

Introduction

There are basic requirements for safeguarding cutting and turning machines. These basic safety requirements include safeguarding, controls, disconnects, starters, covers, and other considerations. We have explained the basic safety requirements below and have arranged this catalog so you can make your safeguarding choices quickly and easily.

1. SAFEGUARDING: When safeguarding the point of operation on a cutting or turning machine, shields (barriers) can be installed between the hazard and the operator. These shields can also deflect chips, sparks, and coolant that are generated at the point of operation.

2. CONTROLS: Most cutting and turning machines are directly driven by a motor. When the motor is turned on, the tool or workpiece rotates causing a point-of-operation hazard. When the motor is turned off, the tool or workpiece coasts to a stop and the hazard is eliminated. The basic requirement, for controls, is that all cutting and turning machines must have an emergency-stop device located within reach of the operator. Some of the motor stop/start operator stations offered in this catalog are equipped with an emergency-stop push button to meet this requirement. These emergency-stop buttons can also be supplied separately.

3. DISCONNECTS: All cutting and turning machines must have a disconnecting means to shut off all electrical power coming to the machine. It must be capable of being locked only in the off position. Also under OSHA 29 CFR 1910.147 (lockout/tagout), this same disconnecting means can be used when repairing or maintaining the machine.

4. STARTERS: All cutting and turning machines must have a starter that will automatically drop out when the control voltage is lost to the machine. To restart the machine when power is restored, someone must start the motor with some type of overt action, for example, pressing the start push button. This prevents the machine from automatically restarting when the voltage is restored.

5. COVERS: All cutting and turning machines must have the mechanical power-transmission apparatuses covered (guarded) if below a 7' level from the floor or working platform. This includes motor shafts, belts, pulleys, chains, sprockets, gears, etc. This catalog offers a pulley and belt cover for Bridgeport mills as shown on page 38. If special covers are required, ask for our *Mechanical Motions Cover* (CVR) catalog, or contact the OEM or a local fabricator to satisfy this requirement.

6. OTHER CONSIDERATIONS: Other auxiliary safeguarding equipment may be required to make cutting and turning machines as safe as possible. This equipment includes safety switches which can be used to interlock the shield or guard to the machine's starter. Electronic motor brakes are available for machines that have a long coastdown time. These brakes are used to decrease the long coasting time after the motor is turned off. This increases productivity because the operator does not have to wait for the machine components to coast to a stop. Signs are used to warn of the hazards on a machine.

When safeguarding cutting and turning machines, the general requirements that apply to these types of machines are in OSHA (Occupational Safety and Health Administration) Title 29 of the Code of Federal Regulations. The following is a list:

1. An Act—Public Law 91-596, 91st Congress, S. 2193, December 29, 1970, Duties, Section 5(a)(1)(2)(b)

2. OSHA 29 CFR sections that an employer (user) must comply with include:

- 1910.211 Definitions
- 1910.212 General requirements for all machines
- 1910.213 Woodworking machinery requirements
- 1910.215 Abrasive wheel machinery
- 1910.219 Mechanical power-transmission apparatus

3. OSHA 29 CFR 1910.147 The control of hazardous energy (lockout/tagout).

4. OSHA 29 CFR 1910.301-1910.399 Electrical

These publications can be acquired by contacting:

U.S. Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954
(202) 512-1800 • <http://bookstore.gpo.gov>

The basic OSHA standard, 29 CFR 1910.212, states that any machine that creates a hazard must be safeguarded to protect the operator and other employees. OSHA can also cite violations using other standards such as the ANSI (American National Standards Institute) B11 series. The following is a list of applicable and related ANSI standards available at the printing of this publication.

