Safety, Health, and Environmental Standard

Title: **WELDING AND CUTTING (HOT WORK)**

Standard No.: C5

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Releasability: There are no releasability restrictions on this publication.

The provisions and requirements of this standard are mandatory for use by all base operating contractors engaged in work tasks necessary to fulfill the AEDC mission. Please contact your safety, industrial health and/or environmental representative for clarification or questions regarding this standard.

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Safety, Health, and Environmental Standard

WELDING AND CUTTING (HOT WORK)

1.0 INTRODUCTION/SCOPE/APPLICABILITY

1.1 Introduction – This standard describes the tasks, activities and actions required when welding and cutting operations are to be performed at AEDC. The standard implements the requirements of OSHA, ANSI, ASME, NFPA, API, Air Force and other nationally recognized national consensus standards.

1.2 Scope

1.2.1 This standard establishes the general guidelines for safety of personnel and facilities when performing welding, cutting or grinding (hot work) operations. General requirements, personal protective equipment, health protection, welding in confined areas, fire protection, and electric arc and resistance welding requirements are included.

1.2.1 This standard shall be considered to be the Contractor-developed Welding, Cutting Plan and Grinding, which incorporates the requirements and objectives of OSHA, ANSI, ASME, NFPA, API, Air Force and other nationally recognized national consensus standards to assure implementation at AEDC. Should there be any conflicts noted between this standard and industry or national codes, standards or regulatory requirements, the Air Force or Base Operating Contractor's Safety Office shall be notified so that any issue(s) can be resolved.

1.3 Applicability

1.3.1 This standard applies to all AEDC base operating contractors and operations, including Air Force, Navy, US Army Corps of Engineers, and Contractors (including Outside/Subcontractors) at the Tennessee location and operations conducted by AEDC personnel outside the confines of Arnold AFB.

1.3.2 For outside/subcontractor personnel, training requirements are established and provided by their management. However, they must include basic fire safety training as specified in NFPA 51B, Standard for Fire Prevention During Welding, Cutting and Other Hot Work, and any contractual welding certification(s) requirements for the task they are to perform, confined space training, and lockout/tagout training. Contract monitors assist outside/sub-contractors in obtaining AEDC-specific forms/approvals required by this standard.

2.0 BASIC HAZARDS/HUMAN FACTORS

Welding, cutting and grinding (hot work) operations produce numerous hazards. The primary ones are exposures to ultraviolet and infrared rays, toxic gases, fumes, and dusts; flying debris; sparks; burns to personnel; fire; and explosions. Hazards vary greatly according to the type of welding being done, the environment, and the types of welding materials being used.

3.0 DEFINITIONS

Angle Grinder – Also known as a side grinder, right-angle grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing.

Base Operating Contractor – A long-term contractor directly accountable to the Air Force for the AEDC mission. This is the term used to identify the AEDC Operation, Maintenance, Information Management and Support Contractor(s).

Check-Valve – A device designed to prevent reverse flow of gas; also known as a back-flow preventer.

Confined Space – An enclosed or partially enclosed space having limited access or egress, which may present a hazard to persons entering or occupying that enclosure. Confined spaces may include storage tanks, pressure vessels, boilers, test cells, ducting, coolers, heaters, driers, sewers, tunnels, pipelines, and open-top spaces such as pits, tubs, and vaults.

Fire Watcher – A qualified individual proficient in the operation of available fire extinguishing equipment and knowledgeable of fire reporting procedures, assigned to work with a welder, normally outside a designated or approved area, to watch for fires which could result from welding, cutting, or brazing operations.

Flashback Arrestor – A device designed to prevent a flashback, which is a rapid flame propagation, from passing through the device and progressing into upstream equipment; also known as a flame arrestor.

Hot Tapping – A tapping operation performed on a pressurized flammable gas line in which a tee fitting is welded to the line before attaching a tapping machine.

Hot Work – Work that involves burning, welding, grinding or any similar operation that can produce sparks and/or initiate fires or explosions.

Hot Work Permit – AF Form 592, USAF Hot Work Permit.

Inside Area – A specific area established and designated by management and approved by the Contractor Fire Department and bioenvironmental authorities, specifically for welding, cutting, brazing or grinding operations.

Base Operating Contractor –A long-term contractor directly accountable to the Air Force for the AEDC mission;. used to identify the AEDC Operation, Maintenance, Information Management and Support Contractor.

Outside Area – An area in which work cannot be moved but can be made fire safe. It requires a fire watch and a written permit prior to any welding, cutting, brazing or grinding operations.

Outside Contractor/Subcontractor – An organization employed by the Base Operating Contractor or the Air Force to do construction, maintenance, repair or other work at AEDC. This term includes those who may be subcontracted by an outside contractor for specific portions of a project. Also referred to as the construction contractor.

Purging – The displacement of hazardous vapors or gases by the injection of a predetermined volume of an inert gas into a system to be worked hot. Purging continues for a specified period of time after the hot work is complete.

Welder – An operator of electric or gas welding and cutting equipment.

Work Lead – The welding machine's return, often incorrectly referred to as the "ground lead or grounding lead". The work lead should not be referred to as the ground lead or grounding lead. It is preferable to connect the work lead directly to the work piece rather than to the table.

4.0 REQUIREMENTS/RESPONSIBILITIES

4.1 Procedures

4.1.1 Before any work is performed in an area, NOT under the control of the Party Performing the Work, a Master Work Permit, shall be obtained from a designated issuing official. See AEDC SHE Standard B1 for additional guidance.

4.1.2 Before any welding, cutting or grinding (hot work) operations are performed at AEDC, the area shall be approved by the Base Operating Contractor Fire Department for such operations and/or a hot work permit (AF Form 592), shall be obtained. See AFI 91-203 Air Force Consolidated Occupational Safety Instruction and AEDC COI 32-1, Fire Prevention, for additional guidance.

4.2 Management/Supervision Shall

4.2.1 Establish and designate permissible areas for hot work (Inside areas).

4.2.1.1 Contact the Base Operating Contractor Fire Department for approval of designated areas and ensure approval letter is issued before starting any welding/cutting operations.

