



What is welding?

The first step toward achieving welding safety is to follow the safety and maintenance instructions supplied by the manufacturer of the apparatus.

Next, the welder should check the equipment. Have a competent person conduct a thorough inspection of all equipment at least once a month. Replace or repair excessively worn equipment. Discontinue using unsafe or defective equipment until you make repairs. Use replacement parts specified by the equipment's manufacturer.

Safety-approved electrical arc welding equipment should meet the standards of the National Electrical Manufacturers Association (NEMA). Most insurance companies and local authorities recognize oxygen and acetylene equipment listed by Underwriters' Laboratories Inc.

While the safety suggestions in this booklet apply specifically to portable welding equipment and its use, they also are generally applicable for the safety maintenance and operation of stationary welding machines.

Arc welding equipment

Because arc welding involves an electrical arc, the source of power is the first point to check. Are all electrical connections tight and properly made? Does the generator or transformer safety-disconnect switch have adequate amperage? Are detaching plugs on smaller equipment easily accessible?

Correct current is important

Too little current reduces the efficiency of the operation. Too much current causes inferior welds, overloads and damages equipment. For the correct current, refer to the operations manual supplied with the equipment. Check the current load with an ampmeter.

Guard it well

To prevent accidental contact, welding machines should have mechanical and electrical protection. Guard all moving parts. Mechanical power trans-

mission apparatus with clutches, gears and couplings should have these danger points screened or guarded. Insulate all parts that carry current. Turn off the generator before changing electrodes or cables.

If using a gasoline-powered generator indoors or in a confined space, transmit the exhaust outdoors to prevent an accumulation of carbon monoxide. Also, check for fuel leaks.

Keep machines clean. To prevent excessive flashing, keep commentators clean; for cleaning, use No. 00 sandpaper, not flammable liquids. Keep rectifiers free of dust or lint that could interfere with ventilation.

Check the cables

Welding cables should have high-quality insulation, and should be flexible and large enough for the job. Overloading burns away the insulation, causing both shock and fire hazards.

It is important that the neutral wire (often referred to as the ground wire) be fully insulated. When using DC current, this is a current-carrying wire, and becomes the hot wire.

Frequently inspect cables. Always keep them in good repair and out of water, oil, ditches or the bottoms of tanks. Try to avoid abrasion caused by rubbing against sharp corners or being dragged over objects on construction sites. Do not leave cables in the paths of workers and ship trucks. If it is necessary to cross the line of traffic, suspend cables overhead if possible.

Watch those splices

When splicing cables, make sure the connectors are well-insulated and have a capacity equal to or greater than the cable. Make splices with insulated pressure connectors or welded joints. Connecting lugs should have more than one bolt for a reliable, tight connection and complete insulation. Do not use cables with splices within 10 feet of the holder.

Hold out for safe electrodes

Fully insulate holders because they support the electrode and transmit the current from the machine to the electrode. Fully insulated holders, an added safety factor for operation in close quarters, reduce the danger of striking an accidental arc.

Using inert gas for shielding

Precautions for handling inert argon, helium gas and oxyacetylene cylinders are the same. Always attach the regulator and flowmeter to the argon supply. Use argon at 20 psi pressure. Check for leaks.

Do not touch metal with a water-cooled inert-gas torch. On contact, the arc jumps from the electrode to the gas cup and causes a short. Be sure the cooling water is clean and use filters to prevent clogged passages, which can cause equipment to overheat. Check for water leaks. Do not wear exposed cotton clothing while doing gas-shielded arc welding, because higher levels of ultraviolet radiation disintegrate cotton clothing rapidly. Check for dangerous trichloroethylene and perchloroethylene vapors.

Take special care when using inert gases in an area of confined entry, due to the danger of asphyxiation. In such a situation, there will be no obvious warning signs of a hazard.

