

SAFETY CODE FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	GAS CUTTING & GAS WELDING	Doc. No: SC/07
		Rev no. : 00 Effective Date : --

1. OBJECTIVE

Objective of this safety code is to provide guidelines to prevent working person and surrounding from the hazards like fire, explosion, burn and fumes of un-burnt gases while performing gas cutting or heating by gas and gas welding jobs.

2. SCOPE

- 2.1 This Safety Code provides safety guidelines in carrying out gas cutting or heating by gas and gas welding work at site while taking up fabrication, maintenance and manufacturing jobs in iron & steel industry.
- 2.2 The scope does not cover arc welding work.

3 PROCEDURE

- 3.1 The activity of gas cutting or heating by gas and gas welding work involves following preliminary actions to avoid accidents:

- i. Checking / cleaning transportation of gas cutting set or unit and all other equipment concerned.
- ii. Fixing of gas cutting set.
- iii. Checking of leakage from different fittings.
- iv. PPEs needed to carry out job.
- v. Precautions to be taken during back fire.
- vi. Dismantling of set
- vii. Work permission by site In-charge/Section in-charge before start of the work.
- viii. Ascertaining qualification/training of gas cutter
- ix. Joining of hoses.
- x. Fire fighting arrangements.
- xi. After completion of the job, the cylinders, hose pipe, torch, cables, spatters, etc. are to be properly removed and kept at designated place. Area to be cleaned and waste matter removed.
- xii. Being a routine and hazardous job SMP for the same needs to be enforced.

3.1.1 General Requirements

- i. The procedure has to be implemented by all departmental Heads with the help of their authorized representative at work place and is also applicable to Contractor's employees.
- ii. Work permit shall be issued to working agency before start of gas cutting/welding, by the authorized person of the department
- iii. If the gas cutting/welding job is to be carried out at height (more than 2 meters) from ground level/in confined space/gaseous hazardous area/near electrical installation, separate entry permit/work permit should be obtained from authorized agency.

Falling of spatters from height must be prevented. For this a metal trough should be used and spatters should be collected in a trough at the point of generation. Moist ceramic cloth may also be used wherever required. In case of problem in preventing of all the spatters falling down at the area below the site of hot work the area has to be barricaded. No cylinders should be kept in the barricaded area. Proper covering of the knob, valves etc of the cylinders adjacent to the barricading, must be ensured.

- iv. After completion of the job, the cylinders, hose pipe, torch, cables, spatters, etc. are to be properly removed and kept at designated place. Area to be cleaned and waste matter removed.
- v. After completion of the job, the work permit shall be returned by working agency and the receiving authority of owner department shall enter the form in the original along with the white copy.
- vi. Always use seamless tubing for connections with cylinder. All cracked hoses are to be scraped and removed from the site.
- vii. Test the area for flammables before welding and cutting when the atmosphere is vulnerable to such hazards.

3.2 TERMINOLOGY

3.2.1 For the purpose of safety code, the definitions given in IS 818 shall apply, besides the definition given under 3.11.

3.2.2 Confined space – A small or restricted space, such as a tank, boiler, pressure vessel or small compartment of a ship.

3.3 FIRE PREVENTION AND PROTECTION

- i. All gas cylinders should be kept with safety protective caps when not in use.
- ii. It should be ensured that before starting the job surrounding area of the work side should be made free of fire hazard.
- iii. Employees engaged on working, cutting or heating by gas and gas welding work/ other hot jobs should be trained and capable to use fire equipments in case of any fire emergency.
- iv. Adequate fire fighting provision to be made available close to each area of cutting and other hot job.
- v. Emergency telephone number should be made available and displayed at work site by concerning agencies.
- vi. Objects to be cut or heated/ welded shall be moved to a designated safe location or, if the objects to be cut, or heated cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place, or otherwise protected.
- vii. If the object to be cut or heated/ welded cannot be moved and if all the fire hazards cannot be removed, positive means shall be taken to confine the heat and slag, and to protect the immovable fire hazards from them.
- viii. No cutting or heating/ welding shall be done where the application of flammable paints or the presence of other flammable compounds, or heavy dust concentrations creates a hazard.
- ix. Suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use.