ANSI Publications

- B11-2008 *General Safety Requirements Common to ANSI B11 Machines*
- B11.1 *Mechanical Power Presses*
- B11.2 *Hydraulic Power Presses*
- B11.3 *Power Press Brakes*
- B11.4 *Shears*
- B11.5 *Iron Workers*
- B11.6* *Lathes*
- B11.7 *Cold Headers and Cold Formers*
- B11.8* *Drilling, Milling, and Boring Machines*
- B11.9* *Grinding Machines*
- B11.10* *Metal Sawing Machines*
- B11.11* *Gear and Spline Cutting Machines*
- B11.12 *Roll Forming and Roll Bending Machines*
- B11.13 *Automatic Screw/Bar and Chucking Machines*
- B11.14 *Withdrawn (now see ANSI B11.18)*
- B11.15 *Pipe, Tube, and Shape Bending Machines*
- B11.16 *Metal Powder Compacting Presses*
- B11.17 *Horizontal Hydraulic Extrusion Presses*
- B11.18 *Coil Processing Systems*
- B11.19* *Performance Criteria for Safeguarding*
- B11.20 *Integrated Manufacturing Systems*
- B11.21 *Machine Tools Using Lasers for Processing Materials*
- B11.22* *Turning Centers and CNC Turning Machines*
- B11.23* *Machining Centers and CNC Milling, Drilling, and Boring Machines*
- B11.24 *Transfer Machines*
- B11.TR1 *Ergonomic Guidelines*
- B11.TR2 *Mist Control Considerations*
- B11.TR3* *Risk Assessment and Risk Reduction*
- B11.TR4 *Selection of Programmable Electronic Systems (PES/PLC) for Machine Tools*
- B11.TR5 *Sound Level Measurement Guidelines*
- B11.TR7 *Design For Safety and Lean Manufacturing*

ANSI Publications (continued)

- R15.06 *Robotic Safeguarding*
- B15.1 *Mechanical Power Transmission Apparatus*
- B56.5 *Guide Industrial Vehicles and Automated Function of Manned Industrial Vehicles*
- B65.1 *Printing Press Systems*
- B65.2 *Binding and Finishing Systems*
- B65.5 *Stand-Alone Platen Presses*
- B151.1 *Horizontal (Plastic) Injection Molding Machines*
- B152.1 *Hydraulic Die Casting Presses*
- B154.1 *Rivet Setting Machines*
- B155.1 *Packaging and Packaging-Related Converting Machinery*
- 01.1* *Woodworking Machinery*

* ANSI Standards for Cutting and Turning Machines

These standards can be purchased by contacting:

ANSI (American National Standards Institute, Inc.)
25 West 43rd Street, 4th Floor
New York, New York 10036
(212) 642-4900 • www.ansi.org

Another good reference for safety on machine tools is the following publication from the National Safety Council:

Safeguarding Concepts Illustrated—7th Edition

This publication can be purchased by contacting:

National Safety Council
1121 Spring Lake Drive
Itasca, IL 60143-3201
1-800-621-7619, ext. 2199 • www.nsc.org

Other sources that can be used for reference include:

- 1. NFPA 79, *Electrical Standard for Industrial Machinery***
- 2. NEC (National Electrical Code) Handbook**
- 3. NEMA (National Electrical Manufacturers Association)**

For additional safety information and assistance in devising, implementing or revising your safety program, please contact the machine manufacturer, your state and local safety councils, insurance carriers, national trade associations, and your state's occupational safety and health administration.

* ANSI Standards for Cutting and Turning Machines

This catalog offers a variety of equipment including a complete line of shields (barriers), cord and plug lockouts, fused disconnect switches, magnetic motor starters, self-latching emergency stops, and accessories which are available to meet the electrical energy source portion of these standards.

The shields (barriers) offered in this catalog are usually installed on drilling machines, lathes, milling machines, grinding machines, band saws, belt sanders, disc sanders, and table saws. Many of the shields can be used on other types of equipment including woodworking machines. Most of these shields are intended to deflect chips (swarf), sparks, splashing coolant, or lubricant away from the operator and other employees in the machine area. Most shields provide visibility to the point of operation.

Although these shields provide some degree of guarding for the operator, they cannot be considered guards. When using these shields and before any of the shields illustrated in this catalog are moved from their normally applied position, power must always be turned off.

In some cases, more than one type of shield per machine may be necessary to provide protection. For example, on lathes, a chuck shield may be required along with a magnetic-base shield where the tool comes into contact with the workpiece.

This catalog offers several different types of shields. When considering shielding for your machines, be sure to choose the shield that fits your machining applications and still maintains current levels of productivity.

DRILLING MACHINES

As with other cutting machines, the operator must be protected from the rotating chuck and swarf that is produced by the drill bit. Specially designed shields can be attached to the quill and used to protect this area. A telescoping portion of the shield can retract as the drill bit comes down into the workpiece. On larger gang or radial drills, a more universal-type shield is usually applied.

