FACT SHEET

HOT WORK SAFETY

Hot work fires result in avoidable death, injury, and hundreds of millions of dollars in property loss each year. When everyone follows safe hot-work practice, these fires are preventable. The risk with hot work is high because it introduces a hazard—an ignition source. That's why the number one safety recommendation is to determine whether there is an alternative to hot work and by avoiding hot work, you minimize the risk.

What Is Hot Work?

- Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions.
- Activity involving flame, spark production, or heat.
- Welding and allied processes include arc welding, oxy–fuel gas welding, open-flame soldering, brazing, thermal spraying, oxygen cutting, and arc cutting.

Hot Work Hazards

Hot work has the potential to unite all three parts of the fire triangle: oxygen, fuel, and an ignition source.

Oxygen is present in the ambient air. Unsafe practices involving pure oxygen can cause oxygen enrichment (over 22 percent by volume) in the workplace.

Fuel includes anything that can be ignited. Examples of common fuels include the following:

- Construction materials such as wood, plastic, insulation, roofing materials, including those in concealed spaces
- Flammable and combustible liquids or gases such as fuel, paint, cleaning solvents
- Simple combustibles such as rags, paper, cardboard, lumber, furnishings

Ignition sources can be as simple as the hot work itself. Ignition results when any heat source sufficient to ignite a fuel does so. It can occur through the direct or indirect application of heat. *Direct* application of heat includes: welding, cutting and burning. *Indirect* application includes heat conducted through metal surfaces to fuel sources on the other side (e.g., through to the other side of a bulkhead) and sparks travelling to a distant fuel source (e.g., to a pool of liquid or other combustible material).

Case Study: Partnering for Safety

- In March of 2014, a fire in Boston, MA, took the lives of fire fighter Michael Kennedy and Lieutenant Edward Walsh. The cause of the fire was determined to be unpermitted welding, where the workers did not take factors such as high winds and nearby combustible material into account.
- The city of Boston responded by passing an ordinance requiring individuals in certain roles to obtain a hot work safety certificate. The Boston Fire Department and City of Boston's Inspectional Services Division partnered with NFPA to create a training and certificate program.
- A similar regulation was adopted by Massachusetts, effective July 1, 2018. Other states and jurisdictions are exploring implementing a similar approach.

DID YOU KNOW?

NFPA 51B is required by reference, and therefore, compliance is not optional. OSHA references NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* in 29 CFR 1910 Subpart Q, and NFPA 1, *Fire Code,* requires compliance with NFPA 51B in Chapter 41.

HOT WORK DANGER: FACTS AND FIGURES

When looking at data from 2013-2017, it is clear just how dangerous hot work can be to the public as well as to first responders. The 2019 NFPA report, "Structure Fires Caused by Hot Work," found the following statistics.*

4,630
Structure fires involving hot work per year

Of the fires involving hot work...

57% were in or on non-home properties

43% were in or on homes

15
Civilian deaths are caused per year from these fires

198
Civilian injuries are caused per year from these fires

$355M
In direct property damage results from these fires per year

5
Number of firefighter fatalities (between 2001–2018)

*These statistics do not include near miss fire events from improper hot work. Near miss events include those where the fire department was not contacted because the fire watch dealt with the fire event, or those where no open fire resulted but there was localized scorched or charred material following improperly performed hot work.

HOT WORK SAFETY *CONTINUED*

Ways to Minimize Hot Work Hazards

Use "Recognize, Evaluate, and Control" Process

One process to reduce hot work hazards is called "Recognize, Evaluate, and Control." This process is covered in NFPA 51B and focuses on the following:

- **Recognize** – Determine if fire risks exist before hot work is started.
- **Evaluate** – Determine if hazards are present, especially hazards that could fuel a fire (flammable and combustible liquids or gases and simple combustibles).
- **Control** – Take appropriate steps to eliminate or minimize the hazards.