Atomic hydrogen welding

Fire, accident and health safeguards are the same for gas and electrical welding. Precautions against electrical shock are doubly important because of the much higher voltage. Hydrogen tanks increase the danger of fire and explosion. Follow general safety suggestions of oxygen and acetylene handling and storage.

Set up for safety

For maximum performance and safety, set up electrical welding equipment carefully. Faulty installation and operation are dangerous. Poor or worn connections can cause short circuits, defective welds, dangerous arcs and electrical shock. Look for grease or oil in plugs, sockets or on the machine. Dry, clean and tight electrical connections are the best and safest. Make sure the welding machine frame is adequately grounded. If equipment becomes wet, dry it thoroughly and test it before use.

Caution: Cut off current before making an adjustment on any part of electrical welding equipment—the welding wire, wire reel, mechanized welding head and electrode holder.

Spot welding equipment

Resistance (or spot) welding is usually performed on a permanently installed machine. The machine may be manual, semiautomatic or fully automatic. The hazards and routine protective measures are generally controlled through engineering.

Because spot welding machinery varies in its methods of applying pressure — manual, mechanical, electrical, pneumatic or hydraulic — and often has intricate timing and control devices, it demands strict and frequent maintenance.

If welding machines store up energy in capacitors or combination transformer — reactors, the low currents and high voltages can be hazardous to the operator.

Only qualified personnel should install spot welding machines. Throw the line disconnecting switch before making any adjustments. This is imperative where single-pole primary circuit breakers and electrical contactors are used because it leaves one hot line to the machine.

Check electronic controls

You must properly insulate and guard electronic controls in the primary circuit of the machine with lockouts and safety switches to protect the operator from high voltage hazards.

How are your connections?

No plug connections are permitted, except in the control circuits. Attach power lead terminals permanently with screws or bolts.

Don't overlook spot welding cables

Resistance welding cables must withstand severe abuse, so even the best require frequent replacement. Twisting, bending and electrical impulses at 3,600 per minute cause rapid breakdown.

Strapping the cable to the machine helps reduce wear and kicking, which can cause muscular strain for the operator. Cable blowouts caused by steam pressure from faulty water cooling circulation cause

injuries; a periodic cable checkup will uncover weak spots and prevent accidents.

Safe electrodes and holders

Both the electrode and the holder should be water-cooled to minimize the danger of heat softening the metal and radiant burns. Redress and replace electrodes frequently because of the wear caused by the application of force and high current density.

Can you answer these questions about spot welding equipment?

- Is it grounded? Make certain welding machines and all auxiliary equipment are grounded.
- Is stored energy equipment (more than 550 volts) completely enclosed? Are the condensers short-circuited when the door or panel is opened? Is there a safety switch or absolute discharge or condensers?
- Are machine access doors locked to prevent tampering?
- Are punch press-type-guards on the machine? Are they in good working order?
- Is the ventilating system working?
- Is the hood on the flash welding machine adequate to control the flash?
- Is there a safety glass or shield available to protect the operator and others from flying sparks?
- Are foot switches guarded to prevent accidental starts?
- Is the power cut-off switch convenient to use — before servicing or in an emergency?

Gas welding equipment

These maintenance suggestions generally apply to both portable and permanent oxygen and acetylene welding equipment.

What's the correct acetylene pressure?

Acetylene pressure at the generator, in distribution lines and at the point of use, must not exceed 15 psi gauge pressure due to the possibility of an explosion.

Never use matches or open flame around a generator.

Fill the water chamber of an acetylene generator completely before repairing it. This eliminates the possibility of explosive gas pockets or carbide dropping into an insufficient amount of water. If possible, make hot repairs outdoors.

Watch the space around the generator; it should be easily accessible for making adjustments and charging. Remove all clutter and obstacles.

Check the generator's hydraulic back-pressure valve regularly, and keep it properly filled with water. Don't overlook the proper grounding of the generator.

Portable generator precautions

Clean and charge portable acetylene generators outdoors. Do not move carbide-charged generators by crane or derrick. Anchor the generator to a vehicle before transferring it. Turn off truck motors before charging, cleaning or operating a generator.

