MECHANICAL POWER PRESS SAFETY ENGINEERING GUIDE

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PREFACE

This Guide is written primarily for the safety professional who has responsibility for mechanical power press safety. However, others in the field, such as management, may find it a useful tool in implementing an overall program of sound safety practices.

It is recognized that there are other publications in the field of mechanical power press safety. This Guide is not meant to replace these publications, but to add to and supplement them in order to benefit those professionals in the performance of their safety responsibilities and to make their task easier and more rewarding.

It should be pointed out that this Guide is not a compliance document, but a Safety Engineering Guide. Therefore, it may occasionally go beyond the Occupational Safety and Health Act regulations. When this occurs, the statement that exceeds or modifies the regulations is denoted by an asterisk (*) and an explanation is given in the form of a footnote. Any statement that exceeds or modifies the regulations should be taken to mean only a recommendation and not a requirement.

This Guide was written under NIOSH Contract 210-75-0042 as part of the contractual efforts. Interested professionals may wish to refer to the Final Report of this Contract for further detail and understanding of the requirements set forth in this Guide.

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ABSTRACT

This Guide explores the technical, behavioral, and ergonomic aspects of mechanical-power-press safety as it pertains to workers who set dies on, operate, and maintain presses.

Various safeguarding systems are evaluated and recommendations are given for proper use to safeguard the press worker from various hazards including the inherent hazard of a press, which is the hazard of being injured at the point of operation.

Each safeguarding system is described as to its operation and whom it protects (operators, helpers, die setters, maintenance men, or passersby). The use of the system as to type of press is given with limitations stated. Installation instructions and recommendations are outlined. Maintenance instructions are covered in order to assure that the system is properly maintained so as not to compromise its safeguarding performance. Advantages and disadvantages of each system are given as an aid to the safety professional when he has to make a safeguarding system decision. The safety considerations section is a discussion of the safety factors which must be considered when using the system. An installation checklist is provided to ensure proper installation. A safety inspection checklist is provided and must be completed at specified intervals to ensure continued proper operation and safeguarding integrity of the system.

A special section is devoted to information that will aid the safety professional to reach a decision as to which safeguarding system is best suited to his particular presses.

A safety responsibilities section delineates the particular responsibilities of each group of people who are involved with presses in the hope that their involvement will be both safe and productive.

SECTION A
THE MECHANICAL POWER PRESS

INTRODUCTION

Mechanical power press safety must begin when the press is being designed and continue through to the time the press is taken out of service. Thus, power press safety must become the concern of the press manufacturer, the employer (user), the die setter, the operator, and maintenance personnel. This concern must be converted to positive safety action if the large number of mechanical power press injuries — as many as 1,200 in the last six months of 1975 — are to be reduced.

One of the overriding considerations of power press safety is ergonomics, or the relationship of human factors to machines and their operation. A press operator cannot go through a complete work day that consists of thousands of repetitive motions without moments when his mind wanders. A die setter or maintenance person, however experienced, may forget to observe a safety precaution in the performance of his duties. In short, people are not infallible. Because this is true, a press worker is in danger of incurring an injury unless the press and its attachments are designed, manufactured, and installed in such a manner as to make an accident almost impossible, despite the worker's fallibility. It is not enough to put up warning signs or tell the worker to "work safely". Factories which have an abundance of signs and where safety meetings are regularly held still have injuries.

The mechanical power press is an inherently dangerous machine. The machine action is essentially that of a giant hammer hitting with forces measured in the thousands of pounds. Each time this hammer is raised it is necessary to remove worked material from under its head and insert new material. Certainly any erroneous action on either the part of the machine or the part of the worker is likely to result in a most severe injury to the worker.

But while this machine is dangerous, the technology exists to make the mechanical power press as safe for the worker as any other machine in industrial use. Indeed, the mechanical power press can be made so safe through the application of technical safety considerations that it can be the safest of all industrial machines, with expectations of a metal stamping plant being free of power press injuries during a worker's lifetime. This is the goal that this Guide aims for. Achieving anything less indicates that the safety professional needs to further consider the safeguarding of the presses in his plant.

To attain this safety goal requires the application of technical safety factors to the machine and the removal of the human factor to the greatest extent possible. With the number of existing machines which technically or economically cannot be rebuilt so as to remove the human factor completely, that factor must be considered until such machines are taken out of service.

Where the human factor cannot be so totally removed, sound safety practices and programs, centered in management, must be applied. These safety practices include the selection and proper use of press safeguarding systems as well as other specific actions. Safeguarding is not an afterthought but a factor to be considered in the production set-up, just as important as the tooling. Where safeguarding has been considered along with other safety practices and programs, increased production, lower insurance rates, and reduction in loss of production due to injury have resulted in economic gain.

The major reason for increasing safety is, of course, a humanitarian one. Obviously, no one wishes to be injured or to see another person injured. From the humanitarian point of view, any injury must be avoided if at all possible.

Added to the above considerations are the requirements that have been imposed by federal regulations. The primary intent of the regulations is to assure the greatest degree of safety possible and thus reduce power press injuries. It is apparent from the economic, humanitarian, and legal point of view that the concepts of increased power press safety and reduction of injuries make good common sense.

As stated earlier, the human factor must be accounted for in dependable safety equipment design by removing it, the human element, as much as possible from the safety equation. Among human factors to be considered are carelessness, thoughtlessness, deliberate chance taking, fatigue, and illness. Other factors such as curiosity, lack of knowledge, distraction, zeal, laziness, worry, and anger fit into one or more of the primary factors. In systems that rely upon human actions to make the operation safe, one or more of the above factors will occasionally cause an improper action, resulting in unsafe conditions. Removing the need for human performance is the best way to eliminate these mistakes. Where human operations are necessary, the design must require the proper human performance before any operation of the press is possible.

One human factor that need not be accounted for in the safety equipment design is the factor of sabotage. Sabotage means the deliberate, calculated, intentional efforts to render ineffective or circumvent the protection afforded by the safety equipment. Management disciplinary action is the proper manner to handle such behavior.

In any discussion of power press safety, the terms brake monitor, interlock, dependable design, reliability, redundancy, fail-safe, and self-checking arise. These are very important concepts and for that reason their definitions and relationships to mechanical power presses are covered later in this document.

It must be emphasized that other safeguarding means may develop to add to those covered in this document. As the state of the art of power press safety advances, this will undoubtedly be the case. As these new safeguarding means evolve and are proven acceptable, they may render some of the present safeguarding means less desirable. Further, changing regulations may render some means obsolete. For example, present regulations prohibit the use of sweeps as safeguarding mechanisms after December 31, 1976. Power press users and manufacturers should be alert to new advances in power press safety and changing regulations.

DESCRIPTION, CONTROLS, AND MODES OF OPERATION OF THE MECHANICAL POWER PRESS

Description

In order to operate or maintain any machine safely, one should have an understanding and knowledge of the characteristics and functions of that machine. It is imperative, from a safety standpoint, that any and all personnel involved with a mechanical power press be armed with such understanding and knowledge.

One of the most common methods of cold forming metal into a useful shape is by using a power press. A power press is a machine that shears, punches, forms, or assembles metal or other material by means of cutting, shaping, or combination dies attached to slides. The major components of a press are a stationary bed or anvil, and a slide or slides having a controlled motion toward and away from the bed surface, the slide being guided in a definite path by the frame of the press.

Power presses may be operated mechanically, hydraulically, pneumatically, or occasionally by some other method. These three major methods share some sommon features; however, the scope of this Guide is limited to mechanical power presses only (Figures 1 and 2).

A mechanical power press operates on a reciprocating principle. A clutch transmits the stored energy of the flywheel to the crankshaft. On the downstroke the crankshaft lowers the slide and attached upper die to the work area, known as the point of operation. The workpiece, having been fed into the die, is formed when the upper and lower dies press together. On the upstroke the slide and upper die are raised by the crankshaft, the newly formed workpiece is removed, a new workpiece is fed into the die, and the process is repeated.

Mechanical power presses have two basic designs: the straight side frame (Figure 1), which is basically shaped like an "H" and has numerous configurations, and the gap frame press (Figure 2), which is shaped like a "C". The gap frame press is the more common. It is usually lighter and has a lower tonnage capacity.

The gap frame group of presses is composed of:

1. Open back inclinable press (Joint Industry Conference designation "OBI")
2. Open back stationary gap presses (Joint Industry Conference designation "OBS")

3. Adjustable bed presses, including horn presses (Joint Industry Conference designation "AB")
4. Closed back stationary gap presses (no Joint Industry Conference designation). These presses are sometimes referred to as "deep throat presses".

A knowledge of mechanical power press nomenclature is very beneficial in the study of power press safety. For that reason, the components listed below are defined. Refer to Figures 3 and 4 for physical location of the components.

1. FRAME - The frame is the heavier part of the press on which are mounted all working parts of the machine. On larger presses, the frame is composed of several parts, commonly called the bed, the uprights and the crown. All are secured together with tie rods or bolts.

2. BASE - The base is the cradle or fixture that supports the press.

3. BED - The bed is the work area of the press frame that supports the bolster with the lower die.

4. FLYWHEEL - The flywheel is a device used to store energy until needed to turn the crankshaft during a stroke of the press. It is usually belt driven by an electric motor and runs continuously.

5. BOLSTER PLATE - The bolster plate is attached to the top of the bed of the press and has drilled holes or T-slots for attaching the lower die or die shoe.

6. CONNECTING ROD - The connecting rod is a member that is fastened to the crankshaft by a bearing at one end and to the slide at the opposite end by an adjustment screw or bearing. The connecting rod changes the rotary movement of the crankshaft to the up and down movement of the slide. The working height of the slide can be adjusted by means of the adjustment screw. Other terms used for the connecting rod are pitman, strap, or screw.

7. SLIDE - The slide is the working member of the press that is connected to the lower end of the connecting rod and travels up and down in relation to the bolster plate and lower die. The upper die is attached to the lower part of the slide. Other names for the slide are ram, plunger, platen, and punch.

8. COUNTERBALANCE - The counterbalance is a device that balances or supports the weight of the connecting rod, slide, and slide attachments. The proper function of the counterbalance is to ensure smooth press stroking. Therefore, as heavier dies are attached to the slide, the counterbalance pressure should be adjusted accordingly. A counterbalance is not to be used instead of an adequate brake.

9. CLUTCH - The clutch is the coupling mechanism used on a mechanical power press to couple the flywheel to the crankshaft, either directly or through a gear train. The two types of clutches usually used on mechanical power presses are the positive or full revolution clutch and the part revolution friction clutch.

   (A) Positive or Full Revolution Clutch - A positive or full revolution clutch is a type of clutch that, when engaged, cannot be disengaged until the crankshaft has completed a full stroke. Positive type clutches are almost always full revolution types. Usually an engaging device releases spring pressure to move engaging members which by nature require a full revolution before they can be disengaged, generally by a throw-out cam arrangement which is part of the clutch mechanism. Since a positive or full revolution clutch must make a full revolution before it can be released, presses equipped with this type clutch are a greater safety hazard than presses equipped with a part revolution friction clutch.

   (B) Part Revolution Friction Clutch - A part revolution friction clutch is a type of clutch that can be disengaged at any point before the crankshaft has completed a full revolution and the slide a full stroke. Part revolution clutches are usually air engaged and are usually friction type mechanisms, although some types of positive engagement clutches are capable of being disengaged during the stroke of the slide. Other types of clutches, such as magnetic or hydraulic engaging, are sometimes used for part revolution operation.

10. BRAKE - The brake is the mechanism used on a mechanical power press to stop the crankshaft and slide and hold them, either directly or through a gear train, when the clutch is disengaged. The brake may be a constant drag type (typical on a positive or full revolution clutch press), or may be a type disengaged while the clutch is engaged (most typical on a part revolution friction clutch press).

11. CRANKSHAFT - The crankshaft converts the rotary motion of the flywheel to the up and down motion of the connecting rod and attached slide.

12. TIE RODS - Tie rods extend from the top of the crown through the uprights to the bottom of the bed. They prevent the crown from lifting off the uprights and also maintain alignment of press components.

13. CUSHIONS - Cushions provide holding pressures for draw jobs and workpiece ejection. They are located in the press bed and transmit their pressure through the bolster plate by pins. In some cases they may be built into the slide. Cushions can obtain their pressure by pneumatic, hydropneumatic, or hydraulic means.

14. GIBS - The gibs guide the slide and hold it in correct alignment with the bed and bolster.

The above definitions apply to the major components of a mechanical power press. For a more comprehensive listing of press terms, refer to Section F.

Press Controls and Modes of Operation

The word press control refers to all those mechanisms on a press needed to control the press and its attachments in every mode of operation. These mechanisms usually include motor starters, slide adjusting motors, air valves, a clutch, a brake, relays, mode selectors actuators, start buttons, stop buttons, crank position sensors such as a cam operated limit switch, air pressure sensor, automatic lubricators, and may include die cushions, counterbalances, and a host of other accessories. These mechanisms are usually all mounted in, or attached to, a large control box, which is mounted on the frame of the press. Some mechanisms provide only control over the motor. Others provide control over the stroking of the press as well, by means of the clutch and brake.

The purpose of the stroking control is to provide a number of different modes of operation or ways of causing the slide to move up and down, to satisfy the needs of die setting, maintenance, and different types of production work. The modes usually supplied by the manufacturer of the press are "Off" (no movement possible), "Single Stroke" (one complete closing and opening movement each time the actuator is operated), "Continuous" (multiple closing and opening movements each time the actuator is operated, ending when the actuator is released or when a special stop button is depressed) for production; and "Bar" (turning the flywheel and crankshaft manually with a lever), and/or "Jog" (momentarily energizing the motor with the clutch engaged), and "Inch" (momentarily engaging a part revolution clutch to make a partial closing movement) for die setting and maintenance.

Much time, paper, and ink has been expended in the past in attempts to place safety requirements on these modes of operation. The application of systems design techniques used in this Guide, however, has shown this to be an inefficient and sometimes overly restrictive approach in terms of preventing point of operation injuries.

The basic danger present in the point of operation of a mechanical power press is that of being caught in the moving parts between the slide and bolster. This hazard only exists when these parts are open and about to close. The hazard is more or less capable of injuring a man in any mode of operation, so long as the flywheel is capable of delivering sufficient energy to crush the body. Thus the mode of operation has no bearing on the need for point of operation safeguarding.

The fact is that most safeguarding systems are capable of being used efficiently and practically in more than one mode of operation.

Thus the essential criteria are that a safeguarding system, capable of preventing point of operation injuries, be functioning whenever the slide is capable of, or in the process of, moving toward the bolster.

This Guide does not make specific recommendations of a given safeguarding system for every mode of operation. It is left up to you to consider the Safeguarding System Requirements in the next pages, and the information contained in Tables 3 and 4 of Section B, to ensure that whenever any of your presses are used in any of their modes, all your workers are protected from their hazards by a functioning safeguarding system. The best way to accomplish this is, of course, to build press controls so that the mode selectors automatically select a safeguarding system in every position.

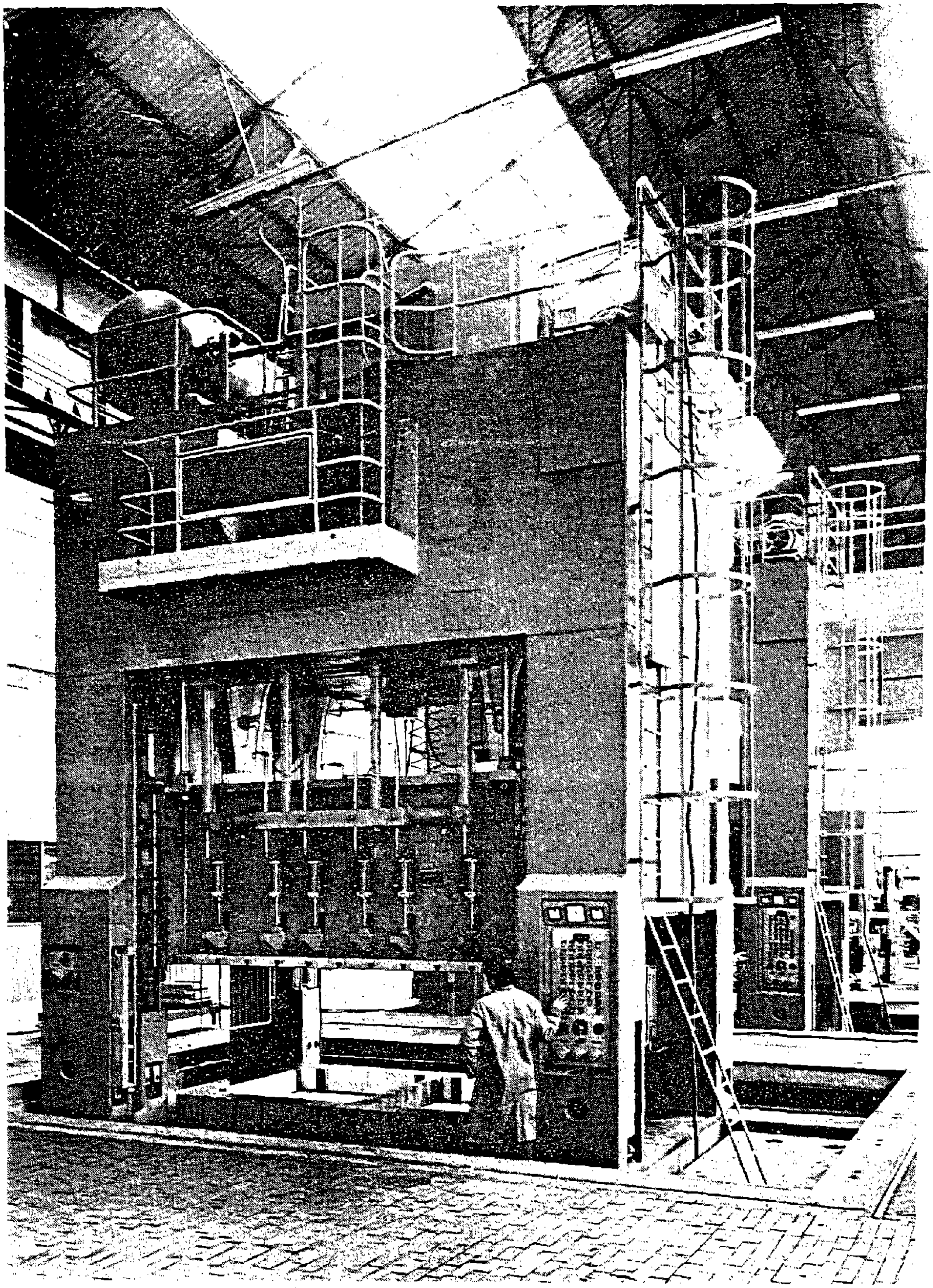


Figure 1. - View of straight side frame mechanical power press.

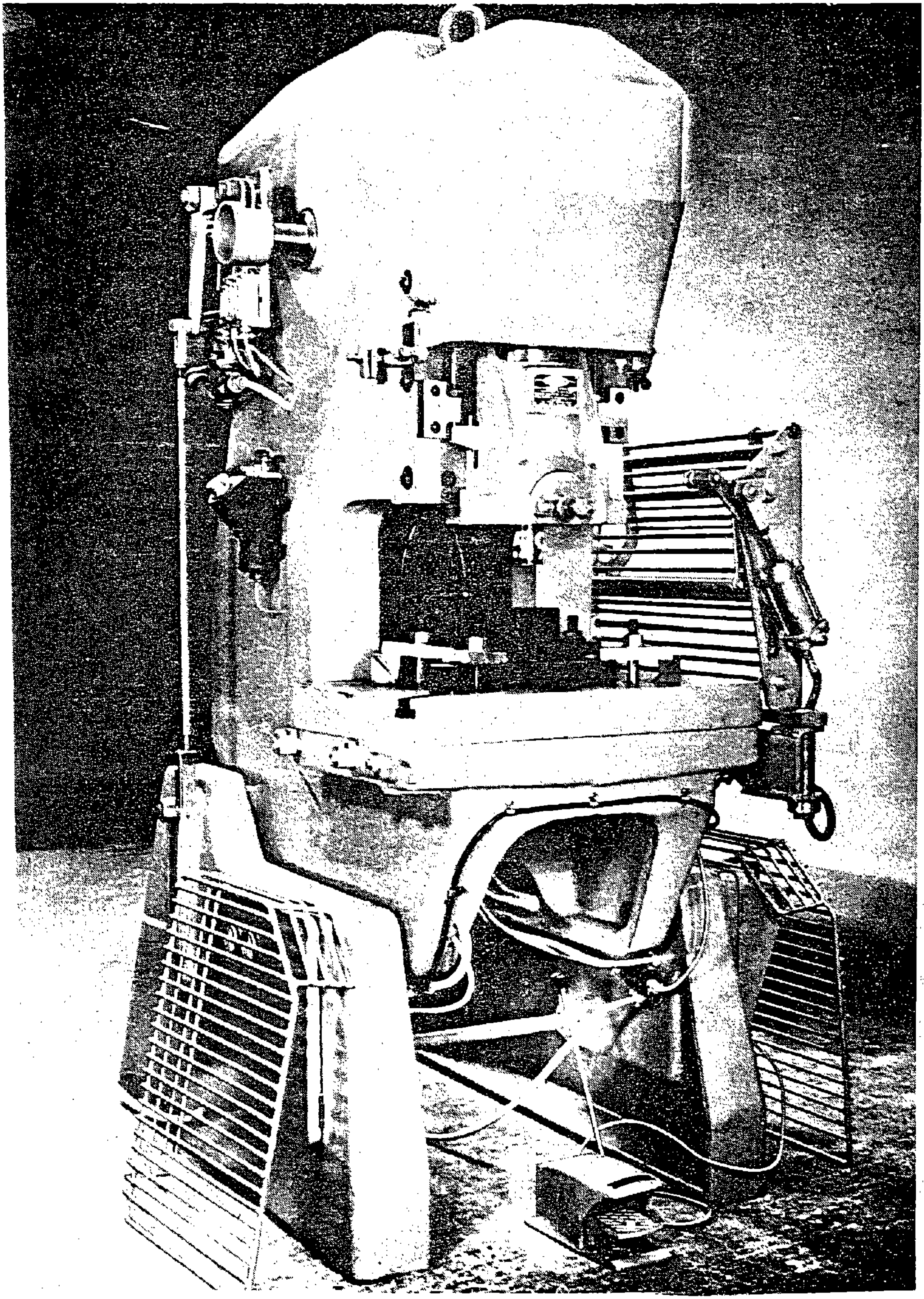


Figure 2. - View of gap frame mechanical power press (barriers removed for clarity).

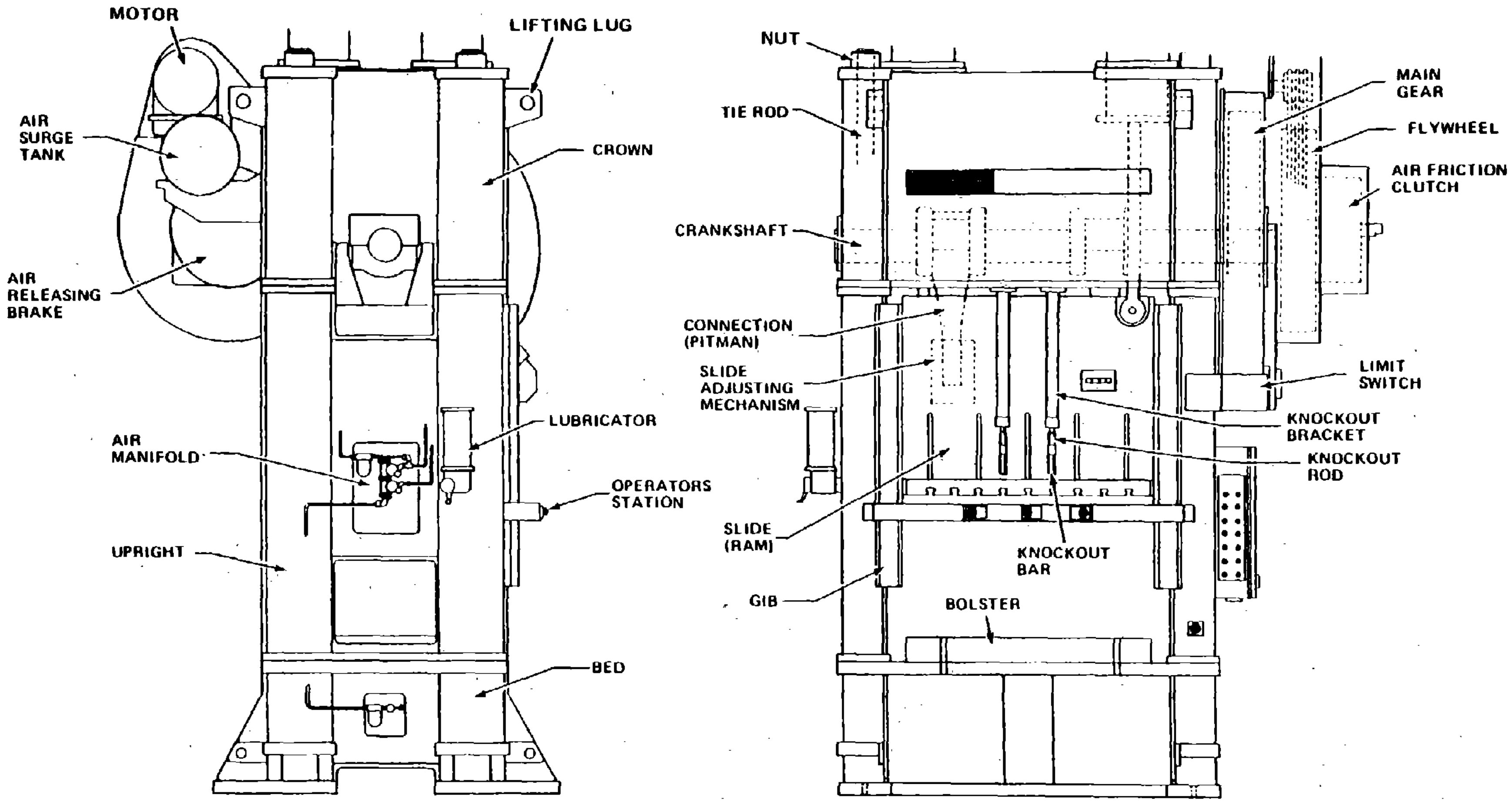


Figure 3. - Terminology for typical straight side frame mechanical power press.

