# TOKYO GAS' EFFORTS REGARDING IMPACT ASSESSMENT ON SURROUNDINGS AND EMERGENCY RESPONSE TRAINING

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**ABSTRACT**

In Japan, 82 commercial Hydrogen Refueling Stations (HRSs) were constructed as of March 1, 2017, but few impact assessments have been reported on the surroundings at HRS. In addition, as HRSs become more widespread, the number of HRSs around narrow urban areas will also increase. Thus, the necessity of impact assessments on the surroundings of HRSs is expected to increase. In order to confirm that the influence from our HRS is not problematic to the surrounding residences, we conducted an impact assessment on the surroundings at HRS by using the actual HRS construction plan. Although safety is one of the objects of an impact assessment, in Japan, the safety of an HRS is guaranteed by observing the High Pressure Gas Safety Act, its Technical Standards, and other related regulations. On the other hand, if an accident such as a hydrogen leak or hydrogen fire occurs at an HRS, it becomes important to prevent secondary disasters and to minimize influence on the surroundings by means of an initial response by the operators of the HRS. Therefore, we have conducted training to improve the emergency response capability of the HRS operators and to prevent secondary disasters. In this paper, we describe the abovementioned information with regard to an impact assessment on the surroundings and for emergency response training.

## 1.0 INTRODUCTION

Tokyo Gas Co., Ltd. was founded in 1885 and supplies gas to more than 11 million customers mainly in the Japanese capital region by utilizing a pipeline network. In addition to full electric power liberalization beginning on April 1 of last year, we started to sell low-tension power to customers for home use and business use.

Tokyo Gas Co., Ltd. previously focused on hydrogen utilization as energy, and has been working on the development of hydrogen utilization technology. In 2009, we began to sell 'ENE-FARM' for the first time around the world. This is a household fuel cell that produces hydrogen from city gas and generates electricity. As of October 2016, we achieved a cumulative sales volume of 70,000 units, and we are striving to further disseminate ENE-FARM.

With regard to HRSs, we participated in the 'Japan Hydrogen and Fuel Cell Demonstration Project' (JHFC), a Ministry of Economy, Trade and Industry (METI)-funded project, beginning in 2002. We have been working on technology development and research for demonstration. In 2003, we constructed the first Hydrogen Refueling Station (HRS) in Tokyo, and contributed to developing international refuelling standards, etc., through the technological development of hydrogen refuelling to a fuel-cell vehicle (hereinafter called FCV) as a demonstration vehicle. In 2010, we participated in the 'Hydrogen Highway Project' of METI, constructed an HRS capable of refuelling hydrogen to a bus, conducted a high-operation-rate demonstration of facilities at an HRS, and demonstrated the separation and recovery of $CO_2$ generated by a city gas reformer. After the demonstration project, in order to contribute to the promotion of the dissemination of FCVs, which is a foothold in a hydrogen society, we constructed one HRS in FY 2014 and two HRSs in FY 2015, and have been operating them since.

In Japan, 82 commercial HRSs were constructed as of March 1, 2017, but there are few reports on impact assessments of the surroundings at HRSs. In addition, as HRSs become more widespread, the number of HRSs around narrow urban areas will also increase. However, in this case, it is difficult to ensure sufficient distances between the facilities related to an HRS and the surrounding residences. Thus, the necessity of an impact assessment on the surroundings of HRSs is expected to increase. In order to confirm that the influence from our HRS is not problematic to the surrounding residences, we conducted an impact assessment on the surroundings at an HRS by using the actual HRS construction plan.

Although safety is one of the objects of an impact assessment, in Japan, the safety of HRSs is guaranteed by observing the High Pressure Gas Safety Act, its Technical Standards, and other related regulations. On the other hand, if an accident such as a hydrogen leak or hydrogen fire occurs, it becomes important to prevent secondary disasters and to minimize the influence on the surroundings by means of an initial response by operators of the HRS. Therefore, we conducted training to improve the emergency response capability of HRS operators and to prevent secondary disasters.

First, this paper will introduce the HRS of our company and the fundamental concept of the safety for an HRS. Then, the paper will describe an impact assessment of noise and exhaust gas on the surrounding residences of the HRS. Noise and exhaust gas were chosen as the objects of the impact assessment based on the results of an interview survey of residents around the construction planning site before HRS construction. It became clear that there is concern about the influence of the 'noise' and 'exhaust gas' of the HRS. With regard to emergency response training, this paper will describe the content of the training, and the problems and countermeasures clarified from the training.