- x. When the cutting or heating/ welding operation is such that normal fire prevention precautions are not sufficient, additional personnel shall be assigned to guard against fire while the actual cutting, or heating operation is being performed, and for a sufficient period of time after completion of the work to ensure that no possibility of fire exists. Such personnel shall be instructed as to the specific anticipated fire hazards and how the firefighting equipment provided is to be used.
- xi. When cutting or heating/ welding is performed on walls, floors, and ceilings, since direct penetration of heat transfer may introduce a fire hazard to an adjacent area, the same precautions shall be taken on the opposite side as are taken on the side on which the welding is being performed.
- xii. For the elimination of possible fire in enclosed spaces as a result of gas escaping through leaking or improperly closed torch valves, the gas supply to the torch shall be positively shut off at some point outside the enclosed space whenever the torch is not to be used or whenever the torch is left unattended for a substantial period of time, such as during the lunch period. Overnight and at the change of shifts, the torch and hose shall be removed from the confined space. Open end fuel gas and oxygen hoses shall be immediately removed from enclosed spaces when they are disconnected from the torch or other gas-consuming device. In no case a gas cutting torch should be kept in gas release condition when not in use.
- xiii. Except when the contents are being removed or transferred, drums, pails, and other containers, which contain or have contained flammable liquids, shall be kept closed. Empty containers shall be removed to a safe area apart from hot work operations or open flames.
- xiv. Drums, containers, or hollow structures which contains toxic or flammable substances shall, before cutting, or heating is undertaken on them, either be filled with water or thoroughly cleaned of such substances and ventilated and tested.
- xv. Before heat is applied to a drum, container, or hollow structure, a vent or opening shall be provided for the release of any built-up pressure during the application of heat.
- xvi. Flash back arrester is to be provided in oxygen and fuel line at both ends.

3.4 **EXECUTION**

The following points shall be strictly adhered to, while carrying out gas cutting or heating/ welding job:

3.4.1 **Preparation**

- i. Gas cutting set shall be properly cleaned / checked and kept in a special trolley for transportation.
- ii. Nozzle shall be used as per job specification.
- iii. Nozzle shall be cleaned by proper method. Before using it, ensure that the hoses are clear (no jamming is there).
- iv. Clamps shall be used for joining hoses whenever required.
- v. Ensure non-return valve on Dissolved Acetylene (DA) cylinders.
- vi. Ensure proper fire fighting arrangements at work place where job is to be carried out.

- vii. Opening key must be hung on DA cylinder all the time during work.
- viii. DA cylinder shall be in vertical and Oxygen cylinder shall be in horizontal position during work, with proper fixing arrangement.
- ix. Provision of flash back arrestor as per IS : 11006-1984 (Specification of flashback arrestor / flame arrestor) shall be ensured in the welding / gas cutting sets on the oxygen and fuel gas line in the regulator as well as nozzle side to avoid flashback.
- x. LPG / BCG Cylinders should not be exposed to heat.
- xi. Wet gunny bags may be used along the LPG cylinder,
- xii. All cylinders shall be stored at a safe distance, of not less than 10 metre from all operations which result in excessive heat.

3.4.2 Work Place Inspection

- i. Moving machinery near work vicinity.
 - a) Proper shutdown shall be taken before carrying out job in such areas.
- ii. Gas prone area
 - a) All gas lines are to be inspected and proper precaution shall be taken. Proper shut down shall be taken before carrying out the job.
 - b) Air sampling shall be done before start of the work and at regular intervals.
 - c) Proper fire fighting arrangement must be made before start of the work.
- iii. Oily / Grease area
 - a) Area shall be cleaned by proper method & or shall be covered by non-combustible material before start of the work.

3.4.3 Execution in Specific Area

- i. Cutting/ Welding Jobs at Height: Safety code for working at height shall be applicable.
- ii. Cutting/ Welding Job in Confined Space: Safety Code for Working in Confined Spaces shall be followed.
- iii. Cutting Job For Dismantling Of Old/Existing Structure
 - a) Structure which has to be cut shall be tied with wire rope and care has to be taken that no one is just above the cut point to avoid swing, after cutting job is over. Use of manila rope is strictly prohibited.
 - b) Cutting job shall be carried out in presence of experienced personnel/supervisor/site incharge.