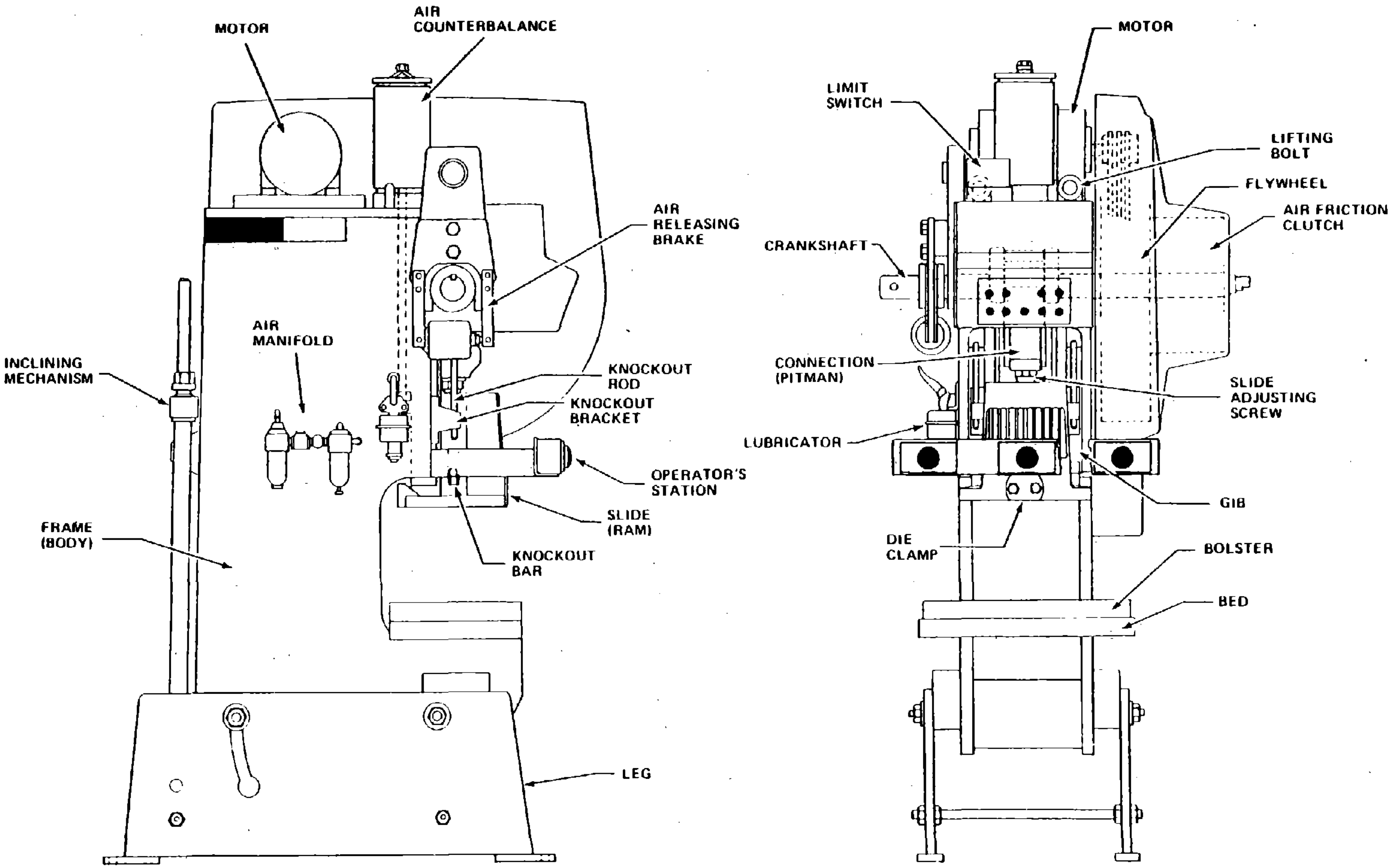


Figure 4. - Terminology for typical gap frame mechanical power press.

SECTION B

SAFEGUARDING SYSTEMS

SUBSECTION 1. - SAFEGUARDING SYSTEMS REQUIREMENT LISTS

The following lists give complete safeguarding systems design requirements for each safeguarding system presently in common use on mechanical power presses. These requirements are the result of rigorous application of the systems approach to each safeguarding system. This work was performed under the same contract as produced this Guide, and is detailed only in a separate report which may be obtained from NIOSH. Throughout this work, safety requirements for the machine were maximized by application of "dependable" design to every system wherever possible, in order to minimize all safeguarding dependence on human action.

The applicable requirements should be read and understood by all personnel responsible for press safety. These people will need to work closely with production, engineering, and management in order to incorporate the requirements on machines in your plant and especially to specify new machines which will satisfy these requirements. In every case, total use of all these requirements will result in optimum safety.

GENERAL SAFEGUARDING SYSTEM REQUIREMENTS

These requirements pertain to all machines and are part of the safeguarding systems covered in the following sections.

1. The power disconnecting means must be mounted on or next to each press and be capable of being locked in the "Off" position only.

2. A means that automatically disconnects power and prevents automatic press restarting due to a power or air pressure loss must be provided.

3. The motor starting means must be protected against accidental activaction.

4. Power supplied at any controlling means of the machine must be no more than a nominal of 120 VAC supplied by a transformer with an isolated secondary or a nominal 240 VDC. Exception: motor starters with integral motor start-stop buttons may use line voltage.

5. All electrical press wiring must be in compliance with the requirements of 29CFR 1910.309 as applicable.

6. Air controlling equipment must be supplied with air free of foreign material and water and lubricated when needed.

7. All pressure vessels must be in compliance with the requirements of the American Society of Mechanical Engineers Code for Pressure Vessels, 1968 edition.

8. All hydraulic equipment must be designed to assure that the safe working pressure rating of any component is not exceeded by any pressure developed by any use of the press.

9. Slide counterbalance systems, if supplied, must be designed to contain any broken parts and arranged to prevent the sudden loss of that function due to a component failure in the system or air supply failure.

10. All actuators must be designed to minimize operator fatigue and discomfort and protect against unintentional operation. This protection should not be a hindrance to the operator.

11. Mode selectors which control whether a given safeguarding system is in use or control which system is in use must be capable of being supervised. A key lock switch meets this requirement.

12. Mode selectors which control which safeguarding system is in use must be clearly marked to indicate which system is in use at each position of the selector.

13. If a mode selector is provided which does not automatically preclude operation without a functional safeguarding system in every selector position, a system of inspections, records, and supervisory control must be maintained to ensure that whenever the press is operated a safeguarding system capable of preventing worker point of operation injuries is in use.

14. The materials used in any barrier must provide maximum die visibility consistent with other requirements.

15. Materials and components used in any safeguarding system must be of sufficiently rugged construction to reduce the chance of failure, the incentive to modify the system, and the probability of loss of safeguarding function.

16. The mechanisms of any interlocks required for the safeguarding performance of a safeguarding system must be difficult to circumvent.

17. If a friction clutch is supplied, it must not be subject to either uninitiated strokes, or repeat strokes, due to sudden failure.

18. If a positive clutch is supplied, a system of inspections, records, and supervisory controls must be maintained, and a record of an inspection of the clutch and brake and needed repairs must be made weekly, in order to minimize the possibility of an uninitiated stroke. In addition, the workers responsible for making these inspections must be thoroughly trained in the operation, maintenance, and failure modes of the type of positive clutch involved.

19. Every system must be provided with a brake capable of stopping the slide quickly and of holding it and its attachments in any position, without the assistance of a counterbalance. All brakes must be designed to eliminate the possibility of sudden loss of function due to the failure of a single component. All brakes must be set by multiple, guided, compression springs.

20. Any provision in the press for turning the crankshaft manually by means of a lever or bar must preclude the possibility of inserting the bar while the flywheel is in motion. Holes provided for the bar must not be located in the crankshaft, but may be located in the flywheel.

21. If the press is provided with a "Bar" mode to trip the clutch with the motor de-energized, it must incorporate a mechanism which prevents the motor from re-energizing unless the clutch is disengaged and a separate "Bar" actuator must be provided for tripping the clutch.

22. Safety blocks must be provided for use whenever dies are adjusted or maintained on every press. They must either be designed to withstand full force of the press stroke or be interlocked to prevent a powered press stroke whenever they are in the press. A training program and a system of supervisory control must be instituted and maintained to inform all workers responsible for die setting or maintenance and supervision, of the need to use safety blocks and to ensure that they are used.

BARRIER OR ENCLOSURE SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which prevent workers from entering the point of operation by placing a stationary obstruction between workers and hazards.

Performance Requirements for All Mechanical Power Presses

1. All systems must meet the general safeguarding system requirements for mechanical power presses.

2. When the complete system, including die, workpiece and barriers is in place, all opening in and between the die, workpiece, barriers, and press components must be so small that no worker can pass any part of the body through them and into the point of operation hazards. In addition, all openings larger than 2 inches must meet the requirements of Table 2, for the other dimension.

3. The barrier(s) must be securely attached with fasteners that are not readily removed or provided with interlocks and a press control to preclude tripping whenever they are not in their protective position. If interlocks are provided, the system, including but not limited to, interlocks, press control, and clutch and brake, must of "dependable" design.

4. If an interlocked barrier is provided, then it must be designed so that it cannot be used for press feeding. (See GATES)

5. The barrier must eliminate all pinching and shearing hazards which could be created between the barrier and the moving parts of the press.

6. Materials used in a barrier safeguarding system must be sufficiently rugged to minimize the chance of a failure, and loss of safeguarding function.

7. An additional safeguarding system must be provided to protect workers during die setting, maintenance, and other procedures where this system cannot be used.

8. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and deciding whether barrier safeguarding will be utilized, or adjusting a barrier for a given job fully understand all the above design requirements.

9. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at the beginning of each shift, after each die change, and after each maintenance, modification, or adjustment of the barrier to ensure its continued use, applicability, and conformance with the above design requirements.

TYPE A GATE SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems where a movable barrier opens for the purpose of manual feeding and encloses the point of operation prior to stroke initiation and remains closed until the motion of the slide has ceased.

Performance Requirements for Use on All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. The gate or movable barrier must be locked closed before stroke initiation is possible and remain locked closed until the ram has come to rest at the completion of its motion.

3. When the gate or movable barrier is in its closed position, all openings in and between the gate, supplemental barriers, and press components must be so small that no worker can pass any part of the body through them and into the point of operation hazard and, in addition, the opening between the closing edge(s) of the movable barrier(s) and the adjacent bolster plate, supplemental barrier, or workpiece, must meet the requirements of Table 2.

4. Supplemental barriers must be used to enclose the point of operation where needed and they must either be interlocked to prevent tripping whenever not in their protective position or be permanently attached employing fasteners not readily removable.

5. The gate and supplemental barriers must eliminate all pinching and shearing hazards which could be created between them and the moving parts of the press.

6. Operation of the gate mechanism must not cause undue worker fatigue.

7. The gate must not present any hazard to the operator from which he is not protected by another means.

8. The movable barrier's speed should be as fast as possible, consistent with other requirements, to minimize incentives to modify the system.

9. The system must be provided with a mechanism, which, when the system is removed from its effective position for the purpose of die setting and maintenance, either precludes tripping the clutch or automatically selects another safeguarding system.

10. The system, including, but not limited to, interlocks, locks, motion sensors, gate mechanism, and press controls must be of "dependable" design to assure continued protective function.

11. If the gate safeguarding system is not used, additional safeguarding means must be provided for worker protection from point of operation injuries during die setting and maintenance procedures.

12. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and deciding whether Type A gate safeguarding will be utilized for a given job fully understand all the above design requirements.

13. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at the beginning of each shift, after each die change, and after each maintenance, modification, or adjustment of the gate or supplemental barriers to ensure its continued use, applicability, and conformance with the above design requirements.

TYPE B GATE SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems where a movable barrier opens for manual feeding and encloses the point of operation prior to stroke initiation and prevents the operator from reaching into the point of operation prior to cessation of slide motion during the downstroke.

Performance Requirements for Machines Equipped With a Positive or Full Revolution Clutch

This system must not be used alone on presses equipped with positive or full revolution clutches.

Performance Requirements for Presses Equipped With Part Revolution Friction Clutches

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. a. The system must be equipped with interlocks and used with a press control to prevent tripping the clutch unless the gate is closed and be equipped with locks to prevent workers from opening the gate whenever the slide is in motion and be equipped with a brake monitor arranged to prevent further strokes whenever deteriorated stopping performance results in slide top-stop overrun greater than 1/4 inch of slide movement, or

   b. The system must be equipped with interlocks and a press control to both prevent tripping the clutch unless the gate is closed and disengage the clutch and apply the brake automatically whenever a worker opens the gate while the slide is in motion and be located at a sufficient safety distance in inches, equal to or greater than (system stop time in seconds) x (63 inches/second) from the nearest point of operation hazard and be equipped with a brake monitor arranged to prevent further strokes whenever deteriorated stopping performance results in an inadequate safety distance.

3. When the gate or movable barrier is in its closed position, all openings in and between the gate, supplemental barriers, and press components must be so small that no worker can pass any part of the body through them and into the point of operation, and in addition, the opening between the closing edge of the movable barrier and the adjacent bolster plate, supplemental barrier, or workpiece, must meet the requirements of Table 2.

4. Supplemental barriers must be used to enclose the point of operation where needed and must either be interlocked to prevent tripping whenever not in their protective position or be permanently attached employing fasteners not readily removable.

5. Operation of the gate mechanism must not cause undue worker fatigue.

6. The gate must not present any hazard to the operator from which he is not protected by another means.

7. The movable barrier's speed should be as fast as possible, consistent with other requirements, to minimize incentives to modify the system.

8. The system must be provided with a mechanism, which, when the system is removed from its effective position for the purposes of die setting and maintenance, either precludes tripping the clutch or automatically selects another safeguarding system.

9. The safeguarding system, including gate mechanism, interlocks, brake monitor, clutch, brake, and press controls must be "dependable" design to assure continued protective function.

10. If the gate safeguarding system is not used, additional safeguarding means must be provided for worker protection from point of operation injuries during die setting and maintenance procedures.

11. The gate and supplemental barriers must eliminate all pinching and shearing hazards which could be created between them and the moving parts of the press.

12. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and deciding whether Type B gate safeguarding will be utilized for a given job fully understand all the above design requirements.

13. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at the beginning of each shift, after each die change, and after each maintenance, modification, or adjustment of the gate or supplemental barriers to ensure its continued use, applicability, and conformance with the above design requirements.

PULLOUT SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which use a slide-operated mechanism to pull a worker's hands out of the point of operation before the dies close.

System Requirements for All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. The system must be adjusted to withdraw the worker's hands before a hazard is created in the point of operation.

3. The pullouts must be directly operated by the slide.

4. The maximum withdrawal of the pullouts must limited to 16 inches by system design.

5. The maximum rate at which the pullouts may withdraw the hands must be limited to 28 inches per second by system design.

6. The pullout mechanism, cables, hand attachments, and other hardware must be ruggedly constructed.

7. The pullout hand attachments must be designed to minimize the possibility of falling off.

8. Each hand attachment must be clearly marked with the hand for which it is intended to preclude worker injuries from the hazard of the pullout caused by placing them on the wrong hands.

9. The clutch must be tripped by concurrent application of each pullout protected hand to a separate mechanism. It must be impossible to operate these mechanisms by any means except application of these hands.

10. Every die must be designed and set to eliminate all protrusions which would be capable of catching the hand attachments or cables.

11. A separate safeguarding system must be provided in combination with every pullout safeguarding system to protect operators, helpers, and passersby who are not protected by the system and to protect workers during die setting, maintenance, and other procedures where this system cannot be used.

12. Materials used in supplemental barrier safeguarding must be sufficiently rugged to minimize the chance of failure or loss of safeguarding function.

13. All workers responsible for die setting, maintenance, inspection, adjustment, die design, and supervision must be thoroughly trained in the usage, maintenance, and the above safety design requirements of the system.

14. All workers who will use the pullouts must be thoroughly trained in the need for, use of, and proper operation of the system. These workers must be instructed to immediately cease work whenever the system appears to them to be operating improperly, and so inform their supervisor.

15. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection and adjustment of the system at the beginning of each shift, after each die change, whenever operators or helpers are changed, and after each maintenance, modification, or adjustment of the pullout to ensure its continued applicability, use, and conformance with all the above design criteria.

RESTRAINT SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which prevent the worker from reaching into the point of operation through limiting movement of the worker's hands by means of attachments to the hands.

Performance Requirements for All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. The system must be adjusted to prevent the worker from reaching into the point of operation any time during press operation.

3. The restraining hand attachments, cables, and other hardware must be securely attached in a fixed position and must be sufficiently rugged to withstand continued use without stretching or breakage.

4. The restraint hand attachments must be designed to minimize the possibility of falling off.

5. A separate safeguarding system must be provided in combination with every restraint safeguarding system to protect operators, helpers, and passersby who are not protected by the system and to protect workers during die setting, maintenance, and other procedures where this system cannot be used.

6. Materials used in supplemental barrier safeguarding must be sufficiently rugged to minimize the chance of failure and loss of safeguarding functions.

7. All workers responsible for die setting, maintenance, inspection, adjustment, and supervision must be thoroughly trained in the usage, meintenance, and the above safety design requirements of the system.

8. All workers who the restraints are intended to protect must be thoroughly trained in the need for, use of, and proper operation of the system. These workers must be instructed to immediately cease work whenever the system appears to them to be operating improperly, and so inform their supervisor.

9. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection and adjustment of the system at the beginning of each shift, after each die change, whenever operators or helpers are changed, and after each maintenance, modification, or adjustment of the restraint to ensure its continued applicability, use, and conformance with all the above design criteria.

TWO-HAND TRIP SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which require the use of two hands, each one on a separate remote actuator, to initiate tripping every stroke of a mechanical power press.

Performance Requirements for Mechanical Power Presses Equipped With a Positive or Full Revolution Clutch

*Two-hand trip safeguarding systems must not be used alone to safeguard presses equipped with a positive or full revolution clutch.

Performance Requirements for Mechanical Power Presses Equipped with a Part Revolution Friction Clutch

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. The system must either

   a) Be equipped with a mechanism which monitors system start time and precludes further strokes whenever the start time is exceeded by a preset time increment, and this increment must be included in the system start time used to calculate the safety distance, and provide a safety distance, measured from the nearest point of operation hazard to the nearest part of each hand when it is in its normal operating position on each actuator, equal to or greater than that required by the following formula:

      Safety distance in inches = the sum of the system start time, measured from the instant the actuators are operated to the instant the crankshaft has accelerated to one-half its maximum rotational velocity, plus the time needed for the press to complete the downstroke, plus the start time monitor increment, in seconds, multiplied by the hand reach speed constant of 63 inches per second or,

   b) Be equipped with a mechanism which requires the continued presence of each hand on each actuator, in order to trip the clutch, until the mechanism senses that the crankshaft has reached one-half its maximum rotational velocity, and provide a safety distance, measured from the nearest point of operation hazard to the nearest part of each hand when it is in its normal operating position on each actuator equal to or greater than that required by the following formula:

Safety distance in inches = the time needed for the press to complete the downstroke, in seconds, multiplied by the hand-reach speed constant of 63 inches per second.

*3. The system must be equipped with a brake monitor arranged to prevent further strokes whenever deteriorated stopping performance results in slide top-stop overrun greater than 1/4 inch of slide movement.

*4. The system must be so designed, constructed, and arranged that application of one hand to each of the two hand actuators within one-half second of each other is required to initiate every stroke of the press; and otherwise, the system must prevent the clutch from tripping.

*5. The two-hand actuators must be so designed, constructed, and arranged that the only probable means of operating both actuators within one-half second is by the two hands of a single worker. It must not be possible to operate both mechanisms within one-half second of each other by means of a falling object or with any other parts of the body.

6. The operation of multiple actuator pairs need not be simultaneous between pairs, but must be concurrent to initiate tripping.

7. Consistent with the safety distance requirement, the position of the two-hand actuators must prevent the hands and all other parts of the body from being in the point of operation during the downward stroke of the slide. Specifically, they must not be mounted above the slide on an inclined press.

8. The system, including, but not limited to, actuators, press controls, clutch, brake, brake monitor, and start time or starting monitor, must be of "dependable" design.

9. Another safeguarding system must be used in combination with every two-hand trip system to provide point of operation protection to helpers and passersby during all operations and to protect workers during die set-up, maintenance, and continuous mode or other operations not protected by this system.

10. If sufficient safety distance for every die or work set-up used in the press is not provided by fixed mounting of the actuators, a system of inspections, records, and supervisory controls must be maintained, and a record must be made of an inspection of the system at the beginning of each shift, after each die change or modification, and after each movement of the actuators, to ensure that adequate safety distance is maintained. In addition, those workers responsible for die setting, maintenance, die design, supervision, and location of the actuators must be thoroughly trained in the above safety distance requirements.

*Exceeds 29CFR 1910.217.

TWO-HAND CONTROL SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which require the use of two hands, each on a separate remote actuator, to initiate tripping of a mechanical power press, and continued presence of the hands on the actuators in order to continue and complete any downstroke of the slide.

Performance Requirements for Mechanical Power Presses Equipped With Positive or Full Revolution Clutches

Two-hand control safeguarding systems must not be used alone on presses equipped with a positive clutch, and cannot be used on presses equipped with a full revolution clutch.

Performance Requirements for Mechanical Power Presses Equipped With a Part Revolution Friction Clutch

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. Removal of either of any worker's hands from an actuator during any and every downstroke of the slide must quickly de-activate the clutch and apply the brake to stop slide motion. Re-initiation of such an interrupted stroke must require release and subsequent simultaneous operation of both actuators.

3. Each actuator must be located at a safety distance measured from the nearest point of operation hazard to the nearest part of each hand when it is in its normal operating position on each actuator sufficient to meet the following requirement:

   Safety distance = system stop time x 63 inches/second

4. The system must be equipped with a brake monitor arranged to prevent further strokes whenever stopping performance has deteriorated beyond a preset time increment. This time increment must be added to the system stop time when calculating and setting safety distance.

*5. The system must be so designed, constructed, and arranged that application of one hand to each of the two hand actuators within one-half second of each other is required; and otherwise, the system must prevent the clutch from tripping.

*6. The two hand actuators must be so designed, constructed, and arranged that the only probable means of operating both actuators within one-half second is by the two hands of a single worker. It must not be possible to operate both mechanisms within one-half second of each other by means of a falling object or with any other parts of the body.

7. The operation of multiple actuator pairs need not be simultaneous between pairs, but must be concurrent to initiate tripping.

