Purpose: Machine guarding will be provided to protect the operator and other employees in the machining area from injury as a result of coming in contact with the work in progress, moving parts or the mechanical motions of the machines.

APPLICATION OF GUARDING TECHNIQUES

The following will apply in the application of guarding techniques:

1. Multiple Guarding - One or more techniques of machine guarding may be required to effectively meet appropriate requirements. A piece of equipment may require more than one basic guarding device since the machine may present more than one type of exposure. For example, power transmission guarding may be required for the belt and pulley and a barrier guard may be required for the in-running nip points of the same machine.

2. Machine Guarding Defined - Machine guarding for the purpose of this manual may be defined as a system that may employ a simple fixed position barrier, two-hand tripping devices, interlocks, electronic or pneumatic systems, sweep guards or any combination thereof which will effectively protect the operator and others nearby from coming in contact with mechanical motions or mechanisms of the machines.

3. Mechanical Motions Defined - To effectively identify all danger points of a machine that requires guarding, a basic knowledge of the resulting actions of certain mechanical motions must be understood. There is a wide variety of machinery employed in a multiplicity of uses, but there are only a few rather simple mechanical motions involved. The mechanical motions coupled with one or more mechanisms create the hazards and conditions to be guarded. Mechanisms employ rotary motions, reciprocating motions or a combination of both. Each of these motions can produce a crushing or shearing action:

   Rotary motion is found in simple rotating mechanisms which include drums, extractors, circular saws, slicing machines, cloth cutters, band saws, milling machines, grinding machines, drilling and boring machines, screw and worm mechanisms, extruding machines, screw conveyors, and food choppers. Mechanical power transmission apparatus such as shafting, flywheels, pulleys, belts, fall under the rotating mechanisms category.

   Reciprocating motion is found where sliding (i.e., reciprocating) parts, usually supported in guides, approach or cross a fixed part of a machine or stock. Reciprocating motions and mechanisms are usually found in slides (i.e., rams) on power presses and forging hammers, plaining mill tables, rams of shapers, and as clamping or hold down fixtures, guillotines, and squaring shears.

HARZARDOUS MECHANISMS TO BE GUARDED

The following hazardous mechanisms are to be guarded:

1. Rotating Mechanisms - These mechanisms present a variety of hazards that require handling. Among the many, but limited to, are mechanical power transmission apparatus which involved the guarding of gears, shafting, flywheels, pulleys, belts, and clutches.

2. Cutting and Shearing Mechanisms - The hazards relating to these mechanisms lie at the point where the rotary cutting action is applied or where the reciprocating mechanism crosses a fixed object. Some examples of machines using cutting and shearing mechanisms are grinding machines, drilling and boring machines, circular saws, band saws, and lathes.

3. In-running Nip Points - Special hazards are created by mechanisms having one or more rotating parts. In some situations, in-running nip point09:0require only simple fixed barrier guards (i.e., flywheels, belts, and pulleys). In other instances a complex series of barrier and inter-locking systems may be needed to effectively protect the operator or those nearby.

    - The hazard of in-running nip points is that it draws objects in, crushes or flattens them. Once an object (or part of body) becomes drawn into the nip point, it is difficult or impossible to withdraw it. Nip points exist wherever a part rotates in, over, under or near a stationary object or another rotating object. The nip point occurs whether or not the mechanisms are rotating in opposite directions in close proximity or at different speeds. Examples of nip points may be gear and rack, chain and sprockets, belt and pulley, gear and pinion, in-running side or rolling mills and calendars, rolls used for bending and forming, rotating drums and tumblers, rolls used for printing, corrugating, embossing or feeding and conveying stock.

4. Screw and Worm Mechanisms - Machines employing worm or screw mechanisms are meat grinders, food mixers, screw conveyors and materials mixers of various types. These mechanisms set up shearing actions between the moving screw and the fixed part creating a battering or mangling action. Guarding must be provided where an exposure of an operator being caught between the action of the worm mechanism and the fixed part of the equipment exists.

