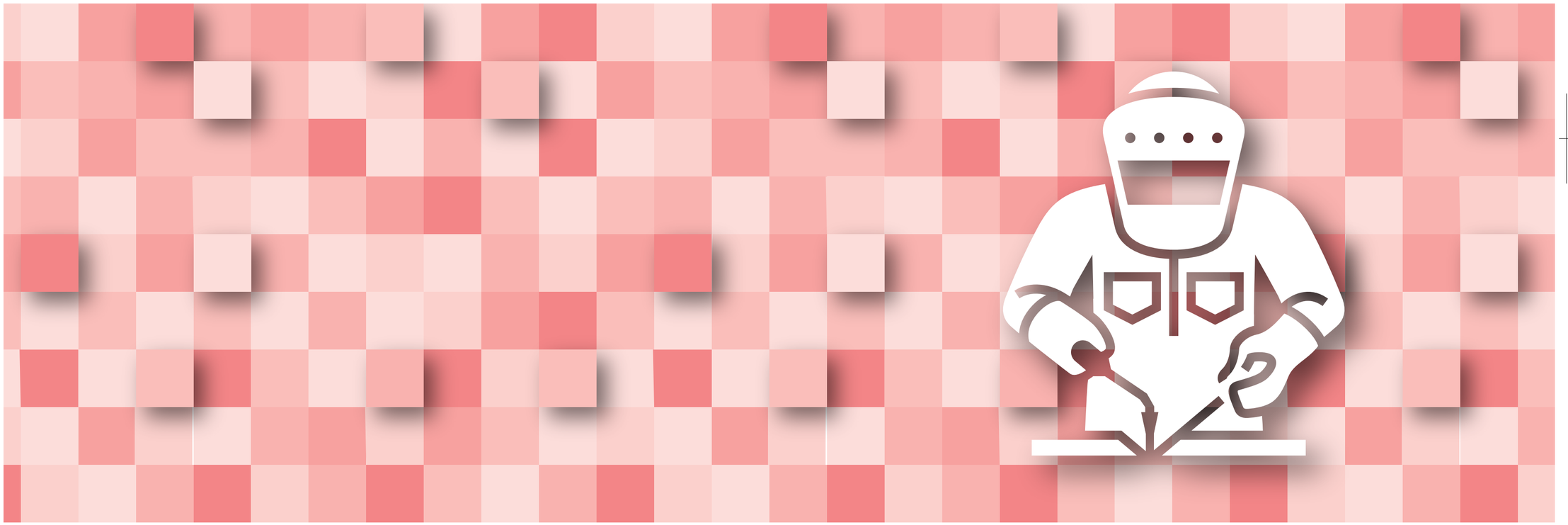
厚生労働省委託事業

ガス溶接技能講習
補助テキスト

Gas Welding (Gasu Yousetsu) Skill Training
Supplementary Text



厚生労働省 労働基準局 安全衛生部

英語版 English Version

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2021年3月

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Preface

In recent years, mainstream welding is shifting from gas to arc, but even now, cutting is often done via gas cutting (gasu setudan). In addition, gas welding (gasu yousetu) is still used at many work areas because the equipment is simple and can be shared for cutting operations, and the flashing is less intense than with arc welding. However, because the acetylene (asechiren) gas used in gas welding (gasu yousetu) can explode due to slight impact or static electricity, there is a risk of serious accidents such as an explosion or fire if it is handled improperly.

In recent years, safety-conscious products have become widespread for appliances such as acetylene (asechiren) gas and oxygen (sanso) containers, pressure regulators (aturyoku chousei ki), and welding torches (tochi). However, improper handling of containers and improper use of pressure regulators (aturyoku chousei ki), welding torches (tochi), etc., may lead to serious accidents.

In fact, in addition to burns caused by gas welding (gasu yousetu), accidents such as ruptures (haretu), explosions, and fires have occurred during welding, and there are concerns about the occurrence of occupational diseases such as pneumoconiosis (jinpai). In FY2018, there were 82 casualties that resulted in more than 4 days of missed work due to gas welding (gasu yousetu) equipment.
(From the text preface)

Chapter 1 Equipment Used for Gas Welding (Gasu Yousetsu), etc.

1.1 Basic gas welding (gasu yousetu) theory, etc.

1.1.1 Basics of gas welding (gasu yousetu)/gas cutting (gasu setudan)

- **Characteristics of gas welding (gasu yousetu) (Text Page 2)**

The advantages and disadvantages of gas welding (gasu yousetu) compared to arc welding are as follows.

● Advantages

- Since the equipment is simple and does not require a power source, work can be done anywhere there is a gas supply source (gas cylinder (bonbe))
- If welding metal, which forms the wall of the joint, is not required, welding can be performed without using a covered electrode
- There is little generation of harmful ultraviolet rays, fumes (hyumu), and spatter (supatta; melted metal particles and powder scattered during cutting and welding work)

● Disadvantages

- The temperature of the heat source is low
- It takes a long time to heat the metal until it melts
- It is difficult to overheat the welded part locally
- A lot of strain is generated
- The heat-affected zone is large
- Not suitable for welding different metals together or thick plates

- **Characteristics of gas cutting (gasu setudan) (Text Page 2)**

Since gas cutting (gasu setudan)is performed by oxidizing metal, only iron-based materials and such that oxidize depending on the combustion temperature of the gas can be cut. However, even thick plates can be cut as long as the material oxidizes at the gas combustion temperature.

1.1.2 History of gas welding (gasu yousetu)/gas cutting (gasu setudan)

- Skill training system (Text Page 4)

From the viewpoint of preventing occupational accidents, the "Gas Welding Skills Training System" based on the Labor Standards Act started in 1967 as a qualification necessary for performing gas welding (gasu yousetu) work. Starting in 1972, the Industrial Safety and Health Act (roudou anzen eiseihou) became the law on which it was based, and this has continued to this day.

- Gas welding operations chief (gasu yousetu sagyou shuninsha) license system (Text Page 4)

In 1947, when the Labor Standards Act came into effect, the acetylene (asechiren) welder license system was established to offer certification for restricted employment activities based on occupational safety and health.

As a result, to handle acetylene (asechiren) welding equipment, those appointed as welding chief must have obtained an acetylene (asechiren) welder license from the Director of the Prefectural Labor Standards Bureau.

Since 1972, this has been the "gas welding operations chief (gasu yousetu sagyou shuninsha) license" system.

1.1.3 Overview of the toxicity of gas welding (gasu yousetsu)/gas cutting (gasu setudan)

- Risks of gas welding (gasu yousetsu)/gas cutting (gasu setudan) (Text Page 4)

Gas welding (gasu yousetu) and cutting are routinely performed at various factories and construction sites. However, this work uses a dangerous gases to generate high-temperature flames, and serious accidents will occur if sufficient care is not taken. It is necessary to always be aware of this during work.

Handling oxygen (sanso) and flammable gas involves risk. Oxygen (sanso) violently burns flammable materials, and flammable gases cause explosions and fires.

There are countless examples of gas welding (gasu yousetsu) work causing accidents in which a high-temperature flame ignited nearby flammable steam or gas during actual gas welding work, causing it to explode. Additionally, there have been many accidents in which people were injured by touching hot base materials or spatter (supatta).

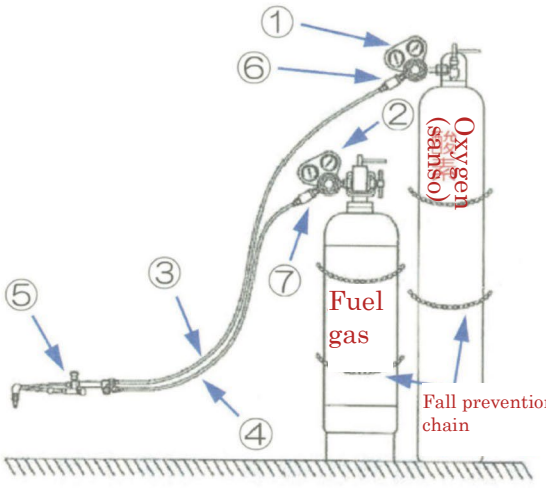
- Toxicity of gas welding (gasu yousetsu)/gas cutting (gasu setudan) (Text Page 5)

When it comes to not only gas welding (gasu yousetu), but occupational accidents, the focus tends to be on preventing injuries and fatal accidents, but it is also necessary to prevent occupational illnesses. If a large amount of fumes (hyumu) generated by gas welding (gasu yousetsu) are inhaled even for just a short period of time, one may be afflicted by illnesses such as fume fever. Also, even if the amount is small, inhaling fumes (hyumu) for long periods of time may cause one to suffer from serious illnesses such as pneumoconiosis (jinpai).

Additionally, gas flames generate ultraviolet rays and infrared rays in addition to strong visible light, and they may cause damage to the eyes and skin.

1.2 Equipment used for gas welding (gasu yousetu), etc.

1.2.1 Equipment used for gas welding (gasu yousetsu) and gas cutting (gasu setudan) (Text Page 6)



(1) Oxygen (sanso) pressure regulators (aturyoku chousei ki))
(2) Fuel gas pressure regulator (aturyoku chousei ki)
(3) Oxygen (sanso) hose (housu) (blue)
(4) Fuel gas hose (housu) (red or orange)
(5) Welder or cutter (setudanki) (suction pipe and nozzle (higuchi))
(*Figure shows an example of a cutter (setudanki))
(6) Flashback arrester (kanshiki anzen ki) for oxygen (sanso) (flashback (gyakka) prevention device)
(7) Flashback arrester (kanshiki anzen ki) for fuel gas (flashback (gyakka) prevention device)

Source: Partially revised figures from the National Institute of Occupational Safety and Health Technical Guidelines

Fig. 1-1 Equipment used for gas welding (gasu yousetsu) and gas cutting (gasu setudan))

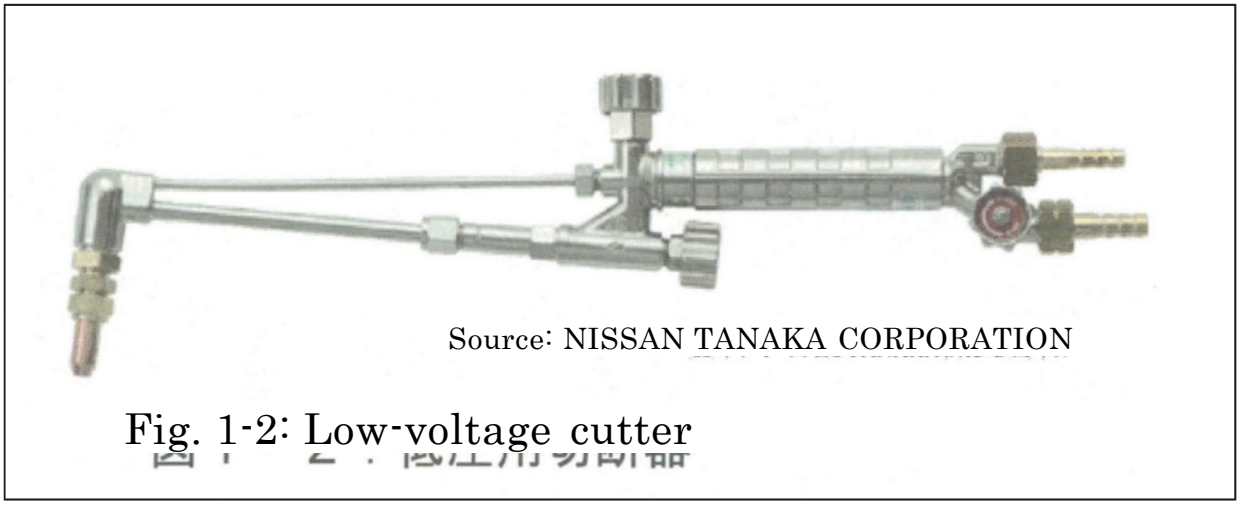
Welders cannot necessarily be used with any flammable gas. Welders appropriate for the type and pressure of the flammable gas must be used.

Additionally, gas cutting (gasu setudan) can be performed by replacing the blowpipe (suikan) and nozzle among the equipment used for gas welding (gasu yousetsu) (see Fig. 1-1) with equipment used for gas cutting (gasu setudan).

1.2.2 Torch (Text Page 7)

A torch (tochi) is an instrument used for performing operations such as manually heating, welding,and cutting a metal (base material) using not only a gas flame, but also a gas shield arc or a plasma arc. Figure 1-2 shows an example of a torch (tochi) (low-voltage cutter (setudanki)).

Welders for gas welding (gasu yousetsu) and cutters (setudanki) for gas cutting (gasu setudan) are torches (tochi) that mix and burn flammable gas and oxygen (sanso) to heat metal materials. They are sometimes called blowpipes or burners. These welders and cutters (setudanki) consist of a blowpipe (suikan) and a nozzle.

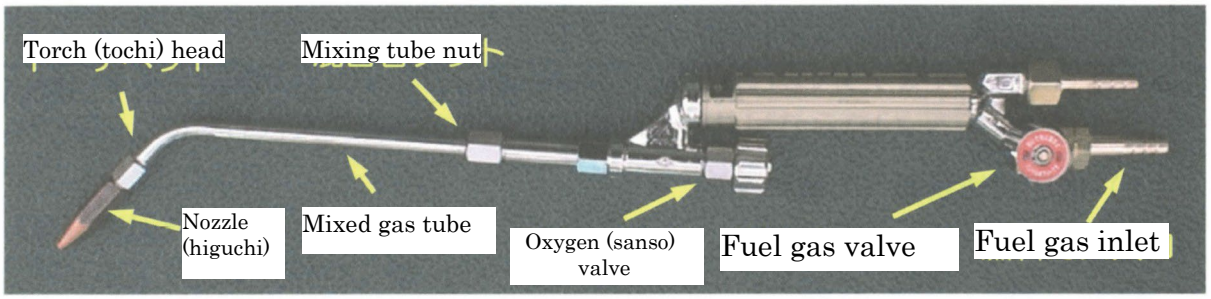


Source: NISSAN TANAKA CORPORATION

Fig. 1-2: Low-voltage cutter

（日酸 TANAKA(株)提供）

- Welder for gas welding (gasu yousetu) (Text Page 9)

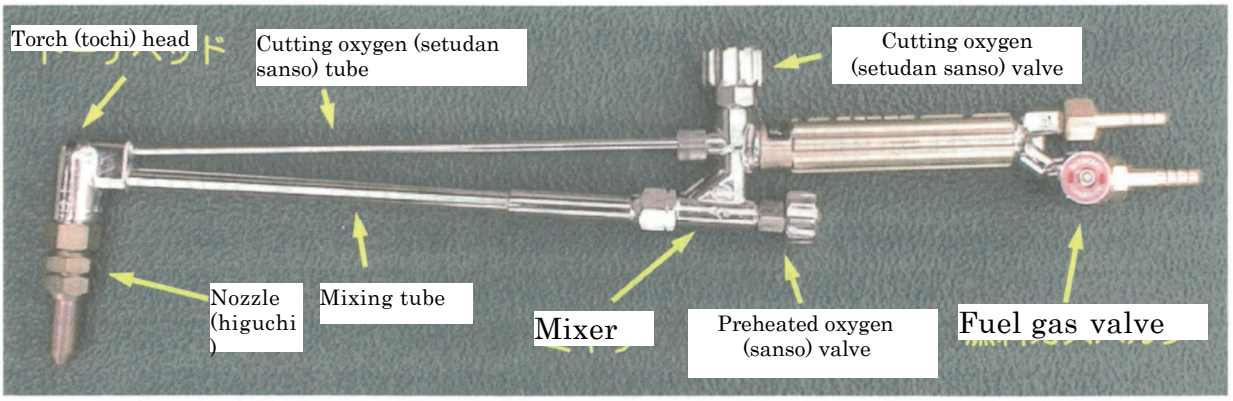


Source: KOIKE SANSO KOGYO Co.,LTD.