8. Consistent with the safety distance requirement, the position of the two hand actuators must prevent the hands and all other parts of the body from being in the point of operation during the downward stroke of the slide. Specifically, they must not be mounted above the slide on an inclined press.

9. The system, including, but not limited to, actuators, press controls, clutch, brake, and brake monitor, must be of "dependable" design.

10. Another safeguarding system must be used in combination with every two-hand control system to provide point of operation protection to helpers and passersby during all operations and to protect workers during die set-up, maintenance, or other operations when they are not protected by this system.

11. If sufficient safety distance for every die or work set-up used in the press is not provided by fixed mounting of the actuators, a system of inspections, records, and supervisory controls must be maintained, and a record must be made of an inspection of the system at the beginning of each shift, after each die change or modification, and after each movement of the actuators, to ensure that adequate safety distance is maintained. In addition, those workers responsible for die setting, maintenance, die design, supervision, and location of the actuators must be thoroughly trained in the above safety distance requirements.

*Exceeds 29CFR 1910.217.

PRESENCE SENSING SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE: Those systems which create a remote sensing field between workers and point of operation hazards, preventing injury whenever a worker's presence is sensed in the field by preventing tripping, or initiating a stopping signal during the downstroke if a worker's presence is sensed in the field.

Performance Requirements for Mechanical Power Presses Equipped with Positive or Full Revolution Clutches

This safeguarding system cannot be used on machines equipped with a positive or full revolution clutch.

Performance Requirements for Mechanical Power Presses Equipped With a Part Revolution Friction Clutch

1. All systems must meet the general safeguarding system requirements for mechanical power presses.

2. The system must prevent tripping the clutch whenever a worker's presence is sensed.

3. The system must quickly disengage its clutch, apply its brake, and decelerate the slide to a stop, whenever a worker's presence is sensed during the downstroke.

4. The system must not be affected by external fields, foreign materials, or ambient conditions.

5. The design of any presence sensing device must provide a sensitivity sufficient to detect the presence of a hand, or an object of 2 inches in diameter, at any point in its sensing field.

6. All systems must be installed with the sensing field at a safety distance from the nearest point of operation hazard sufficient to meet the following requirement:

    Safety distance (inches) = system stop time (seconds) x 63 inches/second

7. All systems must incorporate a brake monitoring mechanism which is interlocked with the press control to inhibit further press stroking once the stopping time has increased beyond a predetermined time increment. This time increment must be added to the system stop time for calculation and setting of safety distance.

8. The presence sensing device must be marked with the maximum reaction time of the device and this time must be included in the system stop time for calculation and setting of safety distance.

9. Every sensing device used in a presence sensing safeguarding system must be marked by the manufacturer with the additional safety distance required to compensate for the device's minimum sensitivity. The correct way of using this information in setting safety distance must be supplied by the manufacturer in written installation instructions, along with the correct way of measuring the safety distance with respect to the effective position of the sensing field created by his device.

10. Supplemental safeguarding must be used to prevent the worker from entering the point of operation from over, under, or around the sensing field, whenever this possibility exists, and to prevent any worker from standing between the sensing field and the point of operation, without being sensed.

11. All gaps created in the sensing field for feeding material or feeding equipment which create the possibility of any worker entering the point of operation without detection, must be safeguarded by supplemental safeguarding means.

12. If supplemental barriers are used as a supplemental safeguarding means, they must be either interlocked to prevent tripping the clutch whenever they are not in their protective positions, or they must be permanently mounted with fasteners not readily removable. They must not create a shearing or pinching hazard with the moving parts of the press.

13. The system, including, but not limited to, sensing device, interlocks, press control, clutch, brake, and brake monitor, must be of "dependable" design.

14. If the presence sensing safeguarding system is not used during die setting, maintenance, and any other operations, an additional safeguarding means must be used to protect workers from point of operation injuries at these times. In addition, visible indicators and energy sources associated with the presence sensing system must be automatically extinguished whenever it is not in use.

15. If the system is provided with "sensitivity" adjustments these means must be locked and carefully supervised. The "sensitivity" adjustments must be regularly inspected by supervisory personnel and a record must be made of each inspection to ensure that the sensitivity and the safety distance are sufficient to protect all workers on every job setup.

16. If sufficient safety distance for every die or work setup used in the press is not provided by fixed mounting of the sensing device, a system of inspections, records, and supervisory controls must be maintained, and a record must be made of an inspection of the system at the beginning of each shift, after each die change or modification, and after each movement of the sensing device, to ensure that adequate safety distance is maintained. In addition, those workers responsible for die setting, maintenance, die design, supervision, and location of the sensing device must be thoroughly trained in the above safety distance requirements.

SWEEP SAFEGUARDING SYSTEM REQUIREMENTS

Sweep safeguarding systems must not be used as the sole safeguarding system to protect the point of operation of any mechanical power press after December 31, 1976.

SAFE WORKPIECE SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which employ the workpiece and its nature as a safeguarding mechanism.

System Performance Requirements on All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. a. The workpiece must be of such size or shape that the worker cannot reach into the point of operation whenever the workpiece is in position both before and after the work is performed, or

   b. The workpiece must be of such size, shape, and material that it must be supported and held by a worker with at least one hand whenever it is in the point of operation, at such a distant point that the worker cannot reach into the point of operation with either hand or the workpiece will be dropped or damaged, or

   c. The workpiece must be of such size or shape that it must be held by both hands whenever it is in the point of operation or it will fall.

3. It must be impossible for the worker to support the workpiece in such a manner that either hand can be placed in the point of operation.

4. The die must be designed so there is no need for any worker to place his hand in the point of operation to remove parts or scrap.

5. All dies or work setups must provide interlocks with the press control which prevent tripping unless the workpiece is in its protective position.

6. Supplemental safeguarding must be supplied to protect the operator or helper and other personnel where needed or an additional safeguarding system must be used.

7. When provided as supplemental safeguarding, supplemental barriers must be either non-removable or interlocked to prevent tripping unless they are in their protective position. They must not create a shearing or pinching hazard with the moving parts of the press.

8. The setup and operation procedure must be designed to minimize operator discomfort and fatigue.

9. The safeguarding system, including, but not limited to, interlocks, press control, brake, and workpiece, must be of "dependable" design.

10. An additional safeguarding system must be provided in combination with safe workpiece safeguarding for worker protection from point of operation hazards during die setting and maintenance procedures and jobs which are not included in number 2 above.

11. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at the beginning of each shift, after each die change, and after each modification or adjustment of the workpiece or work method to ensure continued use, applicability, and conformance with all the above requirements.

12. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, die design, die setting, and deciding whether safe workpiece safeguarding will be utilized for a given job fully understand all the above design requirements.

SAFE OPENING SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which require feeding the part into the die through an opening in or between the dies and utilizing the die itself as a means of safeguarding.

System Requirements For All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. a. The maximum width of the die opening must be less than 1/4 inch, or

   b. The maximum width of the opening above the material must be 1/4 inch with material in position in the die and interlocks are provided to prevent press stroking until the material is in its protective position, or

   c. The minimum width of the opening between unguarded portions of the die, ram, bolster, or materials with the ram in the closed position must be 3 inches.

3. Supplemental barriers must be used to prevent access to any openings greater than 1/4 inch with the ram in the open position and less than 3 inches with the ram in the closed position.

4. There must not be any hazard created between the workpiece or supplemental barriers and any other part of the press or die during operation.

5. With the complete system, including die, workpiece, and supplemental barriers in place, all openings in and between the die, workpiece, supplemental barriers, and press components must be so small that no worker can pass any part of the body through them and into any point of operation hazard.

6. The system, including, but not limited to, interlocks, press control, clutch, and brake, must be of "dependable" design.

7. A separate safeguarding system must be provided in combination with safe opening on the press for point of operation safeguarding during die setting, maintenance, and jobs not meeting the requirements of 2 above.

8. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, die design, die setting, and deciding whether safe opening safeguarding will be utilized for a given job fully understand all the above design requirements.

9. A system of inspections, records, and supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at the beginning of each shift, each die change, and after each maintenance, modification, or adjustment of the system to ensure its continued use, applicability, and conformance with the above design requirements.

REMOTE ACTUATOR SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which require the use of a remote actuator to initiate tripping of a mechanical power press and continued operation of the actuator in order to continue and complete any downstroke of the slide, used primarily for die setting and maintenance operations.

Performance Requirements for Mechanical Power Presses Equipped with Positive or Full Revolution Clutches

Remote actuator safeguarding systems must not be used on presses equipped with a positive clutch, and cannot be used on presses equipped with a full revolution clutch.

Performance Requirements for Mechanical Power Presses Equipped With a Part Revolution Friction Clutch

1. The system must meet the general safeguarding system requirements for mechanical power presses.

2. The system must prevent the clutch from tripping whenever the actuator is not operated.

3. Release of the actuator during any and every downstroke of the slide must quickly de-activate the clutch and apply the brake to stop slide motion. Re-initiation of such an interrupted stroke must require subsequent re-operation of the actuator.

4. The actuator must be mounted at a safety distance from the nearest point of operation hazard sufficient to meet the following requirement:

   Safety distance (inches) = [system stop time (seconds) x 63 inches/second] + 72 inches

5. Sufficient safety distance for every die or work set-up used in the press must be provided by fixed mounting of the actuator.

6. Consistent with the safety distance requirement, the position of the actuator must prevent the hands and all other parts of the body from being in the point of operation during the downward stroke of the slide.

7. The system must be equipped with a brake monitor arranged to prevent further strokes whenever stopping performance has deteriorated beyond a preset time increment. This time increment must be added to the system stop time when calculating and setting safety distance.

8. The system, including, but not limited to, actuator, press controls, clutch, brake, and brake monitor, must be of "dependable" design.

9. Another safeguarding system must be used in combination with every remote actuator system to provide point of operation protection to operators, helpers, and passersby during all operations and to protect workers during die set-up, maintenance, or other operations if they are not protected by this system.

ZERO FLYWHEEL ENERGY BAR SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which allow die setting and maintenance operations to be performed by engagement of the clutch while manually turning the flywheel by means of a lever or bar, with the flywheel at rest.

Performance Requirements for All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

Whenever the mode selectors are in the "Bar" mode, the system must meet the following requirements:

2. The system must incorporate a mechanism which is interlocked with the press control to prevent engagement of the clutch unless the flywheel is at rest.

3. The system must be interlocked with the motor starter to prevent energization of the motor, unless the clutch is disengaged.

4. The system, including, but not limited to, the motion sensing or timing mechanism, press control, motor starter, clutch, and brake, must be of "dependable" design.

5. An additional safeguarding system must be incorporated in the press to provide point of operation hazard protection to all workers in every other mode of press operation.

6. A spring loaded turnover bar must be provided for use with the system.

7. A safety training program must be instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, and die setting fully understand the need for and use of the spring loaded turnover bar.

8. A system of supervisory controls must be maintained on each machine and a record must be made of an inspection of the system at each die change to ensure the continued use of the spring loaded turnover bar.

ZERO FLYWHEEL ENERGY JOG SAFEGUARDING SYSTEM REQUIREMENTS

SCOPE - Those systems which allow die setting and maintenance operations to be performed through continuous engagement of the clutch and momentary energization of the drive motor, with flywheel at or very near rest.

Performance Requirements for All Mechanical Power Presses

1. The system must meet the general safeguarding system requirements for mechanical power presses.

Whenever the mode selectors are in the "Jog" mode, the system must automatically meet the following requirements:

2. The system must incorporate a mechanism which prevents tripping the clutch whenever the flywheel is not at or very near rest, and quickly de-energizes the motor whenever flywheel speed causes the speed of the ram to exceed 2 inches per second.

3. The system, including, but not limited to, the motor starting means, press control, and speed sensing or timing mechanisms, must be of "dependable" design.

4. An additional safeguarding system must be incorporated in the press to provide point of operation hazard protection to all workers in every other mode of press operation.

SUBSECTION 2. - SAFEGUARDING SYSTEMS APPLICATION

Perhaps the most commonly used expression in any discussion of power press safety is "point of operation". There is good reason for this. A large number of the injuries in pressrooms are injuries that take place at the point of operation. The injuries sustained involve the loss of one or more fingers, with the loss of one or both hands not uncommon. While this Guide will not exclude coverage of other power press hazards, major emphasis must be placed on the unique hazard, the point of operation. The regulations define the point of operation as "the area of the press where material is actually positioned and work is being performed during any process such as shearing, punching, forming, or assembling". The major hazard of the point of operation is that of pinching or crushing between two sections of tooling which close together within the thickness of the stock material under total forces measured in tons, with tens and hundreds of tons very common and thousands of tons not unusual. With or without material in the tool there is no space available for any part of the body such as a finger or a hand. Other pinch points just as dangerous may exist in the vicinity of the point of operation. These, however, differ from the point of operation in one very important detail. These pinch points can be eliminated by good safety design. This is not true of the point of operation. Its very reason for being (to open for insertion of stock material, to close under great pressure to make the part, and to open for removal of the finished part) precludes its being eliminated by careful design.

It must be emphasized that in any point of operation safeguarding considerations, safety begins with the press and working conditions. The characteristics of the press and working conditions must be taken into account before the point of operation safeguarding system can be determined. An inventory should be taken of all presses that need to be safeguarded, listing the characteristics and working conditions of each one. Tables 3 and 4 can be very useful tools in listing such characteristics and conditions, as well as aids in selecting the proper point of operation safeguarding system.

It is the responsibility of the press user (management) to provide and ensure the use of a properly applied and adjusted point of operation safeguarding system for every operation performed on a press, consistent with the requirements of the dies being used, with the feeding methods being used, with the type of stroking (single stroke or automatic) being used, or other features unique to the operation, so as to provide maximum protection to the press operator, helper, and other persons who may be exposed to the hazard.

Just as the press itself if not functional until the user installs his die unique to the product he is making, a complete, functional, and safeguarded machine does not exist until the user installs a point of operation safeguarding system made mecessary by that operation, and then further assures its use. Even if a form of point of operation safeguarding exists prior to installation of the die, adjustment (for instance of an adjustable barrier or pullout device) is usually necessary for the particular operation.

From a systems engineering point of view, there are eight basic methods for safeguarding the workers from the hazards of the point of operation. These are:

1) Physically prevent entry of any part of the body into the point of operation during the closing stroke.

2) Physically remove the worker should he be within the point of operation during the closing stroke.

3) Locating stroke starting means so that the worker cannot reach the point of operation.

4) Stop the slide motion should the worker enter the point of operation during the closing stroke (after-reach).

5) Prevent starting of the press stroke if the worker is within the point of operation.

6) Assure that the maximum opening of the die does not exceed safe conditions.

7) Assure that the worker, by virtue of the size or shape of the workpiece, is prevented from access to the point of operation.

8) Use such procedures and management control as to protect the worker to the greatest extent possible. Since this method relies heavily on human action to succeed, its use is discouraged and not recommended. Further, it is not in compliance with the regulations.

Each of these methods differ in the manner of providing protection for the worker. Indeed the last one, which has been widely used, ignores the technical aspects of safety. The other methods impose technical requirements upon equipment design and construction (the press and accessories to the press) in order to protect the worker.

Several systems are presently used to implement methods 1, 2, 3, 4, and 5. They consist of barriers, gates or movable barriers, pullouts, restraints, two-hand trips, two-hand controls, presence sensing, and sweeps. Each of these will be discussed in this subsection. Methods 6 and 7 have unique and special requirements and their use will also be discussed.

Whatever point of operation safeguarding system is selected, it must meet minimum performance requirements.

Every point of operation safeguarding system must:

1. Provide protection from injury, independent of adjustments to the greatest extent possible.

2. Maintain a safe condition in the event of any probable failure.

3. Be reasonably difficult to sabotage, including minimizing the incentive to sabotage.

4. Create no hazard for the workers in itself.

GENERAL MECHANICAL POWER PRESS SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This general checklist should be completed whenever a safeguarding system is installed. Also, the specific checklist for that particular safeguarding system must be completed. These specific checklists are located in this section at the end of each safeguarding system evaluation.

Does the system have:

Yes	No		
___	___	1.	A lockable disconnect mounted on or next to the machine?
___	___	2.	An interlocked magnetic motor starter?
___	___	3.	An interlocked low pressure air switch?
___	___	4.	A protected motor start button?
___	___	5.	A 120 VAC or less isolated transformer or 240 VDC or less power supply for control components? Note: Motor starters with integral start/stop buttons may be of line voltage.
___	___	6.	All press wiring in compliance with 29CFR 1910.309?
___	___	7.	All mode selectors capable of being locked?
___	___	8.	All mode selectors clearly marked with which safeguarding system is in use?
___	___	9.	A functional safeguarding system automatically selected in every mode selector position, or, a complete set of inspection procedures, ready for daily usage, to ensure that a functional safeguarding system is always in use?
___	___	10.	All interlocks designed and installed to be difficult to circumvent?
___	___	11.	Actuators which are easy to operate?
___	___	12.	Actuators protected against unintentional operation?
___	___	13.	Supply air that is clean and properly lubricated?
___	___	14.	Air pressure vessels that meet ASME Code for Pressure Vessels, 1968 edition?

Yes No

___ ___15. All hydraulic equipment used within its safe working pressure?

___ ___16. Rugged system components?

___ ___17. Maximum visibility consistent with other requirements?

___ ___18. A brake that stops the slide quickly and holds the slide and its attachments any place in the stroke?

___ ___19. A brake set with multiple compression springs?

___ ___20. Any counterbalances designed to prevent sudden loss of function?

___ ___21. a. A friction clutch designed to minimize sudden failures? or
b. A positive clutch that is thoroughly inspected and tested for proper operation, and a complete set of inspection procedures and records, ready for weekly inspection of the clutch?

___ ___22. Every hole provided for barring the press located in the flywheel, and none located in the crankshaft?

___ ___23. Have either full tonnage safety blocks or interlocked safety blocks, and a training program and supervisory controls to ensure their use?

If the answer to any of the above questions is "No", the system must not be placed in service.

BARRIER OR ENCLOSURE SAFEGUARDING SYSTEMS

1. DESCRIPTION OF BARRIERS AND ENCLOSURES

Barriers can protect operators, helpers, and passersby from the hazards of the point of operation. They do not protect die setters and maintenance men, and some other means of safeguarding must be used to protect them. However an interlocked barrier, although increasing time and effort for the job, can protect die setters and maintenance men.

Barriers are mechanical fixtures that prevent the hands or fingers from reaching through, over, under, or around the barrier into the point of operation. They accomplish this by acting as an obstruction between the hands or fingers and all access to the hazard. They do not move or open and close with each press stroke. With barriers, feeding the press material into the point of operation directly by hand is impossible, since the worker cannot place his hand in the hazard zone at any time. Press feeding must be accomplished by auxiliary hand tools, feeding mechanisms, or chute.

Since most presses use many different sets of dies, each with a different geometry, their barriers must either be adjustable in shape or specifically designed for each job. A minority of presses use dies whose geometry is similar enough to allow one barrier to be used on all jobs.

The four general types of barriers presently in use are: fixed barriers (Figure 5), adjustable barriers (Figure 6), die enclosure barriers (Figure 7), and interlocked barriers (Figures 8 and 9). All barriers must be either interlocked* or not removable. Since some part of the barrier must be removable for die setting or maintenance, interlocks are usually necessary.

A fixed barrier is a die space barrier that must be securely attached to the press frame or bolster plate in a fixed position or is free standing and which need not be adjusted when the die is changed. An adjustable barrier is a barrier that must be securely attached to the press bed, bolster plate, or die shoe. It requires adjustment for each job or die set-up. A die enclosure barrier is an enclosure that must be securely attached to the die shoe or stripper, or both, in a fixed position. An interlocked barrier is any of the above which is interlocked so that the press stroke cannot be started normally unless the barrier itself, or its hinged or movable section, is in the protective position, enclosing the point of operation.

*Exceeds 29CFR 1910.217.

2. USE OF BARRIERS

Barriers can be used on any mechanical power press job except those with a hands in die requirement. Refer to Tables 3 and 4 for more detailed information as to the use of barriers.

3. INSTALLATION OF BARRIERS

The barrier should be so designed and installed on the press (or die shoe or stripper in the case of a die enclosure barrier) that the worker cannot reach through, over, under, or around the barrier into the point of operation. The barrier must not be installed in such a manner that it will weaken the structure of the press. It should be durable and so constructed as to resist wear and shock and withstand long use with minimum maintenance. It must present no hazard in itself such as sharp corners, pinch points, rough edges, shear points, or other injury sources.

The barrier should be high enough to cover all pinch points between the bolster and the slide. When installing barriers, fasteners must be used that will make them not readily removable by the operator with tools at his disposal. This can be accomplished by using special rivets, screws, or other fasteners. The barrier must be constructed and installed in such a manner that will facilitate its inspection. Barrier slots should be vertical since vertical slots allow better visibility than horizontal slots. Transparent barriers (shields) should be kept free of scratches, grease, oil, dirt, or any other material that would reduce visibility. Metal barriers should be painted with flat black paint to eliminate reflections. Painting the dies with contrasting colors will aid visibility. Where practical, a light source should be mounted in the press throat.

4. MAINTENANCE OF BARRIERS

Since barriers have no moving parts, they require little maintenance. They should be repainted with flat black paint as required. A barrier must be inspected when it is removed and then reinstalled, after any repair work is performed on the barrier, when the barrier is modified, when the barrier is adjusted, and when a barrier-related accident occurs. A record of each inspection must be kept. The "Safety Inspection Checklist for Barrier or Enclosure Safeguarding Systems", shown at the end of this discussion, can serve as such a record. The "Barrier or Enclosure Safeguarding System Installation Checklist", also shown at the end of this discussion, should be completed when a barrier or enclosure safeguarding system is installed. It is imperative that any barrier that is removed be reinstalled before attempting to operate the press. If a barrier is damaged, it must be repaired or replaced immediately.

5. ADVANTAGES AND DISADVANTAGES OF BARRIERS

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4 will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Barriers

1. There is a low initial cost.
2. Little maintenance is required.
3. The barriers are mechanically simple.
4. Movement of the operator is unrestricted (both hands are free).
5. Interlocked barriers operate automatically to ensure that the point of operation is enclosed before the press can stroke.
6. If properly installed, adjusted, and used, barriers protect against repeat stroke, uninitiated stroke, unintended stroke, delayed stroke, and intended stroke.
7. They offer partial protection from projectiles caused by broken dies, etc.
8. They are protection from after-reach injuries.

B. Disadvantages of Barriers

1. They are limited to specific operations where the operator is not required to have access to the point of operation.
2. They can be intentionally left off the press, making it possible for the operator to reach into the point of operation under any conditions (non-interlocked barriers).
3. Visibility may be limited.
4. They often must be custom-made for each press.
5. Adjustable barriers create the risk of improper adjustment, allowing the operator to be exposed to the hazard and to after-reach into the point of operation.
6. They must be removable, creating the risk of inadvertent non-replacement, which could expose workers to hazards at the point of operation (non-interlocked barriers).
7. When the production method is changed, the barrier usually has to be changed or modified.
8. Barriers may create incentives for sabotage or circumvention.
9. On a barrier equipped with an access door, the access door can be left open, creating a possible entry to the hazard area (non-interlocked barriers).
10. Tools and mechanisms used to feed a press equipped with a barrier may create hazards.
11. The operator may feel that barriers hinder his efforts and production.

6. SAFETY CONSIDERATIONS

If the largest dimension of the barrier opening is less than 2 inches, the distance from the nearest point of operation hazard must conform to Table 1. Table 1 gives the distance between the barrier opening and the nearest point of operation hazard for varying maximum dimensions. (All shapes of barrier openings must be considered, e.g. square, round, rectangular, diamond-shaped, etc.)

*TABLE 1 - MAXIMUM PERMISSIBLE BARRIER OPENINGS (2" OR LESS)

Distance of Opening From Nearest Point of Operation Hazard, Inches	Maximum Dimension of Opening, Inches
Under 1-1/2	1/4
1-1/2 - 2 1/2	3/8
2 1/2 - 4	1/2
4 - 15	2

If any dimension of a barrier opening used for stock feeding is more than 2 inches, the opening and its position must conform to Table 2. Table 2 gives the maximum width of the barrier opening for varying distances between the barrier opening and the nearest point of operation hazard. All slot-like shapes of barrier openings must be considered, e.g. elliptical, rectangular, narrow and curved, etc. Table 2 applies to the widths of openings having any one dimension over 2 inches.

*Present regulations do not treat shapes of openings.