## 2.0 REGARDING HRS OF TOKYO GAS CO., LTD.

Generally, HRSs are divided into two types: an on-site HRS that produces hydrogen locally, and an off-site HRS that procures hydrogen from outside the HRS. Although the on-site HRS requires the equipment cost for the hydrogen manufacturing apparatus as compared with the off-site HRS, there is an advantage in that the on-site HRS does not incur the transportation costs of hydrogen at the time of operation. In addition, on-site HRSs have the advantage of being able to supply city gas for the production of hydrogen cheaply and stably by utilizing the existing pipeline network. This is a plus for city gas operators. In view of the above, we are focusing on on-site HRSs that produce hydrogen locally by a city gas reformer that utilizes city gas from our pipeline network. A flowchart of the on-site-type HRS of our company is shown in Figure 1.

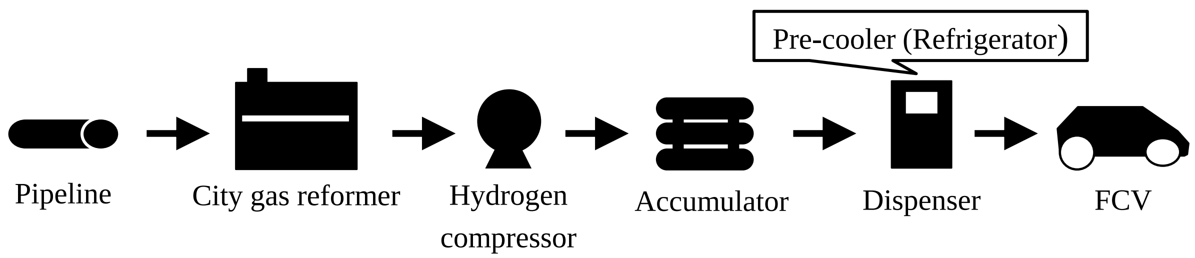


Figure 1. Flowchart of our on-site-type HRS

## 3.0 FUNDAMENTAL CONCEPT FOR SAFETY OF HRS

In Japan, the safety of HRSs is guaranteed by observing the High Pressure Gas Safety Act and its Technical Standards, the Building Standards Act, the Fire Service Act, and other related regulations.

The following five items form the fundamental concepts about safety in an HRS. (1) Leakage prevention: Install facilities with a margin of strength, and routinely conduct appearance and leakage checks. (2) Enlargement prevention: Gas leakage detectors are installed where there is a possibility of hydrogen leakage. When a hydrogen leak is detected, the facilities of the HRS are automatically stopped. (3) Retention prevention: In order to prevent the structure from retaining hydrogen, adopt a structure that easily diffuses hydrogen, such as installing the ventilation equipment in a hydrogen compressor unit, installing the ventilation port in an accumulator unit, inclining the canopy, etc. (4) Ignition prevention: Prevent ignition by adopting explosion-proof equipment, and ensure a legal separation distance from hazardous materials. (5) Prevention of influence on the surroundings: Prevent influences on the surroundings owing to igniting or exploding by ensuring a legal separation distance from a high-pressure gas facility to the site boundary and establishing a barrier. [1]

In addition to the abovementioned safety measures for facilities, we conducted emergency response training in order to prevent secondary accidents and to minimize the impact on the surroundings owing to accidents, etc. Details of this effort are described in chapter 5.

## 4.0 IMPACT ASSESSMENT ON THE SURROUNDING AREA AT HRS

### 4.1. Impact Assessment of Noise on Surrounding Area of HRS

#### 4.1.1 Setting Conditions for Noise Simulation

In order to assess the impact of noise from an on-site HRS on the surrounding area, we conducted three-dimensional noise simulations by using the living-environment noise-prediction software ‘SoundPLAN’. The simulations were conducted assuming that all the facilities in the HRS in operation. The main input dates of simulation are as follows: a) sound power level of the facility as a noise source, b) layout of the site to be constructed, and the layout and shape of the HRS’s facilities and existing buildings, and c) sound pressure level date of the background noise. Each item is described below:

a) Sound power level of the facility as a noise source

The major noise sources in an on-site HRS are the hydrogen manufacturing apparatus (city gas reformer), hydrogen compressor, refrigerator, cooling tower, and instrumentation compressor. In order to calculate the sound power level of the above facilities, the sound pressure level dates of the facility as a noise source were obtained from manufacturers, etc. Regarding facilities for which manufacturers do not possess sound pressure level dates, these were acquired by conducting noise measurements for facilities that were equivalent to existing facilities.

