Shop and Makerspace Safety

1. Purpose / Background

Machines, tools, and equipment can pose a range of potential hazards. This document has been developed to help reduce the risks of injuries from these devices by providing standard guidance for their administration and the oversight of shops and other spaces where physical fabrication occurs. It establishes a framework for classifying tools and work spaces, training and supervision, and guidelines for the safe use of tools and equipment. Mechanisms have also been developed to address unique situations that might arise from the diversity of MIT's educational and research missions.

2. Scope

This document applies to woodworking shops, machine shops, makerspaces, and all other locations where physical fabrication activities occur at MIT. It applies to all students, faculty, employees, alumnae, visitors, guests, and contractors who operate tools and machines in these spaces. Tools and machines used in other locations must meet the same safeguarding requirements.

3. Procedures

Departments, Laboratories and Centers (DLCs) that operate shops or fabrication spaces shall develop and implement procedures for their administration and oversight, access control, user training, emergency preparedness, tool/equipment maintenance, repair and recordkeeping.

3.1 Administration of Shops and Fabrication Spaces

3.1.1 The DLC shall designate a Shop Manager for each shop or fabrication space, with overall authority and responsibility for that location.

3.1.2 Shop Managers may further designate one or more Supervisors or Monitors to assist with day-to-day operations, provide user oversight and supervision, and offer training on certain tools and equipment in their space. The Shop Manager or a designee may also serve as the EHS Representative.

3.1.3 Unless tools and equipment can be locked-out and rendered inoperable and harmless, entry doors to shops and other fabrication spaces shall be secured with locking / combination knobs or card reader access control systems. Contact the MIT Security Office for more information on card reader access controls systems.

3.2 Supervision and Oversight

3.2.1 Shop Managers and their designees shall ensure that tool and equipment users have received appropriate safety and use training. Individual Shop Managers have the authority to accept, verify, or reject user credentials from other operations on campus.

3.2.2 Levels of supervision shall be based upon user experience. Regardless of their MIT status, new users are considered “trainees” and subject to supervision at all times. This requirement may be relaxed as users gain experience and demonstrate their qualifications on specific tools and machines. Authorization to use Class 4 equipment may only come from Shop Managers or Supervisors (roles and responsibilities are also addressed in Definitions).

3.2.3 Only employees and faculty who are professional-level machinists, woodworkers, or other experienced fabricators may work alone, although the buddy system is recommended at all times along with a review of work plans in advance with the Shop Manager.

3.3 Machines, Tools, and Equipment

3.3.1 MIT’s classification system for machines, tools, and equipment appears in Appendix A, Tool Classification System. This system uses a potential hazard rating scale ranging from 1 to 4, with 4 representing the highest tool hazard level. Understanding that some tools may be difficult to categorize and require additional professional assessment, the system provides descriptions of the size and power of each tool class, common examples, and requirements for access control, supervisory oversight, training, and authorization. Consult MIT EHS for additional assistance in classifying unique or special equipment.

3.3.2 Tools and equipment should be selected based upon good design with adequate strength, castings / forgings, proper edge tempering, and anti-vibration characteristics as necessary. New tools and equipment shall also meet nationally-recognized design standards including Underwriters Laboratory (UL,) the American National Standards Institute (ANSI), CSA Group and the American Society of Mechanical Engineers (ASME), as applicable.

3.3.3 Electric tools shall be double insulated or provided with grounded three-prong plugs to help prevent electric shock.

3.3.4 Unless they are powered by removable cord and plug, tools and equipment shall be installed with a disconnect switch that can be locked in the off position during servicing and repair to facilitate safe lock-out / tag-out.

3.3.5 Power equipment and large manual tools shall be leveled and adequately secured to the floor or workbench, as appropriate, to prevent/minimize movement, tip-over, walking, and vibration.

3.3.6 Pneumatic tools and tool holders should have a retainer if there is a potential for tool ejection.

3.3.7 Airlines and hoses shall be designed for their intended pressure and service, and compressed air stations used for cleaning shall be set at a value not to exceed 30 psig or shall have OSHA compliant safety tip permanently installed.

3.3.8 Manufacturer's operating manuals for all tools and equipment shall kept and made available in the shop or fabrication space or kept accessible in a public location on the shop's website.

3.3.9 Tools, equipment, and other machines shall meet or exceed applicable regulatory and advisory safety and safeguarding standards (also see References). These vary by tool type and agency, with specific prescriptive OSHA requirements for many wood- and metal-working tools. Note that even many newly-manufactured machines do not always meet these standards. Machine safeguarding can be a complex and difficult process, especially for older equipment and unique or unusual machine configurations. Consult MIT EHS for assistance in evaluating safeguarding needs prior to new equipment purchase and for existing equipment, as well as recommendations for preferred parts, supplies, and contractors for service work.

3.3.10 Basic machine safeguarding generally includes one or more of the following features depending upon the specific type of tool and materials processed:

a. Shields or covers for protection from the point-of-operation where the tool actually performs work and any flying chips or objects;
b. Guards or enclosures to prevent inadvertent contact or access to dangerous rotating parts and motions elsewhere on the machine;
c. E-stops or other rapid and readily-accessible means to shut the machine off in the event of an accident or emergency;
d. Anti-restart protection where unanticipated restart after an electrical outage could result in injuries; and
e. Methods to control, capture, filter, or exhaust dusts, vapors, mists, or gases generated during machine and tool use.

A general guide to machine hazards and safeguarding appears in Appendix B.

3.3.11 It is recognized that under certain specific circumstances, guards or shields may impact the use of a machine by interfering with the point-of-use. A common example involves special cuts and shaping actions on a tablesaw (e.g., bevel cuts, tenoning, slotting and dadoing), where a traditional over-the-blade guard, splitter, and anti-kickback pawl will often impede work. Under these specific kinds of conditions, alternative safeguarding must be implemented. These shall be discussed first with the Shop Manager, Supervisor, or Monitor, and may include the adoption of special jigs, "sleds," templates, fixtures, or other means to effectively control hazards.

3.3.12 All powered tools and machines (except those with momentary or trigger pressure switches) shall be equipped with a means to safely shut power off during normal operations and in the event of an emergency or accident. For Class 2 and higher machines and tools, this mechanism is generally in the form of one or more factory-installed or aftermarket emergency power stops ("E-stops"). These may include red-colored mushroom-style buttons, paddles or large format toggle switches, trip wires, and other readily-identifiable and readily-accessible means to effectively shut the machine off by a single motion. Light curtains, foot brakes, and step-off pads may also fulfill this requirement in certain circumstances. All emergency controls must be prominently marked and red in color; new E-stops must also have a yellow background.

3.3.13 Equipment that emits high levels of noise may trigger requirements for the use of hearing protection or implementation of special engineering controls (e.g., covers, enclosures, noise absorbing panels). Consult MIT EHS for assistance in evaluating noise levels, selecting appropriate personal protective equipment, and advice on other control measures.

