Welding Safety

1. **Purpose / Background**
   Welding, cutting and brazing operations have a number of safety and health hazards. These include the risk of fire and potential exposures to smoke, fumes, electrical hazards, heat and ultraviolet light. Protecting welders and bystanders involves controlling hazards by the use of welding screens, personal protective equipment, exhaust ventilation, protective clothing and well maintained equipment.

   At MIT, welding is performed in designated areas/shops by Department of Facilities trades personnel. In addition, a number of academic departments conduct various forms of welding that is performed by both students and faculty as part of academic coursework or in support of research. Lastly, welding at MIT is also performed by outside contractors during building repair, construction and renovation projects.

   Alternative work methods are encouraged. It has been demonstrated that in lieu of welding, other methods (use of flanges/bolts etc.) can often provide the same end result/product without the potential hazards.

2. **Scope**
   This SOP applies to MIT employees and students who may conduct welding (MIG, TIG, Oxy/Acetylene, Stick/Electric Arc, etc.) cutting or brazing.
   Contractors conducting welding, cutting and brazing are expected to follow the MIT Hot Work SOP as well as all applicable regulatory requirements regarding welding safety and are responsible for evaluating welding jobs, providing their employees with appropriate safety training and personal protective equipment.

3. **Prerequisites**
   None

4. **Procedures**
   **4.1 General requirements**
   4.1.1 Compressed gas cylinders used for welding, cutting or brazing shall be upright, secured at all times and stored away from heat sources such as radiators, portable heaters and furnaces.

   4.1.2 Regulators used on compressed gas cylinders shall appropriate for the contents of the cylinder. See MIT Compressed Gas SOP.

   4.1.3 Welding equipment shall undergo periodic inspections. Hoses or cables showing damage, leaks, burns or worn spots shall be taken out of service and replaced immediately.

   4.1.4 Personnel performing welding or cutting should be proficient in the field of welding and have acquired the necessary expertise, experience and training in the safe operation of the equipment.

   4.1.5 Welding screens or booths shall be utilized to shield/protect other people that are located in the vicinity of the welding from eye hazards.
4.1.6 Warning signs shall be prominently posted at all welding shops/designated areas. Eye hazard warnings shall act as a reminder to avoid direct line of sight to welding and the potential for eye injury.

4.1.7 All combustible materials shall be moved at least 30 feet away from the welding area, before the job begins.

4.1.8 A portable fire extinguisher shall be readily available during welding, cutting or brazing.

4.1.9 Fire watch personnel may be required for certain welding jobs. Fire watch requirements and duties are outlined in the MIT Hot Work SOP.

4.1.10 Welding cutting or brazing shall not be done on, or inside, drums, tanks, vessels or confined spaces unless reviewed and approved by the Department of Facilities and/or the EHS Office.

4.1.11 Eye protection shall be worn at all times during welding, cutting and brazing operations. Refer to section 4.3, Eye Protection.

4.1.12 Welding and cutting shall be evaluated for safety and health hazards before the work begins. Supervisors should ensure that welders understand the hazards associated with the work and that appropriate precautions are taken. Consult the Material safety data sheets.

4.1.13 Academic instructors shall brief student welders on the hazards associated with welding and the means to protect themselves. The names of trainees shall be forwarded to the EHS Office.

4.1.14 Supervisors and faculty shall only permit welding under safe conditions, make sure that personal protective equipment is available, worn at all times and in good condition.

4.1.15 Welding shall only be conducted in well-ventilated areas. Opening a window or door is generally not considered to be adequate protection against inhalation of welding fumes. Because of this, mechanical exhaust or air filtration systems are required, especially if stainless steel, painted stock or materials (other than bare mild steel) are being welded.

4.1.16 Materials Safety Data Sheets (MSDS) for welding gases, filler metals/rods and fluxes shall be maintained by welders. Read warning labels on manufacturer’s packaging/containers of filler materials, fluxes and electrodes.

4.2 Health hazards of welding, cutting and brazing

4.2.1 Gases and Fumes
        4.2.1.1 Welding, cutting and brazing results in the generation of smoke which can contain fine particles (fumes) as well as various residual gases, many of which can be dangerous to breath and can irritate the eyes, nose and respiratory tract.