Fig. 1-4 Type-B welder (French style)

（小池酸素工業株式会社提供）

- Cutters for gas cutting (gasu setudan) (Text Page 10)



Source: KOIKE SANSO KOGYO Co.,LTD.

Fig. 1-5 Low-pressure (torch (tochi) mixing) cutter (setudanki) (French style)

（小池酸素工業株式会社提供）

1.2.3 Nozzle (higuchi)

- Flammable gas types and nozzles (Text Page 14)

Because the properties of flammable gases differ depending on the type, the structure of the nozzle differs depending on the type of flammable gas as well.

As shown in Table 1-3, compared to propane (puropan), which is the main component of LPG, acetylene (asechiren) is easier to ignite and has a faster combustion rate. For this reason, the rise in temperature is minimized before it erupts from the nozzle in order to prevent flashbacks (gyakka), and it erupts from the nozzle at a high speed.

Table 1-3 Acetylene (asechiren) gas and propane (puropan) gas combustion rates

	Minimum ignition temperature (In oxygen (sanso)) 【°C】	Combustion rate (Neutral mixture ratio) 【m/sec】
Acetylene (asechiren)	296	7.2
Propane (puropan)	470	2.7

*: The figures are based on "Summary: Thermal Cutting Q&A" from The Japan Welding Engineering Society.

- Dangers of using incorrect flammable gas types (Text Page 16)

The shapes of the nozzle for acetylene (asechiren) and the nozzles for other gases are different because of differences in the ease of ignition and the combustion rate.

Since acetylene (asechiren) has a faster combustion rate than other flammable gases, nozzles for acetylene have a structure in which the spouting speed is made faster than the combustion speed to prevent flashbacks (gyakka). For this reason, if a gas with a slow combustion rate such as LPG is used in the nozzle for acetylene (asechiren), the preheating flame (yonetu en) will migrate away from the nozzle or blowout (the flame disappears) will occur.

On the other hand, LPG and the like have a structure in which the combustion speed is slow and ignition is difficult, so the gas is heated at the nozzle and the ejection speed is slowed down. For this reason, if acetylene (asechiren) gas is used with a nozzle (higuchi) for other flammable gases, a flashback (gyakka) will occur, which is extremely dangerous

1.2.4 Pressure regulators (aturyoku chousei ki) and safety units (anzen ki)

- Pressure regulator (aturyoku chousei ki) (Text Page 17)

Oxygen (sanso) and flammable gas that a container is filled with cannot be used without installing an appropriate pressure regulator (aturyoku chousei ki). The pressure regulator is for adjusting the original pressure of the cylinder (bonbe) to a pressure suitable for welding and cutting. Since the material, structure, and so on differ depending on the type, pressure, flow rate, and other properties of the gas, it is necessary to carefully consider the properties and usage conditions of the gas and select the one that is suitable.

- Notes for using pressure regulators (aturyoku chousei ki) (Text Page 18)

When performing welding, etc., the valve inside the pressure regulator (aturyoku chousei ki) must be stable at a fixed clearance. However, if the pointer of the pressure regulator (aturyoku chousei ki) is vibrating fractionally or abnormal noise is generated from the pressure regulator body when gas is flowing, confirm the pressure regulator settings, close the valve on the low- pressure side once and open it slowly. If the same phenomenon occurs even after repeating this several times, stop using it and send it in for repairs.

Acetylene (asechiren) pressure regulator (aturyoku chousei ki) (Text Page 19)

Pressure regulators (aturyoku chousei ki) for acetylene (asechiren) gas must be exclusively for acetylene. A type with a built-in flashback arrester (kanshiki anzen ki) is also available.

As shown in Fig. 1-17, the cylinder (bonbe) cap has no screws and is secured by being pressed with mounting brackets. Therefore, it cannot be mistakenly attached to the oxygen (sanso) container.

Note that acetylene (asechiren) may react with copper, silver, and their compounds to form metal acetylides. Metallic acetylides may spontaneously ignite, causing explosive decomposition of the acetylene (asechiren). For this reason, the Industrial Safety and Health Act stipulates that copper or substances containing more than 70% copper should not be used where acetylene (asechiren) may come into contact with them. Containers and such subject to the High Pressure Gas Safety Act must not use containers containing more than 62% copper.

Source: NISSAN TANAKA CORPORATION

Fig. 1-17: Acetylene (asechiren) gas regulator

（日酸 TANAKA(株)提供）

- Oxygen (sanso) pressure regulator (aturyoku chousei ki) (Text Page 20)

Oxygen (sanso) pressure regulators (aturyoku chousei ki) that are exclusively for oxygen must be used.

As shown in Fig. 1-18, the cap of the oxygen (sanso) pressure regulator (aturyoku chousei ki) has right-hand threads, so that it cannot be attached to a flammable gas cylinder (bonbe).

Also, pressure regulators (aturyoku chousei ki) for oxygen (sanso) must not be lubricated.

There are two types of oxygen cylinder (bonbe) caps: the German type, which has a male screw, and the French type, which has a female screw. As shown in Fig. 1-18, the oxygen (sanso) pressure regulator (aturyoku chousei ki) also has a mounting nut type with a female screw (cap nut) and a mounting screw type with a male screw. Conversion joints are sold because they are not compatible as-is.

Mounting nut types are mainly distributed in the Kanto region, and mounting screw types are mainly distributed in the Kansai region, so care must be taken when doing work on business trips.

Mounting nut type (German style)

Mounting screw type (French style)

Source: KOIKE SANSO KOGYO Co.,LTD.

Fig. 1-18: Oxygen (sanso) regulator mounting screws

（小池酸素工業株式会社提供）

- Gas welding (gasu yousetu)/gas cutting (gasu setudan) and flashbacks (gyakka) (Text Page 20)

In gas welding (gasu yousetu), if flammable gas and oxygen (sanso) are not handled properly, a phenomenon called a flashback (gyakka) may occur in which a flame enters the inside of a welder or a hose (housu). Flashbacks (gyakka) are stopped by safety units (anzen ki) (flashback arresters (gyakka boushi souchi)). If the safety unit (anzen ki) works properly, the flashback (gyakka) will stop, but even in that case, the flashback (gyakka) will reach the welder and gas hose (housu) before the safety unit. Not only does this damage the device, but soot may adhere to the interior and combust later on. In addition, during a phenomenon called "detonation," in which the flashback (gyakka) speed exceeds the speed of sound, a shockwave may be generated and the hose (housu) may rupture (haretu) or ignite.

Furthermore, if the safety unit (anzen ki) is not activated, the flame will return to the gas container, resulting in a serious accident.

It is important not to think everything will be okay just because there is a safety unit (anzen ki) and to make efforts to prevent flashbacks (gyakka).

1.2.5 Welding hose (housu)

- Exterior color of gas hoses (housu) for welding/cutting (Text Page 24)

The colors of the rubber layer on the exterior of the rubber hose for welding/cutting (yousetu/setudan you gomu housu) is not stipulated by law, but they are specified in JIS K 6333 for each type of gas. JIS K 6333 is for "rubber hoses (housu) for fusing," but the term "fusing" refers to both welding and cutting. Additionally, this standard also applies to hoses for inert or activated shield gases in arc welding.

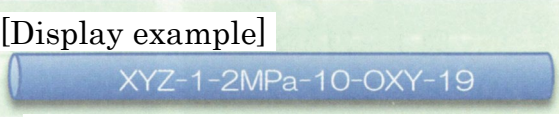
JIS provisions are not legally binding, but must be observed in order to carry out work in a safe manner. The gas hose (housu) should be specific to each gas and should not be shared with other gas hoses.

- Display of rubber hoses for welding/cutting (yousetu/setudan you gomu housu) (Text Page 24)

JIS K 6333 stipulates that the following indications should be displayed on rubber hose for welding/cutting (yousetu/setudan you gomu housu) at least every 1 m.

- Manufacturer or supplier mark
- Number indicating the type of hose (housu)
- Maximum working pressure expressed in MPa
- Nominal diameter (inner diameter) expressed in mm
- Symbol indicating the type of gas (Table 1-5)
- Year of manufacture

[Display example]



This symbol provides the following information.
(1) The manufacturer is "XYZ."
(2) The hose (housu) type is "Type 1."
(3) The maximum working pressure is 2MPa.
(4) The nominal diameter is 10 mm.
(5) The gas type is oxygen (sanso).
(6) The year of manufacture is 2019.

Table 1-5: Gas type symbols and identifying col

Gas type symbol	Gas type	Color of exterior rubber layer
ACE	Gas for acetylene (asechiren) and other fuels (*) (Excluding LPG, MPS, natural gas, and methane)	Red
OXY	Oxygen (sanso)	Blue
SLD	Air, nitrogen, argon, carbon dioxide	Black
LMN	LPG, MPS, natural gas, methane	Orange
AFG	Acetylene (asechiren), LPG, MPS, natural gas, methane, and other fuel gases	Red and orange

*Manufacturer

※ 製造業者は、水素用途に対する適合性について検討しなければならない

1.2.6 Various gas containers (cylinders (bonbe)) and acetylene (asechiren) gas generators

(1) Display and color of various gas containers

- **Filling labels for gas containers (Text Page 27)**

The gas container has a filling label affixed to it. The filling label provides the following information:

- Filling gas name
- Filling pressure or mass at the time of filling
- Filling date/manufacturing lot identifier
- Store (seller) contact information/factory (manufacturer) contact information
- Filling gas properties
- General notes
- Contains explanations of priority items,

etc.

- **Color of gas container (Text Page 28)**

By law, the cylinders (bonbe) of gas containers are required to be the colors shown in Table 1-9 according to the type of gas used to fill them. The law stipulates that more than half of the cylinder's (bonbe) surface be colored, but most high-pressure gas cylinders, with the exception of medical gas, have their entire surfaces colored.

Note that containers with an internal capacity of 0.1 liters or less and containers used without sealings may not conform to this color scheme. Additionally, when performing welding work in a foreign country such as China, please note that the color of the cylinder color may be different from that in Japan.

Table 1-9: Gas

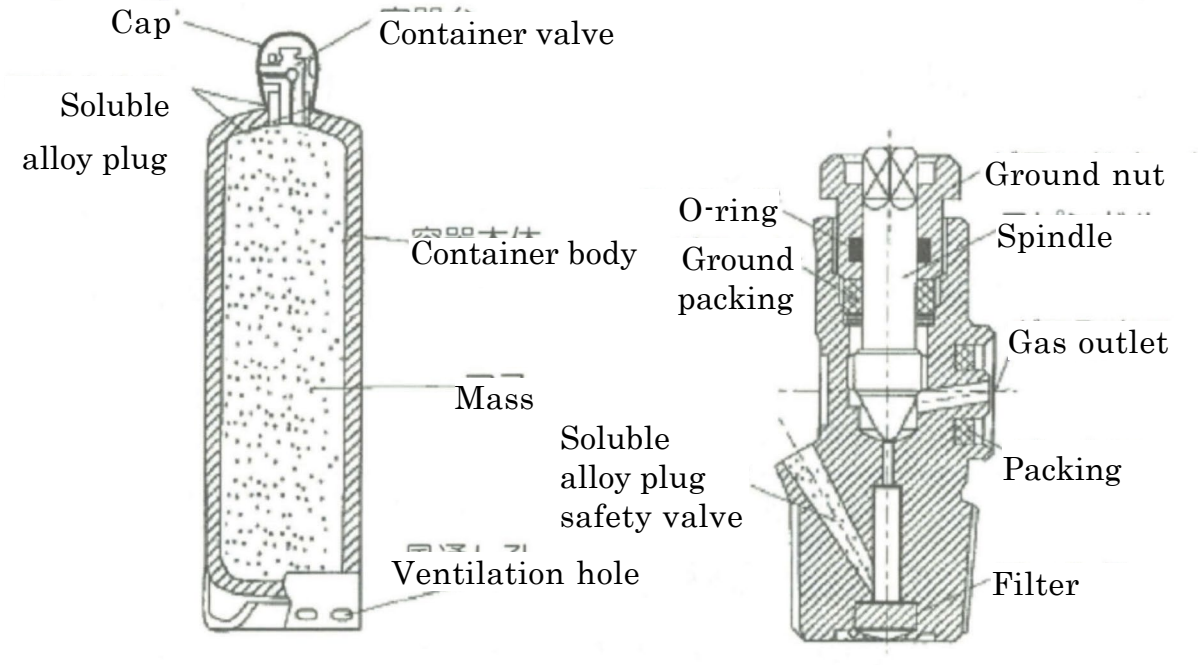
Filling gas	Container color
Oxygen (sanso)	Black ■
Acetylene	Brow ■
Hydrogen	Red ■
Liquefied	Green ■
Liquefied	White □
Liquefied	Yello ■
Other gases (LPG, etc.)	Gray ■

(2) Acetylene (asechiren) gas cylinders (bonbe)

- Internal structure of acetylene (asechiren) cylinder (bonbe) (Text Page 28)

Acetylene (asechiren) gas is an unstable substance, and it is dangerous to fill the cylinder (bonbe) as-is under high pressure. Therefore, the internal structure of the acetylene (asechiren) gas cylinder (bonbe) is significantly different from that of other gas cylinders. The cylinder for acetylene gas (asechiren you no gasubonbe) contains a porous solid into which acetone or N, N-dimethylformamide (DMF) has permeated. This is called a "mass," and nowadays calcium silicate is often used. Masses must pass tests conducted by the High Pressure Gas Safety Institute of Japan.

Acetylene (asechiren) filling is performed by dissolving it in acetone or DMF soaked in a mass. For this reason, if the acetylene (asechiren) cylinder (bonbe) is laid on its side, acetone and DMF may leak from the mass, so it is necessary to stand it upright. If it falls, do not use it immediately after standing it up, but wait for a while. Also, do not lay down used acetylene (asechiren) cylinders (bonbe).



Source: National Institute of Occupational Safety and Health Technical Guidelines

Fig. 1-25: Acetylene (asechiren) container and container valve

- Acetylene (asechiren) cylinder (bonbe) appearance (Text Page 29)

The base of the acetylene (asechiren) cylinder (bonbe) is called a spigot-type, and since it has no screws (it has natural rubber packing), it is installed by being tightened with a mounting bracket to the side of the pressure regulator (aturyoku chousei ki).

Additionally, there is a fusible plug (yousen) on the shoulder of the acetylene (asechiren) cylinder (bonbe) so that the fusible alloy melts at a temperature of 105°C or higher and the gas inside blows out. This prevents the cylinder (bonbe) from rupturing (haretu) due to high internal pressure.

(3) Other flammable gas cylinders (bonbe) (Text Page 30)

For propane (puropan) and butane, etc., the cylinder (bonbe) is filled in a high-pressure liquid state. Since it is liquefied, if the container valve is opened while the container is lying down, the liquid will flow to the low-pressure chamber side in the regulator, and the pressure on the low-pressure side will rise, which may cause malfunctions.

The cap of flammable gas (and helium) cylinders (bonbe) is a left-hand screw, with the exception of ammonia, etc.