3.3.14 Equipment that emits dusts, fumes, vapors, or gases may require local exhaust ventilation or other contaminant control devices. Some common examples include specialty exhaust systems for laser cutters, dust collection systems for sanders, and spray booths for certain painting and coating activities. These systems must be carefully designed, installed, and periodically inspected to ensure safe effective operations. Consult MIT EHS for technical assistance in design, selection, installation, and periodic inspection and testing of these systems.

3.3.15 Many parts created by 3D printing require support removal. Avoid chemical hazards by selecting mechanical “break away” techniques or non-hazardous solutions. If a caustic bath solution is still required, recognize that the typical chemicals used are corrosive and require special handling for safe use, including:

a. Limiting solution handling and use to authorized individuals, who have received chemical safety training and access to safety data sheets;
b. Shop or laboratory room must be equipped with an emergency eyewash;
c. Personal protective equipment (PPE) must be appropriate for working with caustic solutions, recommended PPE includes a full face shield over safety glasses, chemical resistant gloves, and a laboratory coat or rubber laboratory apron;
d. Baths must be constructed from corrosion-resistant materials and located in low-traffic areas of the laboratory or shop on a secure non-moveable surface, provided with secondary containment to collect leaks and contain small spills or drips, and kept covered when not in active use. Ideally, they should also contain a spigot or valve to enable easy draining for waste collection. They must also be prominently labeled for OSHA Hazard Communication compliance with the full chemical name of the bath contents, signal word “Danger”, and the corrosive materials pictogram.
e. It is generally safer to purchase pre-made, ready-to-use caustic solution since this eliminates any mixing. The next preferred alternative is to purchase the caustic in a slightly higher concentration and then dilute the material with distilled / deionized water during filling. If solutions must be mixed from solid hydroxide pellets or flakes, consult the Shop Manager for directions and assistance.
f. Spent caustic bath solutions must be collected for disposal as Hazardous Waste. Submit a waste pick-up form which can be found at: http://ehs.mit.edu/site/content/chemical-waste-collection-form.

3.4 Room and Infrastructure

3.4.1 To ensure a safe and appropriate location, designs for the construction, alteration, renovation, and/or installation of new equipment in shops or other fabrication spaces shall be reviewed with MIT EHS, the DLC Coordinator, and DLC Facility Manager.

3.4.2 In addition to basic room-level infrastructure requirements established by the MIT Facility Design Guidelines for Shops and Makerspaces, at a minimum shops and fabrication spaces shall:

a. Physically limit or restrict access to authorized users only;
b. Have a working landline telephone with posted emergency contact information;
c. Contain at least one portable ABC fire extinguisher.
d. Post basic safety rules, and have specific equipment and tool operating manuals and other information available;
e. Make appropriate personal protective equipment available to users free-of-charge;
f. Provide other supplies and equipment appropriate to operations in the space, including special waste collection containers, spill supplies, and a plumbed eyewash station (if corrosive chemicals or other chemical hazards are used).

3.5 Inspection, Maintenance, and Repair

3.5.1 Shop Managers and their designees shall regularly inspect their spaces, tools, and equipment for safety, housekeeping, and general condition. This includes a general overview of the space and its contents each day, periodic formal documented inspections with the DLC EHS Representative and MIT EHS Office, and tool-specific inspections following manufacturer's instructions. Inspections shall also be performed after any accident, injury, or report of unsafe conditions. A sample shop and tool inspection outline appears in Appendix E.

3.5.2 Authorized users shall inspect their work area and tools prior to each use, and report any damages, off-normal conditions, or problems encountered during use to their Shop Manager, Supervisor, or Monitor. In particular:

a. Electrical wire and connections must be in good condition. Check to ensure that the plug is equipped with a grounding prong and that the cord sheathing is not taped, damaged, split, or cut.

b. Where required, mechanical guards or shields shall be present, properly adjusted, and in good condition. Refer to the Level II Inspection Guidance or consult MIT EHS for additional information on guarding.

3.5.3 Damaged tools and equipment shall be immediately removed from service and rendered inaccessible or inoperable until repaired or replaced.

3.5.4 Shop supervisors should determine if any of their tools have maintenance or repair activities that require Lock-Out/Tag-Out (LOTO). Contact EHS if you have questions as to whether your equipment needs LOTO and an Energy Control Procedure. Minor tool changes and adjustments or other minor servicing activities that are routine, repetitive, and integral to the use of the equipment generally do not require LOTO as long as accidental energizing is not possible.

3.6 Tool Operation and Use

3.6.1 General shop and tool use safety guidance is provided in Appendix C. Shop Managers are further encouraged to also develop their own specific operating procedures and safety guidelines.

3.6.2 Access to and use of tools and equipment shall be restricted to authorized individuals. Authorization may be granted after demonstrating user qualifications, either by successfully completing applicable tool-specific training or by demonstrating competency to the Shop Manager or their designee. In the event of joint DLC ownership of a shop or other fabrication space and/or equipment, authorization to work shall come from both organizations. (Also see Training, below.)

3.6.3 Tools and equipment shall not be used during non-scheduled or "off" hours without permission from the Shop Manager.

3.7 Safety Rules

3.7.1 All shops and fabrication spaces shall post space-specific safety rules that cover, at a minimum:

a. Practice good housekeeping.
   - Prevent slip/trip hazards by keeping floors clear and clean, and wiping up any spills immediately.
   - Properly collect and dispose of waste cutting oils, coolants, chips, and other waste materials (also see Appendix D).
   - Maintain clear aisles and store stock and supplies in an orderly manner.

b. Do not wear loose clothing or jewelry.

c. Do not wear sandals or open toed shoes. Instead, wear closed-toed shoes (steel-toe safety shoes may be required in some spaces or while conducting specific tasks).

d. Tie-back long hair and contain long beards to prevent entanglement in rotating parts.

e. Wear safety glasses with side shields (or goggles) whenever active work is in progress in the shop or fabrication space. Use additional personal protective equipment as required or appropriate.

f. Keep all tools in good condition with regular maintenance.

g. Examine each tool for damage before use and take any damaged or defective tools out of service immediately. Bring the problem to the attention of the Shop Manager, Supervisor, or Monitor.

h. Operate tools according to shop and manufacturer's instructions and do not remove or defeat equipment safeguards. Consult the Shop Manager, Supervisor, or Monitor before starting a new operation or if you have any questions.

i. Keep fingers and hands clear of the point of operation by using push sticks, fixturing, jigs, hooks, pliers, or other holding devices.

j. Use brushes, hooks or other tools to remove chips and shavings - never use hands or fingers.

k. Avoid distractions and never distract someone else while operating shop tools.

l. Report all accidents, injuries, and unsafe conditions to the Shop Manager, Supervisor, or Monitor as soon as possible.

4. Roles and Responsibilities

4.1 Departments, Laboratories and Centers (DLCs)

4.1.1 DLCs are responsible for understanding, implementing, and supporting this SOG, including providing feedback and information where modifications or improvements might be beneficial.