After emptying carbide and gas from portable generators, store them in well-ventilated rooms where there are no open lights or flames.

Carbide storage precautions

Store carbide in dry, well-ventilated locations. Clearly mark containers: Calcium Carbide — DANGEROUS IF NOT KEPT DRY. Keep partly empty containers tightly closed.

Post a sign in the storage area reading: CALCIUM CARBIDE — In case of fire do not use water or foam extinguishers. Use carbon dioxide or dry chemical.

Piping system precautions

Use steel and wrought iron piping only for acetylene, never copper or copper alloys with more than 65 percent copper. Copper, silver, mercury and a number of other incompatible substances when combined with acetylene form metallic acetylides, which are unstable and capable of exploding.

Do not overheat the piping. Maintain proper sign and color identification in areas with more than one gas line. Test for leaks with grease-free soap water.

Be aware of gas cylinders

Clearly mark the contents of every gas cylinder. When cylinders are not in use, keep the cap on to protect the valve mechanism. If empty, close the valve and mark the cylinder EMPTY or MT.

Do not place cylinders near radiators or other sources of heat. Never store them near oil, excelsior, grease or any highly combustible material. Separate oxygen cylinders from acetylene and fuel gas cylinders in storage by at least 20 feet or by an approved partition.

Shield cylinders in outdoor storage areas from the heat of the summer sun and accumulate winter snow and ice. In freezing weather use only warm (not boiling) water to thaw ice in cylinder valves; never use a flame. The fusible plugs (safety releases) melt at about the temperature of boiling water.

Always store oxygen and acetylene cylinders in an upright, secure position with a chain or cable. (An acetylene cylinder contains a fluid, which may escape if the cylinder is on its side; this could cause an explosion.)

Keep cylinders in a dry, well-protected and well-ventilated area away from stairways, elevators and gangways. Keep the valve end up on acetylene cylinders.

Have a DANGER—NO SMOKING sign at the storage area entrance. Knocks, falls and rough handling may cause leakage.

Separate oxygen cylinders in storage from fuel-gas cylinders or combustible materials (especially oil or grease) by a minimum distance of 20 feet or by a noncombustible barrier at least 5-feet high and having a fire-resistance rating of at least one-half hour.

When not in use, protect cylinders from any heat-radiating objects or open flames, which could cause the cylinder to rupture or could cause the fusible plug to melt.

What to do about leaking cylinders

To stop acetylene leaks around the valve spindle when the valve is open, close the valve and tighten the gland nut. If this does not work, mark the valve defective and return the cylinder.

If cylinder or fusible plug leaks occur when the valve is closed, remove the cylinder from the storage area. Place it in a location where there is no danger of ignition, and open the valve slightly to let acetylene escape. Follow the supplier's instructions for further disposition.

If any trouble occurs with oxygen cylinder valves, contact the supplier immediately for instructions. Do not use a hammer or wrench to open valves; use hand pressure only.

Cylinder manifold safety

Place approved flash arresters between each acetylene cylinder and the coupler block. Three or fewer cylinders require only one arrester between the coupler block and regulator. Make sure each cylinder lead has a back-flow check valve. When in manifold, acetylene and liquefied gas cylinders should be in vertical positions. The aggregate capacity of fuel gas cylinders connected to a portable manifold should not exceed 300-cubic feet of gas.

Gas pressure regulators

During periodic testing of regulators and gauges, do not test oxygen gauges with oil; use soap water (nonfat) or an approved leak-test solution. Creeping regulators allow a steady pressure increase and should be repaired immediately. When repairs or adjustments are needed, send the regulator to the supplier.

If gas leakage occurs when regulators are connected, check for faulty seating of unions and connections. Replace damaged connections.

Caution: Always release pressure-adjusting screws on regulators to drain out all gas before attaching the regulator to the cylinder. Be sure to use the correct regulator for the type of gas being used.