(4) Oxygen cylinder (sanso bonbe) (Text Page 30)

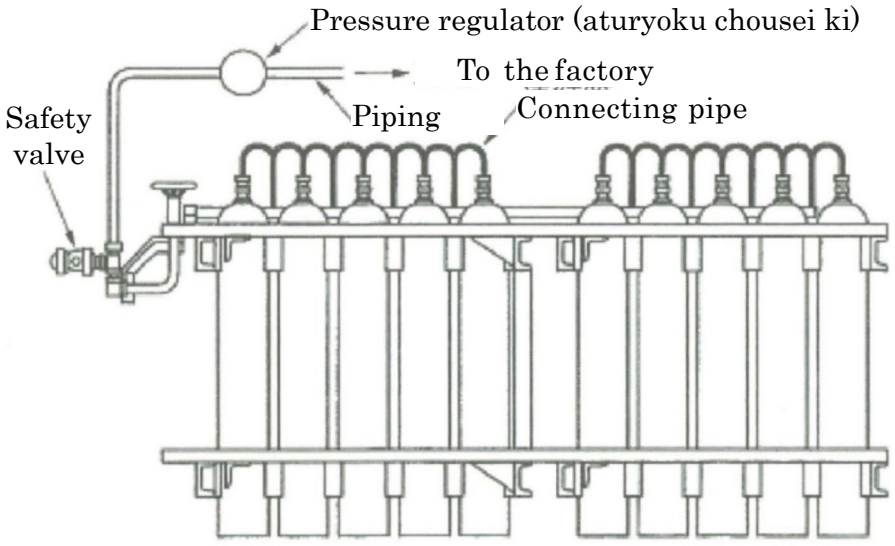
Oxygen (sanso) used for welding is fed into an oxygen cylinder (sanso bonbe) in a gaseous state at a pressure slightly lower than 15 MPa. Oxygen cylinders (sanso bonbe) are thick and sturdy to withstand high pressures and are generally quite heavy.

The caps (filling mouth) of oxygen cylinders (sanso bonbe) have right-hand threads, the opposite of flammable gas

Oxygen (sanso) helps things burn, and even a small amount of oxygen burns violently when oil or the like adheres to the flow path, which is extremely dangerous.

(5) Gas manifold

- **Gas welding equipment using manifolds (Text Page 30)**



Source: National Institute of Occupational Safety and Health Technical Guidelines

Fig. 1-28: Conceptual diagram of oxygen (sanso) gas manifold

- **Managing gas welding equipment using manifolds (Text Page 32)**

When performing metal welding, fusing (welding) or heating work using a gas manifold, a gas welding operations chief (gasu yousetu sagyou shuninsha) must be appointed.

1.3 Handling of equipment used for gas welding (gasu yousetu), etc.

1.3.1 Qualifications (Text Page 33)

Work such as gas welding (gasu yousetu) must not be performed without qualifications, including completing gas welding skill training. Brazing with a gas torch (tochi) that does not use oxygen (sanso) does not require any special qualifications.

There are age restrictions, and no one under the age of 18 should be engaged in gas welding (gasu yousetu) work (Regulations on Labor Standards for Minors, Article 8, Item 29). Also, boiler welding work must not be assigned to anyone under the age of 18 for both arc welding and gas welding (gasu yousetu).

1.3.2 Cylinder (bonbe) and acetylene (asechiren) generator

(1) Notes for transporting cylinders (bonbe)

- **Notes for vehicle transportation (Text Page 34)**

Flammable gas containers used for welding must be upright or tilted, and must be directly secured to a dedicated tool or vehicle for transportation. Also, for liquefied gas (ekika gasu), transport oxygen cylinders (sanso bonbe) in stacks, and for compressed gas, transport them arranged horizontally.

Gas cylinders (bonbe) should be loaded in front of the vehicle and at least 30 cm away from the rear bumper. This is to prevent the container from rupturing (haretu) when it is hit from behind.

Also, do not leave it as-is for a long time after it arrives at the destination.

- **Notes on transportation in factories, etc. (Text Page 36)**

Use dedicated gas cylinder (bonbe) carriers to transport gas cylinders at factories and construction sites. Do not use a cylinder (bonbe) carrier that has had the fixing belt or rope removed.

Do not forego using the cylinder carrier and drag or roll the cylinder (bonbe). Note that, when the cylinder (bonbe) is upright, it may be rotated at a slight angle to be carried for a short distance, but this kind of transportation method is not recommended.

When carrying cylinders (bonbe) by hand, the valve part of the container must not be held. Also, when moving to another floor in a building with an elevator, use the elevator and do not carry it on the stairs.

(2) How to use cylinder (bonbe) gas

- Cylinder (bonbe) usage instructions (Text Page 36)

When using a cylinder (bonbe), be sure to keep it upright or tilted and secure it to a special tool or a building wall, etc., using a chain or the like.

Securely install a pressure regulator (aturyoku chousei ki), etc., to the cylinder (bonbe) valve, and then slowly open it with a special tool. Do not use a monkey wrench. Also, note that some types of gas should not be fully opened.

If the valve is opened suddenly, the air remaining in the pressure regulator will be compressed and heat up, which may turn it into an ignition source and cause an explosion. Note that acetylene (asechiren) can explode even without oxygen (sanso), so care is required.

Leave the instrument (wrench) used for opening the cap attached until usage is complete.

- Notes on using cylinders (bonbe) (Text Page 37)

Keep the following in mind when using cylinders.

[Notes for using cylinders (bonbe)]

- Be sure to secure the cylinder (bonbe)
- Do not use cylinders (bonbe) on the loading platform of a transport vehicle
- When securing the cylinder (bonbe), do not secure it at the neck.
- Do not touch the oxygen cylinder (sanso bonbe) with oily gloves. Also, do not place oil near the cylinder (bonbe).

(3) Notes for disposal/return

- Returning gas containers, etc. (Text Page 37)

Gas containers can be purchased in-house or borrowed from a gas manufacturer, but in most cases they are borrowed from a gas manufacturer. For this reason, gas containers must be returned to the manufacturer after use.

Additionally, even when containers are purchased, when they are no longer needed, the supplier or the contact indicated on the container must be contacted to request collection. Do not leave cylinders (bonbe) in the factory as-is or dispose of them as general industrial waste. Never cut a container filled with oxygen (sanso) or flammable gas, as doing so is extremely dangerous.

If the supplier is not known and there is no contact indicated on the container, contact the High Pressure Gas Safety Institute of Japan in the prefecture.

- Notes for returning gas containers (Text Page 37)

Gas manufacturers often stipulate in their contracts (contracts with gas purchasers) that gas containers should be returned without being used up. This is because when the gas is used up, the pressure of the cylinder (bonbe) becomes the same as the atmospheric pressure, and dirty air may enter the container. For this reason, the gas container must be returned to the manufacturer without all of the gas being used up.

In actuality, containers may be returned when the pressure on the high- pressure side of the pressure regulator (aturyoku chousei ki) reaches a pressure close to the minimum memory of the pressure gauge.

1.3.3 Pressure regulator (aturyoku chousei ki)

(1) Pressure regulator (aturyoku chousei ki) fixing (Text Page 41)

The procedure for installing a pressure regulator (aturyoku chousei ki) to various gas cylinders (bonbe) is as follows.

[Pressure regulator (aturyoku chousei ki) fitting procedure]

(1) Removing dust, etc.

- **For oxygen cylinders (sanso bonbe):** Before installing a pressure regulator (aturyoku chousei ki), open the valve about half a turn, leave it for about 1 second, and blow off the dust from the filling port using gas.

-**For flammable gas cylinders (bonbe):** Wipe the filling port with a waste cloth.

(2) Check the packing

Make sure that the packing is installed normally and that there are no scratches.

(3) Install the pressure gauge

- **For oxygen cylinders (sanso bonbe):** Do not point the radiation aperture toward yourself, but adjust the position so that the pressure gauge is easy to see, and install it such that five or more screw threads on the regulator side are applied. At this time, a special fitting tool is used.
  Do not use a monkey wrench as it may not fit into the nut or may crush the threads.

- **For acetylene (asechiren) cylinder (bonbe):** Do not point the radiation aperture toward yourself, but adjust the position so that the pressure gauge is easy to see, and press it with the mounting bracket to secure it. At this time, if the screws are not tightened securely, gas leakage may occur. On the contrary, if it is tightened too much, the packing will be damaged and this will also cause gas leakage.

(4) Check the control handle

After installing it correctly, make sure that it is turned all the way to the left and is loose so that it does not face the pressure gauge at an angle to the regulator. If the control handle is loosened, gas will not flow. Please note that it is the opposite of a water faucet.

(5) Open the valve

Next, gently and slowly open the cylinder (bonbe) valve. Do not open it suddenly. If the valve is stiff, tap the open/close handle with your palm. Leave the handle as-is after opening the valve.

- **For oxygen cylinders (sanso bonbe):** Fully open the gas valve.
- **For acetylene (asechiren) cylinders (bonbe):** Turn the acetylene (asechiren) cylinder (bonbe) valve about one and a half turns (do not fully open it).

(6) Check for gas leaks

Next, apply soapy water, etc., to the connecting part, visually check from at least two directions, verify that there are no bubbles, and check for gas leaks.

(2) When the pressure regulator (aturyoku chousei ki) shows abnormalities

- **High pressure on the low pressure side (Text Page 42)**

If dust adheres to the valve inside the regulator, gas may leak from the high-pressure side to the low-pressure side even if the control handle is fully loose. In this situation, a phenomenon known as “outflow” occurs in which the pressure on the low-pressure side gradually rises when no gas is being used.

If outflow occurs, immediately stop using the regulator and request repairs from the manufacturer or retailer.

(3) Precautions for using pressure regulator (aturyoku chousei ki) (Text Page 43)

When using a pressure regulator (aturyoku chousei ki), keep the following in mind.

[Points to note when using a pressure regulator (aturyoku chousei ki)]

(1) When not in use, turn the control handle all the way to the left to loosen it.

(2) Do not apply grease or oil to the regulator parts or handle them with oily gloves. In particular, do not get any oil on the oxygen (sanso) pressure regulator (aturyoku chousei ki).

(3) If the mounting screw of the pressure regulator (aturyoku chousei ki) is damaged, do not try to forcibly install it.

(4) Do not move a cylinder (bonbe) with a pressure regulator (aturyoku chousei ki) installed to it.

(5) If the acetylene (asechiren) pressure drops during work, check the amount remaining inside the cylinder (bonbe).

(6) When work is finished or being suspended, close the cylinder (bonbe) valve and turn the control handle all the way to the left to loosen it.

(7) Do not disassemble or repair the pressure regulator (aturyoku chousei ki).

1.3.4 Welding, etc.

(1) Installation (Text Page 43)

The procedure for connecting the pressure regulator (aturyoku chousei ki) and the welder, etc., is as follows.

[Procedure for connecting the pressure regulator and the welder]

(1) Before connecting, check that the hose (housu) has not deteriorated or have cracks.

(2) Make sure that there are no dust, insects, or water inside the hose (housu).

(3) Make sure that the blowpipe (suikan) valve is closed.

(4) Use a blue hose (housu) for oxygen (sanso) and a red hose for acetylene (asechiren). Do not share hoses (housu) for different types of gas.

(5) If one-touch type connectors are attached to both ends of the hose (housu), securely connect the output side of the pressure regulator (aturyoku chousei ki) to the blowpipe (suikan). Note that the one-touch type has a structure in which the pressure regulator (aturyoku chousei ki) for oxygen (sanso) and the hose (housu) for acetylene (asechiren) cannot be connected.

At this time, if the flammable gas pressure regulator (aturyoku chousei ki) does not have a flashback arrester (kanshiki anzen ki), install a flashback arrester on the hose (housu) side of the flammable gas.

(6) After all the connections are completed, set the oxygen (sanso) pressure to about 0.3 to 0.5 MPa and check for gas leaks using soapy water or the like. After checking for oxygen (sanso) gas leaks, set the pressure of the flammable gas to about 0.03 to 0.05 MPa and perform a gas leak check in the same manner.

(7) If there is no gas leak, open the valve of the flammable gas in the blowpipe (suikan) for 2 to 3 seconds to release the gas, and repeat this twice. Next, with the flammable gas valve closed, open the oxygen (sanso) gas valve for about 5 seconds to release the oxygen. This is to expel the air contained in the hose.

At this time, be careful not to inhale the gas directly. Pure oxygen cannot be said to be harmless to the human body.

(8) Finally, close the blowpipe (suikan) valve, close the cylinder (bonbe) valve, loosen the pressure regulator (aturyoku chousei ki) completely, and wait for about 5 minutes. Afterwards, check the pressure on the high-pressure side and low-pressure side of the pressure regulator (aturyoku chousei ki). If either pressure is decreasing, gas is leaking. If the pressure on the high-pressure side drops and the pressure on the low-pressure side rises, the pressure regulator (aturyoku chousei ki) valve is malfunctioning. Repairs are required in either case.

(2) Ignition and flame control

- Adjusting low-pressure side pressure of pressure regulator (aturyoku chousei ki) (Text Page 44)

Adjust the low pressure side pressure according to the following procedure.

[Procedure for adjusting pressure on the low-pressure side]

(1) Re-confirm that the blowpipe (suikan) valve is closed.

(2) Slowly turn the control handle for the oxygen (sanso) and flammable gas with the pressure regulator (aturyoku chousei ki) to adjust the pressure on the low-pressure side. The appropriate pressure differs depending on the nozzle (higuchi) and is described in the manual, etc., of the nozzle manufacturer. Generally, oxygen (sanso) is 0.2 to 0.3 MPa, and flammable gas is 0.02 to 0.03 MPa.

- Ignition and flame control (Text Page 44)

Follow the procedure below to adjust the ignition and flame.

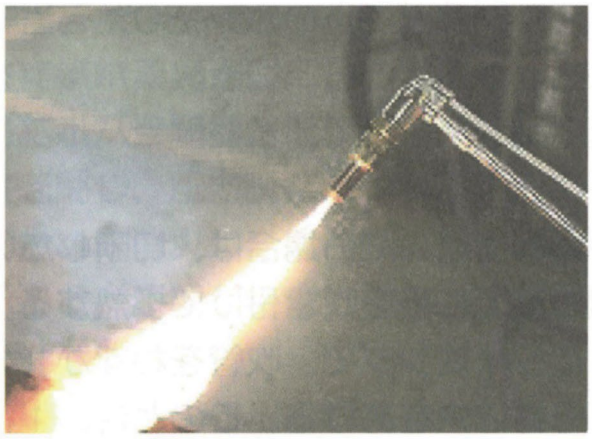
[Procedure for adjusting ignition and flame] (For welding)

(1) Wear protective welding gear and light-shielding protective glasses for gas welding (gasu yousetu) in an appropriate manner.

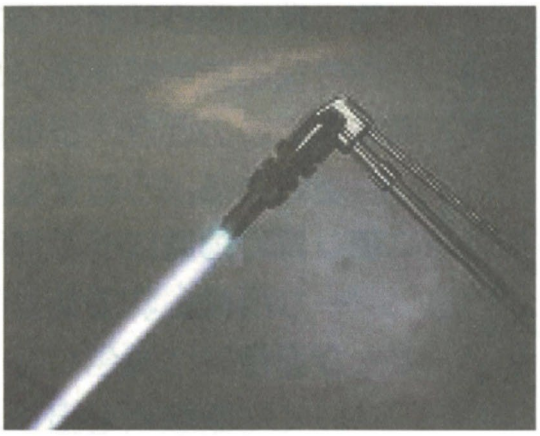
(2) Open the blowpipe (suikan) flammable gas valve.

(3) Ignite using special ignition equipment (welding lighter (yousetu you raita)).

