



Liability & Property Pool Workers' Compensation Fund

RISK CONTROL SOLUTIONS

A Service of the Michigan Municipal League Liability and Property Pool and
the Michigan Municipal League Workers' Compensation Fund

HOT WORK PROGRAM GUIDANCE

During building repairs, renovation, or construction, it may be necessary to join or separate materials using heat-generating processes, such as soldering, brazing, welding, powder-driven fasteners and cutting. The most common construction and repair activities that use heat processes include demolition, framing, electrical, plumbing, mechanicals, and roofing. Heat processes may also be used to repair vehicles and mobile or fixed equipment, in repair shops or in the field. Heat may be applied to stuck parts to loosen them, or to pipes to thaw ice blockage. The source of heat may be electrical resistance or arc, the use of flammable gas such as propane or acetylene, or other less common techniques including plasma and laser. The temperatures may range from 330° to 15,000°F or more. The use of processes generating such temperatures may result in fires or explosions causing property damage or severe injury or death. Ignition sources may include the direct heat sources like open flame or arc, as well as molten slag or metal, or sparks from such work. This work may be performed by your own employees or contractors, but the hazards and the safety countermeasures are the same.

The purpose of this document is to:

- provide education about the hazards of heated or hot work;
- guide workers, including outside contractors and property managers, who manage, supervise, or perform hot work operations;
- establish steps to prevent or minimize fire or explosion resulting from hot work operations consistent with the following standards – NFPA 51B, OSHA 1910.252, and OSHA 1926.352.

Definitions

Conduction – Process where heat travels from a warmer object to a colder object by direct contact.

Convection – Process by which heat travels from a warmer object to a colder object through air, water, and other gases or liquids.

Hot Work – Hot work is any work that involves burning, welding, cutting, brazing, soldering, grinding, using flame or spark-producing tools, or other work that produces a source of ignition.

Hot Work Operator – The employee or contractor performing hot work.

Designated Area – A specific area designated and approved to perform hot work operations such as welding, torching, grinding, cutting, etc. A maintenance shop or detached outside location, noncombustible or fire resistant, free of combustible or flammable contents, and suitably segregated from adjacent areas.

Fire Watch – Employee(s) or contractor(s), trained for and continuously observing the work area for the presence of fire or hazardous conditions, and equipped for responding to emergencies within the hot work area before, during, and for at least 30 minutes after the hot work.

Fire Monitor – monitoring may include automatic smoke detection, security camera, security or maintenance checks, or workers in the area.

Permit – A Hot Work Permit is a document, required when the task involves the use of a flame, heat, or sparks, sufficient to be a source of ignition.

Permit Authorizing Individual (PAI) – Construction or shop superintendent, or their designee, responsible for all hot work operations, program compliance, and for issuing Hot Work Permits. The PAI performs a risk assessment, determines the need for hot work, appropriateness of the location, and the necessary precautions, including the need for, scope, and duration of a fire watch.

Permit Required Area – Any location, other than a designated area, approved for hot work and made safe by removing or protecting combustibles from ignition sources.

Radiation – Process where heat travels from a warmer object to a colder object separated by material colder than both objects.

Hot Work Operations

The following operations are examples of hot work operations that can occur within or outside of the designated area;