The ANSI standard for drilling machines is ANSI B11.8.

LATHES

There are two main safety considerations for lathes (engine, turret, etc.). One is the rotating chuck that could catch the operator's clothing, jewelry, hair, or hand and pull it into the machine. The other is the hazardous flying chips and splashing coolant that are generated at the point of operation (where the tool contacts the workpiece being machined). To protect these areas, two shields can be applied—one around a portion of the chuck and the other at the point of operation. See the photo on page 24. Larger sliding shields can protect both areas, providing the workpiece is not too long.

On VTLs (vertical turret lathes), the safety concern is the rotating table and the point-of-operation swarf. Special barriers may have to be fabricated around the tables of

these machines; shields can be provided at the point of operation.

If railings are used to keep operators away from hazard areas, these railings must be 42" above the floor or platform.

The ANSI standard for lathes is ANSI B11.6.

MILLING MACHINES

The main safety consideration for milling machines is the swarf that is generated at the point of operation. Another safety concern is the tool cutter, which could catch operator's clothing, jewelry, hair, or any other part of the body. Usually on smaller mills, the operator and other employees in the machine area are protected by shields. These shields can be applied around the perimeter of the table or bed area or close to the cutter, depending on the size of the workpiece and the application. On larger milling machines, operators are sometimes protected by location; however, when working close to a cutting tool, operators must be protected from swarf.

The ANSI standard for milling machines is ANSI B11.8.

GRINDING MACHINES

Shields are usually applied to grinding machines to protect the operator from chips (swarf), sparks, splashing coolant, or lubricant.

Other safety concerns for grinders are the adjustment of the work rests and the adjustable tongues or ends of the peripheral members at the top of each wheel. Work rests shall be kept adjusted closely to the wheel with a maximum opening of $\frac{1}{8}$ ". The distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top shall never exceed $\frac{1}{4}$ ".

Grinding machines are covered by OSHA in 29 CFR 1910.215. The ANSI standards for grinding machines are B11.9 and B7.1.

BAND AND TABLE SAWS

Shields are applied to band saws and table saws to protect the operator from flying chips, splinters, and dust. As with other cutting machines, care must be taken around the moving blade of the machine. Avoid wearing loose clothing and jewelry; properly restrain long hair.

Band saws and table saws for woodworking are covered by OSHA in 29 CFR 1910.212 and 1910.213. The ANSI standard for metal sawing machines is ANSI B11.10.

DISC/BELT SANDERS/GRINDERS

Shields can be applied to disc/belt sanders/grinders to protect the operator from flying chips, splinters, and dust. As with other machines with rotating parts, care must be taken around the point of operation. Avoid wearing loose clothing and jewelry; properly restrain long hair.

Disc and belt sanders for woodworking are covered by OSHA in 29 CFR 1910.212 and 1910.213. The ANSI standards for grinding machines are B11.9 and B7.1.

ELECTRICAL REQUIREMENTS

As stated in OSHA 29 CFR 1910.147 The control of hazardous energy (lockout/tagout): “(a)(1)(i) This standard covers the servicing and maintenance of machines and equipment in which the unexpected energizing or start-up of the machines or equipment, or release of stored energy could cause injury to employees. This standard establishes minimum performance requirements for the control of such hazardous energy.”

To lockout electrical energy sources:

1. Unplug the machine and use an electrical plug lockout or use a disconnect switch with padlocks, lockouts, and tags.
2. Disconnect and ensure that all power sources are locked and tagged out.
3. Stored electrical energy must be bled to obtain zero energy state.
4. Use a volt meter to make sure all circuits are dead.

NFPA 79, ELECTRICAL STANDARD FOR INDUSTRIAL MACHINERY

Incoming Supply Circuit Conductor Terminations

Under 5.1.1, it states that “where practicable, the electrical equipment of a machine shall be connected to a single power supply circuit.”

