

# Health, Safety and Environment Guidelines for Geothermal Well Drilling

March 2021

Japan Oil, Gas and Metals National Corporation

# Recommendation

Based on the Strategic Energy Plan, the Ministry of Economy, Trade and Industry (METI) has set out the Long-term Energy Supply and Demand Outlook, which is the outlook for composition of power supply in Japan for fiscal year 2030. Renewable energy and geothermal power generation are expected to account for 22-24% and about 1.0-1.1% (equivalent to 1.4-1.55 million kW of power generation capacity) respectively.

In October 2020, Prime Minister Suga announced that the Japanese government would aim to realize a carbon neutral and decarbonization society by 2050, by measures such as maximizing the introduction of renewable energy. As geothermal power generation is a renewable energy and is a base-loaded power source that can generate electricity stably without being affected by natural conditions such as weather, its role has been greater than ever.

Under these conditions, it is especially important to preserve the surrounding environment in drilling of a geothermal well. In particular, the aging of workers and the increase in number of engineers from outside of Japan have made ensuring safety in drilling a more important issue in recent years.

With the aim of contributing to the prevention of occupational accidents and pollution in geothermal well drilling, the Japan Oil, Gas and Metals National Corporation (JOGMEC) has established a Safety Guideline Review Committee composed of experts with the cooperation of the geothermal development industry. At the committee meeting, matters that geothermal-related businesses voluntarily comply with were deliberated, and safety guideline for geothermal well drilling was established.

We would like to express my deep respect for the enthusiasm of the geothermal development industry and the dedication of Chairman Dr. NAGANAWA Shigemi and each committee member deliberated.

We expect that planning and construction of geothermal power generation will be comply with this safety guideline and the participants will make every effort to ensure safety and preserve the environment.

March 2021

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# Preface

According to the recent promotion of geothermal development accompanied by aging of the workers and the increase in foreign engineers, insufficient safety measures have become a serious problem in Japan. The word "Ho-an" or "保安" an abbreviated phrase of "maintaining safety" expresses the concept of health, safety and environment, and the safety measures for mining and petroleum industries are described in the Mining Safety Act. However, no Japanese laws covers safety measures in geothermal well drilling.

This guideline provides the standards of Japanese geothermal industry necessary to ensure safe operations at the site of geothermal well drilling. This guideline revises the Standard for Safe Geothermal Well Drilling first published in 1986, and was revised several times until 2003. Many useful regulations in the Mining Safety Act were cited in the standard while it is not regally applied to geothermal industry.

This new guideline reflects all the recent changes of the Mining Safety Act and the recent development in drilling technologies. We believe that this English version of new guideline is useful for foreign engineers working in Japanese geothermal industry to improve the level of health, safety and environment.

March 2021

NAGANAWA Shigemi

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JGA: Japan Geothermal Association

JTAD: Japan Technical Association of Drilling

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# Health, Safety and Environment Guidelines for Geothermal Well Drilling

## Chapter 1 General provisions

### Section 1: General rules

#### 1. (Purpose)

This document, “Health, Safety and Environment Guidelines for Geothermal Well Drilling” (hereinafter referred to as “Guideline”) aims to ensure “Hoan” when a company who explores and develops geothermal resources, conducts geothermal well drilling and related surveys.

#### 2. (Definition of terms)

The definitions of the main terms used in this Guideline are defined as follows.

- (1) “Hoan” is synonymous with “safety and health”, and it is defined as, an action during the drilling of the geothermal wells and exploring steam, hot water, and others, which aims for; prevention of the personal injury in the work site, maintenance of drilling equipment and facilities, and the environment protection.
- (2) “Geothermal resource” is defined as, the heat existing underground as a heat energy source, or steam or hot water that sprung out from underground.
- (3) The “Operator” is defined as, those that directly conducts geothermal exploration and development, etc., or those who are entrusted to actually perform these tasks (generally, a contractor).
- (4) “Geothermal well” is a general term for production wells of geothermal resources, injection wells of hot water, exploration wells for geothermal resource development, and related workover wells, suspended wells, or wells which are planned to be abandoned. Small diameter wells that are used for geophysical survey are excluded.
- (5) “Blowout preventer” is defined as wellhead equipment necessary to prevent the blowout of steam, hot water, gas, etc. during drilling or workover operations of a geothermal well.
- (6) “Wellhead equipment” is defined as equipment at the wellhead necessary for conducting a steam and hydrothermal flow test, and other surveys in a geothermal well.
- (7) “Surface installation” is defined as a major facilities such as drilling rig, wellhead, separators, and silencers.
- (8) “Other workpieces” is defined as a workpieces which are necessary for drilling and related activities, such as fuel tanks, electrical facilities, water supply facilities, environmental conservation facilities and others.

#### 3. (The scope of the Guideline)

The scope of the Guideline is for the activities related to the drilling, workover, flow test, abandonment, etc. of geothermal wells, assembling, operating, and demobilization of the equipment and devices listed in the following items.

- (1) Drilling equipment
- (2) Blowout preventer
- (3) Wellhead equipment

- (4) Mud treatment equipment
- (5) Cementing equipment
- (6) Compressor and the auxiliary equipment for air drilling/aerated mud drilling
- (7) Water injection equipment
- (8) Well test equipment
- (9) Other workpieces

## Section 2: Safety and health management system

This Guideline describes the necessary safety and health management system stipulated by laws and regulations with a reference to the provisions of the Industrial Safety and Health Act, etc. Article 1 summarizes the requirements regarding the work site with regular workers of less than 50, classified as small-scale, and Article 2 summarizes the requirements regarding the work site with workers of 50 or more, which is classified as large-scale. Regarding the more common practice of geothermal well drilling, which is a small-scale with approx. 20 workers, the requirements shall be referred to Article 1.

### 1. (Safety and health management system for small-scale work site)

#### 1.1 Appointment of a safety and health promotor

The operator shall appoint a safety and health promotor, who is recognized as having sufficient knowledge, from the operator's organization, and have that person manage the matters listed in the following items at the work site of the scale\* specified by the Cabinet Order.

- (1) Inspection of facilities, equipment, etc. (including safety devices, occupational health-related equipment, personal protective equipment, etc.), assessment of the equipment usage and conditions, and necessary measures based on these results
- (2) Inspection of work environment (including the measurement of work environment), inspection of work method, and necessary measures based on these results
- (3) Appointment of an inspector as the person in charge of the inspections in (1) and (2) to enhance the inspection
- (4) Health examination and maintenance, as well as the promotion of worker's health
- (5) Environmental protection
- (6) Safety and health education
- (7) Emergency response
- (8) Investigation of cause of occupational accidents and its recurrence prevention measures
- (9) Collection of safety and health information, as well as the preparation of statistics on occupational accidents, illnesses, absence from work, etc.
- (10) Reports, notifications, etc. related to safety and health, to the related administrative agencies

\*Work site constantly using 10 or more and less than 50 workers.

#### 1.2 Collection of the opinions from the involved workers

Even when the work site where the establishment of a safety committee is not required, an opportunity to

receive the opinions from the involved workers regarding the safety or health matters shall be provided.

### 1.3 Prevention of the occupational accidents in multi works at same site

The operator shall take necessary measures to prevent occupational accidents resulting from the work of their employees and related contractors being carried out in the same place.

### 1.4 Appointment of the person equivalent to the Overall Safety and Health Controller

The operator shall appoint a person equivalent to the Overall Safety and Health Controller\* to enhance the overall safety and health management.

\* Persons who shall be appointed in a work site, which employs 50 or more workers constantly in one place, which also has a contractor undertaking part of the work. The appointed person shall supervise the implementation of the actual work.

(1) The principal operator shall appoint the person equivalent to the Overall Safety and Health Controller, as well as the person equivalent to the Principal Safety and Health Supervisor, or a person equivalent to a Site Safety and Health Supervisor\*, at each construction site.

\* Who is based on head offices, branches, sales offices, etc. that is responsible for management over the involved site(s)

(2) When the principal operator appoints a person equivalent to the Overall Safety and Health Controller, and the person equivalent to the Principal Safety and Health Supervisor, the involved contractor shall appoint the person equivalent to the Safety and Health Controller.

(3) For the appointment of the person equivalent to the Overall Safety and Health Controller, the person who supervises the operation at the place concerned shall be selected. A person equivalent to the Overall Safety and Health Controller shall supervise and manage necessary measures to prevent occupational accidents during the multi works at same site.

### 1.5 Enhancement of the overall safety and health management

(1) The principal operator shall ensure the implementation of the necessary actions to prevent occupational accidents caused by multi works at same site, and enhance the overall safety and health management at the work site.

(2) The involved contractor shall ensure that their measures are appropriately implemented, as well as implement the necessary measures according to the measures taken by the principal operator.

### 1.6 Enhancing guidance and support for the work sites by the office

Head offices, branches, sales offices, etc. which manages the involved work site shall enhance the guidance and the support for the work site.

### 1.7 Construction work that require a license, qualification, training, etc.

The items listed in (1) to (12) below shall be carried out by qualified personnel according to the Industrial

Safety and Health Act. The items listed in (13) and (14) regards to the regulations concerning electricity business or construction, the item in (15) to the Explosives Control Act, and item in (16) to the High Pressure Gas Safety Act, respectively.

(1) Supervision of steel frame assembly, etc.

Direction of the work of assembling, disassembling or changing the steel frame of a building or a tower (with a height of 5 m or more) shall be carried out by a qualified person, who has completed the steel frame assembly operation chief's skill training course.

(2) Slinging work (1t or more)

Slinging of a mobile crane with a hoisting capacity of 1t or more, shall be carried out by a qualified person who has completed the slinging skill training course.

(3) Gas welding work

Acetylene welding work shall be carried out by a person who is licensed as a gas welding operation chief, or a qualified person who has completed a gas welding skill training course.

(4) Operation of mobile crane (5t or more)

Operating a mobile crane with a hoisting capacity of 5t or more, shall be carried out by a person who is licensed as a mobile crane operator.

(5) Operation of small mobile crane (1t to less than 5t)

Operation of small mobile crane (1t to less than 5t) shall be carried out by a qualified person who completed the relevant skill training course.

(6) Operation of a boring machine

Operation of a boring machine shall be carried out by a qualified person who has completed special safety and health education.

(7) Operation of a winch or hoist

Operation of a winch or hoist shall be carried out by a qualified person who has completed special safety and health education.

(8) Operation of aerial work platforms (work floor of 10m height or more)

Operation of aerial work platforms (work floor of 10m height or more) shall be performed by a qualified person who completed the skill training course.

(9) Driving a forklift (1t or more)

Driving a forklift (1t or more) shall be performed by a qualified person who completed the skill training course.

(10) Handling of ordinary class-1 pressure vessel

Handling of ordinary class-1 pressure vessel shall be performed by a qualified person, who has completed the skill training course for the ordinary class-1 pressure vessel handling operation chief.

(11) Work at heights (work performed using a full-body harness and relevant equipment for fall prevention device, at the places with a height of 2m or more, where it is difficult to provide a work floor surface)

Work at heights shall be performed by a qualified person who has completed special safety and health education.

(12) Operations carried out at places with an oxygen deficiency hazard and harmful gases

Operations shall be performed by a qualified person, who has completed the skill training course for operations chief of hazardous work of oxygen deficiency and hydrogen sulfide.

(13) The installation of electric facilities for private use

The installation of private electric facilities shall be performed by a chief electrical engineer.

(14) Electric work

(a) A class-1 electrician shall perform work on the electric facilities for private use (power plants, substations, electrical work related to demand facility with a maximum power generation of 500 kW or more (excluding special electrical work)).

(b) A class-1 or class-2 electrician shall perform electrical work related to electric facilities for general use.

(c) A person who has been certified special electrical work qualification, shall perform on the electrical work related to special electric facilities.

(d) Simple electrical work may be performed by a person who has been certified as an electrician.

(15) Work handling explosive substances

Explosive substances shall be handled by a person who are qualified for explosives handling and safety engineer's license, which is specified by the Explosives Control Act, or a person who has a license as a rupture engineer, which is specified by the Industrial Safety and Health Act, or a person who has passed the national examination, which is specified by the Mine Safety Act.

(16) Operation of a mobile compressor (air pressure in an air compressor exceeding 5MPa at a temperature of 35°C)

Operation shall be performed by a qualified person, which is specified by the High Pressure Gas Safety Act, or equivalent.

## 2. (Safety and health management system in a large-scale work site)

The safety and health management system of large-scale work sites, that constantly employs 50 or more workers, is stipulated in the Industrial Safety and Health Act as the following, which differs from the case of small-scale geothermal well drilling work sites mentioned above in Article 1 of this guideline.

(1) Appointment of a General Safety and Health Manager

(2) Appointment of a Safety Officer

(3) Appointment of a Health Officer

(4) Occupational physician

(5) Operation chief

(6) Overall Safety and Health Controller

(7) Principal Safety and Health Supervisor

(8) Site Safety and Health Supervisor

(9) Safety and Health Controller

(10) Safety Committee

(11) Health Committee

(12) Safety and Health Committee

The outline of an Overall Safety and Health Controller, Principal Safety and Health Supervisor, Safety and Health Controller cited above is described below.

•Overall Safety and Health Controller

The operator, in the case of a work site of the scale specified by the Cabinet Order, when a part of the work is contracted to a contractor in one place, shall appoint an Overall Safety and Health Controller, who supervises the implementation of the operation.

•Principal Safety and Health Supervisor

The operator who has appointed an Overall Safety and Health Controller, shall also appoint a Principal Safety and Health Supervisor from among those that have the qualifications specified by the Ordinance of the Ministry of Health, Labor and Welfare. The operator shall have the appointed person take charge of managing the technical matters, among the necessary measures to prevent occupational accidents, such as the establishment and operation of the consultation organization.

•Safety and Health Controller

Apart from the operator who should appoint an Overall Safety and Health Controller, a contractor, who oneself performs the work involved, shall appoint a Safety and Health Controller, who shall be assigned with the tasks specified by the Ordinance of the Ministry of Health, Labor and Welfare, including the communication with the Overall Safety and Health Controller.

Section 3: Notification and approval of license

1. (Notification)

- (1) The operator shall submit a notification to the Chief of Labor Standards Inspection Office of the jurisdiction when installing, relocating, or changing the main structural parts of a derrick taller than 31m or the machinery, buildings, and attached accommodations of the work site, etc., that are stipulated in the Labor Standards Act or the Industrial Safety and Health Act
- (2) The operator shall notify and consult with the prefectural governor of the jurisdiction when using a mobile compressor in which the gauge pressure of air exceeds 5MPa at a temperature of 35°C.
- (3) The operator shall submit a notification of appointment of a Chief Electricity Engineer and its safety regulations to the Minister of Economy, Trade and Industry when installing a mobile generation facility for private use with an output of less than 1,000kW, based on the Electricity Business Act.
- (4) The operator shall notify the Minister of Economy, Trade and Industry of the appointment of a Chief Electricity Engineer, its safety regulations, and the construction plan when installing a mobile generation facility for private use with an output of 1,000kW or more, based on the Electricity Business Act. In addition, the construction shall not be started until 30 days from the date of the acceptance of the construction plan.
- (5) The operator shall submit a notification of appointment of Chief Electricity Engineer and its safety regulations to the Minister of Economy, Trade and Industry when installing a demand facility for private use with a receiving voltage of less than 10,000V and a maximum power of less than 500kW, based on the Electricity

Business Act.

When installing a demand facility for private use with a maximum power of 500kW or more, or a receiving voltage of 10,000V or more, it is necessary to submit a construction plan in addition to the notification cited above, and the construction shall not be started until 30 days from the date of the acceptance of the construction plan.

2. (Inspections, etc.)

The containers, such as separators, that are regulated by relevant laws and regulations are subject to application or notification to the relevant administrative director of the jurisdiction and to the stipulated inspection.

3. (License and approvals)

- (1) The operator must be approved by the prefectural governor of the jurisdiction when using explosives, based on the Explosives Control Act.
- (2) The operator shall comply with the facility standards stipulated in the Fire Service Act and must be approved by the chief of the fire department of the jurisdiction when installing a fuel tank.

#### Section 4: First-aid in accident

1. (Obligation of notification)

The operator shall always have clean first-aid tools and necessary medicines ready and notify workers how to use them and first-aid procedure.

2. (First-aid)

When a serious injury occurs, the operator shall immediately contact a doctor and take first-aid for relief.

3. (Report of accident)

In the event of a disaster corresponding to any of the following provisions, the operator shall submit a report to the Chief of the Labor Standards Inspection Office of the jurisdiction as well as the director of the relevant administrative department of the jurisdiction.

- (1) A gas explosion, fire, accident caused by burst of pressure containers, crane accident, loss of explosives, theft or other accident
- (2) An accident caused by blowout of steam, hot water, etc.
- (3) A collapse of a building, etc.
- (4) A worker dies or is absent from work for 4 days or more (if it is less than 4 days, the case is required to be included in a quarterly report) due to injury, suffocation, acute poisoning, etc. while working in the work site or in an attached building.

4. (Development of sketch, etc.)

In the report of an accident described in the Paragraph 3 above, a sketch of the accident location shall be developed

and the condition of the site at the time of disaster shall be conserved if necessary.

5. (Investigation of cause of accident and prevention of accident)

When an accident occurs, the operator shall investigate the cause, take countermeasures, and make the best efforts to prevent similar accidents.

**Section 5: Safety education, clothing and discipline, safety promotion activities**

1. (Safety education)

The operator shall provide education for safety or health on the following matters to the newly assigned foreman and other persons who directly instruct or supervise the workers in work (excluding the work chief) according to the Ordinance of the Ministry of Health, Labor and Welfare.

- (1) Decision of work procedure and placement of workers
- (2) Method of guidance or supervision to workers

In addition, the operator shall constantly make every effort to raise consciousness of the workers for accident prevention and environmental conservation and provide safety education for the workers engaged in the work corresponding to any of the following provisions.

- (1) Operation of well drilling machine
- (2) Arc welding work
- (3) Slings work for mobile cranes with a hoisting capacity of less than 1t
- (4) Operation of a forklift (less than 1t)

2. (Clothing and discipline of workers)

When drilling or performing other work, the operator shall establish standards for wearing protective caps, safety shoes, work clothes, etc., and establish discipline to be complied in the work site to ensure work safety.

3. (Safety promotion activity)

The following activities are generally carried out as safety promotion activities at work sites.

(1) Accident case study

Accident case study is a method of systematically grasping the facts and background of actual cases of occupational accidents and other accidents and establishing effective accident prevention measures.

(2) Voluntary safety training

This is a voluntary training to be conducted to confirm the operating status and operation method of the equipment used in the geothermal well drilling, and to confirm the method of wearing protective equipment.

(3) Pre-start / pre-end meetings

An on-site manager such as a safety and health promoter shall hold a meeting to give daily work safety instructions to every person before the start of work. Also, before the end of work, a meeting shall be held to report the accidents occurred in the work on the day and to confirm the work contents on the next day. The

meeting generally includes the contents of (4) to (6) below.

(4) Near-miss accident report and investigation

Near-miss accident report and investigation is an activity which recognizes and shares the cases that did not lead to an accident but was on the verge of a serious accident, aimed at preventing occupational accidents and recurrence.

(5) KY activity (Hazard identification activity)

Before the start of work, all workers discuss the work content and procedure of the day, the role division, etc., to predict the possible hazard in the work, and implement countermeasures. KY is an acronym for “Kiken Yochi” or hazard prediction.

(6) Health management

It includes the check of the health condition before work (including measures against infectious diseases) and check of work breaks and water supply during work to prevent heat stroke.

(7) Education for new workers

Education will be provided for new workers on the site about the conditions of the site, work outline, dangerous places, rules at the work site, etc.

It shall be noted that the safety and health education for workers from outside of Japan, which have been increasing in recent years, requires appropriate consideration so that the work procedures and safety rules are thoroughly understood.

## Chapter 2 Ensuring safety

### Section 1: Spindle type drilling machines

#### 1. (Preparation)

##### 1.1 Mobilization/Transportation

- (1) Remove all fuel.
- (2) Attach packing to inlets for lubricant and oil.
- (3) Fix hydraulic cylinders.
- (4) Sling gears (Hanging tools) used shall be able to withstand the load.
- (5) Fix the machines firmly.
- (6) A power supply system/motor shall be stopped.

##### 1.2 Installation

- (1) Machines shall be installed horizontally and rigidly fixed.
- (2) Bolts and joints shall be retightened.
- (3) Guide pulleys shall be installed perpendicular to or facing the shaft of hoist drums.
- (4) The distance between shafts of hoist drums and guide pulleys shall be at least 15 times the width of the drums.
- (5) A safety cover and a fence shall be attached to the rotating parts.

##### 1.3 Before starting operation

- (1) Machines shall be inspected for deformation and damage.
- (2) Wire ropes (drilling lines) shall be inspected for wear.
- (3) Inadequate wire ropes (drilling lines) shall not be used.
- (4) The safety factor of the wire ropes (drilling lines) shall be 3 or more.
- (5) The number of the dead wrap of wire ropes (drilling lines) shall be 2 or more. When possible, more than 6 dead wraps are recommended.
- (6) Deformation and wear of hoist bands and brake bands shall be checked.
- (7) Belt wear shall be checked.
- (8) The type and amount of lubricant and oil shall be checked.

<<In the case of using a motor for a power supply system>>

- (1) It shall be checked whether there is any abnormality in the switch on switchboard.
- (2) The earth cables shall be connected.
- (3) The capacity of the power cable and the damage shall be checked.
- (4) Earth leakage breaker shall be tested at least once a month.
- (5) Be careful to prevent electric shock from the switchboard.
- (6) The generator shall have the capacity to supply the required power.

<<In the case of using an engine for a power system>>

- (1) The engine shall be used after reading and understanding thoroughly its instruction manual.
- (2) Inspection and maintenance should be performed according to the manufacturer's instruction manual.
- (3) It should be confirmed that ventilation is ensured.

#### 1.4 Trial run/ function test

- (1) A power supply system shall be started carefully.
- (2) The operating condition of each equipment shall be checked.
- (3) It shall be checked whether there are any damages or oil leaks in hydraulic equipment and hoses.
- (4) Major measurement gauges shall be inspected.
- (5) Feeding pressure and balancing force shall be confirmed.

### 2. (Operation)

#### 2.1 Operation

- (1) A trial run/ function test shall be conducted before an operation.
- (2) A water swivel hose shall be fixed to a derrick/mast.
- (3) The screws connecting to the water swivel and a rod shall be tightened firmly.
- (4) Operation of a manual chuck shall be conducted with caution.
- (5) A rod shall be securely held when it is made up or broke out.
- (6) The hoist shall not be overloaded with its capacity.
- (7) Any loads shall not be applied when wire ropes (drilling line) are wound irregularly.
- (8) A machine operator shall stay at the operating position during the operation.
- (9) Prohibit to leave from hoist under load on its hoist.
- (10) A signal shall be given before a slide base acts.

#### 2.2 Safety operation of wire-line coring

- (1) Running in the overshots
- (2) Pulling out of inner tubes
- (3) Retrieving a core sample
- (4) Running in the inner tubes

### 3. (Maintenance after operation)

- (1) Maintenance shall be performed by observing actual operating condition of a machine.
- (2) Maintenance shall be performed after a power supply system has been completely stopped.
- (3) Maintenance shall be performed after each part of a machine has been cooled down
- (4) Maintenance shall be performed after releasing the internal pressure of the hydraulic system.
- (5) Use genuine parts as replacement parts.
- (6) After the maintenance, make sure that there are no abnormalities in a test run

## Section 2: Derrick

### 1. (Substructure of derrick)

- (1) The substructure of the derrick shall be designed to have the bearing capacity to support the maximum total load and to prevent collapse of the derrick due to wind pressure.
- (2) The maximum total load in (1) is the sum of the maximum static load, acceleration load, friction load in the hole, under the expected wind pressure of 30m/s on all exposed surfaces of the derrick including siding, legs, plows, braces, and drill pipes placed on them.
- (3) The safety factor for the legs of iron derrick shall be more than 2.7 for the maximum static load.
- (4) The maximum static load shall be the sum of weight of the derrick itself and the hoisting load of the drilling system.

### 2. (Guy lines)

The installation of guy lines to the derrick shall be conducted according to the followings.

- (1) Use wire ropes and buried blocks that are strong enough to withstand wind pressure and vibration or that have equivalent strength.
- (2) Keep lines tensioned by using turnbuckles etc.
- (3) Unless under special circumstances, the inclination shall be 45 degrees or less, and shall be installed diagonally on the derrick's leg.
- (4) The number of guy lines shall follow the description below.

Number of legs	Derrick height is over 22m	Derrick height is 22m or less
4	8 or more	4 or more
3 or less	6 or more	3 or more

### 3. (Passage)

- (1) When the height of rig floor is 0.5m or more above the ground surface, a passage connecting to the ground surface shall be installed.
- (2) The inclination of the passage of (1) shall be less than 30 degrees. In addition, a handrail with a height of 85 cm or more and a middle rail with a height of 35cm to 50cm shall be installed.