- Soldering - a process in which two or more items are joined together by melting and putting a filler metal into the joint. The filler metal has a lower melting point than the adjoining metal. Soldering is commonly used in plumbing, electrical, and roofing. This is the lowest temperature form of hot work, generally between 360° and 450°F, depending on the type of solder. Lower temperature, lead-based or *soft*, solder typically uses an electric soldering iron or “gun”. Higher temperature, silver-based or *hard*, soldering may use a torch.
- Brazing – a form of soldering above 450°F, usually between 1,150° and 1,550°F, where the filler (copper, brass, bronze, aluminum, iron, alloy) metal is stronger than soft or hard solder. Brazing generally uses a torch.
- Welding - joins materials using high temperature to melt the parts together, and allowing them to cool, causing fusion. A filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form the joint. Welding is distinct from brazing and soldering, which do not melt the base metal. There are multiple types of welding, such as arc, MIG, TIG, and oxyacetylene. Temperatures can range from 5,600° to 15,000°F.
- Powder-driven fastening – involves the use of a specially designed gun (also known as Hilti or Ramset) to drive threaded or un-threaded nail-like fasteners. The mechanism of driving the fastener is essentially a blank firearm cartridge, typically .22 caliber. They may be single-shot or magazine-fed, manual or automatic cycling.
- Oxy-fuel metal cutting – involves the use of a fuel, like acetylene or propane, in the presence of oxygen to burn the metal into a metal oxide that flows off as slag along the line of cut.
- Metal grinding – grinding is a subset of cutting, as grinding is a true metal-cutting process, using a portable or bench mounted grinding wheel as the cutting tool.
- Miscellaneous heating – hot work equipment may be used to loosen mechanically connected objects (bolted), where the connection point is rusted or corroded, by expanding the nut and/or

burning off contaminants in the threads. Heat may also be applied by torch to thaw ice blockage in frozen pipes (a risky process, see the MML Risk Control Solution - *Thawing Frozen Underground Water Lines*, for additional information).

Hazards

Hazards are generally the transfer of heat, sparks, smoke and metal fumes, and intense light.

The heat from hot work can vary from 330°F to more than 15,000°F. Combustible or flammable materials close enough to be heated by conduction, radiation, or convection may melt, char, or vaporize and ignite or explode. Sparks form when a cutting or welding electrode is brought into contact with the workpiece then moved away, allowing air to be ionized between the two metals and electrons to jump across the gap. As a result, heat and bright light are generated. The temperatures of the welding spatter can range from 1,000° to 2,200°F. Grinding spark temperatures are typically above 1,000°F, as is welding slag. Combustible or flammable materials in the immediate area may ignite or explode if not properly shielded (examples 4 & 5 listed below).

High temperatures can cause working materials to produce smoke and vaporized metal fume, and nearby materials may produce vapors dangerous to breath or be explosive. See example 6 below. Intense light can damage unprotected eyes. Clothing can ignite if proper technique or personal protective equipment (PPE) is not used (example 7 listed below).

The hazard is not always in the immediate vicinity. Sparks, spatter, or slag can fall through cracks or other openings to lower levels, starting fires in concealed areas. Moving conveyors or ductwork may carry sparks or slag to other areas (example 1 below). Work on pipes or other metal equipment may conduct heat to nearby combustible partitions or insulation, igniting fires on the opposite side of a roof, floor, or wall. Once torch work stops, the head may remain extremely hot for several minutes and melt or ignite combustibles it comes in to contact with (example 2 listed below).

The hazard is not always immediately observed. Ignition may be immediate, and explosive (example 8 below), or char, slag, and sparks may result in a slow smolder in wood, insulation, or other material, that takes an hour or more to develop into an open fire (example 3 below).

Between 2013-2017, the US averaged 4,630 structure fire per year, resulting from hot work. Non-home property accounted for 57% of the fires, and 43% occurred in or on homes, including one and two family, apartments, and other multi-family buildings. These fires resulted in an average of 15 civilian deaths, 198 civilian injuries, and \$355,000,000 in direct property damage per year. Between 2001-2018, five firefighter deaths resulted from four hot work-caused fires.

The leading types of equipment involved were:

- Welding torch – 39% of non-home and 32% of home fires.
- Cutting torch – 27% of non-home and 14% of home fires.
- Heat treating equipment – 17% of non-home and 8% of home fires.
- Soldering – 6% of non-home and 32% of home fires.

The leading areas of fire origin were:

- Non-home – exterior roof surfaces 12% and process areas 11%.

- Home – wall assemblies/concealed space 16% and bathroom/lavatories 13%.

The leading materials of fire origin were:

- Flammable/combustible liquids or gases, filters, or pipe – 16% of non-home and 5% of home fires.
- Exterior roof cover or finish – 10% of non-home and 6% of home fires.
- Insulation within structure – 9% of non-home and 21% of home fires.
- Structural member/frame – 8% of non-home and 24% of home fires.