4.2.1.2 Post a copy of the approval letter in the immediate area.

4.2.3 Ensure that only approved equipment, machines and/or hand tools are used.

4.2.4 Ensure all welding, cutting and grinding equipment is examined to ensure it is in a safe operating condition, required flash back devices and/or other protective devices are installed and functioning properly:

4.2.4.1 Tag equipment found to be incapable of reliable safe operation, remove it from service, and arrange to replace or have it repaired. The Base Operating Contractor use a Safety Information (Tag).

4.2.4.2 Ensure that electric welding machines, gas cutting torches and gas pressure regulators are inspected annually. For the Base Operating Contractor, this is accomplished through the Safety Recall Program tracked via the Computerized Maintenance Management System (CMMS), Oracle-WAM.

4.2.5 Ensure that all individuals involved in the hot work operations, including outside contractors, are familiar with the provisions of this standard.

4.2.6 Ensure individuals involved in hot work operations are trained in the safe operation of their equipment and in the safe use of the process:

4.2.6.1 Inform welders of appropriate safety, health, and fire protection matters. (If an operation requires specialized safety or health considerations not contained in this standard, contact the Base Operating Contractor Safety and Health Group).

4.2.6.2 Verify, when required, appropriate welding procedures are noted on timecards to verify welds and ensure welders are fully qualified and certified in accordance with requirements specified by the American Society of Mechanical Engineers.

NOTE: Welding certifications are maintained by the Metallurgical Laboratory.

4.2.7 Ensure individuals involved in hot work operations have an awareness of the inherent risks involved and understand the emergency procedures in the event of a fire:

4.2.7.1 Ensure personnel who may be assigned as a fire watcher are properly trained (see Section 4.8.2) and assign a fire watcher for welding operations being conducted outside of an approved inside area.

4.2.7.2 Request training from the Base Operating Contractor Fire Department.

4.2.8 Ensure a fire watch is at the site when required (see Section 4.7).

4.2.9 Advise all contractors about site specific flammable materials, hazardous processes or conditions, or other potential fire hazards.

4.2.10 Ensure only approved protective clothing and equipment is purchased for use and is used.

4.2.11 Ensure employees are provided with proper signs for welding and cutting areas.

4.2.12 Ensure that their welders follow the safety and health rules.

4.2.13 Ensure an AF Form 592 is obtained by employees before any welding/cutting operations are begun outside of an approved inside area.

4.3 AEDC Fire Department Shall

4.3.1 Inspect and approve designated hot work (inside) areas for welding, cutting, and brazing operations utilizing in-house check lists. The Fire Chief having jurisdiction will make the final decision on those areas to have an approved inside hot work area:

4.3.1.1 Conduct inspections initially, when areas are designated, and at least annually thereafter unless conditions warrant more frequent inspection.

4.3.1.2 Determine site-specific flammable materials, hazardous processes, or other potential fire hazards that are present or likely to be present in the hot work (inside) area.

4.3.1.3 Coordinate with Safety and Health on all designated hot work inside areas before approval letters are issued.

4.3.1.4 Issue an approval letter, signed by the Fire Chief, for inside hot work areas.

4.3.1.4.1 Approve the area for one year unless conditions warrant a shorter time period.

4.3.1.4.2 Have the power to revoke the approval letter anytime unsafe practices or conditions are observed during inspections.

4.3.2 Inspect all outside areas prior to performing welding, cutting or grinding operations.

4.3.2.1 Determine that fire protection and extinguishing equipment of the correct type and quantity are properly located at the site.

4.3.2.2 Ensure the protection of combustibles from ignition by the following means:

4.3.2.2.1 Have the work moved to a location that is free from combustibles.

4.3.2.2.2 If the work cannot be moved, have the combustibles moved to a safe distance or have the combustibles properly shielded against ignition.

4.3.2.2.3 Have the hot work scheduled so that operations that could expose combustibles to ignition are not begun during hot work operations.

4.3.3 Issue an AF Form 592 only if the criteria of 4.3.2.2 are met and after areas are determined to be free of recognized fire hazards.

4.3.4 Upon request, provide Fire Safety Training for welders and fire watchers.

4.4 Employee Responsibilities

4.4.1 Welders Shall

4.4.1.1 Handle equipment safely and use it as follows so as not to endanger lives and property:

4.4.1.1.1 Complete an AF Form 592 before starting hot work operations.

4.4.1.1.2 Check all equipment and tools each day before use to ensure it is in good condition. For Base Operating Contractor activities, ensure a current inspection tag, DD1574, (Serviceable TAG – Material) or DD1574-1, (Serviceable label – Material) is on equipment. Do not use equipment if tag or label is not present.

4.4.1.1.3 Check electric arc and resistance welding equipment for grease or oil buildup on plugs, sockets, and electrical connections; clean the equipment when necessary.

4.4.1.1.4 Remove any defective equipment from service and immediately report it to supervision.

4.4.1.2 Ensure the area is adequately barricaded and warning placards are prominently displayed. Annex C illustrates approved placards. AEDC SHE Standard B3, Control of Hazardous Areas, provides additional guidance.

4.4.1.3 Cease hot work operations if unsafe conditions develop and notify management, the area supervisor, or the AEDC Fire Department for reassessment of the situation.

4.4.1.4 Do not operate welding equipment in a confined space unless adequate ventilation exists. Contact the Base Operating Contractor Safety and Health Group for additional guidance as required.

4.4.2 Fire Watcher Shall

4.4.2.1 Be trained to understand the inherent hazards of the worksite and of the hot work in progress.

4.4.2.2 Be familiar with the facilities and procedures for sounding an alarm in the event of a fire.

4.4.2.3 Have fire extinguisher equipment of the proper size and type readily available and be trained in its use.

4.4.2.4 Continuously inspect the work site for fire hazards and ensure that safe conditions are maintained during the operation.