Check hoses frequently

Leaks, burns, worn spots and loose connections are just a few of the hose hazards. Repair leaks and burns immediately by splicing. Do not use tape repairs. Correct excessive wear at connections by cutting off a portion of the hose and securely reinserting the connections.

Flashback or continual wear demand a thorough inspection. Conduct testing at least once a year with oil-free air or oil-free inert gas at double normal pressure, or at least 200 psi.

Fasten connections so that twice the normal pressure, or not less than 300 psi, can be accommodated without leakage. Do not use white lead, oil, grease or pipefitting compounds for sealing joints. They do not require a sealing compound.

Parallel lengths of oxygen and acetylene hose that are taped together to prevent tangling should not have more than 4 of the 8 inches covered by the tape. Use approved hose reels. If using metal reinforced hose, do not expose the metal to the inside gas or outside atmosphere. A metal-covered hose would add extra hazards if accidental bursting pressure built up in the line.

If a hose has been used for one gas, never use it for another. Oxygen passing through a hose used for acetylene, for example, might form a combustible mixture. Never use pneumatic air hose or fittings. Always keep hoses and regulators away from grease and oil.

A red hose is normally used for acetylene, and a green or black hose identifies the oxygen line. Before using a new hose, blow it out with oxygen, never acetylene. The inside of a new hose is dusted with fine talc. Avoid excessive lengths of hose because they can cause a drop in pressure at the apparatus.

Check the torch

Correct leakage around torch valve stems by repackaging with the packing supplied by the manufacturer. **DO NOT USE OIL.**

Clean clogged tips with the proper size cleaning tool, drill, or copper or brass wire. Never use a sharp, hard tool that could enlarge the orifice. **CLEAN FROM THE LARGER END.**

Take apart a defective shut-off valve and clean it thoroughly. Insert new parts if necessary for proper and safe seating.

Job location safety check

After determining that the equipment is in safe condition, check the safety of the job location.

The job location for production-line welding is of minimum concern because it is stationary. The major concern of this section is to present safety precautions and suggestions for nonproduction line welding activities, whether electric arc, resistance or oxyacetylene.

In addition to specifically engineered welding safeguards, a general safety check of mechanical hazards is necessary wherever performing production-line welding. Safeguard all moving parts of production-line machinery and properly insulate current carrying parts. Also, guard or screen any exposed gears, shafts or clutches that provide power to the machine.

Welding fire hazards

Someone who is familiar with the fire hazards of welding should inspect the work area to determine the necessary fire performing steps. One specific location is suggested for all welding operations. You can use these general suggestions for guidance when setting up fire safeguards.

- Before welding at a new location, check with the supervisor in that area to learn fire hazards and obtain permission to do the job. If the work area is not a specific welding or cutting area, a hot work permit must be obtained from the departmental manager.
- Do not use welding equipment near sparks, open flames, flammable vapors, liquids, dust or any other combustible materials.
- Move welding work to a safe location whenever possible, or try to remove all movable combustibles to a safe place. If neither is possible, use sparkproof curtains (not tarpaulins) to confine the sparks. Weight the fireproof curtain down tightly against the floor.

An extra person is recommended as a fire guard if ignition of material is possible. Maintain a 30-minute watch after completing welding.

Concrete floors are the safest in welding locations. Make wood floors fire-safe by covering them with a fireproof cloth.

Where there are openings in the floor or walls that you cannot cover, keep combustible materials away because welding sparks may fly through the openings.

Sparks can fly 25 feet or more and hold their heat for several seconds after landing. Always protect all wooden construction — beams, partitions and flooring — from the heat of welding.

You must keep sprinkler systems in good working order. If you must shut down the sprinkler system temporarily, do not perform welding.

When welding close to automatic sprinkler heads, shield the heads with damp cloth or spark-proof sheets.