### 4. (Water table (Crown))

- (1) In principle, a safe platform surrounded by handrails shall be provided at the top of the derrick.
- (2) A grounding wire with a lightning protection effect shall be installed in the derrick, as necessary.

### 5. (Fixed ladder)

The installation of fixed ladder to the derrick shall be conducted according to the followings.

- (1) Treads shall be made of sturdy materials and be placed in equal intervals.
- (2) Appropriate equipment and safety measures shall be provided in order to ensure safe going up/down; for

example, the upper end of the ladder shall extend beyond the top edge of the surface by 0.6m or more.

(3) Ladder shall not be tilted backwards from the vertical position.

(4) Ladder shall be kept away from the derrick by at least 0.1m or more distance.

(5) Safety equipment shall be provided in order to prevent falls during the going up/down of the derrick.

#### 6. (Fall prevention device, safe descending device)

A fall prevention device, such as full-body harness, shall be used when working at a place with a height of 2m or more without a working platform, or when working at a place where installation of fences, handrails, etc. is difficult on the edges or openings of the work platform. However, when there is a risk that a worker with a full-body harness type device may fall onto the ground (from the height 6.75m or less), a torso belt type (single suspension) fall prevention device may be used.

#### 7. (Crown sheave, head pulley)

The crown block of the derrick shall be equipped with safety equipment to prevent the wire rope (drilling line) jumping out from the crown sheave.

#### 8. (Overwind prevention device)

Appropriate safety measures shall be taken to prevent overwinding of the drilling system.

#### 9. (Inspection)

Before start drilling and other work, each part of the derrick such as the mounting status of the bolts and other parts, the degree of abrasion of the guy line, and other shall be inspected for abnormalities.

### Section 3: Wire rope (drilling line) and cat line

#### 1. (Requirements)

The wire rope (drilling line) shall meet the followings.

(1) Use plated products or apply oil to the wire ropes in order to prevent rusting.

(2) When connecting the rope, shall follow the instructions below

(a) For rope with a diameter of 15mm to 22mm shall be overwrapped for 5m or more.

(b) For rope with a diameter of over 22mm and below 32mm shall be overwrapped for 6m or more.

(c) For rope with a diameter of 32mm or more shall be overwrapped for 7.5m or more.

(3) Use clips or babbitt stop when clipping the end of the rope.

(4) Do not use a wire rope with broken/loosened strands, reduced elasticity, and/or significant corrosion.

## 2. (Safety factor)

The safety factor of hoisting ropes (wire ropes, drilling lines) used for drilling equipment shall be 3 or more with respect to the maximum load on the fast line. The safety factor may be reduced if specific safety measures are taken.

The safety factor is calculated based on the following formula.

$$Sf = Sr / W \times A$$

$$W = W_0 \times 1 / (n \times \eta)$$

$$W_0 = (W_1 + W_2 \times \alpha) \times g$$

$$\eta = 1 / n \times (\epsilon^n - 1) / \epsilon^s \cdot (\epsilon - 1)$$

$$\alpha = 1 - X / Y$$

Sf : Safety factor of the hoisting rope

A : Rope bending efficiency, set to 0.96

Sr : Guaranteed breaking load provided by rope manufacturer (kN)

W : Maximum value of load on fast line (kN)

W<sub>1</sub> : Weight of hoisting rope and hoisting equipment (t)

W<sub>2</sub> : In air weight of casing or strings (t)

n : Number of hoisting ropes hanging on the traveling block

$\eta$  : Sheave efficiency

$\epsilon$  : Sheave friction coefficient

s : Number of rotating sheaves

$\alpha$  : Coefficient of buoyancy of mud

X : Specific gravity of mud

Y : Specific gravity of steel

G : Constant (9.8 m/s<sup>2</sup>)

## 3. (Management for drilling line)

Drilling Line shall be managed by the amount of work done to determine the timing for replacement or cutting off.

## 4. (Cat line)

The use of the cat line shall be conducted according to the followings.

- (1) Do not use a cathead that has grooves due to abrasion.
- (2) Do not use fatigued or spliced cat lines.
- (3) Cat line guide shall be attached.
- (4) Do not pull suddenly while applying a heavy load, such as handling of the casing string.

## 5. (Inspection)

Prior to commencing the work, inspector shall inspect the abnormalities such as abrasion and corrosion for, the hoisting wire rope (drilling line), cat line, neckline and the eyes of the rope.

#### Section 4: Hoisting equipment (Drawworks) and the accessories, mud pump etc.

##### 1. (Hoisting equipment (Drawworks) brake)

The brake of the hoisting equipment (Drawworks) shall be able to stop the operation reliably and hold.

##### 2. (Emergency circuit breaker)

If possible, the emergency circuit breaker shall be installed near the operator (driller) who is in charge of the operation of the hoisting equipment.

##### 3. (Weight indicator, etc.)

(1) When using a rotary drilling equipment, weight indicator shall be installed and performed timely calibration.

(2) When using a spindle type drilling machine, a device that can monitor the bit load etc. shall be installed.

##### 4. (Rotary hose (delivery hose))

The followings shall apply to the hoses used for drilling.

(1) The hose shall be resistant to the maximum working pressure of the mud circulation.

(2) Both ends of the hose shall be connected with chains or wires to the gooseneck or swivel bail and standpipe vent.

##### 5. (Pipe tongs)

The followings shall be applied for the pipe tongs.

(1) Attach the guyed cable to the legs of the derrick.

(2) The balance weight of the pipe tongs shall be installed at the position not disturbing the work and shall be protected by appropriate protective equipment such as a guide protector.

(3) Inspect the slips before use and avoid using worn-out die.

##### 6. (Traveling blocks (running blocks), hook)

(1) The traveling block or hook block shall be equipped with metal covering with a hole for passing the wire rope for safety.

(2) The hook shall be equipped with a safety locking device to prevent the pipe elevator link or swivel bail from detaching.

(3) When using a rotary drilling equipment, Ministerial Ordinance for Establishing Technical Standards for Mining Equipments, and Technical Guideline concerning Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) are applied mutatis mutandis regarding the safety factor of pipe elevator, hooks and traveling blocks, and shall be 4 or above with respect to the maximum static load. When using a spindle type drilling equipment, the safety factor shall be 3 or more.

##### 7. (Pipe elevator)

The use of a pipe elevator with a safety clutch with lock is recommended. When using a pipe elevator without a

safety clutch with an internal lock, safety measures shall be taken in order to prevent the door from opening, such as tying the door with a rope each time.

#### 8. (Mud pump)

- (1) The mud pump shall be equipped with a safety valve and a pressure gauge. Additionally, the pipes on the downstream side of the safety valve shall be fixed firmly.
- (2) Workers shall not operate the mud pump before ensuring that all the valves in the operating system have been opened.

#### 9. (Mud tank)

During the drilling operation, it is necessary to monitor the abnormal increase or decrease in mud volume constantly in the circulating mud tank system in order to detect abnormal situations such as lost circulation or kick.

#### 10. (Lighting)

During the night operation, a lighting equipment with sufficient brightness shall be provided for safe working environment.

#### 11. (Inspection)

The inspector shall routinely inspect the lubrication points, chains, brakes, safety valves, and measurement gauges of the drilling equipment, and record the results in the safety report.

### Section 5: Fence surrounding the work area, etc.

#### 1. (Fence and other hazard prevention equipment)

Fences, coverings, and other safety equipment shall be provided for the dangerous parts of the machine and/or equipment, as listed below.

- (1) Drawworks' rotary chain, sprocket, friction transmission equipment, and couplings with protruding parts, such as bolts or nuts.
- (2) Transmission equipment consisting of shafts, protruding shaft ends, and belt chain with a height of 2m or less from the floor or installation base.
- (3) (1), (2) and other machines driven by power.

#### 2. (Coverings)

The horizontal axles and other driving equipments installed in a place where may be approached or crossed by the workers for work activity or as a passage, shall be equipped with covering or other suitable equipment.

## Section 6: Blowout prevention

### 1. (Blowout preventer)

When drilling, workover, and conducting various tests on geothermal wells that have potential risk for steam or hot water blowout, blowout preventer shall be installed according to the followings.

- (1) The blowout preventer shall be an open/close type that can operate quickly; preferably a remotely-operated type.
- (2) If the equipment in (1) has an operatable mechanism with a stem, the stem shall be long enough to enable operation from outside of the derrick.
- (3) An emergency actuator or alarm for the equipment shall be provided in (1), near the worker operating the drilling equipment.
- (4) An equipment which prevents the steam or hot water blowout from the inside of the drill pipe or casing, shall be prepared.
- (5) When conducting various tests of the well, a blowout prevention equipment such as a lubricator shall be installed at the top of the wellhead, as necessary.

### 2. (Pressure test)

The blowout preventer shall have passed the pressure test conducted at the pressures described below.

- (1) In case the maximum wellhead pressure can be estimated from the offset wells, the pressure shall be set to at least 0.7 times of that pressure.
- (2) In cases other than (1), the pressure shall be set to 14 MPa or more.

### 3. (Mud storage for emergency use, cooling water, etc.)

A drilling or flow test of the geothermal well where there is a risk of steam or hot water blowout, etc., shall be performed as follows.

- (1) A back-up mud pump and a cooling tower shall be installed, and mud storage for emergency use, or the materials for new mud shall also be prepared.
- (2) In preparation for the immediate water injection in an emergency event, a sufficient amount of fresh water to cool the well, shall be prepared

### 4. (Function test)

The inspector shall conduct a function test of the blowout preventer at least once a month and record the results in the safety report.

## Section 7: Casing and cementing

### 1. (Casing)

- (1) The casing on which the master valve is installed, shall meet API standard, with grade J-55 or above, thickness of 7mm or more, and buttress thread or premium thread shall be used for connection. If these requirements are not achievable, casing and connection having enough strength to these requirements shall be used.

- (2) In the case of (1), the clearance between the diameter of the hole and the outer diameter of the casing shall be 50 mm or more for cementing, and the corresponding number of centralizers shall be installed to the casing.
- (3) For geothermal drilling, the casing without the master valve installed, shall be a pressure carbon steel pipe (STPG370 Sch40) or of equivalent or higher quality.

## 2. (Cementing, cement)

Cementing of the casing to which the master valve is installed, shall be conducted by the circulation method. If the temperature of the well is expected to reach 110°C or higher, high-temperature heat-resistant cement shall be used.

## Section 8: Air drilling/aerated mud drilling

When performing air drilling or aerated mud drilling in a geothermal well, the provisions of the following shall be applied additionally,

### 1. (Air lines and valves)

- (1) The air line shall use a material with a pressure resistance of at least twice the maximum operating pressure.
- (2) An inlet valve and a blow valve shall be installed in the air line.
- (3) A check valve shall be installed on the compressor outlet side.
- (4) Each valve shall have passed the pressure test that is 1.5 times larger than the maximum operating pressure.
- (5) Vibration prevention countermeasures shall be installed at the appropriate points of the pipes, such as fixing said pipes on a mounting.
- (6) Valves shall be installed at positions where workers can operate them safely.

### 2. (Blooie line)

- (1) Countermeasures shall be taken to prevent the dispersion of cuttings, dust, etc. at the tip of the Blooie Line.
- (2) The bends on the Blooie Line shall be as less as possible.

### 3. (Pressure test)

- (1) A pressure test for the drain separator and the air line shall be conducted for each compressor at a pressure higher than the operating pressure.
- (2) If leakage is detected in the test of (1), release the pressure first and take corrective action.

### 4. (Operation)

- (1) When operating the compressor, the operator and the driller shall be placed within the field of view of each other as a general rule, in order to prevent accidents. If this is not feasible, sufficient communication methods, such as a signal or telephone shall be made available.
- (2) Before running in or pull out of the drill pipe, the air supply to the drill pipe shall be stopped and ensure that the residual air pressure in the pipe has reached to zero before start operation.

5. (Safety valve, pressure gauge and thermometer)

Safety valves, pressure gauges, and thermometers shall be installed where they are necessary, on the compressors and air lines.

**Section 9: Water injection**

When water injection is carried out into a geothermal well to improve permeability, the following provisions shall be followed in addition to the applicable provisions described above.

1. (Injection line and valve)

- (1) For the injection line material, a high-strength seamless steel pipe is recommended that is durable against the predicted maximum pressure during the injection job.
- (2) The injection line from the pump to the wellhead shall be connected with a welded wing union instead of a screw type connection and shall not be connected by flange or on-site welding.
- (3) For injection line and wellhead, screw tightening shall be secured, and appropriate measures shall be taken such as using flexible joints to prevent vibration.
- (4) The outlet valve of the pump and the relief valve in the injection line shall have a structure that can be opened and closed safely and easily under high pressure conditions.

2. (Safety valve and pressure gauge)

- (1) A safety valve shall be installed on the discharge side of the pump.
- (2) Pressure gauges shall be installed at each key point of the line and wellhead.

3. (Pressure test)

- (1) A pressure test at a pressure 1.5 times the maximum injection pressure or above shall be conducted for the injection line and wellhead in advance.
- (2) The maximum injection pressure described in the previous provision shall be within the withstanding pressure of the master valve, bleed valve and casing used for injection from the wellhead without using a packer.

4. (Operation)

- (1) The pump shall not be operated until it is confirmed that all the valves of the operating system are open.
- (2) The pump operation shall be immediately ceased if the wellhead pressure or pumping pressure exceeds the test pressure of the equipment during operation.
- (3) Headphones, microphones, etc. shall be worn to prevent damage due to noise during work.
- (4) Water injection work during night shall be avoided as much as possible.

## Section 10: Wellhead, separator and silencer

### 1. (Wellhead)

(1) When performing a flow test of steam, hot water, etc. in a geothermal well, the equipment listed below shall be installed alongside the wellhead.

- (a) Wellhead
- (b) Bleed valve, bleed pipe
- (c) Pressure gauge
- (d) Master valve
- (e) Branching pipe
- (f) Flow pipe and control valve, which directly connects to the separator or silencer
- (g) Top valve

(2) The master valve, bleed valve and wellhead in (1), shall have a pressure resistance of twice or more, of the shut-in wellhead pressure. The master valve and other wellhead valves shall be able to open and close appropriately at the temperature expected at the wellhead.

### 2. (Separator)

The separator shall have enough capacity in order to continuously separate steam and hot water.

### 3. (Silencer)

The silencer shall meet the items listed below.

- (1) Reduces noise of the flow test.
- (2) A structure that can continuously discharge steam and hot water.
- (3) When only the steam is being ejected, countermeasures to prevent the scattering of cuttings, etc. shall be taken.

## Section 11: Countermeasures for dust and harmful gases

### 1. (Countermeasures for dust)

Workers, who handle powders such as clay, mud making materials for the build up and/or condition of the drilling mud and such, shall take safety measures such as using an effective mask or using a mixer, as necessary.

### 2. (Countermeasures for harmful gas)

For geothermal wells, the occurrence of harmful gas, including hydrogen sulfide and carbon dioxide is highly expected in the following cases.

- (a) When encountering a reservoir layer which pressure is higher than the hydrostatic pressure during the drilling.
- (b) When a reservoir layer is encountered, while the hydrostatic pressure was reduced by the drilling condition (e.g., lost circulation drilling, air drilling).
- (c) When a gas blowout from the upper layer is induced by the decrease in water level due to the lost circulation.
- (d) When an abnormally high temperature layer is encountered, resulting in an increased temperature inside

the well, causing a gas blow out.

- (e) When decompression in the well occurred due to the swabbing (e.g., sudden pulling the pipe)
- (f) When the shut-in pressure is rising caused by gas migration in the well.
- (g) When steam or hot water swabbing is induced, and during those production event.

During normal drilling operation and flow tests, harmful gas may be ejected from the well, after being released from the liquid phase. However, since the concentration of harmful gas in the liquid phase is originally low, combined with it being diluted with steam, the concentration of the gas when being ejected to the ground above is relatively low in most cases. Nevertheless, harmful gas may be contained in high concentration in the gas reservoir layer, or the gas retained within the well while the wellhead is closed. The blowout of gas in the gas reservoir often occurs with a noticeable signs ahead, such as the gradual rise of gas concentration above the ground. In the case of retained gas in the well where the wellhead is closed, high-concentration gas is directly released as the valve is opened. These statuses shall be taken in consideration when countermeasures are established.

Since the occurrence of harmful gas highly depends on geological characteristics, it is necessary to consider the survey results in the corresponding region.

Countermeasures for harmful gases shall comply with the provision of Occupational Safety and Health Act and its government ordinances (Ordinance on Industrial Safety and Health, Oxygen Deficiency Prevention Regulations, etc.), and items listed below shall be followed as well.

(1) Work environment standards

The work environment standard for harmful gases is specified as "hydrogen sulfide concentration shall not exceed 10 ppm, oxygen concentration is 18% or more, and/or carbon dioxide concentration shall not exceed 1.5%".

At workplaces where harmful gas occurs and the gas concentration may exceed the standards, which is listed above, limited access area shall be established in advance according to the contents of work at that location, in order to restrict the entry of unauthorized person. In addition, evacuation routes and evacuation sites shall be established for the case that the occurrence of harmful gas affects the area beyond the restricted area.

(2) Work environment assessment

At workplaces where harmful gases may occur, hydrogen sulfide detectors, carbon dioxide detectors and oxygen concentration detecting devices shall be provided and said appropriate measurements shall be performed as required.

During the drilling operation with a risk of unexpected generation of harmful gas, or during swabbing work which has the risk of high-concentration harmful gas being released, a continuous measurement for hydrogen sulfide, carbon dioxide, and oxygen concentrations shall be performed.

(3) Installation of windsock

At workplaces where harmful gases could be generated and may exceed the work environment standards, windsocks, etc. shall be installed at appropriate locations in order for the observation of the wind direction and strength.

(4) Gas diffusion fan

When working at a workplaces where harmful gases could be generated and may exceeds the work environment standards, gas diffusion fan shall be provided at the workplace, and shall be operated, as necessary.

(5) Respiratory protection device

When working at a workplaces where harmful gases could be generated and may exceeds the work environment standards, an air respirator, oxygen respirator or air supply masks (hereinafter referred to as "air breathers, etc.") which complies with the provision of Ordinance on Prevention of Anoxia, etc. and are specified in JIS, shall be provided in the equal to or greater than the number of people working at the said location at once, and shall be worn as necessary as a respiratory protective device.

However, if the oxygen concentration of 18% or higher and the carbon dioxide gas concentration of 1.5% or lower can be maintained with a gas diffusion fan, etc., a hydrogen sulfide gas mask can be used instead of the air respirator, etc.

(6) Safety training

A worker shall be appointed for the role of "Chief of oxygen deficiency dangerous work" on site. "Oxygen deficiency dangerous work chief" shall instruct the safety training to all workers, with materials regarding on the characteristics of hydrogen sulfide and carbon dioxide, concentration of hydrogen sulfide and carbon dioxide causing decrease in oxygen concentration, how to deal with such situation, as well as the training on wearing respiratory protective device, evacuation training, etc.

(7) Gas diffusion during bleeding

During the bleeding work, decision of commencing the work shall be determined based on the direction and strength of the wind, etc. When commencing the bleeding, gas diffusion measures such as operating a gas diffusion fan, shall be performed if necessary, as well as warning measures such as access restriction and surveillance shall be taken in dangerous areas such as natural depressions/sunken area.

(8) Additional criteria for swabbing work

(a) Division of roles during swabbing activity

In order to maintain the safety during the swabbing, and to respond reliably and swiftly in case of emergency, a manager for swabbing work, a swabbing operator, a work environment assessment staff, an evacuation staff and an emergency contact personals shall be appointed.

(b) Notification before commencing the work

Before the flow induction begins, the operation manager shall determine the commencement of the work, as well as the evacuation route, the evacuation site, and keep the involved persons well informed.

The person in charge of managing the operation shall ensure that all involved parties are thoroughly informed about the measures to be taken, in the event of the gas concentration exceeding the work environment standard.

(c) Emergency response

All activities including the evacuation in the event of emergency shall be carried out under the direction of the operation manager. In addition, the evacuation staff shall guide people uninvolved to the work, while

the emergency contact person shall notify the outside regarding the emergency.

(d) Reduction of harmful gas before flow induction work

If a large amount of harmful gas in the well is expected, the amount of harmful gas contained inside the well shall be reduced by an appropriate method, before starting the flow induction work.

3. (Countermeasures for flammable gases)

The following countermeasures shall be taken to prevent fires caused by flammable natural gas during the drilling of the geothermal well.

- (a) The wellhead shall be placed at least 3m away from the site boundary, and installation of equipment which uses fire, as well as the use of fire shall be prohibited within the perimeter.
- (b) A portable flammable gas measuring detector and a fire extinguisher shall be installed.
- (c) The methane concentration shall be measured at least once every working day, and the results shall be recorded.
- (d) Disaster prevention regulations shall be prepared and made available at the site.

If blowout of flammable natural gas is expected at the drilling site, based on the surrounding geological characteristics and past drilling results, the following countermeasures will be taken in addition to the countermeasures described above.

- (e) The wellhead shall be placed at least 8m away from the site boundary, and installation of equipment which uses fire, as well as the use of fire shall be prohibited within the perimeter. Additionally, fences around the drilling shall be installed in order to limit the access of unauthorized personals.
- (f) A blowout preventer shall be installed.
- (g) Flammable natural gas alarms shall be installed at the wellhead and mud pit.
- (h) When installing electrical machinery and equipment, use explosion-proof specifications.

## Section 12: Safety Confirmation / Inspector

The Safety Officer or the safety and health promoter shall appoint an inspector for safety confirmation of equipment and measurement for environmental management. The inspector shall inspect and measure predetermined inspection points and measurement items and keep records.

## Chapter 3 Environmental conservation

The project operator shall take the following measures to protect the environment.

### Section 1: Countermeasures for hot water, waste mud, waste oil, etc. (Discharge of hot water, waste mud, waste oil, etc.)

1. Hot water discharged from equipment related to the geothermal well shall be treated with necessary measures for environmental protection, such as injecting it into the injection well.
2. In order to treat waste oil, waste mud, cuttings, etc. generated by drilling of geothermal wells, necessary countermeasures shall be taken for environmental protection, such as installing facilities including waste disposal/collection sites, mud reservoirs and filter basins.
3. The embankment of mud reservoir and filter basin shall be constructed from solidified clay or other impermeable material.

### Section 2: Countermeasures for noise and vibration (Noise and vibration regulations)

1. When noise or vibration is generated from equipment related to geothermal well drilling and it is expected to cause disturbance in the neighborhood, it is necessary to consult with local residents and take appropriate countermeasures if necessary.
2. In the noise and vibration regulation areas, the regulation standards based on the Noise Regulation Act or the Vibration Regulation Law shall be observed.
3. If breakdown, damage or any accident occurs, or such event is expected to occur at the facility that causes noise or vibration, or at a facility that prevents noise or vibration, emergency measures shall be taken immediately for the accident for a quick recovery.

### Section 3: Dust

When performing air drilling or aerated mud drilling, necessary countermeasures shall be taken to prevent the scattering of cutting dust and other fine particles.

### Section 4: Environmental protection during sticking

When drilling geothermal wells, oil spotting with diesel etc. shall not be performed during sticking.

### Section 5: Countermeasures during steam and hot water blowout

1. When performing swabbing work, effective countermeasures shall be taken to minimize the scattering of steam, hot water and mud water, as well as to prevent damaging the vegetation in the surrounding area.
2. Depending on the concentration of hydrogen sulfide gas and carbon dioxide gas during the blowout, concentration of hydrogen sulfide gas and carbon dioxide gas in the surrounding area shall be monitored, as necessary. Depending on the concentration detected at the site, the blowout shall be stopped, or other necessary countermeasures shall be taken in order to ensure the environmental protection.

3. If the occurrence of noxious gas such as hydrogen sulfide gas and carbon dioxide gas, is associated with the geothermal well drilling, necessary countermeasures for environmental protection shall be taken.
4. In the event of a breakdown/damage, or a risk of such arises to the steam or hot water treatment facilities, which would interfere environmental protection, safety measures shall be taken as soon as possible.

#### Section 6: Geothermal well suspension or the measures regarding the abandonment

1. When suspending a geothermal well, the wellhead shall be sealed, fenced with a sturdy material, and safety measures such as access restriction shall be taken.
2. When abandoning a geothermal well, the well shall be filled with sufficient amount of cement for safety, in order to prevent the leaking of spring water and steam gas after the abandonment.

Notes on the Health, Safety and Environment Guidelines for Geothermal Well Drilling

## Preface

This explanatory note explains the grounds for establishing the "Health, Safety and Environment Guidelines for Geothermal Well Drilling" (hereinafter referred to as "Guideline") and the guidelines for compliance, in order and collating with related laws and regulations.