4.4.2.5 Watch for fires in all exposed areas and try to extinguish them only when the fires are obviously within the capacity of the equipment available. The decision to extinguish the fire should be made only after assessing all the facts. Notify the AEDC Fire Department immediately by calling 911.

4.4.2.6 Immediately notify the AEDC Fire Department by any method available if a fire should occur.

4.4.2.7 Have the authority to stop the operations if unsafe conditions develop.

4.4.2.8 Maintain a fire watch for 30 minutes after all operations have ceased.

4.4.2.9 When the job is complete, sign the AF Form 592 on line 16, and return the hot work permit to the issuing authority.

4.4.2.10 Be permitted to perform additional tasks, but those tasks shall not distract him or her from their fire watch responsibilities.

4.5 Permissible Areas

4.5.1 General. Hot work shall be permitted only in areas that are or have been made fire safe.

4.5.1.1 Designated or Permit-Required Areas. Hot work shall be performed in either designated areas or permit-required areas.

4.5.1.1.1 **Designated Areas:** A designated area shall be a specific area designed or approved for hot work, such as a maintenance shop or a detached outside location that is of noncombustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas.

4.5.1.1.2 **Hot Work Permit-Required Areas:** A permit-required area shall be an area made fire safe by removing or protecting combustibles from ignition sources. Signs shall be posted designating hot work areas.

4.5.2 Non-permissible Areas:
Hot work shall not be permitted in the following areas**:**

4.5.2.1 In areas not authorized by management.

4.5.2.2 In sprinkler-equipped buildings where sprinklers are impaired, unless the requirements of NFPA25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, are met.

4.5.2.3 In the presence of explosive atmospheres (i.e., where mixtures of flammable gases, vapors, liquids, or dusts with air exist).

4.5.2.4 In the presence of uncleaned or improperly prepared drums, tanks, or other containers and equipment that have previously contained materials that could develop explosive atmospheres.

NOTE: Exercise caution when welding, cutting, or brazing such containers since toxic or flammable materials may be trapped in scales or crevices.

4.5.2.5 In areas with an accumulation of combustible dusts that could develop explosive atmospheres.

4.5.2.6 In the presence of flammable gases and vapors in the air. Ten percent of the lower flammable limit shall not be exceeded.

4.5.2.7 In areas containing chlorinated solvent vapors without an airline respirator.
NOTE: These solvent vapors may decompose into highly toxic gases in the presence of a welding arc.

4.5.2.8 On lines carrying flammable liquids or gases.
NOTE: Pipeline hot tapping by qualified personnel is normally exempt from this requirement.

4.5.2.9 In atmospheres immediately dangerous to life and health, unless the express written consent of the Base Operating Contractor Safety and Health Group is obtained.

4.5.3 Hot Work Permit, (AF Form 592, USAF Hot Work Permit)

4.5.3.1 Before hot work operations begin in a non-designated location (outside area), a written hot work permit shall be issued by the AEDC Fire Department shall be required.

4.5.3.2 Before a hot work permit is issued, the AEDC Fire Department shall verify the following conditions:

4.5.3.2.1 The equipment to be used shall be in satisfactory operating condition and in good repair

4.5.3.2.2 Where combustible materials, such as paper clippings, wood shavings, or textile fibers are on the floor, the floor shall be swept clean for a radius of 35 feet (11 meters); the following criteria also shall be met:

4.5.3.2.2.1 Combustible floors (except wood on concrete) shall be kept wet, covered with damp sand, or protected by noncombustible or fire-retardant shields.

4.5.3.2.2.2 Where floors have been wet down, personnel operating arc welding equipment or cutting equipment shall be protected from possible shock.

4.5.3.2.3 All combustibles shall be relocated at least 35 feet (11meters) in all directions from the work site; the following criteria also shall be met:

4.5.3.2.3.1 If relocation is impractical, combustibles shall be protected with fire-retardant covers or otherwise shielded with metal or fire-retardant guards or curtains.

4.5.3.2.3.2 The edges of covers at the floor shall be tight to prevent the entrance of sparks, including at the point at which several covers overlap where a large pile is being protected.

4.5.3.2.4 Openings or cracks in walls, floors, or ducts within 35 feet (11 meters) of the site shall be tightly covered with fire retardant or noncombustible material to prevent the passage of sparks to adjacent areas.

4.5.3.2.5 Ducts and conveyor systems that may carry sparks to distant combustibles shall be shielded, shut down, or both.

4.5.3.2.6 If hot work is done near walls, partitions, ceilings, or roofs of combustible construction, fire-retardant shields or guards shall be provided to prevent ignition.

4.5.3.2.7 For hot work on one side of a wall, partition, ceiling, or roof, one of the following criteria shall be met:

4.5.3.2.7.1 Precautions shall be taken to prevent ignition of combustibles on the other side by relocating the combustibles.

4.5.3.2.7.2 If it is impractical to relocate combustibles, a fire watch shall be provided on the side opposite from where the work is being performed.

4.5.3.2.8 Hot work shall not be attempted on a partition, wall, ceiling, or roof that has a combustible covering or insulation, or on walls or partitions of combustible sandwich type panel construction.

4.5.3.2.9 Hot work performed on pipes or other metal that is in contact with combustible walls, partitions, ceilings, roofs or other combustibles, shall not be undertaken if the work is close enough to cause ignition by conduction.

4.5.3.2.10 Fully charged and operable fire extinguishers that are appropriate for the type of possible fire shall be available immediately at the work area.

4.5.3.2.11 If existing hose lines are located within the hot work area defined by the permit, they shall be connected and ready for service but shall not be required to be unrolled or charged.

4.5.3.2.12 The following shall apply to hot work done in close proximity to a sprinkler head:

4.5.3.2.12.1 A wet rag shall be laid over the sprinkler head and then removed at the conclusion of the welding or cutting operation.

4.5.3.2.12.2 During hot work, special precautions shall be taken to avoid accidental operation of automatic fire detection or suppression systems (e.g., special extinguishing systems or sprinklers).