5. Bending and Forming Mechanisms - Typical examples of bending and forming mechanisms are found on power presses, foot presses, hand presses, press brakes, metal shears, forging machines and bending presses for forming and stamping pieces of metals and other materials. The principal hazards lie at the point of operation where the punch or upper die approaches, crosses or comes in contact with the lower die.

DESCRIPTIONS AND TYPES OF GUARDS

The hazards involved in machinery operations can be eliminated by application of effective guarding techniques. Effective protection may require the use of a single simple fixed guard or a system of the several guards described below in some combination.

Except for the treatment of guarding power transmission apparatus in the following section, the main effort is directed to machine and point of operation guarding. The three types of guards most frequently used are described as follows.

1. Fixed (Enclosure) Guards - The fixed guard is considered preferable to all other types of guards and should be used unless it has been determined to be impractical. As a general rule, fixed guards usually satisfy the requirements for guarding power transmission mechanisms and for confining flying particles. The fixed guard, when properly adjusted, will accommodate feeding, but will at all times prevent the operator's hands from reaching the danger zone.

2. Interlocking Guards and Devises - Where fixed guards cannot be used, an interlocking guard should be used. Interlocking guards may be enclosure, barrier or gate type guards operated mechanically, electrically, pneumatically, electronically, or a combination thereof. An interlocking device should be of a design that prevents machine motion until the guard is moved into place or otherwise acting so that the operator cannot reach the danger zone.

   To be effective, an interlocking device must satisfy three requirements:

1. It must act to guard the dangerous part before the machine can be operated,
2. It must keep the guard closed until the dangerous part is at rest, and
3. It must always prevent operation of the machine if the interlocking device fails.

3. Automatic Guards - These guards may be used when either a fixed or an interlocking guard is practicable. Automatic guards function independently of the operator, and its action is usually repeated as long as the machine is in motion. Such guards are usually operated by the machine itself through a system of linkage or levers. There are many variations of this type guard: e.g., sweep guards, swing guards, pullback guards, etc.

   Whenever automatic guards are used on machines loaded or unloaded by hand, the operator should be provided with and required to use hand tools.

4. Other Guarding Devices and Techniques - There are guarding devices and techniques other than those described above, which can be effectively used to

complement other type guarding or, if circumstances and safety permit, used in lieu of them.

a. Two-handed operating devices may be used to activate the machine. These devices require simultaneous action of both hands of the operator on electrical switch buttons, air control valves, or mechanical levers. On presses with a non-interrupting stroke, two-handed operating devices should require manual operation until a point is reached in the cycle at which the hazard ceases. Hand controls may be interconnected with foot controls to permit operation of the machine. The actuating controls will be so located as to make it impossible for the operator to be able to move his hands from the controls to the danger zone before the machine has completed its closing cycle. The two-handed controls will be so designated as to prevent the blocking, tying down, or holding down of one control to allow one hand free access to the point of operation. When more than one person is working a machine, additional controls should be installed and designed so that all people must simultaneously activate the starting mechanism from remote locations.

b. Automatic or semi-automatic feed and ejectable devices feed stock to the danger points by chutes, hoppers, conveyors, movable disks, dial feed rolls, etc. and automatically ejects thereby reducing the continuous exposure created by hand feeding of work or its removal. Exposed point must be guarded by an enclosure guard to prevent any part of the body from coming into the danger zone.

c. Auxiliary devices include:

1. Feeding Tools - A variety of special feeding tools have been developed for use in connection with automatic feeds or enclosure guards. These tools will be made of woods, soft metal, aluminum, or magnesium (some are magnetized) and include pushers, pickers, pliers, tweezers of various types, forks, and disks. Tools provide protection only if they are used by the operator. They will never be used as a substitute for proper guarding.

2. Foot Control Guards - Presses operated by foot pedal, treadle or foot switch will not be permitted unless the danger zone or die is guarded and the foot pedal or switch is also guarded to prevent accidental tripping.