In addition, we also explained the licensing procedure, security and environmental management system for drilling, licenses, qualifications, work that requires training, etc., for the convenience of those who comply with this Guideline.

Currently, there are a wide variety of laws and regulations that must be observed for safety reasons regarding the drilling work of geothermal wells, including the Industrial Safety and Health Act, as described in this Guideline. Those who are engaged in the drilling work of geothermal wells must pay the careful attention not only to this Guideline but also to the compliance with relevant laws and regulation.



# Notes on the Health, Safety and Environment Guidelines for Geothermal Well Drilling

## Chapter 1 General provisions

### Section 1: General rules

#### 1. (Purpose)

This Guideline aims at ensuring safety for the Operator exploring and developing geothermal resources, when carrying out development work such as drilling of geothermal wells and related surveys. This Guideline is established by examining and adjusting the provisions of the related laws and regulations that shall be considered, as well as items that are not included in the laws and regulations, such as Industrial Safety and Health Act, with reference to the internal rules of the Mining Safety Act, etc., and are meant to be voluntarily followed.

#### 2. (Definition of terms)

##### (1) Safety

The term “safety” is defined with reference to the occupational accident prevention provisions of the Industrial Safety and Health Act and the safety provisions of the Mine Safety Act. It is synonymous with “safety and health”.

##### (2) Geothermal resource

A simple term is adopted to avoid confusion with a similar term “underground resource”.

##### (3) Operator

Article 2 of the Industrial Safety and Health Act stipulates that "Operator" shall be defined as one who carries on an undertaking and employs workers", whereas the Mine Safety Act practically refers only to the mining rights holders. This Guideline incorporates the concept of the Industrial Safety and Health Act and defines "Operator is a person/organization who directly conducts geothermal exploration, development, etc., or a person (generally a contractor) who is entrusted by the Operator to perform these tasks.

##### (4) Geothermal well

The term Geothermal wells does not only refer to geothermal production wells and injection wells, but it also refers to, according to this Guideline, exploration wells for geothermal resources (promotion survey wells, structural survey wells, precision survey wells, environmental survey wells, verification survey wells, heat flow survey wells, etc.) as well as the related workover wells, suspended wells, and wells which are planned to be abandoned. Small wells that are used for geophysical exploration are excluded

##### (5) Blowout preventer

##### (6) Wellhead equipment

##### (7) Surface installation

##### (8) Other workpieces

The equipment and devices in (5) to (8) have been defined as common definitions with oil and natural gas facilities.

### 3. (The scope of the Guideline)

The scope of this Guideline is for the activities related to the drilling, workover, flow test and abandonment of geothermal wells, as well as assembling, disassembling, and demobilization of the drilling-related equipment, devices and other workpieces listed in (1) to (8).

### Section 2: Safety and health management system (Industrial Safety and Health Act)

This Guideline (and its explanation) describes the necessary safety and health management system stipulated by laws and regulations with a reference to the provisions of the Industrial Safety and Health Act, etc. Article 1 summarizes the requirements regarding the work site with regular workers of less than 50, classified as small-scale, and Article 2 summarizes the work site with workers of 50 or more, which is classified as large-scale. The more common practice of geothermal well drilling, which is a small-scale with about 20 workers, shall be referred to Article 1.

According to the Industrial Safety and Health Act, regarding the safety and health management system at the work site, it is required to appoint general a General Safety and Health Manager, Safety Officers, Health Officers, and Occupational Physician, depending on the scale of the work site.

In addition, at the geothermal well drilling sites, there are many cases where principal contractors, subcontractors, etc. are working each work at same site, which requires an additional to establish a safety and health management system specific at the site where multi works are operated (Article 30, paragraph (1) of the Industrial Safety and Health Act). "Multi works at same site" here is not a term defined by the Industrial Safety and Health Act, etc. It refers to the case when an Operator entrusts a part of the tasks being performed at one work site to a contractor, and the workers of the Operator and the workers of the contractor perform the tasks together in the work site.

There may be a case, where more than one principal contractor exists regardless of the scale of work site. When the Operator, who is not the specified principal operator engaged in a specific task such as the construction industry, entrusts the part of the work to two or more contractors, shall appoint a contractor who is to carry out the appropriate measures on behalf of the specified principal operator (Article 30, paragraph (2) of the Industrial Safety and Health Act).

The persons who shall be appointed to these positions are explained in the table below and shown in the following chart as well. The conditions for each appointment are different, as shown in the footnote \*1 through \*7. In addition, the tasks of the Overall Safety and Health Controller and those that are equivalent to the Overall Safety and Health Controller are different.

For the specific tasks and the relationships between these roles, paragraphs (1) and (2) shall be referred.

Basis for appointment	Scale of the work site (number of regular workers (construction industry))		
	Large-scale work site (50 workers or more)	Small-scale work site (10 to less than 50 workers)	
	Industrial Safety and Health Act	Industrial Safety and Health Act	Notification of Director of Labor Standards Bureau
Person who supervises the implementation of the business at the work site	General Safety and Health Manager <sup>*1</sup> Overall Safety and Health Controller <sup>*2</sup>		Person equivalent to Overall Safety and Health Controller <sup>*2</sup>
Qualified person	Safety officer Health officer Occupational physician Principal Safety and Health Supervisor <sup>*3</sup>		Person equivalent to Principal Safety and Health Supervisor <sup>*5</sup> Person equivalent to Site Safety and Health Supervisor <sup>*6</sup>
Person recognized as having the necessary abilities		Safety and Health Promotor	
Not specified	Safety and Health Controller <sup>*4</sup>		Person equivalent to Safety and Health Controller <sup>*7</sup>

\*1 For the case when the work site has 100 workers or more.

\*2 For the case when a part of the task is contracted to a contractor (resulting in the multi works at same site)

\*3 The Operator who appointed the Overall Safety and Health Controller

\*4 The Operator other than the one who has appointed an Overall Safety and Health Controller, when a said person was appointed.

\*5 The Operator who appointed the person equivalent to Overall Safety and Health Controller

\*6 In case where the part of task is contracted to a contractor, and a person equivalent to the Overall Safety and Health Controller is not appointed.

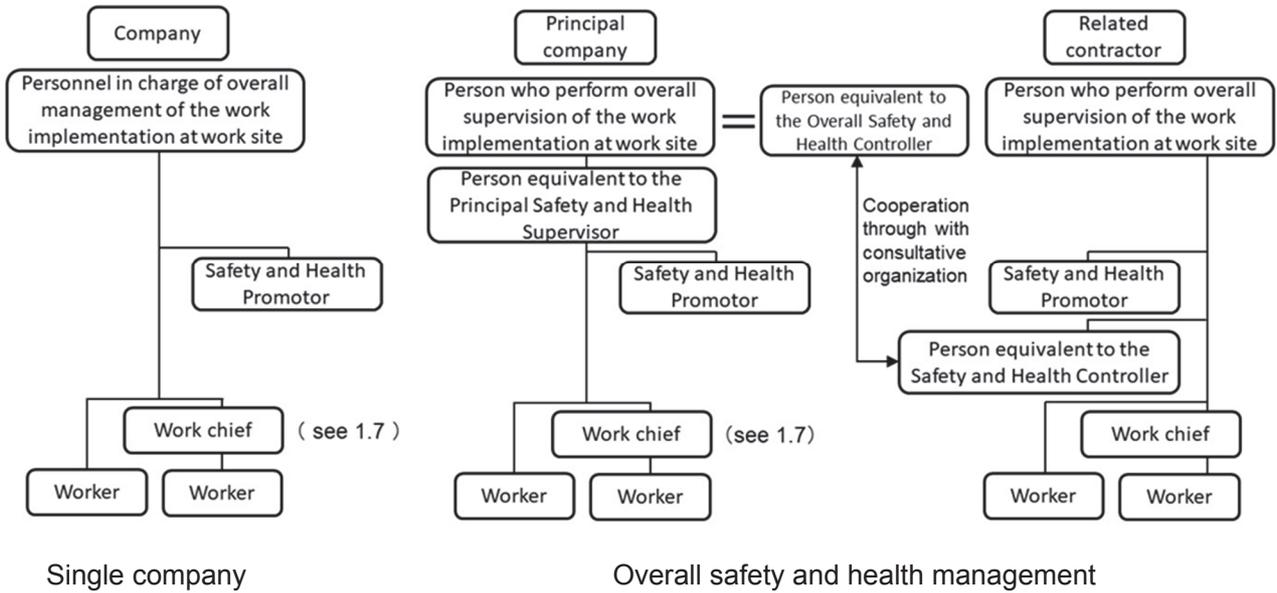
\*7 The Operators other than the one who has appointed the person equivalent to Overall Safety and Health Controller, when a said person was appointed.

It is necessary to appoint a health and safety promoter within 14 days from the day when the reason for the appointment occurs, and to inform the relevant workers by posting the name in an easily visible place in the work site. In addition, safety officers, health officers, industrial physicians, etc. shall report to the relevant Labor Standards Inspection Office without delay within 14 days from the date when the reason for their appointment occurs.

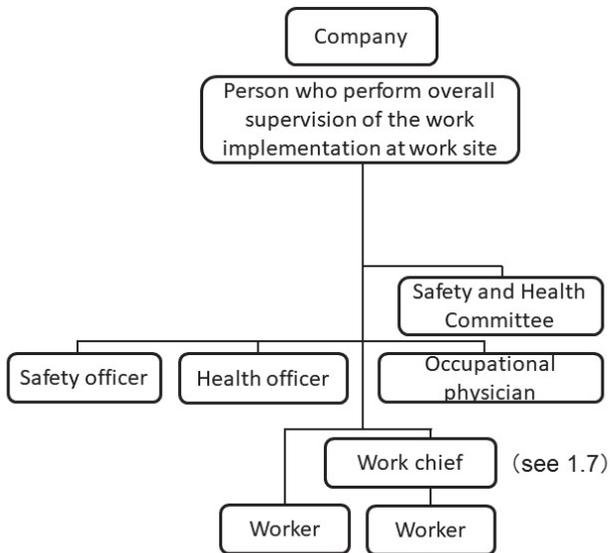
## Safety and health management system

### ■ Small-scale work sites (10 to less than 50 workers)

Each person in charge may also conduct the task concurrently depending on the workplace.



### ■ Large scale work site (50 workers or more)



Safety and health management by a single company

## 1. (Safety and health management system for small-scale work site)

### 1.1 Appointment of a safety and health promotor (Article 12 of the Industrial Safety and Health Act, Article 12-2 of the Ordinance on Industrial Safety and Health Act)

The operator shall appoint a safety and health promoter, who is recognized as having sufficient knowledge, from within the Operator's organization at the work site of the scale<sup>※</sup> specified by the Cabinet Order, and have that person manage the matters listed below.

- (1) Inspection of facilities, equipment, etc. (including safety devices, occupational health-related equipment, personal protective equipment, etc.), assessment of the equipment usage and conditions, and necessary measures based on these results
- (2) Inspection of work environment (including the measurement of work environment), inspection of work method, and necessary measures based on these results
- (3) Appointment of an inspector as the person in charge of the inspections in (1) and (2) to enhance the inspection<sup>※※</sup>

On-site inspections and records will be carried out by an appointed inspector, excluding the equipment related to the inspection of the gas welding operation chief, etc. The inspector will be described in detail in Chapter 2. As an example of inspection, it is stipulated that when a boring machine is assembled, it can be used only after being confirmed that there are no abnormalities by a prescribed inspection (Article 192 of the Industrial Safety and Health Act).

- (4) Health examination and maintenance, as well as the promotion of worker's health
- (5) Environmental protection<sup>※※</sup>
- (6) Safety and health education
- (7) Emergency response
- (8) Investigation of cause of occupational accidents and its recurrence prevention measures
- (9) Collection of safety and health information, as well as the preparation of statistics on occupational accidents, illnesses, absence from work, etc.
- (10) Reports, notifications, etc. related to safety and health, to the related administrative agencies
  - ※ Work site constantly using 10 or more and less than 50 workers
  - ※※ Although this is not required by the regulation, it is to be assigned to the safety and health promoter

It is necessary to appoint a health and safety promoter within 14 days from the day when the reason for the appointment arises, and it is necessary to inform the involved workers by posting the health and safety promoter's name in an easily visible place at the work site.

The qualification for those that shall be appointed are as follows.

- (1) Those that have graduated from a university or a college of technology and have more than one year of practical experience in health and safety after the graduation.
- (2) Those that have graduated from high school and have more than 3 years of practical experience in health and safety after the graduation.
- (3) Those that have more than 5 years of practical experience in health and safety.
- (4) Those that have completed the training (training for safety and health promoters, etc.) specified by the Director of Labor Standards Bureau, Ministry of Health, Labor and Welfare.
- (5) Others approved by the Director of Labor Standards Bureau, Ministry of Health, Labor and Welfare.

## 1.2 Collection of the opinions from the involved workers

Even when the work site where the establishment of a safety committee is not required, an opportunity to receive the opinions from the involved workers regarding the safety or health matters shall be provided (Article 23-2 of the Ordinance on Industrial Safety and Health). There are no provisions regarding the participants of the committee, or the frequency of these meetings, as well as the recording of proceedings, etc. Though, it is desirable to consider the followings with reference to the provisions of meeting of the committee (Article 23 of the Ordinance on Industrial Safety and Health).

- (1) The chairperson shall be carried out by the management personnel of the work site, with the participation of persons with experience in safety and health and persons in charge of the actual works.
- (2) The frequency of meeting shall be at least once a month.
- (3) Record of the proceedings shall be developed and kept for 3 years afterwards. Inform the workers regarding the summary of the proceedings by posting or issuing a document.

## 1.3 Prevention of the occupational accidents in multi works at same site.

- (1) A specific principal operator engaged in a specific task such as the construction industry, shall take necessary measures to prevent occupational accidents resulting from the work of their employees and related contractors being carried out in the same place. (Article 30, paragraph (1) of the Industrial Safety and Health Act).

1) Establish and operate a consultation organization.

2) Communicate and coordinate between tasks.

3) Patrol the work area.

4) Provide guidance and assistance regarding the education for worker's safety and health conducted by the involved contractors.

5) Develop a plan for the work process, as well as a plan for the placement of machines, equipment, etc. at the work site, and give instruction to the relevant contractor in taking measures regarding the work using the said machines, equipment, etc. based on the said law or the provisions of orders based on the said law.

6) Other necessary matters to prevent the occupational accident

- (2) When an Operator, which is not the specified principal operator described earlier, entrusts the part of the work to multiple contractors, said Operator shall appoint a person who carries out the measures described in (1) (Article 30, paragraph (2) of the Industrial Safety and Health Act).

## 1.4 Appointment of the person equivalent to the Overall Safety and Health Controller

The Operator is required to, in the Notification<sup>\*\*2</sup> of Director of Labor Standards Bureau, to appoint a person equivalent to the Overall Safety and Health Controller<sup>\*\*1</sup> to enhance the overall safety and health management. It is desirable to appoint a person equivalent to the Overall Safety and Health Controller according to the notification to enhance the overall safety and health management. The title is to be determined by each Operator, but in this Guideline, it will be tentatively called as "a person equivalent to the Overall Safety and Health Controller".

※1“an Overall Safety and Health Controller” is a person who shall be appointed in a work site, which employs 50 or more workers constantly in one place, which also has a contractor undertaking part of the work. The appointed person shall supervise the implementation of the actual work.

※2"Enhancement of safety and health management at medium-scale construction sites" (Notification of Director of Labor Standards Bureau No. 209-2 (March 31, 1993))

- (1) The principal operator, depending on the situation at the construction site, appoints a person equivalent to the Overall Safety and Health Controller, or a person equivalent to the Principal Safety and Health Supervisor for each construction site.
- (2) When the principal operator appoints a person equivalent to the Overall Safety and Health Controller, as well as the person equivalent to the Principal Safety and Health Supervisor, the involved contractor shall appoint a person equivalent to the Safety and Health Controller, as a person equivalent to the Safety and Health Controller.
- (3) Knowledge, experience, etc. required to the person equivalent to the Overall Safety and Health Controller:
  - 1) For the appointment of the person equivalent to the Overall Safety and Health Controller, the person who supervises the operation at the place concerned shall be assigned.
  - 2) A person equivalent to the Principal Safety and Health Supervisor shall be appointed from those that have the knowledge and experience equivalent to the qualifications, listed in Article 18-4 of the Ordinance on Industrial Safety and Health.
  - 3) A person equivalent to the Site Safety and Health Supervisor shall be appointed from those that have the knowledge and experience equivalent to the qualifications, listed in Article 18-7 of the Ordinance on Industrial Safety and Health.
- (4) Task of the person equivalent to the Overall Safety and Health Controller:
  - 1) The person equivalent to the Overall Safety and Health Controller shall supervise and manage necessary measures to prevent occupational accidents during the multi works at same site.
  - 2) The person equivalent to the Principal Safety and Health Supervisor shall manage technical matters among the measures necessary to prevent occupational accidents during the multi works at same site.
  - 3) The person equivalent to the Site Safety and Health Supervisor shall conduct the following tasks:
    - Give guidance to those in charge of matters necessary to prevent occupational accidents due to multi works at same construction sites
    - Inspect the construction site, at least once a month
    - Have a clear understanding of the progress at the construction work
    - Participate in the consultation organization of the construction site at any time
    - Confirm the plan for the work process related to the construction work, as well as the plan for the installation of machines, equipment, etc. at the work site
  - 4) The person equivalent to the Safety and Health Controller shall conduct the following tasks:
    - Maintain communication with a person equivalent to the Overall Safety and the Health Controller, to receive relative information, which shall be shared among the involved persons
    - Manage the implementation of the issues informed by the person equivalent to the Overall Safety and

#### Health Controller

- Coordinate the work plan, etc. developed by the contractor with a person equivalent to the Overall Safety and Health Controller
- Check for the potential danger, resulting from the multi works at same site
- If the contractor entrusts a part of the work to the next contractor, maintain communication and coordinate with a person equivalent to the Safety and Health Controller at that contractor

#### 1.5 Enhancement of the overall safety and health management

Among the matters of enhancement in the overall safety and health management required by the above notification, the overall safety and health management at the work site is as follows:

(1) The principal operator shall implement the followings to enhance the overall safety and health management at the construction site.

1) Matters necessary to prevent occupational accidents caused by multi works at same site is described as:

- Establish and operate a consultation organization
- Communicate and coordinate between tasks
- Patrol the work area
- Provide guidance and assistance regarding the education for worker's safety and health conducted by the involved contractors
- Develop a plan for the work process and a plan for the placement of machines, equipment, etc. at the work site, and give instruction to the relevant contractor in taking measures regarding the work using the said machines, equipment, etc.
- Other necessary matters to prevent the occupational accidents

2) Give guidance and instructions to prevent violations of the Industrial Safety and Health Act by the involved contractors

3) Give guidance to the involved contractors to ensuring the safety of work areas

4) Implement appropriate measures, when allowing workers of involved contractors to use equipment as an orderer.

5) Other matters necessary to prevent occupational accidents at construction sites, such as the implementation of safe construction cycle activities

(2) The involved contractor shall ensure that their measures are appropriately implemented, as well as implement the necessary measures according to the measures taken by the principal operator. In addition, when a contractor is entrusted for a part of the work which involves the use of a mobile crane or related equipment, and the work is carried out jointly, the communication and adjustment regarding the work contents, etc. shall be appropriately performed.

Of these, (1) corresponds to the provision of Article 30, paragraph (1) of the Industrial Safety and Health Act (measures to be taken by the specified principal operators, etc.). In addition, pursuant to paragraph (2) of the same Article, when an orderer, who is not the specified principal operator, entrusts the part of the work to two or more

contractors, an appointed contractor, who will conduct the main part of the construction work, shall carry out the relevant measures (Article 643 of the Ordinance on Industrial Safety and Health).

#### 1.6 Enhancement of guidance and support for the work sites by the office

Among the matters of enhancement in the overall safety and health management required by the above notification, the enhancement of guidance and support for work sites by the office shall be as follows.

(1) The office shall conduct safety and health patrols, develop a safety and health management plan as an office, establish inspection standards for construction machinery and equipment, and provide various safety and health information, etc. for the enhancement of guidance and support for overall safety and health management at construction site.

(2) In particular, for construction sites where a person equivalent to the Overall Safety and Health Controller and a person equivalent to the Principal Safety and Health Supervisor have not been appointed, a person equivalent to the Site Safety and Health Supervisor shall be appointed in the office to instruct these matters and ensure that the necessary actions are carried out, in order to prevent occupational accidents caused by multi works at same site.

• Regarding the number of construction sites where a person equivalent to the Site Safety and Health Supervisor takes charge of giving instruction, the task assigned to that person and the mutual distance of the sites will be considered, as well as a sufficient consideration shall be given to the number of construction sites that one person will be in charge, in order to ensure the implementation of the task will be appropriate.

(3) The principal operator shall encourage the person who is equivalent to the Overall Safety and Health controller, a person who is equivalent to the Principal Safety and Health Supervisor, and a person who is equivalent to the Site Safety and Health Supervisor, to receive trainings such as "level-up training for Site Safety and Health Supervisor" organized by The Japan Construction Occupational Safety and Health Association.

#### 1.7 Construction work that requires a license, qualification, training, etc.

According to Article 14 of the Industrial Safety and Health Act, it is stipulated that a work chief shall be appointed for the works that need safety management to prevent the occupational accident, and the appointed work chief take charge of the task of instructing the workers involved. This is the same for the geothermal well drilling work and various licenses, qualifications or completion of special safety and health education or skill training course are required such as follows:

(1) Supervision of steel frame assembly, etc.

Those that directs the work of assembling, disassembling, or altering the buildings or towers (with a height of 5 m or more) shall be an operation chief, who has completed skill training course (given 1 to 2 times a year) sponsored by organizations related to the Labor Standards Bureau in each region according to Article 14 of the Industrial Safety and Health Act. (Article 6 of the Order for Enforcement of Industrial Safety and Health Act, Articles 16 and 79 of the Ordinance on Industrial Safety and Health)

(2) Slings work (1t or more)

Slings work of a mobile crane with a hoisting capacity of 1t or more, shall be carried out by a qualified

person who has completed the slinging skill training course for hoisting cranes with a hoisting capacity of 1t or more, according to Article 61 of the Industrial Safety and Health Act. (Article 76 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Article 41 of the Ordinance on Industrial Safety and Health)

(3) Gas welding work

Acetylene welding work shall be carried out by a person who is licensed as a gas welding operation chief, or a qualified person who has completed a gas welding skill course, according to Article 61 of the Industrial Safety and Health Act (Article 76 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Articles 41, 62, 69, 70 and 79 of the Ordinance on Industrial Safety and Health).

(4) Operation of mobile crane (hoisting capacity of 5t or more)

Operation of mobile crane with a hoisting capacity of 5t or more, shall be carried out by a person who is licensed as a mobile crane operator, according to Article 61 of the Industrial Safety and Health Act (Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Article 41 of the Ordinance on Industrial Safety and Health).

Since a driver's license on a general road is not included in this license, an additional driver's license under the Road Traffic Act is required in order to drive these mobile cranes on a general road.

(5) Operation of small mobile crane (lifting load of 1t to less than 5t)

Operation of a small mobile crane with a lifting load of 1t less than 5t, shall be carried out by a person who has obtained a mobile crane operator license, or a qualified person who has completed a small mobile crane operation skill training course, according to Article 61 of the Industrial Safety and Health Act (Article 76 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Articles 41 and 79 of the Ordinance on Industrial Safety and Health).

(6) Operation of a boring machine

Operation of a boring machine shall be carried out by a qualified person who has completed special health and safety education and its certificate, according to Article 59 of the Industrial Safety and Health Act (Article 36 of the Ordinance on Industrial Safety and Health, Article 12-3 of the Safety and Health Special Education Regulations (Ministry of Labor Notification No. 92, 1972))

(7) Operation of a winch or hoist

Operation of a winch or hoist driven by electricity, air and etc., and drilling operation with a sand-line, slick-line or hoist equipped to derrick, shall be carried out by a qualified person who has completed special safety and health education and a certificate of completion, according to Article 59 of the Industrial Safety and Health Act and Article 36, paragraph (11) of the Ordinance on Industrial Safety and Health.

(8) Operation of aerial work platforms (work floor of 10m height or more)

Operation of aerial work platforms with a work floor of 10m or more shall be carried out by qualified personnel who have completed aerial work platform operation skill training course, in accordance with Article 61 of the Industrial Safety and Health Act (Article 76 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Articles 41 and 79 of the Ordinance on

Industrial Safety and Health).