The hot work permit helps the permit authorizing individual, hot work operator, and fire watch recognize potential hazards. Areas can be protected with the use of welding pads, blankets, or curtains, clearing combustibles from a 35-ft (11-m) radius space around the hot work, or moving the hot work to an area free of combustibles.

Identify Alternatives to Hot Work

Hot work hazards can be avoided if there is an alternative method to complete the job. Some options include the following:

- Screwed, flanged, or clamped pipe
- Manual hydraulic shears
- Mechanical bolting or pipe cutting
- Compressed air-actuated fasteners

WHAT YOU SHOULD KNOW

If you are a **code official,** you must know and enforce the requirements of NFPA 51B.

If you are a **building owner** or **facility manager,** you must have a procedure in place for documenting hot work hazards and for advising all contractors about site-specific potential fire hazards. You also need to know any jurisdiction-specific regulations you need to comply with.

If you are a **contractor** or **someone working on a job site**, you should know the specific combustible hazards within a client property, where manual fire-fighting tools are located, and where hot work is not allowed.

DID YOU KNOW?

Fires can start after the hot work is complete. The fire watch must remain on site for a minimum of 60 minutes to monitor for smoldering fires, per NFPA 51B. The permit authorizing individual could require the fire watch to remain on site longer depending on the conditions of the work site.

RESOURCES

- Get free access to NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work* at: nfpa.org/51B.
- 29 CFR 1910 (Occupational Safety and Health Standards) Subpart Q (Welding, Cutting, and Brazing)
- 29 CFR 1926 (Safety and Health Regulations for Construction) Subpart J (Welding and Cutting)
- ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, 2012

NEXT STEPS YOU CAN TAKE

- Download "Structure Fires Caused by Hot Work" report.
- Get your hot work safety training and certificate at: nfpa.org/hotwork.
- Access the latest information and resources, including a sample hot work permit at: nfpa.org/51BNews.

IT'S A BIG WORLD.
LET'S PROTECT IT TOGETHER.

OSHA® FactSheet

Controlling Hazardous Fume and Gases during Welding

Welding joins materials together by melting a metal work piece along with a filler metal to form a strong joint. The welding process produces visible smoke that contains harmful metal fume and gas by-products. This fact sheet discusses welding operations, applicable OSHA standards, and suggestions for protecting welders and coworkers from exposures to the many hazardous substances in welding fume.

Types of welding

Welding is classified into two groups: fusion (heat alone) or pressure (heat and pressure) welding. There are three types of fusion welding: electric arc, gas and thermit. Electric arc welding is the most widely used type of fusion welding. It employs an electric arc to melt the base and filler metals. Arc welding types in order of decreasing fume production include:

Flux Core Arc Welding (FCAW) filler metal electrode; flux shield

Shielded Metal Arc (SMAW) electrode provides both flux and filler material

Gas Metal Arc (GMAW or MIG) widely used; consumable electrode for filler metal, external gas shield

Tungsten Inert Gas (GTAW or TIG) superior finish; non-consumable electrode; externally-supplied inert gas shield

Gas or oxy-fuel welding uses a flame from burning a gas (usually acetylene) to melt metal at a joint to be welded, and is a common method for welding iron, steel, cast iron, and copper. Thermit welding uses a chemical reaction to produce intense heat instead of using gas fuel or electric current. Pressure welding uses heat along with impact-type pressure to join the pieces.

Oxy-fuel and plasma cutting, along with brazing, are related to welding as they all involve the melting of metal and the generation of airborne metal fume. Brazing is a metal-joining process where only the filler metal is melted.

Welder using local exhaust ventilation to remove fume from breathing zone. (Photo courtesy of the Lincoln Electric Company).

What is in welding fume?

Metals

Aluminum, Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Silver, Tin, Titanium, Vanadium, Zinc.

Gases

- **Shielding**—Argon, Helium, Nitrogen, Carbon Dioxide.
- **Process**—Nitric Oxide, Nitrogen Dioxide, Carbon Monoxide, Ozone, Phosgene, Hydrogen Fluoride, Carbon Dioxide.