The facilities for which noise measurements were conducted include the hydrogen compressor, the refrigerator, and the cooling tower. Regarding the measurement points, the hydrogen compressor and the refrigerator were measured in the vicinity of the four wall surfaces and the roof surface, the intake duct, and the exhaust duct. In addition, the cooling tower were measured the vicinity of the top fan, the louver, and the pump. Additionally, although the hydrogen compressor and refrigerator are installed in a rectangular parallel-piped enclosure, the cooling tower has a shape similar to a cylinder. Therefore, it was assumed that there was no difference in the sound power level depending on the direction, so the vicinity of the louver instead of the four wall surfaces was measured.

Based on the sound pressure level date obtained above, the sound power level was calculated. With regard to noise sources other than surfaces of the wall, roof, and louver (for example, instrumentation compressor, pump ducts, etc.), the sound power level was calculated as a point sound source instead of a surface sound source. Additionally, the sound power level is the amount of sound energy per unit time radiated from the sound source, and it is a measurement amount that represents the noise characteristic of the sound source.

Table 1 lists the sound power level for each part of each facility. The sound power level of each part was about 60 to 80 [dB]. The enclosures of facilities such as the city gas reformer and the hydrogen compressor have openings such as ventilation ports and ducts, and exhibit high values of about 80 [dB] at their openings. In addition, compared with the city gas reformer and the hydrogen compressor (which are the main facilities of an HRS), some sound power levels of the refrigerator and cooling tower exhibit a high value. This is because rotating machines (for example, row material compressor and air blower of a city gas reformer) constituting the main facilities of HRS are installed inside the enclosure. By contrast, rotating machines (for example, brine pump and cooling water pump) constituting the refrigerator and the cooling tower of HRS are installed outside the enclosure.

Table 1. Sound power level of each facility

| Facility name | Sound power level [dB] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| City gas reformer | Wall ① | Wall② | Wall③ | Wall④ | roof | Ventilation fan | exhaust duct | Blower silencer |
| | 65.0 | 64.6 | 64.1 | 64.7 | 65.0 | 77.5 | 76.6 | 66.7 |
| Hydrogen compressor | Wall ① | Wall② | Wall③ | Wall④ | roof | intake duct | exhaust duct | - |
| | 62.6 | 64.0 | - | 62.6 | 60.6 | 63.9 | 76.4 | - |
| Refrigerator | Wall ① | Wall② | Wall③ | Wall④ | roof | intake duct | exhaust duct | brine pump |
| | 73.0 | 72.4 | 74.4 | 74.4 | 67.3 | 74.1 | 73.9 | 80.4 |
| Cooling tower | top fan | louver | cooling water pump | - | - | - | - | - |
| | 78.5 | 67.9 | 81.4 | - | - | - | - | - |
| instrumentation compressor | instrumentation compressor | - | - | - | - | - | - | - |
| | 69.2 | - | - | - | - | - | - | - |

b) Layout of the site to be constructed, and HRS facilities

Figure 2 shows the layout concept of the site to be constructed, and the HRS facilities. The area inside the blue frame indicates the construction site, the orange part indicates the HRS, the green part indicates the Compressed Natural Gas (hereinafter called CNG) stand, the purple part indicates the surrounding residence, and the red frame indicates a soundproof wall. Additionally, the yellow line indicates the site boundary line around the residence closest to the HRS (hereinafter noted as ‘around the site boundary of the eastern residence’). The HRS, CNG stand, gas holder, and institutions related our company are installed at this site. These facilities are obstacles to sound waves, so they are reflected in the simulation.

