SAND, GRAVEL, AND CRUSHED STONE ON-THE-JOB TRAINING MODULES

Module 7 - “Welding and Cutting”

UNITED STATES DEPARTMENT OF LABOR
ELAINE L. CHAO
SECRETARY

MINE SAFETY AND HEALTH ADMINISTRATION
DAVE D. LAURISKI
ASSISTANT SECRETARY

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ON-THE-JOB TRAINING
FOR THE
SAND, GRAVEL, AND CRUSHED STONE INDUSTRY

WELDING AND CUTTING

This module describes basic job steps, potential hazards and accidents, and recommended safe job procedures for welding and cutting.

Welding and cutting is done during repair, or modification, of existing equipment, and during construction of new equipment. Welders must protect themselves, and others, from accidents and injuries that might occur due to welding and cutting operations.

Welding is essential to the expansion and productivity of mining companies. Welding is one of the principal means of fabricating and repairing metal products. It is almost impossible to name an industry that does not use some type of welding. Welding is an efficient, dependable, and economical method of joining metal. Gas welding and arc welding are the

most commonly used methods of welding.

For gas welding, intense heat is generated by the combustion of gas - usually acetylene and oxygen. The welder uses the oxyacetylene equipment to control and direct the heat on the edges of the metal to be joined, while applying a suitable metal filler. The gas welder may also do flame cutting, with a cutting attachment and extra oxygen pressure. Flame, or oxygen, cutting is used to cut various metals to a desired size or shape, or to remove excess metal from castings. Gas welders need to adjust regulators, select proper tips and filler rods, prepare metal edges to be joined, and properly manipulate the flame and the filler rods.

For arc welding, intense heat is generated by a high amperage electric arc between an electrode and the metal pieces to be joined. Molten metal from the tip of the electrode is deposited in the joint, together with molten metal from the edges of the pieces to be joined. This metal solidifies to form a sound, uniform, connection. Arc welders need to properly select electric currents, select electrodes, prepare the metal edges to be joined, and manipulate the electrodes.

Welders are usually classified as skilled or semi-skilled. Skilled welders have the ability to plan, lay out work from drawings or written specifications, and weld all types of joints in various positions. Skilled welders also have a wide range of technical knowledge involving properties of metals, effects of heat on welded structures, control of expansion and contraction forces, and recognition of welding defects. A skilled welder may be proficient in several types of gas and arc welding processes. As a rule, when the quality and strength of a weld is critical, skilled welders are certified by their employer, a government agency, or an inspection authority, for the particular welding job they are required to perform.

Semi-skilled welders usually do repetitive work which usually does not involve critical strength requirements. They usually start on simple production jobs, and gradually work up to higher levels of skill. They primarily weld surfaces only in upright positions.

Welding equipment should not be used until exact instructions on its operation have been received. Manufacturer’s recommendations are very important, and should be followed at all times. Attempting to operate a piece of equipment without instruction may damage the equipment, or result in serious injury. Welding equipment is safe to use when it is used in the proper manner.

Welding must be done in a well ventilated area. There must be sufficient movement of air to prevent the accumulation of toxic fumes, or the possibility of oxygen deficiency. Adequate ventilation is extremely critical in confined spaces, where dangerous fumes and smoke are likely to collect. Where considerable welding is done, an exhaust system may be necessary in order to keep toxic gases and fumes within prescribed health limits. An adequate exhaust system is especially important when welding or cutting zinc, brass, bronze, lead, cadmium, or beryllium bearing metals. Fumes from these materials are very hazardous to your health.

Sparks, and dangerous ultraviolet and infrared radiation, are generated by any welding or cutting operation. Consequently, suitable clothing and proper eye protection are necessary.

Sparks may lead to serious burns. Radiation is extremely dangerous to the eyes. Welders should know that these dangers exist during any welding operation, and know the safe practices to follow to prevent personal injury.

Sufficient precaution should be taken to ensure that containers, that are to be welded or cut, are safely vented. Accumulated air or gas in confined areas will expand when heated. The enclosed pressure may build up and cause an explosion. Welding and cutting should not be done on used drums, barrels, tanks, and other containers, unless they have been thoroughly cleaned of all combustible substances that may produce flammable vapors or gases. Flammable and explosive materials include gasoline, light oil, and non-volatile oils or solids that release vapors when heated. Containers of acids that can react with metals to form hydrogen gas must be thoroughly cleaned before welding or cutting.

