Welding and Hot Work Safety Program

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Berkeley Environment, Health & Safety

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Overview

The Welding & Hot Work program comprises two main subject areas—designated hot work areas and temporary hot work permits. It provides procedures and supplemental information for welding and hot work in any situation. It also provides specific guidance in the key program elements of: hot work permits, training requirements, roles & responsibilities, personal protective equipment (PPE), and recordkeeping.

Buildings may contain both combustible and flammable materials. Any open flame, spark, or other ignition source presents a fire hazard to buildings, structures, and materials, and most importantly, a significant injury potential.

Additionally, this program details procedures (and practical guidance) for performing hot work safely. These include the program roles of the operator performing hot work, the fire watch, the campus fire marshal, and the **permit-authorizing individual (PAI)**. Shop management and the establishment of designated hot work areas are other key elements. The program also contains supplemental information that is useful to educators, industrial hygienists, engineers, and similar parties responsible for safety and health.

Hot work procedures are a key component of this program and apply to all hot work operations regardless of whether the hot work is done in designated hot work areas or at temporary locations in the field.

The permit process discussed in this document is designed to prevent fire, prevent injury, and improve overall safety and is required for hot work areas outside officially designated hot work areas. Official designated hot work areas are inspected and approved by the Campus Fire Marshal and do not require a hot work permit.

Purpose

The purpose of this program is to protect persons from injury and illness, and to protect property and equipment from damage by fire and explosions resulting from flame, spark, or other ignition source; especially welding which is the most common type of hot work. The procedures outlined in this program must be followed by staff who perform welding and other hot work on UC Berkeley property. Throughout this document the phrase “hot work” will be used to represent the concept of “welding and other hot work” as used in the California Fire Code, and as defined on page 6 of this document. This program is designed to prevent injuries, prevent fire, control hazards, and to ensure compliance with Cal/OSHA safety regulations and the California Fire Code (CFC).[1]

By adhering to this program, all hot work operations conducted on UC Berkeley property comply with Cal/OSHA regulations and the California Fire Code.[1]

Implementation of procedures and adherence to the requirements outlined in this program are mandatory for all persons performing hot work on UC Berkeley property. This includes operations in research, instruction, housing, food preparation, and property maintenance. Hot work program training is provided to all affected UC Berkeley personnel. However, UC Berkeley does not provide this training to contractors.

Scope and Applicability

Adherence to procedures outlined in this program is mandatory for persons in any UC Berkeley department performing operations (indoor and outdoor) that produce heat adequate to ignite materials. This may include, but is not limited to:

- Oxy-fuel gas welding, cutting, heating (See Appendix 2 for safety guidance on blended gas torch systems)
- Arc welding and cutting
- Resistance welding
- Plasma cutting
- Brazing
- Pipe sweating/flame soldering
- Heat treating
- Grinding
- Any work requiring use of a torch

Exceptions:

- Laser cutting and all other laser use (Laser use must be approved by the Office of Environment, Health & Safety's [EH&S] Laser Safety Officer and the Non-Ionizing Radiation Safety Committee).
- Candles used in research and theater arts, if attended for the duration of use.
- Ovens specifically designed and built by a reputable manufacturer with a Nationally Recognized Testing Laboratory (NRTL) certification, such as Underwriters Laboratory (UL), for heat treatment or annealing of research materials
- Electric soldering irons
- Bunsen Burners and other flame operations in labs or spaces designed and supplied for this type of equipment
- Stoves and other cooking operations
- Candles
- Pyrotechnics or special effects

Roles and Responsibilities

Managers, Supervisors, and Principal Investigators

Managers, Supervisors, and Principal Investigators have the primary responsibility of ensuring the health and safety of their employees. When hot work is done outside of a designated hot work area with an approved hot work permit, the supervisor is responsible for the following:

- Ensuring their units comply with the UC Berkeley Welding and Hot Work Safety Program.
- Ensure that individuals performing programmatic roles receive hot work program training.
- Ensure that a hot work permit is issued by a permit-authorizing individual before the hot work starts each day.

- Ensure that a fire watch signs the day's hot work permit before the hot work starts, is present when required, and remains on-site during the hot work and for at least 30 minutes after the hot work is complete.
- Being aware of the personal and environmental risk factors present in designated hot work and welding areas.
- Designate individuals to perform the programmatic roles of "permit authorizing individual", "operator", and "fire watch".
- Obtain approval from the UC Berkeley Fire Prevention Division whenever a fire alarm needs to be deactivated for a project (Call the Facilities Services Shut-down Desk at (510) 642-1032 to request a scheduled deactivation). Supervisors are also responsible for ordering that the alarms be reactivated at the end of each shift. If the alarms cannot be reactivated, the supervisor must coordinate a fire watch for the building.
- If applicable, verify that any disabled fire alarms were reactivated. Sign the supervisor section on the Hot Work Permit acknowledging the verification and filing of the permit each day.
- Where fire sprinkler systems are in the hot work area, the supervisor shall ensure the fire sprinkler system is not impaired. Hot work is not permitted where fire sprinkler systems are shut off.[1]
- Wear all appropriate Personal Protective Equipment (PPE), and ensure that all employees working in designated hot work and welding areas are wearing the appropriate PPE.
- Observe and follow all safety guidelines, signage, and operating instructions.
- Checking that a working fire extinguisher is present in all designated hot work areas.

Permit Authorizing Individual (PAI)

The permit-authorizing individual has the following responsibilities:

- Performs the initial safety assessment of the hot work area, as well as daily re-assessments before hot work resumes.
- Ensures compliance with the safe work requirements listed in the hot work permit section of this program.
- Must either act as fire watch, or verify that a fire watch is on site and has signed the day's hot work permit.
- Completes and signs the hot work permit every day.
- May act as fire watch simultaneously, but not as operator.