3.4.4 Transporting, moving, and storing compressed gas cylinders

- i. Valve protection caps shall be in place and secured.
- ii. When cylinders are hoisted, they shall be secured on a cradle, sling board, or pallet. They shall not be hoisted or transported by means of magnets or choker slings.
- iii. Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck, or permitted to strike each other violently.

- iv. When cylinders are transported by powered vehicles, they shall be secured in a vertical position.
- v. Valve protection caps shall not be used for lifting cylinders from one vertical position to another
- vi. Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved.
- vii. A suitable cylinder trolley, chain, or other steadying device shall be used to keep cylinders from being knocked over while in use. Such cylinders are not considered to be "in storage."
- viii. When a job is finished, when cylinders are empty or when cylinders are moved at any time, the cylinder valve shall be closed.
- ix. Compressed gas cylinders shall be secured in an upright position at all times except, if necessary, for short periods of time while cylinders are actually being hoisted or carried.
- x. Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of 3.0 m.

3.4.5 Placing cylinders

- i. Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them. When this is impractical, fire resistant shields shall be provided.
- ii. Cylinders shall be placed where they cannot become part of an electrical circuit. Electrodes shall not be struck against a cylinder to strike an arc.
- iii. Fuel gas cylinders shall be placed with valve end up whenever they are in use. They shall not be placed in a location where they would be subject to open flame, hot metal, or other sources of artificial heat.
- iv. Cylinders containing oxygen or acetylene or other fuel gas shall not be taken into confined spaces.

3.4.6 Treatment of cylinders

- i. Cylinders, whether full or empty, shall not be used as rollers or supports.
- ii. No person other than the gas supplier shall attempt to mix gases in a cylinder. No one except the owner of the cylinder or person authorized by the owner, shall refill a cylinder. No one shall use a cylinder's contents for purposes other than those intended by the supplier.
- iii. No damaged or defective cylinder shall be used.

3.4.7 Use of fuel gas

The employer shall thoroughly instruct employees in the safe use of fuel gas, as follows:

- i. Before a regulator to a cylinder valve is connected, the valve shall be opened slightly and closed immediately. (This action is generally termed "cracking" and is intended to clear the valve of dust or dirt that might otherwise enter the regulator.) The person cracking the valve shall stand to one side of the outlet, not in front of it. The valve of a fuel gas cylinder shall not be cracked where the gas would reach welding work, sparks, flame, or other possible sources of ignition.

- ii. The cylinder valve shall always be opened slowly to prevent damage to the regulator. For quick closing, valves on fuel gas cylinders shall not be opened more than 1-1/2 turns. When a special wrench is required, it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel gas flow can be shut off quickly in case of an emergency. In the case of manifold or coupled cylinders, at least one such wrench shall always be available for immediate use. Nothing shall be placed on top of a fuel gas cylinder, when in use, which may damage the safety device or interfere with the quick closing of the valve.
- iii. Fuel gas shall not be used from cylinders through torches or other devices which are equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.
- iv. Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.
- v. If on opening a fuel gas cylinder, leak is detected around the valve stem, the valve shall be closed and gland nut to be tightened. If this action does not stop the leak, the use of the cylinder shall be discontinued, and it shall be properly tagged and removed from the work area. In the event that fuel gas should leak from the cylinder valve, rather than from the valve stem, and the gas cannot be shut off, the cylinder shall be properly tagged and removed from the work area. If a regulator attached to a cylinder valve effectively stops a leak through the valve seat, the cylinder need not be removed from the work area
- vi. The cylinder valve shall always be opened slowly to prevent damage to the regulator. For quick closing, valves on fuel gas cylinders shall not be opened more than 1-1/2 turns. When a special wrench is required, it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel gas flow can be shut off quickly in case of an emergency. In the case of manifold or coupled cylinders, at least one such wrench shall always be available for immediate use. Nothing shall be placed on top of a fuel gas cylinder, when in use, which may damage the safety device or interfere with the quick closing of the valve.
- vii. Fuel gas shall not be used from cylinders through torches or other devices which are equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.
- viii. Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.
- ix. If on opening a fuel gas cylinder, leak is detected around the valve stem, the valve shall be closed and gland nut to be tightened. If this action does not stop the leak, the use of the cylinder shall be discontinued, and it shall be properly tagged and removed from the work area. In the event that fuel gas should leak from the cylinder valve, rather than from the valve stem, and the gas cannot be shut off, the cylinder shall be properly tagged and removed from the work area. If a regulator attached to a cylinder valve effectively stops a leak through the valve seat, the cylinder need not be removed from the work area