4.5.3.2.13 Nearby personnel shall be suitably protected against dangers such as heat, sparks, and slag.

4.5.3.3 Based on local conditions, the AEDC Fire Department shall determine the length of the period for which the hot work permit is valid.

4.6 Fire Watch

4.6.1 A fire watch shall be required by the AEDC Fire Department when hot work is performed in a location where other than a minor fire might develop or where the following conditions exist:

4.6.1.1 Combustible materials in building construction or contents are closer than 35 feet (11 meters) to the point of operation.

4.6.1.2 Combustible materials are more than 35 feet (11 meters) away from the point of operation but are easily ignited by sparks.

4.6.1.3 Wall or floor openings within a 35 feet (11 meters) radius expose combustible materials in adjacent areas, including concealed spaces in walls or floors.

4.6.1.4 Combustible materials are adjacent to the opposite side of partitions, walls, ceilings, or roofs and are likely to be ignited.

4.6.2 A fire watch shall be maintained for at least 30 minutes after completion of hot work operations in order to detect and extinguish smoldering fires.

4.6.3 More than one fire watch shall be required if combustible materials that could be ignited by the hot work operation cannot be directly observed by the initial fire watch.

4.7 Personal Protective Equipment

(**NOTE:** Also see SHE Standard F2 Personal Protective Equipment.)

4.7.1 Protective Clothing: Supervisors shall determine which employer-furnished garments (jackets, capes, sleeves, leggings, hoods, etc.) are needed and ensure that they are available and are being used correctly. Clothing shall be selected to minimize the potential for ignition, burning, trapping hot sparks, or electric shock. Wool or flame-retardant, cotton clothing should be worn. Use of synthetic fabrics such as nylon, rayon, polyester, etc., which are not treated with a fire retardant (FR) is prohibited, since slag easily burns

through or ignites such fabrics. Employees shall protect themselves from sparks, flying slag, and bright flames at all times:

4.7.1.1 Protective sleeves, aprons, and shoes should be worn to protect skin and clothing from sparks and slag.

4.7.1.2 Keep all clothing and protective apparel absolutely free of oil and grease.

4.7.1.3 Adjust clothing where necessary to keep out flying sparks and slag. Sparks may lodge in rolled-up sleeves, in pockets of clothing, or in cuffs of trousers. Keep sleeves and collars buttoned when necessary to keep sparks and slag out.

4.7.2 Protective Gloves (Hand Protection): Welders and any helpers or employees in close proximity, who may be exposed to hot metal or slag during oxy-fuel cutting, heating, and welding operations, shall wear suitable protective gloves to protect from heat, sparks, slag, etc.

4.7.3 Ear Protection: Earmuffs or plugs (non-foam), to prevent sparks from entering the ear canal, shall be worn when overhead work is necessary or when circumstances require an employee to lie on the side or back.

4.7.4 Eye and Face Protection: Employees shall wear proper eye protection at all times when performing, or in the immediate vicinity of, welding or cutting operations:

4.7.4.1 Approved protective eyewear (designed to meet ANSI Z-87+ specifications) shall be worn to provide employee protection from injurious light radiation.

4.7.4.2 A Number 5 lens shade shall be considered adequate for routine torch cutting activities.

4.7.4.3 For arc welding activities, a hand-held hood or welder's helmet with a filter lens shall be used for protection from flash burns to the eyes and flying objects. Refer to Annex A for additional information related to eye protection and selection guide for filter shades.

4.7.4.4 Safety glasses shall be worn under burning and welding shields and hoods.

4.7.4.5 Weld hoods and burning goggles with flip-up dark lens and protective cover lens are recommended to give burner or welder additional face and eye protection during de-slagging and grinding operations.

4.7.4.6 Welder’s helpers shall wear protective (impact/Z87+ and filtered) eyewear adequate to task and distance from work.

4.7.5 Foot Protection: Employees shall wear foot protection that meets the requirements of ANSI (NSC) Z41, Personal Protection – Protective Footwear.

4.7.5.1 Low shoes with unprotected tops shall not be worn for work where there is possibility of sparks or slag entering shoes.

4.7.5.2 Shoes constructed with other than natural leather or simulated leather, such as synthetic cloth or mesh cloth on the outer surface, shall not be worn for cutting and welding operations.

4.7.6 Respiratory Protection: Respiratory protection shall not be required for all operations; however, when ventilation is not adequate the need to use some form of respiratory protection may arise during any welding operation. See AEDC SHE Standard F4, Respiratory Protection, for requirements and guidance in the selection of respiratory protection for welders. For specific respirator selection or specifications, contact Base Operating Contractor Safety and Health Group

4.8 Health Protection

4.8.1 Maximum allowable concentration - Local exhaust or general ventilating systems shall be provided and arranged to keep the amount of toxic fumes, gases, or dusts below the maximum allowable concentrations as specified in 1910.1000 or applicable exposure guidance. The following ways of ventilating welding shops have proven useful and shall be used as appropriate. See AEDC SHE Standard C3, Local Exhaust Ventilation, for additional requirements and guidance:

4.8.1.1 Local air currents can be used outdoors to keep welding fumes and gases out of the breathing zone. The welder shall be positioned upwind of the object to be welded

4.8.1.2 Pedestal fans and air movers can be used to blow fumes and gases created by arcs away from a welder. The fan shall be located to the welder's side or at an angle behind the welder. The fan shall never be located in front of the welder since the fan will blow fumes in his face. A fan shall not be used if the fan will blow

fumes to another worker nearby (less than 10 feet away in an open building or if another worker is in the same small room or confined space).

4.8.1.3 General area exhaust ventilation shall be provided in welding shops where there is less than 10,000 cubic feet of air per welder or the ceiling is less than 16 feet above the floor, if welding booths or elephant trunk systems are not practical.

4.8.1.4 A welding booth consisting of a ventilated system in which the air flow pulls fumes away from the welder shall be used instead of building ventilation when possible.

NOTE: Hoods - Freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of air-flow sufficient to maintain a velocity in the direction of the hood of 100 linear feet (30 m) per minute in the zone of welding when the hood is at its most remote distance from the point of welding may be used in place of a welding booth.