To operate an aerial work platform with a work floor of less than 10 m height, a special education and its certificate of completion is required according to Article 59 of the Industrial Safety and Health Act (Article 36 of the Ordinance on Industrial Safety and Health, Rules on Special Education for Safety and Health (Ministry of Labor Notification No. 92, 1972) Article 13)

(9) Operation of a forklift (maximum load of 1t or more)

Forklifts with a maximum load (meaning the maximum load that can be applied to the rated load center depending on the structure and material of the forklift) of 1t or more (excluding driving on general roads) shall be operated by a qualified person who has completed the forklift driving skill training course, according to Article 61 of the Industrial Safety and Health Act. To drive these forklifts on the general roads, a driver's license under the Road Traffic Act is required, same as (4) above. (Article 76 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, Article 41 and Article 79 of the Ordinance on Industrial Safety and Health).

To operate a forklift with a maximum load of less than 1t, a special education and its certificate of completion is required according to Article 59 of the Industrial Safety and Health Act (Article 36 of the Ordinance on Industrial Safety and Health, Article 7 of the Rules on Special Education for Safety and Health (Ministry of Labor Notification No. 92, 1972))

(10) Handling of ordinary class-1 pressure vessel

Although a separator is not used when drilling a geothermal well, separator is necessary when investigating the amount of steam and hot water. Therefore, it is included in this Guideline to establish the criteria. Since the separator, which separates steam and hot water, corresponds to the class-1 pressure vessel stipulated in the Industrial Safety and Health Act, the person handling it is required to have the qualification of the ordinary class-1 pressure vessel handling operation chief according to Article 14 of the Industrial Safety and Health Act (Article 6 of the Order for Enforcement of Industrial Safety and Health Act and Article 16 of the Ordinance on Industrial Safety and Health)

To obtain this qualification, one has to possess a special-grade, class-1, or class-2 boiler engineer license, or one has to take an operation chief skill training course, for the chemical equipment-related class-1 pressure vessel handling or the ordinary class-1 pressure vessel handling, specified in Article 123 of the Boiler Regulations, and obtain its certificate of completion (Article 76 of the Industrial Health and Safety Act, Article 16 of the Ordinance on Industrial Safety and Health, Article 124 of the Ordinance on Safety of Boilers and Pressure Vessels, Regulations on the skill training course for operations of boilers, the chemical equipment-related class-1 pressure vessel handling operation chief skill training course, and an ordinary class-1 pressure vessel handling work chief skill training course, (Ministry of Labor Notification No. 117, 1972)).

(11) Work at heights (work performed using a full-body harness and relevant equipment for fall prevention device, at the places with a height of 2m or more, where it is difficult to provide a work floor surface)

For a person performing work at heights (work performed using a full-body harness and relevant equipment for fall prevention device, at the places with a height of 2m or more, where it is difficult to provide a work floor surface), a special education and its certificate of completion is required according to Article 59 of the

Industrial Safety and Health Act. (Article 36 of the Ordinance on Industrial Safety and Health, Article 24 of the Safety and Health Special Education Regulations (Ministry of Labor Notification No. 92, 1972))

(12) Operations carried out at places with an oxygen deficiency hazard and harmful gases

When harmful gases may exceed the legally regulated value during a geothermal well drilling or performing a flow test, a person who has completed the skill training course for operations chief of hazardous work of oxygen deficiency and hydrogen sulfide shall be appointed as an operations chief of hazardous work of oxygen deficiency according to Article 59, paragraph (3) of the Industrial Safety and Health Act and Article 36, paragraph (26) of the Ordinance on Industrial Safety and Health.

(13) The installation of electric facilities for private use

When installing a private electric facility, a chief electrical engineer shall be appointed according to the scale of the facility pursuant to the Electricity Business Act. There are four methods for the appointment system.

(a) Appointment of a qualified person who has a chief engineer license (appointment notification)

Chief electricity engineer licenses are categorized into Type 1, 2 and 3, and the scope of supervision is stipulated for respective type. For example, Type 1 is allowed to construct, maintain and operate all types of electric facilities for business use except Type 1 dam waterways, Type 1 boilers and turbines, whereas Type 2 is capable of construction, maintenance and operation of electric facilities for business use with less than 170,000V on premises and less than 100,000V outside, and Type 3 is capable of maintaining and operating commercial electric facilities (excluding power plants of 5,000kW or more) with less than 50,000V on the premises and less than 25,000V outside the premises (Articles 52 and 56 of the Regulation for Enforcement of the Electricity Business Act). Qualified persons shall be appointed according to the scale of the electric facilities to be installed and notified to the Minister of Economy, Trade and Industry. (Article 43, paragraph (3) of the Electricity Business Act)

(b) Appointment of a person other than a qualified person who has a chief engineer license (individual permit)

An unqualified person can also be appointed with the permission of the Minister of Economy, Trade and Industry (in the case of one jurisdiction, the Director-General of Regional Bureau of Economy, Trade and Industry) (Article 43, paragraph (2) of the Electricity Business Act). However, there are certain conditions for obtaining permission, and the details are described in Interpretation and Operation of the System on Chief Electricity Engineer (the Notification of Director of Industry Safety Bureau No. 1 (September 29, 2020)). The Notification also identifies the persons owing the following qualification as having the equivalent or higher knowledge and skills as listed in Article 2, paragraph (1), item (ii), (g), regarding portable power generation equipment that will be used for a short period of time at construction sites, etc.: a private power generation equipment specialist (installation work or maintenance area) specified by the Japan Engine Generator Association (telephone 03-5439-4391), or persons who are qualified as portable generator maintenance engineers specified by the Japan Construction Machinery Rental Association (telephone 03-3255-0511). In each case, training course to obtain the qualification is provided regularly in various places in Japan.

(c) Appointment of a person who has been appointed as the chief engineer in another work site (approval of concurrent posts)

In case the Minister of Economy, Trade and Industry (in the case of one jurisdiction, the Director-General of Regional Bureau of Economy, Trade and Industry) approves for a special reason, the concurrent posting will be approved. However, it is based on the condition of no concern regarding the safety of construction, maintenance and operation of electric facilities for business use, as well as the ability to arrive at the site within 2 hours upon request. (Article 52, paragraph (3) of the Regulation for Enforcement of the Electricity Business Act, Interpretation and Operation of the System on Chief Electricity Engineer (the Notification of Director of Industry Safety Bureau No. 1 (September 29, 2020))

(d) When it is possible not to appoint a chief engineer (approval of non-appointment)

For work sites related only to the power plants with an output of less than 1,000kW (excluding nuclear power plants) and power receiving facility that receives power at a voltage of 7,000V or less, it is possible, with the permission of the Director-General of the competent Regional Bureau of Economy, Trade and Industry, to outsource the security work to a designated organization (e.g., Kanto Electricity Safety Services Association, telephone 03-6453-8888) or individuals (e.g., Tokyo Electricity Management Engineer Association, telephone 03-3263-7261) that meet the requirements of the Ministry of Economy, Trade and Industry Notification No. 249 of 2003), instead of appointing a chief engineer.

In such case, the application shall be submitted to the Director-General of Regional Bureau of Economy, Trade and Industry with the necessary attachments in the prescribed form for approval.

The Electricity Safety Services Association or the Electricity Management Engineer Association is located at the headquarters of electric power companies all over Japan.

(Refer to Article 52, paragraph (2) of the Regulation for Enforcement of the Electricity Business Act)

(14) Electric work

According to Article 3 of the Electricians Act revised on September 1, 1987, electrical work for private electric facilities (power plants, power receiving equipment with a maximum power of 500kW or more) shall be performed only by a first-class Electrician, and only a first-class or second-class electrician can perform electrical work related to general-purpose electric facilities. Out of the private electric facilities, neon construction and electrical construction related to emergency standby power generation equipment can only be performed by qualified special electrical construction personnel. Among the electrical work of private electric facilities, simple electrical work, specified by the Ordinance of the Ministry of Economy, Trade and Industry, may be performed by a person who has been issued a certified electrician worker certificate regardless of the above provisions. (Article 3 of the Electricians Act)

Electric facilities used for electric power business are not covered by the Electricians Act, but the electric work in this field will be carried out by a responsible contractor under the supervision of the chief electrical engineer, and that does not mean any personnel can conduct the work.

Also, Article 4 of the Electricians Act stipulates that the prefectural governor issues first-class or second-class electrician licenses, as well as the conditions for the license. In addition, first-class electricians shall take a training course on safety within 5 years from the issue of the license, and the same applies after the day of training. Other obligations of electricians are also stipulated, and the details is described in the relevant Articles of the Electricians Act and the Order for Enforcement of Electricians Act, which are excerpts from

relevant laws and regulations.

For transitional measures accompanying the revision of the law, the Supplementary Provisions of the Electricians Act shall be referred, which is an excerpt of relevant laws and regulations.

For more information, please contact the Electrical Engineering Technology Training Center (telephone 03-3435-0897) or the Japan Electrical Construction Association, Japan Electric Association, and The Federation of Electrical Engineering Contractors Cooperatives of Japan.

A Chief Electrical Engineers who have more than 5 years of work experience can also obtain a first-class electrician's license by applying to the prefectural office or the Electrical Engineering Technology Training Center (Article 2-5, item(i) of the Ordinance for Enforcement of Electricians Act).

- Inquiries about general electrical laws and regulations

Ministry of Economy, Trade and Industry, Commerce and Information Policy Bureau, Industrial Safety Group,  
Electricity Safety Division 03-3501-1742

Agency for Natural Resources and Energy, Electricity and Gas Business Department, Policy Division

03-3501-1746

#### (15) Work handling explosive materials

The work of perforation, loading, wiring, ignition and inspection and disposal of unexploded charge or residual explosive material in the case of blasting, is designated as work with restricted employment by Article 20 of the Order for Enforcement of Industrial Safety and Health Act, and only qualified personnel can perform the blasting work. The required qualification is any of a blasting expert (Industrial Safety and Health Act), an explosive handling and safety engineer (Explosives Control Act), and a part of mine safety technical staff (Mine Safety Act). (See Article 61 of the Industrial Safety and Health Act, Article 20 of the Order for Enforcement of Industrial Safety and Health Act, and Article 41, Annexed Table 3 of the Ordinance on Industrial Safety and Health)

The blasting expert examination is conducted by the director of the prefectural Labor standards bureau, and the qualifications for applying to the examination are also stipulated in Article 70 of the Ordinance on Industrial Safety and Health. Therefore, when a drilling operator who does not have an explosive handling and safety engineer uses explosives (including detonators and blasting powder) in a well, the work shall be outsourced to a specialist who has a proper license to handle explosives.

#### (16) Operation of a mobile compressor (air pressure in an air compressor exceeding 5MPa at a temperature of 35°C)

In the High Pressure Gas Safety Act before amendment, compressed air in the compressor used for civil engineering work was exempted (Article 3 of the High Pressure Gas Safety Act, Article 2, paragraph (3), item(i) of the Order for Enforcement of High Pressure Gas Safety Act). Therefore, in many prefectures, the air compressor, which is a mobile manufacturing facility used for air drilling of geothermal wells, was considered to be for civil engineering work and is not covered by the High Pressure Gas Safety Act. In July 1987, the Order for Enforcement of High Pressure Gas Safety Act was partially revised, and the provision that compressed air in a compressor used for civil engineering work being exempted, was deleted. Instead,

it stipulates that the High Pressure Gas Safety Act would not be applied to compressed air in a compressor with a gauge pressure of 5 MPa or less at a temperature of 35°C (Order for Enforcement of High Pressure Gas Safety Act, Article 2, paragraph (3), item (i)). In this manner, the compressed air in the compressor whose gauge pressure exceeds 5 MPa, which was previously excluded from the application, became subject to the High Pressure Gas Safety Act.

According to the High Pressure Gas Safety Act, regarding safety-related work concerning the production of high pressure gas, Security Supervisor (Article 27-2, paragraph (1) of the High Pressure Gas Safety Act, Article 64 of the Regulation on Safety of General High Pressure Gas), Safety Technology Manager (Article 27-2, paragraph (3) of the High Pressure Gas Safety Act, Article 65 of the Regulation on Safety of General High Pressure Gas), Safety Chief (Article 27-3, paragraph (1) of the High Pressure Gas Safety Act, Article 69 of the Regulation on Safety of General High Pressure Gas), Safety Officer (Article 27-2, paragraph (4) of the High Pressure Gas Safety Act, Article 66 of the Regulation on Safety of General High Pressure Gas), Safety Planning Promoter (Article 27-3, paragraph (2) of the High Pressure Gas Safety Act, Article 70 of the Regulation on Safety of General High Pressure Gas) shall be appointed for each work site or facility, as stipulated respectively by the relevant laws and regulations. However, since there are many exceptions and diverse cases, relevant laws and regulations shall be referred for more detail.

For example, there are provisions of a case where, an appointment of a safety technical manager is not required if air is manufactured by a mobile air compressor (Article 27-2, paragraph (3) of the High Pressure Gas Safety Act, Article 65, paragraph (2), Item (iii) of the Regulation on Safety of General High Pressure Gas).

As the application of the High Pressure Gas Safety Act may still differ depending on the prefecture, it is necessary to contact the prefectural governor and obtain guidance from the prefecture as conventionally.

## 2. (Safety and health management system in a large-scale work site)

### (1) Appointment of a General Safety and Health Manager (Article 10 of the Industrial Safety and Health Act)

The Operator shall appoint a General Safety and Health Manager for each work site depending on its scale<sup>※</sup> specified by a Cabinet Order, in accordance with the Ordinance of the Ministry of Health, Labor and Welfare. The Operator shall have the appointed Manager take charge of the task of instructing a Safety Officer, a Health Officer, or a person who manages technical matters pursuant to the provisions of Article 25-2, paragraph (2) of the Industrial Safety and Health Act and supervising the implementation of the following operations.

- 1) Necessary measures to prevent danger or health impairment of worker.
- 2) Implementation of the education for the worker's safety or health.
- 3) Implementation of health examinations and other measures to maintain and promote worker's health.
- 4) Investigation of cause of occupational accident and measures to prevent recurrence.
- 5) Other work necessary to prevent occupational accidents, which is specified by the Ordinance of the Ministry of Health, Labor and Welfare (Article 3-2 of the Ordinance on Industrial Safety and Health Act, "works and operations supervised by the General Safety and Health Manager")

#### 5.1) Manifestation of health and safety policy

5.2) Investigation of hazards or harmfulness <sup>※※</sup> and measures to be taken based on the results.

5.3) Preparation, implementation, evaluation and improvement of health and safety plan.

※ Work sites which regularly employ 100 or more workers for geothermal well drilling (Article 2 of the Order for Enforcement of Industrial Safety and Health Act)

※※ Investigation of the danger or harmfulness stipulated in Article 28-2, paragraph (1) or Article 57-3, paragraphs (1) and (2) of the Industrial Safety and Health Act

Article 28-2, paragraph (1) The Operator shall, as provided for by the Ordinance of the Ministry of Health, Labor and Welfare, endeavor to investigate the danger or harm, etc., due to buildings, facilities, raw materials, gases, vapors, dust, etc., and those arising from work actions and other duties. The Operator shall, based on the results of the said investigations, take necessary measures to prevent dangers or health impairment to workers, in addition to taking the measures provided for by the provisions pursuant to this Act or the orders. However, in the case of investigation other than investigation of chemicals, preparations containing chemicals and others, which are likely to bring about danger or health impairment to workers, this shall apply to the Operator of the undertaking in the manufacturing industry or other industries provided for by the Ordinance of the Ministry of Health, Labor and Welfare.

Article 57

Substances that is explosives, pyrophorics, or flammables and other substances, which are liable to cause danger to workers, or benzene, preparations containing benzene or other substances which are liable to inflict health impairment upon workers and are provided for by Cabinet Order, or the substances set forth in paragraph (1) <sup>※</sup>of the preceding Article, shall, (snip) indicate (snip) on the container or the package.

※ Article 56 (snip) dichlorobenzidine, preparations containing dichlorobenzidine or other substances which are likely to inflict serious health impairment upon workers (snip)

Article 57-3, paragraph (1) An Operator (snip) shall, in advance, undertake an investigation of toxicity of substances defined by the Cabinet Order among which are liable to cause danger or health impairment to workers, or the substances set forth in the provisions of paragraph (1) of Article 57, provided for by the Ordinance of the Ministry of Health, Labor and Welfare.

paragraph (2) The Operator who has carried out the investigation of toxicity, shall take necessary measures in a timely manner, based on the result of the said investigation for preventing impairment of workers' health caused by the said new chemical substance.

paragraph (3) In addition to the matters covered by Article 28, paragraphs (1) and (3), other matters necessary for the appropriate and effective implementation of the notification in the two preceding paragraphs are provided for by the Ordinance of the Ministry of Health, Labor and Welfare.

paragraph (4) The Ministry of Health, Labor and Welfare may provide individual companies and organizations of companies with necessary guidance and assistance, etc., under the guidelines in

the preceding paragraph.

(2) Appointment of a Safety Officer (Article 11 of the Industrial Safety and Health Act)

The Operator shall, as provided for by the Ordinance of the Ministry of Health, Labor and Welfare, appoint a Safety Officer from among those in possession of the qualification<sup>※※</sup> provided by the Ordinance of the Ministry of Health, Labor and Welfare at each work site of the scale<sup>※</sup>, and in the industries defined by Cabinet Order, and have the said Safety Officer take charge of the technical matters related to safety among the matters listed below.

- 1) Necessary measures to prevent danger or health impairment of worker.
- 2) Implementation of education for worker's safety or health.
- 3) Implementation of health examinations and other measures to maintain and improve the health of workers.
- 4) Investigation of cause of occupational accident and measures to prevent recurrence.
- 5) Other work necessary to prevent occupational accidents, which is specified by the Ordinance of the Ministry of Health, Labor and Welfare
  - 5.1) Manifestation of health and safety policy
  - 5.2) Investigation of hazards or harmfulness and measures to be taken based on the results.
  - 5.3) Preparation, implementation, evaluation and improvement of health and safety plan.

※ Work site which regularly employ 50 or more workers (Article 2 of the Order for Enforcement of Industrial Safety and Health Act)

※※ The qualifications required for the person to be appointed are as follows.

- 1) Those that have completed the training specified by the Minister of Health, Labor and Welfare and meet any of the following.
  - Person who have graduated from a university science course and have more than two years of experience in industrial safety.
  - Person who have graduated from a high school etc. science course and have more than 4 years of experience in industrial safety.
  - Others stipulated by the Minister of Health, Labor and Welfare (Those that have more than 4 years of experience in industrial safety after graduating from a university other than science, those that have more than 6 years of experience in industrial safety after graduating from the similar high school, and those that have more than 7 years of experience in industrial safety, etc.)
- 2) Occupational safety consultant

(3) Appointment of a Health Officer (Article 12 of the Industrial Safety and Health Act)

The Operator shall, as provided for by the Ordinance of the Ministry of Health, Labor and Welfare, appoint a Health Officer according to the type of the operation, from among those with the certificate from the Director of the Prefectural Labor Bureau or those in possession of the qualification<sup>※</sup> provided for by the Ordinance of the Ministry of Health, Labor and Welfare at each work site of the scale by Cabinet Order and have the said Health Officer take charge of the technical matters related to health among the matters listed below.

- 1) Necessary measures to prevent danger or health impairment of worker.
- 2) Implementation of education for worker's safety or health.
- 3) Implementation of health examinations and other measures to maintain and improve the health of workers.
- 4) Investigation of cause of occupational accident and measures to prevent recurrence.
- 5) Other work necessary to prevent occupational accidents, which is specified by the Ordinance of the Ministry of Health, Labor and Welfare
  - 5.1) Manifestation of health and safety policy
  - 5.2) Investigation of hazards or harmfulness<sup>※※</sup> and measures to be taken based on the results.
  - 5.3) Preparation, implementation, evaluation and improvement of health and safety plan.

※The qualifications required for the person to be appointed are as follows.

- 1) Those having the class-1 health officer's license, the health officer's license on industrial hygiene, doctor, dentist, or occupational health consultant, etc.
- 2) Health officer (Class 1 / Class 2)
  - Those who passed the health officer's license examination (Class 1 / Class 2).
  - Public health nurses, pharmacists, etc.
- 3) Health officer on industrial hygiene
  - Those that have graduated from a university or college of technology after completing a course related to engineering or science, and have completed a designated course, etc.

(4) Occupational Physician (Article 13 of the Industrial Safety and Health Act)

The Operator shall, at each work site of the scale defined by Cabinet Order, appoint an occupational physician from medical doctors, and have the said person take charge of managing the following items.

- 1) Implementation of health examinations and interview guidance, etc., and measures to maintain the health of workers based on these results
- 2) Maintenance of work environment
- 3) Work management
- 4) Health management of workers
- 5) Health education, health counseling and other measures to maintain and improve the health of workers
- 6) Hygienic education
- 7) Investigation of cause of health impairment of worker and measures to prevent recurrence

※The qualification required for the person to be appointed are as follows.

- 1) Those that have completed the training specified by the Minister of Health, Labor and Welfare (Basic training in industrial medicine by the Japan Medical Association, Basic course of industrial medicine at the University of Occupational and Environmental Health, Japan)
- 2) Those that have passed the occupational health consultant examination in the category of health and hygiene

- 3) Those experienced as a professor, associate professor, or full-time lecturer in charge of occupational health subjects at the university
- 4) Those that have more than 3 years of experience as an industrial physician as of the end of September 1998 (transitional measures)

(5) Operation chief (Article 14 of the Industrial Safety and Health Act)

Described above (1.7)

(6) Overall Safety and Health controller (Article 15 of the Industrial Safety and Health Act)

When the Operator has contractors to carry out a part of the work in an undertaking executed at one place, and its undertaking is related to construction or other industries prescribed by Cabinet Order, the Operator shall, where workers employed by the operator and by the contractors perform work at the said place, appoint an Overall Safety and Health Controller in order to prevent industrial accidents which may occur as a result of the work carried out by these workers at the same place. The operator has that person take charge of directing the work of Principal Safety and Health Supervisor, as well as exercise overall control of the following items (Article 30, paragraph (1)). The position of the Overall Safety and Health Controller shall be filled by a person who exercises overall control of the execution of the undertaking at the said place.

- 1) Establish and operate a consultative organization
- 2) Communicate and coordinate between tasks
- 3) Patrol the work area.
- 4) Provide guidance and assistance regarding the education for worker's safety and health conducted by the involved contractors
- 5) Develop a plan for the work process, as well as a plan for the placement of machines, equipment, etc. at the work site, and give instruction to the relevant contractor in taking measures regarding the work using the said machines, equipment, etc. based on the said law or the provisions of orders based on the said law.
- 6) In addition to the matters listed in each preceding item, necessary matters to prevent the occupational accidents.

(7) Principal Safety and Health Supervisor (Article 15-2 and Article 30, paragraph (1) of the Industrial Safety and Health Act)

As provided for by the Ordinance of the Ministry of Health, Labor and Welfare, the operator who has appointed an Overall Safety and Health Controller shall also appoint a Principal Safety and Health Supervisor from among those that have the qualifications specified by the Ordinance of the Ministry of Health, Labor and Welfare. The operator shall have the said person take charge of technical matters out of the matters listed in each item of Article 30, paragraph (1), as shown below.

- 1) Establish and operate a consultation organization.
- 2) Communicate and coordinate between tasks.
- 3) Patrol the work area.

- 4) Provide guidance and assistance regarding the education for worker's safety and health conducted by the involved contractors.
- 5) Develop a plan for the work process, as well as a plan for the placement of machines, equipment, etc. at the work site, and give instruction to the relevant contractor in taking measures regarding the work using the said machines, equipment, etc. based on the said law or the provisions of orders based on the said law.
- 6) In addition to the matters listed in the preceding each item, necessary matters to prevent the occupational accidents.

※The qualification required for the person to be appointed are as follows.

- 1) Those that have completed a science course at a university or a college of technology and have more than 3 years of practical experience in safety and health at a construction site after graduation. (5 years of experience for non-science course graduate)
- 2) Those that have completed the science course in high school and have more than 5 years of practical experience in health and safety at construction sites after graduation. (8 years' experience for non-science course graduate)
- 3) Those that have more than 10 years of practical experience in safety and health at construction sites.

(8) Appointment of a Site Safety and Health Supervisor (Article 15-3 of the Industrial Safety and Health Act)

Not applicable to geothermal well drilling site

※The number of workers is determined regarding the construction of tunnels, bridges, pressure-air construction, and the construction of buildings with main structural parts of steel or steel-framed reinforced concrete, since those operation may involve a high risk of accidents due to mixed-group work among the construction works, and there is a high need for Overall Safety and Health management by the Principal Operator.

(9) Safety and Health Controller (Article 16 of the Industrial Safety and Health Act, Article 19 of the Ordinance on Industrial Safety and Health)

Apart from the operator who shall appoint an Overall Safety and Health Controller, a contractor, who oneself performs the work involved, shall appoint a Safety and Health Controller, who shall be assigned with the tasks specified by the Ordinance of the Ministry of Health, Labor and Welfare, including the communication with the Overall Safety and Health Controller.