Keep work areas clear of waste paper, paint residue, oily waste, soiled rags, excelsior wrapping, wood chips and other combustible refuse.

Welding ventilation hazards

When checking for sufficient ventilation in a welding area, consider:

- The size of the room, particularly the ceiling height;
- The number of workers in the area;
- The possibility of fumes, gases or dust resulting from the operation.

An exhaust fan in an exterior wall of the welding room is not the complete answer. Too often, the fan only removes the contaminated air after the worker inhaled and exhaled it.

One of the most effective methods of ventilation is to have a flanged duct opening within approximately 6 inches of the arc or torch. "Fume suckers" or exhaust ducts with flexible tubing extensions can be placed at the actual point of the welding operation to assure proper ventilation. Fire and glare screening should never restrict the air flow. The heating system should not interfere with the natural or mechanical exhausting of welding fumes.

General ventilation precautions

Mechanical ventilation must supplement natural air ventilation if any of the following conditions exist: the ceiling is less than 16-feet high; there is less than 10,000-cubic feet per welder; or the welding space is confined, or cross ventilation is obstructed by balconies, partitions or other structural barriers. Avoid strong drafts across the welding work.

If mechanical ventilation is not required, the recommended cubic feet of air per minute required for each welder varies, depending upon the size of rod, toxicity, number of welders in an area and obstruction to the natural air flow.

Where using mechanical ventilation, provide an adequate source of replacement air, free from contamination. In areas where employees are performing inert-gas welding, ventilation should not be powerful enough to affect the gas shield around the arc.

Provide a portable hood so workers can move freely into position, as close to the work as practical. This type of equipment should remove air from the welding zone at a flow rate equivalent to a velocity of 100-linear feet per minute when the hood is at the farthest point from the welding operation.

The exhaust booth, with a top and at least two sides, should shield the welding operation and have an exhaust air flow equivalent to at least 50-linear feet per minute.

Confined spaces may require the use of a respirator.

Protect welders and others nearby from toxic materials and possible oxygen deficiency hazards in confined areas. All incoming air should be clean; or for even greater protection, use air-supplied respirators.

Station a worker outside of the confined area to service the power and ventilation lines. For example, if the oxyacetylene welder is working inside a boiler, always leave the gas cylinders outside with a helper. Use a hose to deliver the gas to where the work is being performed. Never use oxygen to ventilate a confined space. It accelerates combustion and can cause clothing to ignite and burn.

Special metals and special fume hazards

Welding certain metals presents certain health hazards. Provide and have employees use proper respirators or air-supplied masks.

Lead fumes and dust demand the protection of an air-supplied respirator, even when working outdoors. Because of the presence of oil fumes and the need for special traps and filters to provide restorable air, an ordinary compressed air line may be dangerous to use as the source of air.

Use an air-supplied respirator when welding metals are coated with beryllium, cadmium, mercury or other hazardous compounds.

When welding brass, bronze or zinc-coated surfaces in a fairly open area, a stream of air may be sufficient ventilation.

In confined spaces, use air-supplied masks. Respirators and air-supplied masks should conform to the standards established by the U.S. Bureau of Mines.

Inert arc (heliarc) welding presents a special hazard because the arc is engulfed in an atmosphere of argon or carbon dioxide. The heat is intense and is accompanied by strong visible and invisible ultraviolet radiation.

The combination of the arc and artificial atmosphere may generate oxides of nitrogen or ozone with metal fumes, which may cause discomfort or possible illness to the welder. For safety, provide a good flow of air moving away from the welder and the arc.

Underground and other problem locations

When welding in mines or caissons, do not use acetylene generators or hydraulic seals because it is difficult to vent them. Use approved flash arresters between acetylene regulators and valves. Test for leaks frequently. Protect mine timber from sparks, and shield the hose and cylinders. Before beginning welding operations in extremely dusty or grassy locations, take proper precautions to prevent explosion or fire.