GUARD DESIGN AND CONSTRUCTION

Every guard will be reliable in construction, application and adjustment. It will be so designed and substantially constructed as to:

1. Prevent the operator or other personnel from having any part of their body in the danger zone during the operation,
2. Facilitate inspection and lubrication and so designed to minimize the possibility of its being removed or misused,
3. Present no hazards itself, such as splinters, pinch points, shear points, sharp corners, rough edges, or other sources or injury, and
4. Contain flying fragments, missiles, or particles that may be thrown during the operation.

Openings in guards, barriers or screens at the point of operation will be small enough to prevent the operator or others from placing parts of their body into the danger zone. Open work guards can be of woven wire expanded metal, perforated metal or wood strips.

GUARDING AT THE SOURCE OF POWER

Distinct from guarding at the point of operation but complementary to it is the matter of guarding at the point where power is delivered to machinery. Devices to control delivery of power at the source include electrical switches of many kinds and numerous varieties of valves, regulators, and metering devices. The latter are used to open, shut, or otherwise control the flow and pressure of steam, pneumatic, and hydraulic media that energize machinery. These devices must be of a design that will bleed-off or relieve residual pressures in the lines, after the power has been shut off, beyond the control point so as to prevent an accidental cycle or stroke of the machine.

GUARDING OF SPECIFIC MACHINES AND MECHANISMS

The following will apply for guarding of specific machines and mechanisms:

Power Transmission and Related Rotating Mechanisms-Genera

All moving parts of equipment used in the mechanical transmission of power, located so that any part is 7 feet or less above floors and platforms, will be guarded to prevent persons from coming in contact with rotating mechanisms. These mechanisms include but are not limited to flywheels, shafting spindles, belts, pulley, gears, sprockets, cams, and coupling, keys and set screws.

All revolving collars will be cylindrical, and screws or bolts used in collars will not project beyond the largest periphery of the collar.

Shaft couplings will be so constructed as to prevent no hazards from bolts, nuts, set screws, or revolving surfaces. Bolts, nuts, and set screws will, however, be permitted where they are covered with safety sleeves or where they are used parallel with the shafting and are countersunk of else do not extend beyond the flange of the coupling.

Cranks and connecting rods when exposed to contact will be guarded.

All gears will be guarded except hand-operated gears used only to adjust machine parts and which do not continue to move after hand power is removed.

When frequent oiling must be done, openings with hinged or sliding self-closing doors will be provided. All points not readily accessible will have oil feed tubes if lubricant is to be added while machinery is in motion.

All projecting keys, set screws and other projections in revolving parts will be removed or covered. This does not apply to sprocket casings or other enclosures, nor to keys, set screws or oil cups in hubs of pulleys less than 20 inches in diameter where they are within the plane of the rim of the pulley.

Rotating Mechanism Machinery

The following sections do not cover power transmission guarding previously covered. Certain cutting processes generate chips, flying particles, etc. The guarding system should therefore include protection against such missiles by applicable guards or exhaust systems. Machinery using rotating mechanisms will be guarded as follows.

1. Circular Table Saws - Each circular hand-fed rip and cross-cut table saw will be guarded by a hood which will completely enclose that portion of the saw above the material being cut. The hood and mounting will be arranged so that the hood will automatically adjust itself to the thickness of and remain in contact with the material being cut. Each hand-fed circular rip saw will be furnished with a spreader and non-kickback fingers or dogs. Each circular cross-cut saw should be provided with a spreader.

   Each circular metal saw will be provided with a guard of not less than 1/8-inch sheet metal positioned to stop flying sparks. Suitable means should be provided to trap sparks below the saw.

   Swing and sliding cut-off saws will be provided with a hood that will completely enclose the upper half of the saw, the arbor ends, and the point of operation at all positions of the saw. Its hood will be so designed that it will automatically cover the lower portion of the blade, so that when the saw is returned to the back of the table, the hood will rise on top of the fence; and when the saw is moved forward, the hood will drop on top of and remain in contact with the table or material being cut. Each saw will be installed in such a manner that the saw will return automatically to the back of the table when released at any point of its travel. Limit stops or other equally effective devices will be provided to prevent the saw from swinging beyond the front or back edges of the table, or beyond a forward position where the gullets of the lowest saw teeth will rise above the table top. A latch or equivalent device

should be provided to catch and retain the saw at the table and to prevent its rebounding.