(4) Open the preheated oxygen (sanso) valve as soon as possible. Operate the flammable gas valve first, followed by the oxygen (sanso) valve, to create a pale flame. At this time, the white conical section (white cone (white spots)) formed at the mouth of the nozzle (higuchi) in the gas flame should emerge from the tip of the nozzle by about as much as is shown in Fig. (2) of Fig. 1-30. The flame that is in an appropriate state at this time is called a neutral flame or standard flame.



(1) Flame immediately after ignition (carbonizing flame)



(2) After adjusting the amount of oxygen (sanso) (standard flame)

Source: KOIKE SANSO KOGYO Co.,LTD.

Fig. 1-30: Adjusting the flame

（小池酸素工業株式会社提供）

(3) Welding and cutting

- Welding (Text Page 45)

The welding procedure is as follows.

[Gas welding (gasu yousetu) procedure]

(1) Set the base material to be welded in the joint.

(2) Heat one end of the base material joint so that the distance between the surface of the base material and the tip of the white cone is about 2 to 3 mm. After a while, the surface of the base material that is exposed to the flame will turn red, and a welding pool will form in the center. The welding pool should look shiny. If both base materials do not fuse, fuse them by adding a covered electrode.

(3) When one end of the base material joint is fused, weld the other end of the joint in the same manner. This is called tack welding and will temporarily fix the joint of the base material. When welding thin plates, the number of tack welds can be reduced to prevent the strain from growing large.

(4) Next, form a welding pool at one end of the base material joint and perform welding while moving the torch (tochi) toward the joint so as to keep it at a constant size. When welding thin plates, do not add more covered electrodes than necessary. On the contrary, when the plate thickness of the base material is large, melt the base material at a position close to the white cone and weld it while adding a covered electrode.

- Cutting (Text Page 45)

The cutting procedure is as follows.

[Gas cutting (gasu setudan) procedure]

(1) Set the base material to be cut.

(2) Begin by using a preheating flame (yonetu en) to apply a white cone to the spot to be cut to make the base material glow red.

- When cutting from the edge, apply 50% to 80% of the flame to the edge and heat until the surface of the base material turns red. When the base material turns red, open the cutting oxygen valve by turning it one or more turns. At this time, the flame will become a carbonizing flame, so adjust the preheated oxygen valve so that it turns into a neutral flame.
- If you want to cut from a spot other than the edge of the base material, set the blowpipe (suikan) vertically and blow the flame to preheat it at a single spot along the line you want to cut. When the preheated area turns red or yellow, tilt the blowpipe (suikan) slightly (about 15 degrees) to release cutting oxygen (setudan sanso) and make a hole in the base material. At this time, slowly release the cutting oxygen (setudan sanso) at a rate of 1 rotation per second.

(3) While keeping the blowpipe (suikan) slightly tilted, slowly move it along the line you want to cut. At this time, take care to keep the distance between the nozzle (higuchi) and the base material constant, and move it at a constant speed so that the cutting spatter flies directly below.

- The reason why the blowpipe (suikan) is tilted slightly is that if it is held vertically, spatter (supatta) may enter the nozzle.
- If the spatter (supatta) flies in the direction opposite of the cutting direction, the movement is too fast. Also, if it re-fuses, it is already too late. An extremely high cutting speed results in an uncut edge, and cutting will not be able to be completed.

- Notes for welding/cutting work

When there is an abnormal noise from the blowpipe (suikan) (Text Page 46)

If you hear an occasional clicking sound after ignition, the nozzle (higuchi) may be loose or scratched. Extinguish the fire immediately, tighten the nozzle (higuchi), and replace the nozzle if the problem persists.

If there is a crackling noise from the blowpipe (suikan) during welding or cutting work, there may be a flashback (gyakka). Immediately stop work, clean and retighten the nozzle (higuchi), check for gas leaks, etc. The following are possible causes of flashback (gyakka).

[Causes of flashback (gyakka)]

- The mixing ratio of oxygen (sanso) and flammable gas changed.
- Foreign matter such as spatter (supatta) entered the nozzle (higuchi).
- The tip of the nozzle (higuchi) was blocked due to hitting the base material, etc.
- The temperature of the nozzle (higuchi) rose.
- The nozzle (higuchi) was not sufficiently tightened.
- Air entered the flammable gas supply system.

- Fire extinguishing method (Text Page 47)

When extinguishing a fire, first close the preheated oxygen valve, then close the fuel gas. For cutting work, close the valves in the following order: cutting oxygen (setudan sanso), preheated oxygen, and fuel gas. If the fire goes out during welding/cutting work, close the valves immediately in the same order.

However, if a flashback (gyakka) occurs during work, immediately close the preheated oxygen valve, then close the fuel gas valve, and finally close the cutting oxygen (setudan sanso) valve. Next, close the oxygen (sanso)/fuel gas container valve and loosen the pressure control handle (aturyoku chousei handoru).

If the fire is extinguished due to a flashback (gyakka), identify the cause and take countermeasures before resuming work. Do not restart without identifying the cause.

1.3.5 Nozzle (higuchi)

- Nozzle selection (Text Page 47)

The nozzle (higuchi) must be selected appropriately according to the type of flammable gas used and the thickness of the base material based on the manual from the manufacturer, etc.

- How to install the nozzle (Text Page 47)

The procedure for installing the nozzle is as follows.

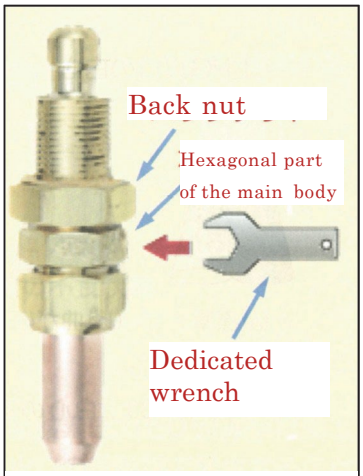
[Nozzle (higuchi) fitting procedure]

(1) Make sure that the contact parts between the nozzle (higuchi) and the blowpipe (suikan) are not scratched and that there are no contaminants or oil on them.

(2) Completely return the back nut (packing nut) in Fig. 1-31.

(3) Screw the nozzle (higuchi) into the blowpipe (suikan) as far as it will go.

(4) Fully tighten the hexagonal part of the nozzle (higuchi) body with a dedicated wrench. If a monkey wrench is used at this time, the outer tube nut may rotate, so a monkey wrench should not be used.



Source: KOIKE SANSO KOGYO Co.,LTD.

Fig. 1-31: Nozzle (higuchi) fixing

図１－31：火口の取付け

（小池酸素工業株式会社提供）

(5) Rotate the back nut by hand until you feel resistance.

(6) Rotate the back nut with a dedicated wrench. When installing it for the first time, it should be at 1/2 rotation. The second and subsequent fittings should be at about 1/4 rotation.

- How to clean the nozzle (Text Page 49)

When welding or cutting, spatter (supatta) may clog the tip of the nozzle. If this happens, clean it with a nozzle cleaning needle.

1.3.6 Hose (housu)

▪ One-touch joint (wantacchi tugite) fixing (Text Page 50)

The gas welding (gasu yousetu) hose (housu) is a set of two, one for oxygen (sanso) and one for flammable gas, and is often sold with the one-touch joint (wantacchi tugite) shown in Fig. 1-36 attached to both ends.

When purchasing the hose (housu) and the one-touch joint (wantacchi tugite) separately and attaching the one-touch joint to both ends of the hose, do the following.

[One-touch joint (wantacchi tugite) fitting procedure for both ends of the hose (housu)]

(1) Firmly secure it with a hose band (housu bando). At this time, do not use oil or grease, forcibly twist it, scrape the inner surface, or tap to soften it.

(2) Plug the hose (housu) joint tightly, immerse it in a water tank, apply a pressure of about twice the maximum working pressure for 5 minutes with nitrogen or dry air (only for objects without any oiliness), and verify that there is no leakage or disconnection of the joint.

Source: NISSAN TANAKA CORPORATION

Fig. 1-36: Example of gas welded one-touch joint (wantacchi tugite)

（日酸 TANAKA(株)提供）

- Gas hose (housu) visual inspection (Text Page 51)

Visually inspect the following items before use. In particular, if the oxygen (sanso) hose (housu) has a flashback (gyakka) even once, soot will adhere to the interior, and if there is another flashback, it may violently combust, so be careful.

[Pre-use visual inspection items]

- Cracks that extend to the reinforcing layer on the hose (housu) surface
- Wear or swelling
- Discoloration/hardening
- Metal joint chafing
- Inspect the oxygen (sanso) hose (housu) interior for foreign matter (contaminants, insects, etc.)

If even one spot is abnormal, do not repair, but replace with a new hose (housu). Do not repair leaking parts of a hose with insulating tape, etc..

- Precautions for handling gas hoses (housu) (Text Page 52)

When using a gas hose (housu), pay sufficient attention to the following items.

[Notes for using gas hoses (housu)]

- Do not use below the minimum bending radius
- Do not use by slinging over the neck of the cylinder (bonbe) or the shoulders of the operator
- Do not apply oils or fats to the hose (housu)
- Do not repair and use scratched items
- Do not hang it on a nail when storing
- Do not store in a place where ozone is generated

1.3.7 Inspection of equipment used for gas welding (gasu yousetu))

- Inspection of equipment used for gas welding (gasu yousetu) (Text Page 52)

Equipment used for gas welding (gasu yousetu) deteriorates with daily use and the passage of time after purchase. Therefore, it is necessary to carry out daily inspections for these items and to take measures such as inspections and disposal by the manufacturer when the specified period shown in Table 1-17 has passed.

Table 1-17: Timing of disposal of equipment used for various welding operations or inspections by the manufacturer

Target device	First inspection		Second and subsequent inspections
	Start time	Period	Period
Suction tube	After manufacture date	5 years	Period specified by the manufacturer
Pressure regulator (aturyoku chousei ki)	After manufacture date	7 years	Period specified by the manufacturer
Flashback arrester (kanshiki anzen ki)	After starting to use	3 years	Period specified by the manufacturer

Source: National Institute of Occupational Safety and Health Technical Guidelines

- Blowpipe (suikan) (torch (tochi)) inspections, etc.

Inspection items by business operator (Text Page 53)

When inspecting the blowpipe (suikan), it is necessary to determine the inspection items as shown in Table 1-18 in advance and perform it precisely. Daily inspections (nichijou tenken) should be performed before the start of work on that day, and monthly inspections should be performed regularly each month.

Table 1-18: Inspection items (example)

Inspection item	Locations inspected	Details of inspection	Daily inspection (nichijou tenken)	Periodic monthly inspection
Visual inspection	Body, hose (housu), joint stand, and pipe	Are there any cracks or corrosion?	●	●
	Valve, etc.	Is there any damage or deformation?	●	●
	Nozzle (higuchi) contact, hose (housu) joint base contact	Are there any scratches or deformation?	●	●
	Nozzle	Is there any deformation or melting damage?	●	●
Airtightness inspection	Valve	Is there a sheet leak?	●	●
	Nozzle (higuchi) fitting section	Are there any gas leaks?		●
	Fitting sections for valves and parts	Is there any external leakage?		●
Check the flame state	Flame	Can it be adjusted smoothly?	●	●
	Cutting oxygen (setudan sanso) airflow	Is it normal?	●	●

- Pressure regulator (aturyoku chousei ki) inspections, etc.

Inspection items by business operator (Text Page 54)

When inspecting the pressure regulator (aturyoku chousei ki), it is necessary to determine the inspection items as shown in Table 1-19 in advance and perform it precisely. Daily inspections (nichijou tenken) should be performed before the start of work on that day, and annual inspections should be performed regularly each year.

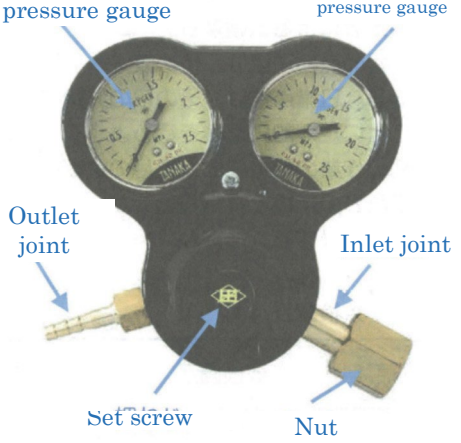


Fig. 1-40: Names of pressure regulator (aturyoku chousei ki) parts

Table 1-19: Inspection items (example)

Inspection item	Locations inspected	Details of inspection	Daily inspection (nichijou tenken)	Periodic monthly inspection
Visual inspection	Body, cover	Are there any cracks or corrosion?	●	●
	Inlet joint, outlet joint, pressure gauge	Is there any damage or deformation?	●	●
	Junctions and screws between the inlet joint and the container valve	Are there any scratches, deformation, or weak adhesiveness?	●	●
	Pressure gauge case	Is there any deformation?	●	●
	Pointer position	Has it returned to the zero position?	●	●
Airtightness inspection	(1) Inlet joint screw-in section (2) High-pressure pressure gauge screw-in section (3) Back cap screw-in section	Supply gas with the pressure control handle (aturyoku chousei handoru) while it is loose and check for gas leaks with soapy water	●	●
	Outlet	Are there any gas leaks (outflow)?	●	●
	(4) Body and cover screw-in section (5) Low-pressure pressure gauge screw-in section (6) Outlet joint screw-in sections (7) Safety valve	Set the working pressure with the outlet closed and check for gas leaks with soapy water.	●	●
Verification of specification pressure range	Is it possible to supply gas and operate the pressure control handle (aturyoku chousei handoru) to set the maximum pressure normally?			●
	Are there any gas leaks from the safety valve outlet?			●
Verification of pressure drop	Does the high-pressure pressure gauge decrease when gas is allowed to flow during use?			●

Chapter 2 Basic Knowledge about Flammable Gases and Oxygen (sanso)

2.1 Basic knowledge about oxygen (sanso)

2.1.1 Introduction (Text Page 57)

Because oxygen (sanso) is required for many living things on the earth to maintain their biological activities, some think that it is always beneficial for humans. However, high concentrations of oxygen (sanso) are extremely dangerous and also harmful to the human body. Low concentrations have serious adverse effects on human health as well.

There is a tendency to handle oxygen (sanso) easily without being aware of its dangers, but like other dangerous and harmful chemical substances, it requires careful handling.

2.1.2 Oxygen (sanso) risks

- Characteristics of oxygen (sanso) (Text Page 57)

Oxygen (sanso) is colorless, transparent, and odorless. Since it is heavier than air, pure oxygen (sanso) may stay unnoticed in low-lying cavities and the like.

Oxygen (sanso) has the function of strongly assisting with combustion, so it makes even objects that do not burn in the air violently combust. It is said that when calico, which is a material used in clothing, is burned in the air with 10% additional oxygen, it burns like celluloid film. Additionally, when oxygen (sanso) concentrations are high as shown in Table 2-1, the ignition temperatures of various substances decrease, making them easy to combust.

Also, the combustion temperature in oxygen (sanso) is higher than when combusting in air. Gas welding (gasu yousetu) and gas cutting (gasu setudan) also utilize this feature. Therefore, burns are more likely to be more serious when clothes burn up in concentrated oxygen than when they do so in the air.