4.8.2 Welding or cutting operations involving hexavalent chromium (stainless steel), lead, beryllium, cadmium, mercury, or other heavy metals shall not be conducted without first contacting the Base Operating Contractor Safety and Health Group for special evaluation and recommendations.

NOTE: Epoxy, asphaltic, polyvinyl chloride (PVC), polystyrene, and polyurethane coatings release highly toxic fumes and gases when heated to decomposition. Welding or cutting adjacent to such coatings shall be done in a booth, by using an elephant trunk system or approved respirator.. See AEDC SHE Standard F4, Respiratory Protection, or contact the Base Operating Contractor Safety and Health Group for additional guidance.

4.8.3 Respiratory protection shall be used if a torch is used to burn off paint. Paint shall be removed prior to cutting or welding. Follow lead abatement procedures found in ADEC SHE Standard E19, Lead and Heavy Metals. Contact the Base Operating Contractor Safety and Health Group for special evaluation and recommendations.

4.8.4 All surfaces coated with toxic preservatives or any residual materials from previous use shall be removed for a distance of four (4) inches from either side of the point of any hot work to prevent accumulation of vapors/fumes.

4.8.5 Employees shall be instructed not to look at welding arcs. Where possible, welding screens shall be positioned around arc welding areas to provide the highest level of protection possible for bystanders who could look at the arc. Supervisors and welders shall keep people who are not required out of hot work areas.

4.9 Welding in a Confined Space

4.9.1 Workers shall obtain a ~~Form GC 1732~~ AF Form 1024 from the designated issuing official who shall discuss the work to be performed with entrants and attendants and identify all materials that will be taken into the space. See AEDC SHE Standard B5, Confined Space, for additional guidance.

4.9.2 Workers shall obtain an AF Form 592 from the Fire Department and contact the Base Operating Contractor Safety and Health/Industrial Hygiene to evaluate control measures to be implemented.

4.9.3 Space shall be adequately ventilated to prevent possible oxygen deficiency or accumulation of toxic materials. In circumstances where it is not possible to provide such ventilation, proper respiratory protection shall be used.

4.9.4 Welding/cutting equipment shall be left outside the confined space.

4.10 Electric Arc Welding

4.10.1 The work piece or metal upon which the welder welds shall be grounded independent of the welding leads to a good electrical ground unless a qualified person assures it is safe to work on an ungrounded work piece.

4.10.1.1 If allowed to weld on an ungrounded work piece, the deviation shall be documented on the Job Safety Analysis (JSA) and the JSA shall be signed off by the qualified person who approved the deviation. (See SHE Standard A10, Job Safety Analysis, for use of the JSA.)

4.10.1.2 Grounding shall be done by locating the work on a grounded metal floor or platen, or by connection to a grounded building frame or other satisfactory ground. Care shall be taken to avoid the flow of welding current through a connection intended only for safety grounding since the welding current may be of a higher magnitude than the grounding conductor can safely carry.

4.10.2 Frames of electric motor generator welding machines shall be grounded. The grounding conductor shall have a current-carrying capacity at least equal to that of the individual conductors in power leads to the machine. Welding tables shall be grounded independently from welding machines.

4.10.3 Welding terminals or welding generator leads shall not be bonded to welding machine frames.

4.10.4 Welding cables shall be completely insulated and flexible. They shall be capable of carrying the maximum current requirements of the work in progress, considering the duty cycle of the welding machine.

4.10.5 Splices and joints in welding cables shall be secure and insulated. Insulated cable connectors that lock together and have a current-carrying capacity equal to or greater than that of the cable are recommended. Splices shall not be made within 10 feet of the electrode holder.

4.10.6 The work lead shall have adequate current-carrying capacity to prevent heating and be as short as practicable.

4.10.7 The welding electrode holder shall grip the electrode firmly to avoid the generation of heat and to avoid arcing. The electrode holder shall be insulated as far as possible.

4.10.8 Open-circuit (no load) voltage of arc welding machines shall be as low as possible.

4.11 Resistance Welding

4.11.1 Equipment shall be installed by qualified electricians.

4.11.2 A safety-type disconnect switch, circuit breaker, or interrupter to open each power circuit to the machineshall be located at or near the machine so power can be shut off when the machine or its controls are serviced.

4.11.3 Employees designated to operate resistance welding equipment shall have proper instruction in operating such equipment.

4.11.4 Controls of automatic or air and hydraulic clamps shall be arranged or guarded to prevent accidental activation.

4.12 Oxy-Fuel Cutting and Gas Welding

4.12.1 Equipment Inspection

All oxy-fuel cutting, heating, and welding equipment shall be kept clean and in good repair, and shall be inspected by the user prior to each use.

4.12.1.1 Any tools or equipment found to be defective shall not be used.

4.12.1.2 Defective tools and equipment shall immediately be properly repaired, replaced, or returned to the tool room or supervisor.

4.12.1.3 Users shall inspect hoses carefully at least once every shift for leaks, wear, and loose connections. Whenever a leak is suspected, and each time before equipment is pressurized, users shall turn the cylinder valves to the on position and then back to the off position. During this leak check, users shall look for pressure loss on the high pressure gauge. If a leak is detected, the user shall attempt to locate the leak source and make necessary repairs or turn in the equipment for repair or replacement.

4.12.1.4 As a minimum, a flashback arrestor shall be installed at the regulator end and a check-valve shall be installed at either the torch or regulator end. Many flashback arrestors have check-valves built into them and this type device can serve to fill both requirements.

NOTE: Some oxygen and fuel regulators have flashback prevention built into them. This shall be verified before external flashback devices are installed, as manufactures do not recommend two devices in the line due to the potential of creating flow restrictions.

4.12.2 Handling Cylinders

When handling cylinders, users shall comply with requirements of AEDC SHE Standard D4, Compressed Gas Cylinders, in addition to the following instructions:

4.12.2.1 Never place cylinders beneath work, where sparks or slag could fall on top of them.

4.12.2.2 In the event acetylene cylinders have been carried or stored in a horizontal position, they shall be kept up right for 30 minutes prior to use to allow the acetone to stabilize within the cylinder.