4.2.2 Welding smoke/fumes can originate from;
        Base and/or the filler materials
        Coating and paints on base metals
        Shielding gases (argon, carbon dioxide etc)

An official hardcopy of this document exists in the EHS Office or on the EHS website.
See Legal Disclaimer at: http://ehs.mit.edu/site/content/legal-disclaimer
UV light and materials reacting together
Vapors/ambient air contaminants

4.2.3 Depending on the type of welding, the smoke and fumes generated can contain toxic substances such as chromium, arsenic, cadmium, carbon monoxide, lead, ozone and others.

4.2.4 Welders shall be knowledgeable about the materials involved in the welding job, as well as the type of welding being conducted. For instance, brazing and soldering operate at a lower temperature than the base material. Because of this, a filler material is used that melts, joining the metal pieces together. Welders should be aware that these filler materials can be toxic, often containing lead and cadmium. See the MSDS for more information.

4.2.5 In order to minimize/eliminate potential exposures to welding smoke, all welding shops at MIT shall be equipped with local exhaust ventilation.

4.2.6 Welding stainless steel shall only be performed with local exhaust ventilation. Contact the EHS Office for more information.

4.3 Eye Protection

4.3.1 Welding can result in exposure to ultraviolet light if personal protective equipment is not worn, or if the wrong shade is selected. Eye protection shall be worn at all times during welding, cutting and brazing.

4.3.2 Eye protection shall be appropriate for the hazards associated with the particular type of welding. See Table 1 of this SOP for eye protection/protective shade selection.

4.3.3 Employees and students conducting welding shall use equipment with filter lenses that have a shade number appropriate for the work being performed. The following is a listing of appropriate shade numbers for various operations.
TABLE 1

<table>
<thead>
<tr>
<th>Welding operation</th>
<th>Shade No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shielded metal-arc welding - 1/16-, 3/32-, 1/8-, 5/32-inch electrodes</td>
<td>10</td>
</tr>
<tr>
<td>Gas-shielded arc welding (nonferrous) - 1/16-, 3/32-, 1/8-, 5/32-inch electrodes</td>
<td>11</td>
</tr>
<tr>
<td>Gas-shielded arc welding (ferrous) - 1/16-, 3/32-, 1/8-, 5/32-inch electrodes</td>
<td>12</td>
</tr>
<tr>
<td>Shielded metal-arc welding:</td>
<td></td>
</tr>
<tr>
<td>3/16-, 7/32-, 1/4-inch electrodes</td>
<td>12</td>
</tr>
<tr>
<td>5/16-, 3/8-inch electrodes</td>
<td>14</td>
</tr>
<tr>
<td>Atomic hydrogen welding</td>
<td>10-14</td>
</tr>
<tr>
<td>Carbon arc welding</td>
<td>14</td>
</tr>
<tr>
<td>Soldering</td>
<td>2</td>
</tr>
<tr>
<td>Torch brazing</td>
<td>3 or 4</td>
</tr>
<tr>
<td>Light cutting, up to 1 inch</td>
<td>3 or 4</td>
</tr>
<tr>
<td>Medium cutting, 1 inch to 6 inches</td>
<td>4 or 5</td>
</tr>
<tr>
<td>Heavy cutting, 6 inches and over</td>
<td>5 or 6</td>
</tr>
<tr>
<td>Gas welding (light) up to 1/8 inch</td>
<td>4 or 5</td>
</tr>
<tr>
<td>Gas welding (medium) 1/8 inch to 1/2 inch</td>
<td>5 or 6</td>
</tr>
<tr>
<td>Gas welding (heavy) 1/2 inch and over</td>
<td>6 or 8</td>
</tr>
</tbody>
</table>

NOTE: In gas welding or oxygen cutting where the torch produces a high yellow light, it is desirable to use a filter or lens that absorbs the yellow or sodium line in the visible light of the operation.

4.4 Protective clothing

4.4.1 Welders shall wear protective fire resistant gloves, aprons and face shields, during welding, cutting and brazing.

4.5 General Welding Safety

4.5.1 Welding and cutting has the potential to generate heat and sparks. It has been shown that if not controlled, heat and sparks from welding and cutting are a common source of building fires.