4.1.2 DLCs are responsible for designating a Shop Manager for each shop, makerspace or other fabrication space. The Shop Manager has overall authority and responsibility for the space, including providing or documenting shop and tool-specific training for users, repairs and maintenance, and general safe operations. The Shop Manager also has responsibility for promptly reporting any accidents or injuries to their DLC and MIT EHS Office as soon as possible and for the proper management of any hazardous waste generated. The Shop Manager is usually also the EHS Representative, with the EHS Coordinator being responsible for ensuring that the shop meets all the requirements of the EHS-MS.

4.1.3 Shop Managers shall have significant prior experience with the tools and equipment in their space, and be capable of supervising users and implementing effective responses to any emergencies or accidents that might arise. Shop Managers are assigned to the Shop Supervisors training group by EHS and shall complete any additional MIT-required training courses as applicable to their space and operations. Shop Managers can review training requirements with their EHS Representative, MIT EHS Coordinator, or their Training Role in the on-line MIT Training Management System.

4.1.4 Shop Managers may, as noted earlier, also designate one or more Supervisors and /or Monitors to help them with supervision, training, and maintenance for their operation.

4.2 MIT EHS Office

4.2.1 The MIT EHS Office is responsible for overall development and management of this SOG and other related programs that support and promote the safe use of tools, machines, and other equipment on-campus. This includes:

a. Providing assistance to DLCs during Level II Shop Inspections;
b. Convening meetings and discussions with key program stakeholders;
c. Revising and updating this SOG and other supporting materials as appropriate;
d. Providing technical advice on shop and fabrication spaces, tools and equipment, machine safeguarding, contaminant controls and local exhaust ventilation systems, and personal protective equipment, and;
e. Developing recommendations for preferred parts, supplies, and service contractors.
f. Interpreting the guidelines and requirements of this SOG for application to unique situations and equipment

4.3 Individual Users

4.3.1 Individual tool and equipment users are responsible for obtaining all required training, following safety rules and safe work practices, properly using and maintaining tools and equipment, and immediately notifying the Shop Manager, Supervisor, or Monitor of any problems or unsafe conditions. They are also responsible for choosing appropriate safe attire and wearing all required personal protective equipment.

5. Training and Information

5.1 The Shop Managers, Supervisors, or Monitors are generally the source for new user training. Prior to working in a shop, new users shall receive shop-specific training and be informed of other available information and resources. Training shall cover, at a minimum:

a. Basic shop / fabrication safety, including appropriate attire, use of personal protective equipment and the location of safety equipment such as eyewashes and fire extinguishers;
b. Reporting and removing defective or damaged tools from service;
c. Actions to take in the event of an emergency, building evacuation, accident, or observation of an unsafe condition.

5.2 Users may receive their tool-specific training as part of the shop specific training or separately. Individuals with prior experience using specific tools may furnish documentation of their training from other trusted shops and, at the discretion of the Shop Manager, then demonstrate proficiency with specific tools to qualify for authorization to use those tool(s). Shop Managers have overall authority to determine who may use their space. Tool-specific training may include the following:

a. Proper selection, use, adjustment, and cleaning of specific tools and equipment;
b. Inspection procedures prior to tool use;
c. Use and function of guards, shields, special fixturing, remote parts handling or retrieval, emergency stops, and any other safety features or components;

All welding training should be performed by competent welders designated by the Shop Manager. Instructors in shops with experienced, competent student welders may designate students as trainers. Shops without enough experienced welders may opt to have new students trained in other hot work areas with experienced welders. Training should cover key points of welding safety including prohibited materials, PPE, fire safety, and ventilation. Refer to EHS SOP-0066: Welding, Cutting, and Brazing Safety for more details.

5.3 All training shall be documented. Training records may be kept on-file locally, shared with a wider campus credentialing system, or submitted to the MIT EHS Office for electronic training record retention in the EHS-MS Training System.

5.3.1 Shop Managers must complete the following MIT-wide training courses: Hazard Communication, Hazardous Waste Generation, Emergency Preparedness and Lock-Out/Tag-Out.

These are maintained in the EHS-MS Training System.

5.3.2 Training records must contain, at a minimum:

a. Shop or fabrication space
b. Instructor
c. Date(s) of training
d. Name(s) and Kerberos of trainee(s)
e. Tools, equipment, or other subjects covered.

A sample training record form is attached in Appendix F.

5.3.3 Additional information about training and documentation is available from the EHS Office at (617) 452-3477 or by e-mail at environment@mit.edu.

6. Record Management

6.1 Training records maintained in the EHS-MS Training System will be retained indefinitely.

6.2 Training records maintained locally in shops and other fabrication spaces shall be retained for a minimum of 5 years.

6.3 Inspection records for tools and shop/fabrication spaces shall be retained for a minimum of 5 years.

7. References

7.1 Appendices

- A: MIT Tool Classification Guidelines
- B: Tool and Machine Safeguarding
- C: General Safety Guidance for Common Tools and Machines
- D: Best Management Practices for Shop Hazardous Waste
- E: Sample Self-Inspection Outline for Fabrication Spaces
- F: Sample Training Record Form

7.2 Standards

- OSHA – 29 CFR 1910.212 – General Requirements for All Machinery
- OSHA – 29 CFR 1910.213 – Wood Working Machinery requirements
- OSHA – 29 CFR 1910.219 – Mechanical Power Transmission Guarding
- OSHA Publication 3067 – Concepts and Techniques of Machine Safe Guarding
- ASME B107 Hand Tools
- ANSI Standards:
    - B11.1 Construction, Care and Use of Mechanical Power Presses
    - B11.4 Construction, Care and Use of Shears
    - B11.6 Construction, Care and Use of Lathes
    - B11.8 Construction, Care and Use of Drilling, Milling and Boring Machines
    - B11.9 Construction, Care and Use of Grinding Machines
    - B11.10 Construction Care and Use of Metal Sawing Machines
    - B15.1 Mechanical Power Transmission Apparatus
        - Woodworking Machinery – Safety Requirements

7.3 Other MIT SOPs / SOGs / EHS Web pages

To view the SOPs/SOGs go to https://ehs.mit.edu/sops/ and search for the SOP/SOG listed. MIT Certificates are required to view SOPs/SOGs.

- EHS-0059: EHS Electrical Safety Management for Facility / Operations Work Environment
- EHS-0060: Lab Electrical Safety
- EHS-0020: Flammable and Combustible Liquids
- EHS-0114: Hearing Conservation
- EHS-0058: Hot Work Permit
- EHS-0038: Personal Protective Equipment
- EHS-0066: Welding, Cutting, and Brazing Safety

- EHS web page: Hire/Host a Minor

8. Definitions

- **Authorized User** – an individual who has received general shop / fabrication safety training and tool- specific training, and been documented as qualified to work with those tools by a Shop Manager.