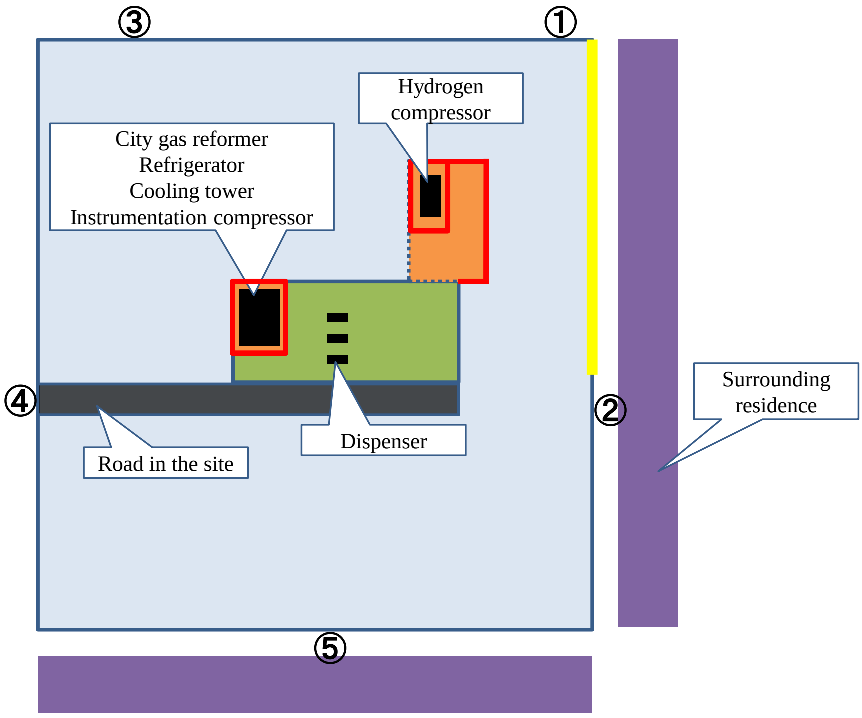


Figure 2. Layout concept of site to be constructed and HRS facilities

c) Sound pressure level data of background noise

Table 2 lists the noise measurement results at the site boundary. The measurements were conducted to obtain the sound pressure level date of the background noise. As the sound pressure level of background noise decreases, the impact of the target noise (the noise of the HRS) increases when synthesizing the noise. Therefore, the noise measurement was conducted at midnight, which is the quietest time in the area. The measurement points are indicated as ① to ⑤ in Figure 2. The noise values around the area of the residence at points ② and ⑤ were about 45 [dB]. The value of point ③ was large because of the noise from the arterial road located on the western side of the site.

Regarding point ④, since there is an obstacle (building) between the measurement point and the arterial road, it is considered that a value smaller than point ③ has been measured. Regarding point ①, insect noises were confirmed at the time of the noise measurement at point ①. Thus, it is considered that the sound pressure level exceeded 50 [dB]. In this paper, to calculate the impact of the noise on the residence adjacent to the HRS, a noise simulation was conducted by setting the background noise to 45 [dB] based on the measurement results at points ② and ⑤.

Table 2. Noise measurement results at site boundary [dB]

| Point | ① | ② | ③ | ④ | ⑤ |
|---|---|---|---|---|---|
| Sound pressure level [dB] | 51 | 44 | 60 | 48 | 45 |

### 4.1.2 Results of Noise Simulation

Table 3 lists the results of the noise simulation: the sound pressure levels from the HRS around the site boundary of the eastern residence before background noise synthesis is conducted. The higher the height from the ground, the higher the sound pressure level. It is considered that sound waves were blocked when the distance from the ground was shorter, depending on the soundproof walls. (The height around the city gas reformer and the hydrogen compressor was 3.8 m, and the height of the other soundproof walls surrounding the site of the HRS was 2 m). Table 4 lists the standards of noise. From Table 4, it was confirmed that the sound pressure level calculated by the simulation is at a noise level (about 40 to 50 [dB]) similar to that in a library or art museum. The regulation standard value of noise (sound pressure level at the site boundary) in this area is 65 [dB] in the morning and evening (6 PM to 8 PM and 7 PM to 10 PM), 70 [dB] during the daytime (8AM to 7 PM), and 60 [dB] at night (10 PM to 7 AM).

Table 3. Sound pressure levels from HRS around site boundary of eastern residence (before background noise synthesis)

| Height from the ground [m] | 1.5 | 4.5 | 7.5 |
|---|---|---|---|
| Sound pressure level [dB ] | 39.3 | 41.5 | 42.3 |

Table 4. Standards of noise [2]

| 30–40 dB | 40–50 dB | 50–60 dB | 60–70 dB | 70–80 dB |
|---|---|---|---|---|
| In a hotel, high -rise residential area (nighttime) | In a library or an art museum | Teller window of office or bank, in a museum | In a coffee shop or a bus | In a subway or aircraft |

Table 5 lists the results of the noise simulation: the sound pressure levels from the HRS around the site boundary of the eastern residence after background noise synthesis. The sound pressure level increased by about 5 [dB] compared with the sound pressure level before background noise synthesis. In addition, similar to the result before background noise synthesis, the greater the height from the ground, the higher the sound pressure level.