Examples of hot work-caused fires and injury include:

1. A grinder was used to cut commercial laundry dryer ductwork, while the dryer was operating, sparks ignited lint in the duct. The resulting blower-driven flames vented 7 floors above.
2. A butane torch was used, turned off and placed on a plastic storage shelf. Parts of the torch were still hot. The shelf ignited and melted, triggering the fire alarm and sprinkler system.
3. Embers from a torch, used earlier in the day, started a fire on the roof of an electrical closet attached to one of nineteen apartment buildings under construction. All 19 were damaged or destroyed.
4. In a garage used for bus maintenance, a worker standing in a pit below a bus began welding a vehicle's chassis. Sparks ignited combustible debris that had accumulated in the pit, and fire spread to the bodies of several buses parked near each other.
5. Workers welded a bracing system in a bathroom of a 22-story Colorado hotel that was under construction. The spray-on insulation on an interior wall ignited.
6. A worker was using a welding torch and solder to repair a food refrigeration case in a grocery store and inhaled residual refrigerant that had oxidized when heated. Afterwards, he felt ill and subsequently died from the exposure.
7. A man was welding when sparks ignited his jacket causing second-degree burns to his forearm.
8. A worker was cutting lids off four 55-gallon drums containing the solvent methyl ethyl ketone, using a torch. Before cutting the fourth, he placed his torch on top of it. The drum exploded. The worker was struck by the drum's top, suffering facial fractures and head trauma.

Hazard Control

Management Responsibility – Management should have a hot work plan for each location that uses, or might use, hot work. Minimally, the plan includes avoidance, the use of designated areas, and permit required areas. Management establishes, and maintains, a hot work permit process that includes a risk assessment for the location, contents, and work to be performed. Ensure all cutting and welding equipment is in satisfactory condition and good repair. Designate a Permit Authorizing Individual (PAI) who conducts the risk assessment for any work outside designated areas, determines the hazard controls, authorizes hot work by issuing a physical hot work permit, and maintains records. Any work requiring a hot work permit, regardless of the person performing the work, whether employee or third-party contractor, must follow **your** plan and permit process.

- **Avoidance** – Evaluate if hot work is necessary. Determine whether the work can be done without flame, spark, or heat producing equipment. Examples of avoiding hot work include;
 - a band or reciprocating saw or mechanical shears instead of a grinder,
 - using mechanical or adhesive roof materials instead of torch-applied or hot tar roofing,
 - mechanical fasteners and/or threaded or press connections instead of soldered pipe.
- **Designated Area** – Perform work in an area designed, constructed, and designated for hot work where conditions can be controlled to remove or isolate combustibles, contain sparks, spatter, and molten slag, and with appropriate ventilation. Provide appropriate PPE based upon a hazard assessment for employees performing the task.
- **Permit Required Area** – As part of a hot work permit process, the PAI performs a site-specific inspection of the proposed hot work area to identify flammable materials, hazardous processes, or other potential fire hazards that could be present. Provide appropriate ventilation and PPE based upon a hazard assessment for employees performing the task. This process applies regardless of the employment status of the hot work operator.

Hot work plans should meet the following criteria:

- Schedule work during an area shutdown, when possible.
- No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks or other containers until they have been cleaned thoroughly of flammable, combustible, or other materials which when heated, might produce flammable or toxic vapors.
 - Any pipe lines or connections to drums or vessels shall be disconnected or blanked.
 - All hollow spaces, cavities or containers shall be vented to permit the escape of air or gases before preheating, cutting or welding. Purging with inert gas is recommended.
 - Observe all confined space entry rules.
- Move hot work to a location free of combustible materials or,
 - If work cannot be moved, remove combustibles to at least a 35-foot safe horizontal distance from the operation and check the area to 15-feet above and below the work location to account for sparks and spatter. This includes sweeping floors of dusts, cleaning up and removing oils, removing combustible wall and ceiling attachments, or
 - If combustibles cannot be moved at least 35-feet to a safe horizontal, and 15-foot vertical distance from the operation, shield combustibles from ignition sources with fire-resistant materials. This includes storage or equipment with dust, lint, or oily deposits.
 - Options for shielding include wetting or covering floors with damp sand, fire-resistant tarpaulins, welding blankets, flame, UV and radiant heat resistant curtains, welding pads, welding blankets and tents, and metal shields. Check the temperature rating of products against potential slag, spatter, and spark temperatures of the work.
 - Cover floor, wall, or ceiling openings against flying or falling sparks, spatter, or slag igniting fires on other levels or concealed spaces. Use UL Listed or FM Approved fire stop material. Ductwork openings should be covered, shut down, or both.
 - Where floor, wall, ceiling, or roof openings cannot be covered, extend the hot work area to the adjoining area.

- Hot work frequently generates smoke and products of combustion – notify persons in the area about hot work, especially when working outside a designated area. Notify the fire detection and alarm provider before disconnecting any fire alarm system. Sprinkler heads or fire alarm systems shall not be covered or manipulated during hot work operations.
- Provide appropriate fire extinguishers in the hot work designated area. Provide an extinguisher, immediately available, during the hot work and the fire watch period for the operator and each fire watch.
- Define if fire watch is required, and the scope and duration of the fire watch.
- Administer a hot work permit for all operations in which it is required. The permit should specify;
 - Date
 - Work location
 - Work to be performed
 - Who is performing the work
 - Who is performing the fire watch
 - Who authorized the work
 - Required precautions
- Ensure employees are suitably trained in the safe operation of equipment and understand the hot work process.

Hot Work Operator Responsibilities – Hot work operators, whether employee or a contractor, are responsible to:

- Remove combustibles from within 35-feet horizontally of the work site and 15-feet vertically. If performing hot work in an elevated or drafty area, consider extending the clear area to 50-feet.
- Use welding blankets, pads, screens and shields to protect combustible materials that cannot be removed, including floors, walls, or ceiling areas around hot work operations.
- Place non-combustible or flame-resistant screens to protect personnel in adjacent work areas from heat, flames, UV, radiant energy and weld splatter.
- Ensure all cutting and welding equipment is in satisfactory condition and good repair.

Fire Watch / Monitor – A fire watch and monitor, duration, number, and location, is determined by the PAI.

- Fire watch persons are trained to recognize inherent hazards of the work site and the hot work operations. Fire watch persons understand how to activate fire alarm systems and summon a fire response.
- The fire watch has authority to stop hot work if conditions are unsafe.
- The fire watch has appropriate fire extinguishing equipment immediately available, and training for its use.

- The fire watch watches for fires, will only try to extinguish fires obviously within their capabilities, and otherwise immediately sounds the alarm.
- A fire watch may perform other duties, but only if they do not distract them from the primary responsibility of fire watch.
- The PAI determines if a fire monitor is necessary after the watch period ends. The table below is an *example* of what watch and monitor requirements might be, based upon construction, contents, and work to be done.

		Construction					
		Non-combustible		Combustible – no concealed spaces *		Combustible – concealed spaces	
		Watch	Monitor	Watch	Monitor	Watch	Monitor
Occupancy	Apartments, offices, museum, library, telecom, jails, healthcare **	30-minute	1-hour	1-hour	1-hour	1-hour	2-hour
	Parking garage, waste/ recycling, sports arena, utility plants **	30-minute	1-hour	1-hour	1-hour	1-hour	2-hour
	Storage, vehicle repair, loading dock, theater/ exhibition, wood/ metal shop **	30-minute	2-hour	1-hour	2-hour	1-hour	3-hour
	Bulk storage – paper, wood, bark, coal **	1-hour	3-hour	1-hour	3-hour	1-hour	4-hour
	No combustibles or non-combustible containment **	30-minute	0-minute	30-minute	1-hour	1-hour	1-hour
	Roofing ***	2-hour	2-hour	2-hour	2-hour	2-hour	2-hour

* Open walls, ceiling, exposed structural members

** If an infrared camera is used, reduce Monitor by half

*** If an infrared camera is used, reduce Watch and Monitor by half

When determining fire watch and monitor times, consider the construction, contents, and presence of concealed spaces that can allow smoldering with a resulting fire becoming noticeable hours after the work finishes.