Operators

The operator is the person using the equipment that produces a potential ignition source. Operators have the following responsibilities:

- Must be qualified to fill the roles of PAI and fire watch, though they must not fill either of these roles while acting as operator.
- Must be qualified to operate the hot work equipment. Qualification is determined by their supervisor.
- Must verify that the equipment is safe to use; that its condition will not cause injury or accidental ignition.

- Is responsible for performing the hot work in accordance with hot work procedures and all precautions listed on the hot work permit.
- Must wear all required personal protective equipment (PPE).
- Must not perform hot work unless all persons within the hot work area are also wearing appropriate PPE.
- Must stop work and inform their supervisor if conditions change after the hot work permit is issued.

When working outside of a designated hot work area, operators have the following additional responsibilities:

- Must not begin hot work until the daily hot work permit has been completed, signed, and posted on site by the PAI.
- If a fire watch is required, the operator may only begin hot work once the fire watch has signed the hot work permit.
- If a fire watch is required, the operator may only perform hot work while the fire watch is present. If the fire watch leaves the area, the operator must stop work.

Fire Watch

A “fire watch” is required when fire hazard exposures are present or whenever combustible material is within 35 feet of the heat-producing operation and cannot be isolated from the work by other means such as welding pads or fire cloths. This requirement includes all areas separated by wall openings, floor openings, or metal partitions within a 35-foot radius from the hot work operation. Such openings might expose combustible material in an adjacent area to ignition temperatures through heat conduction or radiation--which may cause the material to ignite. Additional fire watches are required where areas below the hot work area are exposed to the hot work area. A fire watch is not required in a hot work area that has no fire hazards or combustible materials.

The fire watch duties can be assigned to anyone who understands the hazard of the hot work being performed and the limitations placed on the work operation by the PAI issuing the hot work permit for that day. The fire watch reviews and signs the permit prior to the start of work. The fire watch has the responsibility to make certain the hot work area is maintained in a fire-safe condition throughout the performance of the hot work and has the authority to stop the hot work if unsafe conditions are observed.

If it is not possible for one fire watch to observe the entire area for potential fire, the fire code requires that additional fire watches be assigned to ensure that the exposed areas are monitored (CFC).[1]

Persons acting as fire watch must:

- Receive annual training in the use of portable fire extinguishers.
- Understand the basic hazards of any combustible construction and materials.
- Maintain proper isolation of all hot work operations from combustible or flammable materials.
- Mitigate fire exposure hazards adjacent to, above or below the hot work operation.
- Keep a fire extinguisher with a minimum rating of 2-A:20-B:C within 30 feet of the hot work location or, where required, a charged water hose.
- Know how to activate the fire alarm and call UCPD.
    - (510) 642-3333 – Cell Phone
    - 911 – Campus Landline

- When calling UCPD to report a fire, include the building name, floor, area or room number, injuries, and any other important information.
- Watch for fires in all exposed areas.
- Extinguish fires only when it is obviously within the capacity of the available equipment.
- Activate the fire alarm if immediate attempts to control a fire are not successful.
- Maintain a fire watch for the duration of hot work and for at least 30 minutes after completion of the hot work.

The fire watch may also act as the PAI, but never the operator, on the same job.

Campus Fire Marshal

- Designates, inspects, and approves hot work areas on campus.
- Oversees the permitting process for designated hot work areas.
- Oversees the building's fire sprinkler and fire alarm systems and any precautions taken to avoid accidental operation of systems.
- Extends fire watch based on hazards or work being performed.

EH&S

- Health & Safety Team Specialist reviews Hot Work Permits when work is performed by UC employees.
- Inspects Designated Hot Work Areas as part of the Shop Safety Program.

Employees, Welders and Qualified Persons

- Be up to date on all training required for welding and hot work.
- Be able to identify, report, and control hazards present in welding and designated hot work areas.
- Must wear the appropriate PPE.

Definitions

Allied Processes – A code term used to describe hot work processes such as arc cutting, oxygen cutting, thermal spraying, and plasma cutting.

Approved - In this document the use of the word approved refers to something that is officially accepted, confirmed, or sanctioned by EH&S staff.

Combustible – Generally refers to any material capable of burning, generally in air under normal conditions of ambient temperature and pressure. The Globally Harmonized System (GHS) of the Hazard Communication Standard defines a combustible liquid as having a flash point above 199.4°F (93°C). The California Fire Code defines a combustible liquid as having a flash point at or above 100°F (38°C).[1]

Designated Hot Work Area – A permanent location designed for safe hot work operations and approved by the UC Berkeley EH&S Fire Prevention Division.

Fire Watch - A person or persons responsible for continuously observing the hot work area, maintaining fire-safe conditions, and responding to emergencies during hot work operations and in the established period following.[4]

Flammable – Generally refers to materials that can readily undergo combustion in the presence of a source of ignition under standard circumstances. The GHS defines a combustible liquid as having a flash point at or below 199.4°F (93°C). The California Fire Code defines a flammable liquid as having a flashpoint below 100°F (38°C).

Hot Work – Any operation which requires use of an open flame, or which produces sparks or heat sufficient to ignite nearby materials; hot work operations include cutting, welding, brazing, soldering, thermite welding, induction welding, grinding, thermal spraying, pipe thawing, installation of torch-applied roofing, or any other activity that uses open flame or generates temperatures sufficient to ignite materials.