Table 2-1: Ignition temperature of substances (℃)

	Gasoline	Kerosene	Heavy oil	Sawdust	Hydrogen
In the air	383	432	424	310	585
In oxygen (sanso)	272	251	256	280	585

Source: Kogaku Komamiya, "Dangers of Oxygen and Disaster Prevention Measures" (from the Research Institute of Industrial Safety, 1961)

- Examples of accidents caused by high-pressure oxygen (Text Page 58)

In 2008, an accident occurred in which a pressure control valve was blown off and one worker was injured (burned) while operating an oxygen cylinder (sanso bonbe). It is highly probable that the temperature on the high-pressure side of the pressure control valve rose sharply because the valve was opened suddenly, and contaminants such as metal fragments and such with oil adhering to the interior ignited and exploded.

2.1.3 Toxicity of oxygen (Text Page 59)

With regard to oxygen (sanso), according to the GHS classifications and categories for items related to harmful effects on health conducted by the government, oxygen is Category 2 in terms of reproductive toxicity and Category 3 (respiratory tract irritation) in terms of specific target organ/systemic toxicity (single exposure). This means that reproductive toxicity is observed in animals exposed to oxygen (sanso), and after exposure, symptoms such as coughing, pain, suffocation, and dyspnea appear and respiratory function is impaired, but recovery occurs after some time.

2.2 Flammable gas

2.2.1 Introduction

(1) The 3 elements of combustion and exceptions (Text Page 60)

If flammable gas, vapor, dust, etc., are present in the air at a certain concentration, they may explode and burn depending on the ignition source. In order for an object to combust, it must have the "3 elements of combustion": a flammable material, oxygen (sanso), and an ignition source. If any of these is missing, combustion will not occur.

An explosion is violent combustion, so if one of these three elements of combustion is missing, in principle, no explosion occurs.

However, acetylene (asechiren) and the like explode without oxygen (sanso), and silane gas and such spontaneously ignite in the air even without an ignition source. In addition, hydrogen, which has received attention as a flammable gas for gas cutting (gasu setudan) in recent years, has an extremely low minimum ignition energy, so once it leaks into the air and reaches a concentration in the combustion range, there is no realistic way to prevent it from exploding by eliminating the ignition source.

(2) Lower explosive limit (bakuhatu kagen kai) and upper explosive limit (Text Page 60)

If flammable gas leaks into the air, it will not explode unless it is within a certain concentration range. This range is called the combustion (explosion) range. A gas with a small lower explosive limit enters the explosion range when just a small amount of it leaks, so it can be considered more dangerous.

(3) Combustion rate (Text Page 61)

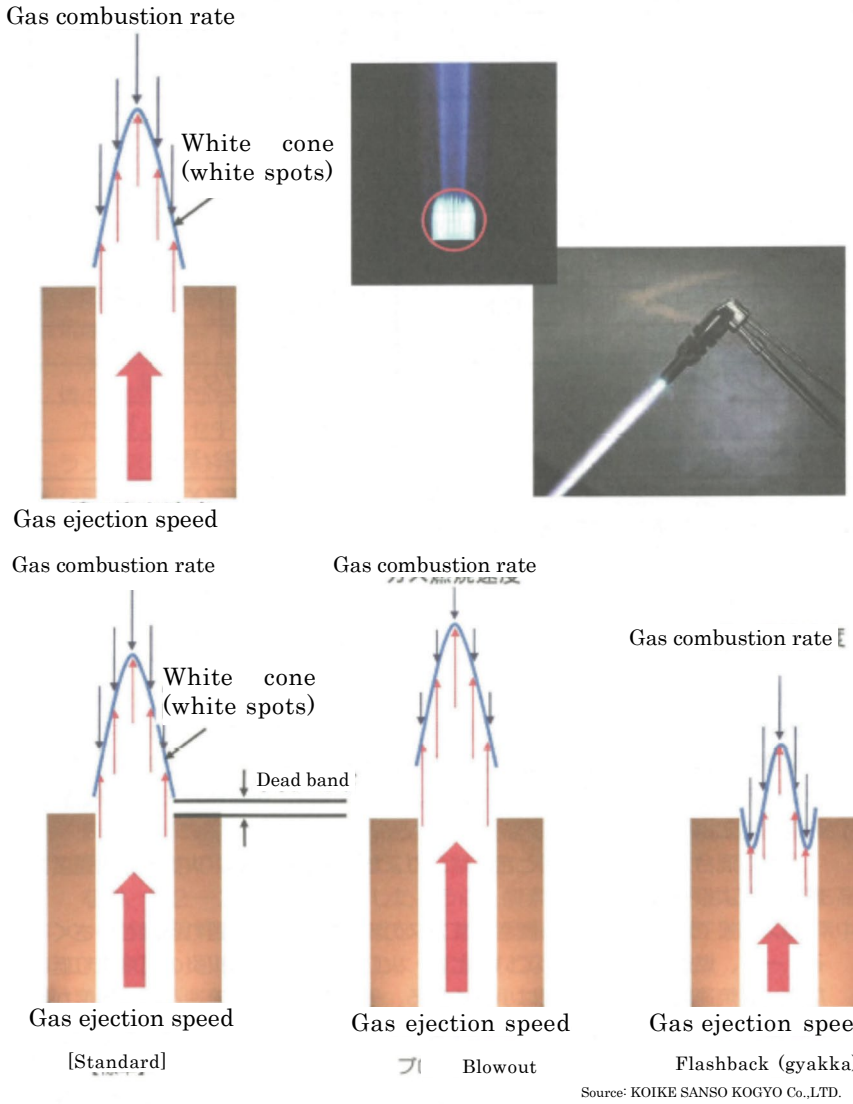


Fig. 2-1: Formation of flame surface (white cone)

（小池酸素工業株式会社提供）

(4) Minimum ignition energy

- Minimum ignition energy (Text Page 63)

When the concentration of flammable gas reaches the explosive limit value, the gas explodes if there is a certain amount of energy.

- Ignition sources (Text Page 63)

Depending on the condition of the flammable gas, gas explosions can occur even due to the electrostatic energy from the human body.

In addition, there are many ignition sources in the workplace, such as electric motors, pilot fires for gas appliances, high-temperature objects, frictional heat, and impact sparks (*). Even in general factories, there is a surprising number of ignition sources, and it is difficult to ensure that all ignition sources are not overlooked. In order to prevent explosions during welding work, it is necessary to prevent leakage of flammable gas.

*Sparks generated when tools or metal parts are dropped on a concrete floor, etc.

2.2.2 Flammable gas used for welding, etc.

(1) Physical properties, etc. (Text Page 65)

Table 2-6: Physical properties, etc., of gases used for welding, etc.

	Acetylene (asechiren)	Propane (puropan)	Hydrogen
Color and odor	A colorless, odorless gas. Acetylene (asechiren) used for welding features a distinct odor belonging the solvent and impurities used for dissolving and for filling the container. (Note 1)	A colorless, odorless gas. Propane (puropan) used in ordinary households is required by the High Pressure Gas Safety Act to have an odorant, but this is not required for industrial LPG.	A colorless, odorless gas.
Chemical formula	C_2H_2	C_3H_8	H_2
Gas specific gravity (Note 2)	0.895	1.6	0.07
Boiling point	-83.6°C	-42.1°C	-252.8°C
Minimum ignition temperature	305°C		
Other	The flame temperature is high compared to other flammable gases for welding, making it suitable for gas welding (gasu yousetu).		

Note 1: This odor is quite different from the odor of household propane (puropan) gas.
2: Weight ratio compared to air. If it is smaller than 1, it may accumulate near the ceiling, and if it is larger than 1, it may accumulate in the pit, etc.

(2) Risk of harm

- Risks (Text Page 66)

Acetylene (asechiren) gas, propane (puropan) gas and hydrogen are highly flammable and ignitable gases, and they may explode if the gas container heats up. Hydrogen easily ignites, and the flame is hard to see.

- Risk of harm (Text Page 66)

Acetylene (asechiren) gas, propane (puropan) gas, and hydrogen are extremely dangerous because they may cause oxygen deficiency (sanso ketubou) when inhaled at high concentrations. It is also said that inhaling acetylene (asechiren) gas may cause pulmonary edemas. In addition, inhaling acetylene (asechiren) gas or propane (puropan) gas may cause drowsiness or dizziness, hypoesthesia, and headache.

(3) Precautions in case of fire (Text Page 66)

Use dry chemicals (hunmatu shouka zai) or inert gases (N_2, Ar, CO_2, etc.) to extinguish fires caused by acetylene (asechiren) gas, propane (puropan) gas, and hydrogen. If there's a big fire, sprinkle or spray water onto it. Straight steaming should not be performed.

2.3 High-pressure gas

2.3.1 What is high-pressure gas (Text Page 67)

[Types of high-pressure gas] (From the High Pressure Gas Safety Act)

(1) Compressed gas

Compressed gas refers to compressed gas whose pressure (meaning gauge pressure; the same applies hereafter) is 1 MPa or higher at normal temperatures and with a pressure that is actually 1 MPa or higher, or 1 MPa or higher at a temperature of 35°C (excluding compressed acetylene (asechiren) gas)

(2) Compressed acetylene gas

Compressed acetylene (asechiren) gas whose pressure is 0.2 MPa or higher at normal temperatures and with a pressure that is actually 0.2 MPa or higher, or 0.2 MPa or higher at a temperature of 15°C.

(3) Liquefied gas (ekika gasu)

Liquefied gas (ekika gasu) refers to liquefied gas whose pressure is 0.2 MPa or more at normal temperature and whose pressure is actually 0.2 MPa or more or attains pressure of 0.2 MPa at a temperature of 35°C or less

2.3.2 Risks of high-pressure gas

(1) Risks of being compressed

- **Occurrence of a rupture (haretu) accident (Text Page 67)**

A normal compressed gas cylinder is filled at a pressure of 14.7 MPa or less according to the High Pressure Gas Safety Act at the time of filling. 14.7 MPa is a pressure of about 150 kg per 1 cm^2. There are many examples of the blast pressure from a ruptured tank damaging surrounding buildings.

According to the Ministry of Economy, Trade and Industry, of accidents involving high-pressure gas, over 93% are characterized by spouting or leakage, but there are also accidents in which high-pressure gas containers are ruptured or damaged.

- **Cylinder (bonbe) flight accidents (Text Page 68)**

If the valve part of a filled cylinder (bonbe) is broken, there are cases where the cylinder will fly around violently, in some cases like a rocket. If this occurs, there is no way to deal with it other than waiting for the gas to run out.

(2) Notes for handling high-pressure gas (Text Page 68)

The High Pressure Gas Safety Acts stipulates that high-pressure gas must be stored in locations below 40°C.

Table 2-8: Changes in pressure due to temperature

Temperature (°C)	Gas pressure in the container (MPa)	Value when the pressure at 25°C is 1
25	17.7	1.0000
35	18.3	1.0335
45	18.9	1.0671
75	20.7	1.1677
85	21.3	1.2012

2.4 Disaster prevention

2.4.1 Disasters that occur due to gas welding (gasu yousetu)

- **Health disorders caused by fumes (hyumu) (Text Page 74)**

Although not as many fumes (hyumu) are generated by gas welding (gasu yousetu) as by arc welding, there are concerns about the occurrence of pulmonary edemas due to the welding and cutting of galvanized base materials, and lung cancer and asthma due to the cutting of stainless steel.

Additionally, in recent years, the health effects of welding and cutting of copper materials containing manganese on the central nervous system have become an issue.

2.4.2 Preventing disasters that occur due to gas welding (gasu yousetu)

(1) Preventing burns (Text Page 75)

Article 312 of The Ordinance on Industrial Safety and Health requires workers to wear protective goggles and protective gloves for welding work, etc., done with acetylene (asechiren) welding equipment and Article 313 of the same requires this for work done with gas welding (gasu yousetu) equipment using manifolds.

Figu. 2-10: Welding protective equipment

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(2) Preventing explosions/fires

- Causes of disasters occurring due to explosions and fires

Conditions surrounding explosions and fires (Text Page 75)

During gas welding (gasu yousetu), occupational accidents due to explosions and fires, such as leaked flammable gas exploding or the surrounding combustibles igniting, are very common. In particular, if steam or dust explodes in a ship or tank, the size of the explosion can be severe and can result in major disasters.

In most cases of explosions and fires during gas welding (gasu yousetu) work until now, flammable gas for welding has exploded or erupted in flames. The causes include leakage due to improper fitting of equipment and hoses (housu) and leakage from deteriorated facilities, as well as flashbacks (gyakka).

Dust explosions (Text Page 77)

If gas welding (gasu yousetu) is performed in locations where flammable material (kanensei no mono) become fine particles (dust) and float through the air in large quantities, a violent explosion could occur.

It should be noted that dust can occur not only from flour, sugar, and plastic, but also in metals such as aluminum and iron that do not burn in bulk as long as they are flammable, even if they are not a substance such as coal.

- Preventing explosions and fires

■ Preventing explosions caused by fuel gas (Text Page 77)

Most of the explosion accidents that occur in gas welding are caused by the leakage of fuel gas such as acetylene into the work space and the ignition flame or ignition lighter as the ignition source. For this reason, in order to prevent explosions, it is essential to eliminate fuel gas leakages. Providing sufficient ventilation in the workplace on a daily basis is also recommended.

Further, if mixed work with other businesses is expected, it is necessary to make sufficient adjustments in advance to prevent painting work and so on from being performed nearby.

In particular, when remodeling, repairing, cleaning, and so on for a ship, the concentration of vapors from flammable substances and flammable gases must be measured in and around the work area at the start of work and periodically during work in the ship interior, such as holds, and in neighboring locations (The Ordinance on Industrial Safety and Health, Article 328 Item 3).

■ Preventing explosions and fires due to flashback (gyakka)

Flashback and its causes (Text Page 78)

During gas welding (gasu yousetu) and gas cutting (gasu setudan), flammable gases and oxygen (sanso) are present in welders and hoses (housu). For this reason, if care is not taken sufficiently, a flashback (gyakka) will occur in which the flame returns to the inside of the welder or hose (housu) and the flammable gas inside burns.

The following are possible causes of flashback (gyakka).

[Causes of flashback (gyakka)]
(1) The combustion rate becomes faster than the gas flow due to an increase in nozzle temperature, insufficient flow rate, a change in the mixing ratio, etc.
(2) The tip of the nozzle is blocked due to contact with the base material or spatter (supatta).
(3) A nozzle for LPG gas is used for acetylene (asechiren).
(4) Air was present inside the flammable gas hose (housu) due to insufficient purging or air leakage.
(5) Metal powder or soot from a previous flashback (gyakka) has adhered to the interior of the oxygen (sanso) hose (housu).

Disasters caused by flashbacks (gyakka) (Text Page 78)

Property damage accidents caused by flashback (gyakka) include burning of nozzles and blowpipes (suikan). In addition, the hose (housu) may rupture (haretu) due to combustion inside the hose due to (4) and (5) above.

Even if the flashback (gyakka) is stopped by the safety unit (anzen ki), if this happens repeatedly, the inside of the hose (housu) or the like will thin out due to combustion, and it may be unable to withstand the pressure and rupture (haretu). Addtionally, if soot adheres to the interior of the oxygen (sanso) hose (housu) due to a flashback (gyakka), the soot may combust explosively.

Preventing disasters caused by flashbacks (gyakka) (Text Page 79)

In order to prevent flashback (gyakka), it is important to make sure to purge the gas before commencing the work, perform reliable inspections and maintenance of equipment, and perform handling in accordance with the standards for flammable gas and oxygen (sanso).

In addition, a safety unit (anzen ki) must be securely attached as a countermeasure for flashbacks (gyakka).

■ Preventing fires due to causes other than fuel gas

Removal of flammable materials (kanensei no mono), etc. (Text Page 79)

In principle, flammable materials should be removed from the vicinity of welding work. If it is not possible to remove flammable materials, cover them with flameproof sheets (bouen shito) or set up a partioning screen. During welding and cutting work, there should be someone to look out for fires.

