



# **Welding and Hot Work**



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# What is Hot Work?

**Hot work** is any work process that produces flames or sparks that present a fire ignition hazard to the surrounding environment and personnel.

## Examples of hot work:



**Gas torch welding and cutting** uses a flame to join or cut metal.



**Arc welding and cutting** uses an electric arc between a metal electrode and a base material to join or cut metal.



**Grinding** uses a grinding wheel that rotates at high speed to cut metal.



**Brazing and soldering** uses heat to melt a filler metal that is used to join metal.

# Course Overview

1. Hazards of Hot Work
2. Hazard Prevention Safeguards
3. Personal Protective Equipment (PPE)
4. Arc Welding
5. Torch Welding, Cutting, and Brazing
6. Cylinder Handling and Storage

# 1

## Hazards of Hot Work

### What you need to know:

1. The hazards associated with hot work
2. Which environments require unique hazard prevention training and precautions



# Hazards Associated with Hot Work

**Hot work presents a variety of hazards.**

Before hot work can begin, your supervisor will identify the hazards in your workplace.

## Fire

Intense heat, sparks, or metal splatter produced during hot work can create fire hazards.

## Electric shock

If you touch two metal objects containing voltage, you will become a part of the electrical circuit. Higher voltages increase the risk of injury or death.

## Arc flash

Arc flash occurs when an electric current leaves its intended path and travels through the air from one conductor to another or to the ground.

## Burns

Radiant energy, sparks, or metal splatter can cause serious burns.

## Flammable gases

If allowed to accumulate, flammable gases can flash or explode with catastrophic results.

## Intense light

The incredibly bright light of arc welding can cause serious eye damage.

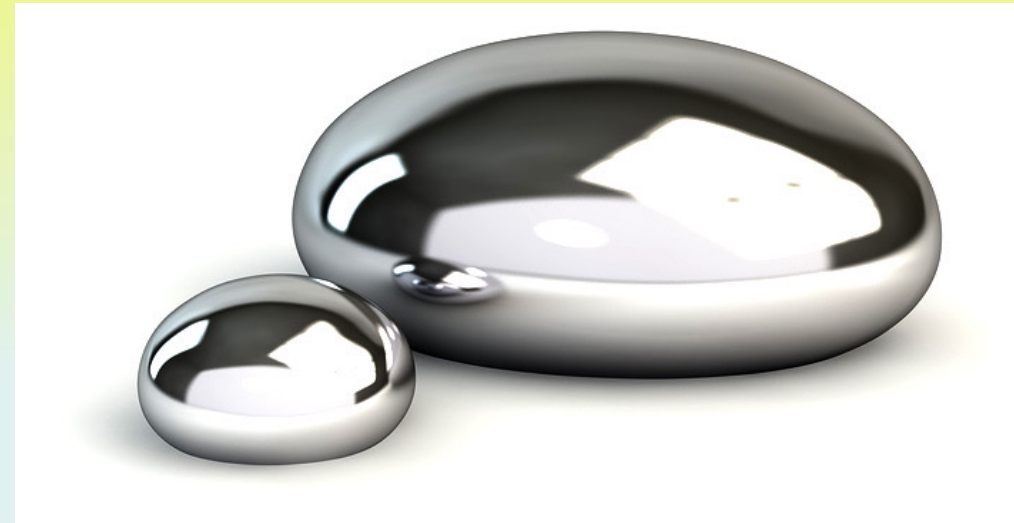
# Hazards Associated with Hot Work

Combustion creates gases, and molten metal releases fumes, both of which are dangerous to inhale. However, certain metals and coated surfaces are especially prone to emitting toxic fumes and gases.

## Toxic metals and coatings:

Proper ventilation and respiratory protection are critical when performing hot work on materials containing the following:

- Zinc
- Chromium
- Lead
- Cobalt
- Cadmium
- Mercury
- Beryllium



# Environments with Special Hazard Considerations

The hazards of hot work intensify in certain environments, such as wells or other confined spaces.

## Potential hazards in oil or gas wells:

- Flammable or combustible gases, vapors, and liquids
- Toxic gases in deadly amounts

## Hazards in confined spaces:

- Limited escape routes
- Limited visibility, which impedes awareness of injuries and delays emergency response
- Limited ventilation, presenting a greater risk of exposure to harmful fumes
- Displaced oxygen caused by welding flames in a confined space, which can be fatal

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## Hazard Prevention Safeguards

### What you need to know:

1. Roles and responsibilities
2. Administrative procedures
3. General hazard controls
4. Additional controls
5. Safety restrictions





# Roles and Responsibilities

You, supervisors, and management all have the responsibility to assure a safe environment for hot work.