Hot Work Area – The area exposed to sparks, hot slag, radiant heat, or convective heat as a result of the hot work .[1]

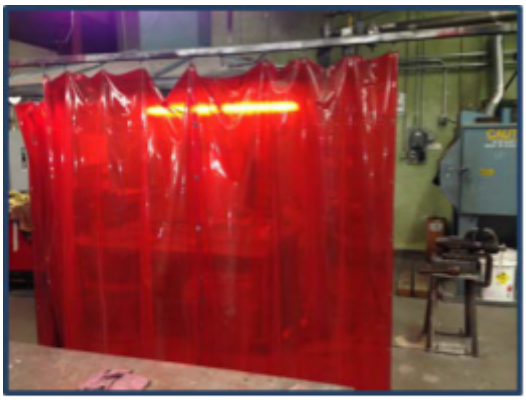
Hot Work Equipment – Electric or gas welding or cutting equipment used for hot work .[1]

Hot Work Permit – A document issued for the purpose of verifying the safety of an area where hot work is to be conducted, as per the requirements of this program. Permits are issued by the Permit Authorizing Individual under this hot work program permitting Hot Work to be done. Hot Work permits are issued for any Hot Work being done outside of Designated Areas.

Non-ionizing Radiation – Lasers, electron beams, or any other type of electromagnetic radiation that does not carry enough energy to ionize atoms or molecules; within the context of hot work, this is limited to ultraviolet light, lasers, and the infrared light that is generated during research and instruction.

Permit Authorizing Individual (PAI) – Performs the initial safety assessment of the hot work area, as well as daily re-assessments before hot work resumes. Ensures compliance with the safe work requirements listed in the hot work permit section of this program before approving the new permit for each day of hot work. Must either act as fire watch, or verify that a fire watch is on site and has signed the hot work permit. Completes and signs the hot work permit. May act as fire watch simultaneously, but not as operator.

Principal Investigator (PI) – Is the holder of an independent grant administered by a university and the lead researcher for the grant project, usually in the sciences, such as a laboratory study or a clinical trial. The phrase is also often used as a synonym for "head of the laboratory" or "research group leader". PI's manage the compliance of their research with this safety program. They may delegate personnel to fill the programmatic roles of fire watch, operator and PAI, or act in some of the programmatic roles themselves. They demonstrate implementation of this program by maintaining hot work permits and training documentation as part of their research records.



Welding area, with the welding curtain separating work area from the rest of the space

Qualified Person – A person who by reason of training, education, and experience, has been determined by their supervisor to be knowledgeable in the operations to be performed and is competent to identify and control the hazards involved.

Welder – Any operator of electric or oxy fuel gas welding or cutting equipment, or person performing allied processes. This includes educators and students who are engaged in similar activities.

Welding Curtain – A heat-resistant hanging barrier designed to contain hazards that result from hot work such as exposure to sparks or ultraviolet light; they are hung in areas where work such as grinding, heat treating, sandblasting, and light-duty welding is performed.

Welding Pads – A heat-resistant fabric mat designed to protect materials underneath it against ignition; pads are placed on the surface of flammable materials directly under a hot work operation where hot debris might cause damage or start fires.

Designated Hot Work Areas

Design

A designated hot work area is an area specifically designed and approved* for hot work. It is constructed of non-combustible or fire-resistive material, is free of flammable objects, and is isolated from adjacent areas not designed for hot work.

Permit Approval

A designated hot work area must be approved by the campus fire marshal or their designee who has been trained in the California Fire Code, Chapter 35, Welding and other Hot Work*, Cal/OSHA §§ 4848, 3219, and 3221.[1,2] Once established, designated hot work areas must be inspected or reviewed annually (and documented) by a responsible supervisor to ensure ongoing fire safety.

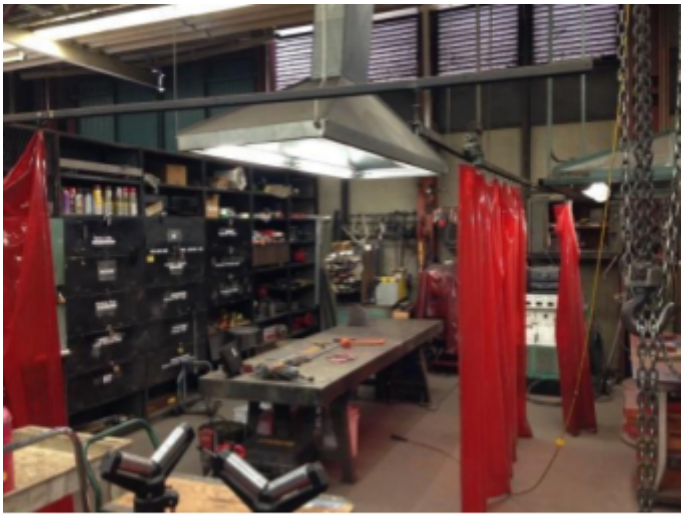
To find out more about establishing a designated hot work area, contact the EH&S fire prevention division by email fireprevention@berkeley.edu or by phone (510) 642-3073.

* *Per the CFC a permit (referred to as "approval" in this document) is required to conduct hot work in a designated hot work area. A permit can be issued for a prescribed period of time and be subject to periodic inspections.*[1]

Requirements of a Designated Hot Work Area

The California Fire Code (CFC) § 3504 states that a work area must have the following design characteristics to be classified as a designated hot work area (NOTE: This list is not all-inclusive of the requirements of the CFC. See CFC Chapter 35 for additional requirements.[1])