3.4.8 Fuel gas and oxygen manifolds

- i. Fuel gas and oxygen manifolds shall bear the name of the substance they contain in letters at least 1-inch high which shall be either painted on the manifold or on a sign permanently attached to it.
- ii. Fuel gas and oxygen manifolds shall be placed in safe, well ventilated, and accessible locations. They shall not be located within non ventilated spaces.
- iii. Manifold hose connections, including both ends of the supply hose that lead to the manifold, shall be such that the hose cannot be interchanged between fuel gas and oxygen manifolds and supply header connections. Adapters shall not be used to permit the interchange of hose. Hose connections shall be kept free of grease and oil.
- iv. When not in use, manifold and header hose connections shall be capped.
- v. Nothing shall be placed on top of a manifold, when in use, which will damage the manifold or interfere with the quick closing of the valves.

3.4.9 Hose

- i. Fuel gas hose and oxygen hose shall be easily distinguishable from each other. The contrast should be made by different colors (Red for LPG/DA and black for Oxygen) Oxygen and fuel gas hoses shall not be interchangeable. A single hose having more than one gas passage shall not be used.
- ii. All hose in use, carrying acetylene, oxygen, natural or manufactured fuel gas, or any gas or substance which may ignite or enter into combustion, or be in any way harmful to employees, shall be inspected at the beginning of each working shift. Defective hose shall be removed from service.
- iii. Hose which has been subject to flashback, or which shows evidence of severe wear or damage, shall be tested to twice the normal pressure to which it is subject, but in no case less than 300 psi. Defective hose, or hose in doubtful condition, shall not be used and be removed from site.
- iv. Hose couplings shall be of the type that cannot be unlocked or disconnected (Use Jubilee clamp) by means of a straight pull without rotary motion.
- v. Boxes used for the storage of gas hose shall be ventilated.
- vi. Hoses, cables, and other equipment shall be kept clear of passageways, ladders and stairs.
- vii. Gas hoses and cable should not be allowed to touch each other and must have a minimum distance of 250mm between them, so that any heat or spark from the cable should not cause any fire in the gas hose.

3.4.10 Torches

- i. Clogged torch tip openings shall be cleaned with suitable cleaning wires, drills, or other devices designed for such purpose.
- ii. Torches in use shall be inspected at the beginning of each working shift for leaking shutoff valves, hose couplings, and tip connections. Defective torches shall not be used and be removed from site.
- iii. Torches shall be lighted by friction lighters or other approved devices, and not by matches or from hot work.
- iv. Nozzle mixing cutting torches shall be used

3.4.11 Regulators and gauges

Oxygen and fuel gas pressure regulators, including their related gauges, shall be in proper working order while in use.

3.4.12 Oil and grease hazards

Oxygen cylinders and fittings shall be kept away from oil or grease. Cylinders, cylinder caps and valves, couplings, regulators, hose, and apparatus shall be kept free from oil or greasy substances and shall not be handled with oily hands or gloves. Oxygen shall not be directed at oily surfaces, greasy clothes, or within a fuel oil or other storage tank or vessel.

3.5 Protective clothing

3.5.1 General requirements

Employees exposed to the hazards created by cutting or brazing or heating/welding operation shall be protected by personal protective equipment in accordance with the requirements. Appropriate protective clothing required for any welding operation will vary with the size, nature and location of the work to be performed.

3.5.2 Specified protective clothing. Protective means which may be employed are as follows:

- i. Except when engaged in light work, all welders should wear flameproof gauntlet gloves. The welding gloves should be dry and free from holes and grease.
- ii. Flameproof aprons made of leather, or other suitable material may also be desirable as protection against radiated heat and sparks.
- iii. Cotton clothing should be used while performing any gas cutting/welding. Outer clothing such as jumpers or overalls should be reasonably free from oil or grease.
- iv. Sparks may lodge in rolled-up sleeves or pockets of clothing, or cuffs of overalls or trousers. It is therefore recommended that sleeves and collars be kept buttoned and pockets be eliminated from the front of overalls and aprons. Trousers or overalls should not be turned up on the outside.