TABLE 2 - MAXIMUM PERMISSABLE WIDTHS OF BARRIER OPENINGS
(Having Any One Dimension More Than 2")

Distance of Opening From Point of Operation Hazard, Inches	Maximum Width of Opening, Inches
1/2 to 1-1/2	1/4
1-1/2 to 2-1/2	3/8
2-1/2 to 3-1/2	1/2
3-1/2 to 5-1/2	5/8
5-1/2 to 6-1/2	3/4
6-1/2 to 7-1/2	7/8
7-1/2 to 12-1/2	1-1/4
12-1/2 to 15-1/2	1-1/2
15-1/2 to 17-1/2	1-7/8
17-1/2 to 31-1/2	2-1/8

Adjustable barriers have provisions for adjusting their shape. This allows the user to use the same barrier with more than one die or job. However, adjustable barriers create the risk of improper adjustment; thus the use of adjustable barriers is not encouraged. When they are used, the following rules apply:

1) The adjustable barrier must be inspected for proper adjustment each time an adjustment is made.

2) Records must be kept of each inspection and adjustment.

If the above rules are rigidly enforced, the risk of injury will be reduced, but like any safeguarding device that requires human action to succeed, the risk cannot be entirely eliminated. Adjustable protection is nearly always undesirable.

An inherent shortcoming of all barriers is the fact that they must be removable for die setting, scrap clearing, and maintenance. Without constant human supervision, a worker will occasionally fail to replace them, creating a dangerous situation. Periodic inspections and records could reduce this risk, but they would not eliminate it. For this reason barriers must be equipped with interlocks to prevent starting the press unless the barriers are in place. Interlocks must be installed by a skilled person to minimize the possibility of their failure or sabotage, allowing continued press operation in an unsafe condition.

A barrier is not intrinsically safe itself. Shearing and crushing hazards created by the barrier's close proximity to the reciprocating slide are often overlooked when the barrier is being fabricated. Also, auxiliary tools and mechanisms necessary to feed a press equipped with a barrier may create hazards. Hand tools may be caught in the closing dies and crush the operator's hand between themselves and the barrier or another part of the press. Feeding mechanisms which move blanks or strips into the die may create pinching, shearing, or in-running nip point hazards within their own mechanisms or between themselves and the press or barrier. These hazards must be eliminated by design, or if impossible to eliminate, they must be adequately guarded against.

Although barriers themselves have no moving parts and are thus free from failure due to wear, the material handling equipment used to transport stock and dies often damages them. For this reason, all damaged barriers must be inspected and repaired, and a record kept of such inspections and repairs.

It should be noted here that if a press is fed through an interlocked barrier, it is a gate and not a barrier and therefore must meet the requirements of a gate.

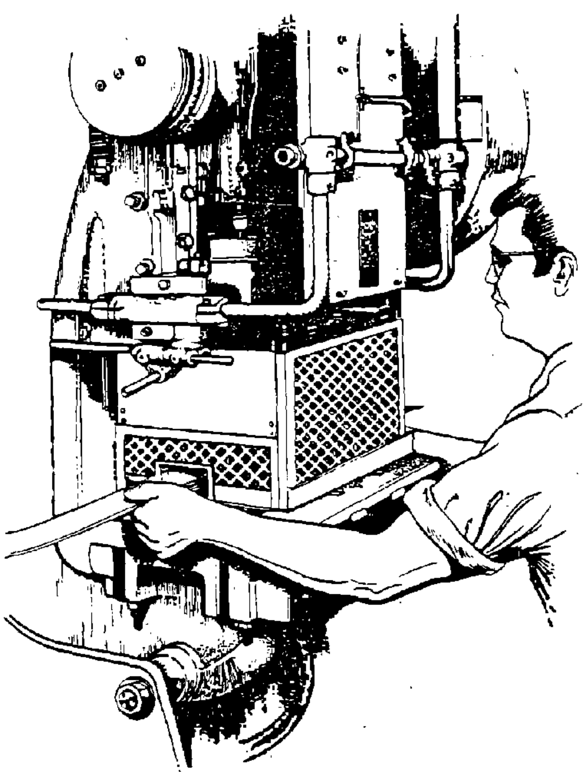


Figure 5. - A fixed barrier.

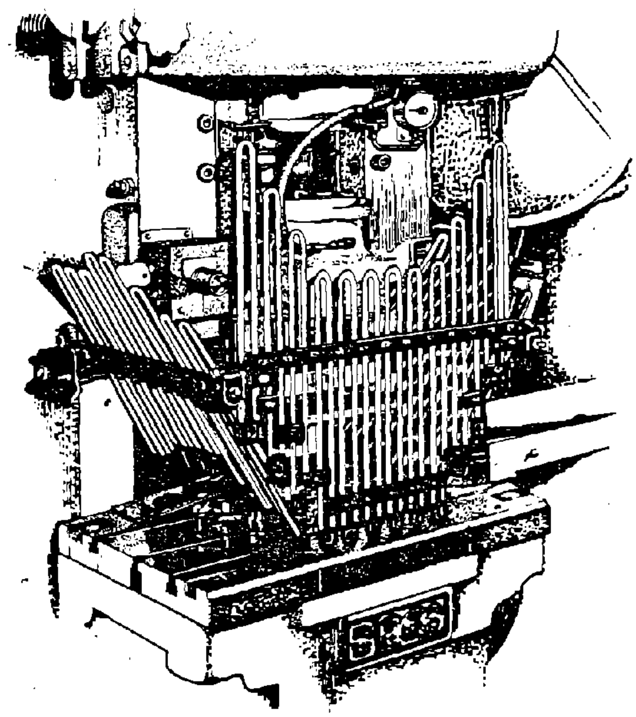


Figure 6. - An adjustable barrier.

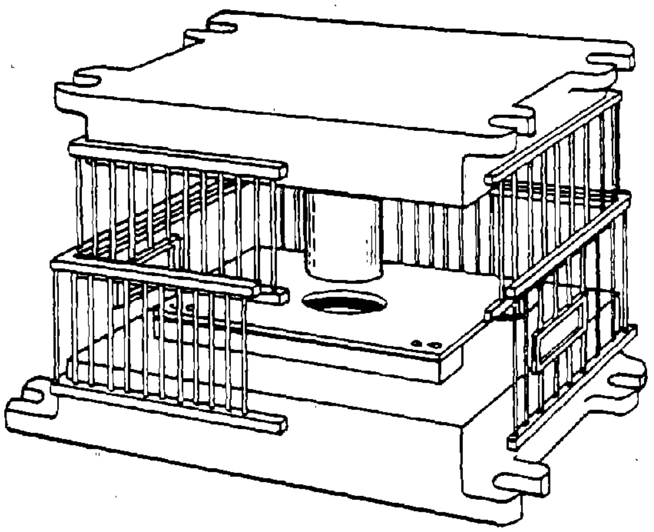


Figure 7. - A die enclosure barrier.

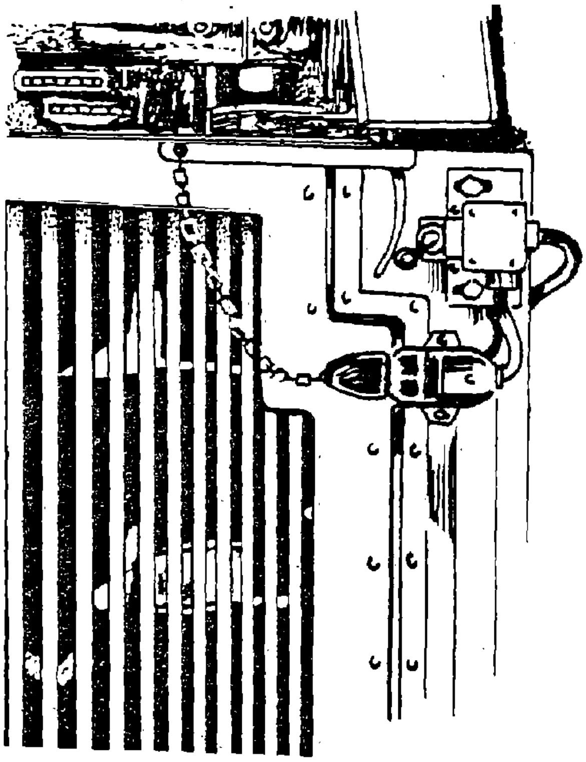


Figure 8. - An interlocked opening in a barrier.

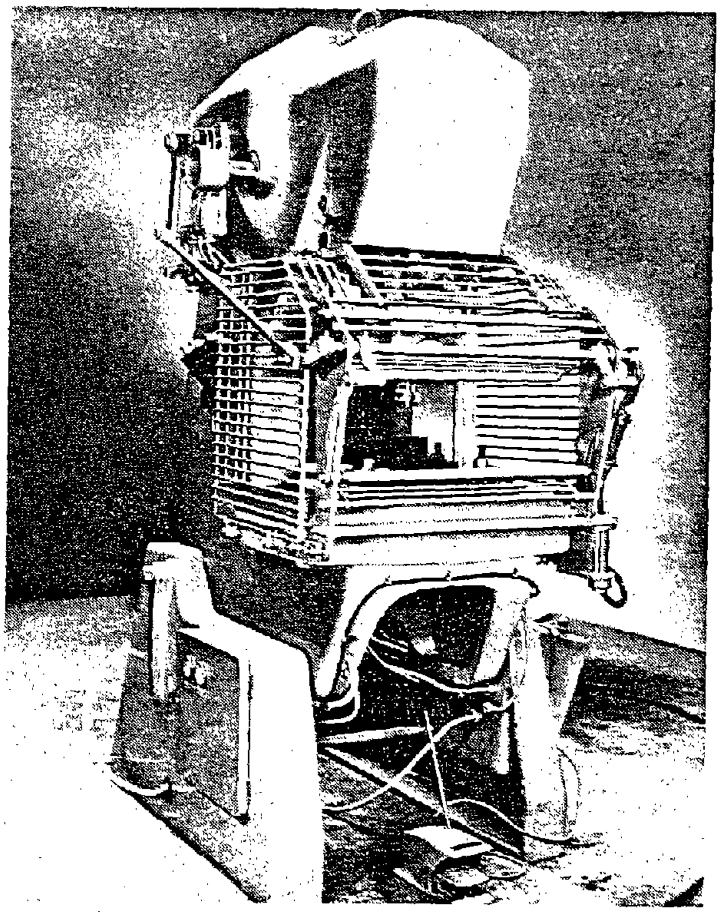


Figure 9. - Gap frame press equipped with interlocked barrier.

BARRIER OR ENCLOSURE SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a barrier or enclosure safeguarding system is installed.

Does the system:

Yes	No		
___	___	1.	Meet the general power press safeguarding system requirements (page B-2)?
___	___	2.	Meet the requirements of Table 2 for all openings with any one dimension larger than 2 inches?
___	___	3.	Prevent all workers from reaching into any point of operation hazard?
___	___	4.	Have all barriers interlocked or permanently attached?
			Complete the following question if interlocks are used:
___	___	5.	Have interlocks and press control of "dependable" design and a design which precludes press feeding through opening and closing of the barrier?
___	___	6.	Have an additional safeguarding system for die setting and maintenance?
___	___	7.	Eliminate all shearing and pinching hazards between the barrier and the slide and die?
___	___	8.	Have a safety training program instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and operation or adjustment of the barrier fully understand all the above design requirements?
___	___	9.	Have a daily inspection, records, and supervisory controls on each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR BARRIER OR ENCLOSURE SAFEGUARDING SYSTEMS

This safety inspection checklist for barrier or enclosure safeguarding systems is a sample that includes the information that must be recorded:

1. At the beginning of each shift.
2. After each die change.
3. When the barrier or enclosure is removed for any reason and then reinstalled.
4. When any repair work is performed on the barrier or enclosure.
5. When the barrier or enclosure is modified.
6. When an adjustable barrier or enclosure is adjusted.
7. When a barrier or enclosure related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Does the barrier or enclosure (if not transparent) need a new coat of flat black paint?

___ ___ 2. Does the safeguarding system have any hazards in itself such as sharp corners, pinch points, rough edges, shear points, or other injury sources?

___ ___ 3. Has the barrier or enclosure been sabotaged or otherwise rendered unsafe or ineffective?

If the answer to any question 1 through 3 is "Yes", corrective action must be taken.

___ ___ 4. Is the barrier or enclosure interlocked or permanently attached?

___ ___ 5. If equipped with an interlock, is the interlock performing its function properly?

___ ___ 6. If an interlocked barrier is provided, is it designed so that it cannot be used for press feeding? (See "Gate or Movable Barrier Safeguarding Systems".)

___ ___ 7. If the barrier or enclosure is transparent, is it free of scratches, grease, oil, dirt, or any other material that reduces visibility?

___ ___ 8. If the barrier or enclosure is adjustable, is it properly adjusted?

___ ___ 9. Does the system prevent all workers from reaching into any point of operation hazard?

Yes No

___ ___10. Do all openings with one dimension larger than 2 inches meet the requirements of Table 2?

___ ___11. Does the system have an additional safeguarding system for die setting and maintenance?

___ ___12. Is a safety training program instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and operation or adjustment of the barrier fully understand all the above requirements?

If the answer to any question from 4 through 12 is "No", corrective action must be taken.

Describe any maintenance, replacement, modification, adjustments, repairs, or other corrective action taken (if "none", so state):________________

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___die change
___barrier or enclosure removed or replaced
___barrier or enclosure repaired
___barrier or enclosure modified
___adjustable barrier or enclosure adjusted
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature:________________________
Title:____________________________
Date:_____________________________
Shift:____________________________
Time:_____________________________
Machine No.:_______________________
Serial No.:________________________

GATE OR MOVABLE BARRIER SAFEGUARDING SYSTEMS

1. DESCRIPTION OF GATES OR MOVABLE BARRIERS

Gates or movable barriers can protect operators, helpers, and passersby from the hazards of the point of operation. Gates or movable barriers can also protect die setters and maintenance men; however, they increase the time and effort for these persons to complete their jobs.

A gate or movable barrier is a mechanism arranged to enclose the point of operation before the press stroke can be initiated. A Type A gate (Figure 10) encloses the point of operation before a press stroke can be initiated and maintains this closed position until the motion of the slide has ceased. A Type B gate (Figure 11) encloses the point of operation before a press stroke can be initiated, so as to prevent a worker from reaching into the point of operation prior to die closing or prior to cessation of slide motion during the downstroke. Commercially manufactured gates generally are Type A and operate as follows: with the press slide stopped at the top of the stroke, the gate is open. Two interlocks, which may be pneumatically, electrically, or mechanically operated, are arranged to trip the clutch when the gate is in the closed position. As long as the gate remains open, the press will not trip. Once closed, the gate is held in place by latches or air pressure. As the press cycles, the gate is locked closed and remains closed until the press stops with the slide at the top of the stroke.

Type B gates operate as follows: with the slide stopped at the top of the stroke, the gate is open. Two interlocks, which may be pneumatically, electrically, or mechanically operated, are arranged to trip the clutch when the gate is in the closed position. As long as the gate remains open, the press will not trip. Once closed the gate can be held in place by latches or air pressure. As the press cycles, the gate remains closed until the slide starts the upstroke.

Movable barrier safeguarding systems are primarily used to provide safeguarding in production modes. Since these systems create a barrier whenever the dies are closing, all workers, operators, helpers, and passersby are equally protected from point of operation injuries.

In die setting and maintenance work, however, movable barriers, like all barriers, cannot be easily used. These jobs require free die access. Since the gate system obstructs the die area, and must be operated or swung open and closed every time the worker makes an adjustment to the dies, they greatly hamper the work and create great incentives for sabotage. Some other means of protecting these workers is preferable.

2. USE OF GATES OR MOVABLE BARRIERS

Type A gates can be used on any mechanical power press. Type B gates can be used on any mechanical power press except those equipped with a positive or full revolution clutch.*

3. INSTALLATION OF GATES OR MOVABLE BARRIERS

The gate or movable barrier must be installed in such a manner that it will not weaken the structure of the press. It should be durable and so constructed as to resist wear and shock and withstand long use with minimum maintenance. It must present no hazard in itself such as sharp corners, pinch points, rough edges, shear points, or other injury sources.

Supplemental safeguarding must be so designed and installed that no worker can reach through, over, under, or around the guarding into the point of operation. Consult the gate or movable barrier manufacturer's literature for detailed information for installing a particular gate or movable barrier.

4. MAINTENANCE OF GATES OR MOVABLE BARRIERS

Maintenance requirements for gates or movable barriers vary from manufacturer to manufacturer. Consult the manufacturer's literature for maintenance recommendations for a particular gate or movable barrier.

Gates or movable barriers must be inspected when they are removed and then reinstalled, after any repair work is performed on them, when they are modified, when adjustable supplemental barriers are adjusted, and when a gate or movable barrier related accident occurs. A record of each inspection must be kept. The "Safety Inspection Checklist for Type A (Type B) Gate or Movable Barrier Safeguarding Systems", shown at the end of this discussion, can be used as such a record. The "Type A (Type B) Gate Safeguarding System Installation Checklist", also shown at the end of this discussion, should be completed when a Type A or Type B gate safeguarding system is installed.

5. ADVANTAGES AND DISADVANTAGES OF GATES OR MOVABLE BARRIERS

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4 will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Gates or Movable Barriers

1. Gates prevent the worker from receiving injuries caused by intended and unintended strokes because interlocks prevent press stroking unless the gate is closed.

*Exceeds 29CFR 1910.217.

2. After the gate is closed, after-reach is impossible since the gate and supplemental barriers form a complete enclosure of the die.

3. Movement of the operator is unrestricted (both hands are free).

4. Gates protect against delayed strokes and after-reach if the gate is locked during the downstroke.

5. A Type A gate protects against repeat strokes.

B. Disadvantages of Gates or Movable Barriers

1. Visibility is limited, although it can be increased by the use of clear windows.

2. Gates are often equipped with adjustable supplemental barriers which create the risk of improper adjustment.

3. A relatively high initial cost is involved.

4. Gates do not provide protection against uninitiated strokes.

5. A Type B gate does not protect against repeat strokes.

6. Some Type B gates can be opened during the downstroke, making it possible for the worker to enter the point of operation.

7. The time necessary to operate the gate slows down production, which may create an incentive to sabotage.

8. Some models require relatively complex installation procedures.

9. Gates require frequent maintenance.

6. SAFETY CONSIDERATIONS

For most primary operations, whether manual, semiautomatic, or automatic feed is employed, the gate can be locked closed and used as an interlocked barrier safeguarding system. Gates are most useful, however, for safeguarding secondary operations where manual or semiautomatic feeds are employed. It should be noted that a "sliding bolster" is merely a feeding mechanism, which doesn't prevent worker access to the closing dies, and a gate safeguarding system is a commonly employed safeguarding system when sliding bolster mechanisms are used. Automatic feeding mechanisms used for secondary operation, such as transfer mechanisms, generally require too much room to allow movable barriers to be employed, although large movable barriers on large straight side presses have been built and so used.

All workpieces used with these systems must be either small enough to fit inside the enclosed area, or the supplemental barriers must allow the workpiece to enter the enclosed area through a slot in the supplemental barriers or under the movable barrier.

Since a Type A gate remains closed whenever the slide is in motion, it provides worker protection from repeat strokes, that is, an uninitiated successive press stroke. Since a Type B gate opens during the upstroke, it does not provide any protection from repeat strokes.

Protection from repeat strokes is especially important for a press equipped with a positive or full revolution clutch, since this type clutch is susceptible to repeat strokes. Since Type B gates provide no protection from repeat strokes, they must not be used on presses equipped with a positive or full revolution clutch.*

Part revolution friction clutches, on the other hand, can be designed to eliminate the risk of catastrophic failure such as repeat strokes. Type B gate systems can be designed with these type clutches, a brake monitor and "dependable" system design to provide a high level of point of operation protection.

A repeat stroke is not an inherent shortcoming of friction clutches. Most part revolution clutches are friction types, with multiple spring-set brakes, and failure modes characterized by gradual loss of clutch or brake torque and increase in stopping distance and time. A stuck friction clutch is rare. Repeat strokes have occurred on presses equipped with friction clutches, but caused mainly by component failure in the air valves, spring, or control component failures, and can be practically eliminated through "dependable" system design. In such a system, no repeat stroke protection is necessary, and Type B gates can be used safely.

Both types of gates can protect against delayed strokes. If the clutch fails to engage immediately when the worker expects it to, he may attempt to re-enter the die. If the gate is locked closed at this point, he will be prevented from doing so. Neither Type A nor Type B gates provide protection from all uninitiated strokes, since the worker may be in the point of operation when they occur. Fortunately uninitiated strokes, like repeat strokes, can be practically eliminated if a friction clutch is used and the system is of "dependable" design.

*Exceeds 29CFR 1910.217.

Not all part revolution clutches are friction clutches, however. A few positive (usually jaw-type) clutches exist which are not full revolution by design. These clutches are susceptible to catastrophic failure and are not safe for use with a Type B gate.

Positive clutches are always susceptible to uninitiated strokes. Although neither type of gate provides any protection from uninitiated strokes, this risk can be adequately controlled through the inspections required by the present regulations, provided the worker making the inspections is adequately trained to detect imminent failures.

In hand fed production runs, a gate prevents the worker from injuries from both intended and unintended strokes, since the presence of his arms will prevent the gate and hence the interlocks from closing and thus prevent the clutch from tripping.

After the gate has closed, after-reach is impossible, since the gate and supplemental barriers form a complete barrier safeguarding system, if the gate is locked closed. This is a necessary design feature if a positive clutch is used. The design of such clutches precludes interruption of a stroke, once started. This uninterrupted stroke feature requires that the gate remain locked all through the downstroke. This function is absent on some commercially built gates. Thus it is possible for the worker to open the gate and enter the die after the clutch has tripped. The risk becomes proportionately greater as stroking speed decreases, as this gives the worker more time to enter the die. It is therefore recommended that the gate be of a type that remains locked in the closed position during the downstroke to prevent after-reaching into the point of operation after the press has been tripped and before the dies close.

Some confusion exists over whether or not a gate should be able to open, allowing after-reach, during the slide downstroke when a friction clutch is used. Under the present regulations, Type A gates must remain closed at all times the slide is in motion. Thus, in the event of an interrupted stroke, the Type A gate begins to open as soon as the slide stops moving. Technically, this requires the system to have a means of detecting slide motion. Motion detectors are widely used in press systems for applications such as brake monitoring and detecting failure of limit switch drives. Thus the technology necessary to comply with this requirement is available and well proven.

The present regulation requires the Type B gate to prevent the worker from "reaching into the point of operation prior to die closure or prior to cessation of slide motion during the downward stroke". Holding the gate closed until the motion has ceased would certainly comply.

Some users, however, maintain that this is unnecessary; that if the stop signal is given to the system by the gate interlocks as the gate is opened, the time necessary for the worker to open the gate and then reach into the die can be made less than the stop time of the press.

However, though the hazard time can be measured just as accurately for gates as other mechanisms, the access time cannot. Some gates open automatically, through operation of a control, others must be opened by hand. In the first case, access time would be dependent on gate speed, stroke, and position relative to the die, and in addition the speed of each worker's reaching hand and his coordination with the moving gate. In the second case, gate speed is also variable from worker to worker. The number and kind of motions involved are entirely different than those encountered with the other safeguarding systems, and thus the same time constants cannot be used. Like the other systems, however, predetermined time systems analysis cannot be applied directly since the motions are not of the repetitive, learned, and practiced variety. Thus the ergonomics of this application are not sufficiently known and Type B gates which operate in this manner are not recommended.

Further study of these access times might eventually reveal workable standards for application of such systems. The benefit, however, would be very small. It is obvious that there is no additional safety to be obtained by allowing this practice. Keeping the gate closed until after the hazardous motion has ceased is clearly safer than allowing the worker unobstructed access to the closing dies. Additionally, the time saved for production would be extremely small. The hazard time, in this case, the system stop time, is from 1-tenth to 5-tenths of a second. Since an interrupted stroke is of advantage only to adjust a misfed part, and both this and the adjusting of the part automatically disrupts the production cycle, the time necessary to stop the slide is insignificant.

On a Type B gate this leaves only the potential initial cost benefit derived by eliminating the need for a motion detector. A motion detector is necessary for the time measuring type of brake monitor, and is a part of most top stop type of brake monitors and thus the motion detector usually cannot be eliminated. It is therefore recommended that all gate safeguarding systems, whether Type A or B, and regardless of the type of clutch used, should remain held closed whenever the slide is in motion and the dies are closing.

Beside the movable barrier itself, and its associated hardware, a complete system includes a number of supplemental parts. On a gap frame press such as the OBI, the die access through the open sides must be protected by supplemental barriers. These supplemental barriers must meet the performance requirements for barrier safeguarding systems. Refer to "Barrier or Enclosure Safeguarding Systems".