4.12.2.3 Maintain the oxygen cylinder’s pressure above 25 to 50 psig. If it becomes empty, the cylinder will lose its positive pressure, and fuel gas may enter the oxygen equipment, creating the potential to produce an explosion.

4.12.2.4 Tools, clothing, supplies, etc. shall not be stored atop any cylinder. Such items can interfere with quick closure of the valve and damage the fusible safety plugs. Avoid allowing this recessed top become filled with water when using the cylinder.

4.12.2.5 For fuel gas cylinders (example: acetylene, MAPP Gas, Propane) the valve shall be opened approximately ¾ turn. Under no circumstances shall the valve be opened more than 1½ turns. This is to allow for rapid closing should an emergency situation occur.

4.12.2.6 Regulators shall be set to the desired pressure and the system checked for leaks. A "Quick" test of the gas system may be performed once the hoses and torch have been hooked up by closing the cylinder valves after pressurizing the system and observing the time required for the system to loose pressure. A leak is indicated if the pressure regulator loses pressure.

4.12.3 Grease and Oil Hazards

4.12.3.1 Oxygen cylinders and fittings shall be kept away from oil or grease. Oil or grease may ignite violently in presence of oxygen under pressure.

4.12.3.2 Oily or greasy substances shall be kept away from cylinders, cylinder valves, couplings, regulators, hose, and apparatus. Precautions shall be taken to prevent a jet of oxygen from striking an oily surface, greasy clothes, or entering a fuel oil or storage tank that has contained flammable substances.

4.12.3.3 Oxygen cylinders or related apparatus shall not be handled with oily hands or gloves.

4.12.3.4 Oxygen cylinders shall not be handled on the same platform with oil or be placed in a position where oil or grease from overhead cranes or belts may fall upon them.

4.12.3.5 Repairs shall not be attempted on oxygen cylinder valves nor shall valves be tampered with in any way. If trouble is experienced, the supplier shall be notified.

4.12.3.6 Oxygen shall not be used as substitute for compressed air as serious injury may result.

4.12.3.7 Oxygen shall not be used to oil pre-heating burners, start internal combustion engines, blow out pipelines, dust off clothing or work areas; create pressure ventilation; or supply breathing air equipment, nor shall it be used in pneumatic tools.

4.12.4 Oxy-Fuel Torches

4.12.4.1 Torches shall be lit with a friction lighter or other approved device and not by matches, cigarette lighters, or from hot work.

4.12.4.2 When lighting a torch, the operator shall:

4.12.4.2.1 Close the oxygen valve and purge the torch by depressing the handle.

4.12.4.2.2 Open the acetylene (or other fuel gas) valve at the torch.

4.12.4.2.3 Hold the torch facing away from the user and any flammable, combustible, and/or oxidizer, and depress the handle while placing the striker at the torch tip.

4.12.4.2.4 Never light a torch while oxygen is being supplied to the torch.

4.12.4.2.5 Adjust the mixing valve on the torch only after the fuel gas is lit. At this time, the oxygen valve can be opened and correct flame can be obtained.

4.12.4.3 When using a rosebud or very large cutting tip, manufacturer recommendations shall be checked should it become necessary to remove the flashback arrestor because of flow restrictions.

4.12.4.4 Torches and hoses shall be removed from confined spaces when burning or heating operations are completed, during lunch, or at the end of the shift.

4.12.5 Hoses

4.12.5.1 Only hoses and connections made especially for oxy-acetylene welding and cutting with ends firmly crimped to nipples shall be used.

4.12.5.2 Hoses shall be examined carefully at least once every shift for leaks, wear, and loose connections.

4.12.5.3 Hose lines shall be purged individually each time before lighting the torch. This will ensure that no oxy-fuel gas mixture is present in the hoses, which could cause an explosion.

4.12.5.4 Each time a cylinder valve is opened to pressurize a hose, the cylinder valve shall be closed immediately and the high pressure gauge observed to detect pressure loss. If pressure loss is detected, the leak source shall be located and necessary and approved repairs shall be made.

4.12.5.5 Leaks in the hose at the nipple connection shall be repaired at once by cutting off the hose a few inches from the end and remaking the connection. Leaks at other locations shall be repaired by cutting off the damaged section and inserting a hose coupling as a splice. Repair with tape shall not be performed.

4.12.5.6 When hoses are taped together for convenience and to prevent tangling, not more than four out of 12 inches shall be covered by tape.

4.12.5.7 White lead, oil, grease, or other pipe fitting compounds shall not be used for making joints.

4.12.5.8 Should a flashback occur, oxygen and fuel gas valve shall immediately be turned off at the torch and at the cylinders. If the hose is burned, that length of hose shall be discarded. Following flashback, the torch shall be tagged out of service and inspected by a competent person prior to reuse.

4.12.5.9 Hoses shall be protected from damage or interference, from being trampled or run over. Hoses shall be used and stored so as to avoid tangles and kinks and so they will not be tripped over. Caution shall be exercised to prevent connections from being pulled off or to protect the cylinders and equipment from being pulled over by a sudden strong tug on the hose.

4.12.5.10 Hoses shall not be allowed to contact oil or grease. Hoses, regulators, or torches shall not be stored in gang boxes or storage bins where there is a potential for contact with oils, solvents or other flammable and combustible materials. These deteriorate the rubber and constitute a hazard with oxygen.

4.12.5.11 Hoses shall be protected from flying sparks, hot slag, or other hot objects and open flames.

4.12.6 Angle Grinders

4.12.6.1 Shall be equipped with a constant-pressure switch or control and may have a lock-on control, provided turn-off can be accomplished by a single motion of the same finger (or fingers) that turns it on.

4.12.6.2 Grinding wheels shall be inspected for signs of damage prior to use. Notify Supervisor immediately if damage is discovered or suspected.