- **Shop Managers** - employees or faculty designated by their DLC with overall authority and responsibility for their shop or fabrication space, including providing or documenting shop and tool-specific training for users, repairs and maintenance, and general safe operations. The Shop Manager also has responsibility for proper management of any hazardous waste generated from equipment and tools. Shop Managers may further designate one or more Shop Supervisors or Monitors to assist with day-to-day operations, provide user oversight and supervision, and offer training on certain tools and machines in their space.

- **Shop Supervisors** - employees, faculty, or other staff members with professional-level experience. They may be designated to serve under a Shop Manager to provide assistance with day-to-day operations, supervision of users, and tool- and machine-specific training.

- **Shop Monitors** - experienced undergraduate or graduate students, post-doctoral associates, or other staff members with appropriate tool experience (and for Class 4 equipment, documented extensive tool experience). Like Shop Supervisors, Monitors may also be designated under their Shop Manager to provide equipment and user oversight, and train new users on specific tools and machines. If permitted by the Shop Manager, Monitors may also qualify and credential new users on tools and machines up to and including Class 3 tools; however, only a Shop Manager or Supervisor may credential users on Class 4 machines. Monitors otherwise have full authority over operations in their space.

- **Shop or Makerspace** – a dedicated area where physical processing and fabrication of materials occurs using hand or powered tools, machines, digital; fabrication tools or other equipment. Operations include but are not limited to machining, cutting, drilling, grinding, sanding, surfacing / resurfacing, and depositing.

Appendix A: Tool Classification Guidelines

April 13, 2017 revised

Device Class	1	2	3	4
Description	Low power hand and bench tools	Medium power hand and small benchtop tools	Medium power industrial and construction-scale tools	Powerful portable and industrial tools
Examples Portable / Handheld Tools	• Most manual hand tools • "Dremel" style tools • Cordless drills ≤ ½ hp • Palm sanders • Soldering irons • Glue guns	• Small corded portable hand tools < 1/3 hp such as 3/8" chuck hand drills, hand planers, jig saws, belt sanders, angle grinders • Cordless drills > ½ h.p. • Pneumatic tools	• Portable construction-scale powered hand tools such as circular saws, reciprocating "Sawz All" saws, ½" chuck hand drills, hand-held routers	• Powder-actuated tools
Machine and Woodworking Tools ○ Mills		Small benchtop units, enclosed and interlocked	Large industrial units	
○ Lathes	Small "Jeweler" style	Small mini-benchtop units, enclosed and interlocked	Benchtop units	Large industrial units
○ Sheetmetal Tools (brakes, shears, rollers)	Small manual benchtop units	All other manual units	Small powered units	Large industrial units, including all powered rollers
○ Drill Presses		Small bench units	Stand-alone units	
○ Band Saws		Small bench units	Stand-alone units	
○ Chop/Miter Saws		XXX		
○ Table Saws			Table saws with presence sensing safety feature, e.g., SawStop or equivalent only	All other table saws
○ Radial Arm Saws			XXX	
○ Belt/Disc Sanders		Small bench units	Stand-alone units	
○ Grinders & Buffers		Small bench units	Stand-alone units	
○ Shapers / Moulders				XXX
○ Hydraulic Presses		Small bench units	Small stand-alone units	Large industrial units
○ Water Jets		Small stand-alone units	Large industrial units	
3D Printers	Fused deposition modeling (FDM) printers (ABS, PLA, etc)	Liquid resin units		Powdered metal printers
Laser Cutters		Small bench units	Larger format units	
Robotic Tools		Small bench units, interlocked	Mid-sized units	Large open-format units (e.g., Kuka)
Glassblowing		Small-scale "lamp" work	Heavy or larger parts work	

Appendix A: Tool Classification Guidelines

April 13, 2017 revised

Device Class	1	2	3	4
Description	Low power hand and bench tools	Medium power hand and small benchtop tools	Medium power industrial and construction-scale tools	Powerful portable and industrial tools
Blacksmithing & Foundries		Small-scale work	Heavy or larger parts work	
Welding and Torch Cutting		Electric "spot" welding	Electric arc welding	Oxyacetylene torch operation
Printing Presses	Small manual bench units	Stand-alone manual units	Larger, powered units	
Miscellaneous Tools: ○ Sewing Machines	XXX			
○ Vinyl Cutters	XXX			
○ Thermal Foam Cutters	XXX			
○ Spray Booths	Small benchtop units	Larger / walk-in units		
Supervision of Users: Trainees / New Users	• By Shop Manager, Supervisor, or Monitor	• By Shop Manager, Supervisor, or Monitor	• By Shop Manager, Supervisor, or Monitor	• By Shop Manager or Supervisor Only
Experienced/ Credentialed Students	• Solo work permitted	• Buddy system recommended	• Buddy system required	• By Shop Manager, Supervisor, or Monitor; Peer Buddy with Shop Manager Permission
Professional Staff	**Solo work permitted at all tool levels, with buddy system recommended for higher class tools**			
User Training Trainees / New Users	• Pre-read any available tool use guides • MIT shop safety rules • In-person review of shop safety and tool use by Shop Manager, Supervisor, or Monitor • Hands-on proficiency demonstration	• Pre-read any available tool use guides • MIT shop safety rules • In-person review of shop safety and tool use by Shop Manager, Supervisor, or Monitor • Hands-on practice and proficiency demonstration	• Pre-read any available tool use guides • MIT shop safety rules • In-person review of shop safety and tool use by Shop Manager, Supervisor, or Monitor • Hands-on practice and proficiency demonstration	• Pre-read any available tool use guides • MIT shop safety rules • In-person review of shop safety and tool use by Shop Manager, Supervisor, or Monitor • Extended hands-on practice and proficiency demonstration
Experienced / Credentialed Users	• In-person review of shop and tool safety • Proficiency "test" at discretion of Shop Manager, Supervisor, or Monitor	• In-person review of shop and tool safety • Proficiency "test" at discretion of Shop Manager, Supervisor, or Monitor	• In-person review of shop and tool safety • Proficiency "test" at discretion of Shop Manager, Supervisor, or Monitor	• In-person review of shop and tool safety • Proficiency "test" at discretion of Shop Manager, Supervisor, or Monitor
Authority to Credential Users	• Shop: ○ Manager	• Shop: ○ Manager	• Shop: ○ Manager	• Shop: ○ Manager

Appendix A: Tool Classification Guidelines

April 13, 2017 revised

Device Class	1	2	3	4
Description	Low power hand and bench tools	Medium power hand and small benchtop tools	Medium power industrial and construction-scale tools	Powerful portable and industrial tools
	○ Supervisor ○ Monitor	○ Supervisor ○ Monitor	○ Supervisor ○ Monitor	○ Supervisor

Appendix B: Tool Safeguarding Guidelines[1]

(see p18 for footnotes)