Note: For heavy work, fire-resistant leggings, high boots, or other equivalent means should be used.

- v. In protection work a sheet metal screen in front of the worker's legs can provide further protection against sparks and molten metal in cutting operations.
- vi. Shoulder covers made of leather or other suitable materials should be worn during overhead welding or cutting operations. Leather skullcaps may be worn under helmets to prevent head burns.

3.6 Ventilation and Protection in Cutting or Heating/ Welding

3.6.1 Mechanical ventilation. For purposes of this section, mechanical ventilation shall meet the following requirements:

- i. Mechanical ventilation shall consist of either general mechanical ventilation systems or local exhaust systems.

General mechanical ventilation shall be of sufficient capacity and so arranged as to produce the number of air changes necessary to maintain welding fumes and smoke within safe limits.

- ii. Local exhaust ventilation shall consist of freely movable hoods intended to be placed by the welder or burner as close as practicable to the work. This system shall be of sufficient capacity and so arranged as to remove fumes and smoke at the source and keep the concentration of them in the breathing zone within safe limits.
- iii. Contaminated air exhausted from a working space shall be discharged into the open air or otherwise clear of the source of intake air.
- iv. All air replacing that withdrawn shall be clean and respirable.
- v. Oxygen shall not be used for ventilation purposes, comfort cooling, blowing dust from clothing, or for cleaning the work area.

3.6.2 Cutting or Heating/ Welding in Confined Spaces

- i. Either general mechanical or local exhaust ventilation meeting the requirements of clause 3.5.1 shall be provided whenever welding, cutting, or heating is performed in a confined space.
- ii. When sufficient ventilation cannot be obtained without blocking the means of access, employees in the confined space shall be protected by air line respirators , and an employee on the outside of such a confined space shall be assigned to maintain communication with those working within it and to aid them in an emergency.

3.6.3 Cutting or Heating/ Welding of metals of toxic significance

- i. Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subsection shall be performed with either general mechanical or local exhaust ventilation meeting the requirements of clause 3.6.1:
 - a. Zinc-bearing base or filler metals or metals coated with zinc-bearing materials.
 - b. Lead base metals
 - c. Cadmium-bearing filler materials
 - d. Chromium-bearing metals or metals coated with chromium-bearing materials
- ii. Welding, cutting, or heating in any enclosed spaces involving the metals specified in this subdivision shall be performed with local exhaust ventilation in accordance with the requirements of clause 3.6.1, or employees shall be protected by air line respirators:
 - a. Metals containing lead, other than as an impurity, or metals coated with lead-bearing materials;
 - b. Cadmium-bearing or cadmium-coated base metals;
 - c. Metals coated with mercury-bearing metals;
 - d. Beryllium-containing base or filler metals. Because of its high toxicity, work involving beryllium shall be done with both local exhaust ventilation and air line respirators
- iii. Employees performing such operations in the open air shall be protected by filter-type respirators. Except that employees performing such operations on beryllium-containing base or filler metals shall be protected by air line respirators.
- iv. Other employees exposed to the same atmosphere as the welders or burners shall be protected in the same manner as the welder or burner.

3.6.4 General Cutting or Heating/ Welding

- i. Welding, cutting, and heating, not involving conditions or materials described in clauses 3.6.2 and 3.6.3 may normally be done without mechanical ventilation or respiratory protective equipment, but where, because of unusual physical or atmospheric conditions, an unsafe accumulation of contaminants exists, suitable mechanical ventilation or respiratory protective equipment shall be provided.
- ii. Employees performing any type of welding, cutting, or heating shall be protected by suitable eye protective equipment.