Metal cleaning compounds increase hazards

A toxic gas, phosgene, is formed when the ultraviolet rays of an electrical arc come in contact with chlorinated degreasing solvents.

Do not use any metal that you have degreased until the solvent has completely evaporated.

Do not weld near degreasing tanks.

Store and use chlorinated solvents in a room separated from the welding operation to keep vapors from reaching or being drawn into the air surrounding the welding operation.

Electrical shock hazards

Moisture around electrical welding operations is dangerous. Dampness can damage equipment and cause harmful shocks to the welder. Do not begin

an electric welding operation if the floor or the equipment is wet or damp.

Make sure your hands are dry before touching an electrical switch.

Double-check to make sure the power is off before adjusting an electrical welding apparatus. Never replace fuses, electrodes, holders, welding wire or wire reels when the current is on. Never touch uninsulated wires unless you are absolutely certain the power is off.

When welding above ground level, a mild electrical shock can involuntarily contract the muscles and cause a serious fall. Use safeguards to prevent falls.

It's potentially dangerous to use cables with splices or repaired insulation within 10 feet of the electrode holder.

Electrically ground stationary acetylene generators and stationary acetylene manifolds for safety.

Whatever the location of the arc welding operation, follow these precautions to prevent electrical shock:

- Perspiring increases the danger of shock. Never permit any part of the electrode holder to touch bare skin or wet clothing;
- When changing electrodes, never stand on wet or grounded surfaces; never use bare hands or wet gloves;
- Ground the frame of portable and stationary welding machines as specified in the Grounding Section of the National Electrical Code;
- Approved plugs and receptacles are recommended for cables of portable welding machines capable of carrying full-load machine circuits;
- Keep welding supply cables away from power supply cables and other high tension wires;
- If the work lead or electrode lead becomes worn and the conductor is exposed during operation, cover the exposed area immediately with rubber or friction tape. Replace the cable as soon as possible;
- All operating procedures are covered in the Electrical Welding Section of the National Electrical Code.

Arc welding work habits

The first step toward arc welding safety is to make sure all electrical connections are properly made. Check the magnetic work clamps; they should be free of metal particles on the contact surfaces. The work lead must be firmly attached to the work. Spread out the welding cable to prevent overheating and insulation deterioration. Check the grounding of the machine; be extra careful if the machine is portable.

Look for cooling water, engine fuel or shield gas leaks. Then, follow the manufacturer's instructions for machine use.

Before stopping or leaving the work for a period of time, or before moving the welding machine, open the current supply switch. Disconnect the equipment when it is not in use.

How to avoid arc burns

Arc burns caused by current passing through a grounded cylinder occur quickly. To prevent arc burns, keep the torch, arc and source of current away from compressed gas cylinders. Follow these suggestions:

- Never strike an arc on a cylinder;
- Insulate argon cylinders and others that must remain in the area from the building structure to which they are secured. This prevents accidental arcing from grounding of the electrode on the cylinder. Keep cylinders away from work tables, too;
- Ground connections should never touch cylinders;
- Never hang welding torches on the flow meters;
- Keep empty cylinders out of the work area;
- Replace all frayed electrical wiring.

Never coil or loop electrode cable around your body.

When metal and carbon electrodes are not in use, remove them from the holders to prevent contact with persons or conducting objects.

Remove or retract tungsten electrodes into the holder. Also retract or cut off wire electrodes to eliminate the danger of contact.

Place electrode holders that are not in use on a dry, non-conducting surface away from employees, fuel, tanks and electrical conducting materials.

In manual shield metal arc welding, use only electrode holders with well-insulated jaws that are in good condition. Never cool holders by immersing them in water.

Always turn off the welding machine that supplies power to the arc before changing electrodes in tungsten-arc electrode holders. Take the same precautions before threading coiled electrodes into consumable electrode equipment.