- 1) Communicate with the Overall Safety and Health Controller
- 2) Share the information provided by the Overall Safety and Health Controller among the involved persons.
- 3) Manage the implementation of measures related to the relevant contractor concerning the issues informed by the Overall Safety and Health Controller cited in 2)
- 4) Coordinate with the Overall Safety and Health Controller to ensure consistency between the plan prepared by the relevant contractor for the implementation of the work of their workers and the plan ((7) 5)) prepared by the specified principal operator.

- 5) Confirm the presence or absence of danger related to occupational accidents caused by work performed by the contractor's workers and work performed by workers other than the contractor's workers, under Article 15, paragraph (1) of the Industrial Safety and Health Act (occupational accidents caused by the work of workers of the specified principal contractor and involved contractors being performed in the same place).
- 6) Communicate and coordinate with the Safety and Health Controllers of the other contractor when the contractor outsources a part of the work to another contractor.

(10) Safety Committee (Article 17 of the Industrial Safety and Health Act)

The Operator shall establish a Safety Committee at each work site of the scale and in the industries defined by Cabinet Order, in order to have it investigate and deliberate on the following matters and submit its opinion to the Operator:

- 1) Basic measures for preventing dangers to workers
- 2) Safety issues among the causes of industrial accidents and countermeasures to prevent its recurrence
- 3) In addition to the matters listed in the preceding two items, important matters regarding the prevention of dangers to workers.

(11) Health Committee (Article 18 of the Industrial Safety and Health Act)

The Operator shall establish a Health Committee at each work site of the scale defined by Cabinet Order, in order to have it investigate and deliberate on the following matters and submit its opinion to the Operator:

- 1) Basic measures for preventing worker' health impairment
- 2) Basic measures for maintaining and improving the health of workers
- 3) Health issues among the causes of industrial accidents and countermeasures to prevent its recurrence
- 4) In addition to the matters listed in preceding three items, important matters regarding to the prevention of workers' health impairment and maintaining and improving the workers' health.

(12) Safety and Health Committee (Article 19 of the Industrial Safety and Health Act)

The Operator may, where it has to establish the Safety Committee and the Health Committee under the provisions of Articles 17 and 18, establish a Safety and Health Committee in lieu of the respective committees in order to have the following matters investigated and deliberated and submit its opinion to the Operator.

- 1) Basic measures for preventing workers' danger and health impairment
- 2) Safety and health issues among the causes of industrial accidents and countermeasures to prevent its recurrence
- 3) Basic measures for maintaining and improving the health of workers
- 4) In addition to the matters listed in preceding three items, important matters regarding the prevention of workers' danger, health impairment, and maintaining and improving the workers' health.

The Overall Safety and Health Controller (overall management officer) shall establish a council organization

(accident prevention council, etc.) for contractors and hold regular meetings.

1) Members of the Committee (Article 19, paragraph (2) of the Industrial Safety and Health Act)

- The chairman shall be appointed by the Operator among those that supervise the implementation of the business or those that are equivalent to the above.

- Other members shall be safety officers, health officers, and industrial physicians, and half of the "other members" shall be nominated based on the recommendation of a Labor union organized by a majority of the workers, or a person representing the majority of workers.

2) Record of the meeting (Article 23, paragraph (4) of the Ordinance on Industrial Safety and Health)

The Operator shall make a record regarding the important proceedings discussed at each committee meeting and keep the records for three years afterwards.

3) Notification of the outline of the discussion (Article 23, paragraph (3) of the Ordinance on Industrial Safety and Health) The Operator shall promptly notify workers of an outline of the proceedings discussed at every committee meeting, using any of the following methods:

- To post or place a notice at a readily visible place at any given time in each work site.

- To distribute a written notice to the workers.

- To record a notice on the magnetic tapes, magnetic discs or other similar devices, and to place instrument in the each work sites, which the workers can view the said notice at any given time.

### Section 3: Notification and approval of license

#### 1. (Notification)

(1) According to the Industrial Safety and Health Act and Labor Standards Act, in the case of construction, remodeling, and demolition work of derrick and other machines and buildings with a height of more than 31m (Article 88, paragraph (3) of the Industrial Safety and Health Act, Article 90 of the Ordinance on Industrial Safety and Health), and installation, relocation or alteration of accommodations attached to the work site (Article 96-2 of the Labor Standards Act), it is stipulated that the plan shall be submitted to the Chief of the Labor Standards Inspection Office of the jurisdiction at least 14 days in advance.

(2) In the High Pressure Gas Safety Act before the amendment, when operating a compressor that handles compressed gas (including compressed air) with a pressure of 1MPa or more at normal temperatures, it was necessary to apply to the prefectural governor for its consultation. As described above, the Cabinet Order on High Pressure Gas Control was partially amended in July 1987, and it stipulates that the High Pressure Gas Safety Act would not be applied to compressed air at gauge pressure of 5MPa or less at a temperature of 35°C. However, as compressors handling higher pressure are subject to the same regulations as previously, and the treatment under regulations may differ depending on the prefecture, this guideline only describes as "apply to the prefectural governor for its consultation".

(3) Installation of a mobile generation facility for private use with an output of less than 1,000kW

When installing a mobile generation facility for private use with an output of less than 1,000kW, submission of a construction plan to the Minister of Economy, Trade and Industry is not required, but it is necessary to submit a notification of appointment of a Chief Electricity Engineer and safety regulations (Articles 42, 43,

47 and 48 of the Electricity Business Act.)

Items to be included in the safety regulations are stipulated in Article 50 of the Ordinance on the Electricity Business. Please refer to the excerpts of relevant laws and regulations for the examples of safety regulations in the case of work sites where mobile electric facilities are installed.

(4) Installation of a mobile generation facility for private use with an output of 1,000kW or more

The operator, when installing a mobile generation facility for private use with an output of 1,000kW or more, shall notify the Minister of Economy, Trade and Industry of the construction plan, the appointment of a Chief Electricity Engineer, and the safety regulations based on the Electricity Business Act. In addition, construction shall not be started until 30 days from the date of the reception of the construction plan.

(5) Installation of a mobile receiving facility for private use without installing power generation equipment

In the case only the receiving equipment for electric facilities for private use is installed, the regulation contents differ depending on the scale of the receiving equipments, as described below.

1) Construction plan

When an operator installs a demand facility for private use with a receiving voltage of less than 10,000V and a maximum power of less than 500kW, a submission of the construction plan is not required (Article 48 of the Electricity Business Act, Articles 56 and 65 of the Ordinance on the Electricity Business) (a notification of appointment of the first to third class Chief Electricity Engineer and safety regulations are required).

When installing a demand facility for private use with a receiving voltage of 10,000V or more or a maximum power of 500kW or more, it is necessary to submit a prior notification of construction plan to the Minister of Economy, Trade and Industry (Article 48 of the Electricity Business Act, Article 65 of the Ordinance on the Electricity Business) (a notification of appointment of the first to third class Chief Electricity Engineer and safety regulations are required).

2) A Chief Electricity Engineer

An appointment of a Chief Electricity Engineer is stipulated in the Electricity Business Act (refer to the table “Summary List of Notifications, Licenses, and Approvals for Electric Facilities for Private Use” shown in 3-(3) of this document).

The scope of safety supervision by the first, second and third class Chief Electricity Engineer licenses is described in Section 2, 1.7, (13) of this document or Article 56 of the Ordinance on the Electricity Business Act.

Individual permit: regarding an electric facility for private use, in case of an installation of only a generation facility with a maximum generation of less than 500kW or an electricity receiving facility with a maximum power of less than 500V, an person without the Chief Electricity Engineer license can also be appointed as a Chief Electricity Engineer with the permission of the Minister of Economy, Trade and Industry (in the case of one bureau of jurisdiction, the Director of the Regional Bureau of Ministry of Economy, Trade and Industry) (Article 43, paragraph (2) of the Electricity Business Act, Interpretation and Operation of the System on Chief Electricity Engineer, Circular 1 of the Agency for Natural Resources and Energy on September 24, 2020).

Individual permit is not applicable to an electrical facility with a maximum power of 500V or more (Interpretation and Operation of the System on Chief Electricity Engineer, Circular 1 of the Agency for Natural Resources and Energy on September 24, 2020)

Approval of non-appointment: For work sites related only to demand facility that receives power at a voltage of 7,000V or less, it is possible, with the permission of the Minister of Economy, Trade and Industry (in the case of one bureau of jurisdiction, the Director of the Regional Bureau of Ministry of Economy, Trade and Industry), not to appoint a Chief Electricity Engineer and instead to outsource the electricity security work to an authorized corporations (Section 2, 1.7, (13) of this document cited above, Article 52, paragraph (2) of the Ordinance on Electricity Business).

In case of a demand facility that receives power at a voltage of over 7,000V, approval of non-appointment is not applicable (Article 52, paragraph (2) of the Ordinance on the Electricity Business).

### 3) Safety regulations

When installing a demand facility for private use, safety regulations shall be established and submitted to the Minister of Economy, Trade and Industry based on the Electricity Business Act, regardless of the scale of the facility (Article 42 of the Electricity Business Act and Article 50 of the Ordinance on the Electricity Business).

## 2. (Inspections, etc.)

Among containers such as separators, containers containing liquid with a temperature exceeding the boiling point at atmospheric pressure inside and whose pressure is above atmospheric pressure are the class-1 pressure vessels according to Article 1 of the Cabinet Order on Industrial Safety and Health and are subject to various regulations. The main regulations are described below.

**Permission for Manufacturing:** An operator who is to manufacture a class-1 pressure vessels shall be approved in advance by the Director of the Prefectural Labor Bureau for the class-1 pressure vessels concerned (Article 49 of the Ordinance on Safety of Boilers and Pressure Vessels).

**Structural inspection:** An operator who is to manufacture a class-1 pressure vessels shall have the vessel inspected by the Director of the Labor Bureau or by an agency registered by the Minister of Health, Labor and Welfare (hereafter referred “the Authorized Agency for Inspection at Time of Manufacture”) (Article 51 of the Ordinance on Safety of Boilers and Pressure Vessels).

**Welding inspection:** An operator who is to weld a class-1 pressure vessel shall have the relevant vessel inspected by the Director of the Labor Bureau or the Authorized Agency for Inspection at Time of Manufacture, etc. (Article 53 of the Ordinance on Safety of Boilers and Pressure Vessels).

Anyone other than who is qualified as special class boiler welding shall not weld class-1 pressure vessel. However, this does not apply to the welding operation for which the thickness of welding part is not over 25mm, or which is applied for connection of such as nozzles and flanges. (Article 55 of the Ordinance on Safety of Boilers and Pressure Vessels).

**Installation notification:** When the operator who is to install a class-1 pressure vessel shall submit a Notification on

Installation of it to the Chief of the Labor Standards Inspection Office. (Article 56 of the Ordinance on Safety of Boilers and Pressure Vessels).

Completion inspection: An operator who installed a class-1 pressure vessel shall have the relevant vessel inspected by the Chief of Labor Standards Inspection Office. (Article 59 of the Ordinance on Safety of Boilers and Pressure Vessels).

Inspection certificate: The Chief of the Labor Standards Inspection Office shall issue a class-1 pressure vessel inspection certificate in relation to the first class pressure vessel which passed the completion inspection. (Article 60 of the Ordinance on Safety of Boilers and Pressure Vessels.) The certificate will expire one year. (Article 72 of the Ordinance on Safety of Boilers and Pressure Vessels)

Periodical self inspection: With regard to a class-1 pressure vessel, the operator shall implement periodical self inspection, regularly, and at least once for every month. (Article 67 of the Ordinance on Safety of Boilers and Pressure Vessels)

Limitation on assignment: The operator shall not assign a worker other than qualified boiler mechanic the maintenance work of class-1 pressure vessels. (Article 70 of the Ordinance on Safety of Boilers and Pressure Vessels)

Performance inspection: An operator who intends to renew the expiration date of a class-1 pressure vessel inspection certificate shall undergo a performance inspection in respect of its performance. (Article 73 of the Ordinance on Safety of Boilers and Pressure Vessels)

### 3. (License and approvals)

(1) Article 25, paragraph (1) of the Explosives Control Act stipulates that an operator who intends to explode or burn explosives is required to obtain the permission of the governor of the prefecture of the jurisdiction.

In case the use of explosives for back-off tools (fuse, detonator) in the well is necessary, the application and approval procedure to obtain explosives will take about 10 days, therefore an application shall be submitted in advance if such an occasion is anticipated. The detail of the application procedure shall be confirmed with the explosives department of the prefectural office of the jurisdiction.

(2) According to Article 11, paragraph (1) of the Fire Service Act, when installing a storage facility for combustibles or flammable substances (fuel tank), in the municipality where the fire department headquarter and fire department are located, it is necessary to obtain the permission of the mayor of the municipality, and in other areas, the permission of the prefectural governor who has jurisdiction over the area is required. In addition, the equipment standards shall comply with the Cabinet Order on the Control of Hazardous Materials. It is desirable to consult with a qualified local expert since the regulation is complicated and diverse and there are differences depending on the region.

(3) Under the former Electricity Business Act, it is to be approved when installing a generation facility for private use with an output of 5,000kW or more, or when installing a demand facility for private use with a power receiving voltage of 10,000V or more (Articles 70 and 71 of the former Electricity Business Act, Articles 70

and 71, Annexed Tables 2 and 4 of the Appendix of the Old Ordinance on Electricity Business).

In the former regulations, there was a requirement for submitting the construction plan for approval and other necessary matters to the director of the competent Ministry of Economy, Trade and Industry, notification of the appointment of Chief Electricity Engineer, notification of the electrical safety regulations, and implementation of various procedures such as pre-use inspection after the completion of electrical work. However, the Electricity Business Act amended in 1995 drastically deregulated the licensed items. In other words, the activity with the scale of geothermal power generation is exempted from the requirement of approval of construction plans and pre-use inspection procedures.

As mentioned above and in Section 2, 1.7 (13), Section 3, 1 (3), (4), (5), etc., there are a wide range of notification items and license items related to electric facilities for private use, which also varies depending on the scale of the electric facility, making it difficult to understand.

The table "Summary list of notifications, licenses, and approvals for Electric Facilities for Private Use" shown below summarizes the license system, which will help understand the related laws and regulations, together with the excerpts of related laws and regulations.

Summary List of Notifications, Licenses, and Approvals for Electric Facilities for Private Use

Category	Facility Scale	Prior notification of construction plan	Chief Electricity Engineer			Notification of safety regulations
			Notification of appointment	Individual permit	Approval of non-appointment due to outsourcing contract	
Internal-combustion mobile power generator	Less than 500kW			◎		
	500kW or more and less than 1,000kW	▲	○	×	◎	○
	1,000kW or more	○			×	
Receiving facility	500kW or more and less than 10,000V	▲		◎		
	Less than 500kW				◎	
	500kW or more and less than 7,000V	○	○	×		○
	7,000V or more				×	
Relevant regulations	Act	Article 47, 48	Article 43, paragraph (3)	Article 43, paragraph (2)	Article 43	Article 42
	Ordinance	Articles 62, 65, Table 2,4	Article 52, paragraph (1)		Article 52, paragraph (2) Article 53	Article 50
	other			Circular 1 September 24, 2020		

▲: No notification required ◎: License matters

○: Notification required ×: Application not possible

Act : The Electricity Business Act

Ordinance : The Ordinance on the Electricity Business

Circular 1 : Interpretation and Operation of the System on Chief Electricity Engineer,

Circular 1 of the Agency for Natural Resources and Energy on September 24, 2020

## Section 4: First-aid in accident

### 1. (Obligation of notification)

It stipulates that the operator shall always have clean first-aid tools and notify workers how to use them and first-aid procedure, applying Articles 633 and 634 of the Ordinance on Industrial Safety and Health.

### 2. (First-aid)

It stipulates that when a serious injury occurs, the operator shall immediately contact a doctor, in accordance with Article 105 of the former Mine Safety Regulations.

### 3. (Report of accident)

The company shall submit an accident report in the event of an accident, explosion, an incident involving collapse of a building, or Worker Death and Injury Report when a worker dies or is absent from work for 4 days or more due to work accident, to the Chief of the Labor Standards Inspection Office of the jurisdiction without delay, under the Industrial Safety and Health Act. If the absence is less than 4 days, a quarterly report is sufficient (Articles 96 and 97 of the Ordinance on Industrial Safety and Health).

The similar provision is stipulated in Mine Safety Act, but this guideline follows the Industrial Safety and Health Act.

### 4. (Development of sketch, etc.)

In the event of accident, the development of a layout plan of the accident location and the conservation of the site condition at the time of accident, as necessary, is stipulated in the former Mine Safety Regulations, and this was referred to Articles 96 and 106 of the former Mine Safety Regulations.

### 5. (Investigation cause of accident and prevention of accident)

There are no relevant provisions in the Industrial Safety and Health Act, Mine Safety Act etc., however this guideline specifically stipulates this regulation since it is essential to investigate the cause of the actual accident and establish preventive measures to prevent similar accidents.

## Section 5: Safety education, clothing and discipline, safety promotion activities

### 1. (Safety education)

The Industrial Safety and Health Act stipulates that the operator shall provide education for safety or health on the following items to the newly assigned foreman and other persons who directly instruct or supervise the workers in work (excluding the work chief) according to the Ordinance on Industrial Safety and Health (Article 60 of the Industrial Safety and Health Act).

(1) Decision of work procedure and placement of workers

(2) Method of guidance or supervision to workers

(3) In addition to the items listed above in (1) and (2), items necessary to prevent occupational accidents that are specified by the Ordinance of the Ministry of Health, Labor and Welfare.

The following items are stipulated for the items in (3). In addition, the minimum hours of education are stipulated for items in (3) as well as (1) and (2) above (Article 40 of the Ordinance on Industrial Safety and Health).

- 1) Investigation of the danger or harm, etc., as prescribed in Article 28-2, paragraph (1) of the Industrial Safety and Health Act, or Article 57-3, paragraphs (1) and (2) of the same Act, and measures to be taken based on the results of the said investigation
- 2) Measures to be taken at the time of abnormalities, etc.
- 3) Other actions to be taken by site supervisor with regard to prevention of industrial accidents.

The operator may, omit the education concerning these, for a person who is deemed to have sufficient knowledge and skill of all or part of the matters (Article 40 of the Ordinance on Industrial Safety and Health).

As mentioned above, the Industrial Safety and Health Act stipulates that special safety education is required when workers are assigned to the 49 designated hazardous or harmful operations (Article 59, paragraph (3) of the Industrial Safety and Health Act, Article 36 of the Ordinance on Industrial Safety and Health), and the contents of which are stipulated in the Safety and Health Special Education Regulations (Notification of the Ministry of Health, Labor and Welfare). The Mine Safety Act also stipulates the necessary education required for various qualified persons and designated miners for specific work specified after a similar policy as the provisions of the Industrial Safety and Health Act. In this guideline as well, regarding the works specified in the Industrial Safety and Health Act and those cited in the Mine Safety Act in common, it is stipulated that special education shall be provided for the following works (1) to (4), in addition to the various qualified personnel education and skill training described in Section 2, Paragraph 1.6 of this Guideline, aiming at ensuring thorough safety education.

(1) Operation of well drilling rig

Article 57, paragraph (1) of the former Mine Safety Regulations stipulates that mining rights holders shall implement necessary safety education for miners who perform drilling work with rigs. This education shall be carried out by the operator at each site.

(2) Arc welding work

(3) Slings work for mobile cranes with a hoisting capacity of less than 1t

(4) Operation of a forklift with a capacity of maximum load less than 1t

The work (1) above can be carried out by a qualified person for operating of mobile crane with a hoisting capacity of 5t or more. The work (3) can be carried out by a qualified person for slinging of a mobile crane with a hoisting capacity of 1t or more. Otherwise, an unqualified person shall complete special health and safety education, according to Article 59 of the Industrial Safety and Health Act and Article 36 of the Ordinance on Industrial Safety and Health. Special education is conducted once to twice a year (a training period of about 2 days) by the Labor Standards Bureau-related organizations, and a person having certificate of completion of this training is qualified for the above works.

Please refer to the following organizations for the details.

Tokyo Labor Bureau, Labor Standards Department, Supervision Division

(telephone) 03-3512-1612

Tokyo Federation of Labor Standards Associations

(telephone) 03-5678-5556

Konan Crane Training Institute (Saitama Prefecture)

(telephone) 048-539-0877

## 2. (Clothing and discipline of workers)

Articles 194 and 558 of the Ordinance on Industrial Safety and Health require the use of protective caps and safety shoes (see Articles 151, 538 and 539 of Ordinance on Industrial Safety and Health), and Article 72 of the former Mine Safety Regulations states that regulations shall be established regarding clothing during work.

Furthermore, to protect the safety of work at the work site, it is necessary to establish work site safety discipline such as prohibition of working with cigarettes and alcohol, and it is specifically stipulated in the guideline to ensure implementation.

## 3. (Safety promotion activity)

The activities that are generally performed as a safety promotion activity at the work site are described in the Guidelines. Many of them are not legally stipulated, but they are effective for raising safety awareness at work sites. A person equivalent to the Overall Safety and Health Supervisor specified in Section 2 of this Guideline is strongly encouraged to promote activities on a regular basis by taking the opportunity to hear the opinions of the consultation organization organized with the relevant contractors and other relevant workers.

Examples of specific safety promotion activities are shown below. It is desirable that these are carried out under the lead of the safety and health promoters.

### (1) Accident case study

The procedure for accident case studies is explained below.

#### 1) Verification of facts

The main items (date and time, place, situation, cause, etc.) of the accident occurrence situation are verified, and the facts and information necessary for solving the case are comprehended accurately.

#### 2) Finding problems

If there is a fact that deviates from the standard, judged from the facts grasped in (1), extract it as a problem and analyze the reason.

#### 3) Specifying the fundamental problem

From the problems extracted in (2), the fundamental problem, which was the central factor of the accident, is examined and specified, and the causes of the accident are summarized.

#### 4) Establishment of countermeasures

Take risk reduction measures to prevent recurrence based on the fundamental problem and the causes of the accident.

(2) Safety training

Training shall be conducted as appropriate according to the drilling method, such as an operation test of the blowout preventer as a measure to prevent a blowout, and a training to wear respiratory protective equipment as a measure to prevent effect of hydrogen sulfide blowout. Furthermore, check for the operating condition of the water supply device (casing spool), gas concentration meter, etc. shall be implemented.

(3) Pre-start / pre-end meetings

An on-site manager such as safety and health promoter shall hold a meeting to give daily work safety instructions to every person on work site before the start of work. Also, before the end of work, a meeting shall be held to report the accidents occurred in the work on the day and to confirm the work contents on the next day. The meeting usually includes the contents of (4) Near-miss accident report and investigation, (5) Hazard identification activity, and (6) Health management described below.

(4) Near-miss accident report and investigation

Near-miss accident report and investigation is an activity which recognizes and shares the cases that did not lead to an accident but was on the verge of a serious accident, as well as investigates the cause and takes countermeasures aiming at preventing occupational accidents and recurrence.

It is one of effective methods to understand the work-related hazards.

(5) KY activity (Hazard identification activity)

Hazard prediction activity is an activity to confirm what kind of hazard and harm exist for the work contents of the day, who responds to each hazard, and how to deal with them, before starting the work. Routine minutes of the meeting shall be kept to prevent omissions and to share awareness. It is carried out not only daily, but also monthly or weekly bases. Further, when starting work in a new work site, the hazard and harm specific to that site shall be examined, and when starting new work or operating new machine in the work site, it is necessary to reexamine the hazard and harm specific to the work and the machine.

(6) Health management

The on-site manager such as safety and health promoter shall check the health condition of workers and confirm that no one in bad health condition is in work. It is desirable to prepare a check-sheet for body temperature, sleep status, diet, physical condition, etc.

Check of work breaks and water supply is necessary during work to prevent heat stroke. Check-sheets shall be prepared as appropriate according to the heat index of the working day.

(7) Education for new workers

Education shall be provided for new workers on the site about the conditions of the site, work outline, hazardous places, rules at the work site, etc.

According to the Industrial Safety and Health Act, it is stipulated that when an operator hires a worker or changes the work content of the worker, the worker shall be educated without delay on matters necessary for safety or health regarding his work (Article 59 of the Industrial Safety and Health Act, Article 35 of the Ordinance on Industrial Safety and Health).

Furthermore, there are other effective safety measures to improve quality and safety of work such as "pointing and calling" or pointing to work objects, signs, signals, measurement instruments and confirm their names and status aloud, and an intensive implementation of "5 elements" (sorting, setting-in-order, cleaning, sanitation, discipline).

It shall be noted that the safety and health education for workers from outside of Japan, increasing in recent years, shall be carried out with special consideration to ensure that the work procedures and safety rules are fully understood. The Ministry of Health, Labor and Welfare publishes the following checklist \*.