Most rigid urethane foam used at construction sites these days is flame-retardant, so fire cannot easily spread, but in narrow spaces, flammable gas generated due to heat during welding and cutting accumulates, which may cause an explosion or fire. Additionally, even with spray-type urethane foam marked as flame-retardant, flammable gas and vapors are generated when the temperature exceeds 200°C, and it may burst into flames depending on the location, so caution is required

Mixed work or proximity work (including vertical work), etc. (Text Page 81)

In proximity work, such as mixed work or vertical work, flammable materials being used in other work may ignite due to spatter (supatta), causing a fire.

The initial temperature of spatter (supatta) due to gas cutting (gasu setudan) with acetylene (asechiren) is estimated to be 2,200 to 2,300°C.

Essentially, given that spatter (supatta) flies about 10 m, it is important not to place flammable materials in that range.

(3) Harmful light rays generated during gas welding (gasu yousetu) (Text Page 82)

During gas welding (gasu yousetu) work, strong infrared rays are generated by high-temperature parts such as base materials and flames. The occupational diseases caused by infrared rays listed in Appendix 1-2 of the Labor Standards Act Enforcement Regulations, "List of Occupational Disorders," include eye disorders such as retinal burns, cataracts, and so on, and skin disorders, both of which are caused by work exposure to infrared rays. While it is not as bad as during arc welding, during gas welding (gasu yousetu), strong visible light (light that the eyes can see) and harmful rays (yuugai kousen) such as ultraviolet rays are generated as well.

(4) Oxygen deficiency (sanso ketubou) (Text Page 86)

There is a risk of oxygen deficiency (sanso ketubou) during work such as gas welding (gasu yousetu) in places with insufficient ventilation. When gas welding (gasu yousetu) or fusing is performed in locations with insufficient ventilation, in addition to performing forced ventilation with portable ventilation devices, use appropriate respiratory protective devices (kokyuu you hogo gu) according to the situation.

Note that in oxygen-deficient areas, only masks that supply fresh air, such as airline masks, can be used. Oxygen deficiency (sanso ketubou) is defined as a condition in which the concentration of oxygen in the air is less than 18% as per the Anoxia Ordinance (Ordinance on Prevention of Anoxia, Article 2). In addition, special training for dangerous work that may involve oxygen deficiency (sanso ketubou) is required for work in locations with a risk of oxygen deficiency.

(5) Disasters caused by metal fumes (hyumu)

- Metal fumes (hyumu) and their health effects

Generation of metal fumes (hyumu) due to gas welding (gasu yousetu), etc. (Text Page 86)

Fumes (hyumu) are high-temperature metals that turn into steam and are released into the work environment, cooled in the air, and solidify. In gas welding (gasu yousetu) and gas cutting (gasu setudan), in addition to the base materials, the metal contained in the surface plating also turns into fumes (hyumu).

- Pneumoconiosis (jinpai) and complications

Pneumoconiosis (jinpai) (Text Page 88)

Pneumoconiosis (jinpai) and its complications represent the most serious chronic disorder caused by metal fumes (hyumu). As the symptoms progress, symptoms such as coughing, sputum, wheezing, and shortness of breath manifest, and breathing becomes difficult.

With current medicine, pneumoconiosis (jinpai) cannot be cured. Additionally, there is no guarantee that pneumoconiosis (jinpai) symptoms will not progress any further once the person stops dust work. Even after the work is stopped, the condition may progress further if there was a large amount of exposure to fumes (hyumu) in the past.

Complications (Text Page 88)

If one is afflicted by pneumoconiosis (jinpai), not only will one's lung function decrease, but it may be complicated by various diseases. The following six diseases are recognized by law as complications that are particularly closely related to pneumoconiosis (jinpai). Mesothelial tumors are also recognized as a complication of asbestosis resulting from asbestos exposure.

[Six diseases recognized by law as complications particularly closely related to pneumoconiosis (jinpai)]

- Pulmonary tuberculosis
- Tuberculous pleurisy
- Secondary bronchitis
- Secondary bronchiectasis
- Secondary pneumothorax
- Primary lung cancer

- Countermeasures for metal fumes (hyumu) (Text Page 88)

In general, measures against the inhalation exposure to chemical substances and dust include intrinsic safety that avoids the use of harmful substances, engineering measures that use local exhaust systems, management measures such as safety and health education for workers, and the use of personal protective equipment. Of these, the highest priority should be intrinsic safety, followed by engineering and administrative measures, with personal protective equipment being used last.

In the case of gas welding (gasu yousetu), intrinsic safety is to reduce the generation of fumes (hyumu), but it is difficult to completely eliminate them.

Therefore, in addition to the adoption of low-fume (hyumu) molten material, be sure to implement engineering measures, management measures, and the use of personal protective equipment.

Respiratory protective device (kokyuu you hogo gu) (Text Page 90)

It is difficult to provide a local exhaust system or the like when performing arc welding outdoors or when performing temporary work indoors. Therefore, it is necessary to use respiratory protective devices (kokyuu you hogo gu) to reduce the concentration of harmful substances inhaled by workers to an acceptable level of risk. For this reason, respiratory protective devices (kokyuu you hogo gu) must be selected and used in an appropriate manner.

The use of respiratory protective devices (kokyuu you hogo gu) is a part of work management. Respiratory protective devices (kokyuu you hogo gu) are personal protective equipment that prevents workers from inhaling harmful chemical substances when they are present in workspaces.

Dustproof masks (Text Page 90)

A dustproof mask is a type of respiratory protective device (kokyuu you hogo gu) that removes dust and the like in a workspace using a filter. There is a replaceable type, in which the filter can be replaced, and a disposable type. The replaceable type includes a direct type, in which the filter is directly connected to the mask, and an isolated type, in which the filter is connected through a short hose (housu). The isolated type has better performance.

Surgical masks and non-woven masks used in ordinary homes are not dustproof.

(6) Other

- Heatstroke (necchuushou) prevention measures (Text Page 92)

Managing one's daily physical condition is also important for heatstroke (necchuushou), so do not work constantly and be sure to take appropriate breaks. Especially when in narrow locations or outdoors during summer, work is performed in places with high temperatures, high humidity, and harsh sunlight. Under such conditions, it is important to pay attention to the WBGT (heat index) and to supply oneself with enough water and salt when working. Japanese tea and other beverages that contain caffeine are diuretics, and they are not suitable as a countermeasure for heatstroke (necchuushou).

- Preventing fall accidents (Text Page 93)

When welding at high altitudes, make sure to use fall prevention equipment (tuiraku seishi you kigu) properly to prevent fall accidents (tuiraku saigai). (Special training for full harnesses is required)

Chapter 3 Applicable Laws and Regulations

3.1 Legal system related to gas welding (gasu yousetu), etc. (Text Page 101)

Many laws and regulations, such as the Industrial Safety and Health Act (roudou anzen eiseihou), government ordinances based on the law, and ministerial ordinances have been enacted as laws and regulations related to gas welding (gasu yousetu) work.

This chapter introduces the main ones.

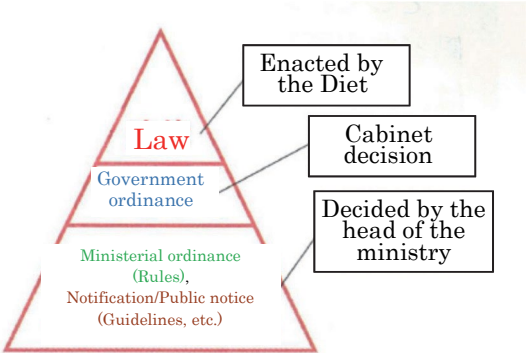

Figure 3-1 Legal system

Occupational safety and health measures were once stipulated in the Labor Standards Act, which sets the standards for working conditions, but in 1972, the Industrial Safety and Health Act (roudou anzen eiseihou) was enacted as a fully featured independent law, and since then, measures have been based on this law, and various regulations for preventing occupational accidents are in place.

These legal systems are as follows.

- Industrial Safety and Health Act (roudou anzen eiseihou)
  - Industrial Safety and Health Act Enforcement Ordinance
    - Industrial Safety Rules
    - Ordinance on Prevention of Lead Poisoning
    - Ordinance on Prevention of Hazards Due to Specified Chemical Substances
    - Ordinance on Prevention of Anoxia, etc.
    - Ordinance on Prevention of Hazards Due to Dust (*Applicable when performing metal gas cutting (gasu setudan) in indoor workplaces, etc.)
    - Ordinance on Examination of Machines and Other Equipment
      - Standards for safety units (anzen ki) for acetylene (asechiren) welding equipment and safety units for gas welding (gasu yousetu) equipment using manifolds
      - Acetylene (asechiren) generator structural standards for acetylene welding equipment
- Pneumoconiosis (jinpai) Law
  - Ordinance for Enforcement of the Pneumoconiosis (jinpai) Act
- Working Environment Measurement Law (*)
  - Enforcement Ordinance of the Working Environment Measurement Law
    - Enforcement Ordinance of the Working Environment Measurement Law

*Work environment measurements are performed when the base material contains a substance such as manganese.

3.2 Industrial Safety and Health Act (Excerpt)

(Responsibilities of business operators, etc.)

Article 3: The business operator must not merely observe the minimum standards for preventing occupational accidents established by this law, but ensure the safety of workers in the workplace by creating a comfortable working environment and improving working conditions. In addition, the business operator must cooperate with the national government's measures for preventing occupational accidents. (Text Page 107)

Article 4: Workers must make efforts to observe the matters necessary for preventing occupational accidents and cooperate on measures related to the prevention of occupational accidents implemented by business operators and other related parties. (Text Page 108)

(Type verification)

Article 44-2: Of the machines, etc., in Article 42, those who manufacture or import the machines, etc., listed in Attached Table 4 specified by Cabinet Order shall be registered by the Minister of Health, Labor and Welfare pursuant to the provisions of the Ordinance of the Ministry of Health, Labor and Welfare. The person who received the test (hereinafter referred to as the "registered type verification organization") must undergo certification of the machine model, etc. Provided, however, that this shall not apply to imported machines, etc., that fall under the machines, etc., for which the following paragraph has been verified for their type. (Text Page 116)

(Note) It is stipulated that those who manufacture or import dust masks, gas masks, respiratory protective equipment with electric fans, protective caps, etc., shall be subject to "type verification" conducted by a registered type verification organization pursuant to the provisions of the Ordinance of the Ministry of Health, Labor and Welfare.

(Working restrictions)

Article 61: Business operators shall operate cranes and other operations that are stipulated by government ordinance using those who have obtained a license for the relevant operations from the Director General of the Prefectural Labor Bureau, or those who have been registered by the Director General of the Prefectural Labor Bureau. Only those who have completed the relevant skill training or who have the qualifications specified in ordinances from the Ministry of Health, Labor and Welfare shall be allowed to engage in the relevant work.

2. No person other than those who can engage in the relevant operations pursuant to the provisions of the preceding paragraph shall perform said relevant operations.
3. A person who can engage in the relevant operations pursuant to the provisions of Paragraph 1 must carry a driver's license or other documents certifying the qualifications pertaining to the relevant operations when engaging in said relevant operations.

(Text Page 118)

3.3 Ordinance on Industrial Safety and Health (Excerpt)

(Training at the time of hiring, etc.)

Article 35: When a worker is hired or a worker's responsibilities change, the business operator must provide training to the relevant worker on matters necessary for safety or hygiene with regard to the work to be engaged in by the relevant worker from among the following items in a timely manner. However, for workers in business establishments in the industries listed in Article 2, Item 3 of the Ordinance, training on matters 1 to 4 may be omitted.

(I) Matters concerning the danger or harmfulness of machinery, raw materials, etc., and how to handle them.

(Ii) Matters concerning the performance of safety devices, hazardous substance control devices or protective equipment, and how to handle them.

(Iii) Matters concerning work procedures.

(Iv) Matters concerning inspections at the start of work.

(V) Matters concerning the causes and prevention of diseases that may occur in the relevant business.

(VI) Matters concerning organization, tidying up, and maintaining cleanliness.

(VII) Matters concerning emergency measures and evacuation in the event of an accident.

(VIII) In addition to the matters listed in the preceding items, matters necessary for safety or hygiene related to the relevant business. (Text Page 130)

2. The employer may omit education on such matters for workers who are recognized as having sufficient knowledge and skills regarding all or part of the matters listed in each item of the preceding paragraph. (Text page 131)

(Reissuing skill training completion certificates, etc.)

Article 82: For a person who has been issued a skill training completion certificate and who is currently engaged in or intends to undertake a job related to said skill training, if it is lost or damaged, with the exception of the case prescribed in paragraph 3, the application for reissuance of the skill training certificate (Form No. 18) must be submitted to the registered training institution from which said person received the skill training completion certificate, and the skill training completion certificate must be reissued.

2. When the person prescribed in the preceding paragraph changes his/her name, except for the case prescribed in paragraph 3, the person must submit the skill training certificate replacement application (Form No. 18) to the registered training institution from which they received the skill training completion certificate and receive a rewrite of the skill training certificate. (Text Page 132)

Preventing explosions or fires due to ventilation, etc.

Article 261: In order to prevent explosions or fires caused by vapor, gas, or dust in locations where flammable vapors, flammable gases, or flammable dust are present and there is a possibility of explosions or fires, measures such as purifying ventilation, cooling ventilation, and dust removal must be taken. (Text Page 133)

(Welding pipes or containers that contain oil, etc.)

Article 285: For containers such as pipes, tanks, drums, etc., where flammable oils that are not dangerous substances, or alternatively, flammable dust or dangerous substances may be present, welding, fusing, or other work involving the use of fire or work that may generate sparks must not be performed until after the business operator removes these substances in advance or take other such measures to prevent explosions or fires.

2. Workers shall not carry out the work set forth in the preceding paragraph until after the measures set forth in said paragraph have been taken. (Text Page 134)

(Welding in places with insufficient ventilation, etc.)

Article 286: Oxygen (sanso) should not be used for purifying or cooling ventilation when the employer performs work that may generate sparks due to welding, fusing, heating metal or other work that involves fire, dry polishing using a grinding wheel, chipping by chiseling, and so on in locations with insufficient purifying or cooling ventilation.

2. In the case of the preceding paragraph, workers shall not use oxygen for purifying or cooling ventilation. (Text Page 135)

(Installing safety units (anzen ki))

Article 306: For acetylene (asechiren) welding equipment, the business operator must equip each blowpipe (suikan) with a safety unit (anzen ki). However, this shall not apply when the main pipe is equipped with a safety unit (anzen ki) and each branch pipe closest to the blowpipe (suikan) is equipped with a safety unit.

For acetylene (asechiren) welding equipment in which the gas reservoir is separated from the generator, the business operator must provide a safety unit (anzen ki) between the generator and the gas reservoir. (Text Page 137)

(Restrictions on the use of copper)

Article 311: The business operator must not use copper or an alloy containing 70% or more of copper for the piping or accessories of the gas welding (gasu yousetu) equipment using manifolds for molten acetylene (asechiren). (Text Page 138)

(Periodic self-inspection (teiki jishu kensa))

Article 317: The employer shall periodically conduct a self-inspection of acetylene (asechiren) welding equipment or gas welding equipment using manifolds (excluding the parts of the piping buried underground. The same shall apply hereinafter in this article) once every year for damage, deformation, corrosion, etc., as well as its functionality. However, this shall not apply to the non-use period of acetylene (asechiren) welding equipment or gas welding equipment using manifolds that are not used for a period exceeding one year.