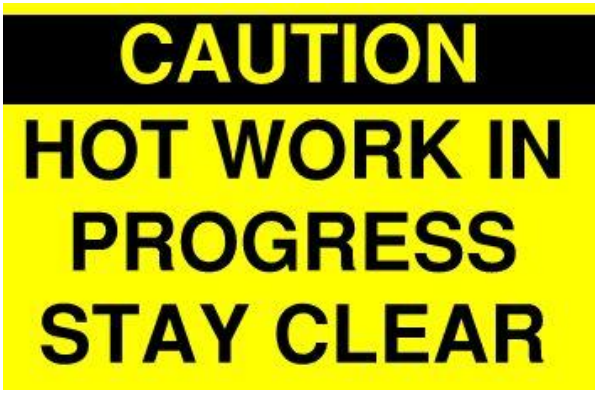
1. Designated hot work areas must be provided with at least one portable fire extinguisher with a minimum rating of 2-A:20-B:C and must be within 30 feet of hot work performed.
2. Combustible materials must be removed or must be provided with appropriate shielding to prevent ignition from sparks, slag, or heat.
3. Openings or cracks in walls, floors, ducts, or shafts must be tightly covered to prevent the



Welding Shop at Facilities Services

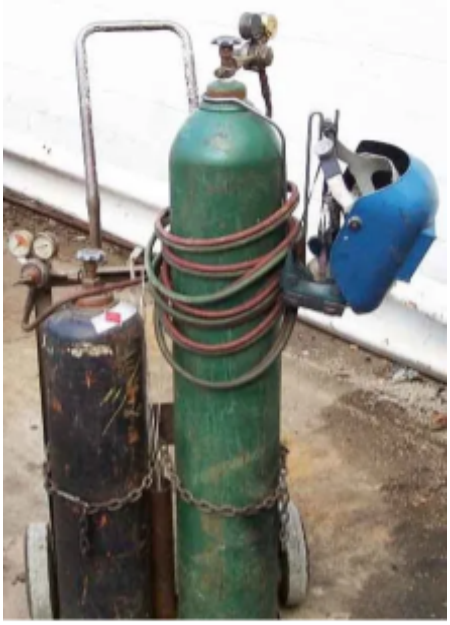
passage of sparks to adjacent or hidden areas. If they cannot be covered, they must be shielded by fire-resistant guards. Fire-safe curtains must be provided to prevent passage of sparks or slag out of the designated hot work area.

4. Floors are kept clean and free from trip, slip, and fall hazards.
5. Floor surfaces must be noncombustible.
6. Conveyor systems that are capable of carrying sparks to distant combustible materials are shielded or shut down during hot work activities.
7. Partitions to prevent the passage of sparks, slag, radiant heat, and UV light from the hot work area
    a. Shall be noncombustible.
    b. Securely connected to the floor so that no gap exists between the floor and the partition.
    c. Openings in partitions must be protected by welding-grade curtains or other permanent physical barriers, either attached to the structure, or of rugged portable construction.
8. Where the hot work area is open to persons other than the operator of the hot work equipment, Warning signs shall be posted displaying the following warning: "CAUTION HOT WORK IN PROGRESS STAY CLEAR."



9. Fire protection systems including fire sprinkler and fire alarm systems shall remain in service, unless specifically permitted to be disabled by the Campus Fire Marshal. The PAI shall contact the Campus Fire Marshal to discuss special conditions that would allow the impairment of any fire protection system. This may involve additional fire watches for the building.
10. An oxygen-fuel gas system with two or more manifolded cylinders of oxygen shall be in accordance with NFPA 51.[3]
11. Compressed gas cylinders and fuel gas cylinders shall comply with CFC Chapters 35 and 53.[1]

Additional requirements are described in the Design and Maintenance Procedures section below.



In use gas-fuel welding cart [8]

Design and Maintenance Procedures, Cylinder Storage and Use

- Cylinders must be kept far enough away from welding or cutting operations so that sparks, hot slag, or flame will not reach them. Otherwise, fire-resistant shields are provided for protection.
- Cylinders containing oxygen, acetylene, or any other fuel or gas must not be taken into confined spaces.

- Welding fuel-gas cylinders are placed with the valve end up whenever they are in use or being stored.
- When in use, nothing is placed on top of an acetylene cylinder which may damage the safety device or interfere with the quick closing of the valve.
- Cylinders connected to regulators and ready for service, are considered to be “in use” when they are kept adequately secured in a welding cart.
- When not “in use” cylinders must be securely stored upright by two non-combustible chains or straps located at the top one-third and bottom one-third of the cylinder height. Chains and straps must be snug. Rope or string is not acceptable. Valve covers or other protective devices shall be installed on the cylinders when not in use.
- When not in use, incompatible welding-gas cylinders (e.g. oxygen & acetylene) must be separated by a distance of 20 feet, or by a non-combustible partition extending not less than 18 inches above and to the sides of the stored cylinders.

Protection of Personnel

- Prior to performing hot work on equipment that contains (or has contained) flammable materials, it must be thoroughly cleaned, dried, and purged.
- Maintain good housekeeping at all times. Keep gasses separated, remove all dust, debris, flammable objects, and substances from the area, properly store cables and hoses, and limit trip and fall hazards.
- Protect persons in areas adjacent to the hot work by installing flame-resistant screens or shields. Separate adjacent hot workstations with similar partitions.

Ventilation

Welding and cutting can release potentially hazardous materials from fluxes, coatings, and metals into the atmosphere. Ventilation within the designated hot work area must be sufficient to keep concentrations of airborne contaminants below the Cal/OSHA Permissible Exposure Limits (PEL).

Welding fumes being pulled out by a snorkel exhaust

If natural ventilation is not sufficient, mechanical ventilation such as exhaust fans or smoke filters must be provided to eliminate the airborne hazards. If mechanical ventilation is not sufficient to maintain contaminants below the PELs, then operators must be provided with respirators.

There are several types of mechanical ventilation including local exhaust, forced air, and general area mechanical air movement.

Local exhaust ventilation is preferred and should be placed as near as practicable to the hot work. Forced ventilation delivers air to workers at a positive pressure, such as a fan placed so that it moves fresh air across the welder’s face. Neral mechanical ventilation may be necessary in addition to forced ventilation. Examples include roof fans, wall or window exhaust fans,

and similar large-area air movers. General mechanical ventilation is not usually satisfactory for health hazard control but is often helpful when used in addition to local exhaust or forced ventilation.