Oxygen and fuel gas welding

Always use the proper gas pressure, as recommended by the manufacturer. Do not work with acetylene gas at more than 15 psi pressure. Excessive pressure scatters sparks needlessly, causes faulty torch operation, and can possibly lead to backfires and flashbacks that may damage the hose. Use flashback arresters for all oxygen and fuel gas operations. The flash-back arrester will prevent the back flow of gases and/or ignition sources.

Keep oil and grease away from oxygen under pressure because it may react violently on contact. Oxygen tank fittings do not need lubrication; do not apply oil or grease under any circumstances. Be sure your hands, gloves and clothes are free of oil and grease before handling the cylinders or valves.

Open gas cylinders slowly and stand to either side of the pressure regulator gauge face. Do not try to transfer any gas from one cylinder to another or mix gases in one cylinder.

Do not use electromagnetic equipment to lift oxygen or acetylene cylinders. Use a cradle, not a sling, when lifting them by crane or derrick.

Keep cylinders away from radiated heat, direct sun rays, sparks, misdirected torch flames and the path of shop trucks. Always anchor tanks securely. Maintain a clear space between the cylinders and the work to assure quick access to pressure regulators. Never use cylinders to support work.

Never use a wrench or similar tool to open oxygen tanks. If it is impossible to open a cylinder by hand, call the supplier.

To open acetylene tanks, use the special T-wrench and leave it in place for emergency closing. Never tamper with fuse plugs.

Never use the recessed tops of acetylene tanks as a resting place for tools; if the tops are filled with water, the fuse plugs no longer offer protection.

Choose the right regulator

Be careful to connect oxygen pressure-reducing regulators to oxygen cylinders and combustible pressure-reducing regulators to acetylene tanks. Check to make sure that threads on regulators and valve outlets match. Never force connections that do not fit.

It's dangerous to hang blowpipes and hoses on regulators or valves. The weight may damage the regulator and interfere with the fast closing of the valve.

If you stop work for 15 minutes or more, disconnect the torch, place it in the tool box and release the pressure in the regulator to prevent the release of gases.

Before attaching a regulator to a cylinder valve, crack the valve. Cracking clears the valve of dust or dirt that could possibly damage the regulator.

Never crack hydrogen cylinders. Never crack a fuel gas cylinder near welding work, sparks, flame or other sources of ignition.

When detaching a regulator, close the cylinder valve, open the blowpipe valve, turn out the pressure adjustment screw, close the blowpipe valve and uncouple the regulator. Before removing the regulator, always release the gas from the regulator and close the cylinder valve.

If leakage occurs, remove fuel gas cylinders from use immediately. Keep these tanks away from any possible source of ignition, tag them and notify the supplier.

If acetylene is supplied by a piping system, never try to operate the torch until the supply is turned on. This precaution prevents an air-acetylene mixture from forming, which can lead to poor blowpipe operation and even serious flashback.

Keep the gas supply hose away from traffic; avoid tangles and kinks. When a hose is tripped over, connections could be pulled apart, or cylinders or equipment could be pulled over. Always keep the hose away from deteriorating oil or grease, flying sparks, flames and hot objects.

In some cases, on construction jobs, it may be more practical to use a longer hose rather than hoist cylinders and anchor it to structural work.

Inspect the hose frequently for leaks and wear. Check connections at the same time.

If a flashback occurs and burns a hose, remove and throw away the burned section.

Lighting the torch

Follow the equipment manufacturer's instructions for the sequence of operations in lighting, adjusting and extinguishing the torch flame, and connecting the apparatus to the gas supply. Procedures vary with different makes of equipment. Use a spark lighter to ignite the torch flame; matches are unsafe.

When you change torches, shut off the regulator. Kinking the hose damages the hose lining and creates a hazard. Always use a torch wrench on the torch nut; never use pliers. Keep oil and grease away from torches.

Use a tip cleaner to clean the welding tip. Makeshift tools can cause costly damage. Remember, cold tips and hot torches don't mix. Don't interchange tips with those of other torches. To dislodge foreign matter from the orifice, use wood block or leather. Do not scrape or knock the tip on an abrasive surface.