Since all gates are interlocked with the clutch/brake, these supplemental barriers can be easily interlocked as well. Alternatively, they can be made an integral part of the gate assembly. In either case, the risk of operating the press with the barriers removed is eliminated.

Since it is not driven by the slide, the closing force of the gate can be designed to be small. The gate must create no shearing or pinching hazard itself to the worker. Commercially available models are successful in minimizing the hazard of the gate. The use of rounded edges, thick, soft rubber pads, and controlled operating force is widespread.

An alternative method of protecting the worker from the gate hazard, useful when the gate movement is powered and not manual, is to interlock actuation of the gate with another safeguarding system, e.g. a two-hand trip or presence sensing device, placed at a safety distance appropriate for the gate's closing time or stopping time, respectively. Either of these systems prevents injuries by requiring the worker to remove his hands from the gate's path by the safety distance before the gate will begin to move, and making it impossible for him to then re-enter the gate's path before it has closed or before it stops moving.

Every gate and movable barrier device allows workers access to the open die. Thus "dependable" system design is necessary. This includes the interlocks and the gate mechanisms, as well as required motion detection and brake monitoring functions. The system must also preclude further press strokes when any element has failed.

The barrier which prevents access from below is commonly made adjustable in position, as is the stroke of the movable barrier and its closed position. This arrangement allows the press to be used for primary operations or pieces too large to fit completely within the enclosed area behind the gate, such as cut-off or notching operations on pipes, and at different die heights. In order for these operations to be safe, the maximum opening in the system, with the gate closed, must not be so large that the worker can reach into the die. Here again, the risk of misadjustment is introduced. Some manufacturers have, by making the lower barrier an integral part of the gate assembly, made it impossible to misadjust this opening without rendering the press inoperative.

Gates and movable barriers must move from their protective position in order to allow workers free access to the die space for die setting and maintenance operations. The system must be so interlocked that when the gate is thus in a noneffective position, either the clutch is prevented from tripping or some other form of safeguarding is selected. This could be a two-hand control, for example. Commercially built gates are usually made to swing away from the die, either to the side or above, and interlocked to preclude tripping in this position. On some such models, the interlock is very easily bypassed. The use of such bypassing means while die setting or making repairs is specifically not recommended.

A Type B gate allows the worker to re-enter the die at some point during the upstroke, in order to unload the part just stamped and load the next. Initially the worker is protected from the intended stroke because the clutch disengages and the brake stops the ram at the top of its stroke. However as a friction clutch/brake wears, the ram stops slower, and the rest position of the ram begins to creep down into the downstroke. If deterioration is allowed to continue unchecked, this closing movement at the end of each stroke will become hazardous to the worker. Thus, a brake monitor is necessary to shut down the machine as this hazard develops.

When the Type B gate opens at the bottom of the press stroke, the opening between the dies is too small to allow the worker to enter. At some crank position in the upstroke, the worker will be able to enter the die. At the complementary crank position in the downstroke, the hazard of die entrapment will exist. The brake monitor must shut down the press before the top stop overrun reaches that point. This crank-hazard angle varies from die to die as well as from press to press. If a long stroke press is used to blank thin sheets, the angle may be 160° or more. If a short press is used for a drawing operation, it may be 20° or less. The latter situation is the most critical, since only a small amount of braking deterioration is required to produce the hazard. It is reasonable to assume the first 1/4 inch of slide movement in the downstroke to be intrinsically nonhazardous, and setting the brake monitor used with Type B gates to shut down the press at this point is recommended.

If a Type B gate is allowed to be opened during the downstroke before the closing motion ceases, protection from after-reach will depend on stop time, hand reach time, and an associated safety distance. Thus, the system must incorporate a brake monitor which is set to preclude further operation whenever stop time increase makes the safety distance inadequate.

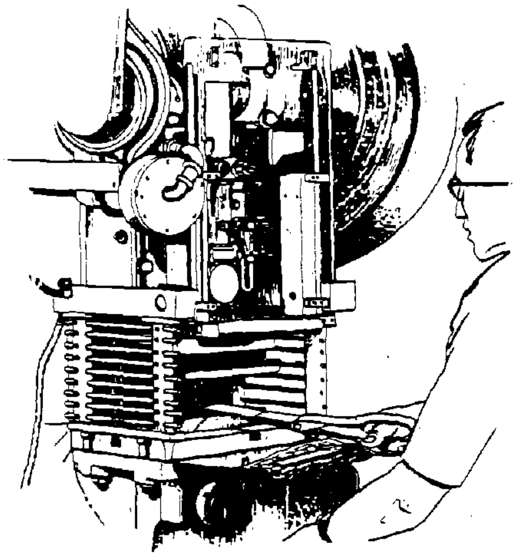
Like all barriers, gates obstruct worker visibility into the die. This is especially important in semiautomatic and primary operations where the worker is feeding strip from outside the enclosure, and the gate may stay closed for several strokes while the worker watches the die. The recently developed strong, transparent, scratch-resistant acrylic and polycarbonate materials are employed for the movable barrier almost exclusively by commercial manufacturers, and provide moderate visibility for all but a very few press operations.

Gates have an adverse effect on the productivity of hand fed operations because they increase the time needed to produce each part, compared to other safeguarding systems. The additional time is necessary to operate the gate. Once the part has been fed, the worker must remove his hands from the die as far as the movable barrier's path. Next, the gate must close before the press will trip.

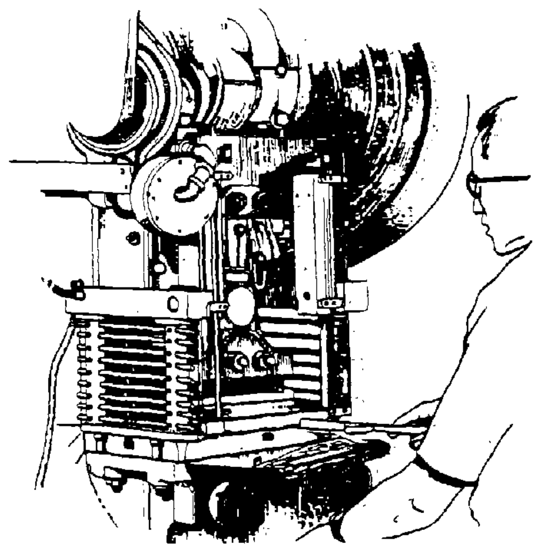
Whether a Type A or B gate operation is used, the worker must wait for the gate to open before he can unload or load again. For Type A, he must, in addition, wait until the end of the upstroke, and wait for the press to stop, before the gate begins to open.

The press user may have an incentive to modify the gate's operation to shorten these times. Shorter times can be achieved in two areas. First, the speed of the barrier's movement can be increased. Second, a user can modify a Type A gate to operate like a Type B gate. This is a common practice, since commercially built gates are usually Type A. Potential loss of safety from this practice is high. Protection from press repeats is lost when the clutch is of positive or full revolution design. If the clutch is a friction type the probable failure of the user to include a brake monitor presents another serious hazard.

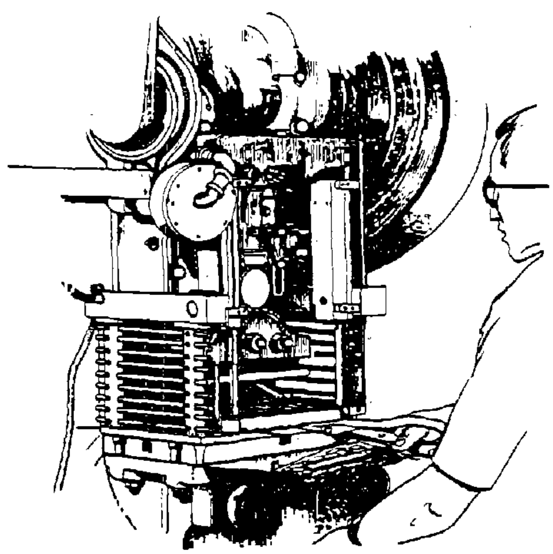
Like all barrier safeguarding systems, gates create incentives to sabotage or modify their shapes for the particular workpiece being processed. Management must, of course, exert efforts to reduce the possibility of alteration and sabotage through disciplinary action and periodic inspection.



View 1. - The gate is open and the workpiece is inserted into the point of operation.

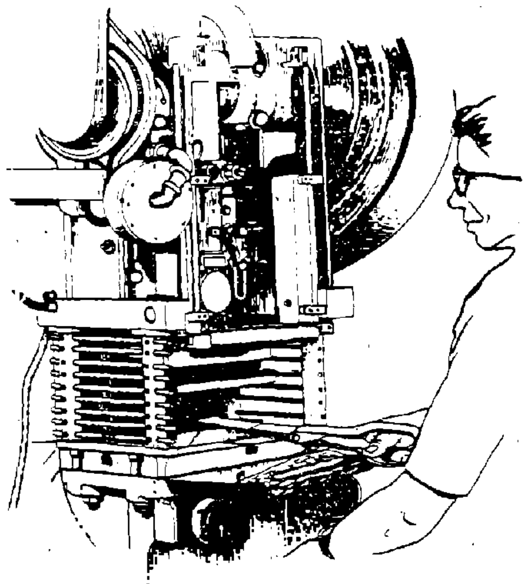


View 2. - The gate closes and then the slide comes down.

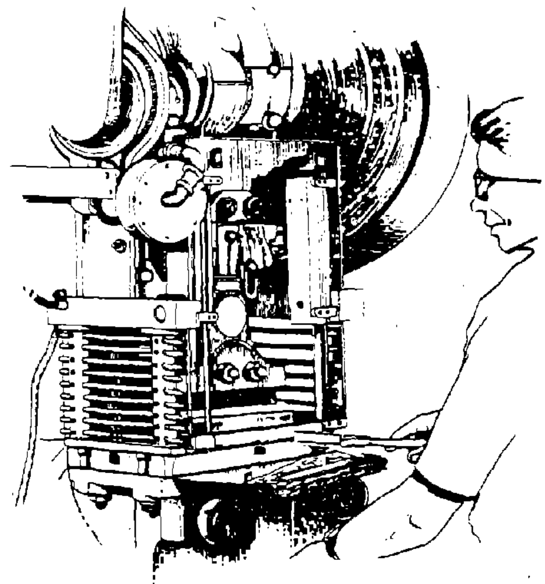


View 3. - The gate remains closed until slide motion ceases.

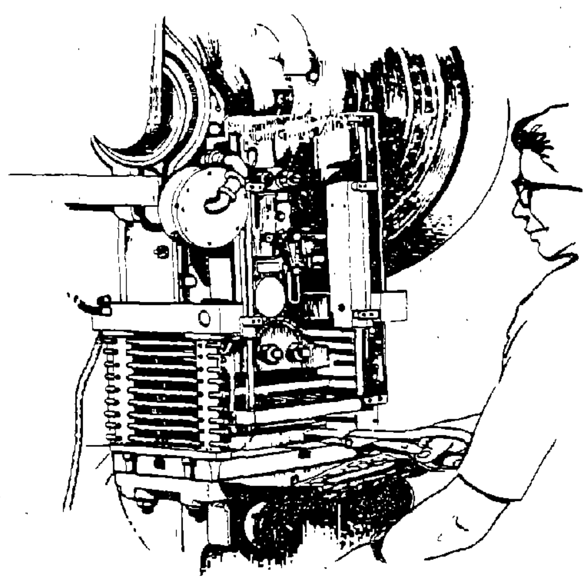
Figure 10. - A Type A gate.



View 1. - The gate is open and the workpiece is inserted into the point of operation.



View 2. - The gate closes and then the slide comes down.



View 3. - The gate raises when the slide raises.

Figure 11. - A Type B gate.

TYPE A GATE SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a Type A gate safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Have a gate or movable barrier that locks closed before stroke initiation and remains locked until the ram has come to rest?

___ ___ 3. Have all openings in, around, and between the gate so small that no worker can reach into the point of operation, and have a proper opening between the closing edge of the gate and the bolster by the requirements of Table 2?

___ ___ 4. Have supplemental barriers to enclose the point of operation where needed?

___ ___ 5. Have all supplemental barriers interlocked or permanently attached?

___ ___ 6. Eliminate all shearing and pinching hazards between the gate, or supplemental barriers, and the slide and dies?

___ ___ 7. Have a gate mechanism that minimizes operator exertion?

___ ___ 8. Have a means of eliminating the gate mechanism hazard to the operator?

___ ___ 9. Move the gate quickly?

___ ___ 10. Have a mechanism which, when the system is removed from its position, either precludes tripping or automatically selects another safeguarding system?

___ ___ 11. Have "dependable" design?

___ ___ 12. Have an additional safeguarding means for protection during die setting and maintenance procedures?

___ ___ 13. Have a safety training program instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and operation of adjustment fully understand all the above design requirements?

Yes No

___ ___14. Have a daily inspection, records, and supervisory controls on each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

TYPE B GATE SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a Type B gate safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Have a part revolution friction clutch?

___ ___ 3. a. Have interlocks which prevent tripping unless the gate is closed, have locks to prevent opening the gate whenever the slide is in motion, and have a brake monitor to prevent further operation when slide top stop overrun exceeds 1/4 inch? or,

b. Have interlocks both to prevent tripping the clutch unless the gate is closed and to disengage the clutch and apply the brake whenever the gate is opened while the slide is in motion, have a safety distance equal to the system stop time (in seconds) times 63 inches/second, between the nearest point of operation hazard and the gate, and have a brake monitor to prevent further strokes whenever stopping performance has exceeded the system stop time used in setting the safety distance?

___ ___ 4. Have all openings in, around, and between the gate so small that no worker can reach into the point of operation, and have a proper opening between the closing edge of the gate and bolster by the requirements of Table 2?

___ ___ 5. Have supplemental barriers to enclose the point of operation where needed?

___ ___ 6. Have the supplemental barriers interlocked or permanently attached?

___ ___ 7. Eliminate all shearing and pinching hazards between the gate, or supplemental barriers, and the slide and dies?

___ ___ 8. Have a gate mechanism that minimizes worker's exertion?

___ ___ 9. Have a means of eliminating the gate mechanism hazard to workers?

___ ___ 10. Move the gate quickly?

Yes No

___ ___11. Have a mechanism which, when the system is removed from its position for die setting and maintenance, either precludes tripping the clutch or automatically selects another safeguarding system?

___ ___12. Have "dependable" design?

___ ___13. Have additional safeguarding means for protection during die setting and maintenance procedures?

___ ___14. Have a safety training program instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and operation fully understand all the above design requirements?

___ ___15. Have daily inspections, records, and supervisory controls on each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR TYPE A GATE OR MOVABLE BARRIER SAFEGUARDING SYSTEMS

This safety inspection checklist for Type A gate or movable barrier safeguarding systems is a sample that includes the information that must be recorded:

1. At the start of each shift.
2. When the gate or movable barrier, or supplemental guarding , is removed and then reinstalled.
3. When any repair work is performed on the gate or movable barrier, or supplemental guarding.
4. When the gate or movable barrier, or supplemental guarding, is modified.
5. When a gate or movable barrier related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Does the gate or movable barrier, or supplemental guarding (if not transparent), need a new coat of flat black paint?

___ ___ 2. Does the safeguarding system have any hazards in itself such as sharp corners, pinch points, rough edges, shear points, or other injury sources?

___ ___ 3. Has the gate or movable barrier, or supplemental barrier, been sabotaged or otherwise rendered ineffective?

If the answer to any question 1 through 3 is "Yes", corrective action must be taken.

___ ___ 4. Is the gate or movable barrier, and supplemental guarding, interlocked or permanently attached?

___ ___ 5. Are the interlocks performing properly?

___ ___ 6. If any part of the gate or movable barrier is transparent, is it free of scratches, grease, oil, dirt, or any other material that reduces visibility?

___ ___ 7. Does the supplemental guarding prevent a worker from reaching through, over, under, or around the guarding into the point of operation?

___ ___ 8. Does the gate function in such a manner as to prevent a worker from reaching into the point of operation during the downstroke and the upstroke?

___ ___ 9. Does the gate lock closed before stroke initiation and remain locked until the slide has come to rest?

Yes No

___ ___10. Are additional safeguarding means available for protection during die setting and maintenance?

___ ___11. Are all openings in, around, and between the gate so small that no worker can reach into the point of operation, and is the opening between the closing edge of the gate and the bolster in compliance with the requirements of Table 2?

If the answer to any question 4 through 11 is "No", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state):__________________

____
____
____
____
____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___gate or movable barrier, or supplemental guarding removed and reinstalled
___gate or movable barrier, or supplemental guarding repaired
___gate or movable barrier, or supplemental guarding modified
___adjustable supplemental guarding adjusted
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g)

Signature:________________________
Title:____________________________
Date:_____________________________
Shift:____________________________
Time:_____________________________
Machine No.:_______________________
Serial No.:________________________

SAFETY INSPECTION CHECKLIST FOR TYPE B GATE OR MOVABLE BARRIER SAFEGUARDING SYSTEMS

This safety inspection checklist for Type B gate or movable barrier safeguarding systems is a sample that includes the information that must be recorded:

1. At the start of each shift.
2. When the gate or movable barrier, or supplemental guarding, is removed and then reinstalled.
3. When any repair work is performed on the gate or movable barrier, or supplemental guarding.
4. When the gate or movable barrier, or supplemental guarding, is modified.
5. When a gate or movable barrier related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Does the gate or movable barrier, or supplemental guarding (if not transparent), need a new coat of flat black paint?

___ ___ 2. Does the safeguarding system have any hazards in itself such as sharp corners, pinch points, rough edges, shear points, or other injury sources?

___ ___ 3. Has the gate or movable barrier, or supplemental barrier, been sabotaged or otherwise rendered ineffective?

If the answer to any question 1 through 3 is "Yes", corrective action must be taken.

___ ___ 4. Is the gate or movable barrier, and supplemental guarding, interlocked or permanently attached?

___ ___ 5. Are the interlocks performing properly?

___ ___ 6. If any part of the gate or movable barrier is transparent, is it free of scratches, grease, oil, dirt, or any other material that reduces visibility?

___ ___ 7. Does the supplemental guarding prevent a worker from reaching through, over, under, or around the guarding into the point of operation?

___ ___ 8. Does the gate function in such a manner as to prevent a worker from reaching into the point of operation during the downstroke?

___ ___ 9. Are additional safeguarding means available for protection during die setting and maintenance?

Yes No

___ ___10. Are all openings in, around, and between the gate so small that no worker can reach into the point of operation, and is the opening between the closing edge of the gate and bolster in compliance with the requirements of Table 2?

If the answer to any question 4 through 10 is "No", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state):_______

____

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___gate or movable barrier, or supplemental guarding removed and reinstalled
___gate or movable barrier, or supplemental guarding repaired
___gate or movable barrier, or supplemental guarding modified
___adjustable supplemental guarding adjusted
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature:________________________
Title:____________________________
Date:_____________________________
Shift:____________________________
Time:_____________________________
Machine No.:______________________
Serial No.:_______________________

PULLOUT SAFEGUARDING SYSTEMS

1. DESCRIPTION OF PULLOUTS

Pullouts (Figures 12, 13, and 14) can protect operators and helpers from the hazards of the point of operation. They do not protect passersby and are impractical for die setters and maintenance men. Some other safeguarding means must be used to protect these persons.

A pullout device is a mechanism that is attached to one or both of the press operator's hands on one end and to the press slide or upper die on the other. It is designed, when properly adjusted, to withdraw the operator's hand(s) as the dies close if the operator's hand(s) are inadvertently within the point of operation. When only one pullout is used, the operator's free hand must be protected by another safeguard.

2. USE OF PULLOUTS

Pullout safeguarding systems can be used on almost any mechanical power press. They generally cannot be used on presses with less than a 2-inch stroke or speed greater than 75 strokes per minute. It is recommended that pullout safeguarding systems utilize a hand actuator for each protected hand to initiate every stroke of the press. Refer to Tables 3 and 4 for more detailed information as to the use of pullouts.

3. INSTALLATION OF PULLOUTS

Pullouts must be securely attached to the slide or upper die of the press on one end and to the operator's hands on the other. As the slide descends, its vertical motion must be multiplied by the pullout and applied in a lateral direction to the operator's hands, withdrawing the hands if they are in the point of operation.

The hand attachments must be flexible enough to allow the operator to feed parts or manipulate stock in the die and must be clearly marked as to left and right hand. The length of the attachments must be flexible enough to accommodate the geometry of different hands, workpieces, dies, and feeding tools.

The pullouts must not be capable of injuring the worker by pulling him too far or too fast. They must pull no further than 16 inches nor any faster than 28 inches per second.

When pullouts are used as the safeguarding means, an additional safeguarding means must be used to protect other workers from the point of operation.

Pullouts must be so installed that they present, in themselves, no hazards to workers.

4. MAINTENANCE OF PULLOUTS

Pullouts should be inspected for proper adjustment, general condition, wear and tear, and proper anchoring when operators are changed, when the pullouts have not been used for 1 day or more, when a new pullout is installed, when a pullout-related accident occurs, and when a new press is placed in service that will use pullouts as the safeguarding means. Work, frayed, or damaged pullouts must be repaired or taken out of service immediately. When there is any doubt as to whether or not they can be safely repaired, they must be taken out of service. Many pullouts have gear shafts, gear racks, cable pulleys, etc. that require lubrication. Refer to the manufacturer's literature for lubrication recommendations.

Records of inspection, maintenance, and replacement must be kept. The "Safety Inspection Checklist for Pullout Safeguarding Systems", shown at the end of this discussion, can be used for such records. The "Pullout Safeguarding System Installation Checklist", also shown at the end of this discussion, should be completed when a pullout safeguarding system is installed.

5. ADVANTAGES AND DISADVANTAGES OF PULLOUTS

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4, will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Pullouts

1. Low initial cost is involved.

2. Pullouts are relatively easy to install.

3. Pullouts provide protection in the event of a repeat stroke, intended stroke, unintended stroke, uninitiated stroke, and delayed stroke.

4. Pullouts are mechanically simple.

5. If properly worn and adjusted, pullouts prevent the worker from after-reaching into the point of operation.

B. Disadvantages of Pullouts

1. Pullouts require unusually good maintenance.

2. Pullouts require frequent critical adjustment.

3. Pullouts require frequent inspection.

4. Movement of the operator is limited.

5. Operator may feel "chained to the press", and the "jerkback" action can be a source of irritation.

6. Work space around operator may be obstructed.

7. The operator cannot quickly extricate himself in the event of an emergency.

8. The operator's hand can become entangled in the die, causing injury when the dies close.

9. Pullouts can generally be used only on presses with at least a 2-inch stroke and a speed of less than 75 strokes per minute.

10. Pullouts create incentives for non-use and sabotage.

11. If not properly worn and adjusted, pullouts can allow the worker to after-reach into the point of operation.

12. If not replaced at reasonable intervals, they can break, leaving the worker with no protection.

13. They must not be used where the hand pullout distance exceeds 16 inches or the pullout speed exceeds 28 inches per second.

6. ADJUSTMENT OF PULLOUTS

Adjustment procedures for pullouts vary from manufacturer to manufacturer. Follow the manufacturer's recommendations when adjusting. It is most important that, after adjustment, the operator's hands will be completely withdrawn from any pinch point within the point of operation during the downstroke of the slide.

7. SAFETY CONSIDERATIONS

Pullouts are widely used in the United States. The low initial cost and simple mechanical nature of these devices make them readily adaptable to the large number of older power presses that are currently in use. Unfortunately, the very reasons for their widespread use also include shortcoming that cause injuries.

Improper adjustment is a major cause of injury on presses equipped with pullouts. It is of utmost importance that these devices be properly adjusted to suit the operation and fit the operator involved. Where these devices are used, management must dictate and enforce checks of their adjustment. Even if the pullout device is properly adjusted, the operator may inadvertently fail to wear it.

In addition to the operator failing to wear the device through neglect or forgetfulness, he may deliberately decide not to wear it. This is largely due to the nature of the devices and ergonomic considerations. Many operators have voiced the complaint of feeling "chained to the machine". Many operators have also complained that the devices "hurt me" or "are uncomfortable". These statements often appear in accident reports as the reason for removing or not wearing the device. The operator resists having his movements constrained and having forces exerted on his body over which he has no control. The pulling action must be slow enough so as not to injure the operator and this may limit the speed of production. To a worker being paid on a piecework basis, this can be irritating. All of these reasons may induce operators not to wear the pullout or deliberately sabotage it to make their work easier, more pleasant, or more economically rewarding.

