

GENERAL MACHINE SAFETY

This SOP is intended to provide general safety guidance for power-driven (including manually operated) stationary machines and equipment used to shape and/or form metal, wood, or other materials by cutting, impact, pressure, electrical or other processing techniques. These types of machines present a number of potential hazards, which must be recognized and controlled to minimize the risk of operator injury. Hand and portable powered tools are beyond the scope of this SOP.

Relevant Standards

Following are common, recognized standards for safe machine operation. The content of this SOP is drawn from these standards. Machine operators are encouraged to become familiar with the content of the cited standards relevant to their work.

- 29 CFR 1910, Subparts O, (Machinery and Machine Guarding), Q (Welding, Cutting, and Brazing), and R (Special Industries), United States Occupational Safety and Health Administration (OSHA)
- ANSI B11.0, Safety of Machinery – General Requirements and Risk Assessment, American National Standard Institute (ANSI)
 - ANSI B11.1- B11.14, Safety Standards for Specific Machine Tools (such as power press brakes, mechanical power presses, woodworking machinery, abrasive wheels, etc.)
- NFPA 79, Electrical Standard for Industrial Machinery, National Fire Protection Association (NFPA)

Hazard Overview

Potential hazards of operating machines and equipment are numerous. Some of the most obvious recognized hazards are from machine motion. Hazardous motion is characteristic of the point-of-operation of the machine, but can also be found in other areas such as behind, to the side, or above a machine.

- Rotating motion of collars, couplings, cams, clutches, flywheels, shaft-ends, set screws, spindles, etc., can be dangerous by gripping clothing or forcing arms/hands or other body parts into dangerous positions. Rotating parts can also create nip points when two adjacent moving parts are in close proximity (e.g., two cogs, two rolling bars, chain and sprocket, etc.); or a rotating part is in close proximity to a fixed point.
- Reciprocating machine motions are also hazardous. A worker may be injured by back-and forth or up-and-down motion when struck by or caught between moving and stationary parts (e.g., saw blades, knives, etc.).

- Transverse machine motion (movement in a straight, continuous line) is another recognized hazard because a worker may be struck or caught in a pinch or shear point by moving parts.

In addition to machine motion, examples of other machine hazards may include:

- Chemical hazards resulting from the product being handled (e.g., toxic fumes emitted from metals, wood dusts, etc.) or the machine itself (e.g., contact with or inhalation of cutting oil mists or cleaning compounds, etc.).
- Ergonomic factors, such as stresses put on the body from awkward positions, repetitive motions, excessive reaching, vibration, heaving lifting of materials or products, etc.
- Fire due to dust accumulations, electrical sparks or arcs, hot surfaces, open flames, etc.
- Tissue damage caused by contact with extremely cold or hot parts of the machine or material being manipulated.
- Excessive noise, which can cause hearing loss or interfere with the ability to communicate during machine operation.
- Eye or skin damage caused by contact with UV light, particularly with machines using laser technology.
- Eye damage caused by foreign objects emitted from the machine (e.g., dust particles, shavings, sparks, etc.)
- Potential for injury resulting from dropping or ejection of a work piece from the machine during operation.

Safe operation of machinery and equipment necessitates that all foreseeable hazards are controlled. Effective control is achieved through a risk assessment process.

Risk Assessment Overview

The ANSI B11.0 standard states, *“The outcome of completing the risk assessment process should be:*

- *A clear understanding of risk(s) including the potential severity of harm and the probability of the occurrence of harm;*
- *Machinery with risks reduced to an acceptable level;*
- *Risk reduction measures appropriate to the circumstances;*
- *Documentation of the risk assessment.”*

The ANSI B11.0 risk assessment process consists of several steps. For the purposes of this SOP, the following steps are emphasized:

1. Identify the tasks and hazards
2. Assess the initial risk
3. Reduce the risk to a feasible and acceptable level
4. Validate the solutions

Identification of Tasks and Hazards

As previously described, a number of different machine hazards are possible, ranging from those inherent to the machine itself to hazards created by the operator or environment in which the machine is located. Take into consideration different tasks, operator competencies, operating modes, and failure scenarios. It is important to identify potential receptors, as well; who or what may be harmed? It may be helpful to review experiences related to past near-miss incidents, literature from trade organizations, and other information sources to ensure thorough evaluation of hazard.

Tasks to be considered may include:

- Machine installation and assembly
- Start-up and change-over
- Various modes of operation
- Various feedstock materials, considering both dimensions and material of construction
- Maintenance, cleaning, and repairs
- Shutdown
- Troubleshooting, clearing jams, etc.

Hazards to be considered may include:

- Mechanical
- Energy sources (e.g., electrical, pneumatic, hydraulic, etc.)
- Unexpected start-up or shut-down, or automatic repeat cycles
- Exposures to harmful substances or environments (e.g., chemical exposures, hot/cold surfaces, sharp edges, vibration, noise, dusts and fumes, etc.)
- Unstable loads, stocks, finished products, etc.
- Other

Hazard evaluation is a dynamic process that needs to be repeated in response to any number of factors that could influence the hazards, e.g., changes in equipment use or design, operator experience, workspace configuration or design, etc.

Assessment of Initial Risk

Once the hazards and potential receptors are identified, it is important to assess the degree of relative risk in terms of the severity of harm and the probability of occurrence. Once this has been determined, appropriate risk reduction strategies can be selected to minimize the severity of harm or likelihood of an adverse event. To the extent feasible, the goal is to implement controls that come as close to achieving a “remote” likelihood of occurrence and “minor” consequences.

