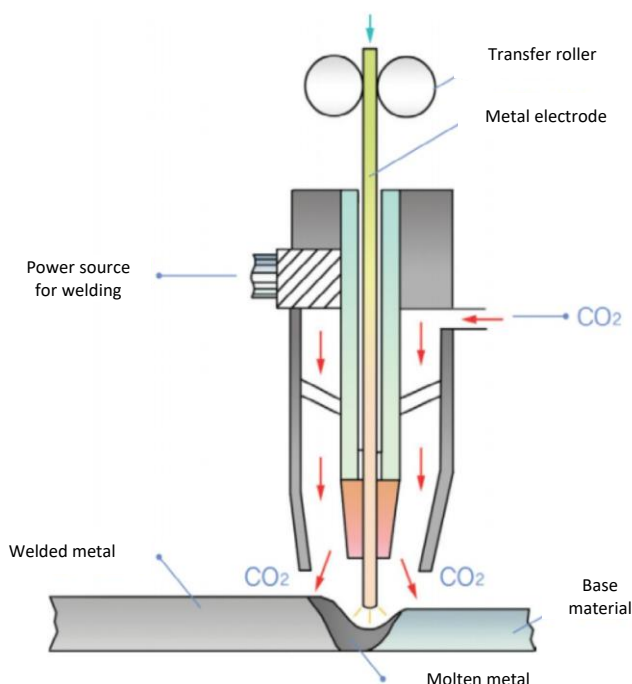


What is safe CO₂ welding?

CO₂ welding (CO₂ Gas Arc Welding) is an electrode method using carbon dioxide gas. It is a welding method in which a welding wire (solid or flux-cored wire) wound around a spool is automatically supplied to the welding torch by a supply motor and welded continuously. The welding power source is energized from the contact tip to the wire and is a technique to melt and join the base material and wire by generating an arc between the (-) side and the (+) side of the wire that goes inside the torch (between the base material and the wire). This method is called CO₂ welding because carbon dioxide gas is supplied as a shielding gas to prevent the molten metal from being affected by oxygen or nitrogen in the atmosphere.

* This welding method accounts for approximately 80% of welding in the shipbuilding process, including assembly and loading processes.

A CO₂ welding machine comprises a CO₂ welder, welding torch, wire feeder, and welding rod. The configuration diagram is shown below.



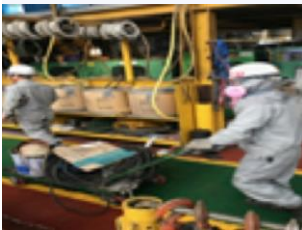
[Configuration diagram of a CO₂ welder]

[Welding for block erection]

① Preparation → ② Welding → ③ Self-inspection
(modification) and finishing

① Preparation

Harms/Hazards	Improvement measures	Relevant codes
• Risk of tripping and falling while moving to work position	• Move the cable by securing a safe passage by checking the surrounding area and organizing it.	Article 22 of the Rules on Occupational Safety and Health Standards (Installation of Passages)
• Risk of accidents due to wearing damaged protective equipment due to failure to inspect protective equipment	• Check the protective equipment and replace it if it is defective. - Welding helmet, welding jacket (skirt), leather pants, dust mask, safety glasses, earplugs, hard hat, etc.	Articles 32 to 34 of the Rules on Occupational Safety and Health Standards (Provision of Protective Equipment ~ Exclusive Protective Equipment)



Preparing for welding

[Note] Safety inspection checklist before work

- ✓ Is the welding rod holder properly insulated?
- ✓ Are the cable (wire) welders and connections properly attached and insulated?
- Is there any part of the cable (wire) where the sheath has been peeled off?
- ✓ Are fire extinguishing supplies (fire extinguisher, water tank, dry sand, etc.) provided at the welding location?
- ✓ Is the welder properly grounded?
- Are there any flammable items such as oil, paint, or rags near the work area?
- ✓ Is the workspace sufficiently ventilated?
- ✓ Is the worker wearing protective equipment such as a welding helmet, protective clothing, and safety shoes?
- ✓ Is the worker aware of the correct use of the device and the risks of the workspace through safety training?