Tool Type	Potential Hazards	Emergency Stopping [2,3]	Shields and Guards	Other Protective Measures [4]
Band Saw	• Band saw blade – lacerations, dismemberment, amputation • Rotating blade and pulleys - pinch points, entanglement • Flying objects - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Blade guard • Fully enclosed pulleys and band saw wheels	• Push sticks • Fence • Dedicated tool light • Local exhaust ventilation for production use or with hazardous materials
Bead / Shot Blaster	• Abrasive shot - skin abrasion • Flying objects - eye, face, skin injuries • Airborne particulates and dust - lungs	• E-stop, accessible single action hand switch, or foot switch • Door interlocks for large units	• No open work - performed inside enclosure ("glove box")	• Gasketed access hatch • HEPA vacuum for clean-up • Tool light inside enclosure
Brake, Manual (Metal Bending)	• Caught between - finger crushing	• Manual - non-needed		• Prominent color marking or striping at point of operation
Buffer, Wheel	• Rotating parts - entanglement • Flying objects - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Rotating shaft guards as feasible	• Small part holding clamps
Drill Press	• Sharp cutting bit - lacerations, punctures • Rotating chuck and bit - entanglement • Flying objects (chips, parts, chuck key) - eye, face, skin injuries • High torque on work piece - impact	• E-stop, accessible single action hand switch, or foot switch	• Covered pulley head • Chip/chuck • Rear shielding or placement against wall	• Vise • Spring-loaded chuck key • Hearing protection for high pitch metal cutting • Dedicated tool light
Foam Cutter	• Hot wire - burns, fire • Smoke - inhalation exposure	• E-stop, accessible single action hand switch, or foot switch	• Cover or enclosure	• Local exhaust ventilation
Grinder, Bench or Pedestal	• Rotating shaft and wheel - pinch points, abrasions • Flying objects - parts, shattered wheel - eye, face, body injuries • Heat / sparks - burns, fire	• E-stop, accessible single action hand switch, or foot switch	• Enclosed wheels • Upper tongue guard • Chip shield • Rear shielding or placement against wall	• Work / tool rest • Depth / feeler gauge to ensure proper clearances for tool rest and tongue guard • Dedicated tool light
Ironworker (Multi-Function Metal-Working Tool)	• Possible flying objects - eye, face, skin injuries • Caught between / pinch points - serious crushing, amputation	• E-stop, accessible single action hand switch, or foot switch	• Varies by functions of specific Ironworker	
Jig and Scroll Saws	• Sharp cutting blade - lacerations • Flying objects - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Blade guard	• Faceshield if excessive flying objects expected
Jointer (Wood)	• Sharp cutting heads - serious lacerations, amputation • Rotating (horiz.) parts - entanglement • Flying objects - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Cutter shield	• Push sticks and blocks • Local exhaust ventilation

Appendix B: Tool Safeguarding Guidelines[1]

(see p18 for footnotes)

Tool Type	Potential Hazards	Emergency Stopping [2,3]	Shields and Guards	Other Protective Measures [4]
Laser Cutter	• Laser - ocular injury, burns, smoke, toxic fumes and vapors • Heat - burns, fire • Moving laser head - physical injuries	• E-stop	• Interlocked access cover	• Local exhaust ventilation • Dedicated portable fire extinguisher
Lathe - Wood	• Rotating parts - entanglement • Flying objects (chips, chuck key, part) - eye, face, skin injuries • Sharp cutting tools - lacerations • Pinch points - crushing, bruising	• E-stop, accessible single action hand switch, or foot switch	• Chuck / chip guard	• Tool rest • Faceshield if point of operation shield not possible
Lathe – Jeweler Style Mini-Bench	• Rotating parts - entanglement • Flying objects (chips, chuck key, part) – eye, face, skin injuries • Sharp cutting tools - lacerations • Pinch points - minor crushing, bruising	• E-stop, accessible single action hand switch, or foot switch	• Portable shield	
Lathe – Metal	• Rotating parts - entanglement, death, dismemberment, amputation, crushing • Flying objects (chips, chuck key, part) - eye, face, skin injuries • Sharp cutting tools - lacerations • Pinch points - crushing, bruising • Heat - burns	• E-stop, accessible single action hand switch, or foot switch • Emergency foot brake / power stop (new machines)	• Fixed or portable chuck shield (interlocked on new machines) • Cross-slide shield • Lead screw if exposed • Bar feeder cover (if present) • Rear shield as needed or placement against wall	• Spring-loaded chuck wrenches • Protect collet release handle if exposed • Prominent color marking or striping of foot brake • Dedicated tool light
Metal Cutting Saw – Horizontal	• Sharp cutting blade - lacerations, amputation • Rotating blade pulley - entanglement, pinch point • Flying objects - eye, face, skin injuries • Heat / sparks - burns, fire	• E-stop, accessible single action hand switch, or foot switch	• Blade guards (upper and lower) • Blade wheel / pulley guards	• Work piece vise / clamp • Outfeed support
Milling Machine	• Sharp cutting bit - lacerations, punctures • Rotating chuck and bit - entanglement • Flying objects – impact from parts working or centrifugal throw (chuck key, part) - eye, face, skin injuries • High torque on work piece - impact • Caught between/ struck by - impact	• E-stop, accessible single action hand switch, or foot switch	• Affixed chuck/chip shield • Drive belt access cover or variable speed motor • Rear / side shielding as needed or location against wall	• Spring-loaded chuck wrenches or auto-collet • Vise • Retractable handles on powered tables • Dedicated tool light

Appendix B: Tool Safeguarding Guidelines[1]

(see p18 for footnotes)

Tool Type	Potential Hazards	Emergency Stopping [2,3]	Shields and Guards	Other Protective Measures [4]
Planer	• Sharp cutting heads - lacerations, amputations • Rotating (horiz.) parts - entanglement • Flying objects - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Adjustable feed guard	• Push sticks • Outfeed support • Hearing protection for noise • Local exhaust ventilation
Printer, 3-D	• Moving print head - physical injuries • Vapors and aerosols - lungs • Support removal - lacerations	• E-stop	• Enclosure (interlocked for large units)	• Emergency eyewash, additional personal protective equipment, and spill supplies for caustic baths
Printing Press	• Rotating parts, pulleys, wheels - entanglement • Caught between - crushing • Possible flying objects - eye, face, skin injuries • Pinch or shear points - crushing, bruising, amputation • Ink and cleaning solvents - chemicals	• E-stop, accessible single action hand switch, or foot switch	• Pulley(s) guards • Feed guards or access restrictors • Roller guards	• Review and address safe chemical use in inks and cleansers
Radial Arm Saw	• Sharp cutting blade - lacerations, amputations • Flying objects - impact to eye, face, skin injuries • Rotating shaft / blade - entanglement	• Finger /constant pressure switch, E-stop, accessible single action hand switch, or foot switch	• Upper enclosed blade cover • Self-adjusting lower blade guard	• Saw auto-retraction • Fence (kerfed to avoid restricting blade guard) • Clamps for parts • Outfeed support
Robotics Devices	• Caught between/ struck by - impact Possible flying objects - eye, face, skin injuries	• E-stop (light curtain, IR field, step-on pad, etc for large open format robots)	Varies by size and format: • Interlocked cover • Separate room with access controls for large, open-format robots	• Marked exclusion zone
Roller, Sheet metal, Manual	• Caught between / pinch points - crushing, limited by manual operation	• Manual - non-needed		• Outfeed support
Roller, Sheet metal, Powered	• Caught between / pinch points - serious crushing, amputation	• E-stop (manual, foot, bump, trip wire, light curtain, etc.)	• Sliding adjustable roller shield	• Outfeed support
Sander, Belt (vertical or horizontal)	• Flying objects - eye, face, skin injuries • Rotating pulleys, belts - entanglement • Pinch points - crushing, bruising, serious abrasion, laceration	• E-stop, accessible single action hand switch, or foot switch	• Pulley guards • Belt roller guards above and below tool rest	• Tool rest • Small part holding clamps