## The employee:

- Lays out the work area
- Keeps the work area clean
- Follows fire prevention and other safety controls
- Follows related procedures, such as lockout/tagout
- Uses all personal protective equipment (PPE) properly
- Uses all equipment properly
- Reports any safety issues

## The supervisor:

- Conducts hazard assessments and identifies safety precautions
- Communicates and enforces safety procedures
- Assigns fire watches, if required
- Secures authorizations
- Assures that equipment is safe to use
- Tells the employee when to proceed

## Management:

- Appoints a qualified supervisor
- Establishes the proper locations, policies, and procedures
- Assures that employees have the training they need to work safely
- Advises contractors of hazards



# Hazard Assessment

Your supervisor must take certain precautions before hot work begins. The most important of these is the hazard assessment.

## The hazard assessment considers:

- All the activities required for completing the task.
- The hazards associated with each of those activities.
- Any additional environmental hazards.



*The hazard assessment will guide the choice of hazard controls and PPE.*



# Administrative Procedures

Next, your supervisor will perform the following administrative tasks.

## Notification:

Notify area management and employees of planned hot work activities.

## Permits:

To certify that hazards are thoroughly identified and addressed, acquire and complete hot work permits.

- Each separate operation requires a permit.
  - Sometimes a new permit is needed for each shift or if new hazards are introduced.
- The organization should keep permits for at least one year after the hot work has been performed.

**HOT WORK PERMIT**  
BEFORE INITIATING HOT WORK, CAN THIS JOB BE AVOIDED? IS THERE A SAFER WAY?

Hot Work Permit is required for any operation involving open flames or heat/spark producing tasks. This includes, but is not limited to: Slicing, Cutting, Grinding, Soldering, Thawing Pipe, Torch Applied Roofing, and Welding.

**INSTRUCTIONS**

- Verify precautions listed at right are taken or do not proceed with the work.
- Complete and retain Permit.
- Issue Permit to person doing job.

**HOT WORK BEING DONE BY:**  
☐ EMPLOYEE  
☐ CONTRACTOR (Name) \_\_\_\_\_

**DATE:** \_\_\_\_\_ **JOB NO.:** \_\_\_\_\_

**LOCATION (BUILDING & FLOOR):** \_\_\_\_\_

**NATURE OF JOB:** \_\_\_\_\_

**NAME OF PERSON DOING HOT WORK:** \_\_\_\_\_

I verify the above location has been examined, the precautions checked as the Required Precautions Checklist have been taken to prevent fire, and permission is authorized for this work.

**SIGN ON SITE SAFETY REPRESENTATIVE:** \_\_\_\_\_

**PERMIT EXPIRES (DATE/TIME (AM/PM)):** \_\_\_\_\_

**REQUIRED PRECAUTIONS CHECKLIST**

- ☐ Sprinklers, hose streams, extinguishers are in service/operable, and in vicinity
- ☐ Hot Work equipment in good repair... hoses, fittings, etc.
- Requirements within 35 ft (11 m) of work**
  - ☐ Flammable liquids, dust, lint and oily deposits removed
  - ☐ Explosive atmosphere in area eliminated
  - ☐ Floors swept clean
  - ☐ Combustible floors wet down, covered with damp sand or fire-resistant sheets
  - ☐ Remove other combustibles (paper, wood products, etc.) where possible. Otherwise protect with fire-resistant tarpaulins or metal shields
  - ☐ All wall and floor openings covered
  - ☐ Fire-resistant tarpaulins suspended beneath work
- Work on walls or ceilings**
  - ☐ Construction is noncombustible and without combustible covering or insulation
  - ☐ Combustibles on other side of walls moved away
- Work on enclosed equipment**
  - ☐ Enclosed equipment cleaned of all combustibles
  - ☐ Containers purged of flammable liquids/vapors and vented if needed, Confined Space Permit issued
- Fire watch/Hot work area monitoring**
  - ☐ Fire watch will be provided during and for 60 minutes after work, including any coffee or lunch breaks
  - ☐ Fire watch is supplied with suitable charged extinguishers
  - ☐ Fire watch is trained in use of this equipment and in sounding alarm
  - ☐ Alarm available
  - ☐ Fire watch required for adjoining areas, above, and below
  - ☐ Monitor Hot Work area periodically for 4 hours after job is completed



# Hazard Controls

Based on the hazard assessment, your supervisor will establish hazard controls for each risk.