Supply Circuit Disconnecting (Isolating) Means

In 5.3.1.1, it states that a supply circuit disconnecting means shall be provided for each incoming supply circuit to a machine. According to 5.3.1.1.1, each disconnecting means shall be legibly marked to indicate its purpose. Under 5.3.1.3, “The supply circuit disconnecting means other than attachment plugs and receptacles shall be mounted within the control enclosure or immediately adjacent thereto. *Exception: Externally mounted supply circuit disconnecting means, whether interlocked or not interlocked with the control enclosure, supplying machines totaling 2 hp or less shall be permitted to be mounted up to 6 m (20 ft) away from the enclosure providing that the disconnecting means is in sight from and readily accessible to the operator.*” Under 5.3.3, the disconnecting means shall be provided with permanent means for locking in the off position only (for other than attachment plugs). In accordance with 5.3.4.1, “The center of the grip of the operating handle of the disconnecting means, when in its highest position, shall not be more than 2.0 m (6 ft 7 in.) above the floor. A permanent operating platform, readily accessible by means of a permanent stair or ladder, shall be considered as the floor for the purpose of this requirement.” According to 5.3.2 (6), the supply circuit disconnecting means can be an attachment plug and receptacle (plug/socket combination) for cord connection to motor loads totaling 2 hp or less.

Control Circuit Supply, Voltage, and Protection

In 9.1.1.1, it states that “Control transformers shall be used for supplying the control circuits.” According to 9.1.1.3, “Transformers shall not be required if the supply voltage does not exceed 120 volts ac.”

In accordance with 9.1.2.1, “The ac voltage for control circuits shall not exceed 120 volts, ac single phase.”

According to 9.1.3, control circuits shall be provided with overcurrent protection.

Overload Protection of Motors

According to 7.3.1, “Overload devices shall be provided to protect each motor, motor controller, and branch-circuit conductor against excessive heating due to motor overloads or failure to start.”

Stop Functions

According to 9.2.2, “The three categories of stop functions shall be as follows:

- (1) Category 0 is an uncontrolled stop by immediately removing power to the machine actuators.
- (2) Category 1 is a controlled stop with power to the machine actuators available to achieve the stop then remove power when the stop is achieved.
- (3) Category 2 is a controlled stop with power left available to the machine actuators.”

In 9.2.5.3.1, it states that “Each machine shall be equipped with a Category 0 stop.” According to 9.2.5.3.2, “Category 0, Category 1, and/or Category 2 stops shall be provided where indicated by an analysis of the risk assessment and the functional requirements of the machine. Category 0 and Category 1 stops shall be operational regardless of operating modes, and Category 0 shall take priority. Stop function shall operate by de-energizing that relevant circuit and shall override related start functions.”

Emergency Stop Functions

In accordance with 9.2.5.4.1, emergency stop functions shall be designed to be initiated by a single human action. In addition to the requirements for stop, 9.2.5.4.1.1 states that “the emergency stop shall have the following requirements:

- (1) It shall override all other functions and operations in all modes.
- (2) Power to the machine actuators, which causes a hazardous condition(s), shall be removed as quickly as possible without creating other hazards (e.g., by the provision of mechanical means of stopping requiring no external power, by reverse current braking for a Category 1 stop).
- (3) The reset of the command shall not restart the machinery but only permit restarting.”

In 9.2.5.4.1.2, it states that “Where required, provisions to connect additional emergency stop devices shall be provided.” According to 9.2.5.4.1.3, “The emergency stop shall function as either a Category 0 or a Category 1 stop. The choice of the category of the emergency stop shall be determined by the risk assessment of the machine.” In accordance with 9.2.5.4.1.4, “Where a Category 0 or Category 1 stop is used for the emergency stop function, it shall have a circuitry design (including sensors, logic, and actuators) according to the relevant risk as required by Section 4.1 and 9.4.1. Final removal of power to the machine actuators shall be ensured and shall be by means of electromechanical components. Where relays are used to accomplish a Category 0 emergency stop function, they shall be nonretentive relays. *Exception: Drivers, or solid state output devices, designed for safety-related functions shall be allowed to be the final switching element, when designed according to relevant safety standards.*”

Devices for Stop and Emergency Stop

In accordance with 10.7.1.1, “Stop and emergency stop pushbuttons shall be continuously operable and readily accessible.” According to 10.7.1.2, “Stop or emergency stop pushbuttons shall be located at each operator control station and at other locations where emergency stop is required.”