In locations where conditioned air or space logistics prevent direct exhaust of smoke, a local smoke remover may be used. This is a portable smoke removal system that scrubs hot work smoke and particulates from the air and exhausts the air back into the work area.

Equipment Selection

All electrical and gas hot work equipment must be approved by a Nationally Recognized Testing Laboratory (NRTL) such as Underwriters Laboratory or similar per the current Federal OSHA NRTL Program list.[5]

Hot Work Permit Procedure

The CFC requires an operational fire permit to be issued for hot work areas. For temporary hot work locations, a new hot work permit must be completed, signed, and posted for each day hot work is performed.[1] See Appendix 1 for a copy of the UC Berkeley Hot Work Permit. The permit must be issued by a PAI. For jobs that occur in both indoor and outdoor locations, a separate permit for each location must be issued.

The safety principles and procedures described in the previous section on designated hot work areas, specifically: Cylinder Storage and Use, Protection of Personnel, Equipment Selection, and Ventilation, apply also to hot work permit areas.

Before a hot work permit is issued, a safety assessment is completed and the following safe work conditions must be verified by a PAI:

- The hot work equipment must be in safe operating condition and good repair.
- Fully charged and operable fire extinguishers appropriate for the type of possible fire must be immediately available at the work area.
- All combustible materials within a 35-foot radius from the hot work must be relocated. If relocation is impractical, the materials must be protected by an NRTL- approved welding curtain, welding blanket, welding pad, or equivalent barrier. To prevent the sparks from passing underneath covers, they must be tight against the floor and held in place from movement. Where covers overlap to cover a pile of combustible material, they must be tightly clipped together.[4]
- The floor must be swept clean for a radius of 35 feet from the hot work in areas where combustible materials such as paper, wood shavings, textile fibers, or rubber are on the floor.
- Combustible floors must be kept wet, covered with damp sand, or protected by an NRTL-approved welding blanket, welding pad, or equivalent barrier. Where floors have been wet down, operators must be electrically-isolated from equipment and protected from possible shock.[4]
- Openings or cracks in walls, floors, or ducts within 35 feet of the site must be covered or sealed with approved fire-rated or non-combustible material to prevent the passage of sparks to adjacent areas.
- Ducts and conveyor systems that are capable of carrying sparks to distant combustible materials must be shielded or shut down.
- If hot work is done near walls, partitions, ceilings, or roofs of combustible construction, they must be protected by an approved welding curtain, welding blanket, welding pad, or equivalent.
- If hot work is done on one side of a wall, partition, ceiling, or roof, precautions must be taken to prevent ignition of flammable materials on the other side by relocating the materials. If it is impractical to relocate

the materials, a person acting as fire watch must be provided on the side opposite from where the work is being performed.
- Hot work must not be attempted on a partition, wall, ceiling, or roof that has a combustible covering or insulation, or on walls or partitions with combustible panel construction.
- Hot work that is performed on pipes or other metal that is in contact with combustible walls, partitions, ceilings, roofs, or other materials must not be undertaken if the work is close enough to cause ignition by heat conduction.
- Access to the permitted hot work area by people not involved in the work must be controlled.
- Curtains, closed doors, barricades or other means must be used to prevent any ultraviolet radiation from leaving the permitted area.
- If water hoses are located within the permitted hot work area, they must be connected and ready for service, but it is not required that they be unrolled or charged with water.
- A fire watch must be present during hot work activities and shall continue for not less than 30 minutes after the conclusion of work. (This is required irrespective of the fire alarm system status)

Special precautions must be taken to avoid accidental activation of automatic fire or smoke detection or suppression systems such as sprinklers or other special extinguishing systems. When conducting hot work in close proximity to a fire sprinkler, a wet rag or similar heat barrier must be laid over the sprinkler head during hot work, and removed at the conclusion of the operation.

Disabling of any fire detection or alarm system must be approved by the Fire Prevention Division of EH&S (510-642-3073), and noted as such on the hot work permit. The supervisor or designee is responsible for requesting a Fire Protection System Shutdown Request from Facilities Services. Unless there is an emergency, the typical Shutdown requires an 11-day notice. Only then may Facilities Services (510-642-1032) personnel disable the alarms or detectors. Facilities Services will also re-enable the alarms or detectors when the hot work is concluded. The supervisor is responsible for verifying that any fire alarms disabled during the work were reactivated upon its completion. The supervisor acknowledges this verification by signing the permit.

Regardless of the scope of work and local conditions, the PAI must assess the area and issue a new hot work permit for each day of work.

Reducing or Increasing the Fire-Safe Distance

The PAI may enlarge or reduce the fire-safe work area as local conditions allow, but must describe these deviations from protocol on the hot work permit. When, for example, windy conditions enable sources of ignition to travel farther than 35 feet, the permit conditions must be extended to the estimated distances and area indicated by local conditions. When it has been determined that the hot work will not generate or transport ignition sources outside of the immediate area, the permit conditions may be reduced to the area of safe operation.