※<https://www.mhlw.go.jp/content/000520596.pdf>

Checklist for safety and health education for workers from outside of Japan			<input type="checkbox"/>
1	Implementation of safety and health education	Is safety and health education actually carried out? (When hiring or changing work content, etc.)	<input type="checkbox"/>
2	Understanding of work procedure	Is the work procedure presented in an understandable way, such as explaining in a language that foreign workers can understand (their mother tongue, for example)?	<input type="checkbox"/>
3	Understanding of instructions and signals	Are the workers given opportunity to learn necessary Japanese and basic signs that they can understand the instructions for preventing occupational accidents?	<input type="checkbox"/>
4	Understanding of signs and notices	Are the signs and notices for occupational accidents prevention given in an easy-to-understand feature, such as using illustrations?	<input type="checkbox"/>
5	Possession of license / qualification	Aren't any unqualified persons assigned work that requires a license or completion of a skill training course?	<input type="checkbox"/>

English version of this Guideline might contribute to the education of workers from outside of Japan.

## Chapter 2 Ensuring safety

### Section 1: Spindle type drilling machines

At present, spindle type drilling machine used for drilling geothermal wells include spindle type machine, drive head type machine, and universal type machine which equipped with a rotary table on the spindle or drive head type.

This section describes the basic safety and compliance items for preparation, operation, and post-work maintenance in order to operate the spindle drilling machine safely.

#### 1. (Preparation)

##### 1.1 Mobilization/Transportation

- (1) Since fuel has a low ignition point, it is dangerous and easy to ignite.

When moving or transporting, it may catch fire due to unexpected causes, therefore fuel tank shall be empty completely.

- (2) Oil and lubricant are dangerous and easy to ignite.

During transportation, there is a risk of leakage and ignition due to spark from vibration, etc. Therefore, Gasket/ Gland packing shall be attached to the inlets for oils, hydraulic oil, and gear oil, etc. to prevent leakage.

- (3) If the hydraulic cylinders are left in motion position, the machine may become unbalanced and tip over, therefore they shall be fixed at the shortest stroke end.

- (4) If a hanging device is inadequate, not only the lift load will fall or be damaged, but it will also cause a serious accident. Therefore, a hanging device's capacity shall match the load.

A worker shall not enter under the lift load while lifting operation as it may fall.

- (5) Machine shall be fixed firmly during transportation since it is extremely dangerous if the machine topples or falls.

- (6) A power supply system/ motor shall be stopped because mobilization/transportation of the system in operating condition may lead leakage of fuel and oils or toppling of the machine.

##### 1.2 Installation

- (1) The machine shall be installed horizontally and rigidly fixed with bolts, etc. so that it will not float, shift, or run out during use. The provision of Article 173 of the Ordinance on Industrial Safety and Health shall be applied.

- (2) Bolts and fittings may loosen during transportation and may cause an unexpected accident if used as they are, therefore bolts and fittings shall be retightened.

- (3) The hoist drum shaft and guide pulley shall be installed vertically or facing each other to prevent damage due to irregular winding or deviation of the wire rope (drilling line). The provision of Article 180, paragraph (2) of the ordinance on Industrial Safety and Health shall be applied.

- (4) The distance between the hoist drum and the guide pulley's shaft shall be at least 15 times the width of the drum to prevent damage due to irregular winding or uneven distribution of the wire rope (drilling line). The provision of Article 180 of the Ordinance on Industrial Safety and Health shall be applied.

(5) A safety cover onto the input shafts shall be attached surely since it is dangerous to touch rotating parts such as machine input shafts.

While the spindle or rod is rotating, it shall be installed a cover or a fence around so as workers to prevent from being caught in the spindle or rod. The provision of Article 101 of the Ordinance on Industrial Safety and Health shall be applied.

### 1.3 Before starting operation

(1) Machine shall be inspected for any deformation / damage, loosening of the binding part, and whether it can be operated or not before starting operation.

Machine shall be inspected daily and regularly in order to demonstrate its performance fully.

1) Daily inspection: The amount of hydraulic oil and lubricating oil, leaks, the operating levers / switches, handles, instruments, etc. shall be inspected.

2) Regular inspection: in addition to the daily inspection items, major component such as clutches, hoists, transmissions, swivel heads, and operating devices shall be inspected in detail.

(2) The wire rope (drilling line) shall be inspected for breaking off, wear, corrosion, etc.

Wire ropes shall be inspected daily and regularly.

1) Daily inspection: the wires shall be inspected visually for disconnection, wear, corrosion, shape loss, oiling, etc.

2) Regular inspection: the wires shall be inspected over the entire length of them at least once a month additionally to the daily inspection items, and if there is any point of significant wear, breaking off, or corrosion, the outer diameter of wires shall be measured with calipers.

(3) Wire ropes (drilling lines) that fall under the "Prohibition of using inadequate wire ropes (Article 174 of the Ordinance on Industrial Safety and Health)" shall not be used.

- Inadequate wire ropes are as follows.

1) with any seam

2) kinked

3) diameter of those has decreased over 7% than the nominal one

4) 10% or more of the number of strands is cut at one twist of those

5) significantly deformed or corroded

(4) The safety factor of the wire rope (drilling line) used for the spindle type drilling machine shall be 3 or more based on the maximum static load of the strings.

(5) The number of dead wraps of wire ropes (drilling lines) shall be 2 or more, in order to prevent the end of the wire rope (drilling line) from slipping out of the hoist drum, the provision of Article 184, paragraph (2) of the ordinance on Industrial Safety and Health shall be being applied, however, more than 6 dead wraps are recommended if possible.

(6) Band deformation and lining wear of the hoist band or brake band shall be checked since the hoist band or brake band must be in perfect contact with the wheel.

*Note:* when the total weight of the drill strings increases, the frictional heat increases with the band brake and

the braking ability decreases. Therefore, a hydraulic brake that can adjust the running speed shall be installed to perform the running operation safely.

- (7) The wear and tension of belt shall be checked to make sure it does not interfere with operation.
- (8) It shall be checked whether the specified amount of oil and lubricant is added in the transmission, oil tank, bearing, rotating part, and sliding part.

<<In the case of using a motor for a power supply system>>

- (1) The operation of the switch and the presence or absence of abnormalities shall be checked.
- (2) The earth cables shall be connected surely since if there is no ground connection or if it is incomplete, there is a risk of electric shock.
- (3) The size of the power cable shall be checked for its conformity to electrical capacity and has no damage.
- (4) A test on an earth leakage breaker (circuit breaker) shall be performed since a failure of the earth leakage breaker may result in an electric shock accident.
- (5) The following items shall be paid attention to since there is a risk of electric shock on the switchboard.
  - 1) Foreign material shall not be put inside of the switchboard.
  - 2) Workers shall not touch the switchboard with wet hands.
  - 3) When it rains, the switchboard shall be covered with to prevent water from entering it.
- (6) The capacity of the generator shall be sufficient to supply the required power to the machine and its accessories.

<<In the case of using an engine for a power supply system>>

- (1) The engine shall be used after reading and understanding thoroughly its instruction manual since the characteristics of an engine differ depending on the type of fuel and the cooling method.
- (2) Inspection and maintenance shall be performed according to the manufacturer's instruction manual, but general inspection items are as follows.
  - 1) Daily inspection: amount of lubricant / lubrication status / leakage, cooling water amount / cooling status, fuel supply status, air cleaner status, etc.
  - 2) Weekly inspection: in addition to daily inspections, lubricating oil pumps, fan belts, etc.
  - 3) Monthly/Regular inspection: the following items shall be inspected by an expertise engineer: ignition system, valves, starter device, crankcase, safety device, governor, etc.
- (3) Sufficient ventilation and exhaust shall be provided, and exhaust gas shall not be inhaled, when using in a confined place.

#### 1.4 Trial run/ function test

- (1) A power system shall be started after confirming that each lever or switch of the machine is in the "off" or "neutral" state since it is dangerous because it may suddenly start moving.

In addition, it shall be confirmed that there are no workers around and a signal shall be given before starting.
- (2) The operating status of the clutch, transmission, hoist, swivel head, and hydraulic system shall be inspected, and it shall be confirmed that there are no abnormalities.

(3) It shall be confirmed that there is no damage or oil leakage to the hydraulic control equipment, hydraulic hoses, and joints because troubles in the hydraulic control equipment will interrupt operation or hinder safe operation.

(4) Instruments shall be inspected before drilling operation and calibrated if necessary.

Machine shall be equipped with at least the following equipment.

- 1) bit load meter (bit weight indicator)
- 2) tachometer
- 3) torque meter
- 4) weight indicator

(5) Feeding pressure and balancing force shall be confirmed.

In order to control the bit load properly, the maximum balance force of the machine shall meet the capacity to sufficiently hold the total weight of the drill strings used in the well. Therefore, the supply pressure and balance force should be checked.

## 2. (Operation)

### 2.1 Operation

(1) A trial run shall be conducted before an operation in order to check the operating condition of each device, confirm that there are no abnormalities, and operate the machine safely.

(2) Hoses shall be fixed to a derrick/ mast since it may cause damage if they wrap around the rod or has a lot of runout. The provision of Article 194, paragraph 3 of the ordinance on Industrial Safety and Health shall be applied.

(3) The thread of the water swivel is easy to break out due to the vibration of the rod, therefore it shall be tightened firmly with the thread between water swivel and rod. The provision of Article 177 of the Ordinance on Industrial Safety and Health of the Safety Regulations shall be applied.

Note: threads shall be tightened with the appropriate torque specified in each standard, to prevent problems with the threaded part, when running the rod into the well.

(4) A work with a manual chuck is dangerous, therefore the following items shall be paid attention to, to prevent accidents.

1) The chucking operation shall be performed after the rotation of the chuck body has stopped completely.

- If the chuck body rotates during the chucking operation, the worker may get caught or the chuck wrench may pop out, resulting in personal injury. Therefore, the operation shall be performed after confirming that the rotation has stopped completely. The provision of Article 194-2 of the Ordinance on Industrial Safety and Health shall be applied.

2) A chuck body shall be prevented from rotating during chucking operation.

- In order to ensure safety during chucking operation, the clutch lever shall be fixed, and the shift lever shall be set to the neutral position to ensure that the rotation is stopped.

3) A chuck with a protruding chuck bolt shall not be used.

- Chuck of Buried tower type shall be used since using the protruding chuck is dangerous. The provision

of Article 101, paragraph (2) of the ordinance on Industrial Safety and Health shall be applied.

4) Chucking operation shall be performed with a signal.

- The chucking operation is performed after setting a signal and confirming that the worker has left from the chuck body.

Note: since there are many work accidents with manual chucks, usage of hydraulic chucks is recommended for its excellent workability and safety.

(5) A rod slipping accident will occur if you do not hold it securely with a rod holder or slip.

- The rod holder is an important work device and should be used always after inspecting its wear and operating conditions of the cutting edge.

Note: when using a rod holder to hold the wire line drill rod, a model with a large contact area of the cutting edge shall be used.

Since the tube body of the rod is thin, the rod may become deformed at the holding portion as the weight of the rod increases.

(6) If a load exceeding the hoisting capacity is applied to the hoist, an overload will be applied to the machine, causing damage to it and making it impossible to control the brakes. The provision of Article 172 of the Ordinance on Industrial Safety and Health shall be applied.

(7) If a load is applied while the wire rope (drilling line) is wound randomly, it will not only be damaged and shorten its life, but also may cause a breaking off accident. The provision of Article 184 of the Ordinance on Industrial Safety and Health shall be applied.

(8) A machine operator shall stay at the proper operating position during the operation.

(9) Prohibit to leave from the hoist under load hanging on its hoist. The provision of Article 186 of the Ordinance on Industrial Safety and Health shall be applied.

(10) Sliding the machine body, which is performed when running in and pulling out the rod and retrieving the inner tube by the wire line, shall be performed after confirming that the worker has left from the machine by giving a signal.

## 2.2 Safety operation of wire-line coring

The wire-line coring method is adopted for cutting the core since it is efficient. There are many safety issues relating the coring operation, therefore special notes are given such as handling the equipment at core recovery.

(1) Running in the overshot

- The running in the overshot is due to natural drop by the weight of the overshot itself, and there is a large difference in the running speed between in the mud and in the air section in the rod.
- When the overshot touches to the mud surface, the running velocity will decrease rapidly, but the wire rope (wire-line) will continue to go in by inertia. Therefore, wire ropes may be kinked, damaged or cut.
- While running in the overshot, workers must stay away from the wire-line.
- If the mud level is low, the running speed of the overshot shall be paid attention to and running too fast shall be avoided.

(2) Pulling out of inner tube

- If the inner tube is pulled out with high speed, the mud is vacuumed out by swabbing and mud level may drop because the mud in the rod may be pushed out. As a result, well could be collapse or be kicked depending on its condition. Therefore, it shall not be pulled out rapidly.
- In particular, special attention shall be taken when using a Q type wire line drill rod and wire line core barrel because the clearance between inner diameter of the rod and outer diameter of the inner tube is quite small.
- In order to prevent the mud level from dropping by pulling out, it is desirable to pull out inner tube while filling up the well from such as the outer circumference of the rod and or the flow line.
- When wiping mud adhering to the wire rope (wire-line) off during pulling out operation, a worker shouldn't hold the wire rope by hand with such as a cloth because he could be injured by wire seriously.

(3) Retrieving a core sample

- When retrieving the core sample from the inner tube by suspending the inner tube, the core sample could be damaged or such as the hands, fingers could be damaged due to a sudden drop of the core.
  - It is desirable to lay the inner tube down on the ground and gradually pump the core sample out using a core pusher (a device that uses a core extrusion plug and a hand pump) or a pump (power sprayer, etc.).
- When transferring the core using the core box, be careful of the working posture because it is a heavy and work with two people.

(4) Running in the inner tubes

When the mud level becomes low due to lost circulation, etc., the running of the inner tube shall be done using overshot and set gently to avoid any damages on the inner tube and also damages on the outer tube such as the bit, because the impact at landing on mud surface is large.

3. (Maintenance after operation)

- (1) Maintenance after operation is performed with reference to the operation record and the actual operating condition during operation.
- (2) Except for maintenance that cannot be done without operating the machine, be sure to stop the power supply system before performing maintenance work.
  - If working while the power is supplied, worker may get caught in a moving part or get caught in it, resulting in personal injury. The provision of Article 107 of the Ordinance on Industrial Safety and Health shall be applied.
- (3) At the time operation is stopped, the machine is still partially hot and may cause burns. Therefore, maintenance should be performed after the temperature of each part has been dropped.
- (4) When disassembling a hydraulic pipe or hydraulic equipment, release the pressure inside the pipe.
  - If the work is done without releasing the pressure, hydraulic oil may spurt out and cause an accident.
- (5) If manufacturer confirmed spare parts are not used, there is a risk of causing safety problem and malfunction.
  - The manufacturer is not responsible for any machine troubles or accidents that occur without using manufacturer confirmed spare parts.
- (6) After the maintenance work, be sure to perform a trial running and confirm that there are no abnormalities in the maintenance part.

## Section 2: Derrick

### 1. (Substructure of derrick)

- (1) The provision of Article 17, paragraph (2), Item 1 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the support capacity of the substructure.
- (2) The provision of Article 17, paragraph (2), Item 2 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments, and Chapter 15, Section 1-2 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) shall be applied regarding the maximum total load and wind pressure.
- (3) The provision of Article 15, paragraph (4) of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) shall be applied regarding the safety factor for the legs of iron derrick which is 2.7 or above.
- (4) The provision of Article 15, paragraph (3) of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) shall be applied regarding the maximum static load.

### 2. (Guy lines)

Installation method of the guy lines are specified below by reference to the method stipulated in the Mining Safety Act etc., although the drilling site of geothermal wells has limited area available, it may be difficult to install the guy lines in a manner as specified.

- (1) Article 17, paragraph (2), Item 3 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the strength of wire ropes and buried block.
- (2) There are no legal requirements regarding the method of maintaining wire rope tensioned, though the practical or conventional methods, such as “the use of turnbuckles, etc.”, was specified.
- (3) The inclination and the angle of the wire rope’s tension when installing a rope on the derrick, was defined in accordance with the provision of Article 129, paragraph (2) of the former Mine Safety Regulations.
- (4) The provision of Article 15, paragraph (5) of the Ministerial Ordinance for Establishing Technical Standards (internal regulation) shall be applied regarding the number of derrick and guy line.

### 3. (Passage)

- (1) The installation of the passage, based on the floor surface height of the derrick, was specified based on the provision of Article 130, paragraph (1) of the former Mine Safety Regulations.
- (2) Tilt and the handrail installation of the passage in (1) is specified in accordance with the provision of Article 552, paragraph (1) of the Ordinance on Industrial Safety and Health.

### 4. (Water table (Crown))

- (1) The installation of a safe scaffold on the top of the derrick was specified in accordance with the provision of Article 131 of the former Mine Safety Regulations. The size of the scaffold is not specified.
- (2) There is no regulation in the former Mine Safety Regulations regarding the grounding wire for lightning protection on a derrick.

However, as a result of the cantilever type derrick being widely used recently, use of the guy line decreased. In addition, the bottom of the derrick is often made of concrete, resulting in an extremely high ground resistance when the lightning strikes. Furthermore, since the drilling of geothermal wells is often carried out in highland areas where lightning strikes frequently occur, the installation of grounding wire acting as a lightning protection is stipulated, using the terms “as necessary”.

- (3) However, appropriate lightning protection device is required when the building height exceeds 20 m, as per Article 33 of the Building code.

#### 5. (Fixed ladder)

The provision of Article 556 of the Ordinance on Industrial Safety and Health regarding ladder at the well site shall be applied to the installation of a fixed ladder at the derrick.

#### 6. (Fall prevention device, safe descending device)

In order to ensure safety during the work at high place on the derrick, as well as during going up and down, the following specifications were established.

- (1) The provision of Article 521 of the Ordinance on Industrial Safety and Health shall be applied to the use of fall-prevention device. “High places” is specified as “the places with the height of 2m or higher” in Ordinance on Industrial Safety and Health.
- (2) The provision of Article 518 of the Ordinance on Industrial Safety and Health shall apply to the fall-prevention safety device. The provision of Article 526 of the Ordinance on Industrial Safety and Health shall apply to the safety ascending-descending device. Preventive measures such as installation of a ladder cage, use of safety block and lollipop are anticipated.

#### 7. (Crown sheave, head pulley)

In order to ensure the safety of workers, the crown block shall be equipped with safety equipment to prevent the wire rope (drilling line) from coming off the crown sheave.

#### 8. (Overwind prevention device)

Based on the provision of Article 655 of the former Mine Safety Regulations, countermeasures to prevent the overwinding of the drilling system at the top of the derrick was specified.

#### 9. (Inspection)

Based on the provision of the former Mine Safety Regulations, the inspection of each parts of the derrick and the machine device before drilling and/or other activities, have been specified.

### Section 3: Wire rope (drilling line) and cat line

The term "wire rope" is a generic term for wires, and the US API (AMERICAN PETROLEUM INSTITUTE) standardizes various types of wire rope for well drilling, including (a) sand line, (b) hoisting service line, (c) mast

raising and lowering line, (d) drilling line, (e) casing setting line, etc.

The safety factor of the drawworks hoisting steel lines, namely the drilling line and the casing setting line are especially important.

Steel rope for spindle drilling is not called a drilling line, though it is called a wire rope, therefor this term is described as “wire rope (drilling line)”.

### 1. (Requirements)

The regulations on the use of wire rope (drilling line) are specified, based on Article 138 of the former Mine Safety Regulations.

- (1) Anticorrosion method.....Article 138, Item 1 of the former Mine Safety Regulations
- (2) Connection method..... " Item 2 "
- (3) How to clip the end..... " Item 3 "
- (4) Prohibition of use..... " Item 4 "

### 2. (Safety factor)

(1) As the safety factor of wire ropes (drilling lines) used for the rotary drilling machines are not specified in the Industrial Safety and Health Act, the provisions of Article 17, paragraph (3), Item 2 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments, and Article 15, paragraph (6), Item 1 of the Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) shall be applied.

(2) Regarding the calculation method of the safety factor, Article 15, paragraph (6), Item 2 of the Technical Guideline concerning Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) shall be applied.

(3) According to API, due to recent drilling well becoming very deep, resulting in difficulty maintaining the theoretical drilling line safety factor, API only indicates safety factors that shall be tentatively observed as follows.

Minimum safety factor	1) Drilling line	...3
	2) Drilling line during the casing descends	...2
	3) Drilling line including drilling pipe detention	...2

(4) This is a regulation regarding the safety factor of wire rope use for the spindle type drilling equipment. The safety factor of "6" stipulated in the Ordinance on Industrial Safety and Health (Article 216, etc.) is intended for wires which hoists machines and cranes, therefor excluding spindle type drilling equipment (test drilling machines) similar to (1). Therefore, the safety factor is tentatively set to "3" following the conventional practice of the manufacturer.

### 3. (Management for drilling line)

The following is the management technique of the 1-1/2" O.D. drilling line commonly used in rotary drilling for your information.

The drilling line is affected by various stress such as bending stress when passing through the sheaves of crown block and travelling block, friction with sheaves, stretch by the weight of the hoisting equipment and strings, and vibration while operation, etc. During drilling operation, because the same part of the drilling line is used repeatedly by travelling block moving up and down, the stress concentrates on the same portion and fatigue is accumulated. Therefore, to prevent the breaking off the drilling line, it is common to calculate workload to be added to the drilling line and replace or cut off when accumulated workload reached to certain value.

API RP9B recommends calculating the workload of drilling line in following five cases and cumulate the total workload.

(1) Round trip operations

Most of the work done by drilling line is that performed in making round trip involving running the strings of drill pipe into the hole and pulling the strings out of the hole. The amount of work performed per round trip should be determined by use of the following formula.

$$\begin{array}{l} \text{(field unit : ft lb)} \\ \text{Tr} = \frac{D(Ls+D)Wm}{10,560,000} + \frac{D(M+\frac{1}{2}C)}{2,640,000} \end{array} \qquad \begin{array}{l} \text{(SI unit : m kg)} \\ \text{Tr} = \frac{D(Ls+D)Wm}{1,460,000} + \frac{D(M+\frac{1}{2}C)}{365,000} \end{array}$$

Where;

- Tr : Work volume done by drilling line during round trip (ton-miles)
- D : Depth of hole (ft, m)
- Ls : Length of drill pipe stand (ft, m)
- Wm : Buoyed weight per foot of drill pipe in drilling fluid (lb, kg)
- M : Total weight of hoisting equipment (lb, kg)
- C : Buoyed weight of drill collar in drilling fluid minus buoyed weight of the same length of drill pipe in drilling fluid (lb, kg)

(2) Drilling operations

The amount of work performed during drilling operation should be determined by use of the following formula.

$$Td=3(T2 - T1)$$

Where;

- Td : Work volume done by drilling line during drilling operation (ton-miles)
- T1 : Work volume (ton-miles) for one round trip at depth T1 (Depth where drilling started after getting in hole, ft, m)
- T2 : Work volume (ton-miles) for one round trip at depth T2 (Depth where drilling stopped before coming out of t hole, ft, m)

(3) Coring operations

The amount of work performed during coring operation should be determined by use of the following formula.

$$T_c = 2(T_4 - T_3)$$

Where;

$T_c$  : Work volume done by drilling line during coring operation (ton-miles)

$T_3$  : Work volume (ton-miles) for one round trip at depth  $T_3$  (Depth where coring started after getting in hole, ft, m)

$T_4$  : Work volume (ton-miles) for one round trip at depth  $T_4$  (Depth where coring stopped before coming out of t hole, ft, m)

(4) Setting casing operations

The amount of work performed during setting casing operation should be determined by use of the following formula. Since setting casing is one-way trip, formula used in round trip operation multiplied by one-half.

$$T_s = \frac{D(L_{cs}+D)W_{cm}}{10,560,000} + \frac{D(M+\frac{1}{2}C)}{2,640,000} \times \frac{1}{2} \quad T_s = \frac{D(L_{cs}+D)W_{cm}}{1,460,000} + \frac{D(M+\frac{1}{2}C)}{365,000} \times \frac{1}{2}$$

(field unit : ft lb) (SI unit : m kg)

Where;

$T_s$  : Work volume done by drilling line during setting casing operation (ton-miles)

$L_{cs}$  : Length of joint of casing (ft, m)

$W_{cm}$  : Buoyed weight per foot of casing (lb, kg) be calculated as follows

$$W_{cm} = W_{ca}(1 - 0.015B) \quad W_{cm} = W_{ca}(1 - 0.0125B)$$

(field unit : lb lb/gal) (SI unit : kg SG)

Where;

$W_{ca}$  : Weight of joint of casing in air (lb, kg)

$B$  : Weight of drilling fluid (lb/gal, specific gravity(SG))

(5) Short trip operations

The amount of work performed during short trip operation should be determined by use of the following formula.

$$T_{st} = T_6 - T_5$$

Where;

$T_{st}$  : Work volume done by drilling line during short trip operation (ton-miles)

$T_5$  : Work volume (ton-miles) for one round trip at depth  $D_5$  ( $D_5$ : Shallower depth, ft, m)

$T_6$  : Work volume (ton-miles) for one round trip at depth  $D_6$  ( $D_6$ : deeper depth, ft, m)

#### 4. (Cat line)

The followings are stipulated as precaution regarding the use of cat lines.