3.7 Cutting or Heating/ Welding in Way of Preservative Coatings

- 3.7.1 Before welding, cutting, or heating is commenced on any surface covered by a preservative coating whose flammability is not known, a test shall be made by a competent person to determine its flammability. Preservative coatings shall be considered to be highly flammable when scrapings burn with extreme rapidity.
- 3.7.2 Precautions shall be taken to prevent ignition of highly flammable hardened preservative coatings. When coatings are determined to be highly flammable, they shall be stripped from the area to be heated to prevent ignition.
- 3.7.3 Protection against toxic preservative coatings:
 - i. In enclosed spaces, all surfaces covered with toxic preservatives shall be stripped of all toxic coatings for a distance of at least 4 inches from the area of heat application, or the employees shall be protected by air line respirators.
 - ii. In the open air, employees shall be protected by a respirator
- 3.7.4 The preservative coatings shall be removed a sufficient distance from the area to be heated to ensure that the temperature of the un-stripped metal will not be appreciably raised. Artificial cooling of the metal surrounding the heating area may be used to limit the size of the area required to be cleaned.

3.8 Checking, Corrective & Preventive Action

Departmental HOD shall ensure implementation and regular compliance of above procedure through periodic interaction with manager/Operators/Contractors and review of work permits system records. In case of any deviation, corrective and preventive action shall be immediately undertaken.

3.9 PRECAUTION TO BE TAKEN IN CASE OF BACK FIRE

- i. Fold the oxygen pipe tightly.
- ii. Close DA cylinder.
- iii. Allow Oxygen to flow till fire gets extinguished
- iv. Close Oxygen cylinder

3.10 NECESSARY DOCUMENTATION

- i. Work permission from concerned department/site in-charge or site clearance is absolutely necessary before start the of work (Please refer Safety Code for permit to work).
- ii. Check list of Job Safety Analysis for gas cutting job.
- iii. A copy of Safety Code for working at height.
- iv. A copy of Safety Code for working on confined space.
- v. A copy of Safety Code for working on fire prone area.

3.11 RECORD

- i. Concerned Sectional In-charge shall maintain record of work permits for Hot Job for at least one year.
- ii. Record for Incident/Accident is to be maintained at the department and is also available at Safety Department for at least five years
- iii. Ensure if all persons left the place. They are informed not to return / restart work without a fresh permit.
- iv. **Monitoring & Reviewing**

Frequency	Mechanism	Record	Responsibility
Daily	Inspection of work permit issue	Record of work Permit	All Contractors, Consultant Contractors

3.12 **PPE's TO USE:** Gas cutter must wear safety goggles, cotton clothing, long hand gloves on both the hands, full body harness.

3.13 TRAINING & MEDICAL TEST

- i. Medically fit and trained person shall be allowed to carry out gas cutting job.
- ii. Special training must be imparted to individuals.
- iii. Appropriate regular medical test shall be carried out to individuals from time to time.
- iv. Permission from Registered Medical Practitioner shall be taken for individuals to carry out jobs at height [fitness certificate].

3.14 The methods in regard to setting the equipment, lighting the torch, re-lighting the torch, closing the system, guidelines for conducting quarterly tests:

3.14.1 Setting up the Equipment

Adhere to the following steps when setting up oxy-fuel equipment:

- i. Step 1: When not in use, compressed fuel-gas cylinders must be secured in the upright position with cylinder valve protector caps in place. **Reason:** Cylinder valves can easily be knocked off, rapidly releasing the fuel gas and discharging the cylinder.
- ii. Step 2: Before installing a regulator on an oxygen or fuel cylinder, inspect the regulator valves and the cylinder valves for oil or contaminants. Do not use dirty components. Check the cylinder valves for leaks around the valve packing glands. Also check the cylinder valve threads for damage. **Reason:** Oil and grease in the presence of oxygen can cause an explosion. Dirt and foreign matter can prevent the regulator and the cutting equipment from working properly. Loose cylinder valves or fittings allow leaks.
- iii. Step 3: Standing to one side of the valve nozzle, crack the cylinder valves. (If the cylinder must be opened in a confined space, do this carefully.) **Reason:** This technique will blow any dirt out of the nozzle without injuring the operator.
- iv. Step-4: Release the tension on the regulator by adjusting the screw counterclockwise. Attach the regulator to the cylinder. Do not over-tighten the regulator compression nuts at the cylinder valves. **Reason:** This technique prevents damage to the regulator diaphragm and to the

regulator valve seat. Also, this will not give the operator a "full system" of gases before he or she can check the hose and torch. Over-tightening pulls the threads on both the regulator valves and the cylinder valves, eventually causing leaks.