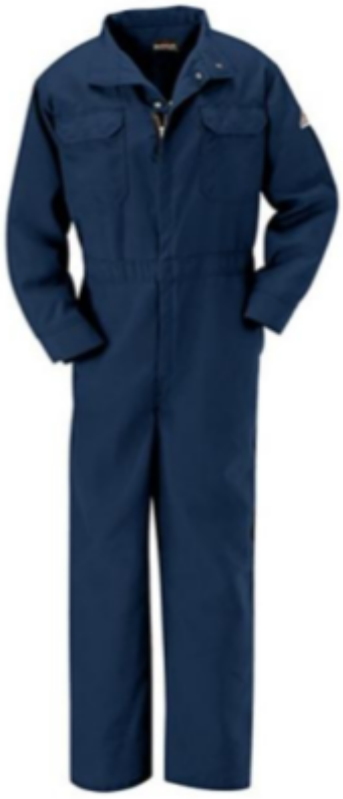
Personal Protective Equipment (PPE)

Protective Clothing – Selection and Preparation

Hot work clothing provides sufficient coverage and is made of non-combustible and sturdy materials to minimize skin burns caused by sparks, spatter, radiant heat, and ultraviolet light. Appropriate protective clothing for a hot work operation will vary by material and coverage based upon location worn on the body and type of hot work.

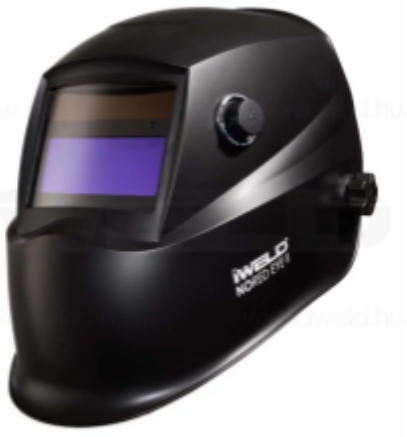
Clothing should be kept reasonably clean, as oil and grease can reduce its protective qualities and could be flammable. Frayed clothing is particularly susceptible to ignition and must not be worn when performing hot work.
Flame-resistant clothing made from tightly woven materials such as wool and heavy cotton or seamless leather is preferable.

Sparks may lodge in rolled-up sleeves, pockets of clothing, or cuffs of overalls or trousers. Sleeves should be rolled down and collars kept buttoned. Pockets should be eliminated or protected by leather aprons or welding jackets worn over clothing. If pockets are worn, they should be emptied of combustible materials. Trousers should overlap shoe tops and ankles to prevent spatter from getting into shoes. Work boots that cover the ankle are preferable to low-rise shoes.



Flame Resistant Clothes [9]

Eye, Face, and Head Protection – Selection and Preparation



Welding Safe Helmet [10]

Welding

Any persons who might be exposed to ultraviolet light (UV) generated by welding must wear eye protection with filter lenses specifically designated for the type of welding they are doing. Personnel must contain any long hair under PPE. Then, wear a welding helmet with the appropriate shade number as shown in the table below for eye and face protection. (Prescription glasses can be worn under the welding helmet).

Welding Operation Reference Table

Welding Operation	Shade No.
Shielded metal arc welding (SMAW, MMA, MMAW, flux shielded, stick): A. 1/16-, 3/32-, 1/8-, 5/32-inch electrodes B. 3/16-, 7/32-, 1/4-inch electrodes	A. 10 B. 12
Gas-shielded arc welding (GMAW, MIG, MAG), (nonferrous) - 1/16-, 3/32-, 1/8-, 5/32-inch electrodes	11
Gas-shielded arc welding (GMAW, MIG, MAG), (ferrous): A. 1/16-, 3/32-, 1/8-, 5/32-inch electrodes B. 5/16 -, 3/8-inch electrodes	A. 12 B. 14
Gas Tungsten arc welding (GTAW, TIG)	11
Atomic hydrogen welding	10-14
Carbon arc welding or cutting (gouging)	14
Medium cutting, 1 inch to 6 inches	4 or 5
Heavy cutting, 6 inches and over	5 or 6
Gas welding (thin material) up to 1/8 inch	4 or 5
Gas welding (medium material) 1/8 inch to 1/2 inch	5 or 6
Gas welding (thick material) 1/2 inch and over	6 or 8

Soldering / Brazing

Prior to performing non-UV-generating hot work such as common soldering and brazing operations, personnel must contain any long hair under PPE. Then, wear a clear full face shield over prescription glasses or eye goggles for eye and face protection. The goggles or prescription glasses must have the appropriate lens shade number in the table below based upon the type of soldering/brazing being done.

Soldering / Brazing Reference Table

Welding Operation	Shade No.
Soldering	2
Torch brazing	3 or 4
Light cutting, up to 1 inch	3 or 4

Hearing Protection

Hearing protection must be used where high-noise hazards exist. Examples of high-noise hot work include air carbon arc cutting (gouging) and grinding steel prep work in a manhole.

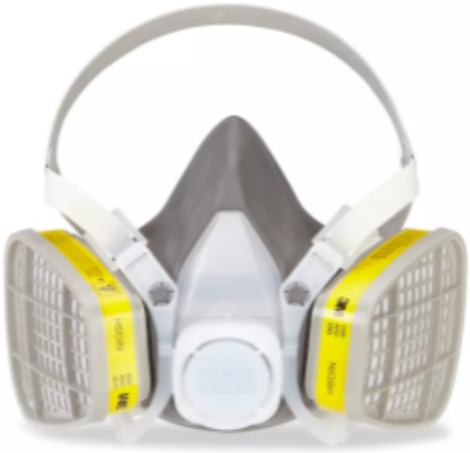
Gloves

Welding Safe Flame-Resistant and Electrically Non-Conductive Gloves [12]

All welding and cutting must be conducted wearing flame-resistant and electrically non-conductive gloves that allow adequate dexterity for manipulation of the welding equipment and controls in addition to weld-filler rods. Gloves must be in good repair with no holes or frayed seams and free of oil or water residue. Gloves must cover the cuff of long-sleeve shirts, fit snuggly around the forearm, and preferably protect up to mid-forearm in length.