Work Procedure and Major Hazards (examples)

Guide for Safe
Work with CO₂
Welding (CO₂
Gas Arc
Welding)



② Welding - 1

Harms/Hazards	Improvement measures	Relevant codes
• Risk of fire due to careless use of an ignited blowpipe (torch) near combustibles or scattering of high-temperature spatter and other sparks	• Remove combustible materials (e.g., combustible liquids, wood, paper, fiber, packaging, or plastic) from the work area. • Be careful not to come into contact with high-temperature spatter, slag, or heated base materials. • In areas where there is a risk of fire caused by flammable substances, such as the scattering of high-temperature welding sparks during welding work, prepare for fire by shielding the area with fireproof cloth, discharging flammable gas through ventilation, and installing a fire extinguisher.	Articles 231 to 241-2 of the Rules on Occupational Safety and Health Standards (Places Where Flammable Liquids are Frequently Handled ~ Fire Monitors)
• Risk of explosion when cutting or repairing tanks or drums containing or including combustible substances	• Prohibit blowpipes for oxygen/fuel gas equipment on drums or tanks containing or possibly including combustible substances. - If combustible substances remain in the drum or tank, thoroughly remove or inactivate them.	
• Risk of falling through openings such as work platforms and block ends during welding	• Install safe work platforms such as scaffolding for welding, and install safety railings in areas with a risk of falling, such as at the end of the scaffold. - If installing a handrail is difficult, install a fall prevention net or safety belt.	Articles 42 to 44 of the Rules on Occupational Safety and Health Standards (Prevention of Falls ~ Safety Belt Attachment)
• Risk of suffocation due to accumulation of fuel gas in pits, etc.	• Ventilate areas where fuel gas can accumulate, such as pits or trenches.	Article 619 (Establishment and Implementation of Confined Space Work Program), Article 619-2 (Measurement of Oxygen and Harmful Gas Concentration), Article 620 (Ventilation, etc.), Article 622 (Access Control), Article 629 (Measures for Welding, etc.) of the Rules on Occupational Safety and Health Standards
• Risk of suffocation due to carbon dioxide leakage and oxygen deficiency during welding in confined spaces, such as inside blocks with insufficient ventilation • Risk of suffocation due to using bypass CO₂ gas hoses	• Before entering a confined space, measure the oxygen concentration and provide continuous ventilation during work. In particular, bypass CO₂ valves should not be used for an extended period in CO₂ welders to reduce welding defects.	



Work Procedure and Major Hazards (examples)

Guide for Safe
Work with CO₂
Welding (CO₂
Gas Arc
Welding)



② Welding - 2

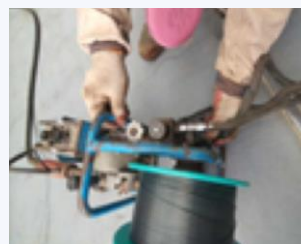
Harms/Hazards	Improvement measures	Relevant codes
• Risk of suffocation due to CO₂ gas leakage if: - The worker is unaware that the operation switch of the welding torch is pressed and activated. - The CO₂ supply line is connected directly to the wire feeder rather than the normal inlet (solenoid valve). - CO₂ gas leaks from connections or surfaces of old CO₂ gas supply hoses.	• Thoroughly manage the operation switch of the welding torch • Supervise the connection of the CO₂ gas supply line to the normal inlet of the welding power source (do not connect directly to the wire feeder). • Prevent leakage, including regular inspection of connections and surfaces of CO₂ gas supply lines. - Place the gas hose on a hanger whenever possible to prevent it from being damaged by being left on the floor.	Article 233 of the Rules on Occupational Safety and Health Standards (Gas Welding, etc.)
• Risk of burns from welding sparks generated during welding and eye injury from arc light	• Wear safety glasses or face shields with sufficient light blocking to protect the eyes from harmful rays generated during welding.	Articles 32 to 34 of the Rules on Occupational Safety and Health Standards (Provision of Protective Equipment ~ Exclusive Protective Equipment)
• Risk of health problems due to welding fume and toxic gases generated during welding • Risk of pneumoconiosis due to gouging for an extended period	• Install and operate dust collection equipment, ventilate the work area, and wear a dust mask (a dustproof/gas mask is recommended if the base material is determined to contain paint, grease, plating, etc.)	
• Risk of electric shock due to insulation damage inside the operation panel, electric control panel, etc., or at the connection of the electric cable (terminal block, connector, etc.).	• Take measures to prevent electric shocks, such as insulating the interior of the operation panel, electric control panel, etc., or the connection of electric cables (terminal blocks, connectors, etc.). • Ground the enclosure of the welding power source, base material, and electrically connected fixtures.	Article 301 (Protection of Live Parts of Electrical Machinery, etc.), Article 302 (Grounding) of the Rules on Occupational Safety and Health Standards
• Deterioration of hearing due to gouging and chipping noises	• Provide earplugs and instruct workers to wear them.	Article 516 of the Rules on Occupational Safety and Health Standards (Provision of Hearing Protective Equipment, etc.)