Training – Initial training is provided before assignment. Management ensures that all employees and contractors meet the requirements before assignment. Employees can be utilized as helpers prior to receiving the initial training, provided they work directly under a trained employee. The names of trained employees shall be documented on a record of training form. Contractors must provide evidence of training before their employees perform hot work.

Initial training should include the following topics:

- Your written hot work program requirements
- Hot work procedures, including how to obtain a permit
- Proper equipment operation
- Handling and storage of hot work materials
- Compressed gas cylinder safety
- Fire watch
- Fire precautions
- Fire extinguisher training
- Physical and chemical hazards
- Hazard control
- PPE selection and use

Employees should receive hot work refresher training at least bi-annually. The refresher training will include the topics set forth by the initial training. It will also provide updates or new requirements, if applicable.

Hot Work Permit System

A hot work permit will be issued before any hot work operations begin in a non-designated location, and is maintained at that location for the duration of the work. The procedures for the permits are:

- The PAI inspects the area before authorizing a hot work permit and determines whether hot work is necessary.
- The hot work operator completes the hot work permit at the job site and post it until completion of the job or the duration of the permit. Permits are not to exceed one work shift unless;
 - The work cannot be completed during one shift.
 - The PAI will inspect the work site at least once per shift during the work.
- The hot work operator returns the permit to the supervisor after the task is complete or at the end of the work shift.
- The PAI retains the hot work permit for a period not less than one year.

Program Evaluation

Evaluate your hot work program on an annual basis utilizing the Audit Checklist. The evaluation team should ideally include the PAI, department director with hot work operators, a hot work operator, and the person responsible for the member's safety program (safety officer). The safety officer will define the scope of the evaluation. The final report will be developed by the safety officer utilizing the information received during the evaluation. The deficiencies determined in the report will be documented and corrective action plans will be developed.

The program evaluation should at least include the following:

- Written program
- Permit system
- Designated areas
- Permit required areas
- Permit compliance
- Training / Refresher Training

For more information, contact the League's Loss Control Services, or MML Risk Management Services.



Important Contact Information

MML Risk Management Services	734/662-3246 or 800/653-2483
Loss Control Services	800/482-2726

References:

OSHA, US Department of Labor
29 CFR 1910 Subpart Q (General Industry), Welding, Cutting, and Brazing
29 CFR 1926 Subpart J (Construction), Welding and Cutting
NFPA 51B - 2019, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, National Fire Protection Association
Hot Work Structure Fires, National Fire Protection Association 2019
NFPA 241 – 2019, Standard for Safeguarding Construction, Alteration, and Demolition Operations, National Fire Protection Association
Data Sheet 10-3 Hot Work Management, FM Global
Guide to Hot Work Loss Prevention, FM Global
MML Risk Control Solution, Thawing Frozen Underground Water Lines;
http://www.mml.org/insurance/risk_resources/pdf/risk_solutions/thawing_frozen_underground_water_lines.pdf

Note: *This document is not intended to be legal advice. It does not identify all the issues surrounding this particular topic. Public agencies are encouraged to review their procedures with an expert or a competent attorney who is knowledgeable about the topic.*