Factors that affect worker exposure to welding fume

- Type of welding process
- Base metal and filler metals used
- Welding rod composition
- Location (outside, enclosed space)
- Welder work practices
- Air movement
- Use of ventilation controls

Health effects of breathing welding fume

- Acute exposure to welding fume and gases can result in eye, nose and throat irritation, dizziness and nausea. Workers in the area who experience these symptoms should leave the area immediately, seek fresh air and obtain medical attention.
- Prolonged exposure to welding fume may cause lung damage and various types of cancer, including lung, larynx and urinary tract.
- Health effects from certain fumes may include metal fume fever, stomach ulcers, kidney damage and nervous system damage. Prolonged exposure to manganese fume can cause Parkinson's–like symptoms.
- Gases such as helium, argon, and carbon dioxide displace oxygen in the air and can lead to suffocation, particularly when welding in confined or enclosed spaces. Carbon monoxide gas can form, posing a serious asphyxiation hazard.

Welding and Hexavalent Chromium

- Chromium is a component in stainless steel, nonferrous alloys, chromate coatings and some welding consumables.
- Chromium is converted to its hexavalent state, Cr(VI), during the welding process.
- Cr(VI) fume is highly toxic and can damage the eyes, skin, nose, throat, and lungs and cause cancer.
- OSHA regulates worker exposure to Cr(VI) under its Chromium (VI) standard, 29 CFR 1910.1026 and 1926.1126.
- OSHA's Permissible Exposure Limit (PEL) for Cr(VI) is 5 µg/m3 as an 8-hour time-weighted average.

Reducing exposure to welding fume

- Welders should understand the hazards of the materials they are working with. OSHA's Hazard Communication standard requires employers to provide information and training for workers on hazardous materials in the workplace.
- Welding surfaces should be cleaned of any coating that could potentially create toxic exposure, such as solvent residue and paint.
- Workers should position themselves to avoid breathing welding fume and gases. For example, workers should stay upwind when welding in open or outdoor environments.
- General ventilation, the natural or forced movement of fresh air, can reduce fume and gas levels in the work area. Welding outdoors or in open work spaces does not guarantee adequate ventilation. In work areas without ventilation and exhaust systems, welders should use natural drafts along with proper positioning to keep fume and gases away from themselves and other workers.
- Local exhaust ventilation systems can be used to remove fume and gases from the welder's breathing zone. Keep fume hoods, fume extractor guns and vacuum nozzles close to the plume source to remove the maximum amount of fume and gases. Portable or flexible exhaust systems can be positioned so that fume and gases are drawn away from the welder. Keep exhaust ports away from other workers.
- Consider substituting a lower fume-generating or less toxic welding type or consumable.
- Do not weld in confined spaces without ventilation. Refer to applicable OSHA regulations (see list below).
- Respiratory protection may be required if work practices and ventilation do not reduce exposures to safe levels.

Some OSHA standards applicable to welding:

- **Welding, Cutting & Brazing**—29 CFR 1910 Subpart Q
- **Welding & Cutting**—29 CFR 1926 Subpart J
- **Welding, Cutting & Heating**—29 CFR 1915 Subpart D
- **Permit-required confined spaces**—29 CFR 1910.146
- **Confined & Enclosed Spaces & Other Dangerous Atmospheres in Shipyard Employment**—29 CFR 1915 Subpart B
- **Hazard Communication**—29 CFR 1910.1200
- **Respiratory Protection**—29 CFR 1910.134
- **Air Contaminants**—29 CFR 1910.1000 **(general industry)**, 29 CFR 1915.1000 **(shipyards)**, 29 CFR 1926.55 **(construction)**

More Information

For more information on hexavalent chromium exposure, visit OSHA's website at www.osha.gov.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For assistance, contact us. We can help. It's confidential.

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