Table 5. Sound pressure levels from HRS around site boundary of eastern residence (after background noise synthesis)

| Height from the ground [m] | 1.5 | 4.5 | 7.5 |
|---|---|---|---|
| Sound pressure level [dB] | 46 | 46.6 | 46.9 |

We measured the sound pressure level around the site boundary of the eastern residence after construction. The results are listed in Table 6. Although the measured values and the simulation values after background noise synthesis correspond to each other at heights of 1.5 [m] and 4.5 [m], at a height of 7.5 m, the results were comparatively different. The actual background noise at a height of 7.5 [m] is considered to be higher than the sound pressure level by 45 [dB] owing to the influence of noise from the expressway on the second level of the arterial road located on the western side of the site.

Table 6. Measurement values of sound pressure level l from HRS around site boundary of eastern residence

| Height from the ground [m] | 1.5 | 4.5 | 7.5 |
|---|---|---|---|
| Sound pressure level [dB] | 45.2 | 46.5 | 50.2 |

As a result of the impact assessment on the surroundings of the HRS (accomplished by conducting a noise simulation and noise measurement), it was confirmed that the influence of the noise radiated from our HRS is not problematic to the surrounding residence. On the other hand, it became clear that the sound power level of the facility (the main noise source of the HRS) is as high as 60 to 80 [dB]. Therefore, in installing a facility which is a noise source at a location close to surrounding residences, it is essential to conduct an impact assessment by simulation, etc., and to implement noise countermeasures such as installation of soundproof walls, etc.

### 4.2 Impact Assessment of Exhaust Gas on the Surrounding Area of HRS

#### 4.2.1 Setting Condition of Exhaust Heat Simulation and $CO_2$-Level Simulation

A hydrogen manufacturing apparatus is installed in an on-site-type HRS. The hydrogen manufacturing apparatus we adopted is a city gas reformer which produces hydrogen by reacting city gas and steam. In the reforming step, the temperature of the reaction furnace increases to about 900 ºC, and exhaust gas of 200 ºC is discharged. Since there is a heating step to obtain a furnace temperature as described above, $CO_2$ on an order of percent is discharged as combustion exhaust gas. Using fluid analysis software, three-dimensional simulations of exhaust heat and $CO_2$ levels were conducted to quantify the influence of the exhaust gas on the surrounding residences.

The main input data for the simulations are flow rate, temperature, composition of exhaust gas, outside air temperature, outside air $CO_2$ level, wind speed, layout of the site, etc. The data for the flow rate, temperature, and composition of exhaust gas in the design values of the city gas reformer were used. The outside air temperature was set to 30 ºC, which is higher than the average temperature in summer (from June to August), taking into consideration the increase in discomfort owing to high air temperature. The air $CO_2$ level was set at 400 ppm from the observation results of the Meteorological Agency. Since the wind speed varies with time, four cases were assumed: 0 [m/s], 1 [m/s], 3 [m/s], and 5 [m/s]. Using these dates, the relationship between the distance from the facility and the temperature and $CO_2$ level of the exhaust gas was calculated.

#### 4.2.2 Results of Exhaust Heat Simulation and $CO_2$ Level Simulation

Figure 3 shows the results of the exhaust heat simulation. As the wind speed increases, the influence range of heat expanded horizontally and flowed to the residence side. By contrast, diffusion of the exhaust gas is promoted as the wind speed increases, and the influence decreases as the overall influence range widens. As a result, the influence of exhaust heat is largest when a wind of 3 [m/s] blows in the direction of the residence in the state with no obstacles such as soundproof or and barriers, or institutions related our company between the city gas reformer and residence. Even when the influence was at a maximum, the temperature increase around the residence was calculated to be about 0.2 ºC at the maximum. When obstacles were considered, it was calculated to be less than 0.1 ºC.