Check installation



Welder settings



Connect with the welding cable feeder



Current and voltage settings

③ Self-inspection (modification) and finishing

Harms/Hazards	Improvement measures	Relevant codes
• Risk of eye damage and burns when removing slag	• Provide safety glasses and supervise workers to wear them.	Articles 32 to 34 of the Rules on Occupational Safety and Health Standards (Provision of Protective Equipment ~ Exclusive Protective Equipment)
• Risk of falling while dismantling and cleaning the welder • Risk of tripping and falling while moving the welder	• When moving the cable, ensure a safe passage by checking and organizing the surrounding area.	Article 3 (Prevention of Falls), Article 4 (Cleanliness of Workplace), Article 22 (Installation of Passageways) of the Rules on Occupational Safety and Health Standards



Removing slag when checking the welding condition

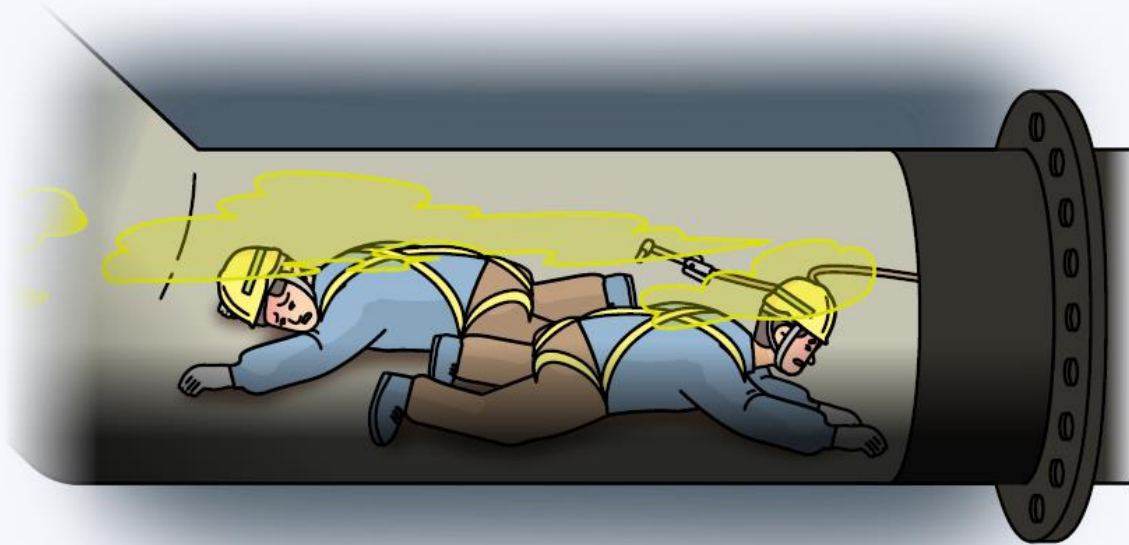


Keep the welding workshop organized after work



Outline

Asphyxiation due to CO₂ gas leaked during CO₂ welding inside the pipe



Cause of the accident

- CO₂ gas leak
 - Failure to perform pre-work inspection of CO₂ gas hose connections
- Non-compliance with the entry permit for confined space work
 - Failure to check oxygen concentration before entering a confined space
 - Failure to provide continuous ventilation while working in a place with insufficient ventilation

Preventive measures

- Preliminary inspection
 - Perform pre-work inspection of CO₂ gas hose connections, gas lines, etc.
- Observe the contents of the entry permit for confined space work
 - Approve an entry permit for confined space work after on-site confirmation.
 - Install a ventilation fan and ensure its continuous operation during work in an area with inadequate ventilation.