- v. Step-5: Open the oxygen cylinder valve slowly, standing on one side of the regulator and the gauge. **Reason**: This technique limits the risk of explosions and injuries to the operator. These accidents typically occur in the front or the back of the regulator and the gauge.
- vi. Step-6: Fully open the oxygen cylinder valve. **Reason**: The oxygen valve tightly seals when it is fully open or fully closed, but may leak when it is in an intermediate position.
- vii. Step-7: Open the fuel-gas cylinder valve. (Acetylene cylinder valves should not be opened more than 3/4 turn. Other cylinder valves may be opened fully.) **Reason**: The fuel-gas cylinder valve (other than acetylene) tightly seals when it is fully open or fully closed, but it may leak when it is in an intermediate position.
- viii. Step-8: Attach the hose to the regulator. If the hose is new or has been out of service, purge it for five seconds for every 50 feet (15 meters) of hose. **Reason**: Purging removes contaminants from the hose, ensuring that it does not contain an explosive mixture of residual fuel gas and air.
- ix. Step-9: Check the seating surfaces and the O-rings of the torch. Assemble the torch. **Reason**: This technique reduces the risk of leaks that could cause a fire.
- x. Step 10: Check the orifice of the nozzle. If it is blocked, clean it only with a nozzle cleaning tool. Do not rub the cutting or heating tip on any soft material (such as wood) to clean the tip. **Reason**: Cleaning the nozzle removes any obstructions, a prime cause of backfires.

3.14.2 Lighting the Torch

Adhere to the following steps when lighting the torch:

- i. Step-1: Open the fuel-gas valve on the torch. Then set the fuel-gas cylinder regulator to the recommended pressure: not more than 30 psi (205 kPa) for fuel gas, and less than 15 psi (105 kPa) for acetylene. Close the torch fuel-gas supply valve, then the fuel-gas cylinder valve. Watch the regulator pressure gauges. If the pressure drops, check for leaks in the assembly. If the pressure remains constant, reopen the fuel-gas cylinder valve slowly. **Reason**: These techniques set the correct pressure, check for leaks, and purge the line of any explosive gas mixtures.
- ii. Step 2: Open the oxygen valve on the torch. Then set the oxygen cylinder regulator to the recommended pressure per the tip manufacturer's tip chart, but not to exceed 80 psi (550 kPa). Close the torch oxygen supply valve, then the oxygen cylinder valve. Watch the regulator pressure gauges. If the pressure drops, check for leaks in the assembly. If the pressure remains constant, reopen the oxygen cylinder

valve slowly. **Reason:** These techniques set the correct pressure, check for leaks, and purge the lines of explosive gas mixtures.

- iii. Step 3: Open only the torch fuel-gas valve to a high flow rate. Light the torch with an approved spark lighter. **Reason:** A high flow of fuel gas cuts down on smoke. Lighting only fuel gas reduces the risk of flashback.
- iv. Step 4: Reduce the gas flow until the flame starts to smoke. Open the oxygen valve on the torch slowly to get the desired flame. **Reason:** This technique sets the correct flow of fuel gas and oxygen for the torch tip. If less heat is required for heating, welding, or brazing, change the tip. Do not reduce the pressure or the flow of either fuel gas or oxygen.

3.14.3 Re-Lighting the Torch

Adhere to the following steps when re-lighting the torch:

- i. Step -1: Always re-purge the system by opening and re-closing the fuel gas torch valve. **Reason:** This technique removes any explosive mixtures that may have accumulated in the system.
- ii. Step -2: Re-purge the oxygen line by opening and re-closing the oxygen torch valve. **Reason:** This technique removes any explosive mixtures that may have accumulated in the system.
- iii. Step -3: Open only the torch fuel-gas valve to a high flow rate. Light the torch with an approved spark lighter. **Reason:** A high flow of fuel gas cuts down on smoke. Lighting only fuel gas reduces the risk of flashback.
- iv. Step -4: Step 4: Reduce the gas flow until the flame starts to smoke. Open the oxygen valve on the torch slowly to get the desired flame. **Reason:** This technique sets the correct flow of fuel gas and oxygen for the torch tip. If less heat is required for heating, welding, or brazing, change the tip. Do not reduce the pressure or the flow of either fuel gas or oxygen