4.5.2 Welding areas should be free of all combustible materials. Fire retardant blankets shall be used to shield wall and floor openings to prevent sparks from entering.

4.5.3 An MIT Hot Work Permit is required for all welding and cutting at MIT. See the MIT Hot Work SOP.

4.5.4 All welding shops at MIT shall be equipped with non-combustible tables/benches and floors.
4.5.5 Welding shops should be equipped with sprinkler protection and shall have an an ABC type portable fire extinguisher.

4.5.6 An annual “Designated Area” Hot Work Permit is required for all welding shops at MIT. See MIT Hot Work SOP. This permit is issued/updated by the EHS Office.

4.5.7 Welding jobs conducted outside of “Designated Areas” including those conducted by outside contractors, must first be evaluated for fire safety by an authorized hot work supervisor (AHWS) or the EHS Office, before the work begins.

4.5.8 Some welding jobs require a Cambridge Fire Department fire watch detail. See the MIT EHS Office Hot Work SOP for more information. Go to http://www2.cambridgema.gov/CFD/PRdetail.cfm for instructions on requesting a CFD Detail.

5. Roles & Responsibilities

5.1 Department of Facilities (DOF) shall monitor outside contractors who conduct welding, cutting and brazing at MIT and ensure that they meet the requirements of the MIT Hot Work Program. DOF trades-persons who conduct welding, cutting or brazing shall adhere to the requirements of the MIT Hot Work SOP, in addition to this SOP.

5.2 Departments/Instructors shall monitor students who conduct welding as part of academic coursework or in support of research projects. Instructors shall brief students on the hazards of welding, cutting and brazing. Material safety data sheets (MSDS) for welding gases, rods, fluxes etc. shall be maintained and available for review.

5.3 EHS Office shall conduct annual fire safety inspections of all designated welding areas/shops and issue “Designated Area” Hot Work Permits.

6. Training

Welders shall be trained in the safe operation of their equipment, the potential hazards associated with the work and the use of appropriate personal protective equipment. Instructors shall closely supervise student welders as they acquire skills through hand-on work.

7. Monitoring Requirements

Welding areas shall be inspected at least annually or as part of the EHS-MS Level 2 inspections, twice annually.

8. Record Management

Welders shall maintain manufacturer’s information/operating instructions for welding equipment and MSDS for welding supplies.

9. References

9.1 Standards
9.1.1 OSHA 1910.133 Eye and Face Protection
9.1.2 OSHA 1910.251 Welding, Cutting and Brazing
9.1.3 ANSI Z49.1:2005 Safety in Welding, Cutting and Allied Processes

9.2 Standard Operating Procedures
9.2.1 MIT EHS Office SOP, Compressed Gases
9.2.2 MIT EHS Office SOP, Hot Work Permit
9.2.3 MIT EHS Office SOP, Personal Protective Equipment
9.2.4 MIT EHS Office SOP, Fire Extinguishers, Portable
9.2.5 MIT EHS Office SOP, Machine and Woodworking Shops
9.2.6 MIT EHS Office SOP, Control and Reporting Fires
9.2.7 American Welding Society Safety and Health Fact Sheet No. 26

10. Definitions
10.1 Hot Work- Work that produces heat and sparks such as welding, cutting, brazing and grinding etc.

10.2 MIT Hot Work Permit- The permit that is required for conducting welding, cutting or brazing at MIT. It outlines the required safety precautions, based on a hazard assessment of each job.

10.3 Welder- any operator of electric or gas welding equipment

10.4 Welding booth- an enclosed area designed to protect other from exposure to sparks or arc welding UV rays.

10.5 Welding screen- a flame-proof shield designed to protect others from exposure to arc welding UV rays.

10.6 Welding- joining (2) or more pieces of metal by the use of a high temperature electric or fuel gas/oxygen source.

10.7 Cutting- melting metal with a fuel gas and high pressure oxygen to separate it into individual pieces.

10.8 Brazing- joining to pieces of metal using a filler material which melts at a lower temperature than the base metal.