4. When the business operator conducts the self-inspection set forth in paragraph (1) or paragraph (2), he/she must record the following items and store them for three years.

(I) Inspection date

(II) Inspection method

(III) Inspection locations

(IV) Inspection results

(V) Name of the person who conducted the inspection

(VI) When repairs or other measures are taken based on the results of the inspection, the details thereof

(Text Page 140)

(Respiratory protective device (kokyuu you hogo gu))

Article 593: If the business operator is involved in operations in extremely hot or cold places, operations that involve handling large amounts of hot or cold objects or harmful substances, operations that involve exposure to harmful light rays, operations in harmful areas that emit gas, steam or dust, operations that have a high risk of contamination due to pathogens, or other harmful operations, appropriate protective equipment such as protective clothing, protective goggles, and respiratory protective devices (kokyuu you hogo gu) must be provided for use by workers engaged in the operations. (Text Page 142)

3.4 Ordinance on Prevention of Hazards Due to Dust

An outline of the Ordinance on Prevention of Hazards Due to Dust is as follows (from page 106 of the text).

- Operations involving the fusing of metal (Ordinance on Prevention of Hazards Due to Dust) (Text page 106)

"Operations involving the fusing of metal or gouging with an arc indoors, in a mine, or inside a tank, ship, pipe, vehicle, etc." correspond to "dust work" under the Ordinance on Prevention of Hazards Due to Dust (Ordinance on Prevention of Hazards Due to Dust, Article 2, Paragraph 1, Item 1 and Attached Table 1, Item 20). Thus, gas cutting (gasu setudan) work corresponds to dust work.

It is obligatory to install a general ventilation system (zentai kankisouchi) (ventilator in the mine), etc., in indoor workplaces where metal is fused, and to measure the concentration of dust in mines where work is performed.

For Gas Welding (Gasu Yousetsu) Skill Training Supplementary Text Exam Questions

Chapter 1 Questions Related to Equipment Used for Gas Welding (gasu yousetsu), etc.

■ Question 1 (Gas cutting (gasu setudan) characteristics)

With regard to gas cutting (gasu setudan) characteristics, which of the following four explanations is INCORRECT?

(1) Even thick plates can be cut as long as the material oxidizes at the gas combustion temperature.
(2) In gas cutting (gasu setudan), the metal is cut via oxidation.
(3) It is possible to cut materials other than those that oxidize depending on the gas combustion temperature.
(4) Gas cutting (gasu setudan) is most often used for cutting steel materials.

■ Question 2 (Dangers of gas welding (gasu yousetsu)/gas cutting (gasu setudan))

With regard to the dangers of gas welding (gasu yousetsu)/gas cutting (gasu setudan), which of the following four explanations is INCORRECT?

(1) There is a certain level of risk inherent in handling oxygen (sanso) and gas.
(2) Flammable gas does not cause explosions or fires.
(3) Gas welding (gasu yousetsu) work has caused accidents in which a high-temperature flame ignited nearby flammable steam or gas, causing it to explode.
(4) There have been many accidents in the past in which people were injured by touching hot base materials or spatter (supatta).

■ Question 3 (Equipment used for gas welding (gasu yousetsu) and gas cutting (gasu setudan))

With regard to the names of equipment used for gas welding (gasu yousetsu) and gas cutting (gasu setudan), which of the following four options is INCORRECT?

(1) Gas cutting (gasu setudan) can be performed by replacing the suction pipe and nozzle among the equipment used for gas welding (gasu yousetsu) with equipment used for gas cutting (gasu setudan).
(2) The same type of welder cannot necessarily be used for all flammable gases.
(3) Gas welding (gasu yousetsu) can be performed as long as you have an oxygen (sanso) container, a flammable gas container, a hose (housu) that sends oxygen and gas to the welder, and a welder. No other equipment is required.
(4) Welders appropriate for the type and pressure of the flammable gas must be used.

■ Question 4 (Torches (tochi))

With regard to torches (tochi), which of the following four explanations is INCORRECT?

(1) Welders for gas welding (gasu yousetsu) and cutters (setudanki) for gas cutting (gasu setudan) burn only flammable gas to heat the metal material.
(2) A torch (tochi) is an instrument for heating, welding, and cutting metal.
(3) Welders for gas welding (gasu yousetsu) and cutters (setudanki) for gas cutting (gasu setudan) mix and burn flammable gas and oxygen (sanso) to heat metal materials.
(4) Welders for gas welding (gasu yousetsu) and cutters (setudanki) for gas cutting (gasu setudan) consist of a blowpipe (suikan) and a nozzle.

■ Question 5 (Flammable gas types and nozzles)

With regard to flammable gas types and nozzles, which of the following four explanations is INCORRECT?

(1) Acetylene is easier to ignite and has a faster combustion rate than propane.
(2) The properties of flammable gases differ depending on the type, but the structure of the nozzle is the same for all flammable gases.
(3) The temperature of the acetylene (asechiren) gas nozzle is designed so that the rise in temperature is minimized before it erupts from the nozzle in order to prevent flashbacks (gyakka).
(4) It is extremely dangerous if flashbacks (gyakka) occur.

■ Question 6 (Pressure regulators (aturyoku chousei ki))

With regard to pressure regulators (aturyoku chousei ki), which of the following four explanations is INCORRECT?

⑴ The material and structure of the pressure regulator (aturyoku chousei ki) differ depending on the type of gas.
⑵ The pressure regulator is for adjusting the original pressure of the cylinder to a pressure suitable for welding and the like.
⑶ Oxygen (sanso) and flammable gas that a container is filled with can be used without installing a pressure regulator (aturyoku chousei ki).
⑷ It is necessary to carefully consider the usage conditions and properties of the gas and select a pressure regulator (aturyoku chousei ki) that suits it.

■ Question 7 (Notes for using pressure regulators (aturyoku chousei ki))

With regard to notes for using pressure regulators (aturyoku chousei ki), which of the following four explanations is INCORRECT?

(1) If the pointer of the pressure regulator (aturyoku chousei ki) is vibrating fractionally or abnormal noise is generated from the pressure regulator body, close the valve on the low-pressure side once and open it slowly.
(2) When performing welding, etc., make sure that the valve is stable at a certain clearance.
(3) If the pointer of the pressure regulator (aturyoku chousei ki) is vibrating fractionally or abnormal noise is generated from the pressure regulator body while gas is flowing, check the pressure regulator settings.
(4) If the pointer of the pressure regulator (aturyoku chousei ki) is vibrating fractionally or abnormal noise is generated from the pressure regulator body, close the valve on the high-pressure side once and open it slowly.

■ Question 8 (Gas welding (gasu yousetu)/gas cutting and flashbacks (gyakka))

With regard to gas welding (gasu yousetu)/gas cutting and flashbacks (gyakka), which of the following four explanations is INCORRECT?

(1) “Detonation” is a phenomenon in which the flashback (gyakka) speed exceeds the speed of sound.
(2) If the safety unit (anzen ki) operates properly, the flashback (gyakka) will stop at the nozzle, but the device may be damaged.
(3) Even if the flashback (gyakka) reaches the welder or gas hose (housu) before the safety unit (anzen ki) and soot adheres to the interior, this will not combust later.
(4) It is important not to cause flashbacks (gyakka).

■ Question 9 (Exterior color of gas hoses (housu) for welding/cutting)

With regard to the exterior color of gas hoses (housu) for welding/cutting, which of the following four explanations is INCORRECT?

(1) The rubber hose for welding/cutting (yousetu/setudan you gomu housu) can be shared with other gas hoses.
(2) JIS K 6333 also applies to hoses for inert or activated shield gases in arc welding.
(3) The color of the rubber layer on the exterior of the rubber hose for welding/cutting (yousetu/setudan you gomu housu) is specified in JIS K 6333 for each type of gas.
(4) JIS provisions are not legally binding, but must be observed in order to carry out work in a safe manner.

■ Question 10 (Filling labels for gas containers)

With regard to the filling labels for gas containers, which of the following four explanations is INCORRECT?

(1) The price of the gas is written on the gas container filling label.
(2) The name of the filling gas is written on the gas container filling label.
(3) The gas container filling label has the filling date/manufacturing lot identifier written on it.
(4) The gas container filling label has the properties of the filling gas written on it.

■ Question 11 (Gas container color)

With regard to the gas container color, which of the following four explanations is INCORRECT?

(1) When the filling gas is oxygen (sanso), the color of the container is yellow.
(2) When the filling gas is acetylene (asechiren), the color of the container is brown.
(3) When the filling gas is hydrogen, the color of the container is red.
(4) When the filling gas is liquefied carbon dioxide, the color of the container is green.

■ Question 12 (Other flammable gas cylinders (bonbe))

With regard to other flammable gas cylinders (bonbe), which of the following four explanations is INCORRECT?

(1) Propane, butane, etc. are filled in a hollow cylinder in a pressurized and liquefied state.
(2) The cap of flammable gas (and helium) cylinders (bonbe) is a left-hand screw, with the exception of ammonia, etc.
(3) Store cylinders such as propane and butane in a state of lying down.
(4) If the container valve is opened with a cylinder such as propane or butane lying down, malfunction may occur.

■ Question 13 (Oxygen cylinder (sanso bonbe))

With regard to oxygen cylinders (sanso bonbe), which of the following four explanations is INCORRECT?

⑴ Oxygen (sanso) used for welding is not liquefied and is filled in a hollow oxygen cylinder (sanso bonbe) at a high pressure slightly lower than 15 MPa.
⑵ It is fine for a small amount of oil to be adhering to the cap of the oxygen cylinder (sanso bonbe).
⑶ The mouthpiece (filling mouth) of the oxygen cylinder (sanso bonbe) is a right-hand screw.
⑷ Oxygen (sanso) is a flammable gas.

■ Question 14 (Qualifications)

With regard to qualifications, which of the following four explanations is INCORRECT?

(1) Work such as gas welding (gasu yousetu) may be performed without qualifications.
(2) Work such as gas welding (gasu yousetu) must not be performed without certain qualifications, such as completing gas welding skill training.
(3) No one under the age of 18 should be engaged in gas welding (gasu yousetu) work.
(4) Boiler welding work must not be assigned to anyone under the age of 18 for both arc welding and gas welding (gasu yousetu).

■ Question 15 (Notes on transportation in factories, etc.)

With regard to notes for transporting objects in factories, etc., which of the following four explanations is CORRECT?

(1) The cylinder may be dragged and carried without using a cylinder carrier.
(2) Cylinders (bonbe) may be rolled and carried without using a cylinder carrier.
(3) When carrying cylinders (bonbe) by hand, hold the valve part of the container.
(4) Use a dedicated cylinder (bonbe) carriers to transport filling containers at factories and construction sites.

■ Question 16 (Notes on using cylinders (bonbe))

With regard to notes on using cylinders (bonbe), which of the following four explanations is INCORRECT?

(1) The cylinder (bonbe) does not need to be secured even if it is not stable.
(2) Do not use the cylinder (bonbe) on the loading platform of a transport vehicle.
(3) When fixing the cylinder (bonbe), do not secure it at the neck.
(4) Do not touch the oxygen (sanso) cylinder (bonbe) with oiled gloves. Also, do not place oil near the cylinder (bonbe).

■ Question 17 (Notes about returning gas containers)

With regard to notes about returning gas containers, which of the following four explanations is INCORRECT?

(1) Gas containers are dangerous if there is still gas inside, so return them after using up the gas.
(2) When the gas is used up, the pressure of the cylinder (bonbe) becomes the same as the atmospheric pressure, and dirty air may enter the container.
(3) The gas container must be returned to the manufacturer without all of the gas being used up.
(4) Containers may be returned when the pressure on the high-pressure side of the pressure regulator (aturyoku chousei ki) reaches a pressure close to the minimum memory of the pressure gauge.

■ Question 18 (Pressure regulator (aturyoku chousei ki) fitting (Part 1))

With regard to pressure regulator (aturyoku chousei ki) fitting, which of the following four explanations is INCORRECT?

(1) Before installing a pressure regulator (aturyoku chousei ki) to an oxygen cylinder (sanso bonbe), open the valve about half a turn, leave it for about 1 second, and blow off the dust from the filling port using gas.
(2) Make sure that the packing is installed normally and that there are no scratches.
(3) When installing a pressure gauge to an oxygen cylinder (sanso bonbe), point it at yourself so that the radiation aperture can be seen clearly, and install it so that the pressure gauge is in an easy-to-see location.
(4) Apply soapy water to the connecting part, visually check from at least two directions, verify that there are no bubbles, and check for gas leaks.

■ Question 19 (Pressure regulator (aturyoku chousei ki) fitting (Part 2))

With regard to pressure regulator (aturyoku chousei ki) fitting, which of the following four explanations is INCORRECT?

(1) When installing a pressure gauge to an acetylene (asechiren) cylinder (bonbe), do not point the radiation aperture toward yourself, but adjust the position so that the pressure gauge is easy to see, and press it with the mounting bracket to secure it.
(2) After installing the control handle correctly, make sure that it is turned all the way to the left and is loose so that it does not face the pressure gauge at an angle to the regulator.
(3) When opening the valve, if the valve is stiff, tap it lightly with a tool.
(4) Turn the acetylene (asechiren) cylinder (bonbe) valve about one turn (do not fully open it).

■ Question 20 (Precautions for using pressures regulator (aturyoku chousei ki) (Part 1))

With regard to precautions for using pressure regulators (aturyoku chousei ki), which of the following four explanations is INCORRECT?

(1) When using a pressure regulator (aturyoku chousei ki), turn the control handle all the way to the left to loosen it.
(2) Do not apply grease or oil to the parts of the regulator.
(3) If the mounting screw of the pressure regulator (aturyoku chousei ki) is damaged, do not try to forcibly install it.
(4) Do not move a cylinder (bonbe) with a pressure regulator (aturyoku chousei ki) installed to it.

■ Question 21 (Precautions for using pressures regulator (aturyoku chousei ki) (Part 2))

With regard to precautions for using pressure regulators (aturyoku chousei ki), which of the following four explanations is INCORRECT?

(1) Do not handle the parts of the pressure regulator (aturyoku chousei ki) with oily hands or gloves.
(2) If the acetylene (asechiren) pressure drops during work, check the amount remaining inside the cylinder.
(3) When work is finished or being suspended, close the cylinder (bonbe) valve and turn the control handle all the way to the left to loosen it.
(4) Frequently disassemble the pressure regulator (aturyoku chousei ki) and repair it if necessary.

■ Question 22 (Connecting a pressure regulator (aturyoku chousei ki) and welder, etc. (Part 1))

With regard to connecting a pressure regulator (aturyoku chousei ki) and welder, etc., which of the following four explanations is INCORRECT?

(1) Before connecting, check that the hose (housu) has not deteriorated or have cracks.
(2) Make sure that there are no dust, insects, or water inside the hose (housu).
(3) Make sure that the blowpipe (suikan) valve is closed.
(4) Use a red hose (housu) for oxygen (sanso) and a blue hose for acetylene (asechiren).

■ Question 23 (Ignition and flame control)

With regard to ignition and flame control, which of the following four explanations is INCORRECT?