3.14.4 Closing the System

Adhere to the following steps when closing the system:

- i. Step -1: Close the oxygen valve on the torch first. Then close the fuel-gas valve on the torch. Reason: If the oxygen valve leaks, the system may backfire. If the fuel-gas valve leaks, the flame will not go out. Either situation indicates that the equipment is defective and requires immediate repairs before continuing use.
- ii. Step -2: Close both cylinder valves. Release the hose pressure by opening the torch valves and allowing gas to escape from the system. Reason: This technique prevents leaks and fires. It also prepares the equipment for the next start-up.
- iii. Step -3: Close both regulator valves by releasing the tension on the regulator screw.

- iv. Step -4: When the regulator screw is turned counterclockwise, the valve is closed, and when turned clockwise, the valve is opened. **Reason:** This technique prepares the equipment for the next start-up.

3.14.5 Guidelines for Conducting Quarterly Tests

Use the following guidelines for quarterly testing of specific parts of oxy-fuel equipment.

i. Regulators and Gauges

- a) Visually inspect for damage all components of fuel-gas and oxygen regulators, including the following:
 - compression nipples and nuts
 - filter screens in the inlet nozzles
 - gauges
 - regulator adjusting screws
- b) Attach the fuel-gas and the oxygen regulators to inert gas or oil-free air systems for testing. Use transition test nipples for testing.
- c) Release regulator-adjusting screws counterclockwise. Then open the cylinder valve and verify that the high-pressure gauge is operating properly. If no inert gas or air flows through the regulator when the cylinder valve is opened, the regulator adjustment valve is in good condition and the regulator diaphragm is not damaged.
- d) Block with a valve the outlet nozzle of the regulator using a plug or hose.
- e) Adjust the regulator-adjusting screw clockwise until the low-pressure gauge indicates a normal operating pressure. Use soapy water to inspect the regulator and gauge connections for leaks.
- f) Close the cylinder valve, and watch the gauges for a drop in pressure. A drop in pressure indicates a leak. Reopen the cylinder valve, and check the low-pressure gauge for any slight drop in pressure (needle creep). Gauge needle creep greater than 2 to 3 psi (14 to 20 kPa) indicates that the diaphragm is damaged.

ii. Hoses

- a) Visually inspect each length of hose for burns, worn areas, decay, and other defects. If defects are found those could cause leaks, remove the hose from the system.
- b) Pressurize each length of hose, and run it through a water vat to check for leaks. Use inert gas or oil-free air for this test at a pressure sufficient to indicate leaks, typically between 15 and 80 psi (103 and 550 kPa). Any length of hose that cannot be tested in the water vat must be tested with soapy water. Replace any length of hose that has leaks.

iii. Combination Reverse-Flow Check Valves and Flame Arresters

- a) Visually inspect each check valve/arrester to verify that the inlet nozzle is free of oxidation, burns, and other defects.

- b) Visually inspect each check valve/arrester by using reverse-flow pressure in the outlet nozzle to verify that the check valve is sealing. For this test, either blow through the unit or use inert gas or oil-free air at a pressure between 1 and 10 psi(7 and 70 kPa), sufficient to close the check valve.
- c) Replace, but do not repair, defective check valves/arresters.
- d) Between inspections and tests, if the units have significant backfires or flashbacks, remove the check valve/arrester for additional inspections and tests.

iv. Cutting Torches and Mixing Chambers

- a) Visually inspect for damage to all components of each torch and mixing chamber, including the following:
 - the O-rings on the torch
 - the seating surface in the mixing chamber
 - the cutting tip seating surface in the torch head
- b) Test the complete system, including cutting torches and mixing chambers, by following the instructions for setting up the system, lighting the torch, and re-lighting the torch as stated in earlier attachments

REFERENCES

1. IPSS 1-11-017-12: Safety Procedure for Gas Cutting by Regular/ Contractor Workers
2. IS: 818 - 1888
3. SAIL Plant Safety Manual