Some things to consider include how quickly the hazard presents and operator reaction time, the duration and frequency of exposure to the hazard, reliability of controls and safety devices, experience of the operator, machine history, number of persons exposed to the hazard, etc.

Risk Reduction

There are a number of possible risk reduction strategies, some being more preferred than others when there is more than one option. Following are machine hazard risk reduction strategies, presented in descending order of preference. When possible, the most preferred option should be selected and implemented (in other words, PPE, training, and awareness devices are not suitable as substitutes for guarding when guarding is feasible).

- Elimination or substitution through inherently safer design. Examples include: automated material handling, substitution of less hazardous chemicals/fluids, reduced mechanical force/energy, elimination of pinch points by increasing clearances, etc.
- Guards or safeguarding devices. Examples include: barriers, interlocks, presence sensing devices, two-handed controls, etc.
- Awareness devices. Examples include: lights, beacons, strobes, computer warnings, signs, labels, beepers, horns, sirens, fences/barrier tape, etc.
- Training and safe work practices/procedures. Examples include: written operating, maintenance, and repair procedures, employee training, employee demonstration of competency, on-going evaluation of employee operating performance, etc.
- Personal Protective Equipment (PPE). Examples include: safety glasses, face shields, ear plugs, protective footwear, helmets, respirators, etc.

When selecting risk reduction measures, keep in mind incentives that may exist or be created for the operator to defeat or circumvent a risk reduction measure. This may occur if the risk reduction measure slows down production, interferes with the ability to complete the task, it is difficult or cumbersome to use or implement, etc.

Validation

The effectiveness of selected risk reduction measures should be validated. This may include initial and periodic testing of interlocks or other safeguarding or awareness devices, initial and periodic observation of operators' techniques, regular medical surveillance in the case of noise or respiratory hazards, prompt review of injuries and near-misses, etc. If experience determines that a risk reduction measure is marginally or ineffective, other risk reduction measures should be considered.

General Safe Operating Rules

Regardless of the particular risk reduction measures selected for a particular machine, there are some general safe operating rules that must be observed.

- Restrict access to shops and individual pieces of equipment/machines to authorized operators.
- Avoid working alone in the area so that someone is available to provide or summon assistance in the event of an emergency.
- Read and adhere to the manufacturer's operating instructions and warnings. Receive training in proper operation and demonstrate competency to an experienced and authorized operator for each type of task to be conducted before operating independently.

- Know the emergency stop/shut-down procedures for the specific machine operated.
- Inspect machines/equipment prior to each operating shift to ensure that:
 - Points of operation and surrounding areas are clean of debris and other hazards.
 - Shields and guards are in place and controls and interlocks or other safety devices are accessible and operating properly (pay attention to the point of operation, as well as the area behind, to the side, and above the machine).
 - Machine components are in good working condition (do not use damaged equipment).
 - Labels and warnings are present and legible.
- Inspect ancillary hazard control devices for proper operation, such as dust collectors used with wood working equipment, etc.
- Do not operate equipment that is damaged or that has missing/defective guards or shields and promptly tag such equipment as “Out-of-Service” and notify the appropriate authority.
- Follow the manufacturer’s recommendations for routine cleaning and preventative maintenance. Do not use compressed air for cleaning of debris.
- Do not attempt to override or defeat safety features. Guards and shields must be in place during normal operation. Observe appropriate Lockout/Tagout procedures when guards, shields, or other safety devices are removed or deactivated for maintenance or repair. See EHS SOPs related to Lockout/Tagout for Machines and Equipment. Complete Lockout/Tagout training, available as a web-based module on the EHS web page, supplemented with machine-specific training from your supervisor (or delegate).
- Operate machinery within its designed limits.
- Do not operate a machine outside of the scope of your abilities, even if it is within the machine’s operating limits.
- Understand the hazards of each type of operation to be conducted, and adhere to all risk mitigation measures that have been prescribed for the machine or task.
- Do not wear loose clothing or jewelry while operating machines.
- Confine long hair, including restraint of ponytails and beards.
- Wear appropriate work attire and prescribed Personal Protective Equipment, including, at a minimum, safety glasses and closed-toed and slip-resistant shoes.
- Avoid distractions and actions that could interfere with good communication (e.g., headphones, loud music, etc.).
- Do not engage in horseplay.
- Restrict persons not involved directly in the operation from the immediate area.
- Ensure adequate space for the machine and operator to avoid cramped conditions or creation of atmospheric or other hazards (e.g., fire, exposure to excessive heat, radiation, etc.) during operation.
- Equip shops with plumbed emergency eyewash and flush on a weekly basis.

- Communicate with others that may be working or occupying space near-by to avoid human-induced hazards (e.g., alert or instruct each other on travel patterns, etc.).
- Ensure unimpeded access to all operating controls, emergency shut-down devices, and electrical panels/shut-offs servicing the equipment.
- Ensure adequate lighting to safely operate the equipment.
- If a machine is designed to be anchored to the floor, then it must be securely attached.
- Do not eat or drink in shop areas or while operating equipment. Wash hands and exposed skin thoroughly after completing work and before leaving the work area.
- Observe good housekeeping. Keep floors and equipment/machines clean. Store stock materials in a neat and secured manner. Do not accumulate excess combustibles. Keep aisles and exits clean.
- Report near-misses or close-calls (an incident where no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage and/or injury or illness easily could have occurred) to your supervisor and EHS. The EHS reporting mechanism is available on the EHS homepage and is titled "Near-Miss/Close-Call Incident Reporting System."