Appendix B: Tool Safeguarding Guidelines[1]

(see p18 for footnotes)

Tool Type	Potential Hazards	Emergency Stopping [2,3]	Shields and Guards	Other Protective Measures [4]
Saw, Cut-Off (abrasive disc and metal cutting)	• Sharp cutting blade - lacerations, amputations • Rotating blade - entanglement • Flying objects - eye, face, skin injuries • Heat / sparks - burns, fire	• Trigger/finger constant pressure switch	• Blade guard (self-adjusting)	• Auto-return to upright • Fence • Vise • Clamps as needed • Outfeed support
Saw, Miter / Compound Miter Chop-Style Saw	• Sharp cutting blade - lacerations, amputations • Rotating blade - entanglement • Flying objects - Impact to - eye, face, skin injuries	• Trigger/finger constant pressure switch	• Blade guard (self-adjusting)	• Auto-return to upright • Fence • Clamps • Laser sight cut line
Saw, Upright Panel Style	• Sharp cutting blade - lacerations, amputations • Rotating blade - entanglement • Flying objects - eye, face, skin injuries	• Trigger/finger constant pressure switch	• Blade guard (self-adjusting)	• Auto-return to upright • Fence • Clamps
Saw, Wet Abrasive	• Sharp cutting blade - lacerations, amputations • Rotating blade - entanglement • Flying objects - eye, face, skin injuries • Water / electrical - shock	• E-stop, accessible single action hand switch, or foot switch	• Blade guard	• GFCI outlet / plug adapter • Fence • Clamps
Shaper / Inverted Router	• Sharp cutting tool - lacerations, amputation • Rotating tool - entanglement • Flying objects – Impact to - eye, face, skin injuries	• E-stop, accessible single action hand switch, or foot switch	• Cutting tool guard	• Fence • Pushsticks
Shear, Sheet metal, Manual	• Sharp cutting blade - lacerations, amputations • Caught between - crushing	• Manual - non-needed	• Blade	
Shear, Sheet metal, Powered	• Sharp cutting blade - lacerations, amputations • Caught between - crushing (from powered part hold-down jaw)	• 2-hand controls • E-stop or foot switch	• Blade and hold down guard • Access to point of operation from outfeed side guarded	• Outfeed support • Laser sight cut line
Surface Grinder	• Rotating shaft and wheel - pinch points, abrasions, entanglement • Flying objects - parts or wheel shatter – Impact to eye, face, skin injuries • Heat / sparks - burns, fire	• E-stop, accessible single action hand switch, or foot switch	• Wheel guard • Shielded table	• Dedicated tool light

Appendix B: Tool Safeguarding Guidelines[1]

(see p18 for footnotes)

Tool Type	Potential Hazards	Emergency Stopping [2,3]	Shields and Guards	Other Protective Measures [4]
Table Saw	• Sharp cutting blade - serious lacerations or amputation • Rotating blade - entanglement • Flying objects - eye, face, skin injuries • Part kick-back - impact	• E-stop, accessible single action hand switch, or foot switch • Presence-sensing technology for new table saws	• Blade guard (self-adjusting)	• Fence and miter gauge • Splitter / riving knife • Anti-kickback pawls • Pushsticks • Featherboards / jigs • Outfeed support
Water Jet Cutter	• High pressure water – serious lacerations, amputations • Moving spray head(s) - physical injuries • Very high noise - hearing	• E-stop	• Interlocked cover for small units	• GFCI outlet / plug adapter • Noise enclosures / absorbers or mandatory hearing protection use
Wire Wheel	• Rotating shafts and wheels - abrasions, lacerations, entanglement • Flying objects - eye, face, skin injuries • Heat / sparks - burns, fire	• E-stop, accessible single action hand switch, or foot switch	• Wheel enclosure as feasible • Chip shield as feasible • Rear / side shielding as needed or location against wall	• Tool / part rest if needed • Small part holding clamps

[1] For all tools: Bench models affixed to work surface with bolts or clamps; standing or pedestal models bolted to floor
Place after-market E-stops and other controls within reach of standard operator
Tool lights must be protected by covers or safety coated bulbs, or by use of low voltage lighting

[2] Controls: Power controls and E-stops or switches in prominent red color on yellow background

[3] Anti-restart: Required by OSHA for woodworking tools but a best practice for any tool where unintended / accidental re-start could result in injury

[4] Warning labels: Warning labels for all bench and stand-alone tools and machines

Appendix C:
General Safety Guidance for Common Tools and Machines

For All Tools and Machines:

- Develop a binder or file of manufacturer's operating and maintenance manuals for on-going reference.
- Post key safety requirements for the shop in general and each tool in particular.
- Secure tools to the bench top or, for larger pedestal-style self-standing machines, the floor to prevent tipping, movement, or excessive vibration. Installing a heavy, wide base may be an acceptable alternative in certain circumstances.
- Install and use all required guards and shields. If removed for service, repair, or other authorized temporary reasons, reinstall them before returning the tool to standard operating use.
- Be aware that processing toxic or reactive materials is hazardous and generally require specials controls, including local exhaust ventilation and possible fire protection or inert atmospheres. Consult the MIT EHS Office for technical assistance in advance.
- Sanders and most woodworking tools generate significant quantities of particulate matter and dust. Wood dust exposure has been associated with a variety of adverse health effects including dermatitis, skin and respiratory sensitization as well as (nasal) cancer. The use of local ventilation is the primary engineering control. Exhaust hoods should be installed as close as possible to the emission source.
- "Kickback" can occur with many tools, most frequently woodworking tools, when a saw blade or cutting head seizes the stock piece and accelerates it in the direction of rotation, generally back at the operator. It occurs more often when cutting parallel to the grain (ripping) than when crosscutting. Kickback can occur when the stock twists and binds, if the blade or other cutter is not sharp or set an incorrect height, wet or poor quality lumber (knots or nails). These hazards can be reduced by using safeguards such as spreaders or splitters, anti-kickback fingers, power feeders, and gauge or rip fences. Hand and body positions relative to the workpiece are also very important.
- Physically deactivate, unplug, or otherwise disconnect power to tools and machines before replacing tools, bits, blades or performing other service and maintenance work where accidental starting could cause injury.