4.12.6.3 Cutting/grinding wheels shall be appropriate for work and rated for the angle grinder. All grinding wheels shall have the operating speed affixed to the wheel.

4.12.6.4 All guards and safety features shall be properly adjusted and serviceable.

4.12.6.5 Abrasive wheels may disintegrate or explode during start-up. Allow the tool to come up to operating speed prior to grinding or cutting. Never stand in the plane of rotation of the wheel.

4.12.6.6 Angle grinders shall never be placed in a vise.

4.12.6.7 Read and follow the manufacturer's operating instructions.

4.12.7 Storage/Transporting

4.12.7.1 Tanks are considered to be in storage when

- They are not installed on a wheeled welding cart or attached to a fixed gas manifold system,
  AND
- There is no anticipated use for them within 24 hours.

4.12.7.2 Regulators and gauges shall be removed from tanks and the protective valve covers installed whenever they are in storage or are being transported from one physical jobsite to another by mechanical means; such as by or within vehicles, forklifts, cranes, etc.

4.12.7.3 Tanks installed on wheeled carts may be moved manually to different work locations within a single job site while the regulators and gauges are installed.

4.13 Welding on Systems That Contain or Have Contained Flammable or Combustible Liquids

4.13.1 The part of the system being worked shall be isolated from other parts of the system containing flammable liquids or vapors. Isolation may be accomplished by plugging (using approved procedures and equipment),

blanking, or removing from the system. Other approaches shall be reviewed by the Base Operating Contractor Safety and Health Group before they can be used.

4.13.1.1 General guidance contained in the applicable American Petroleum Institute (API) Standard shall be referenced and where applicable followed.

4.13.2 The isolated system shall be purged, ventilated, or cleaned before welding, cutting, or brazing may be performed.

4.13.2.1 Before purging, written calculations shall be done to determine the time required to purge a certain size system with a given flow rate of an inert gas.

4.13.2.2 After ventilation or cleaning a system, the lower exposure limit (LEL) shall be less than 10% and the oxygen (O2) level shall be less than 1% at the area to be worked to ensure that there are no residual flammable vapors. LEL and O2 percentages shall be determined using the measuring technique that provides the greatest level of precision and accuracy.

4.13.3 When a part of a system such as a pipe is worked in place, protection shall be accomplished by a combination of purging and blanking-off or cleaning.

4.13.4 Written procedures or work instructions approved by the operational manger and Base Operating Contractor Safety and Health must cover all aspects of the job. The work instruction will be used on the work site, and presented to the Fire Inspector prior to issuance of an AF Form 592, Hot Work Permit.

4.13.5 Written procedures shall include:

4.13.5.1 The name and characteristics of the commodity.

4.13.5.2 Steps for cleaning, purging and/or inerting.

4.13.5.3 Steps for verifying the system/container is safe for hot work.

4.15 Hot Tapping

4.15.1 Hot tapping or other cutting and welding on a flammable gas or liquid transmission or distribution utility pipeline shall be performed by a crew that is qualified to make hot taps.

4.15.2 Should the necessity arrive to perform hot tapping operations, the Metallurgical Laboratory shall be contacted for necessary certification requirements.

4.15.3 General guidance contained in API Standard 2201 shall be referenced and followed.

5.0 TRAINING

5.1 Each Base Operating Contractor worker performing welding operations shall be deemed qualified to perform these operations when the following criteria have been met:

5.1.1 Satisfactory demonstration of knowledge and skill or proficiency to supervision.

5.1.2 Demonstrated welding proficiency by having weld samples evaluated and passed by the Base Operating Contractor Metallurgical Laboratory under the criteria spelled out in ASME Boiler and Pressure Vessel Code, Section IX.

5.1.3 Completion of an initial Welding Safety class (Phase I) provided by the Base Operating Contractor Safety and Health Group.

5.1.4 Completion of initial and/or annual refresher Fire Safety Training provided by the AEDC Fire Department.

5.2 Each Base Operating Contractor worker performing the duties as a fire watcher shall deemed qualified to perform these operations when the following criteria have been met:

5.2.1 Satisfactory demonstration to supervision of knowledge and skill on proper methods and procedures for maintaining a fire-safe work area and requirements for notifying the AEDC Fire Department in the event of a fire.

5.2.2 Completion of initial and/or annual refresher Fire Safety Training provided by the AEDC Fire Department.

6.0 INSPECTIONS/AUDITS

6.1 Base Operating Contractor Safety and Health Group Shall

6.1.1 Periodically monitor, through formal (scheduled) and informal (non-scheduled) inspections, mishap investigations, and weekly walk-through inspections, approved inside and permitted outside hot work areas/operations to assure compliance with respiratory protection program, industrial ventilation, controlling exposure to hazardous materials, fire safety, and compliance with this standard or other related standards.

6.1.2 Document these periodic inspections using Form GC-1703, Safety Observation Reports, or other written format as deemed applicable and appropriate at the time of the visit.

6.1.3 Provide technical assistance and information to managers, supervisors and employees as needed and/or when requested.

6.2 AEDC Fire Department Shall

6.2.1 Inspect and approve designated hot work (inside) areas for welding, cutting, and brazing operations utilizing in-house check lists. The Fire Chief having jurisdiction will make the final decision on those areas to have an approved inside hot work area:

6.2.2 Conduct inspections initially, when areas are designated, and at least annually thereafter unless conditions warrant more frequent inspection.