Containers can be cleaned by flushing several times with water, chemical solutions, or steam. Water cleaning is satisfactory if the substance in the container is readily soluble in water. For all less soluble substances, containers should be cleaned with a strong commercial caustic cleaning compound, or by blowing steam into the container.

Fires often occur as a result of cutting operations, because proper precautions are not taken. Sparks and falling slag can pass through cracks out of sight of the welder. Persons responsible for welding and cutting should observe the following precautions:

1. Never use a cutting torch where sparks will be a hazard, such as near rooms containing flammable materials - especially dipping and spraying rooms.

2. If cutting is to be done over a wooden floor, sweep the floor clean and wet it down before starting the cutting. Provide a bucket or pan, containing water or sand, to catch dripping slag.

3. Keep a fire extinguisher nearby whenever any cutting is done.

4. Whenever possible, perform cutting operations in open areas, so sparks and slag will not become lodged in crevices or cracks.

5. If cutting is to be done near flammable materials, and the flammable materials cannot be moved, suitable fire-resistant guards, partitions, or screens must be used.

6. Practice good housekeeping - reduce any potential for fires and explosions by keeping work areas clean of combustible and flammable materials.

7. Keep flames, sparks, grease, and oily rags away from oxygen cylinders and hoses.

8. Never do any cutting near ventilating system intakes that could result in others being exposed to fumes.

9. Always have standby watchers nearby, with fire extinguishers, if the risk of fire is great.

10. Never use oxygen to dust off clothing or work areas.

Arc welding includes shielded metal-arc, gas shielded-arc, and resistance welding. Only general safety measures can be listed for arc welding, because equipment varies considerably in size and type. Specific manufacturer's recommendations should be followed. Safety practices that are, in general, common to all types of arc welding operations include:

1. Install welding equipment in accordance with provisions of the National Electric Code.

2. Be sure that a welding machine is equipped with a conveniently located power disconnect switch, so that power can be shut off quickly.

3. Be sure that power to welding equipment is locked out before making any repairs to the welder. High voltages used for arc welding machines can inflict fatal injuries.

4. Properly ground welding machines. Stray current may develop, which can cause severe shock if ungrounded parts are touched. Do not ground to pipes that carry gases or flammable liquids.

5. Keep connections tight between cables and electrode holders. Do not use electrode holders with defective jaws or poor insulation.

6. Do not change the polarity switch while the welding machine is under load. Wait until the machine idles and the circuit is open. Otherwise, the contact surface of the switch may be burned, and the person throwing the switch may receive a severe burn from the arcing.

7. Do not operate range switch under load. The range switch, which determines the current setting, should be changed only while the machine is idling and the circuit is open. Switching the current while the machine is under load will cause an arc to form between contact surfaces.

8. Weld only in dry areas, or use a dry board or rubber mat to stand on. Keep hands and clothing dry at all times. Never stand or lie in puddles of water, on damp ground, or against grounded metal when welding.

9. If other persons work nearby a welding site, the welding site must be partitioned off to protect people from the arc welding flash. Do not strike an arc if someone without proper eye protection is nearby.

10. Be careful not to touch pieces of hot metal which have just been welded or heated.

11. Make sure all hollow castings are properly vented before heating, in order to avoid an explosion.

12. Be sure that press-type welding machines are effectively guarded.

13. Be sure that suitable spark shields are used around equipment when flash welding.

14. When welding is completed, turn machine off, pull power disconnect switch, and hang electrode holder in its designated place.

Remember, accidents do not just happen. Invariably, they occur because of indifference to safety rules and regulations, and lack of information or effective training. Injury of any kind is painful and very often can incapacitate a person, or even produce a permanent deformity. If more thought were given to the consequences of injuries, there would be less tendency to ignore safety precautions and, therefore, fewer accidents.