Drill Press Safety Rules:

- Always secure the work in a vise or clamp to the drill table. Never hand-hold a workpiece.
- Operate the drill at the optimum RPM for the diameter of the drill bit and material (check mfg.'s instructions).
- Use the proper size and type of drill; ensure it is sharp and not cracked.
- Use the proper cutting fluid for the material being drilled
- Support material on parallels or backing board when drilling completely through
- If the drill binds, stop the machine and turn the spindle carefully backwards by hand to release the bit
- When drilling a deep hole, withdraw the bit frequently to clear the chips.
- Seek advice and training for drilling Plexiglas (and other brittle materials) if not experienced and approved.
- Wear safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Lathe Safety Rules:

- Ensure the chuck, drive plate, or faceplate is securely tightened onto the lathe spindle.

- Do not use machine power to install the chuck, drive plate or faceplate.
- Ensure the tool bit is sharp and is clamped as secure (short) as possible in the tool holder to minimize the risk of breakage or chatter.
- Remove turnings or chips with a hook or appropriate tool while the machine is switched OFF and not running. *Never with an unprotected hand.*
- Remove the chuck key from the chuck immediately after tightening or loosening.
- Wear safety glasses with side shields or machinist's goggles as a minimum. Consider face shields. Heavy duty or safety shoes are required unless it can be shown that the potential hazards of the task are non-existent or minimal.
- Chip shields/chuck guards and lead screw covers shall be used.

Milling Machine Safety Rules:

- Ensure work is clamped securely in a vise and the vise clamped securely to the worktable.
- Ensure cutter is rotating in the proper direction and spindle is clear before cutting material.
- Use the proper cutting speed and cutting fluid.
- Ensure cutters are sharp and ensure power is off prior to changing.
- Remove tightening wrench immediately after using
- Divert or protect user from chips where cuts throw chips toward the user
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Grinder Safety Rules:

- Ensure guards are in place and operable. The bench tool rest clearance must be less than 1/8 inch. Grinders shall be secured to bench top (or if pedestal) to floor to prevent movement.
- Ensure local ventilation (if required) is in place and operable.
- Ensure grindings wheels are not defective, unbalanced or cracked. Such damage may not be obvious. Stand to one side upon starting.
- Keep the wheel dressed with small amounts frequently.
- For a surface grinder, ensure the magnetic chuck is securely placed.
- Do not grind aluminum due to potential hazards. Check with supervision for safety requirements.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Band Saw Safety Rules:

- Ensure the upper guide and guard is set close to the work (¼")
- Use the proper pitch blade depending on the material thickness. There should be at least 2 teeth in aluminum material and 3 teeth when cutting steel.
- Ensure the blade is not defective or cracked prior to installation and is covered by a blade guard.
- Do not run the saw at a higher speed than recommended for the material being cut.
- If the motor/saw stalls or breaks, shut off the power immediately and keep clear until the machine has stopped.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.
- Use backing materials/blocks to push materials to complete cuts as needed.

Disc and Belt Safety Rules:

- Ensure the guards are in place prior to use.
- Do not operate machines with worn, ripped or torn belts or discs.
- Place the work against the rest on the disc and belt sanders as firmly as possible. Small parts should be held with a jig, pliers, tongs or other means.

- For disc sanders, always use the downward motion side of the disc. Using the upward motion can throw the parts outward with force.
- For horizontal belt sanders, always use the motion of the sanding belt that is away from the body.
- Even for common materials, sanding operations generate significant amounts of dust and require control. For infrequent use local bag filters or filtered shop vacuum cleaners are generally sufficient, but high use units and those involved with more hazardous materials will require true local exhaust ventilation for contaminant control. Consult the MIT EHS Office for technical assistance.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Table Saw Safety Rules:

- Consider presence-sensing emergency stop technology such as the SawStop® for new purchases and the replacement of existing table saws. While this safety feature can be overridden, and it does not prevent workpiece kickback, it can significantly lessen the risk of serious lacerations and amputations when used appropriately.
- Ensure the guards are in place prior to use.
- Use the proper blade for the material being cut. Set it 1/8" above the work.
- Inspect the blade prior to use. Ensure it is sharp and free of defects
- Use a push stick or block to rip narrow pieces of stock. Never place fingers near the blade
- User infeed and outfeed supports for large material, especially full-size sheet goods. If such supports are unavailable or impractical, obtain assistance from the Shop Manager, Supervisor, or Monitor. Alternatively, use a panel saw to dimension and rough cut large workpieces.
- Prevent the accumulation of scraps and sawdust by routinely cleaning the area and discarding waste materials appropriately.
- Provide dust collection under the blade slot. For infrequently used equipment, a fabric dust bag or filtered shop vacuum is generally sufficient. For higher use equipment, true local exhaust ventilation and a dust collector are necessary. Dust collection hoods integrated with an over-the-blade guard are also available.
- Never use miter gauge and fence when cross cutting, use only the miter gauge or cross cut sled.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.
- Under certain specific circumstances, guards or shields may impede actions such as bevel cuts, tenoning, slotting and dadoing. Under these kinds of conditions only, alternative safeguarding must be implemented. These should be discussed first with the Shop Manager, Supervisor, or Monitor, and may include the adoption of special jigs, "sleds", templates, fixtures, or other means that effectively control hazards.

Jig Saw Safety Rules:

- Ensure the guard is in place prior to use.
- Use a threshold rest (slotted foot) to hold the stock.
- Ensure blade is properly attached and secured.
- Make turns slowly, no sharp turns with a wide blade.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Jointer Safety Rules:

- Enclose the cutter head with an automatic (spring loaded, self-enclosing) guard that exposes the cutter head only when the stock is being fed.

- Adjust the cutter head so that the knife projects no more than 1/8 inch beyond the head.
- Keep clearances between the table and the head as small as possible.
- Use hold down push blocks when jointing wood narrower than 3 inches.
- Avoid deep cuts to minimize the hazards of kickbacks.
- Never joint material that is less than four times the width of the bed opening.
- Use safety glasses with side shields or machinists goggles as a minimum. Consider face shields.

Shaper Safety Rules:

- Enclose the spindle with an adjustable guard or cage. For straight shaping, the fence frame should include the guard. Keep the opening as small as possible for the knives. The fence should extend at least 18 inches on either side of the spindle.
- Split adjustable fences are useful for guarding when the entire edge of the stock is to be shaped.
- Mount a ring guard around the cutting bit to reduce the exposure to the bit.
- Ensure the knives are precision ground, balanced and fit properly.
- Apply the power slowly to bring the spindle to operating speed. Listen for chatter to indicate an out of balance condition.
- Use templates, jigs, and fixtures to keep hands from the point of operation
- Cut in the opposite direction of the spindle's rotation
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Router Safety Rules:

- Enclose the tool with an adjustable tool guard.
- Purchase a router with a spindle braking system that gradually engages.
- Ensure the tools are properly attached and secured.
- Label the cutting tools and holders with the maximum permissible cutting speed.
- Use local exhaust ventilation hoods behind the heads of the router table. Locate an open faced or slot hood at the rear end of the table.
- Use safety glasses with side shields or machinist's goggles as a minimum. Consider face shields.