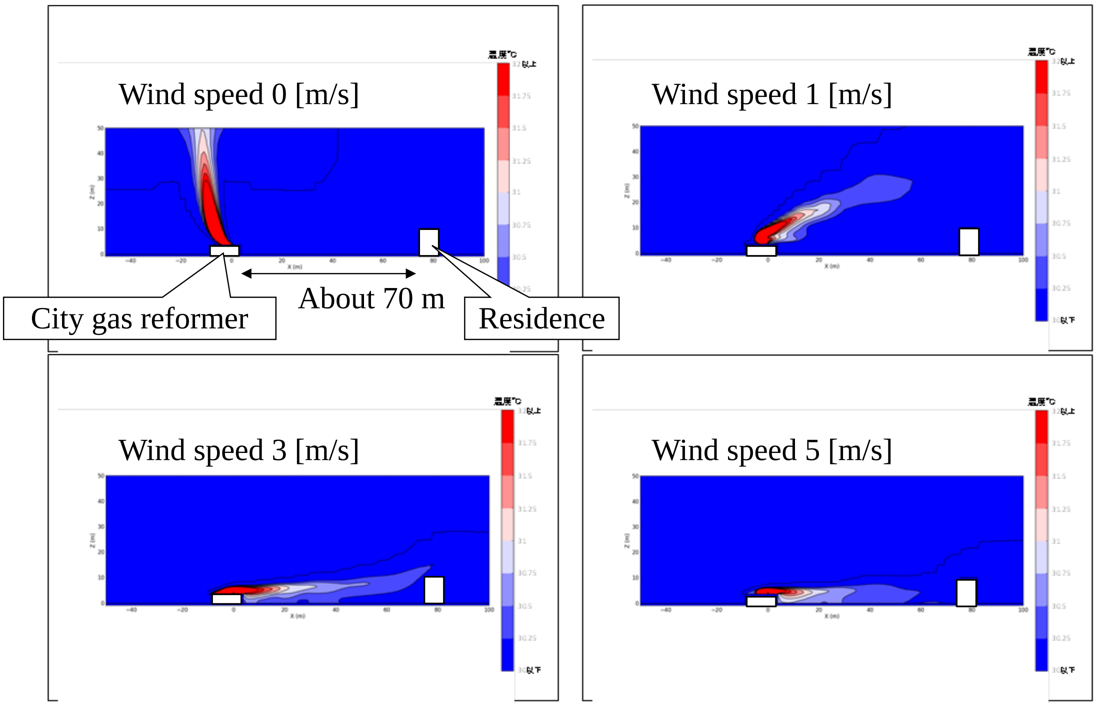


Figure 3. Results of exhaust heat simulation (temperature distribution chart of vertical surface)

Figure 4 shows the results of the $CO_2$-level simulation. As with the influence of temperature, as the wind speed increases, the influence range of the $CO_2$ level expands horizontally, and the influence becomes smaller as the overall influence range widens. As a result, as with the influence of temperature, the influence of the $CO_2$ level is largest when a wind of 3 [m/s] blows in the direction of the residence in the state without obstacles. Even when the influence is at a maximum, the $CO_2$ level around the residence was calculated to be about 500 ppm at maximum. When obstacles were considered, it was calculated to be 470 ppm at a height of 1.5 m, 430 ppm at a height of 4.5 m, and 440 ppm at a height of 7.5 m.