The following safe job procedures will help to minimize incidents that may cause injuries and adversely affect production:

REQUIRED AND/OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT:
HARD HAT, STEEL-TOED SHOES, WELDER'S SHIELD (HOOD) OR GOGGLES, LONG CUFF GLOVES, PROTECTIVE CLOTHING, LEG BANDS, RESPIRATOR, HEARING PROTECTION

I. WELDING ON CONTAINERS, TANKS, AND OTHER OBJECTS

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
1. Check work area.	1. A) Struck by equipment, or caught between equipment and stationary objects.	1. A) Notify equipment operators of your presence and your work plan. Be sure that nearby equipment is shut down and secured in place. Post warning signs. Barricade area.
	B) Fire.	B) Be sure fire extinguishing equipment is available at site.
2. Prepare container, tank, or other objects for work.	2. A) Exposure to bad weather conditions.	2. A) Dress for the weather. Do not arc-weld if weather creates shock hazard.
	B) Exposure to noxious fumes or harmful liquids.	B) Determine type of material stored in tank or container. Determine safe procedure to vent or drain liquids or gases.
	C) Skin contacted by harmful liquids or gases.	C) Wear gloves and proper protective clothing.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
	D) Eye injury.	D) Wear goggles, or safety glasses with side shields, or full face shield, as appropriate.
	E) Hand injury due to tool slipping.	E) Use tool designed to open the type of plug, cap, or vent involved. Hold tools securely, and use controlled force.
	F) Overexertion or strain.	F) Get help with tanks, welder, or heavy parts.
	G) Explosion or fire.	G) Be sure tank or container is properly vented and cleaned before applying heat.
3. Hook up torch or welder.	3. A) Explosion or fire.	3. A) Check for worn places on hoses, and be sure cylinders are secured in upright position.
	B) Contact with electricity or sharp metal.	B) Wear gloves, and avoid contact with non-insulated electrical parts.
	C) Hand or arm injury.	C) Use proper cylinder tools and controlled force.
	D) Struck by dropped tools or parts.	D) Hold tools and parts securely.
	E) Struck by compressed gas.	E) Stand clear of compressed gas stream, and crack valves slowly to blow out foreign material. Do not stand in front of regulator.
	F) Eye injury.	F) Wear goggles, or safety glasses with side shields, or full face shield.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
	G) Electrical shock.	G) When arc welding, have material well grounded and securely clamped. Keep arc welding cables dry, free of grease and oil, and away from power cables. Do not weld in rain without taking proper precautions.
4. Light torch or energize welder.	4. A) Struck by compressed gas.	4. A) Turn torch away from yourself and others nearby.
	B) Burns.	B) Use a proper torch lighter (striker).
5. Perform welding on object.	5. A) Burns.	5. A) Blow metal away from body. Wear long cuff gloves and adequate clothing.
	B) Exposed to arc, flash, or heat rays.	B) Wear adequate clothing. Use proper cutting goggles, or welding shield (hood), depending on type of work. Provide protective barriers in area to protect other workers.
	C) Inhalation of toxic fumes.	C) Use ventilation system and/or respirators provided.
6. Turn arc welding machine off, or extinguish torch and turn off tank valves.	6. A) Electrical shock, or hand and arm injury	6. A) Turn switch off and reel in leads, or use proper cylinder tools.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
7. Check for fire, and remove hot parts.	7. A) Burns - contact with hot metal parts.	7. A) Wear gloves and handle hot parts with tongs.
	B) Fire, smoke, or explosion	B) Search for fire or any smouldering areas. Wet down area with water, if available. Have fire extinguisher immediately available.
8. Disassemble hoses and gauges from tanks.	8. A) Striking gauges or other protruding objects.	8. A) Observe and avoid projections.
	B) Hand or arm injuries.	B) Use proper cylinder tools, and seat them firmly.
	C) Struck by dropped tools or parts.	C) Hold tools and parts firmly.
9. Transport cylinders and hose to storage area.	9. A) Strains.	9. A) Get help, if needed, to handle or move cylinders.
	B) Slipping and tripping hazards.	B) Keep travelways clear.
	C) Explosion hazard.	C) Caps should be in place and hand tightened.