Respiratory Protection

When ventilation of the hot work area is not adequate to maintain healthy breathable air, respiratory protective equipment must be used. Personnel wearing it must be enrolled in the UC Berkeley Respiratory Protection Program. Only respirators approved by EH&S and specific to the hot work hazards may be worn. The UC Berkeley Respiratory Protection Program requires medical clearance by University Health Services Occupational Health Clinic, as well as fit-testing and training by EH&S on respirator care and use. Annual enrollment, medical clearance, and fit-testing may be required for every person enrolled in the UC Berkeley Respiratory Protection Program. Contact EH&S respirator@berkeley.edu / (510) 642-3073 to enroll personnel in the Respiratory Protection Program.



Hot Work Approved Respirator [13]

Training Requirements

PI or Supervisor

Contents of the hot work program including:

- Requirement for delegating responsibility to PAI and hot work personnel
- Programmatic roles played by personnel
- Design and construction of a designated hot work area
- Safe hot work practices and procedures
- Process for completing a hot work permit
- Importance of retaining the permit at the conclusion of the work
- Process for alarm shut-down and re-enabling
- Recordkeeping requirements

Permit Authorizing Individual, Fire Watch, and Operators

Contents of the Hot Work Program including:

- The programmatic roles played by personnel
- Design and construction of a designated hot work area
- Safe hot work practices and procedures
- Process for preparing an area for hot work and completing a hot work permit
- Process for closing out a hot work permit
- Familiarity with the process for ordering a fire sprinkler system or smoke detector shut-down and re-enabling (NOTE: Specific Campus Fire marshal approval is required)
- Fire Watch – Fire extinguisher training is required
- Recordkeeping requirements

Operators

Operators must be trained to safely operate the specific equipment used for their hot work.

Recordkeeping Requirements

- Hot work permits must be kept on file by the issuing department for two years. They must be made available for review by EH&S or regulatory authorities upon request.
- Training records including rosters and subjects covered must be kept by the department for the duration of attendee's employment plus three years. Copies must be provided to EH&S for additional long-term archiving.
- An inventory of designated hot work areas approved by the Campus Fire Marshal is maintained by the Fire Prevention division of EH&S.
- Respiratory protection program training records must be kept for any employees who use respiratory protection. These records are maintained by the responsible department (Medical Qualification records are maintained at UHS. A copy of fit test and respirator training records are maintained at EH&S.)

References

1. California Code of Regulations, Title 24, Part 9 - 2022 California Fire Code, Chapter 35 & 53

- Welding and Other Hot Work §3504 Fire Safety Requirements
- Compressed Gasses §5303 General Requirements

2. California Code of Regulations, Title 8, -Industrial Relations, Division 1 :

- §3219 Maintenance of Fire Protection Equipment, Materials and Assemblies
- §3221 Fire Prevention Plan
- §4845 General Precautions
- §4848 Fire Prevention and Suppression Procedure
- §4850 Electric Welding, Cutting, and Heating – General Requirements

3. National Fire Protection Association (NFPA) 51, Design and Installation of Oxygen-fuel Gas Systems for Welding, Cutting and Allied Processes, 2018 Edition.

4. National Fire Protection Association (NFPA) 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, 2024 Edition.

5. All electrical and other hot work equipment must be approved by an NRTL such as Underwriters Laboratory or similar per the Federal OSHA NRTL program list.

6. All electrical equipment used to perform electric operations and processes are installed and maintained in accordance with the California Electrical Safety Orders, and Chapters 11, 12, and 13 of the American National Standards Institute, ANSI/ASC Z49.1-94, *Safety in Welding, Cutting and Allied Processes.*

7. American National Standards Institute (ANSI) Z49.1-2012, Safety in Welding, Cutting and Allied Processes

8. Image of fuel-gas cylinder. https://torchtips.com/

9. Flame Resistant Clothes. https://www.weldersupply.com/

10. Welding Safe Helmet. https://www.hvalleytools.com

11. Welding Safe Earmuffs. https://www.apexweldingsafety.com

12. Welding Safe Flame-Resistant and Electrically Non-Conductive Gloves. https://www.harborfreight.com

13. Hot Work Approved Respirator. https://www.uline.com

Issued By

REVISION DATE	SECTIONS REVISED	SUMMARY OF CHANGES	CHANGE WRITTEN BY / AUTHORIZED BY
April 10, 2018		Program review	Reviewed and approved by • Associate Director, Health and Safety, EH&S • Campus Fire Marshal, Fire Prevention Division, EH&S
August 19, 2024		Program review	Reviewed and approved by • Assistant Manager of Health and Safety, EH&S • Fire Prevention Specialist, Fire Prevention Division, EH&S

Appendices

Appendix 1: Hot Work Permit

UC BERKELEY HOT WORK PERMIT

Department _____ **WORK ORDER #:** _____ **WORK DATE:** _____

☐ **INDOOR**
Complete sections A, B, and D

BUILDING: _____ **ROOM #:** _____

☐ **OUTDOOR**
Complete sections A, C, and D

NEAREST STRUCTURE: _____

SIDE: ☐ NORTH ☐ SOUTH ☐ EAST ☐ WEST

APPROX. DISTANCE TO STRUCTURE: _____

Description of area covered by permit:

A. GROUNDS AND FACILITIES INFORMATION *(applies to all hot work)*

- ☐ Hot work authorized by this permit will be performed within a confined space. *If checked, see below.*
  - ☐ A 4-gas meter is on site
  - ☐ A Confined Space Entry Permit is posted on site
- ☐ All equipment to be used has been inspected for safe operation by the operator. _____ (operator's initials)
- ☐ Fire alarms are present at the site. *If checked, see below.*
  - ☐ Fire alarms have been disabled because of anticipated smoke.
- ☐ Hot work will be performed near fire sprinklers or smoke detectors. *If checked, see below.*
  - ☐ Sprinklers and/or alarms have been shielded from heat
  - ☐ Shielding has been removed following completion of hot work _____ (initials)
- ☐ Fire extinguishers are available at the site in addition to the fire extinguishers designated for any building.
- ☐ Employees and contractors not directly associated with the hot work have been advised of any flammable materials or other hazardous conditions in the area.
- ☐ A Fire Watch is on duty.