(1) To adjust the pressure on the low-pressure side of the pressure regulator (aturyoku chousei ki), after re-verifying that the blowpipe (suikan) valve is closed, slowly turn the control handle for the oxygen (sanso) and flammable gas with the pressure regulator to adjust the pressure on the low-pressure side.
(2) Before starting ignition work in the case of welding, wear protective welding gear and light-shielding protective glasses for gas welding (gasu yousetu) in an appropriate manner.
(3) After protective gear for welding and light-shielding protective glasses for gas welding (gasu yousetu) have been put on appropriately, open the flammable gas valve of the blowpipe (suikan) and perform ignition. Ignition can be replaced by a commercially available lighter, etc., in addition to dedicated ignition equipment.
(4) Open the preheated oxygen valve as soon as possible after ignition. Operate the flammable gas valve first, followed by the oxygen (sanso) valve, to create a pale flame.

■ Question 24 (Notes during welding / cutting work, fire extinguishing method)

Select one of the following four explanations regarding precautions during welding / cutting work and fire extinguishing method.

(1) If you hear an occasional clicking sound after ignition, extinguish the fire immediately, tighten the crater, and replace the crater if the problem persists.

(2) If there is a crackling noise from the blow pipe during welding or cutting work, there is a possibility that it is flashing back. Immediately stop work, clean and retighten the crater, check for gas leaks, etc.

(3) When extinguishing a fire, first close the preheated oxygen valve and then close the fuel gas. For cutting work, close the valve in the order of preheated oxygen, fuel gas, and cutting oxygen.

(4) If a flashback occurs during work, immediately close the preheated oxygen valve, then close the fuel gas valve, and finally close the cut oxygen valve. Next, close the oxygen / fuel gas container valve and loosen the pressure adjustment handle.

■ Question 25 (Crater selection, installation, cleaning)

Select one of the following four instructions regarding crater selection, installation, and cleaning that is incorrect.

⑴ Since the crater has become more sophisticated in recent years, the work can be performed regardless of which crater is selected.

⑵ To install the crater, first make sure that the contact parts between the crater and the blow pipe are not scratched and that there is no dust or oil on them. After that, completely return the back nut (packing nut) until it hits the hexagonal part of the main body, and screw the crater into the blow pipe as far as it will go.

⑶ After screwing the crater into the blow pipe as far as it will go, tighten the hexagonal part of the crater body to the full using a special wrench. Then rotate the back nut by hand until you feel resistance. The first installation should be 1/2 rotation, and the second and subsequent installations should be about 1/4 rotation.

⑷ If the tip of the crater is clogged by spatter, clean it with a crater cleaning needle.

■ Question 26 (visual inspection of gas hose)

For the visual inspection of the gas hose before use, select one of the following four that is incorrect.

(1) If the oxygen hose is backfired even once, soot will adhere to the inside, and if it is backfired again, it may burn violently.

(2) Check for cracks, wear or swelling, discoloration / hardening, and rubbing of fittings that reach the reinforcing layer on the hose surface.

(3) Check the oxygen hose for foreign matter inside.

(4) If there is any abnormality as a result of visual inspection, repair it with insulating tape.

■ Question 27 (Inspection of blow pipe (torch))

For the inspection of the blow pipe, select one of the following four explanations that is incorrect.

⑴ Daily inspections should be conducted before the start of work on that day.
⑵ Even if the appearance inspection of the crater is carried out by daily inspection, regular monthly inspection is carried out.
⑶ In the airtightness inspection, check for valve seat leaks, gas leaks at the crater mounting part, and external leaks at the valve and component mounting parts.
⑷ It is not necessaryto check the flame condition because an abnormality can be found immediately during work.

■ Question 28 (Inspection of pressure regulator)

For inspection of the pressure regulator, select one of the following four explanations that is incorrect.

(1) Annual inspections shall be carried out regularly within one year.
(2) Visual inspections are carried out on a daily basis and on a regular basis every year.
(3) In the airtightness inspection, use oil or grease to check for gas leaks.
(4) In the confirmation of the working pressure range performed in the annual periodic inspection, gas is supplied and the pressure adjustment handle is operated to check whether the maximum pressure can be set normally and whether there is a gas leak from the safety valve discharge port. To do.

Chapter 2 Problems related to basic knowledge about flammable gases and oxygen

■ Question 29 (characteristics of oxygen)

Select one of the following four explanations about the characteristics of oxygen that is incorrect.

⑴ Oxygen is colorless, transparent, odorless, and lighter than air.
⑵ Oxygen has a function of strongly helping things to burn, so even things that do not burn in the air are burned violently.
⑶ When the oxygen concentration becomes high, the ignition temperature of substances such as gasoline, kerosene, heavy oil, sawdust, and hydrogen becomes low, and it becomes easy to burn.
⑷ Acetylene has a higher combustion temperature in oxygen than in air.

■ Question 30 (3 elements of combustion)

For the three elements of combustion, select one of the following four explanations that is incorrect.

(1) In order for a product to burn, it is necessary to have "three elements of combustion": a combustible material, oxygen, and an ignition source.
(2) Acetylene explodes without oxygen.
(3) Silane gas ignites even if there is no ignition source.
(4) Hydrogen has an extremely high minimum ignition energy.

■ Question 31 (minimum ignition energy)

Regarding the minimum ignition energy, select one of the following four explanations that is incorrect.

⑴ Gas explosion does not occur with the electrostatic energy of the human body.
⑵ There are many sources of ignition in the workplace.
⑶ It is difficult to ensure that all ignition sources are not overlooked.
⑷ In order to prevent an explosion accident in welding work, it is necessary to prevent leakage of flammable gas.

■Question 32 (Hazard of gas used for welding)

Select one of the following four explanations about the harmfulness of the gas used for welding.

(1) There is no problem even if acetylene gas, propane gas and hydrogen are inhaled at high concentrations.
(2) It is said that inhalation of acetylene gas may cause pulmonary edema.
(3) Inhalation of acetylene gas may cause drowsiness or dizziness, hypoesthesia, and headache.
(4) Propane gas may cause drowsiness or dizziness, hypoesthesia, and headache when inhaled.

■ Question 33 (Notes in case of fire of gas used for welding)

Select one of the following four explanations that is incorrect for precautions in case of a gas fire used for welding.

(1) Use powdered fire extinguishing agents or inert gases (N2, Ar, CO2, etc.) to extinguish fires caused by acetylene gas, propane gas, and hydrogen.
(2) When safety is ensured, take measures to prevent leakage.
(3) In the case of a large fire caused by acetylene gas, propane gas and hydrogen, sprinkle water or spray water.
(4) In the case of a fire caused by acetylene gas, it is advisable to inject water in a rod shape.

■ Question 34 (High pressure gas rupture accident)

Select one of the following four explanations for the high pressure gas rupture accident that is incorrect.

(1) A normal compressed gas cylinder is filled at a pressure of 14.7 MPa or less according to the High Pressure Gas Safety Act at the time of filling.
(2) 14.7MPa is a pressure of about 150kg per 1cm ^{2}.
(3) The blast pressure caused by the rupture of the tank will not damage the surrounding buildings.
(4) Most high-pressure gas accidents are spouts and leaks, and there are also accidents in which high-pressure gas containers are ruptured or damaged.

■ Question 35 (cylinder flight accident)

Select one of the following four explanations about the cylinder flight accident that is incorrect.

(1) There is no problem even if the valve part of the filled cylinder is broken.
(2) If the valve part of the filled cylinder is broken, there is a danger that the cylinder will fly around violently due to the force of the ejected gas.
(3) If a flight accident occurs, it is dangerous to deal with it by closing the valve.
(4) In the event of a flight accident, there is no solution other than waiting for the gas to run out.

■ Question 36 (Notes on handling high-pressure gas)

Regarding the provisions of the High Pressure Gas Safety Act, select the correct one from the following four explanations.

(1) It is stipulated that high pressure gas must be stored in a place below 30 °C.
(2) It is stipulated that high pressure gas must be stored in a place below 35 °C.
(3) It is stipulated that high pressure gas must be stored in a place below 40 °C.
(4) It is stipulated that high pressure gas must be stored in a place below 45 °C.

■ Question 37 (health disorder caused by fume)

Choose one of the following four explanations about fume health problems that is incorrect

(1) The amount of fume generated by gas welding is smaller than the amount of fume generated by arc welding.
(2) Fume generated by gas welding is said to have no health problems.
(3) There is concern about the occurrence of lung cancer and asthma due to cutting stainless steel.
(4) In recent years, the health effects on the central nervous system due to welding and cutting of copper materials containing manganese have become a problem.

■ Question 38 (What is a dust explosion)

Choose one of the following four explanations for dust explosions that is incorrect

⑴ Dust explosion is a violent explosion in which flammable substances become fine particles (dust) and float in the air in large quantities, accompanied by an ignition source.
⑵ Dust explosions can occur in wheat flour, sugar, and plastic as long as they are combustible.
⑶ Gas welding does not ignite a dust explosion.
⑷ Dust explosion also occurs in metals such as aluminum and iron that do not burn in bulk.

■ Question 39 (prevention of explosion disaster caused by fuel gas)

Select one of the following four explanations that is incorrect regarding the prevention of explosion disasters caused by fuel gas.

(1) Most of the explosion accidents that occur in gas welding are caused by the leakage of fuel gas such as acetylene into the work space and the ignition flame or ignition lighter as the ignition source.
(2) In order to prevent an explosion accident, it is essential to eliminate the leakage of fuel gas.
(3) It is necessary to provide sufficient ventilation in the workplace on a daily basis.
(4) Even if mixed work with other businesses is expected, it is not necessary to make sufficient adjustments in advance.

■ Question 40 (cause of flashback)

For the cause of flashback, select one of the following four explanations that is incorrect.

(1) When the combustion speed becomes faster than the gas flow due to an increase in crater temperature, insufficient flow rate, change in mixing ratio, etc.
(2) When the tip of the crater is blocked by contact with the base material or spatter
(3) When the crater for acetylene gas is used in LPG
(4) When metal powder or soot from the previous flashback has adhered to the inside of the oxygen hose

■ Question 41 (disaster caused by flashback)

Select one of the following four explanations for a disaster caused by a flashback

(1) The crater and blow pipe may be burned by flashback.
(2) The hose may burst due to flashback.
(3) If the cutout stops the flashback, there is no problem even if the flashback occurs repeatedly.
(4) If soot adheres to the inside of the oxygen hose due to flashback, the soot may burn explosively.

■ Question 42 (prevention of disaster due to flashback)

Select one of the following four explanations for preventing disasters caused by flashback.

(1) Gas purging before the start of work is important to prevent flashback.
(2) Reliable inspection and maintenance of equipment is important to prevent flashback.
(3) Handling of flammable gas and oxygen in accordance with the standards is important for preventing flashback.
(4) The cutout is not effective against flashback, so it is not necessary to install it securely.

■ Question 43 (disaster during gas welding)

Select the correct one of the following four explanations for disasters that occur during gas welding.

⑴ During gas welding work, strong ultraviolet rays are generated from high temperature parts such as base metal and flames.
⑵ In gas welding, strong visible light (visible light) and harmful light such as ultraviolet rays are generated.
⑶ Oxygen deficiency is defined as a condition in which the concentration of oxygen in the air is less than 18% in the regulations for the prevention of anoxia.
⑷ When gas welding or fusing is performed in a place with insufficient ventilation, if forced ventilation is performed with a portable ventilation device or the like, respiratory protective equipment is not required.

■ Question 44 (generation of metal fume due to gas welding, etc.)

For metal fume by gas welding, etc., select one of the following four explanations that is incorrect.

(1) Fume is a high-temperature metal that is turned into steam and released into the working environment, cooled in the air, and solidified.
(2) In gas welding and gas cutting, the metal contained in the surface plating also becomes fume.
(3) Pneumoconiosis is a serious chronic disorder caused by metal fume.
(4) Pneumoconiosis does not cause dyspnea even if the symptoms progress.

■ Question 45 (Countermeasures against metal fume)

Choose the correct one of the following four explanations for measures against metal fume

(1) In general, measures against inhalation exposure to chemical substances and dust include intrinsic safety to avoid the use of harmful substances, engineering measures using local exhaust devices, and management measures such as safety and health education for workers. There are three.
(2) Among the measures against inhalation exposure of chemical substances and dust, the one that should be taken with the highest priority is engineering measures.
(3) Among the measures against inhalation exposure of chemical substances and dust, the one that should be taken with the highest priority is management measures.
(4) In the case of gas welding, intrinsic safety is to reduce the generation of fume, but it is difficult to completely eliminate fume.

■ Question 46 (respiratory protective equipment)

Choose one of the following four instructions for respiratory protective equipment that is incorrect

(1) Even if it is difficult to install a local exhaust system, it is not necessary to use respiratory protective equipment.
(2) Respiratory protective equipment must be selected and used in an appropriate manner.
(3) The use of respiratory protective equipment is related to work management.
(4) Respiratory protective equipment is personal protective equipment.

■ Question 47 (dustproof mask)

For the dust mask, select one of the following four explanations that is incorrect.

(1) A dust mask is a type of respiratory protective equipment that removes dust and the like in the work space with a filter.
(2) There are two types of dust masks: replaceable and disposable.
(3) The performance of the direct-coupled dust mask and the isolated dust-proof mask is higher than that of the direct-coupled dust mask.
(4) Surgical masks and non-woven masks used in ordinary households also do not have a dustproof function.

Chapter 3 Issues Related to Related Laws

■ Question 48 (legal system for gas welding, etc.)

Regarding the legal system related to gas welding, etc., select the correct one from the following four explanations.

(1) Of the multiple laws related to gas welding work, the central one is the Industrial Safety and Health Act.
(2) Of the multiple laws related to gas welding work, the central one is the dust lung method.
(3) Of the multiple laws related to gas welding work, the central one is the working environment measurement method.
(4) Among the multiple laws related to gas welding work, the central one is the regulation for preventing oxygen deficiency.

■ Question 49 (Responsibilities of businesses, etc.)

Regarding the responsibilities of businesses, etc. under the Industrial Safety and Health Law, select the correct one from the following four explanations.

(1) The business operator may comply with the minimum standards for the prevention of occupational accidents stipulated by law.
(2) The employer must ensure the safety of workers in the workplace by realizing a comfortable working environment and improving working conditions.
(3) The employer must cooperate with the national government's measures to prevent occupational accidents.
(4) Workers do not need to cooperate in measures related to the prevention of occupational accidents implemented by businesses and other related parties, in addition to observing the matters necessary to prevent occupational accidents.

■ Question 50 (education at the time of hiring)

Select the correct one of the following four explanations regarding education at the time of hiring under the Occupational Safety and Health Regulations.

(1) When a worker is hired, the employer must provide education on matters necessary for safety or hygiene regarding the work to be engaged without delay.
(2) When the work content of a worker is changed, the employer does not need to provide education on matters necessary for safety or hygiene regarding the work to be engaged without delay.
(3) When a business operator hires a worker, he / she must educate him / her on all matters necessary for safety or hygiene regarding the work he / she engages in without delay.
(4) When the employer changes the work contents of the worker, he / she must provide education on all matters necessary for safety or hygiene related to the work he / she engages in without delay.

■ Question 51 (reissue of skill training certificate, etc.)

Regarding the reissuance of the certificate of completion of skill training in the Occupational Safety and Health Regulations, select one of the following four explanations that is incorrect.

(1) If the skill training certificate is lost or damaged, the skill training certificate must be reissued.
(2) Reissuance of the skill training completion certificate is possible at the registered training institution that received the skill training completion certificate.
(3) Even if the certificate of completion of the skill training is lost, the work related to the skill training can be started.
(4) When the name is changed, the certificate of completion of the skill training mustbe rewritten.

Correct answer

Chapter 1 Questions Related to Equipment Used for Gas Welding (gasu yousetsu), etc.

Chapter 2 Problems related to basic knowledge about flammable gases and oxygen

Chapter 3 Issues Related to Related Laws