Another hazard created by pullouts is the possibility that the hand attachments can become entangled in the die where the press is not tripped by hand. If this happens when the operator is engaged in a work cycle, he might be injured when the pullout exerts its pulling force on his stuck hand and forcibly removes it despite the resistance of the hand attachments, or the pullout and its supporting structure will be damaged. In the latter case, his hand will probably remain in the die and be injured when the dies close. To avoid this injury, it is strongly recommended that the pullout and die be of such design that the possibility of die entanglement is eliminated, and that the "catch points" in the point of operation be eliminated wherever possible.

In addition to the injuries caused by die entanglement, sabotage, improper adjustment, and failure to wear the devices, some injuries are caused by device failure. Because pullouts are subject to wear and tear, they will eventually fail. Since the operator is accustomed to having his hands pulled out of the point of operation, when the devices fail the operator may let his hand remain in the hazard area without thinking. Therefore, when the devices are checked for proper adjustment, they also must be thoroughly inspected for wear and tear and general condition. Any necessary repairs or maintenance must be performed before the devices are used. A record of repairs, maintenance, and replacement must be kept.

Even if the operator does not rely on the devices to protect him and thus avoids injury at the time of failure, the lack of monitoring in the design of pullouts will allow the press to continue to operate, even though effective safeguarding of the operator no longer exists. Thus he may continue to operate the press without any safeguarding, may not even realize that he is no longer safeguarded, and an injury will almost certainly result.

Since pullouts have safety shortcomings which can be overcome only by constant human supervision and also have inherent ergonomic shortcomings, careful consideration must be given before selecting them as the sole point of operation safeguarding for mechanical power presses. They have been successfully used in combination with other safeguards such as the two-hand actuator. When pullouts are used, the following rules apply:

1. They must be inspected and checked for proper adjustment when operators are changed, when dies are changed, when the pullouts have gone without use for a period of 1 day or more, when a pullout is repaired or serviced, and when a pullout-related accident occurs. The adjustment must ensure that the pullout will withdraw the operator's hands from the point of operation before the dies close.

2. At each inspection they should be checked for general condition and any necessary maintenance or repair be performed before they are used.

3. Records of inspection, maintenance, and repair must be kept.

4. Pullouts must have a maximum withdrawal of 16 inches and have a maximum withdrawal rate of 28 inches per second.

5. Pullouts must be connected to and operated only by the press slide or upper die.

6. Where pullout devices are the only safeguarding means provided, separate pullouts must be provided for each operator if more than one operator is used on a press.

7. An actuating control should be used that will assure that the operator's hands are out of the point of operation when the press is activated. An example of a control that will provide such assurance is properly located two-hand actuators, used in conjunction with the pullout.

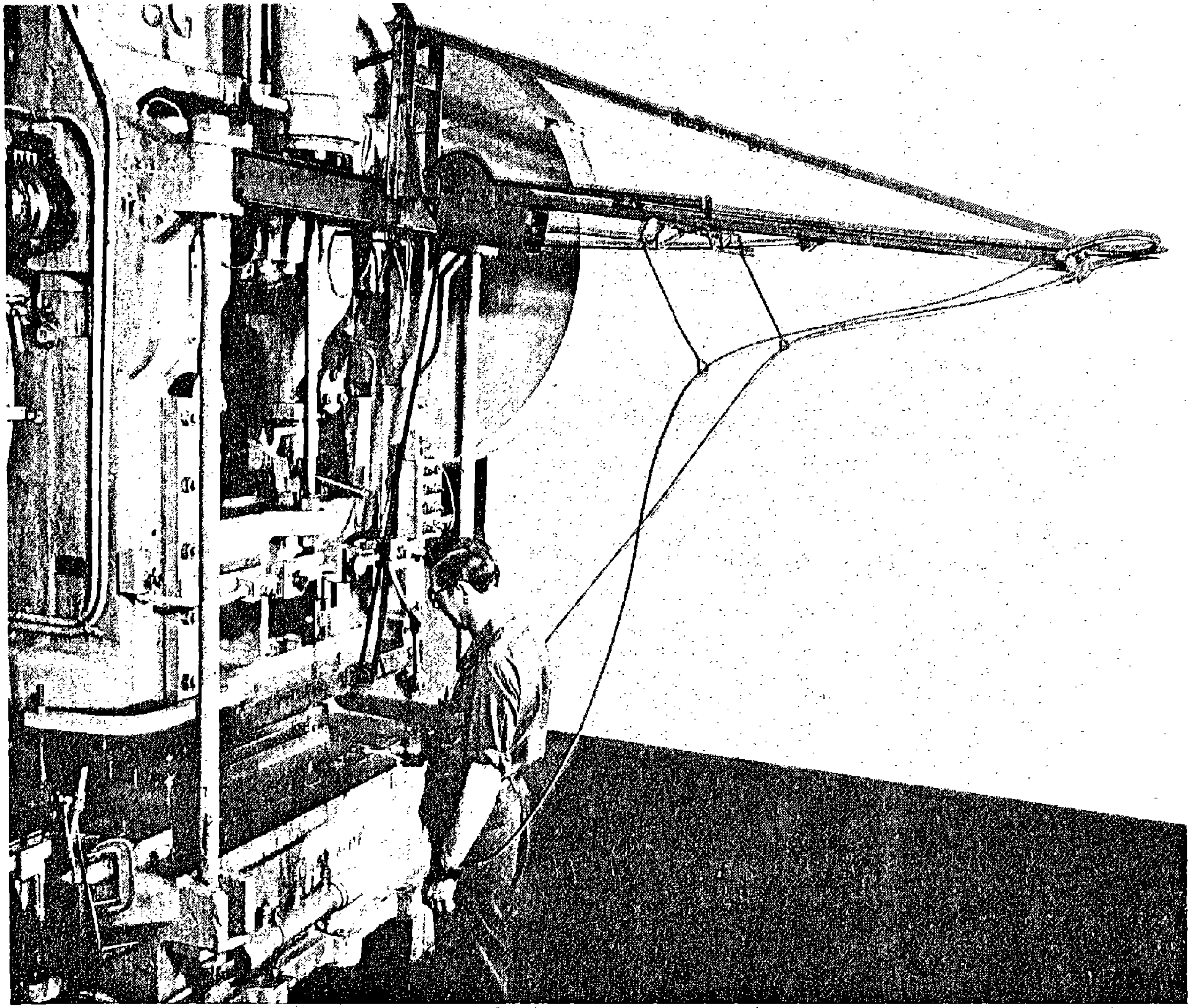


Figure 12. - Commercially available pullouts.

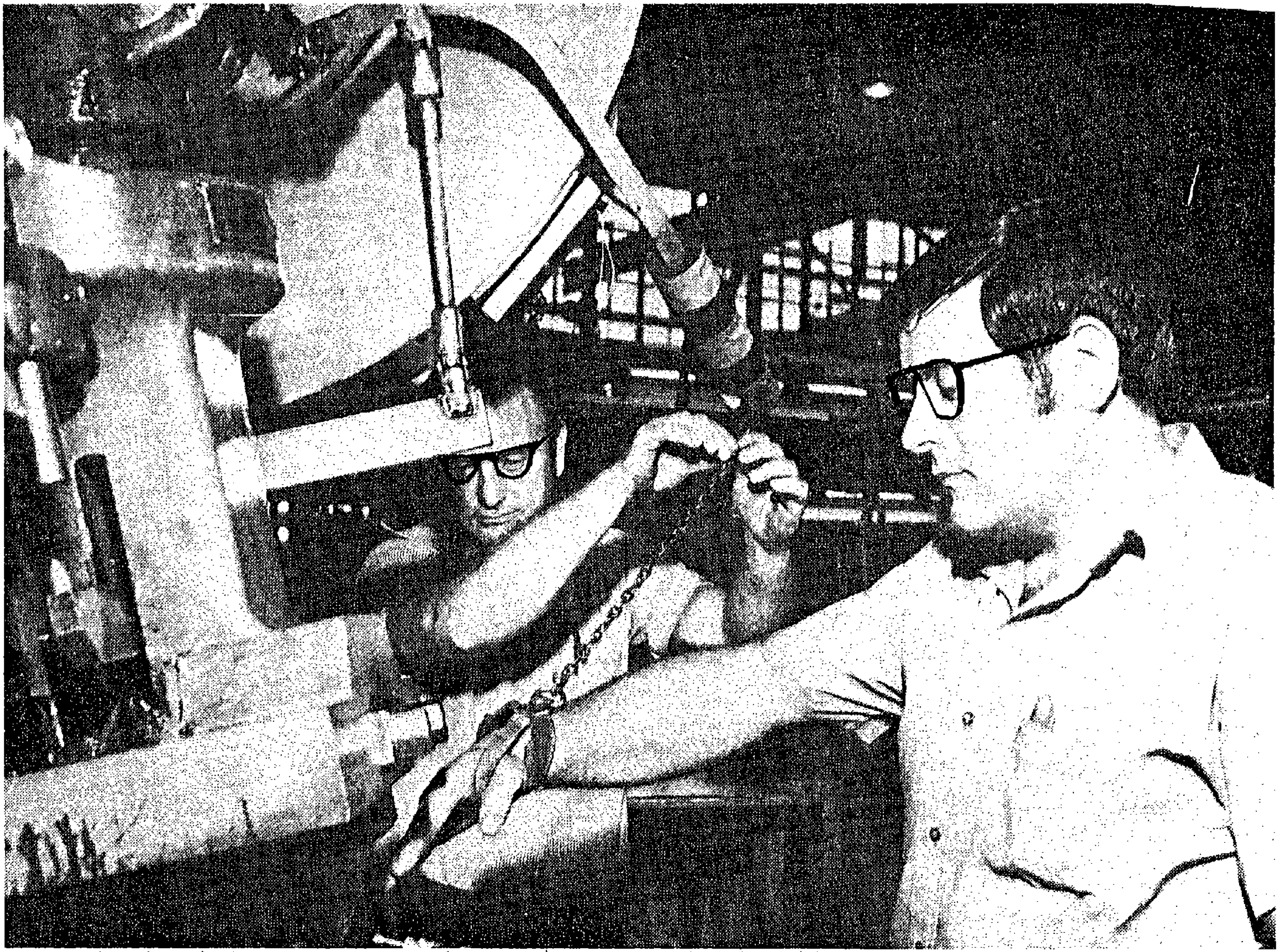


Figure 13. - A custom made pullout being adjusted.

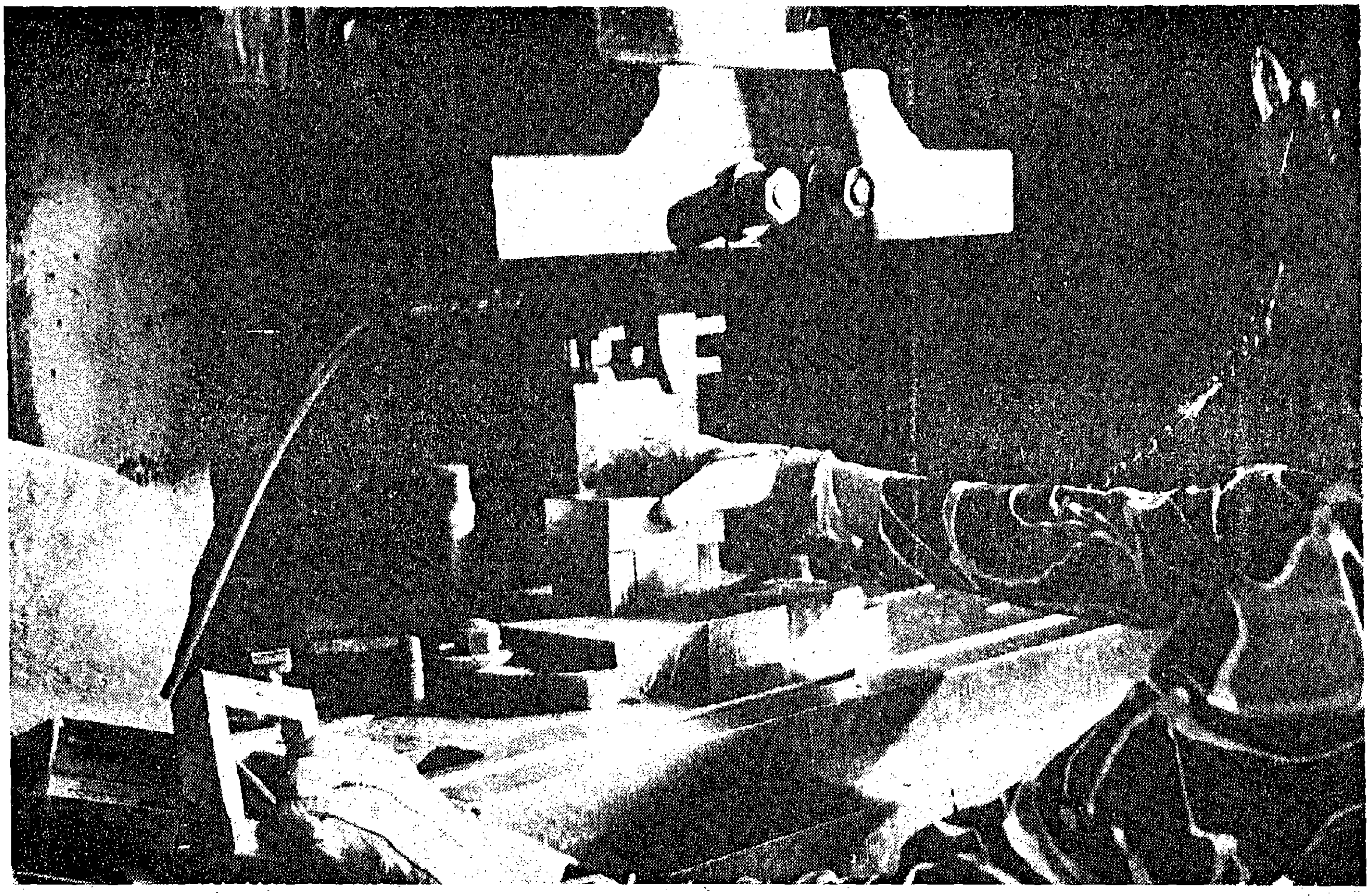


Figure 14. - A pullout allowing the worker's hand to enter the point of operation when the slide is in the raised position.

PULLOUT SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a pullout safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Operate directly by the slide?

___ ___ 3. Have the capability of withdrawing the worker's hands from point of operation hazards?

___ ___ 4. Have a maximum withdrawal of 16 inches or less?

___ ___ 5. Have a maximum withdrawal rate of 28 inches per second or less?

___ ___ 6. Have ruggedly designed mechanisms, cables, and hand attachments to withstand daily pressroom use?

___ ___ 7. Have hand attachments designed to minimize the possibility of falling off?

___ ___ 8. Have hand attachments clearly marked for right and left hands?

___ ___ 9. Have tripping mechanisms that must be actuated concurrently by both hands?

___ ___ 10. Have a separate safeguarding system that protects workers during die setting and maintenance?

11. Have a training program to thoroughly inform:

___ ___ a. Die designers to eliminate protrusions from the dies?

___ ___ b. Supervisors on daily requirements for recording inspections, adjustments, and maintenance?

___ ___ c. Workers on daily requirements for safety?

___ ___ 12. Have a set of inspection and adjustment procedures?

___ ___ 13. Have a set of records to record all inspections, adjustments, and maintenance on the system?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR PULLOUT(S) SAFEGUARDING SYSTEMS

This safety inspection checklist is a sample that includes the information that must be recorded:

1. When operators or helpers are changed.
2. When dies are changed.
3. When the pullouts have gone without use for a period of 1 day or more.
4. When pullouts are repaired or serviced.
5. When a pullout related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Is the system adjusted to withdraw the worker's hands before a hazard is created in the point of operation?

___ ___ 2. Are the pullouts operated directly by the slide?

___ ___ 3. Is the withdrawal of the pullouts limited to a maximum of 16 inches by system design?

___ ___ 4. Is the rate at which the pullouts can withdraw the hands limited to a maximum of 28 inches per second by system design?

___ ___ 5. Are the pullouts designed to minimize the possbility of detachment?

___ ___ 6. Is each hand attachment clearly marked for the hand for which it is intended to preclude worker injuries caused by placing hands in the wrong pullouts?

___ ___ 7. Are there tripping mechanisms that must be actuated concurrently by both hands?

___ ___ 8. Is there a safeguarding system that protects workers during die setting and maintenance?

___ ___ 9. Has the training program thoroughly informed:

   a. Die designers to eliminate protrusions from the dies?

   b. Supervisors on daily requirements for recording inspections, adjustments, and maintenance?

   c. Workers on daily requirements for safety?

___ ___ 10. Is the pullout mechanism firmly anchored?

If the answer to any question 1 through 10 is "No", corrective action must be taken.

Yes No

___ ___11. Are the pullout mechanism, cables, hand attachments, and other hardware broken, worn, or frayed?

___ ___12. Have the pullouts been sabotaged or otherwise rendered unsafe or ineffective?

___ ___13. Does the pullout action create any shearing, pinching, or impact hazard for any employee?

___ ___14. Does the safeguarding system in any way create a hazard in itself?

If the answer to any question 11 through 14 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state):________________
____
____
____
____

Reason(s) for safety inspection. Check appropriate item(s):

___operator or helper change
___die change
___pullouts out of service for 1 day or more
___pullouts repaired or serviced
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature:____________________
Title:____________________
Date:____________________
Shift:____________________
Time:____________________
Machine No.:____________________
Serial No.:____________________

RESTRAINT SAFEGUARDING SYSTEMS

1. DESCRIPTION OF RESTRAINTS

Restraints (Figure 15) can protect operators and helpers from the hazards of the point of operation. They do not protect die setters, maintenance men, and passersby. Some other means of safeguarding must be used to protect these persons.

A restraint device is a mechanism that is attached to one or both of the operator's hands one one end and firmly anchored on the other. When anchored and adjusted it prevents the operator's hands from entering the point of operation. When only one restraint is used, the operator's free hand must be protected by another safeguard.

2. USE OF RESTRAINTS

Restraints can be used on any mechanical power press, but are generally not practical for use with automatic feed presses. Refer to Tables 3 and 4 for more detailed information as to the use of restraints.

3. INSTALLATION OF RESTRAINTS

Restraints must be securely anchored to a rigid supporting structure on one end and securely attached to the operator's hands on the other end to prevent his hands from ever entering the point of operation.

The hand attachments must be flexible enough to accommodate the geometry of different hands, workpieces, dies, and feeding tools.

Restraints must be so installed that they present no hazards in themselves.

4. MAINTENANCE OF RESTRAINTS

Restraints should be inspected for proper adjustment, general condition, wear and tear, and proper anchoring at the start of each shift, when the die is changed, when operators are changed, when the restraints have not been used for 1 day or more, and when a restraint-related accident occurs. Worn, frayed, or damaged restraints must be repaired or taken out of service immediately. When there is any doubt as to whether or not they can be safely repaired, they must be taken out of service. Records of inspection, maintenance, and replacement must be kept. The "Safety Inspection Checklist for Restraint Safeguarding Systems", shown at the end of this discussion, can be used for such records. The "Restraint Safeguarding System Installation Checklist", also shown at the end of this discussion, should be completed when a restraint safeguarding system is installed.

5. ADVANTAGES AND DISADVANTAGES OF RESTRAINTS

The following list of advantages and disadvantages, used in conjunction with the Tables 3 and 4, will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Restraints

1. Low initial cost is involved.
2. Restraints are relatively easy to install.
3. Restraints are mechanically simple.
4. If properly worn and adjusted, restraints prevent the operator from after-reaching into the point of operation.
5. Provide protection in the event of an uninitiated stroke, repeat stroke, delayed stroke, unintended stroke, and intended stroke.

B. Disadvantages of Restraints

1. Restraints require unusually good maintenance.
2. Restraints require critical adjustment.
3. Restraints require frequent inspection.
4. Movement of operator is limited.
5. Operator may feel "chained to the press".
6. Work space around operator may be obstructed.
7. The operator cannot quickly extricate himself in the event of an emergency.
8. Restraints create incentives for non-use and sabotage.
9. If not properly worn and adjusted, restraints can allow operator to reach into the point of operation without any safeguarding.
10. If not replaced at reasonable intervals, they can break, leaving the operator with no protection.

6. ADJUSTMENT OF RESTRAINTS

Adjustment procedures for restraints vary from manufacturer to manufacturer. Follow the manufacturer's recommendations when adjusting. It is most important that, after adjustment, the operator's outstretched fingers cannot possibly reach the danger area.

7. SAFETY CONSIDERATIONS

The low initial cost and simple mechanical nature of restraints make them readily adaptable to the large number of older and inexpensive power presses that are currently in use. Unfortunately, the very reasons for their use also include shortcomings that cause injuries.

Improper adjustment is a major cause of injury on presses equipped with restraints. It is of utmost importance that these devices be properly adjusted to suit the operation and fit the operator involved. Where these devices are used, management must dictate and enforce checks of their adjustment.

Even if the restraint is properly adjusted, the operator may inadvertently fail to wear it. In addition to the operator failing to wear the device through neglect or forgetfulness, he may deliberately decide not to wear it. This is largely due to the nature of the devices and ergonomic considerations. Many operators have voiced the complaint of feeling "chained to the machine". Many operators have also complained that the devices "are uncomfortable". This statement often appears in accident reports as the reason for removing or not wearing the device. The operator also resists have his movements constrained. All of these reasons may induce workers not to wear the restraint or deliberately sabotage it to make their work easier or more pleasant.

In addition to the injuries caused by sabotage, improper adjustment, and failure to wear the devices, some injuries are caused by device failure. Because restraints are subject to wear and tear, they will eventually fail. Since the operator is accustomed to having his hands prevented from entering the point of operation, when the devices fail the operator may reach into the hazard area without thinking. Therefore, when the devices are checked for proper adjustment, they also must be thoroughly inspected for wear and tear and general condition. Any necessary repairs or maintenance must be performed before the devices are used. A record of repairs, maintenance, and replacement must be kept.

Even if the operator does not rely on the devices to protect him and thus avoids injury at the time of failure, the lack of monitoring in the design of restraints will allow the press to continue to operate, even though effective safeguarding of the operator no longer exists. Thus he may continue operate the press without any safeguarding, may not even realize that he is no longer safeguarded, and an injury will almost certainly result.

Since restraint devices have safety shortcomings which can be overcome only by constant human supervision and also have inherent ergonomic shortcomings, careful consideration must be given before selecting them as the sole point of operation safeguarding for mechanical power presses.

When restraints are used, the following rules apply:

1. The restraints must be inspected and checked for proper adjustment at the start of a shift, when operators are changed, when the die is changed, when out of service for one day or more, when a restraint is repaired or serviced, and when a restraint-related accident occurs. The adjustment must ensure that the restraint will prevent the operator from reaching into the point of operation.

2. At each inspection the restraints must be checked for general condition and any necessary maintenance or repair be performed before they are used.

3. Records of inspections, maintenance, and repair must be kept.

4. Where restraint devices are the only safeguarding means provided, separate restraints must be provided for each operator if more than one operator is used on a press.

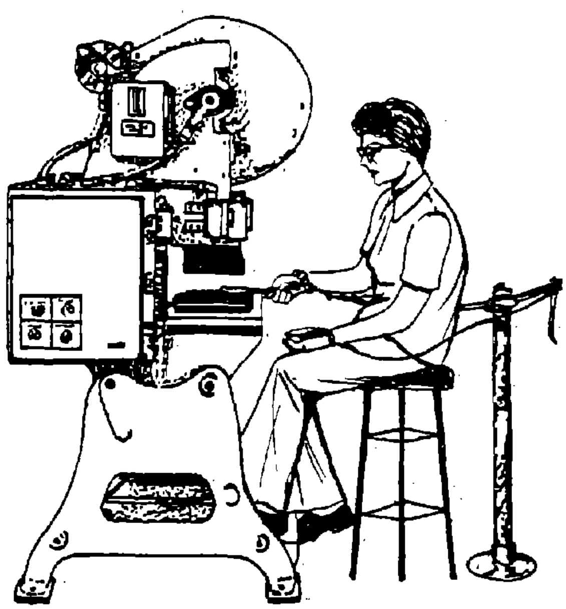


Figure 15. - An example of a restraint.

RESTRAINT SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a restraint safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Have the capability to prevent the worker from reaching into the point of operation?

___ ___ 3. Have hand attachments that minimize the possibility of detachment?

___ ___ 4. Have the restraining mechanisms securely anchored?

___ ___ 5. Have a separate safeguarding system to protect during die setting and maintenance?

___ ___ 6. Have a training program to thoroughly inform all personnel as to the safety requirements and the necessity for adjustment and inspections?