## Controlling combustible materials:

- Remove all combustible materials **35 feet** from the work area.
- Move combustibles located on the opposite side of partitions and ceilings that will be subject to welding or cutting.
- Avoid unmovable combustible materials, such as wooden floors.

## If unable to remove or avoid fire hazards:

- Cover combustible floors or materials with fire blankets or other suitable non-combustible material to contain slag and sparks.
- Use guards.
- Establish restrictions.
- In some cases, hot work may be prohibited entirely.



# Additional Fire Prevention Measures

- **Fire watch:** Establish a fire watch in areas where fires might develop. Continue the watch for at least 30 – 60 minutes after completion of hot work.
- **Fire extinguishers:** Provide at least one 10-pound ABC fire extinguisher in each hot work zone.
- **Ducts and conveyer systems:** Shut down ducts and conveyor systems that might carry sparks.
- **Atmosphere control:** Monitor the air, checking for flammable or explosive gases or vapors. If necessary, purge and inert the atmosphere.
- **Safe disposal:** Provide metal buckets or containers for safe disposal of hot work debris.



# Other Hazards

- **Welding arc rays:** Position welding curtains to protect employees from intense light. Provide the proper shade of lens.
- **Electrical shock:** Keep working conditions dry, and provide proper PPE.
- **Arc flash:** Provide high-resistance grounding and proper PPE.
- **Burns:** Install guards, and provide proper PPE.
- **Fumes and other toxic byproducts:** Properly ventilate work areas, and provide adequate respirators.
- **Toxic coatings:** When possible, strip toxic coatings from metal before beginning hot work.



**A welding curtain shields employees from the direct rays of arc welding and cutting operations.**



**A welder uses a local exhaust duct to quickly remove toxic fumes and gases.**

# Controlling Hazards Around Confined Spaces

Certain environments, such as well sites, vessels, and other confined spaces, require additional precautions.

- Move all ignition sources outside the hot work area.
- Use local exhaust ventilation to keep exposures within acceptable limits.
- Follow your organization's respiratory protection program.
- Your supervisor will arrange for monitoring to evaluate air quality, potential contaminants, and ignition sources.
- Before beginning hot work on vessels that formerly contained flammable or toxic materials, thoroughly clean them.
- Always vent and purge hollow spaces.
- Assure that oxygen is not displaced, or use a supplied air respirator.
- Do not bring cylinders or welding machines inside of confined spaces.
- Follow your organization's policies for working in confined spaces.

# Safety Restrictions

In some conditions, you should **never** perform hot work.

## Never weld in the following locations:

- Rooms where fire sprinklers are impaired
- Spaces with potentially explosive atmospheres
- Areas near the storage of large quantities of readily ignitable materials

## Never weld on the following materials:

- Metal that has combustible covers or layers
- Metal in close proximity to combustibles



# Before Beginning Any Hot Work

- Wait for your supervisor to finalize the permit.
- Only work on equipment if properly trained and authorized by the organization.
- Inspect all PPE.
- Inspect all hot work equipment.
- Follow the lockout/tagout program requirements.
- Follow respiratory protection requirements.



# 3

## Personal Protective Equipment (PPE)

### What you need to know:

1. Common PPE designed for hot work
2. How to select eye protection
3. The proper use of respirators



# Common PPE

Your supervisor will identify required PPE as part of the hazard assessment. Required PPE for hot work may include skin, body, and foot protection.

To protect against **burns**, cover all exposed flesh.

PPE that protects against **electric shock** includes insulated gloves and rubber-soled shoes.



**Buttonable collar**

**Welding hood**  
with adjustable lens filter

**Fire resistant gloves**

**Fire resistant jacket**  
hanging outside of pants  
without open pockets

**Fire resistant trousers**  
without cuffs on pant legs

**Leather high-top boots**  
with steel toes

# Eye Protection

Your supervisor will specify the type of eye protection needed for the task.

## Types of eye protection:

- Welding hoods with properly shaded lenses
- Cutting or burning goggles for torch cutting
- Full face shields for grinding
- Safety glasses worn under welding hoods or face shields when grinding



## Auto-darkening lenses:

Auto-darkening lenses provide continuous protection by adapting to varying levels of light.