In 10.7.2.1, it states that “The types of devices for emergency stop shall include, but are not limited to, the following:

- (1) Pushbutton-operated switches
- (2) Pull-cord-operated switches
- (3) Foot-operated switches without a mechanical guard
- (4) Push-bar-operated switches
- (5) Rod-operated switches”

According to 10.7.2.2, “Pushbutton-type devices for emergency stop shall be of the self-latching type and shall have direct opening operation.” In accordance with 10.7.2.3, “Emergency stop switches shall not be flat switches or graphic representations based on software applications.” For restoration of normal function after emergency switching off, 10.8.3 says that “It shall not be possible to restore an emergency switching off circuit until the emergency switching off circuit has been manually reset.” According to 10.7.3, “Actuators of emergency stop devices shall be colored RED. The background immediately around pushbuttons and disconnect switch actuators used as emergency stop devices shall be colored YELLOW. The actuator of a pushbutton-operated device shall be of the palm or mushroom-head type and shall effect an emergency stop when depressed. The

RED/YELLOW color combination shall be reserved exclusively for emergency stop applications. *Exception: The RED/YELLOW color combination shall be permitted for emergency stop actuators in accordance with 10.8.4.*”

Under 10.8.5, “Where the supply disconnecting means is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the color requirements of 10.8.4.1.” According to 10.8.4.1, “Actuators of emergency switching off devices shall be colored RED. The background immediately around the device actuator shall be permitted to be colored YELLOW.”

Pushbutton Actuators

According to 10.2.1, “Pushbutton actuators used to initiate a stop function shall be of the extended operator or mushroom-head type.” As stated in 10.2.2.1, “The preferred color of start or on shall be GREEN, except that BLACK, WHITE, or GRAY shall be permitted. RED shall not be used for start or on.” In 10.2.2.2, it states that “the preferred color for stop or off shall be RED, except that BLACK, WHITE, or GRAY shall be permitted. GREEN shall not be used for stop or off.” According to 10.2.2.6, “Pushbuttons that cause movement when pressed and stop movement when they are released (e.g., jogging) shall be BLACK, WHITE, GRAY, or BLUE, with a preference for BLACK.” In accordance with 10.2.3.1, “A legend shall be provided for each operator interface device to identify its function and shall be located so that it can be easily read by the machine operator from the normal operator position. The legends shall be durable and suitable for the operating environment.”

Start Devices

According to 10.6, “Actuators used to initiate a start function or the movement of machine elements (e.g., slides, spindles, carriers) shall be constructed and mounted to minimize inadvertent operation.”

Protection Against Supply Interruption or Voltage Reduction and Subsequent Restoration

Under 7.5.1, “Where a supply interruption or a voltage reduction can cause a hazardous condition or damage to the machine or to the work in progress, undervoltage protection shall be provided (e.g., to switch off the machine) at a predetermined voltage level.” For restarting, 7.5.3 states that “Upon restoration of the voltage or upon switching on the incoming supply, automatic or unintentional restarting of the machine shall be prevented when such a restart causes a hazardous condition.”

Protective Interlocks

In 9.3.6, it states that “Where doors or guards have interlocked switches used in circuits with safety related functions, the interlocking devices shall be listed, have either positive (direct) opening operation, or provide similar reliability and prevent the operation of the equipment when the doors or guards are open (difficult to defeat or bypass).” Under 9.3.1, “The reclosing or resetting of an interlocking safeguard shall not initiate machine motion or operation that results in a hazardous condition.”

OTHER SAFETY CONSIDERATIONS

Each machine should be surveyed as an individual system. This includes, but is not limited to, the proper shield(s), controls, drives, tooling, feeding methods, material handling methods, configuration and weight of workpiece, rotating and reciprocating parts, machine production requirements, and future machine needs. The proper disconnect switch, motor starter, lockout equipment and covers for machine rotating components must also be considered. See pages 72 and 73 for a survey report.

When operating the various machines to which shields can be applied, the operator must wear proper personal protective safety equipment and be properly trained. The operator must not wear loose clothing, have unrestrained long hair, and must **not** wear jewelry.



When operating any cutting or turning machine, the hands or any part of a person’s body must never be put into the point of operation or any other hazard area of the machine. Hand tools, fixtures, and other methods must be used so that operators are not exposed to hazards. If the hands or any part of a person’s body is put into the hazard, it could cause serious physical injury or death.