Audit Checklist

Building/Shop _____

Room/Area _____

Supervisor _____

A. General Controls	Yes	No	NA	Comment
1. For type of hot work operations performed				
2. Hot work operations restricted to authorized employees				
3. Hot work performed in designated area				
4. Combustible materials removed at least 35-ft horizontally from worksite, and 15-ft vertically				
5. Floor and wall openings covered at least 35-ft horizontally from worksite, and 15-ft vertically				
6. Procedures developed to prevent hot work in the presence of explosive or toxic air contaminants				
7. Fire resistant curtains and/or tinted shields provided				
8. Hot work permit obtained, and used				
9. Local or general exhaust ventilation adequate				
10. Appropriate personal protective equipment provided, and used				
11. Appropriate fire extinguisher and/or fire suppression equipment provided in immediate vicinity of hot work				
12. Building fire detection and alarm system operational during hot work operations				
13. Building sprinkler system operational during hot work operations				
14. Procedures established to maintain fire watch in hot work areas				
B. Confined Spaces	Yes	No	NA	Comment
1. Procedures developed for confined space entry and rescue				
2. Ventilation and/or respiratory protection provided				
3. Electrodes removed from holders and/or gas supply shut off when operations are suspended for any substantial period				

C. Compressed Gas Cylinders	Yes	No	NA	Comments
1. Oxygen and fuel gas cylinders stored separately with protective valve caps in place				
2. Regulators compatible with gas cylinder				
3. Cylinder carts used for transport				
4. Cylinders secured from tipping while in use				
D. Training	Yes	No	No	Comments
1. Workers trained in use of hot work equipment, material hazards, and control methods				
2. Personal protective equipment and fire extinguisher training provided and documented				
3. Confined space entry training provided, where necessary, and documented				

PRECAUTIONS CHECKLIST

Before initiating any Hot Work, ensure that proper precautions are in place!

General Precautions

- No effective alternative to hot work. If alternatives exist, use them instead.
- Available sprinkler, hose streams and extinguishers are in service/operational.
- Hot work equipment in good repair.

Requirements within 35-feet of work

- Flammable liquids, dust, lint and oil deposits removed.
- Explosive atmosphere in area tested, eliminated and verified.
- Floors swept clean.
- Combustible floors are wet down, covered with damp sand, or with fire-resistant sheets.
- Remove other combustibles where possible. Otherwise protect with fire-resistant tarpaulins or metal shields.
- All wall and floor openings are covered.
- Fire-resistant tarpaulins suspended beneath work.

Work on walls, ceilings, enclosed areas

- Construction is noncombustible and without combustible coverings or insulation.
- Combustibles on other side of walls moved away.
- Danger exists by conduction of heat into another area.
- Enclosed equipment cleaned of all combustibles.
- Containers purged of flammable liquids or vapors.

Fire watch / Hot Work area monitoring

- Fire watch will be provided during hot work and during any coffee or lunch breaks taken.
- Fire watch is supplied with suitable extinguishers.
- Fire watch is trained in use of this equipment and in sounding alarm.
- Fire watch may be required for adjoining areas, or areas above or below the work.

Monitor Hot Work area for 30 minutes after job is completed

HOT WORK PERMIT

This **Hot Work Permit** is required for any operation involving open flames or producing heat and or sparks. This includes, but is not limited to: *Brazing, Cutting, Grinding, Soldering, Thawing Pipe, Torch Applied Roofing and Welding.*

INSTRUCTIONS: Verify precautions listed above, or do not proceed with the work.

HOT WORK BEING DONE BY

EMPLOYEE

CONTRACTOR

DATE _____

JOB NO _____

LOCATION/BUILDING & FLOOR:

NATURE OF JOB:

NAME OF PERSON(S) DOING HOT WORK:

I verify the above location has been examined, assessed, the precautions listed on the *Required Precautions Checklist* (above) have been taken to prevent fire, and permission is authorized for work.

Issued/Authorized By: _____

Signed: _____

PERMIT EXPIRES

DATE: _____ TIME: _____ AM/PM

THIS PERMIT IS GOOD FOR ONE SHIFT ONLY

HOT WORK START TIME: _____AM/PM

FINISH TIME: _____AM/PM

FIRE WATCH START TIME: _____AM/PM

FINISH TIME: _____AM/PM

FIRE WATCH NAME: _____

FIRE MONITOR START TIME: _____AM/PM

FINISH TIME: _____AM/PM

FIRE MONITOR NAME AND/OR METHOD:

FINAL CHECK TIME: _____AM/PM

FINAL CHECK NAME: _____