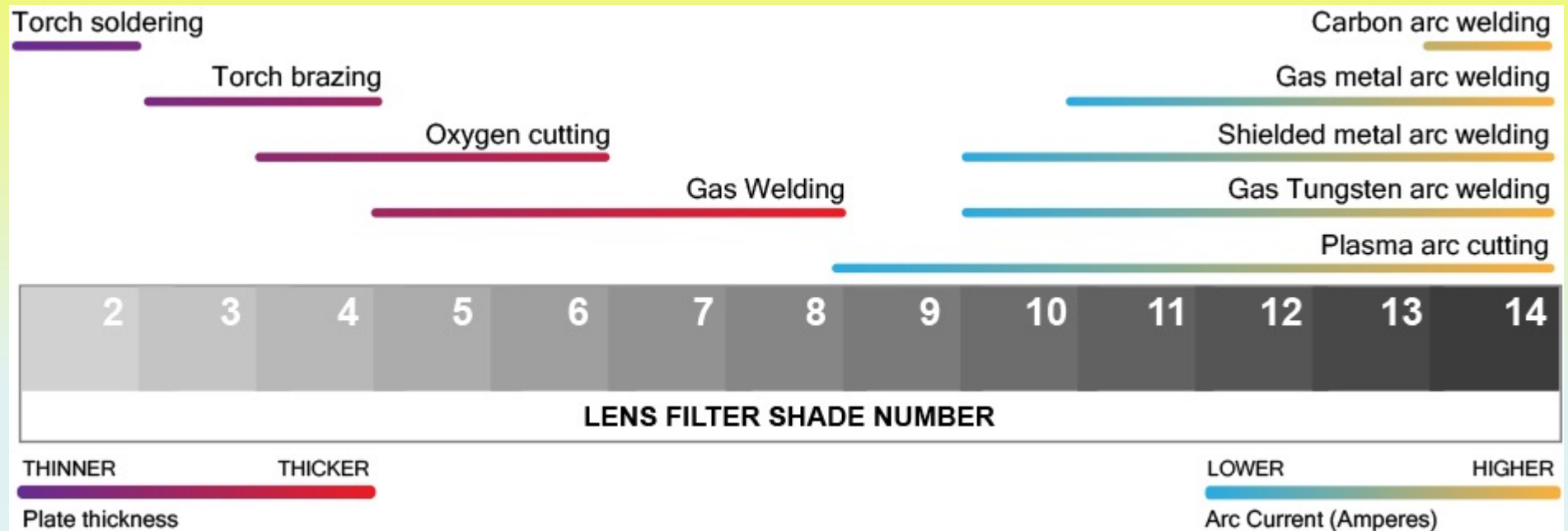
If using an auto-darkening lens:

- Check the manufacturer specifications to confirm that it is rated for the correct intensity.
- Before starting work, check that the battery power is sufficient.



# Protective Lens Shading

**Lens filter shade numbers** range from 2 – 14. Higher numbers providing greater protection. The chart below shows the recommended lens filter shade number for specific types of hot work.



# Respiratory Protection

Filter-type respirators use cartridges to filter incoming air and remove contaminants.

## Uses:

- They are **required** for open-air hot work with metals containing toxic substances such as galvanized steel, zinc, or chromium.
- They **will not provide** adequate protection in confined spaces lacking sufficient ventilation.



*Consult manufacturer specifications to determine the appropriate type of cartridges.*



**REMEMBER:** *You must be trained and authorized before using a respirator. Only wear a respirator designed and rated for the hazards involved.*

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## Arc Welding

### What you need to know:

1. How to safely handle arc welding tools
2. Safety procedures





# The Electrode Holder

Check that all components of arc welding are in good condition, starting with the electrode holder.

## Electrode holder requirements:

- Specifically designed for arc cutting and welding
- Properly insulated
- Able to safely handle the maximum current

## Safe practices:

- When done welding or if leaving the holder unattended, remove and properly dispose of the electrode to prevent contact with people or conducting objects.
- **NEVER** dip a hot electrode or electrode holder in water.



The welder inserts one of these electrodes (right) into the electrode holder (left).



# Cables

Before starting the welding machine, check the condition of the cables.