Welding of closed containers

Make sure you clean thoroughly welding containers that have held flammable liquids. Follow the procedures suggested by the American Welding Society in the booklet *Safe Practices for Welding and Cutting Containers That Have Held Combustibles*.

Steam is generally recommended to remove materials that easily evaporate. Alkaline cleaner can remove heavy oils. We do not recommend the use of chlorinated solvents because these solvents give off toxic vapors when heated.

After cleaning thoroughly the drum, tank, barrel or other container, it is wise to fill it with water. Vent it to permit release of hot air and vapors. Carbon dioxide or nitrogen gas are good substitutes for water. Be sure the gas is always in a sufficient concentration to prevent the occurrence of an explosive or flammable mixture.

Never use carbon tetrachloride; it gives off poisonous vapors.

Check any object that is suspiciously light for hollow spaces. Internal pressure may cause that part of the container to act like a bomb. Always vent the confined air before doing hot work.

General safe practices

Do not drop welding rod stubs on the floor. Place them in a suitable container to prevent fires and serious falls.

Remove or fasten bronze bushings before heating iron castings. Because of the greater expansion rate, the bushing may fly out, creating a hazard and damaging the part.

Protective clothing and equipment

The type of welding and the surrounding circumstances dictate to a great extent the kind of protective clothing that the welding operator should wear.

- All welders should wear fire-retardant gauntlet gloves.
- Fire-retardant aprons of leather, or other suitable materials, provide additional protection against sparks, spatter and radiated heat.

- All welders should wear high, snug-fitting safety shoes; low or loose-fitting shoes may catch hot spatter.
- Wear safety glasses with side shields under your helmet when arc welding.
- Woolen clothing is recommended rather than cotton. Wool offers more protection against temperature changes and is not as easily ignited. However, you can treat cotton chemically to reduce flammability. Outer clothing should be as oil-free and grease-free as possible.
- Wear cuffless pants and overalls without pockets; to prevent sparks from lodging in clothing, aprons also should not have pockets. Button sleeves and collars.
- Very heavy work demands fire-resistant leggings, high boots or similar protection.
- We suggest leather capes or shoulder covers for overhead work. Wearing leather skull caps under helmets prevent head burns. Wood or rubber ear plugs or wire screen protectors are sometimes required for overhead work.
- If there is a danger of falling objects, hard hats are required.

Store protective clothing and equipment in a clean, dry, well-ventilated place when not in use. All individuals who are in a welding area should wear eye protection.

The electric welding arc sends out intense visible rays, as well as infrared and ultraviolet rays. The rays or even the reflection of the rays can burn the skin much like strong sunlight. But the harm they can do to the eyes is far more serious. As a precaution against direct or indirect exposure, cover all skin surfaces and use proper eye protection. Use the correct lens shade number in the helmet. Under certain circumstances, employees should wear eye protection under the helmets. Resistance welders should wear transparent face shields or goggles.

Protect persons near arc welding areas from the arc welding rays; use non-combustible screens or have the individuals wear proper goggles.

Workers should not use helmets or goggles that have been worn by another employee, unless the equipment has been sterilized. Carefully select and handle helmets and goggles. Safety lenses in all goggles and helmets used by welders must pass the test for transmission or radiant energy prescribed in ANSI Z97.1.

When performing light welding work or inspections, spectacles with proper lenses are sometimes acceptable. Lenses designed for eye protection during oxyacetylene welding or cutting do not provide dependable protection against electrical arc rays.

You also can apply the suggestions and recommendations in this booklet to electrical arc and oxyacetylene cutting operations. Because welding and cutting present the same basic hazards, we suggest you make the same basic safety checks on cutting equipment, cutting sites, operating practices and personal protective equipment.

More detailed information is available in the American Welding Society publications *Safety in Welding and Cutting and Recommended Safe Practices for Inert-Gas Shielded Arc Welding*.