- (1) Prohibition of the use of a worn cat line is based on the provision of Article 140, paragraph (1) of the former Mine Safety Regulations.
- (2) Prohibition the use of a fatigued or spliced cat line are based on the provision of Article 140, paragraphs (2) and (3) of the former Mine Safety Regulations.
- (3) Although there is no legal regulation regarding the use of cat line guide, use of such was stipulated due to its importance for the safety.
- (4) The precaution for applying a load to cat line was stipulated according to the provision of Article 141 of the former Mine Safety Regulations.

#### 5. (Inspection)

The enforcement of inspection of the general wire rope (drilling line), the cat line, the neckline etc. before commencing the work, is specified based on the provision of Article 142 of the former Mine Safety Regulations.

### Section 4: Hoisting equipment (Drawworks) and the accessories, mud pump etc.

#### 1. (Hoisting equipment (Drawworks) brake)

The provision of Article 17, paragraph (3), Item 3 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the regulation of the brake.

#### 2. (Emergency circuit breaker)

The provision of Article 17, paragraph (3), Item 4 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the regulation of the emergency circuit breaker on the hoisting equipment (Drawworks).

#### 3. (Weight indicator, etc.)

The obligated use of the weight indicator is stipulated.

- (1) The provision of Article 17, paragraph (4), Item 10 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the regulation of the installation of the weight indicator when using the rotary drilling equipment.
- (2) The provision described in (1) shall also be applied regarding the regulation of the installation of the weight indicator when using the spindle type drilling machine.

#### 4. (Rotary hose (delivery hose))

- (1) The provision of Article 17, paragraph (4), Item 2 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the regulation of the pressure requirement on the hose.
- (2) The provision of Article 17, paragraph (4), Item 3 of the Ministerial Ordinance for Establishing Technical

Standards for Mining Equipments shall be applied to the regulation of the installation of safe attachment device on both ends of the fittings, in order to prevent detachment and/or falling while using the rotary hose.

#### 5. (Pipe tongs)

The safety, operation, and function of the pipe tongs are stipulated.

- (1) Although there is no legal regulation regarding the attachment of the guy lines to the end of the pipe tongs, in order to prevent tongs from coming off and resulting in large shaking, it was specifically stipulated to ensure safe working environment.
- (2) The provision of Article 17, paragraph (4), Item 4 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the installation of balancing weight of the pipe tongs.
- (3) Although there is no legal requirement regarding the use of slips for tongs, it was stipulated due to its importance in order to ensure safe working environment.

#### 6. (Traveling blocks (running blocks), hook)

The safety measure of traveling blocks (running blocks) and hook is stipulated as follows.

- (1) Regarding the installation of a metal covering onto the traveling blocks, in order to prevent foreign objects from being caught between the wire rope (drilling line) and the sheave, as well as for safety reason, the provision of Article 17, paragraph (4), Item 5 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied.
- (2) The provision of Article 17, paragraph (4), Item 6 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied regarding the installation of safety device on the hook.
- (3) Since the safety factor of the elevator, hook, and traveling blocks are not covered by the Industrial Safety and Health Act, the safety factor is set to “4” by applying the provision of Article 17, paragraph (4), Item 7 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments and Article 15, paragraph (7) of the Technical Guideline concerning Ministerial Ordinance for Establishing Technical Standards for Mining Equipments.

When using the spindle type drilling machine, the safety factor is set to “3” according to the common practice of the manufacturer, similar to the case of the safety factor of wire rope.

#### 7. (Pipe elevator)

#### 8. (Mud pump)

The spare parts used for the mud pump, as well as the operation conditions are stipulated.

- (1) The provisions of Article 17, paragraph (4), Item 8 of the Ministry of Mining Ordinance shall be applied regulating the obligation to use safety valves and pressure gauges. It also stipulates the prevention of vibration in the downstream piping when the safety valve is activated.
- (2) The regulation regarding the valve inspection prior to the pump operation was stipulated according to the

provision of Article 154 of the former Petroleum Regulations.

9. (Mud tank)

Early detection of the lost circulation/ pit gain by monitoring total mud volume constantly during drilling is important to prevent drilling trouble. Regarding the monitoring of mud level in mud tanks, the provision of Article 17, paragraph (4), Item 11 of the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments shall be applied.

10. (Lighting)

The lighting equipment used during the night operation are stipulated. During the night operation, Articles 604 and 605 of the Ordinance on Industrial Safety and Health provides the regulations regarding the lighting and illuminance; since the drilling operation is a field work, the wording in the regulations were modified accordingly.

11. (Inspection)

The list of items in need for inspection, as well as the obligation of keeping record in the safety report by the inspector are stipulated. These were stipulated according to the provision regarding a machine security officer in Article 155 of the former Mine Safety Regulations, with the replacement of the terms “machinery security officer” with the term “inspector”.

**Section 5: Fence surrounding the work area, etc.**

1. (Fence and other hazard prevention equipment)

In order to secure a safe workplace, the installation of fences around the movable parts of the machinery and machinery installed across the workers walkway were specified according to the provision of the former Mine Safety Regulations Article 670 as follows.

- (1) Install safety equipment on drawworks rotary chains, sprockets, etc.  
.....the former Mine Safety Regulations Article 670 No. 6
- (2) Install safety equipment to shafts, belts, chains, etc. that are positioned 2 m or less in height from the floor.  
.....the former Mine Safety Regulations Article 670 No. 2
- (3) Install fences and other safety equipment for the machines that are driven by power.  
.....the former Mine Safety Regulations Article 670 No. 7

2. (Coverings)

The installation of covering for horizontal axles and other driving equipment which may be approached or crossed by the workers is specified according to the provision of the former Mine Safety Regulations Article 674.

**Section 6: Blowout prevention**

1. (Blowout preventer)

When drilling, workover, and conducting various tests on geothermal wells that would pose potential risk for

steam or hot water blowout, the installation of blowout preventer is required, and as its functions, the provision of Ministerial Ordinance for Establishing Technical Standards for Mining Equipments, Article 17 Paragraph 4 Item 11 and the provisions of Technical Guidelines for Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) Article 15 Paragraph 8 shall be applied as follows. The blowout preventer (BOP) is commonly installed to the wellhead after setting surface casing.

(1) The blowout preventer shall be capable operating quickly.

..... Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation), Chapter 15, Section 8, Item 1

(2) The blowout preventer shall be operatable from outside the derrick, with the stem.

..... .Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation), Chapter 15, Section 8, Item 2

(3) An emergency actuator or alarm of the device in (1) shall be installed near the worker operating the hoisting equipment (Drawworks).

..... Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation), Chapter 15, Section 8, Item 3

(4) The annulus between the drilling pipe and the casing can be sealed with the equipment described in (1), but this equipment does not seal the inside of the drill pipe. Therefore, a check valve (back pressure valve), an inside preventer, etc. shall be used to seal the drill pipe.

..... Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation), Chapter 15, Section 8, Item 5

(5) Although there is no legal regulation for attaching a blowout preventer to the wellhead, during the various measurements of the well, it was specifically stipulated.

(6) As the ram of the blowout preventer cannot tolerate the high temperature, countermeasures such as water cooling are required.

## 2. (Pressure test)

The conditions of pressure test of the equipment are stipulated as follows.

(1) In case where the maximum wellhead pressure can be estimated, the provision of the Technical Guidelines for the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments (internal regulation) Chapter 15, Section 8, Item 8 shall be applied.

(Although the internal regulations do not specify the medium used for pressure resistance test; water is commonly used as a medium.)

(2) In cases other than (1), the test pressure shall be set to 14 MPa or above. This pressure was tentatively specified considering the standard value of the pressure rising at the wellhead of geothermal wells in Japan.

## 3. (Mud storage for emergency use, cooling water, etc.)

In a geothermal well which has a risk of steam or hot water blowout, a cooling tower shall be installed as well as back-up mud for emergency or cooling water shall also be prepared, as stipulated in the following.

- (1) At the drilling well with a risk of blowout of steam or hot water, the provision of Ministerial Ordinance for Establishing Technical Standards for Mining Equipments Chapter 17, Section 4, Item 11 shall be applied; Additionally, it is necessary to prepare a cooling tower with a mud pump for cool down.
- (2) Preparing for steam blowout during drilling of the geothermal well, it is necessary to secure fresh water near the well, approximately three times of the volume of the well for cooling process.

#### 4. (Function test)

The implementation of the function test of blowout preventer, as well as the recording of their results to the safety report are stipulated according to the provision of Article 162 of the former Mine Safety Regulations.

### Section 7: Casing and cementing

#### 1. (Casing)

- (1) Common practice in oil and gas wells (excluding water-soluble gas wells) uses API standard steel pipes designed for oil well as casing. For the wells drilling with spindle type drilling machine, seamless steel pipes designed for test drilling, and other types of pipes are generally used, but these steel pipes are not strong enough to be used as the casing for installation of the master valve. Therefore, a casing of API standard, grade J-55 or more, thickness 7mm or more, with buttress thread or premium thread is used for installation of the master valve.

(Note)...In a geothermal well, unlike oil and natural gas wells, steam and hot water flow directly from the casing without the use of tubings. Therefore, corrosion and wear, as well as material deterioration on these casing leads to the destruction of casing, resulting in a serious accident.

- (2) The annulus between the casing and the hole diameter in (1) is specified. Even though the strength of the casing meets the required value, if the outside of the casing was not sufficiently filled with cement, and or the cementing process was imperfect, the well cannot be sealed, and the annulus pressure cannot be controlled. This description is specifically stipulated in order for the improvement of cementing efficiency.
- (3) The material of casing set in the well, which is not installed the master valve, is specified as equivalent to carbon steel pipe for pressure service.

#### 2. (Cementing, cement)

The cementing of the casing on which master valve is to be installed, is particularly important as described in Section 7.1 (2), therefore, it is desirable to fill up the well with cement to the wellhead to completely protect the casing. Regarding the type of the cement to be used, the use of high temperature heat-resistant cement was stipulated, since it is necessary to prevent embrittlement of the cement caused by the high temperature of the well.

## Section 8: Air drilling/aerated mud drilling

### 1. (Air lines and valves)

Although there is no legal regulation specifying the surface equipment used in the drilling of the geothermal well using the air or aerated mud, and such equipment's pressure requirement, the following measures have been stipulated as standards specific to this guideline.

- (1) The air line of a material with a pressure resistance of at least twice the maximum operating pressure shall be prepared.
- (2) An inlet valve and a blow valve shall be installed on the air line, whereas the former is a control valve for the air pressure of the compressor, which is necessary for controlling the flow rate of the air. The latter is necessary for the release of pressure inside the drill pipe.
- (3) In case foreign material (dust, metal rust, etc.) or liquid (mud, water, etc.) flowing back from pipeline into the compressor, the internal mechanism of the compressor would be damaged. In order to prevent this from occurring, the installation of a check valve in the air compressor is stipulated.
- (4) Regarding the pressure requirement of each valve, the application of pressure test with at least 1.5 times of the maximum working pressure to the blowout preventer, is stipulated in accordance with the provision of Article 180 of the former Mine Safety Regulations.
- (5) For safety reasons, vibration prevention measures shall be taken at various points in the air piping, from preventing the pipe vibration during operation.
- (6) The valve shall be installed at the position where it could be able to operate quickly and accurately.

### 2. (Blooie line)

Since a large amount of air, gas, mud water, cuttings, etc. are ejected from the well into the Blooie Line, the following measures have been stipulated.

- (1) At the tip of the Blooie line, a water injection equipment shall be installed to a large separator type pipe, in order to prevent dust dispersion.
- (2) Since a large number of substances (such as air and cutting generated from the well) are ejected from the Blooie Line, the Blooie Line shall be installed in a straight line with as few bends as possible in order to prevent abrasion occurring inside the pipe, as well as vibration.

### 3. (Pressure test)

The pressure test of the compressor discharge pipe was specified as follows.

- (1) The pressure test of the drain separator and the air line shall be conducted at the pressure 1.5 times of the operation pressure or more, as with the case of valve.
- (2) In case a leakage is detected in the pressure test of (1), due to the pipe is still under pressure, it is necessary to release the pressure first before the treatment of the defective part. This is a safety precaution to prevent unexpected accidents especially in the test with air.

#### 4. (Operation)

The precautions for compressor operation and air supply are stipulated.

- (1) The intense noise of the operation of the compressor interferes with the communication by voice between the compressor operator and the drilling operator. They shall be placed within the field of view of each other and communicate each other with signal or telephone.
- (2) In case of the running in hole drill pipe, it shall be confirmed that there is no residual air pressure in the pipe to ensure safety. In the case of air drilling, a mistake by confusion with mud drilling may lead to an unexpected accident, so this item was specified as a safety precaution in order to prevent any accident.

#### 5. (Safety valve, pressure gauge and thermometer)

The installation of measurement devices that are required to be installed for the compressor and air line, is specified according to Article 631 of the former Mine Safety Regulations.

### Section 9: Water injection

It is a regulation related to preparation and operation for water injection for improving the permeability of geothermal wells.

Water injection is a method that usually uses a high-pressure plunger pump, applying water pressure into the well through the wellhead, stimulating the target formation (reservoir), and attempts to improve the production capacity of the well. The working pressure is in the high pressure range of 10 to 20 MPa (approximately 2 to 3 times higher in the case of hot dry rock) in geothermal fluid formations.

Since the operation is carried out in the field and using mainly portable equipment, special attention and measures are required to ensure work safety. Furthermore, since each device is often operated at a high pressure, a large pulsation may occur, and it is necessary to consider safety measures such as installing a pulsation dampener.

#### 1. (Injection line and valve)

##### (1) Quality of conduit pipe material

As a feature of water injection, there is a risk related to high pressure and pulsation, vibration, etc. It is therefore necessary to select a material that is guaranteed to withstand such situation. Although there is no legal requirement for material for water injection equipment, the use of high-strength seamless steel pipe is considered to be recommendable as injection line material.

##### (2) Wing union

During water injection work, strong vibration is usually generated by pulsation, so it is necessary to avoid flange connection and apply wing union connection so as not to damage the injection line.

##### (3) High pressure swivel joint

The bent part of the injection line is vulnerable to mechanical stress concentration and is especially prone to damage. In order to secure safety at this particular part, a high-pressure swivel joint with a strong structure such as a Chiksan type shall be used.

##### (4) Connection of injection line

For the connection between the wing union or high pressure swivel joint and the injection line, a friction

welded part imported from the United States is recommended.

(5) Pump discharge valve, etc.

The on-off valves in the injection line usually have low operability under high pressure conditions, and it may cause the opening and closing operation dangerous. A safe and easy-to-operate mechanism must be adopted. In addition, the on-off valves shall be installed in a safe location securing solid scaffold and easy operation.

2. (Safety valve and pressure gauge)

(1) Safety valve

The work must be performed within the specified pressure range, but since there is a possibility that the pressure becomes abnormally high even momentarily for certain reason, a safety valve is absolutely necessary. In addition, the position to install the safety valve must be selected at the safe place such as the nearest side of pump outlet or the manifold part.

(2) Pressure gauge

Since the records of water injection pressure and flow rate during work are important data as the basis of this work, it is necessary to constantly monitor the state from the viewpoint of safety. The pressure gauge shall be installed at least at (1) the pump, (2) between the pump and the wellhead, (3) the wellhead, and (4) the lower part of the master valve. It is desirable to install a pressure recorder at the wellhead pressure.

3. (Pressure test)

(1) Injection line and wellhead

The pressure test of the injection line and wellhead was stipulated according to the provision of "pressure test of pipe" (Article 180) of the former Mine Safety Regulations.

(2) Regulation of maximum injection pressure

When a hole packer is installed in a well using a drill pipe to inject water, there is no concern about the pressure resistance of the wellhead and casing pipe. However, in case the hole packer is not used, the impact of the pressure extends to the master valve, bleed valve, wellhead head, casing pipe, etc. Therefore, the maximum injection pressure shall not exceed these regulated pressure resistance values. If the pressure is exceeded, the pump operation must be stopped immediately as in the case of 4- (2) in the next section.

4. (Operation)

(1) Operation valve

The pump for water injection is a plunger high pressure pump similar to the mud pump, but the maximum pressure can usually rise up to about 70 MPa. Therefore, as a precaution before operating the pump, it was stipulated that the operation should be started only after confirming that the valve of the operation system has been opened according to the provisions of the former Mine Safety Regulations (Article 154).

(2) Pressure rises during operation

As described in (1), the pressure may rise higher than expected in the water injection, so the provision of "Stopping the operation of the pressure pump" (Article 175, item 4) of the former Mine Safety Regulations is

applied and it is stipulated that the operation of the pressure pump should be stopped immediately when the pressure exceeds the test pressure.

(3) Noise during operation

The engine of the water injection pump has a large power and may generate exceptionally large noise. Loud noise may obstruct the workers to communicate with each other, which leads to a serious interference with the understanding of work instructions, resulting in lack of safety in the performance of the work.

Under such circumstances, the use of headphones, microphones, telephones, etc. is indispensable, and visual communication means such as a contact board shall also be considered.

(4) Water injection work has a risk of high pressure and hindrance to mutual communication between workers as described in (1) to (3) above. Therefore, night work should be avoided as much as possible for the safety of work.

## Section 10: Wellhead, separator and silencer

### 1. (Wellhead)

When performing a steam or hot water flow test, the fluid flow changes from vertical to horizontal at the branch portion of the wellhead, resulting in a large internal force applied to the entire wellhead system. Additionally, when the steam and hot water flows in two-phase flow, vibration and various stresses are concentrated to the branch portion. Therefore, a highly safe design is required, considering from pressure requirement and the anti-vibration to other designs including fixing method of the wellhead. The former Mine Safety Regulations strictly regulates the pressure resistance of a wellhead, but it does not have provision regulating the material of the wellhead. On the other hand, the Geothermal Power Generation Facility Regulations established by the Japan Electric Association does specifies, not only the wellhead, but the material of wellhead as well. Thus, it is necessary to follow these regulations depending on the situation.

Furthermore, common phenomenon is observed at geothermal, such that surface part of the wellhead expands its length at the process of hot fluid production, due to the high temperature of the ejected fluid. This heat extension is about 0.3 m in length at maximum and is uncontrollable. Therefore, flowline and/or silencer, which is connected to the wellhead, require the devices that can absorb the well's heat expansion, such as expansion spools and expansion joints for flowline.

The basic wellhead system used in the steam and hot water production test, is shown in Fig. 1 below.

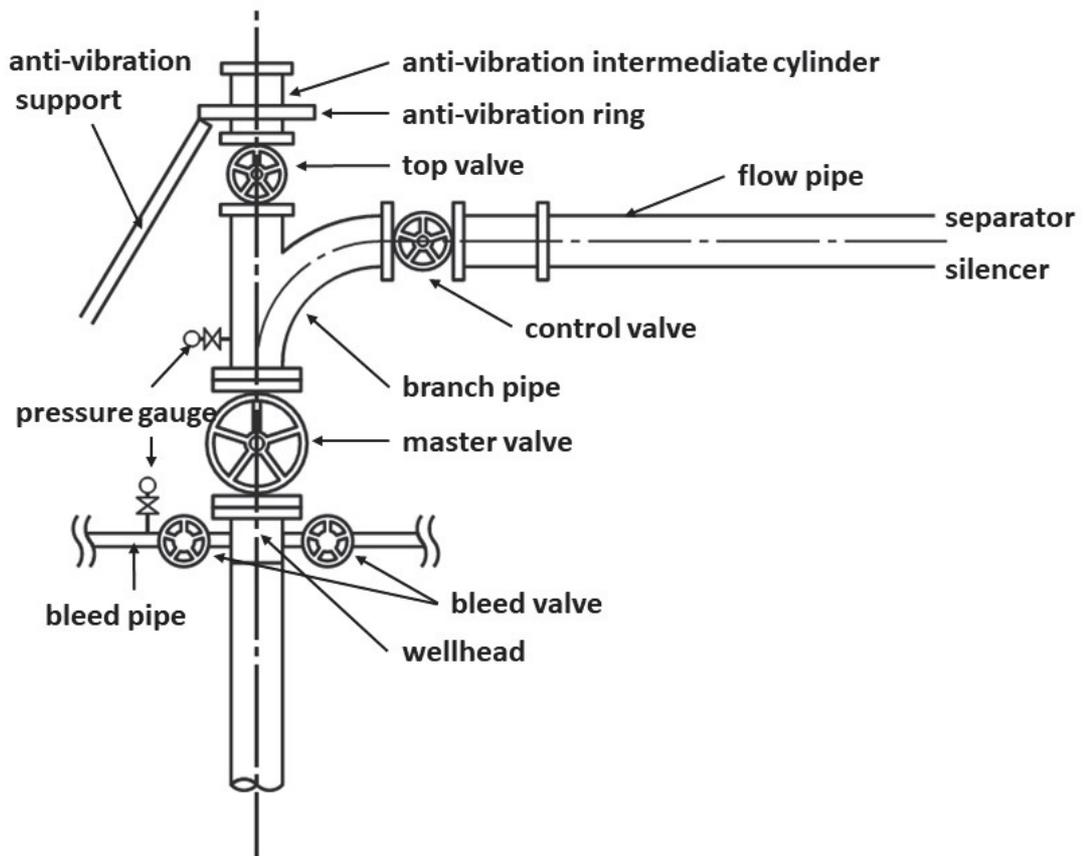


Fig.1 Wellhead System

- (a) The wellhead is a main component that is connected between the casing and the master valve, which requires to meet a required strength. Furthermore, in order to maintain the sufficient proof stress of the connecting part between the wellhead and the casing, this connection shall be constructed from a casing screw or insertion welding, and butt welding method shall not be used.
- (b) The bleed valve and bleed pipe shall be connected to the side ports, located at the two points at both sides of the wellhead.  
When drilling a well, one of the ports will become the choke line, and the other will become the kill line. Additionally, during production tests, these parts will be used to control the amount of fluid jetting, as well as to control the pressure of the well.
- (c) Pressure gauges are usually installed to the wellhead, as well as at the upper part of the master valve, in order to monitor the pressure of the geothermal fluid inside the well.  
The pressure gauge installed at the wellhead is used to monitor the pressure at the wellhead when the master valve is operated. Pressure gauge installed at the upper part of the master valve is used to monitor the pressure while the fluid is flowing. Both gauges play an important role in pressure monitoring.
- (d) The master valve performs the most important function in these terms of safety in the wellhead. The master valve is usually installed above the wellhead directly, immediately after inserting the casing (intermediate

casing or production casing) during drilling.

The master valve is fully opened during the drilling operation of the well. Countermeasures to prevent master valve being damaged, such as using a wire flange to protect the master valve from damage or wear caused by the bit and other tools being running into the well, shall be taken.

- (e) The branch pipe converts the flow of steam and hot water produced from the well, from vertical to horizontal as described above, causing wear and vibration at the branch part due to high flow resistance. A thick-walled structure that is durable against wear, which also could act as a support against vibration and stress, such as steady rest, shall be installed.
- (f) The flow pipe and the control valve directly connected to the separator or silencer, shall not interfere with production and test of the steam or hot water flowing through. It shall be noted that the role of this control valve is to control the pressure and flow rate of produced material, and the separator plays the role of separating steam and water, measuring the pressure, temperature, flow rate, etc. of the steam.
- (g) The top valve is normally closed when steam or hot water is produced or tested, but if circumstances permit, releasing them directly above is also taken into consideration. Additionally, when running measuring instruments in the well for measurement purpose and steam and or hot water ext. are expected to be jetted, the well top valve is used for installing a lubricator thereon for the running of the measuring instruments.
- (h) The master valve, bleed valve and the wellhead are the most important parts of the wellhead equipment as described in (a) of 1. above, and this part shall not only be pressure resistant but also well prepared against corrosion by acid and scale.

According to the former Mine Safety Regulations, the pressure test of the wellhead is specified to be conducted under a pressure that is more than twice of the shut-in pressure (Article 163), and this standard shall be applied here as well. Furthermore, the countermeasures against thermal expansion of valves are also necessary, which is a phenomenon characteristic to geothermal wells. When the valve is closed, the temperature rises corresponding to the shut-in pressure, thus the valve shall be designed to function normally even under the expected temperature to open and close smoothly

In addition, according to the above-mentioned Geothermal Power Generation Facility Regulations, in Chapter 2 Wellhead section, "The maximum working pressure of the wellhead, the master valve and the bleed valve shall be set to the pressure double of the steam lockup pressure expected in the area with sufficient margin, since pressure test of these devices is structurally impossible. The maximum working pressure of the wellhead is set to 20-80kgf/cm<sup>2</sup> (2-8MPa)."