## Cable requirements:

- Completely insulated
- Flexible
- Capable of handling the maximum current requirements

## Repair or splices:

Areas that have been repaired or spliced must be at least 10 feet away from the electrode holder, unless the connectors and connecting lugs have the same level of insulation as the cable.



**One cable carries electricity to power the electrode, and the other grounds the welding machine.**

# Cables

## Additional cable requirements:

- Ground the welding machine properly.
- Keep cables clear of walkways, ladders, and stairways. For example, they can be strung overhead with non-metallic hangers.
- Immediately remove all damaged and worn cables from service until properly repaired.



**Signs of improper grounding include sparks, arcs, and heat.**

# Additional Procedures

Follow your organization's lockout/tagout program and any PPE requirements.

## Before you begin:

- Inspect your PPE.
- Inspect all equipment to assure that it meets the manufacturer's specifications.
- Make sure that the welding machine's power supply has a circuit breaker or can be easily disconnected.

## When you are finished:

- Shut off the welding machine at the end of each shift and whenever the machine is moved.
- Assure that stored energy is released in accordance with the manufacturer's specifications.

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## Torch Welding, Cutting, and Brazing

### What you need to know:

1. Equipment inspection procedures
2. Safe use of torch cutting equipment
3. Safety guidelines for supply hoses
4. Safe use of cylinder valves



# Inspection and General Torch Use

Before torch welding, cutting, or brazing, inspect all equipment. Regularly follow preventive maintenance procedures, and consult the manufacturer's specifications.

## Pre-shift inspection:

- Torches and hoses: Check for leaks, damage, and loose connections.
- Oxygen cylinders and fittings: They must be properly labeled, distinguishable, and free of oil and grease.
- Welding apparatus: Make sure all components are clean and free of oil and grease.
- Valves
- Regulators

## Maintenance:

- Tag and remove defective, damaged, or worn equipment from service. Either repair or discard it.
- Properly clean clogged torch tips.

## Safe torch use:

- Use flashback arrestors.
- Light torches only with approved tools.
- When finished working, shut off valves and relieve hose pressure.

# Safe Hose Preparation and Use

## Hose preparation:

- Keep hoses clear of walkways, ladders, and stairways.
  - For example, you can string hoses overhead using non-metallic hangers.
- You can tape parallel lengths of hose together to prevent tangling, but do not tape more than 1/3 of each 12-inch section.
- Check that hose couplings cannot be disconnected with a pull. Separating them should require a twisting motion.

## Safe hose use:

- Do not use the same hose for different materials.
  - Oxygen and fuel-gas hoses are not interchangeable.
  - Do not use a single hose with more than one gas passage.
- When done with a task, relieve hose pressure.
- When you are finished working, store your hose in a ventilated area or box.



# Using the Cylinder Valve

Proper use of cylinder valves keeps you safe and keeps the equipment working longer.

- Always open valves slowly and carefully.
- When opening valves, stand to the side, not to the front.
- Do not open fuel-gas cylinders near ignition sources.
- **Do not open acetylene cylinders too far:**
  - $\frac{3}{4}$  of a spindle-turn or less is ideal.
  - Never turn the spindle more than 1.5 times.
- Before you connect a valve to a regulator, open the valve a crack and then quickly close it. This allows any foreign material in the valve port to be discharged.



# 6

## Cylinder Handling and Storage

### What you need to know:

1. Hazard communication resources
2. Identification requirements
3. Safe handling practices
4. Guidelines for moving and storage
5. Environments and practices to avoid





# Cylinder Hazard Communication

Before beginning work, you must fully understand the hazards in your work area. Hazard communication is a system for clearly conveying hazards to everyone who needs to know.

## **Training:**

Your employer will provide hazard communication training.

## **Safety data sheets (SDSs):**

SDSs include the manufacturer's statement of origin, the contents of the cylinder, and the hazards of the contents.

## **PPE:**

Use the SDS and your supervisor's hazard assessment to select the proper PPE.



# Cylinder Identification

## Tags:

Use status tags indicating if the cylinder is full, in use, or empty.