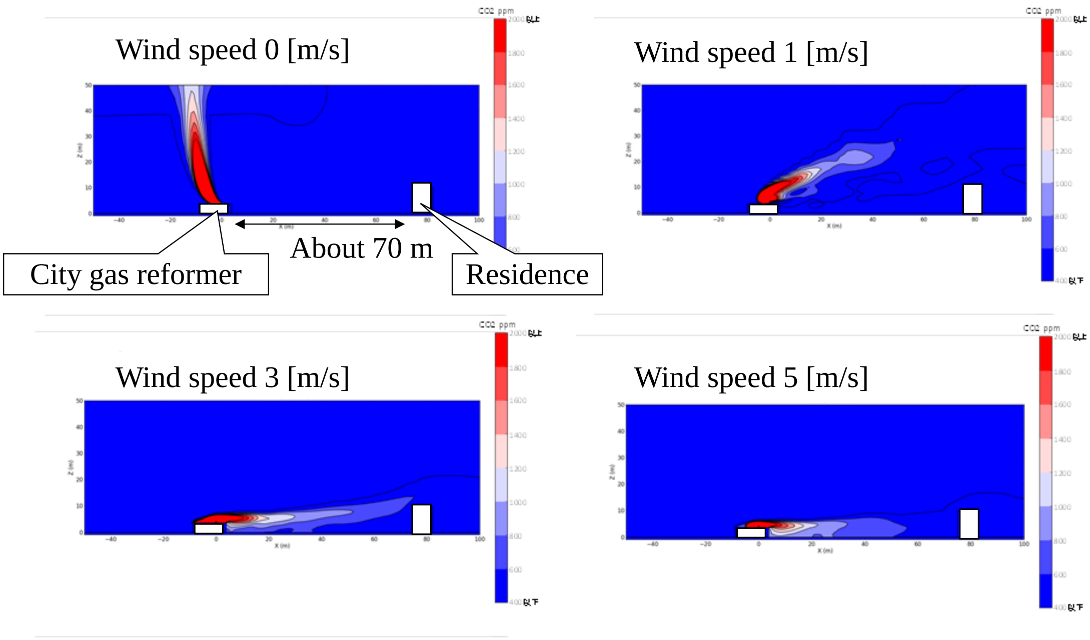

Figure 4. Results of $CO_2$-level simulation ($CO_2$ level distribution chart of vertical surface)

As a result of the impact assessment on the surroundings at HRS (accomplished by conducting an exhaust heat and $CO_2$-level simulation), it was confirmed that the influence of the exhaust heat and $CO_2$ emitted from our HRS is not problematic to the surrounding residence. Both the exhaust heat and $CO_2$ levels had specific wind speed values where the influence on the object was maximized. As the wind speed to the object increased, the influence range horizontally expanded, and although the influence range widened overall, the influence on the object became smaller.

## 5.0 EMERGENCY RESPONSE TRAINING

### 5.1 Significance of Emergency Response Training

In Japan, the safety of HRSs is guaranteed by observing the High Pressure Gas Safety Act and its Technical Standards, the Building Standards Act, the Fire Service Act, and other related regulations. On the other hand, if an accident such as a hydrogen leak or hydrogen fire occurs, it becomes important to prevent secondary disasters and minimize their influence on the surroundings by means of an initial response by operators. Therefore, we conducted training to improve the emergency response capability of HRS operators and to prevent secondary disasters. In this chapter, regarding emergency response training, we will describe the content of the training, and the problems and countermeasures clarified by the training.

### 5.2. Contents of Emergency Response Training

We conducted emergency response training based on an accident scenario at three HRSs operated by our company. The scenario is that a FCV collides with a dispenser, and a hydrogen fire occurs. The scenario is presented in Table 7.

As a training method, we prepared the FCV at the HRSs, set the role of the operators, the driver, and the firefighter, and conducted role play according to the scenario. Additionally, since the general HRS in Japan currently operates with two operators, they were responsible for response at the site in the scenario.

Thought the emergency response training was conducted for mainly HRS operators, manager of the operators who is not usually in HRS and operation consignor who is Tokyo Gas Co., Ltd. also participated. The training was conducted at three HRSs, and a total of seven operators were trained.

Table 7. Accident scenario

| Time | Event | Response at the site |
|---|---|---|
| 0 s | FCV collides with dispenser, Seismographer operation, Emergency shutoff valve closed | - |
| In 30 s | Hydrogen leakage occurs inside dispenser, Hydrogen level HH alarm activation | 【A】Evacuation guidance for FCV driver【B】Confirmation of hydrogen leakage in instrument panel room, notification to fire station |
| In 3 min | Hydrogen fire occurs inside dispenser | 【A】Confirmation of damage situation of facility, if possible fire situation, and preparation of fire extinguishers, etc.【B】Notification to fire station again |
| In 6 | Firefighter arrival, activate after | 【A】Guidance for fire truck, explanation of situation |

| | | |
|---|---|---|
| min | checking the situation | to firefighter 【B】 Report situation to relevant parties |
| In 9 min | Firefighter confirms fire suppression | 【A】 Confirmation of damage situation of facility 【B】 Confirmation of no hydrogen leakage, no residual pressure in system where fire occurred, report complete fire suppression and safety |