2. Radial Saws - The upper hood will completely enclose the upper portion of the blade down to a point that will include the end of the saw arbor. The sides of the lower exposed portion of the blade will be guarded to full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with stock being cut to give maximum protection for the operation being performed. When radial saws are used for ripping, a spreader should be provided and non-kickback fingers or dogs will be provided. An adjustable stop will be provided to prevent the forward travel of the blade beyond the position necessary to complete the cut.

3. Band Saws and Band Resaws - All portions of the saw blade will be enclosed or guarded, except the working portion of the blade between the bottom of the guide rolls and the table. The outside periphery of the enclosure will be solid. The front and back of the band wheel will be either enclosed by solid material or wire mesh or perforated metal. The guard for the portion of the blade between the sliding guide and the upper-saw-wheel guard will protect the saw blade at the front and outer side. This portion of the guard will be self adjusting to raise and lower with the guide. Brakes should be provided to stop the wheel in case of blade breakage. Feed rolls of band resaws will be protected with a suitable guard to prevent the hands of the operator from coming in contact with the in- running rolls at any point.

4. Grinding Equipment - Work rests will be kept adjusted closely to the abrasive wheel with a maximum opening of 1/8-inch to prevent the work from being caught between the wheel and the rest.

   The work rest will be securely clamped after each adjustment.

   The guard will cover the spindle end, nut, and flange protections. It will be mounted so as to maintain proper alignment with the wheel, and the strength of the guard. Where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted.

5. Drum Sanding Machines - Each machine will have an exhaust hood or other guard so arranged as to enclose the revolving drum, except for that portion of the drum above the table.

6. Disk Sanding Machines - Each machine will have an exhaust hood or other guard so arranged as to enclose the revolving disk, except the disk above the table.

7. Belt Sanding Machines - Each machine will be provided with guards at each nip point where the sanding belt runs on to a pulley. The unused run of the sanding belt will be guarded against accidental contact.

8. Planing, Molding, Sticking, and Matching Machines – Each machine will have all cutting heads, and saws if used, covered by a metal guard. Feed rolls will be guarded by a hood or suitable guard to prevent the hands of the operator from coming in contact with in-running rolls at any point. The guard will be fastened to the frame carrying the rolls.

9. Jointers - Each hand-fed jointer with a horizontal cutting head will have an automatic guard which will cover the section of the head back of the gauge or fence.

10. Wood Shapers - The cutting heads of each wood shaper, hand-fed panel raiser, or other similar machine not automatically fed, will be enclosed with a cage of adjustable guard so designed as to keep the operator's hands away from the cutting edge. The diameter of the guard will be not less than the greatest diameter of the cutter.

11. Tenoning Machine - Each machine will have all cutting heads and saws if used, covered by metal guards. These guards will cover at least the unused part of the periphery of the cutting head.

12. Vertical-Head Jointers - Each machine will have either an exhaust hood or other guards so arranged as to enclose completely the revolving head, except for a slot of such width, as may be necessary and convenience for application of the material to be jointed.

13. Shearing Machines - All revolving blades on shearing machines will be guarded so that the opening between the cloth surface and the bottom of the guard will not exceed 3/8-inch.

14. Rotary Cutter - On single knife machines, a guard will be provided to prevent employees from reaching for paper at a point close to the knife. On duplex cutters the same protection will be provided as for single-knife machines for the first knife, and a hood will be provided for the second knife. A guard will be provided for the spreader or squeeze roll at the nip side on sheet cutters. Electrically or manually operated quick power-disconnecting devices will adequate braking action will be provided on all operating sides of the machine within easy reach of all operators. The outside slitters will be guarded.