## 2. (Separator)

A cyclone-type steam-water separator is usually used. It shall be designed to not only have enough separation capacity for efficient production or test purpose, but also to have prevention of vibration from fluid, pressure resistance, wear, and expansion and contraction due to heat considered as well.

As described in Chapter1 Section 3: 2. (Inspection, etc.) of this guideline, the separator is considered as a Type 1 pressure container, thus the corresponding legal procedures are required.

## 3. (Silencer)

- (1) A silencer is a steam discharge device, which acts to minimize the noise. The silencer shall be equipped with a device which could reduce the maximum amount of noise.
- (2) The silencer shall be designed to have capacity with enough capacity, especially considering the time of the first production of a geothermal well. First production's jetting capacity may temporarily be several times larger compared to the regular capacity, therefore it is important to prepare in order to prevent a disaster such as overflow of hot water. It is also noted that enough consideration shall be made for the fixing methods to prevent vibration of the silencer.
- (3) Especially in the case of a steam-dominated geothermal well, the production is mostly dominated by the steam. This may result in the situation where the release of rock powder, cuttings, etc. being released from the silencer to the atmosphere during the production. In order to prevent such situation, it is necessary to take measures to prevent scattering to the atmosphere, such as installing a water injection device in the silencer section.

## Section 11: Countermeasures for dust and harmful gases

### 1. (Countermeasures for dust)

Regarding the countermeasures for dust during producing or mixing mud, which are used as the drilling mud in the geothermal well drilling, Article 582 of the Ordinance on Industrial Safety and Health stipulates removal of dust and prevention of scattering of dust. During the production and mixing of mud, dust including bentonite and sepiolite is generated, not only at indoor procedure but also at the outdoor procedure. Strict safety measures shall be taken to protect worker's health, such as use of effective anti-dust mask, and dust control mixer that uses jet suction.

### 2. (Countermeasures for harmful gas)

The fluid produced from the geothermal well generally contains gas components such as carbon dioxide, hydrogen sulfide, nitrogen, methane, and hydrogen. Depending on the geological location, the temperature of carbon dioxide or hydrogen sulfide contained in the produced fluid may exceed the legally regulated value, thus the preparation of measures against these harmful gases is essential. The following regulations are stipulated in the relevant laws and regulations including Industrial Safety and Health Act, Order for Enforcement of Industrial Safety and Health Act, Ordinance on Industrial Safety and Health, and Oxygen Deficiency Prevention Regulations, although these do not envisage specific work regarding geothermal well drilling and flow test.

The following is a summary of the provisions that are likely to be related to drilling and flow tests.

(1) Article 65 of the Industrial Safety and Health Act

The operator shall, as provided for by the Ordinance of the Ministry of Health, Labor and Welfare, conduct necessary working environment inspection to the indoor and other working area, which involves harmful activities, and results shall be recorded. These environmental inspections shall follow the criteria stipulated by the Minister of Health, Labor and Welfare.”

(2) Article 21 of the Order for Enforcement of Industrial Safety and Health Act

Regarding the workshops specified in Article 65, Annexed Table 6 of the Industrial Safety and Health Act specifies that these workplaces corresponding to the places with a risk of an oxygen deficiency hazard. The workplaces related to drilling are specified as follows.

(a) Inside of a well, etc. (meaning a well, well curb, shaft, tunnel, caisson, pit or other similar structures) which comes in in contact with or leading to the following strata: Strata from which carbonic water is wells up, or likely to well up

(b) Inside a cistern, covered conduit, manhole or pit where rainwater, river water or spring water accumulates or have ever accumulated

(c) Inside of a tank, hold, cistern, pipe, covered conduit, manhole, ditch or pit that holds or have ever held sewage, sapropel, wastewater, pulp liquid or other substances which are apt to decompose

Based on the above regulations, poorly ventilated tanks and the inside of pits can be considered as the area with a risk of an oxygen deficiency danger, whiting the drilling and production tests works.

(3) Articles 585, 593, 596, and 597 of the Ordinance on Industrial Safety and Health

Article 585: “The employer shall prohibit uninvolved personal from entering the following places, and to indicate such as a notice, by displaying it at a readily visible location” These following places are described as ” Places where the concentration of the carbon dioxide gas is exceeding 1.5%, or that of oxygen is less than 18%, or that of hydrogen sulfide exceeding 10 ppm”. Additionally, it is said that “A worker shall not enter the place where it is prohibited from entering, without appropriate reason.”

Article 593: The employer shall, at the work taking (...) places with exuding gas, vapor or dust, (...) and other harmful work, provide suitable personal protective equipment (such as protective clothes, eye protector and respiratory protective equipment) in order to protect workers engaging in the said work.

Article 596: The employer shall, regarding the personal protective equipment (...), ensure that the same number of protective equipment as the workers involved at the work, or more is provided and maintained in a workable condition and is kept clean at all time.

Article 597: The responsibility of workers to use the protective equipment is stipulated as follows: “The worker engaging in the work taking (...) places with exuding gas, vapor or dust, (...) and other harmful work, shall, when instructed, use the prepared personal protective equipment necessary for the said work”.

(4) Article 2 of the Ordinance on Prevention of Oxygen deficiency, etc.

The definitions of oxygen deficiency (state where the oxygen concentration in the air is less than 18%) and oxygen deficiency in the case of class-2 hazardous work of oxygen deficiency (state of oxygen deficiency, or state where the hydrogen sulfide concentration in the air exceeds 10 ppm) is specified. Additionally, it

states that the dangerous work with a risk of oxygen deficiency, is defined as the work in the dangerous place of oxygen deficiency listed previously in Annexed Table 6 of the Ordinance on Industrial Safety and Health. It also stipulates that, in the case where the installation of a ventilation system etc. is impossible, "the employer shall provide air respirators, etc., including air respirators, oxygen respirators or air-supplied respirators in a number equal to or more than the number of the workers who are engaging in the same work at once."

(5) Notice of Administrative Guidance February 7, 2005, Notification No. 0207006 of Labor Standards Bureau "Selection and Use of Gas Masks"

A hydrogen sulfide gas mask shall be used only if the "Oxygen concentration meter confirms that the workplace has been measured with hydrogen sulfide gas concentration of 18% or higher. The provision of the Notification regarding the hydrogen sulfide concentration, wearing time of the gas mask, breathing tube replacement time, etc. are met."

(6) Articles 11 and 12 of the Ordinance on Prevention of Oxygen deficiency, etc.

A worker shall be appointed as a "chief of oxygen deficient dangerous work" on site. The qualification requirements of this appointment are of those who have completed the skill training for the oxygen deficiency/hydrogen sulfide hazardous work supervisor. In addition, the "chief of oxygen deficient dangerous work" shall provide the following education to all workers:

- Causes of oxygen deficiency
- Symptoms of Oxygen deficiency
- How to use an air respirator
- The method of evacuation and emergency resuscitation, in case of an accident

As described above, there are no regulations that apply appropriately to the workplace and protective equipment used for drilling work and production tests that are carried out outdoors. Regardless, it was determined to include appropriate measures in accordance with the above-mentioned laws in order to ensure safer work environment.

For more information on respiratory protective equipment, etc., it is recommended to consult Japan Safety Appliances Association (<https://jsaa.or.jp/>). For gas detectors, consult Industrial Gas Detectors and Monitors Manufacturers Association (<https://sangyogas.jp/>).

For reference, the symptoms of oxygen deficiency when the oxygen concentration is lowered, are summarized in Table 1. The concentration of carbon dioxide in the air and the related symptoms are shown in Table 2, and the poisoning effect of hydrogen sulfide and the first-aid measures in case of acute hydrogen sulfide poisoning are listed in Tables 3 and 4, respectively.

In any cases, when rescuing the victims from a gas related incident, be sure proceed by two or more people with designated respiratory equipment, masks, protective glasses, etc. under the surveillance by other people in order to prevent secondary disasters. Other method of rescuing includes rescuing victims after confirming that the conditions of the disaster area has recovered to fit work environment standards.

Table 1: Oxygen Deficiency Disease caused by Low Oxygen Level and its Corresponding Symptoms.  
(Concentration classification after Henderson & Haggard)

Severity Level	Air		Arteria blood		Symptoms
	Oxygen concentration (%)	Oxygen partial pressure (mmHg)	Saturation of oxygen (%)	Oxygen partial pressure (mmHg)	
1	16~12	120~90	189~85	60~45	Increased pulse/respiratory rate, decreased concentration, miscalculations, deterioration of fine muscle movement headache, tinnitus, nausea
2	14~9	105~68	89~74	55~40	Decreased judgment ability, exaltation, mentally unstable (prone to irritability), no pain in wounds, inebriated state, headache, tinnitus, nausea, vomiting, loss of memory at that time, general weakness, increased body temperature, Cyanosis (pale face), stupor
3	10~6	70~45	74~33	40~20	Loss of consciousness, coma, central nervous system disorder, appearance of Cheyne-Stokes breathing, cyanosis, generalized muscle spasm
4	Below 6	Below 45	Below 33	Below 20	Syncope in an instant, coma, slow breathing → respiratory arrest → cardiac arrest

Note: Cyanosis symptoms are also observed as the lips and nails turning dark purple.

As a first-aid procedure, loosen the victim's clothes and put them in the recovery position to avoid vomit entering the airway.

If breathing is weak or the victim's body have lost strength, use mouse-to-mouth ventilation. Further check the pulse, and if it does not touch, give a heart massage. In the meantime, call an ambulance or immediately transport to a medical institution.

As in the case of poisonous gas poisoning, humans die of brain oxygen deprivation 10 minutes after respiratory arrest and 3-5 minutes after cardiac arrest. This shall be primarily considered when treating the victims.

Table 2: Carbon Dioxide Concentration in Air and its Corresponding Symptoms  
 “Geothermal Well Drilling Voluntary Safety Standards”

Carbon dioxide concentration in air %	Symptoms
0.5	Allowable concentration for occupational health management
1~2	Discomfort occurs
3~4	Symptoms such as increased respiratory rate, increased pulse and blood pressure, headache, dizziness, nausea, etc. appear due to respiratory system stimulation
6~7	Respiratory distress
7~10	Unconsciousness within a few minutes, die of cyanosis
20	Paralyzed in a few seconds and the heart stops

Table 3: Hydrogen Sulfide Poisoning  
 “Geothermal Well Drilling Voluntary Safety Standards” revised and extended with “Industrial Poisoning Handbook (expanded edition)”, etc.

Concentration (ppm)	Effect by body part		
0.0047~ 0.025 0.02~0.2	Smell: Odor threshold		
0.3	Within the range of regulations of Offensive Odor Control Act (specified by area) Clearly senses odor, do not feel pain after acclimating.		
3~5	Moderately strong odor that is unpleasant		
5~10	Odor is extremely unpleasant		
10	Allowable concentration for 8 hours works (Japan Society for Occupational Health 1983)		
			Eye: Lower limit which causes the irritation to the eye’s mucous membrane
20		Respiratory system: Lower limit which causes irritation to the lungs	Eye irritation after 6 hours of exposure
20~30	Tolerable but after acclimating to this level, one becomes insensible to the higher concentration of odor (olfactory fatigue)		

Table 3: (continued)

Concentration (ppm)	Effect by body part		
50~			Conjunctivitis (“gas eye”), itchy eyes, eye pain, feeling of sand in the eyes, feeling dazzling, hyperemia and swelling, corneal opacification, corneal destruction and peeling, visual field distortion and blurring, light enhancing pain
50~150		Few hours of exposure results in mild poisoning symptoms	
100~150	Olfactory nerve paralysis appears after 2-15 minutes of exposure, leading to the false sense that the unpleasant odor is rather alleviated		
100~200		Continuous exposure of 8 - 48 hours leads to bronchitis, pneumonia, suffocation death due to pulmonary edema	
150~200	Upper limit concentration to feel odor. When the concentration exceeds this level, odor cannot be felt due to olfactory fatigue		
200			Burning pain to the eye’s mucous membrane, 30 minutes is the tolerable limit
170~300		Burning pain in the airway mucosa Exposure less than 1 hour is the upper limit for avoiding serious symptoms	
350~400		1-hour exposure can be life-threatening	
400~700		Exposure of 30-60 minutes can be life-threatening	
700	Cranial nerve: Experiencing an excessive breathing for a short time, followed by immediate respiratory paralysis.		
800~900	Loss of consciousness, respiratory arrest, death		
1000~1500	Immediate syncope, convulsions, death from respiratory paralysis		
5000	Immediate death		

Note: The toxicity of hydrogen sulfide is equivalent to that of hydrogen cyanide (hydrocyanic acid gas), and the lethal effect of hydrogen sulfide is said to occur faster than hydrogen cyanide at the same concentration.

Acute hydrogen sulfide poisoning may cause serious prognostic symptoms, such as nervous system complications, cardiovascular system complications and pneumonia, and may also cause other long-term symptoms, including headache, fever, chills, difficulty walking, dementia, postencephalitic complication, etc.

Table 4: First-Aid Procedure for Acute Hydrogen Sulfide Poisoning  
Addition to "Dangerous Gaseous Substances"

General first-aid	<ul style="list-style-type: none"> <li>● Rescue the victims from the polluted site and relocate them to a location with fresh air, while keeping them warm and at rest</li> <li>● In case of cardiac arrest, perform chest compression</li> <li>● In case of respiratory arrest, perform oxygen inhalation with artificial respiration</li> </ul>
Damage by inhalation	<ul style="list-style-type: none"> <li>● In case of respiratory arrest, perform oxygen inhalation with artificial respiration</li> <li>● If the victim is experiencing a breathing difficulties, perform oxygen inhalation</li> <li>● Closely monitor the victim's condition and changes of condition (Especially look out for hyperventilation and respiratory paralysis)</li> </ul>
Eye damage	<ul style="list-style-type: none"> <li>● Wash the eyes with water or lukewarm water, for 15 minutes or more</li> <li>● Repeat this procedure or apply cold compress until the medical treatment is given</li> </ul>
Skin damage	<ul style="list-style-type: none"> <li>● Give shower to the victim and take off the contaminated clothing</li> <li>● Wash the affected area with lots of water or soapy water for 15 minutes or more</li> </ul>

Victims shall be treated by a medical specialist. Even if the victim appears to have completely recovered, Heavy exposure may result in fatal pulmonary edema after 1 to 2 days from the event Victims shall take enough rest, regardless of the severity of the injuries, or they may suffer long-term effects.

### 3. (Countermeasures for flammable gases)

According to the "Guideline for the Protection of Hot Spring Resources (Revision of Geothermal Power Generation) (Revised) October 2017 Ministry of the Environment Natural Environment Bureau P35-37", the geothermal wells are subjected in the provision of Article 3 of the Hot Springs Act. "Those who intends to drill land for the purpose of creating hot spring, shall apply to the prefectural governor and obtain their permission in accordance with the Ordinance of the Ministry of the Environment," part from said article includes the production wells and the geological survey wells planned for the flow test, which could be turned into the production wells.

Geological survey wells and injection wells not intended for the flow test, are not subjected in the Hot Spring Act, thus there are no legal countermeasures for flammable natural gas required in the process of obtain drilling permission from the prefectural governor. However, considering that risk of fire during drilling are always present, all geothermal wells are subjected to the contents of this guideline.

Regarding the measures against flammable natural gas, the provision of Article 1, paragraph (2) of the Ordinance for Enforcement of the Hot Spring Law shall apply. According to the Ordinance for Enforcement of the Hot Spring Law, the required actions to be implemented varies on the risk of flammable natural gas blowout. Therefore, the implementation of the necessary countermeasures is determined for all geothermal wells even if there is no risk of flammable natural gas blowout.

## Section 12: Safety Confirmation / Inspector

The safety manager or the safety and health promoter appoints an inspector. The inspector will inspect and measure the relevant inspection points based on the created check sheet, record the results thereon, and report to the safety manager or the safety and health promoter.

The followings are the examples of relevant inspection / measurement points.

### Inspection / measurement points

#### Before work

- Each member of the derrick, the status of bolt attachment, wear of the rope, etc.
- Wear and corrosion of drilling lines, cat lines, etc.
- Drilling equipment lubrication points, chains, brakes, safety valves and measurement instruments
- Gas concentration at the wellhead (carbon dioxide, methane, hydrogen sulfide, etc.)

#### Once a month

- Blowout preventer

## Chapter 3 Environmental conservation

When conducting drilling of a geothermal well and the investigation related to it, appropriate plans and measures for the following items shall be established for environmental conservation.

### Section 1: Countermeasures for the hot water, waste mud, waste oil, etc. (Discharge of hot water, waste mud, waste oil, etc.)

#### 1. (Discharge of hot water)

Water quality standards for water discharged from project sites to public water areas are commonly regulated by Article 3 of the Water Pollution Prevention Act, and by Article 1, Annexed Tables 1 and 2 of the Ministerial Ordinance issued by the Prime Minister's Office providing the Effluent Standard of the Water Pollution Prevention Act. According to this ordinance, the allowable drainage limit for arsenic and its compounds is 0.1 ppm, the allowable drainage limit for mercury and its compounds is 0.005 ppm, and the pH is 5.8 to 8.6 (5.0 to 9.0 when discharged to the marine area), respectively. Furthermore, according to the provision of Article 16 of the Basic Environment Law (Environmental Standards for Water Pollution), the environmental standard for human health protection for arsenic level is 0.01ppm and the total mercury level is 0.0005ppm, which is significantly stricter than the standard value stipulated in the Water Pollution Prevention Act.

Hot water discharged from geothermal wells often contains harmful substances, therefore it is necessary to inject hot water back into the injection well, regardless of the regulations according to the Water Pollution Prevention Act or regulation of the Basic Environment Law, which are mentioned above. Additionally, the discharge temperature of hot water shall be considered for the environmental protection.

#### 2. (Treatment of waste oil, waste mud and cuttings)

Article 3 of the Waste Management and Public Cleansing Act stipulates that "The contractor shall appropriately manage of the waste left as a result of their activities at their responsibility". According to this law, the transportation or disposal of the waste can be outsourced to a qualified waste disposer. Waste oil, waste mud, cuttings, etc. generated by drilling geothermal wells, shall apply to industrial waste under the law (Article 2 of the Order of Enforcement for Waste Management and Public Cleansing Act), and therefore the transportation and disposal method and the disposal site shall be appropriately conducted under the regulations of Waste Management and Public Cleansing Act (Article 3 of the Order of Enforcement for Waste Management and Public Cleansing Act). In this case, instead of performing waste disposal by the project operator directly, it is possible to outsource the disposal to a professional waste disposer. The disposer must hold a certificate of approval from the prefectural governor for the transportation, treatment, and disposal site of industrial waste.

When outsourcing the waste disposal and the treatment, a manifest (control manifest for industrial waste) shall be issued describing the name of the industrial waste, the transporter, the disposal operator, and precautions for handling the industrial waste. The manifest shall be carried along with the industrial waste, for the purpose of conveying precise information about the industrial waste, and to ensure that the outsourced industrial waste is

properly treated.

If mercury is contained in the waste mud and cuttings (which corresponds to mining slag and sludge based on the classification under the Waste Management and Public Cleansing Act) generated by drilling of geothermal wells, in addition to the general measures for industrial waste, the necessary measures for its disposal are stipulated based on the content (Article 6, paragraph (1), item 2 of the Order of Enforcement for Waste Management and Public Cleansing Act, Article 7-8-2 of the Ordinance for Enforcement on the Waste Management and Public Cleansing Act, Article 7-8-3, paragraph (2) of the Ordinance for Enforcement on the Waste Management and Public Cleansing Act). For more detail, the “Mercury Waste Guidelines” (2017, Ministry of the Environment) shall be referred.

- Disposal of mercury-containing waste (including mercury contained in mercury compounds) of 15 mg/kg or more shall be outsourced as "mercury-containing dust, etc." to a disposer having license for collection, transportation, or disposal. The necessary measures shall be taken to prevent dispersion of these dust into the atmosphere when disposing or recycling.
- Mercury-containing waste (including mercury contained in mercury compounds) of 1,000 mg/kg or above .is required to the mercury recovery obligation, and the treatment shall be outsourced to an appropriate operator who is capable of recovering mercury. When disposing or recycling, mercury shall be recovered by an appropriate heating process.

### 3. (The embankment of mud pit and filter pit)

Complying with the Ministerial Ordinance for Establishing Technical Standards for Mining Equipments, Article 17, paragraph (4), Item 7, the walls of mud pit and filter pit shall be constructed using solidified clay or other impermeable materials such as vinyl sheets, concrete to prevent pollution of the surrounding area through events such as leakage.

## Section 2: Countermeasures for Noise and vibration (Noise and vibration regulations)

1. When noise and vibration are generated during the operations such as drilling geothermal wells, water injection, and production test, and there is a risk of disturbing local residents, it is necessary to consult with them and take appropriate countermeasures if necessary.
2. When activities, which described above, take place in a noise or vibration restricted area, the regulation standards based on the Noise Regulation Act or the Vibration Regulation Law shall be complied.

According to the Noise Regulation Act, the project sites that have installed compressors with a rated output of 7.5 kW or more, are designated as specified factories (Article 2 of the Noise Regulation Act, Articles 1 and 2 of the Order for Enforcement of Noise Regulation Act). If the site is located within the noise restricted area specified by the law, the noise level generated from the specified factories shall comply with the noise regulation standards (Article 5 of the Noise Regulation Act).

Additionally, according to the Vibration Regulation Act, the project sites where a compressor with a rated output of 7.5 kW or more or a sieving machine etc. is installed, it is also designated as a specified factory (Article 2 of the Vibration Regulation Act, Article 1 of the Order for Enforcement of Vibration Regulation Act). If the site

is located within the vibration regulated area specified by the law, the vibration level generated in factories shall comply with the vibration regulation standards for vibrations that occur in factories, etc. (Article 5 of the Vibration Regulation Act).

3. Countermeasures in the event of breakdown, damage or any accident occurs or may occur to the facility which causes noise or vibration, or to the facility which performs noise/vibration prevention, are specified in Article 791, paragraph (2) and Article 796, paragraph (2) of the former Mine Safety Regulations shall be taken.

### Section 3: Dust

When performing air drilling and aerated mud drilling of geothermal wells, compressed air is used as the drilling fluid. For this reason, the cuttings generated by drilling will turn into dust and it will be released into the atmosphere along with air and steam. Hence, it is necessary to take appropriate measures to prevent the diffusion of dust (Article 2 of the Ordinance on Prevention of Hazards Due to Dust, Article 2 of the Air Pollution Control Act, Article 3 of the Order for Enforcement of Air Pollution Control Act). In this regard, the installation of a necessary device such as a hydraulic jet at the tip of the dust discharge pipe is stipulated.

### Section 4: Environmental protection during sticking

When an underground sticking accident occur during the drilling the geothermal wells, it was stipulated that spotting with diesel and other fluids shall not be allowed even during sticking. This is a result of the environmental problems caused by the invasion of diesel into the formation in order to release the sticking state in the past.

### Section 5: Countermeasures during steam and hot water blowout

1. When the geothermal well produces steam and hot water first, mud and cuttings which have flowed into the formation layer during drilling are produced as well. Countermeasures to prevent the scattering of these substances into the atmosphere are described in Chapter 2, Section 5 and Chapter 3, Section 1. This section specifies the implementation of effective measures to prevent the adverse effect of these produced substance onto the trees and other vegetation for environmental protection.
2. It is stipulated that when the concentration of hydrogen sulfide gas and carbon dioxide gas in the jetted steam exceeds the emission control standard, suspension of blowout test and/or other countermeasures shall be taken.
3. It is stipulated that when the occurrence of noxious gas such as hydrogen sulfide gas and carbon dioxide gas, associated with the geothermal well drilling is present, necessary countermeasures for environmental protection shall be taken.
4. In the event of a breakdown/damage, or a risk of such arises to the steam or hot water treatment facilities, which would interfere environmental protection, safety measures specified in Article 764, paragraph (2) and Article 776, paragraph (3) of the former Mine Safety Regulations shall be taken.

### Section 6: Geothermal well suspension or the measures regarding the abandonment

1. For suspending the geothermal well, this standard specifically stipulates the sealing of the wellhead, as well as enclosing the area with fences and limiting the access to the area.

2. For abandoning a geothermal well, necessary measures, including well-sealing is stipulated under Article 25 of the Ordinance for Enforcement of the Mine Safety Act. However, since this guideline aims at a geothermal well, there is a possibility of leakage of spring water, gas, and steam, etc. in the long term due to the corrosion of well caused by the high temperature and the presence of acid substances in order to prevent such event, sealing of the wells with sufficient amount of cement is stipulated.