___ ___ 7. Have a training program to adequately inform those workers who are to be protected of the need to use the system, and proper operation of the system, and to instruct them to never operate the press when there is anything wrong with the system?

___ ___ 8. Have a set of inspection and adjustment procedures?

___ ___ 9. Have a set of records to record all inspections, adjustments, and maintenance on the system?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR RESTRAINT SAFEGUARDING SYSTEMS

This safety inspection checklist for restraint safeguarding systems is a sample that covers the information that must be recorded:

1. When operators or helpers are changed.
2. When dies are changed.
3. At the start of each shift.
4. When the restraints have gone without use for a period of 1 day or more.
5. When the restraints are repaired or serviced.
6. When a restraint-related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Is the system properly adjusted to prevent the worker from reaching into the point of operation any time during press operation?

___ ___ 2. Are the restraining hand attachments, cables, and other hardware securely attached in a fixed position and sufficiently rugged to withstand continued use without stretching or breakage?

___ ___ 3. Are the restraint hand attachments designed to minimize the possibility of detachment?

___ ___ 4. Is there a separate safeguarding system to protect workers during die setting and maintenance?

___ ___ 5. Has the training program adequately informed those workers who are to be protected of the need to use the system, and proper operation of the system, and instructed them to never operate the press when there is anything wrong with the system?

___ ___ 6. Are all workers responsible for die setting, maintenance, inspection, adjustment, and supervision thoroughly trained in the usage and maintenance requirements of the system?

If the answer to any question 1 through 6 is "No", corrective action must be taken.

___ ___ 7. Is either restraint broken, worn, or frayed?

Yes No

___ ___ 8. Has either restraint been sabotaged or otherwise rendered unsafe or ineffective?

___ ___ 9. Does the safeguarding system in any way create a hazard in itself?

If the answer to any question 7 through 9 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state): ____________________

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___operator or helper change
___die change
___restraints out of service for 1 day or more
___restraints repaired or serviced
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature: ____________________________
Title: ____________________________
Date: ____________________________
Shift: ____________________________
Time: ____________________________
Machine No.: ____________________________
Serial No.: ____________________________

TWO-HAND TRIP AND TWO-HAND CONTROL SAFEGUARDING SYSTEMS

1. DESCRIPTION OF TWO-HAND TRIP AND TWO-HAND CONTROL

Two-hand trips (Figure 16) can protect operators from the hazards of the point of operation. They do not protect die setters, maintenance men, helpers, and passersby. Some other means of safeguarding must be used to protect these persons.

A two-hand trip is a clutch actuating means that serves as a point of operation safeguard because it requires the simultaneous* application of each of the worker's hands (within 1/2-second of each other) to individual actuators located at such a safety distance from the point of operation that the slide completes its downward travel before the worker can reach into the point of operation. (When the worker releases one or both actuators, the slide continues movement until it has made a full cycle.) The actuators must also have such a separation distance or be so arranged that they cannot both be actuated by one hand or arm.

When used on a part revolution clutch press, two-hand controls (Figure 17) can protect operators, die setters, and maintenance men from the hazards of the point of operation. They do not protect passersby and helpers; therefore, some other means of safeguarding must be used for these persons.

A two-hand control is a clutch actuating means that serves as a point of operation safeguard because it requires the simultaneous* application of each of the worker's hands (within 1/2-second of each other) to individual actuators located at a safety distance (Figure 18) from the point of operation such that when the worker releases the actuator, the slide stops its downward motion before he can reach into the point of operation. (When the worker releases one or both actuators, the downward motion of the slide stops.) The actuators must also have such a separation distance (Figure 18) or be so arranged that they cannot both be operated by one hand or one arm (Figure 19).

2. USE OF TWO-HAND TRIP AND TWO-HAND CONTROL

The use of the two-hand trip as a safeguarding means is far more widespread on positive or full revolution clutch presses than on part revolution friction clutch presses. However, they are not recommended for use on positive or full revolution clutches because they provide no protection from repeat strokes. When two-hand trip systems are used the press must single stroke only. Also, because of the safety distance requirement, they are not practical for presses whose speed is less than 75 strokes per minute.

*Exceeds 29CFR 1910.217.

Two-hand control can be used as the safeguarding means on any part revolution friction clutch press. They cannot be used as the safeguarding means on positive or full revolution clutch presses. Refer to Tables 3 and 4 for more detailed information as to the use of two-hand control and two-hand trip.

3. INSTALLATION OF TWO-HAND TRIP AND TWO-HAND CONTROL

Two-hand trips and two-hand controls must be installed in such a manner so as not to cause undue operator fatigue. For example, they should not be located high over his head so that he has to stretch to reach them. They must be located such that both hands are required for activation. They must also be so located as to fulfill the safety distance requirement. (See "Setting Safety Distance".) When installing, provisions must be made against unintended operation. Two-hand trip and two-hand controls must be installed in position so that only a supervisor or safety engineer is capable of relocating the controls.

Two-hand trips and two-hand controls must be so installed that they in no way present a hazard in themselves. For example, they must not be mounted above the slide on an inclined press.

4. MAINTENANCE OF TWO-HAND TRIP AND TWO-HAND CONTROL

No scheduled maintenance is required that is attributable to the two-hand trip or two-hand control method of safeguarding the point of operation. If the system should operate improperly, it must be removed from service or be properly repaired before press operation is resumed. They should be inspected at the time intervals given on the "Safety Inspection Checklist for Two-Hand Trip Safeguarding Systems", and "Safety Inspection Checklist for Two-Hand Control Safeguarding Systems" shown at the end of this discussion. The "Two-Hand Trip Safeguarding System Installation Checklist" and the "Two-Hand Control Safeguarding System Installation Checklist", also shown at the end of this discussion, should be completed when a two-hand trip or two-hand control safeguarding system is installed.

5. ADVANTAGES AND DISADVANTAGES OF TWO-HAND TRIP AND TWO-HAND CONTROL

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4, will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Two-Hand Trip

1. Minimal maintenance is required.

2. There is no danger of after-reaching into the point of operation <u>if</u> the system is properly installed.

3. Moderate initial cost is involved.

4. The two-hand trip is simple to operate.

5. Movement of the operator is unrestricted.

6. The system is ergonomically acceptable if it is properly installed.

7. Work space around the operator is not obstructed if the system is properly installed.

8. There is little incentive to sabotage or circumvent the trip if it is properly installed.

B. Disadvantages of Two-Hand Trip

1. No protection from repeat, delayed, or uninitiated strokes is provided.

2. The system requires careful installation.

3. The two-hand trip system generally cannot be used on any press with a speed less than 75 strokes per minute because of the safety distance requirement.

4. The system can only be used on presses equipped with friction clutches.

C. Advantages of Two-Hand Control

1. Minimal maintenance is required.

2. There is no danger of after-reaching into the point of operation if the system is properly installed.

3. Moderate initial cost is involved.

4. The two-hand control is simple to operate.

5. Movement of the operator is unrestricted.

6. Work space around the operator is not obstructed if the system is properly installed.

7. There is no incentive to sabotage or circumvent the system if it is properly installed.

D. Disadvantages of Two-Hand Control

1. No protection from repeat, delayed, or uninitiated strokes is provided.

2. The system requires careful installation.

3. The system can only be used on presses equipped with a part revolution friction clutch.

6. SAFETY CONSIDERATIONS

Two-hand trips and two-hand controls provide point of operation safeguarding by monitoring the position of the worker's hands through the use of a separate interlocking mechanism or actuator for each of the worker's hands.

Two-hand trip systems operate as follows: the worker must apply each hand to a separate remote actuator, or the system will prevent the clutch from tripping. Once tripped, the press completes one stroke only regardless of whether the worker's hands remain on the actuators or not.

Two-hand control systems operate as follows: the worker must apply each hand separately to a remote actuator, or the system will prevent the clutch from tripping. If the worker releases either actuator during the hazard time of any downstroke, the system's interlocking circuits switch to a "stop" condition, disengage the clutch, engage the brake, and decelerate the slide to a standstill. Thus two-hand control systems can only be used on presses equipped with a clutch capable of being disengaged at any point in the stroke.

Both two-hand trip and two-hand control systems can be used to protect operators. A separate pair of actuators must be provided and used for every operator to be protected. Neither can be used to protect helpers, who must either be provided with a pair of actuators, and thus become operators, or be protected by another system. Two-hand trip systems cannot be used to protect die setters or maintenance workers since a two-hand trip system cannot interrupt the stroke as required for these operators. Two-hand control systems, however, can be used for most die setting and maintenance procedures. (When used for die setting, two-hand control is sometimes called two-hand "inch" control, and sometimes a different set of actuators is used for die setting than production.)

Both two-hand trip and two-hand control systems can be used with almost any type of job or feeding method, since they place restrictions only on the worker's hands, but they are generally impractical for use with automatic feeding, since they occupy the worker needlessly by requiring his presence at the actuators for every stroke of the press. When the workpiece must be supported by the worker as it is stamped, neither two-hand control nor two-hand trip systems can be used; often some combination of ONE-hand trip or ONE-hand control and another safeguarding system is used. Those jobs which require the worker to support the workpiece with both hands cannot be safeguarded by any form or combination of these systems.

Neither two-hand control nor two-hand trip safeguarding systems provide any protection from uninitiated strokes, repeat strokes, or delayed strokes, which occur often on positive clutch presses. With two-hand trip systems "anti-repeat" mechanisms are required on positive full revolution clutch presses to limit the press to one stroke for each time the clutch is tripped. Thus they prevent a repeat stroke from occurring if the worker fails to release his actuators during the upstroke. However, "anti-repeat" mechanisms cannot prevent repeat strokes which will occur when the clutch fails catastrophically. Thus neither system can be used alone on a positive clutch press.

If carefully designed, both two-hand trip and two-hand control systems can protect against unintended strokes. Their ability to do so depends on their ability to respond only to the application of one worker's two hands to the pair of actuators provided. The system must be designed not to respond to falling objects, dirt, filings, or any other worker's hands.

Two-hand trip systems protect against intended strokes and after-reach by making the distance the operator must reach so long that the slide completes the downstroke before he can get to the nearest point of operation hazard, even if he after-reaches immediately after he trips the press. This safety distance will vary from press to press, depending on the time necessary for the press to engage the clutch and then complete the downstroke. In order to make the safety distance short enough to be practical, the starting time and downstroking time of the press must be short. This generally limits the use of two-hand trip safeguarding systems to presses whose crankshaft speed is greater than 75 strokes per minute. (See "Setting Safety Distance".)

Two-hand trip safeguarding systems only provide after-reach protection for the first downstroke. The system must, therefore, incorporate a single-stroke feature that requires the worker to place his hands on the actuators again before the next stroke begins. If two-hand trip systems are provided on a press which has a "continuous" mode of operation (more than one stroke without a stop at the top) another safeguarding system must be provided for use whenever continuous mode is used.

Two-hand control safeguarding systems protect against intended strokes and after-reach by making the distance the operator must reach so long that the system can "stop" the downstroke before he can get to the nearest point of operation hazard. In order to make this safety distance short enough to be practical, the system's stop time must be short. This requires the use of a part revolution clutch which is capable of disengaging quickly and a brake which is capable of engaging quickly, and capable of decelerating the slide's speed to zero quickly (within a few tenths of a second). (See "Setting Safety Distance".)

Although two-hand control can be used to protect a worker when the press is in a "continuous" mode, other safeguarding systems, which do not tie up the worker's hands, are generally more practical. When continuous mode is provided on a press safeguarded by a two-hand control system, either the two-hand control system must be used throughout the continuous run, or another safeguarding system must be provided for use whenever continuous mode is used.

It has become common practice to place the actuators on a bracket above the slide. On an inclined press, such as an OBI, this placement forces the worker's body to be dangerously close to the point of operation, and creates the hazard of falling into the press due to imbalancing the worker.

System performance, in providing after-reach protection, relies on clutch and brake action in stopping, or starting and closing, the slide. Thus the design of both clutch and brake must be of the utmost reliability to minimize the probability of sudden failures. This means that positive clutches and band brakes are too unreliable to be used with these systems. Splined or tube type clutches or clutches which employ sleeve bearings and run on the crankshaft are highly undesirable system components. The brake must be set by multiple, guided, compression springs. Continued after-reach protection depends on these components. (See "Part Revolution Friction Clutch Safety Considerations".)

Eliminating the possibility of sudden failures is not enough. Friction designs have failure modes characterized by gradual loss of clutch or brake torque and increase in stop time and start time. Since there is only one clutch and one brake, redundancy cannot be applied. However, performance of two-hand control safeguarding systems can be assured through technical safety by inclusion of a brake monitor. A brake monitor is simply a system function which monitors the stopping performance of the clutch and brake and prevents initiation of a successive stroke if stop time becomes so long as to compromise after-reach performance.

Continued after-reach performance of two-hand trip safeguarding systems depends on the clutch action in starting and closing the slide, and the brake action in stopping the slide at the top of the single stroke.

Once again, monitoring of the appropriate actions is essential. Brake monitoring is needed to prevent further operation of the press when top stop overrun has increased to the point where the operator is endangered. (See "Setting Brake Monitors".)

*Clutch action must also be monitored, since wear or contamination of the friction linings will gradually increase starting time, and if this deterioration is allowed to continue, will eventually result in an insufficient safety distance and compromised after-reach protection. This situation can be prevented through either a starting monitor or a start-time monitor.

Since the brake monitors, starting monitors, and start-time monitors used with two-hand control and two-hand trip safeguarding systems are needed parts of the safeguarding system, they must be of "dependable" design.

*Since a worker may after-reach at any time, whether hands-in-die feeding is used or not, a brake monitor is always required whenever either of these safeguarding systems are used.

Adequate safety distance (and thus protection from after-reach) can be made independent of human behavior by mounting each actuator in a fixed position which provides adequate safety distance from the point of operation hazards of every die used in the press. Of course, the mounting position must be determined under the worst case conditions of largest die, forward-most pinch point, and maximum stopping time or starting time increase allowed by the brake monitor or start-time monitor.

Both two-hand trip and two-hand control systems, if not properly designed, are susceptible to inadvertent and deliberate circumvention. Careful design can eliminate the attendant risk of injury, but first the ergonomic factors involved must be evaluated.

One area where improvement must be made is in the requirement for concurrent action of the buttons. Such a requirement leaves the possibility of a button tie down for one stroke. This is just the type of action that a worker would take if he were encountering difficulty in producing a part which he thought a free hand in the die could help overcome. Further, incidents have been reported where a helper or passerby has contributed to an accident in which the operator was hurt. This occurs when such a helper or passerby leans against one of the buttons. If the operator then actuates the other button while one hand is still in the die, he will be injured.

*Exceeds 29CFR 1910.217.

A worker will soon realize that only one actuator is necessary to trip the press, and then he may attempt to "tie down" one of the two buttons in order to operate the press more easily with only the remaining button. Most existing designs incorporate an anti-tie-down function, which requires that each actuator must be released at the end of each cycle and then reactuated in order to trip the press and begin the next cycle. This is helpful, but not sufficient, because a worker can operate one actuator by means of his hip, his elbow, or a tool, and then operate the other with his hand, causing the press to trip while the remaining hand is free. This free hand can be used to hold the part in the point of operation, or some other equally dangerous task, thus circumventing the safeguarding provided by the two-hand control or two-hand trip system.

Operation with the hip and hand, or the elbow and hand of one arm, has long been recognized as a hazard of two-hand systems and present regulations require the use of "guard-rings" and "separation distances" (Figure 18) which are quite effective in making this kind of circumvention difficult, but are ergonomically undesireable. Also, these installations can be circumvented by means of tools, lashed up by the worker for this purpose.

*Thus it is required that "simultaneous" actuation (within 1/2-second) of the actuators be necessary to trip the press, and not "concurrent" actuation.

If multiple pairs of actuators are installed on a press for protection of multiple operators, the system must, of course, require simultaneous operation of buttons of each pair, but need require only concurrent operation among pairs, in order to trip the press, without danger of possible circumvention or inadvertent loss of function.

It must be noted that when a two-hand control system is used on a part revolution clutch press, and a stroke is interrupted by the worker releasing one of his actuators during the downstroke, the system must require him to release the other actuator, and depress both simultaneously in order to reinitiate the stroke. This is often referred to as interrupted stroke protection. Also, when two-hand control is used on a press in a "continuous" mode, the system must require the worker to release, and simultaneously re-depress his actuators once each stroke (during the upstroke) in order to prevent him from holding one down, or operating one with his hip, elbow, or a tool. This mode of operation is widely used in the U.S. auto industry and referred to as "on the hop" or "on the hump" mode of operation, depending on how much of the safeguarding system, besides the actuators, is operated once each stroke for the purpose of self-checking.

*Exceeds 29CFR 1910.217.

Even simultaneous actuation, however, does not eliminate the incentive for the worker to defeat the system. The need for him to remove both hands by the safety distance slows his production and adds fatigue to the job. In the case of two-hand control, the worker must, in addition, hold the actuators down throughout most of the downstroke, a further time-consuming irritation. Careful design can eliminate the point of operation injuries, but not fatigue and the incentive to sabotage.

Regulations presently require the equivalent of "dependable" design for the "control system" whenever a two-hand control system is used in conjunction with manual feeding, under the heading "control reliability . . . the control system shall be so constructed that a failure within the system does not prevent the NORMAL stopping action from being applied to the PRESS when required, but does prevent initiation of a successive stroke until the failure is corrected." (29CFR 1910.217(b)(13))(emphasis added).

Elsewhere, the regulations define, "control system means sensors, manual input and mode selection elements, interlocking and decision-making circuitry, and output elements to the press operating mechanism." (29CFR 1910.212 (d)(59)). This means the two-hand actuators (sensors), the press control (interlocking and decision-making circuitry), and the clutch and brake (output element to the press operating mechanism) must all be of "dependable" design. (See "'Dependable' Safeguarding System Design".)

Neither two-hand control nor two-hand trip systems obstruct the point of operation, and so die access for scrap clearing, jam clearing, and die work is unrestricted. Thus there is no incentive to sabotage or modify the system from this source.

Supervisory control is necessary only if multiple pairs of actuators, which can be "switched out" for some jobs, are provided, or when sufficient safety distance for every job and work setup is not provided by fixed mounting of the actuators. In the latter case, those workers responsible for die design, die setting, maintenance, locating the actuators, and supervision of these operations must be fully trained in the proper measurement of, and minimum value of, the safety distance for each press, so that sufficient safety distance is always provided. In addition, the system must be inspected regularly to this end. Except in this case, no other supervisory controls or inspections, or safety training is needed to assure the performance of a well designed two-hand trip or two-hand control safeguarding system.

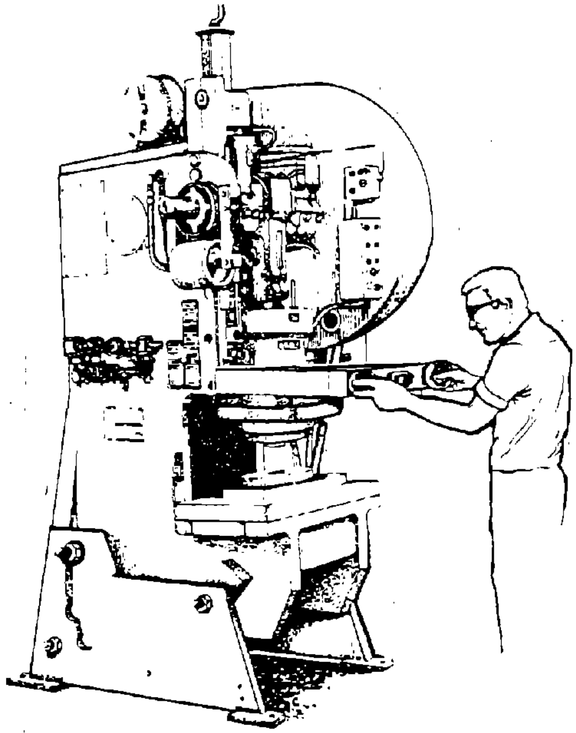


Figure 16. - A two-hand trip.

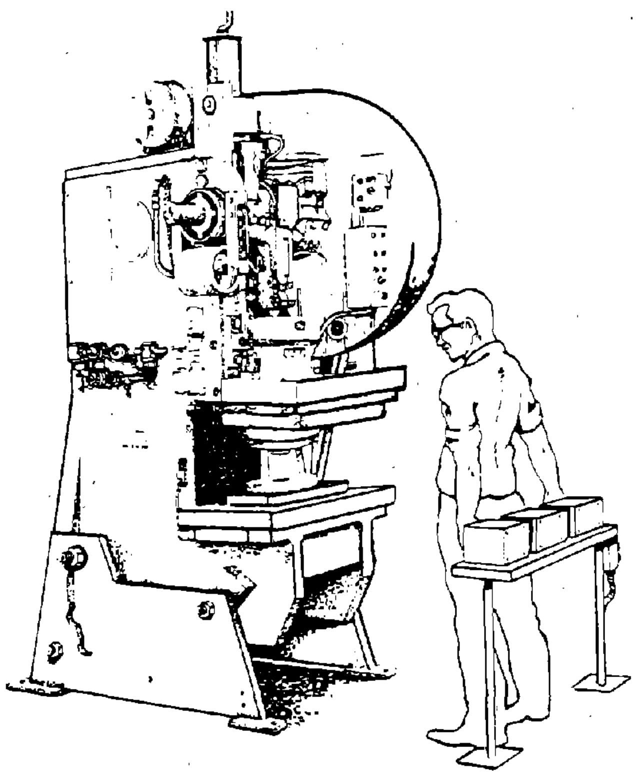


Figure 17. - A two-hand control.

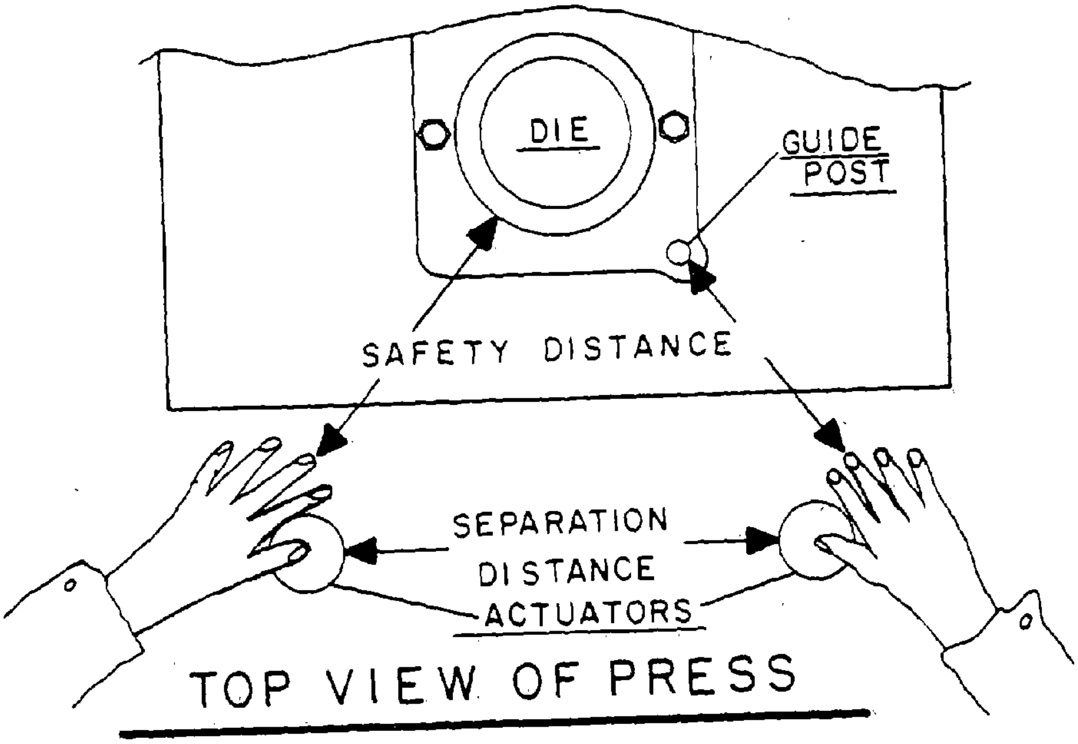


Figure 18. - Safety distance and separation distance.