II. CUTTING WITH AN ACETYLENE TORCH

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
1. Check work area.	1. A) Struck by equipment, or caught between equipment and stationary objects.	1. A) Be sure nearby equipment is shut down and blocked against movement. Notify operators of equipment of your presence and work plan. Barricade off your work area.
	B) Fire.	B) Be sure that fire extinguishing equipment is readily available.
2. Hook up gauges and torch.	2. A) Explosion or fire.	2. A) Check for worn places on hoses, and be sure cylinders are secured in upright position.
	B) Hand or arm injury.	B) Use proper cylinder tools and controlled force.
	C) Struck by dropped tools or parts.	C) Hold tools and parts securely.
	D) Struck by compressed gas.	D) Stand clear of compressed gas stream, and crack valves slowly to blow out foreign material. Do not stand in front of regulators.
	E) Eye hazard.	E) Wear goggles, or safety glasses with side shields.
3. Light acetylene torch.	3. A) Caught on protruding objects.	3. A) Wear gloves and snug fitting clothing.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
	B) Dust, or other material, blown into eye.	B) Wear goggles.
	C) Struck by compressed gas.	C) Turn torch away from yourself and others nearby.
	D) Burns.	D) Use a torch lighter.
4. Cut material.	4. A) Exposed to heat from torch.	4. A) Wear adequate clothing and long cuff gloves.
	B) Inhalation of toxic fumes.	B) Use ventilation system and/or respirators provided.
	C) Struck by material being cut.	C) Stand clear of path of falling material.
	D) Contacted by hot slag.	D) Direct cutting action away from body, or anyone close by.
	E) Contact with hot metal.	E) Wear gloves. Handle small hot parts with tongs.
	F) Fire or explosion.	F) Keep all connections tight. Keep torch and hoses in good repair, and free of oil and grease. Keep hoses where sparks and slag will not contact them.
5. Extinguish torch and turn off tank valves.	5. A) Hand and arm injury.	5. A) Use proper cylinder tools, and seat them firmly.
6. Check for fire, and remove hot parts.	6. A) Burns - contact with hot metal parts.	6. A) Wear gloves and handle hot parts with tongs.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
	B) Fire, smoke, or explosion	B) Search for fire or any smouldering areas. Wet down area with water, if available.
7. Disassemble hoses and gauges from tanks.	7. A) Striking gauges or other protruding objects.	7. A) Observe and avoid projections.
	B) Hand or arm injuries.	B) Use proper cylinders tools, and seat them firmly.
	C) Struck by dropped tools or parts.	C) Hold tools and parts firmly.
8. Transport cylinders and hose to storage area.	8. A) Strains.	8. A) Get help, if needed, to handle or move cylinders.
	B) Slipping and tripping hazards.	B) Keep travelways clear.
	C) Explosion hazard.	C) Caps must be in place and hand tightened. Cylinders must be secured in proper storage place.

GENERAL INFORMATION

This module is part of an Instruction Guide that was developed to assist the sand, gravel, and crushed stone industry in conducting effective on-the-job training (OJT) of new employees, or employees reassigned to different jobs. The use of training materials, such as this module, is an important part of an effective, systematic, OJT program.

This Instruction Guide uses a generic Job Safety Analysis (JSA) of jobs common to the industry. The JSA format facilitates uniform basic training in safe job procedures, while requiring only a minimum of time and effort on the part of the trainer. This material is generic to the industry; therefore, each company using this guide will need to tailor the material somewhat to fit their particular requirements. In some cases, the material must be general in nature, and will not include specific details of procedures or equipment that must be taught by the trainer.

Recommendations for an overall OJT program are contained in the Mine Safety and Health Administration (MSHA) guide: “Structuring Effective On-The-Job Training Programs”

TRAINING RECOMMENDATIONS

On-the-job training is usually best done by the employee’s immediate supervisor. If the supervisor relies on another employee to do certain parts of the training, the supervisor should be present to monitor the training. OJT is conducted at the actual job site, where the work will be done.

The supervisor/trainer should use the training materials (this module, or other materials) while the training is being done, to help ensure that all job steps are covered, and that no important safety precautions are omitted. Effective OJT should begin with an explanation (lecture and/or discussion) of the safe job procedure. The explanation should be followed by a hands-on demonstration of the proper job procedure. A good demonstration is, perhaps, the most important part of OJT. The demonstration is followed by supervised practice, during which the supervisor/trainer coaches (corrects and encourages) the employee, and evaluates when the employee is ready to do the job without direct supervision.

The first step - explaining the job to the employee - can be done in different ways. The supervisor/trainer and the employee can sit down and go through the training materials together. It may be advantageous to provide the employee with a copy of the training modules that are applicable to his/her job. The fact that most of the training is conducted at the job site does not preclude the use of a classroom, or a quiet office, for the first part of the training. Any general theory, or knowledge training, as well as the initial explanation of the job procedure, may be best done in an office/classroom setting; especially when noise levels, or other conditions at the job site, make communication difficult. A complete series of job steps could be presented through the use of slides developed at the mining operation.