Appendix D:
Best Management Practices for Shop Hazardous Waste

Machine shop operations generate chemical waste materials, but in different ways than a laboratory. This document provides some general guidance, but additional information may be required for your shop. Contact the EHS Office at environment@mit.edu.

- Machine shops that generate hazardous wastes on a routine basis shall store it in a dedicated satellite accumulation area (SAA). These areas must be properly labeled and inspected weekly.
- Personnel generating, handling and storing hazardous waste must attend "Managing Hazardous Waste" training, at least annually.
- The EHS Office encourages machine shop personnel to cleanout stocks of obsolete chemicals on a regular basis to avoid accumulating large quantities of obsolete and/or expired materials. Doing this will free-up valuable storage space.

Cutting Fluids Waste

Machine shops operations typically use and dispose of large quantities of cutting and grinding fluids. These consist of either water-soluble or non-soluble (petroleum) based oils.

Best Management Practice **-** Wherever possible use water-soluble cutting fluids. Both types (water-soluble and non-soluble fluids) shall be collected as hazardous waste. Avoid use of chlorinated tapping fluids and take precautions to prevent mixing them with cutting fluids.

Chips and Fines Waste

The primary wastes from metalworking are chips and fines. If saturated with traditional oil-based cooling and cutting fluids, these materials must be collected as hazardous waste.

Best Management Practice – To avoid or minimize generating hazardous waste:

- Completely drain excess cooling fluid from chips prior to recycling using a screen, perforated container, chip wringer, or centrifuge. The drained coolant can then be reused or disposed of as hazardous waste.
- Locate opportunities to recycle chips, fines, and sludge for metal value. Contact the MIT EHS Office for recommendations and outlets.
- Segregate by metal type for increased recycling value.

Metal Coatings, Paints, Sealants, Adhesives, Etc.

These materials often are the largest sources of hazardous waste in a shop. They are often flammable or have other characteristics of hazardous waste. If a material is flammable, store it in a flammable storage cabinet.

Best Management Practice – Miscellaneous waste materials should be disposed of regularly by requesting a shop cleanout.

Degreasers

Degreasing is critical to remove oil, particles, and/or buffing compound contamination. Machine shops typically use mineral spirits as a solvent to remove grease and oil from tools, parts, and equipment. This can result in significant quantities of hazardous waste being generated during routine cleaning processes.

Best Management Practice - Waste degreasers should be disposed of in regular machine shop cleanouts.

Wipes

Rags and wipes which are saturated with a liquid other than water must be collected and managed as a hazardous waste.

Best Management Practice – Use the minimal amount of cleaner necessary to avoid saturating wipes. Wipes that are not saturated with hazardous liquids can be placed in the regular trash.

Appendix E:
Sample Self-Inspection Outline for Fabrication Spaces

Shop or Fabrication Space: _____

Performed by: _____ **Date:** _____

Shop Conditions	
□ **Yes** □ **No**	Is access to the space secured and limited to only authorized individuals?
□ **Yes** □ **No**	Does the room have an MIT Greencard?
□ **Yes** □ **No**	Is the space well-lighted?
□ **Yes** □ **No**	Are all exits clearly marked and accessible?
□ **Yes** □ **No**	Are floors clear of obstructions and debris?
□ **Yes** □ **No**	Is overall housekeeping in good condition, including stored items?
□ **Yes** □ **No**	Are there any conditions or issues that warrant additional follow-up?
Safety Features	
□ **Yes** □ **No**	For spaces with Class 2 tools and higher: Is a Shop Manager, Supervisor, or Monitor present during use?
□ **Yes** □ **No**	Is general shop safety information posted in the space?
□ **Yes** □ **No**	Is at least one portable fire extinguisher present?
□ **Yes** □ **No**	Is there a landline phone with emergency contact information posted?
□ **Yes** □ **No**	Is at least one first aid kit present and in good condition?
□ **Yes** □ **No**	If present, are chemicals labelled by full name and hazard category?
□ **Yes** □ **No**	If present, are chemicals stored properly? e.g., flammables kept inside rated flammable storage cabinet.
□ **Yes** □ **No**	If chemicals or chemical products are present, are Safety Data Sheets and a list of materials present, up-to-date, and accessible to users?
□ **Yes** □ **No**	Is personal protective equipment (PPE) appropriate to the hazards available and in good condition?
□ **Yes** □ **No**	Do tool and machine users wear the required PPE?
□ **Yes** □ **No**	Are users following proper hair, jewelry, and attire requirements?
□ **Yes** □ **No**	Are electrical cords well-managed and protected from damage?
□ **Yes** □ **No**	For spaces with emergency water: Is the eyewash or safety shower tested periodically and labelled by test date?
□ **Yes** □ **No**	Are there any safety issues or concerns that warrant additional follow-up?
Tools and Machines	
□ **Yes** □ **No**	Are tools protected from unauthorized use?
□ **Yes** □ **No**	Are users appropriately trained?
□ **Yes** □ **No**	Does the shop have written training records for new users or can user training be confirmed or verified? If the latter, what method is used to confirm that users are trained? ○ Mobius application ○ Passport or training card ○ Shared spreadsheet

	○ Other:
□ **Yes** □ **No**	Are damaged tools or those undergoing repair or maintenance locked-out of service and so tagged or noted?
□ **Yes** □ **No**	Are all tools properly safeguarded?
□ **Yes** □ **No**	Are there any tool or machine issues or concerns that warrant additional follow-up?
Waste Management	
□ **Yes** □ **No**	Are wastes and recyclable materials collected and removed regularly?
□ **Yes** □ **No**	If the space generates any of the following specific waste materials, are they managed according to MIT hazardous waste rules? ○ Cutting fluids ○ Metal chips, fines, and scraps ○ Degreasing agents ○ Coatings, paints, sealants, and adhesives ○ Solvent or oily rags and wipes

- **Please use this form as a starting point for your shop or fabrication space. Feel free to add other questions and items specific to your space and operation.**
- **Discrepancies and issues should be prioritized and addressed.**
- **Please contact MIT EHS for assistance in performing an audit / survey and for help resolving any problems.**

Appendix F: Sample Training Record Form

Shop or Fabrication: _____

Trainer / Instructor: _____

Date: _____

Subject Matter Covered: _____

Trainee Name (Last, First)	Kerberos	Notes

- **You may also use an electronic record or other paper-based record of your choice, provided you maintain at least the same level of information.**
- **Please retain all training records on-file for at least 5 years.**
- **You may also forward Training Records to MIT-EHS for recordkeeping – contact them at (617) 452-3477 or environment@mit.edu.**