**5.3 Problems and Countermeasures Clarified from the Training**

By conducting the training, the problems that are not obvious from a desk review were clarified. In addition, it became possible to create more realistic emergency response rules. At the time of the disaster, judgment is expected to decrease owing to impatience and tension, so it is also important to repeat the training and establish an emergency response method. The problems and countermeasures clarified from the training are discussed below:

a) Regarding correspondence of hydrogen flame

Operators performed their work near the dispenser to confirm the condition of hydrogen leakage and hydrogen flame. Hydrogen flame is colourless and transparent, and it is difficult to check with the naked eye, so there is a danger that the operator may contact the flame without noticing it. In order to ensure safety, as correspondence of hydrogen flame, we set a standard to wait for the arrival of firefighters and to avoid approaching the flame.

b) Regarding hand valve operation at the time of emergency

It may be possible to reduce the amount of hydrogen leakage and the amount of hydrogen undergoing combustion during a fire by closing the hand valve in the vicinity of the part where accident occurred. However, owing to the following reasons, we set a standard to avoid operating the hand valve at the time of the emergency. First, at the HRS in Japan, the emergency shutoff valves automatically operate at the time of an emergency to block the hydrogen leakage part and other parts. Second, approaching the facility to close the hand valve in the vicinity of where the accident occurred is likely to hurt the operator. For example, as described in a) above, the hydrogen flame is colourless and transparent, so there is a danger that the operator contacts the flame without noticing it.

Third, there is a danger of blocking the flow path to the safety valve by mistake. Figure 5 shows a schematic piping diagram around the accumulator in the HRS. For example, when hydrogen leaks from the joint of V1 and a fire occurs, closing the hand valve of V2 prevents hydrogen from entering the accumulator. However, if the valve of V3 is erroneously closed, the flow path to the safety valve is shut off. In this case, since hydrogen is not discharged from the safety valve, the fire continues for a long time. When the temperature of the accumulator increases owing to the flame, it creates a dangerous situation because there is a possibility of exceeding the permissible temperature and pressure of the accumulator.

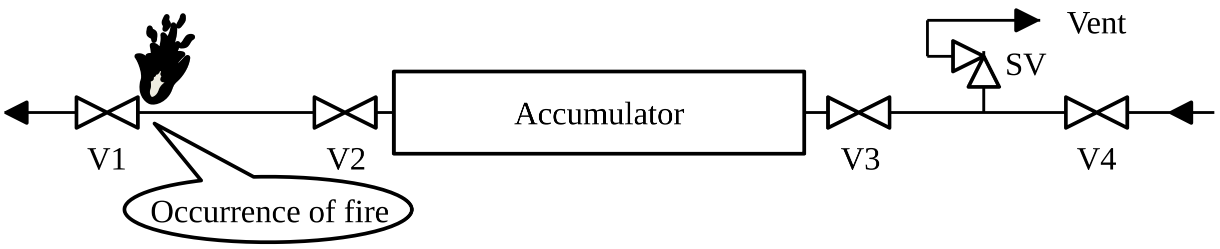

Figure 5. Schematic piping diagram around accumulator

c) Regarding correspondence for HRS and CNG stand at the same site

Regarding our three HRSs, two are installed with a CNG stand. However, the operators of the HRS and the operators of the CNG stand are from separate organizations, and the standard of the method of cooperation between the HRS operators and the CNG stand operator was not established in the training. Thus, as correspondence for HRS and CNG stand at the same site, we set a standard for cooperative timing and cooperative contents with the CNG stand. These include sharing the occurrences of accidents with the CNG stand operators, and restricting the entry of CNG vehicles at the time of the initial notification to the fire station.

## 6.0 CONCLUSION

In this paper, after reviewing the fundamental concept of safety at HRS in japan, we described examples of impact assessments on the surrounding area of HRS, and emergency response training.

As a result of the impact assessment on the surroundings at HRS by conducting a simulation and measurement, it was confirmed that the influence of the noise and exhaust gas emitted from our HRS is not problematic to the surrounding residence. In addition, by conducting emergency response training, the problems that are not obvious from a desk review were clarified. By setting standards for countermeasures against these problems, we were able to contribute to the prevention of secondary disasters.

Through the impact assessment and safety promotion activities such as emergency response training of HRS, we want to contribute to the realization of a safe and secure hydrogen society.

## REFERENCES


1. Atushi Shigemori, Fire safety measures at Hydrogen Refuelling Station, *Journal of Japan Association for Fire Science and Engineering*, 66, No. 3, 2016, pp. 18–23.
2. National noise subcommittee of environmental council, Standard of noise, http://www.env.go.jp/air/ippan/meyasu.pdf. Accessed on March 15, 2017.