The following precautions have been taken in the hot work area and surrounding 35 feet of space:

- ☐ The area is free of combustible materials. *If not, see below.*
  - ☐ Combustible materials in the area are protected from ignition sources with flame-proof covers, or shielded with suitable guards or curtains.
- ☐ Tanks, vessels, and other enclosed areas that may contain flammable vapors or gas have been tested with a 4-gas meter (or similar instrument), and levels have been verified at <10% LEL.
- ☐ Cracks or openings in walls, doorways, windows, or floors are closed or covered, or protected with guards or shields.

- ☐ Walls, partitions, ceiling, or combustible roofing are protected by fire-resistant shields or guards to prevent ignition.
- ☐ If hot work is to be done on a metal wall, partition, ceiling, or roof, combustibles on the other side have been removed.
- ☐ Ducts and conveyor systems that might carry sparks to distant combustibles are suitably protected or shut down.

Fill out Section B for Indoor Hot Work, OR Section C For Outdoor Hot Work.

B. INDOOR HOT WORK

- ☐ Combustible floors are kept wet, covered with damp sand, or protected by fire-resistant shields. (Where floors are kept wet, personnel operating arc welding or cutting equipment must be protected from possible shock.)

C. OUTDOOR HOT WORK

- ☐ Smoke generated by hot work activities is contained or ventilated away from any nearby building's air intakes.
- ☐ Combustible vegetation or landscaping components are kept wet, or protected by fire-resistant shields.

D. PROCEDURAL INFORMATION *(applies to all hot work)*

Type of Heat Production:

- ☐ gas weld or cut
- ☐ arc weld or cut
- ☐ grinding
- ☐ flame heat
- ☐ solder
- ☐ other _____ (please specify)

The following PPE (personal protective equipment) will be used:

- ☐ welding helmet
- ☐ Nomex coveralls
- ☐ air purifying respirator
- ☐ safety glasses/face shield
- ☐ work gloves
- ☐ shaded glasses
- ☐ welding leathers
- ☐ long sleeve shirts
- ☐ other _____ (please specify)

Permit Authorizing Individual

I have inspected the area, found all applicable fire prevention controls to be in place, and hereby approve hot work in this area, so long as the above-listed conditions do not change.

_____
print name

_____
signature

Supervisor

I have verified that, if fire alarms were disabled during this work, they were reactivated upon its completion. This report has been filed in accordance with UC Berkeley's Hot Work Program.

_____
print name

_____
signature

Fire Watch

_____
print name

_____
signature

Operator

_____
print name

_____
signature

Appendix 2: Safety Guidance for Blended Gas Torch Systems

Blended gas mixtures for torches, such as fuel and oxygen, are used for a variety of purposes in research labs; from welding fabrication to soldering, brazing to glassblowing and sealing. Proper use of oxy-fuel torch systems is essential to safe practices both with the torch and the system as a whole. Improper mixing of fuel and oxygen can create explosive atmospheres.

Definitions

Flashback Arrestor - A flashback arrestor is a device used to prevent the backflash of a flame from the torch back through the hose. Most modern flashback arrestors also contain check-valves which act to prevent the backflow of gases.

Check-Valve or Backflow Preventer - A device that prevents the backflow of gases into the line. Cal/OSHA requires backflow prevention where oxygen and gas are used in torches.

Types of Oxy-Fuel Systems

Stand-alone system – The most common type of oxy-fuel set-ups involves two separate cylinders, 1 oxygen and 1 fuel source (e.g. methane, propane, acetylene, hydrogen). These systems involve the use of regulators on each cylinder to control the output pressure of each line. Most purchased stand-alone torch set-ups have check valves or flashback arrestors installed, but this is not always the case. Without proper safety controls, gas from one cylinder can become mixed within the system with the other gas component, which can lead to a potentially explosive atmosphere. To eliminate that danger, Cal/OSHA requires that all oxy-fuel set-ups have flashback arrestors or at least check-valve devices in place on both lines to prevent the mixing of gases in the lines, regulator, or tanks.

House fuel gas systems – More unique, though prevalent on campus, certain facilities are using piped natural gas (methane) as the fuel for oxy-fuel set-ups. In these instances, it is imperative to make sure the system contains flashback arrestors or check valves. House natural gas systems operate at relatively low pressures, and these pressures can fluctuate at times. If the oxygen pressure exceeds that of the natural gas line, and engineering controls such as flashback arrestors or check-valves rated for low pressure are not in place, smaller orifice tips (or partially blocked larger orifice tips) on the torch can create enough resistance to gas flow that oxygen can backfeed into the house natural gas system. If this backfeed occurs, the gasses will mix and create a risk of explosion.

IMPORTANT: Due to the low pressure on the house side, finding suitable backflow preventers can be difficult as most currently available seem to be rated for higher pressures. A survey of your building's house gas pressure will be necessary prior to implementation of a suitable check-valve. As is the case with the stand-alone system, a flashback arrestor or check-valve is required on both lines of the torch system.

The torch should not be used in conjunction with a house natural gas system until the system has been approved as having sufficient engineering controls.

Additionally, the materials, construction, and properties of the hose tube, along with the reinforcement and cover, shall meet or exceed RMA/CGA specifications (Rubber Manufacturers Association/Compressed Gas Association). See manufacturer's data sheet for confirmation.

If you are using a torch in conjunction with a house natural gas system, or if you are unsure if your stand-alone system has the necessary safety controls, please contact EH&S for a review of your set-up.