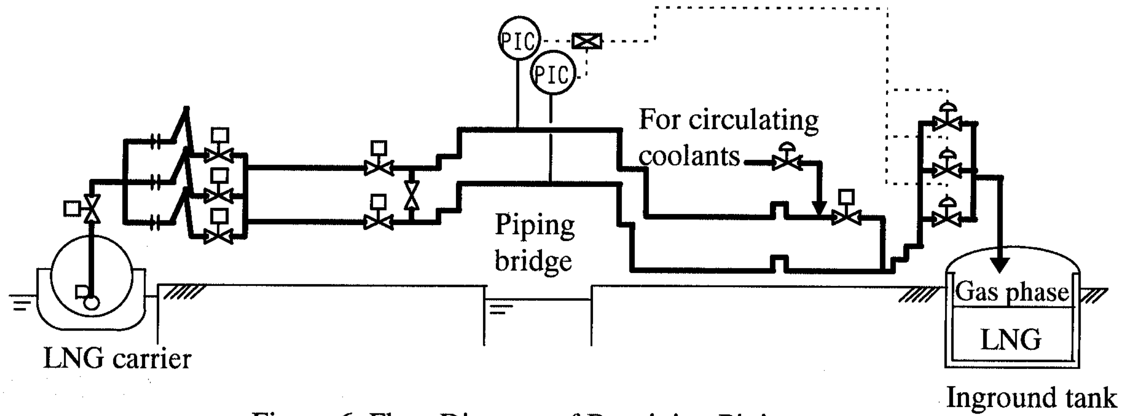

Figure 6. Flow Diagram of Receiving Piping

Table 2. Settings for Receiving Pipe Pressure and Circulating Coolants

Control status	Pipe bridge pressure settings (MPa)	Circulating coolant/LNG volume (t/h)
In-terminal pipe coolant	0.15	60
Receiving berth and pipe changeover	0.07	0
Receiving berth circulating coolant	0.07	150
Receiving standby	0.07	150
Receiving initialization/completion	0.07/0.3	150/90
Steady receiving conditions	0.12	Approx. 5,000 (full rate receiving volume)

5.2 Maneuverable Monitoring of Terminal Equipment by Mobile Wireless Cameras

In addition to the on-premise fixed cameras traditionally used for monitoring, a new wireless mobile camera monitoring system has been introduced to monitor essential equipment, the ORVs interspersed through the terminal, and so on, in detail.

This system has been jointly developed by Toho Gas and Nittetsu Hokkaido Control Systems Co.,Ltd. It uses a low power wireless analog system as its radio wave form. Further, in addition to images, it can also simultaneously transmit voice and contact signals. Because the system transmits information without wires, an operator can walk around freely carrying a transmitting unit, as shown in Figure 7 and monitor also covered objects like equipment and piping etc., which could not be monitored so far with the conventional fixed cameras.

(1) Monitoring areas

ORV areas(Monitoring of sea water distribution and piping conditions, and so forth)

(2) Monitoring implementation conditions

During trial operations, essential monitoring can be done at the time of trouble occurrence as well as before and after the trouble occurence.

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(4) System overview

The operator records objects undersurveillance using a transmitting unit (camera and transmitting device), and sends real time and recorded voice and color images to the Central Control Room in the Control Center via a specially installed wireless and wire network. In the Central Control Room , a projector for monitoring use shows the images and sounds received, thus giving a grasp of the detailed local conditions.

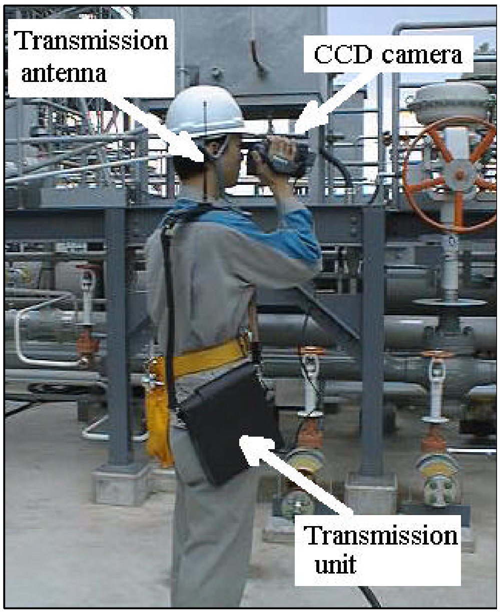

Figure 7. System Usage Conditions

(5) Technical features

(a) Diversity reception

A fixed reception antenna receives the radio waves output by the transmitting unit. To reduce the obstructing effect of objects such as pipes, equipment and so forth, several reception antennas are installed in the surveillance area. However, signals received by these multiple reception antennas can easily go out of phase and also become significantly degraded and useless with simple addition of signals. To control the degradation of signals and to transmit optimal images in this system, the signal levels of each reception antenna is compared full time and the signal from the antenna that has the highest signal level is selected to create a diversity reception system. With this function, it is possible to produce stable images and have sound transmissions even during transmission while moving in the monitoring area.

(b) Spectrum compression of image signals

When carrying out wireless transmission of image signals with the transmission system, the NTSC signals are compressed from 4.5 MHz to 2 MHz using spectrum compression processing (narrow-band frequency modulation). This processing reduces the signal degradation of the transmission part and enables high-grade color image transmissions.

CONCLUSION

The various new approaches which have been put into use or are going to be put into effect in the construction of the Chita-Midorihama Works were examined and described. Although the terminal will begin operations in 2001, to cope with future growth in the demand for gas, a stage-by-stage increase in the number of LNG tanks, vaporization equipment and other related equipment is being planned even after the start of operations. While moving forward safely with both the operation and enlargement of facilities in the future, we will continue to seek optimum solutions for the basic concept of continued harmony between people, the LNG terminal facilities and the surrounding environment.