6.2.3 Inspect all outside areas prior to any welding/cutting operation beginning.

7.0 REFERENCES

29 CFR 1910.243, Subpart P, Hand and Portable Powered Tools and Other Hand-Held Equipment
29 CFR 1910, Subpart Q, Welding, Cutting, and Brazing
29 CFR 1926.300, Subpart I, Tools - Hand and Power
29 CFR 1926, Subpart J, Welding and Cutting
AEDC COI 32-1, Fire Protection
AEDC Safety, Health and Environmental Standards
- B1, Master Work Permit
- B3, Control of Hazardous Areas
- B5, Confined Space
- C3, Local Exhaust Ventilation
- D4, Compressed Gas Cylinders
- E19, Lead and Heavy Metals
- F2, Personal Protective Equipment (PPE)
- F4, Respiratory Protection

AFI 91-203, Air Force Consolidated Occupational Safety Instruction
ANSI Z535.2, Environmental and Facility Safety Signs
ANSI (NSC) Z41, Personal Protection, Protective Footwear
ANSI Z49.1-2005, Safety in Welding, Cutting, and Allied Processes
ANSI Z87.1, Practice for Occupational/Educational Eye and Face Protection
API Standard 1104, Welding of Pipelines and Related Facilities
API Standard 2009, Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries.
API Standard 2201, Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries.
ASME Boiler and Pressure Vessel Code Section IX
Compressed Gas Association (CGA) E-4, Standard for Gas Pressure Regulators
National Fire Protection Association (NFPA) 51B, Standard for Fire Prevention during Welding, Cutting and Other Hot Work
NFPA 69, Standard on Explosion Prevention Systems

8.0 ANNEXES

A. Lens Shade Recommendations
B. Placard Requirements

9.0 SUPPLEMENT

A321-0801-XSP- C5 Welding and Cutting (Hot Work)

Annex A
Lens Shade Recommendations

Welding Operation	Electrode Size	Shade No.
Shielded Metal Arc Welding	1/16,3/32,1/8,5/32	10
Gas Shielded Are Welding (Non ferrous)	1/16,3/32,1/8,5/32	11
Gas Shielded Arc Welding (Ferrous)	1/16,3/32,1/8,5/32	12
Shielded Metal Arc Welding	3/16,7/32,1/4	12
	5/16,3/8	14
Soldering	---	2
Carbon Arc Gouging		14
Torch Brazing	---	3 or 4
Light Cutting (up to one inch)	---	3 or 4
Medium Cutting (one inch up to six inches)	---	4 or 5
Heavy Cutting (six inches and over)	---	5 or 6
Gas Welding- light (up to 1/8 inch)	---	4 or 5
Gas Welding--medium (1/8 to 1/2 inch)		5 or 6
Gas Welding--heavy (1/2 inch and over)		6 or 8

Annex B
Placard Requirements

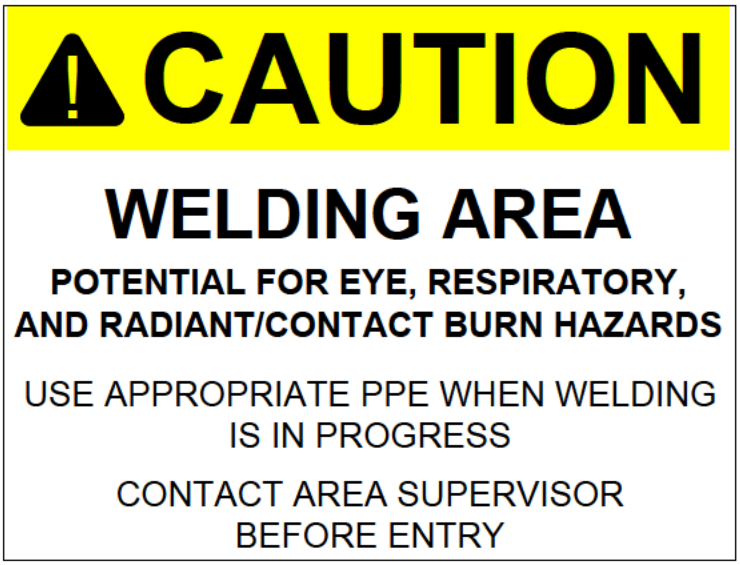

Figure 1, to be posted in all Welding areas

Figure 2, to be posted whenever hot work is left unattended

A321-0801-XSP- C5 Welding and Cutting (Hot Work)

This supplement has been approved for the NFAC Site.

Review: This supplement will be reviewed and updated using the same cycle as the AEDC Safety, Health, and Environmental (SHE) Standard C5, Welding and Cutting (Hot Work)

References: AEDC SHE Standard C5, Welding and Cutting (Hot Work), at the AEDC NFAC Site.

NASA Ames Safety Procedural Requirements APR 8715.1 Chapter 27.9.12 “Construction Safety Management” sub-section “Welding, Cutting and Burning”

Ames Procedural Requirements APR 1700_1 Chapter 20.4 “Hot Work Permits”

Scope:

This supplement establishes general guidelines for safety of personnel and facilities when performing welding or cutting (hot work) operations. General requirements, personal protective equipment, health protection, welding in confined areas, fire protection, and electric arc and resistance welding requirements are included.

This supplement applies to all personnel conducting operations, maintenance, testing and support at NFAC, NASA AMES.

NFAC Worksite Application:

NFAC will follow:

- NASA Ames Safety Procedural Requirements APR 8715.1 Chapter 27.9.12. “Construction Safety Management” sub-section “Welding, Cutting and Burning”
- Ames Procedural Requirements APR 1700_1 Chapter 20.4 “Hot Work Permits”.

Requirements/Responsibilities:

I. NFAC Site Management shall ensure all employees, vendors and customers know and follow the procedures.

II. Supervisors and Test Directors shall

1. Ensure that combustibles have been removed or covered in the area.
2. Post a Fire Watch as required.
3. Have a detailed Safe Plan of Action (SPA) prior to performing any welding and/or cutting.
4. Precautions have been taken so that building fire detection and suppression systems will not be adversely affected.
5. Ensure the appropriate fire extinguisher is available during all the required times of the welding operations to include the 30 minutes thereafter (60 minutes for torch-applied roofing operations).

III. NFAC Safety Engineer/Management Designee shall

1. Assist in obtaining the “Hot Work Permit” as prescribed in APR 8715.1 Chapter 27.9.12.
2. Assess welding/cutting operations.
3. Work with the Fire Marshall to establish a one year Hot Work Permit for the welding area.
4. Conduct periodic inspections of the welding area to ensure full compliance of this supplement.

IV. NFAC Staff shall ensure employees follow this supplement.