## Labels:

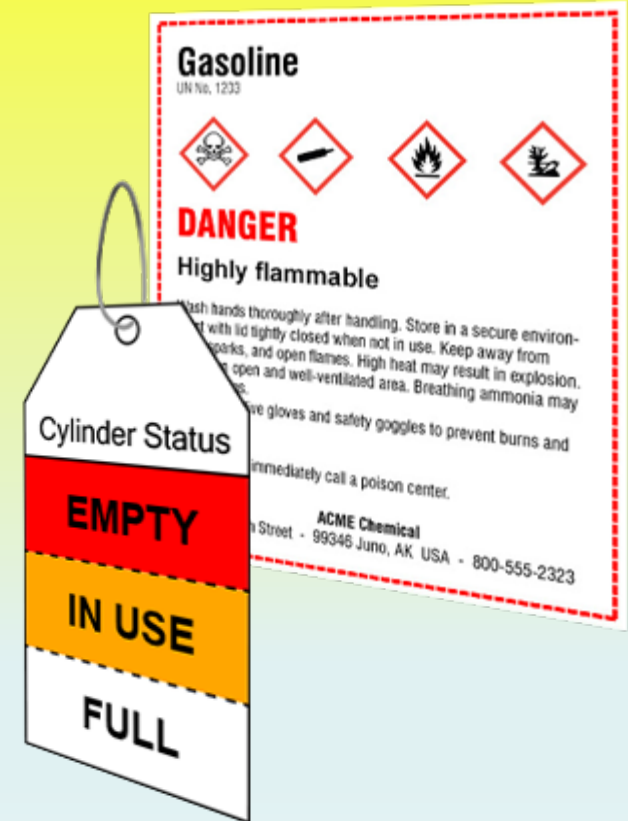
All cylinders must have proper GHS-compliant labels that identify contents and classify hazards.

## Signage:

Be aware of signs at storage areas, such as "Danger: Flammable. No sources of ignition, smoking, or open flames."

## Storage:

Store cylinders with caps and tags on.



# Cylinder Valve Safety

- Close valves, bleed the lines, remove regulators, and replace valve safety caps:
  - When storing cylinders.
  - Before moving cylinders.
  - When a cylinder is empty.
  - When leaving cylinders unattended.
- All cylinders must be equipped with a handle or wrench, so that they can be turned off immediately when necessary.



# Moving Cylinders

## Prior to moving cylinders:

- Get authorization.
- Confirm the cylinders' contents and review the SDSs for handling requirements.
- Close valves, bleed the lines, remove regulators, and replace valve safety caps.
- Make sure that your planned route is clear of obstacles.



## While moving cylinders:

- Use a cart designed for this purpose.
- Use a chain to secure them to the cart.
- Stay on designated pathways.
- Never lay cylinders on their sides, and never roll them by hand.

# Cylinder Storage Guidelines

Store cylinders according to SDSs and local, state, and federal requirements.

## Storage area requirements:

- Cool and dry
- Well-ventilated
- Clean and free from combustible materials
- Protected from recognizable hazards

## Storage practices:

- Limit access to authorized and trained persons.
- Always keep cylinders upright.
- Bleed the lines, remove regulators, and replace valve safety caps.
- Follow safe practices for additional cylinders, whether full or empty.

## Segregation:

- Keep all cylinders and combustible materials 20 feet away from stairs, aisles, and elevators.
- Keep combustible and flammable materials 20 feet away from all cylinders.
- Keep oxygen cylinders separate from fuel-gas cylinders and combustible materials with one of the following:
  - A 5-foot, noncombustible barrier with a ½ hour fire-resistance rating
  - A 20-foot distance
- Some gases have additional storage requirements.

# Cylinder Storage and Handling Practices to Avoid

## Never:

- Use cylinders for anything other than the intended use.
- Move or store gas cylinders in confined spaces.
- Position cylinders near ignition sources.
- Position cylinders between electrical sources.
- Hoist cylinders improperly, such as with magnets.
- Use acetylene with a pressure greater than 15 psi gauge or 30 psi absolute.
- Use hammers or wrenches to open cylinders that have fixed handwheels.
- Strike an electrode against a cylinder when striking an arc.
- Refill cylinders.
- Mix gases in a cylinder.



# Summary

**Hot work can be dangerous:** Your active participation in workplace safety is essential.

**Be able to recognize hazards:** Be aware of the hazards in your workplace, and know what factors increase the danger. Know when it is too dangerous to perform hot work.

**Be prepared:** Be sure that you understand safety requirements and work practices before starting work.

**Conduct inspections:** Be confident that all parts of your equipment and PPE are undamaged and working properly.

**Communicate:** Communicate any hazards you discover to your supervisor and coworkers.