15. Turning Machinery (including lathes and similar machinery) - Each profile and swing-head lathe will have all cutting heads covered as completely as possible by hoods or shields, which should be hinged to the machines so that they can be thrown back for making adjustments.

16. Drilling, Reaming, and Boring Machines - Safety-bit chucks with no projection set screws will be used. Boring bits should be provided with a guard that will enclose all portions of the bit and chuck above the material being worked.

Other Rotating or Revolving Mechanisms

Additional devices using rotating or revolving mechanisms will be guarded as follows:

1. Fans - When the periphery of the blades of a fan is less than seven (7) feet above the ground, floor, or working level, the blades will be guarded. The guard will have openings no larger than one-half (1/2) inch.

2. Mixers - All mixers with power and manual dumping arrangements will be equipped with safety devices which will engage both hands of the operator while the bowl is opened more than 15% of its total opening, in keeping the agitator in motion under power.

3. Washing Machines - Each washing machine will be equipped with an interlocking device that will prevent the inside cylinder from moving when the outer door on the case of shell is open, and will also prevent the door from being opened while the inside cylinder is in motion.

Reciprocating Mechanisms

Included in this section are reciprocating mechanisms used in bending, forming, and shearing actions. Machinery using reciprocating mechanisms will be guarded as follows:

1. Power and Gravity Drop Hammers - A scale guard of substantial construction will be provided at the back of every hammer, so arranged as to stop all flying objects. This guard may be pivoted to permit easy access to dies, supported on floor standards or suspended from the ceiling by chains with hooks at the bottom.

2. Mechanically Operated Hammers - Where only one hand is used or holding the material, safety stop, dog or catch should be provided that will prevent the hammer from coming down until this device has been released and is held out of the way by the other hand, or a hand lever instead of the foot treadle will be provided for tripping the hammer. On hammers where neither hand is used for holding the material, a safety stop or tripping lever, or both, should be provided that will require the use of both hands to trip the hammer.

3. Power Presses - Each press will be equipped and operated with a point-of-operation protection device for every press operation performed except where the point of operation is limited to an opening of 1/4-inch or less. The guard will be attached to the press or the die. The guard itself will not offer any accident hazard. It will be so designed and constructed as to facilitate inspection and to minimize the possibility of removing or misusing essential parts. The guard will be so designed and constructed as to prevent entry of an operator's hand or fingers within the point of operation.

4. Cutting and Trimming Machines - Each guillotine-type cutter will be equipped with a control which requires the operator and his helper, if any, to use both hands to engage the clutch. Each will be equipped with a non-repeat device.

5. Slicers - The cover over the knife head of reciprocating blade slicers will be provided with an interlocking arrangement so that the machine cannot operate unless the cover is in place. On slicers with endless band knives, each motor will be equipped with a magnet brake which operates whenever the motor is not energized. Each door, panel, or other point of access to the cutting blades will be arranged by means of mechanical or electric interlocks so that the motor will be de-energized if any such access doors, panels, or access points are not closed. Where pusher fingers attached to the feed chain enter the bed of the cross feed, the end guard will be extended to cover the pinch point.

6. Power Shears - A positive-type lock-out device for disconnecting the power to the shear will be provided. Effective point-of-operation guarding should be provided at both the feeding and discharge ends of the shears.

7. Dividers - All pinch and shear points from reciprocating or rotating parts of the divider will be enclosed or guarded. Guards at the front of a divider will be so arranged that the weight of dough can be adjusted without removing the guard. The back of the divider will have a complete cover to enclose all of the moving parts, or each individual part will be enclosed or guarded to remove the separate hazards. The rear cover will be provided with a limit switch in order that the machine cannot operate when this cover is open. There will be a saddle guard to other protective devices on any elongated hole in the knife actuating arm at the back of the divider.

8. Sewing Machines - Each sewing machine will be equipped with an approved guard permanently attached to the machine, so that the operator's fingers cannot pass under the needle. It will be of such form that the needle can be conveniently threaded without removing the guard.