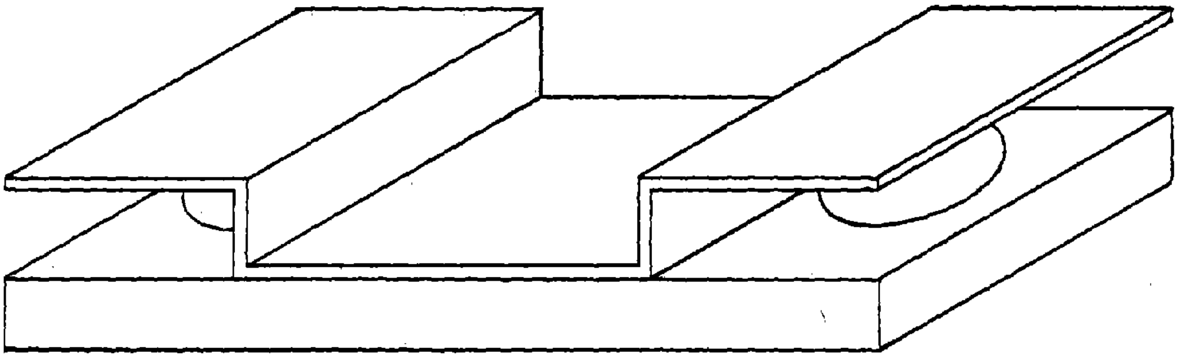


Figure 19. - An actuator that precludes operation by one hand or one arm.

TWO-HAND TRIP SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a two-hand trip safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Have a part revolution friction clutch?

___ ___ 3. a. Have a mechanism which monitors system start time and prevents further stroking when preset start time has been exceeded, and have a safety distance (in inches) = [start time + 1/2 the stroke time (in seconds)] x 63 inches/second? or

b. Have a mechanism which requires the continued presence of each hand on each actuator until maximum rotational crank velocity is reached, and have a safety distance (in inches) = [1/2 the stroke time (in seconds)] x 63 inches/second?

___ ___ 4. Have each actuator mounted at the proper safety distance, measured from the nearest point of operation hazard to the nearest part of each hand when it is in its normal operating position on each actuator?

___ ___ 5. Have a brake monitor?

___ ___ 6. Require simultaneous operation of each actuator in a pair?

___ ___ 7. Have each hand actuator pair arranged to that the only probable means of operation is by a single worker?

___ ___ 8. Require the operation of multiple actuator pairs to be concurrent to initiate tripping?

___ ___ 9. Have the position of the actuators arranged to prevent all parts of the body from being in the point of operation during the downward stroke?

___ ___ 10. Have "dependable" design?

___ ___ 11. Have another safeguarding system for die set-up and maintenance?

Yes No

___ ___12. Have a system of daily inspections, records, and supervisory controls and have a training program to inform those workers responsible for die setting, maintenance, die design, supervision, and location of the actuators? If sufficient safety distance is provided by fixed mounting of the actuators, these inspections need be made only monthly.

___ ___13. Have a set of inspection procedures?

___ ___14. Have a set of records to record all inspections, movement of the actuators, and maintenance on the system?

If the answer to any of the above questions is "No", the system must not be placed in service.

TWO-HAND CONTROL SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a two-hand control safeguarding system is installed.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Have a part revolution friction clutch?

___ ___ 3. Quickly stop the press when any worker's hands are removed from any actuator during any downstroke of the slide and require the release and subsequent simultaneous operation of all actuators to restart the press?

___ ___ 4. Have each actuator located at a safety distance measured from the nearest point of operation hazard to the nearest part of the hand when it is in its normal operating position, meeting the following requirement: safety distance (in inches) = system stop time (in seconds) x 63 inches/second?

___ ___ 5. Have a brake monitor?

___ ___ 6. Require the operation of both actuators within 1/2-second of each other for press operation?

___ ___ 7. Have the two-hand actuators so arranged that the only probable means of operating both is by the two hands of a single worker?

___ ___ 8. Require the operation of multiple actuator pairs to be concurrent to initiate the stroke?

___ ___ 9. Have the position of the two hand actuators arranged to prevent all other parts of the body from being in the point of operation during the downward stroke of the slide?

___ ___ 10. Have "dependable" design?

___ ___ 11. Have another safeguarding system for protection of helpers and passersby?

___ ___ 12. Have another safeguarding system for die set-up and maintenance?

Yes No

___ ___ 13. Have a system of daily inspections, records, and supervisory controls and have a training program to inform those workers responsible for die setting, maintenance, die design, supervision, and location of the actuators? If sufficient safety distance is provided by fixed mounting of the actuators, these inspections need be made only monthly.

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR TWO-HAND TRIP SAFEGUARDING SYSTEMS

This safety inspection checklist for two-hand trip safeguarding systems is a sample that includes information that must be recorded:

1. At the start of each shift.
2. When dies are changed.
3. When the two-hand trip is relocated.
4. When a two-hand trip related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Are the actuators so installed that they meet the safety distance requirement?

___ ___ 2. Are the actuators so installed as to not cause undue operator fatigue?

___ ___ 3. Are the actuators so located or arranged that no part of the body except both hands can be used to actuate them?

___ ___ 4. Is the two-hand trip protected against unintended operation?.

___ ___ 5. On a press using only one operator, do both actuators have to be released before another stroke can be initiated?

___ ___ 6. Are the actuators fixed in such a position that only a supervisor or safety engineer is capable of removing or moving them?

___ ___ 7. Does the two-hand trip require simultaneous operation (both actuators in a pair tripped within 1/2-second of each other)?

___ ___ 8. If the press requires more than one operator, are separate two-hand actuators provided for each operator and are they so designed that concurrent application of all actuator pairs is required to trip the press?

___ ___ 9. Is another safeguarding system provided for die set-up and maintenance?

___ ___10. Is the position of the actuators arranged to prevent all parts of the body from being in the point of operating during the downstroke?

If the answer to any question from 1 through 10 is "No", corrective action must be taken.

Yes No

___ ___11. Has the two-hand trip been sabotaged or otherwise rendered ineffective or unsafe?

___ ___12. Does the safeguarding system in any way create a hazard in itself?

If the answer to question 11 or 12 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state): ____________________

____
____
____
____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___die change
___two-hand trip relocated
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature: ____________________
Title: ____________________
Date: ____________________
Shift: ____________________
Time: ____________________
Machine No.: ____________________
Serial No.: ____________________

SAFETY INSPECTION CHECKLIST FOR TWO-HAND CONTROL SAFEGUARDING SYSTEMS

This safety inspection checklist for two-hand control safeguarding systems is a sample that includes the information that must be recorded:

1. At the start of each shift.
2. When the die is changed.
3. When the two-hand control is relocated.
4. When a two-hand control related accident occurs.

CHECKLIST

Yes No

___ ___ 1. Are the two-hand actuators so installed that they meet the safety distance requirement?

___ ___ 2. Are the two-hand actuators so installed as to not cause undue operator fatigue?

___ ___ 3. Are the two-hand actuators so arranged that the only probable means of operating both is by the two hands of a single worker?

___ ___ 4. Is the two-hand control protected against unintended operation?

___ ___ 5. Does the removal of the worker's hand from either actuator during any and every downstroke of the slide quickly deactivate the clutch and apply the brake to stop slide action?

___ ___ 6. Do all actuators have to be released before an interrupted stroke can be resumed?

___ ___ 7. Are the two-hand actuators fixed in a position so that only a supervisor or safety engineer is capable of removing or moving them?

___ ___ 8. Does the two-hand control require simultaneous application of the worker's hands (within 1/2-second of each other) at each actuator station to trip the press?

___ ___ 9. Is the position of the two-hand actuators arranged to prevent all other parts of the body from being in the point of operation during the downstroke of the press?

___ ___10. Is there another safeguarding system for die set-up and maintenance?

___ ___11. Must multiple actuator pairs be operated concurrently to initiate the stroke?

If the answer to any question 1 through 11 is "No", corrective action must be taken.

Yes No

___ ___12. Has the two-hand control been sabotaged or otherwise rendered unsafe or ineffective?

___ ___13. Does the safeguarding system in any way create a hazard in itself?

If the answer to question 12 or 13 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modification, adjustments, repairs, or other corrective action taken (if "none", so state): ____________________

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___die change
___two-hand control relocated
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature: ____________________
Title: ____________________
Date: ____________________
Shift: ____________________
Time: ____________________
Machine No.: ____________________
Serial No.: ____________________

PRESENCE SENSING SAFEGUARDING SYSTEMS

1. DESCRIPTION OF PRESENCE SENSING

A presence sensing safeguarding system (Figures 20 and 21) can provide protection for all parts of the body of operators, helpers, passersby, die setters, and maintenance men.

A presence sensing safeguarding system is defined as "a device designed, constructed, and arranged to create a sensing field or area and to deactivate the clutch control of the press when (a worker's) hand or any other part of his body is within such field or area". The system provides protection from point of operation hazards by being "interlocked into the control circuit to prevent or stop slide motion if the (worker's) hand or other part of his body is within the sensing field of the device during the downstroke of the slide". Thus a presence sensing safeguarding system is composed of at least the sensing device, the control systems, and the clutch and brake.

Most presence sensing systems operate as follows: If a worker is in the point of operation and sensing field, the system's interlocking circuits are put in a "stop" condition and the clutch cannot be tripped. If the clutch has already been tripped and a worker after-reaches into the point of operation through the sensing field, the interlocking circuits change to a "stop" condition, causing the clutch to disengage, the brake to be applied, and the slide to decelerate until it stops. If there is an object in the sensing field during the upstroke of the slide the system will not respond.

The sensing field by which the system detects workers' presence is generally electro-magnetic in nature, with two major designs predominating: radio frequency fields and light fields.

2. USE OF PRESENCE SENSING

Presence sensing can be used on any mechanical power press except those equipped with a positive or full revolution clutch. Refer to Tables 3 and 4 for more information as to the use of presence sensing.

3. INSTALLATION OF PRESENCE SENSING

The installation instructions for presence sensing systems vary from manufacturer to manufacturer. Refer to the manufacturer's literature for installation instructions. Extreme care must be taken during installation to follow the manufacturer's installation instructions exactly. This is necessary to minimize the need for further attention after initial installation and to assure the effectiveness of the safeguarding system. See Figure 22 for examples of incorrect installation.

4. MAINTENANCE OF PRESENCE SENSING

The maintenance instructions for presence sensing systems vary from manufacturer to manufacturer. Refer to the manufacturer's literature for maintenance instructions. A system must be inspected at the time intervals given on the "Safety Inspection Checklist for Presence Sensing Safeguarding Systems", shown at the end of this discussion. The "Presence Sensing Safeguarding Systems Installation Checklist" also shown at the end of this discussion, should be completed when a presence sensing safeguarding system is installed.

5. ADVANTAGES AND DISADVANTAGES OF PRESENCE SENSING

The following list of advantages and disadvantages, coupled with the information given on Tables 3 and 4, will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Presence Sensing

1. All workers in all modes are protected, with all feeding methods, and for all workpieces.

2. Protection is provided against intended and unintended strokes.

3. Protection is provided against after-reach.

4. A properly designed, constructed, and installed presence sensing system does not rely on human behavior for satisfactory performance.

5. The system is ergonomically acceptable.

6. Unrestricted visibility of the point of operation is maintained.

7. The system presents small incentive for sabotage.

B. Disadvantages of Presence Sensing

1. No protection is provided from uninitiated strokes, repeat strokes, or delayed strokes, if they occur.

2. Initial cost is relatively high.

3. The system requires careful installation.

4. Can only be used with part revolution friction clutch.

6. SAFETY CONSIDERATIONS

Because it protects all body parts, presence sensing can be used with all production methods, primary and secondary operations, whether manual, semi-automatic, or automatic feeding is employed, as long as the feeding equipment does not enter the sensing field during the downstroke of the slide and the press is equipped with a friction clutch. Likewise, presence sensing systems can be used with all types of material and workpieces, as long as they do not enter the sensing field during the downstroke of the slide.

Since the sensing field permits workers to enter the die at any time, presence sensing safeguarding systems provide no protection from uninitiated strokes, repeat strokes, or delayed strokes, if they occur. Since repeat and delayed strokes can occur catastrophically, and without warning, as the result of failures inherent in positive clutch designs, presence sensing systems must not be used alone on presses equipped with positive clutches.

When a friction clutch is employed, the possibility of an uninitiated, repeat, or delayed stroke can be practically eliminated through "dependable" system design, and thus presence sensing systems are acceptable.

A presence sensing safeguarding system prevents tripping whenever it senses any worker in the point of operation; therefore, all workers are protectfrom from all intended and unintended strokes. Protection against intended and unintended strokes depends on the system's ability to sense a worker's presence in the point of operation, regardless of what part of the sensing field he enters. Because of the requirements for after-reach protection and the characteristics of existing mechanical power press designs, the sensing field must be at a safety distance of more than six inches from the point of operation. Thus, for protection from the hazards of intended and unintended strokes, the presence sensing system must be capable of detecting an object the size of the human arm. Based on experience, this requirement is interpreted as sensitivity to a 2 inch minimum diameter object.

Unfortunately, all presence sensing systems which generate their sensing field by radio frequency waves, and some of those which employ light waves, incorporate a "sensitivity" control as an operating adjustment. Installations of this type have been observed where the "sensitivity" control was adjusted so that the system could not detect the presence of an arm in their sensing fields. If a system is equipped with sensitivity controls or gap-creating switches, they must be capable of being carefully supervised.

When a gap is created in the sensing field of any presence sensing system, for example, to allow workpieces or feeding mechanisms to enter the sensing field during the downstroke, the effect of this reduced area of sensitivity may reduce after-reach performance. Some systems allow the introduction of gaps larger even than 2 inches (or an arm's width), and thus degrade protection from intended and unintended strokes as well. Whenever gaps are introduced, safety distance must be checked for adequate after-reach protection. If a gap larger than 2 inches is created, another safeguarding means, usually a supplemental barrier, is necessary to prevent access through the gap from resulting in an injury. An alternative to creating gaps in the sensing field of a presence sensing system is to provide another safeguarding system for use whenever the workpiece or feeding mechanism would enter the sensing field.

However, if the presence sensing device is sometimes not used, the complete system must provide that when it is not in use, there is no possibility of workers unwittingly depending on it. Thus when the presence sensing device is not in use all its associated indicator lights must be extinguished.

Since a presence sensing system allows any worker die access at any time, he may after-reach into the point of operation while the dies are closing. Presence sensing systems provide after-reach protection by means of a safety distance between the sensing field and the nearest hazards, which is great enough to ensure that the time needed to reach the hazard is greater than the time needed to eliminate the hazard. All known presence sensing systems eliminate the hazard by stopping the slide motion through disengaging the clutch and engaging the brake whenever an after-reach is sensed.

In order for the needed safety distance to be short enough to be practical, the stop time must be short. This requires the use of a part revolution clutch which is capable of disengaging quickly and a brake which is capable of engaging quickly, and capable of decelerating the slide's speed to zero quickly (within a few tenths of a second). (See "Part Revolution Friction Clutch Safety Considerations".) In addition, total system stopping time includes the time necessary for the control system to respond to the signal from the presence sensing device, and the reaction time of the presence sensing device. All known commercially available presence sensing devices incorporate electrical and electronic circuits to generate and/or sense the presence of objects in the sensing field. When a worker after-reaches, these circuits require time to respond and signal the control system. This reaction time varies from one-hundredth to one-tenth of a second, depending on design. These times all contribute to the stop time of the system, and must be taken into account in order to achieve maximum protection from after-reach.

All commercially available presence sensing devices are incapable of detecting an object too small to disrupt their electromagnetic sensing fields. The size of the minimum detectable object varies considerably from design to design. The existence of this minimum means that the human hand, which may enter the sensing field at any point, will not be sensed until enough of it has entered the field to exceed the minimum. This distance must be included in the safety distance, and must be specified by the manufacturer of the device.*

*Exceeds 29CFR 1910.217.

Systems which employ radio frequency waves to create their sensing fields have a special problem in providing protection from after-reach. Unlike light wave type designs, radio frequency waves are not easily confined to a flat planar region. As a consequence, these systems are affected by the presence of nearby objects, such as parts bins, stacks of workpieces, feeding mechanisms, passersby, die trucks, and by the particular die in the press. Thus, radio frequency wave presence sensing systems must be adjusted for each job and worker. This adjustment causes the effective position of the sensing field to vary from job to job. Thus, unlike light wave type designs, the safety distance cannot be set for the nearest pinch point upon initial installation.

Recent improvements in design of radio frequency wave presence sensing devices have succeeded in reducing these problems to a manageable level through the use of a manufacturer supplied "antenna" from which the field radiates. With these new designs, adjustments need only be made occasionally, and for some applications, may be eliminated.

Although they must be considered, supplemental barriers are not always part of every presence sensing safeguarding system. If the sensing field is large enough, and the press is of closed straight-sided construction, it is impossible to reach over, under, or behind the sensing field, and thus enter the point of operation without being detected.

If the press is a "C" frame or other open-sided design, some presence sensing device designs sllow the sensing field to be wrapped around the press, and supplemental barriers are not needed. With some light wave type designs this cannot be done reliably or easily, or at all, and thus supplemental barriers or additional presence sensing devices are required for protection at the sides of the press.

Also, with light wave type presence sensing devices, the size of the sensing field is roughly proportional to the cost of the device, and many users save initial costs by purchasing a small device. This often results in the possibility of reaching over, under, or around the sensing field. In these cases supplemental safeguarding is needed, and supplemental barriers are often used. The use of a larger sensing field is always a safer approach.

The particular characteristics of the press may require a safety distance so great that it becomes possible for a worker to stand between the sensing field and the point of operation without being in the sensing field and thus remain undetected while some part of his body is in the point of operation. In these cases three solutions are possible: another sensing field may be added horizontally in the gap to sense the worker in this position, or the sensing field may be tilted in at the bottom and made so large that it both fills the gap and satisfies the safety distance requirements, or a fixed or interlocked supplemental barrier can be used to prevent the workers from standing so close to the die that they are not in the sensing field.

Since the amount of energy needed to create an effective sensing field is very low, there is no need for any design of presence sensing system to create a hazard for workers. None of the known commercially available systems create such a hazard.

The continued performance of presence sensing safeguarding systems can be designed to rely almost entirely on the performance of the safeguarding system iteself, almost eliminating dependence on human behavior. This means the system must be designed for maximum technical safety.

"Dependable" design is required for the control system, the presence sensing device, and the clutch and brake whenever a presence sensing system is used. (See "Dependable Safeguarding System Design".)

System performance, in providing after-reach protection, relies on clutch and brake action in stopping the slide. Thus the design of both clutch and brake must be of the utmost reliability to minimize the probability of sudden failures. This means, briefly, that positive clutches and band brakes must not be used. Splined or tube type clutches or clutches which employ sleeve bearings and run on the crankshaft are highly undesirable system components. The brake must be set by multiple, guided, compression springs. Continued protection depends on these components. (See "Setting Safety Distance".)

Eliminating the possibility of sudden failures is not enough. Friction designs have failure modes characterized by gradual loss of clutch or brake torque and increase in stop time. Since there is only one clutch and one brake, redundancy cannot be applied. Continued performance can be assured through technical safety by inclusion of a brake monitor. A brake monitor is a system function which monitors the stopping performance of the clutch and brake and prevents initiation of a successive stroke if stop time becomes so long as to compromise after-reach performance. As a part of the safeguarding system, the brake monitor must be of "dependable" design. (See "Setting Brake Monitors".)

Present regulations require a brake monitor whenever presence sensing and hands-in-die feeding are used. However, some worker may after-reach at any time, whether hands-in-die feeding is used or not. Therefore, a brake monitor is always required when presence sensing safeguarding systems are used.*

*Exceeds 29CFR 1910.217.

If supplemental barriers are employed in a presence sensing safeguarding system, protection from unintended strokes, intended strokes, and after-reach depends on their continued presence in their protective position. The sensing field is often so large that the supplemental barriers do not have to be removed (permanently mounted) for die setting or maintenance. All supplemental barriers used in a presence sensing system must be either permanently mounted or interlocked with the control system to prevent tripping when they are not in their protective position.* Also, if supplemental barriers are needed for use with a feeding mechanism, they should be mounted on the feeding mechanism.

When gaps are introduced in the sensing field for the purpose of feeding, the risk that they may not be removed when the next job is set is created. Some designs of light wave presence sensing devices provide the possibility of mounting the gap creating means on the feeding mechanism or workpiece iteself, thus assuring that it will be eliminated when the job is changed. This example of technical safety is preferable, but since it is not realizable in all designs, it is not required.

Although the level of protection from after-reach obtained with a presence sensing system depends on the provision of adequate safety distance, most designs have the capability of making continued after-reach performance independent of human behavior. This can be accomplished by mounting the sensing device in a fixed position which provides adequate safety distance from the point of operation hazards of every die used in the press. Of course, the mounting position must be determined under the worst case conditions of minimum sensitivity, largest die, forward-most pinch point, and maximum stopping time increase allowed by the brake monitor. If the need for supplemental barriers is not eliminated in such a design, they must be used. Thus, with presence sensing safeguarding systems, continued performance of the system can be designed to be independent of worker behavior, minimizing the need for supervisory control.

Because of the heavy dependence on technical safety, and the system complexities entailed, a high degree of training is required of those persons installing a presence sensing safeguarding system. Knowledge of the need and techniques of measuring stop time and setting safety distance and the brake monitor is necessary.

The ergonomic factors involved with presence sensing safeguarding systems, even among presently available designs, are excellent. Because their sensing fields do not restrict die access in any way, and because the energy requirements for sensing are very low, both die access and die visilibility are excellent, minimizing the incen-

*Exceeds 29CFR 1910.217.

tive to sabotage[1].

The incentives for sabotage which do exist are: (1) the nuisance of having to withdraw the hands from the sensing field on hand fed operations before the press can be tripped, (2) the need for special attention when the workpiece or a feeding mechanism is required to enter the sensing field during the downstroke, which encompasses a rather small percentage of the total number of press operations.

Because of the system's complexity, the difficulty of successful sabotage or modification which affects safeguarding performance can be designed to be very high. Because "dependable" systems design can be rigorously incorporated throughout presence sensing safeguarding systems, the probability that any modification or sabotage will result in a system which continues to operate when safeguarding performance is compromised can be made extremely remote.

Because presence sensing systems place no physical restriction on the worker's movement, they contribute nothing to the fatigue involved in operating the press. When a presence sensing system is properly designed, built, and used, the worker may trip the press by any convenient means except use of the presence sensing itself as a tripping means is prohibited. The tripping means has no effect on point of operation protection provided.

[1] An exception is commercially available designs of light wave type devices which utilize a standard 40 watt flourescent tube as the sensing energy source, which because of its brilliance, generally interferes with die visibility. Other light wave designs do not have this problem, however, since they are of more efficient design.

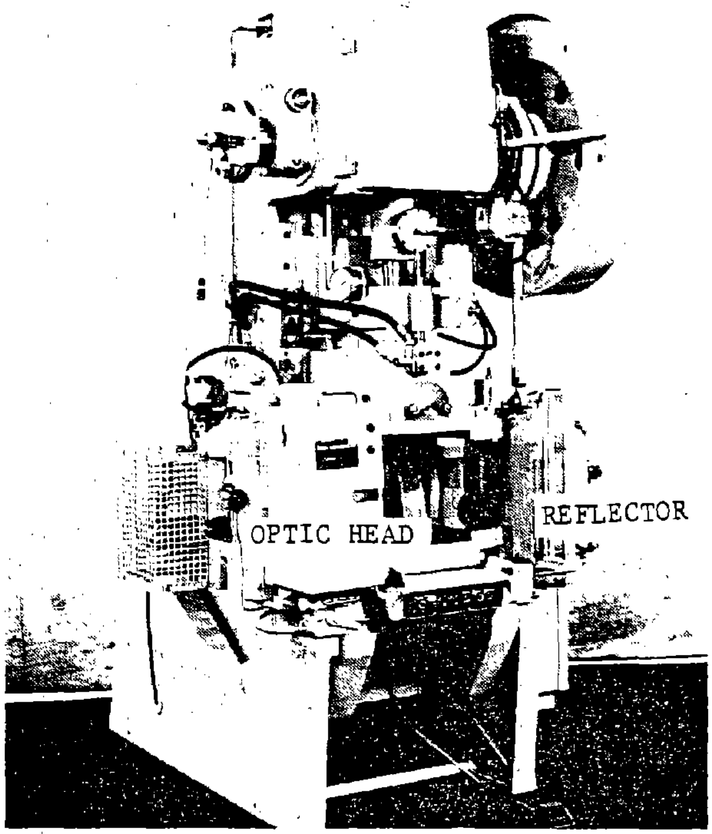


Figure 20. - A presence sensing system safeguarding the point of operation on a gap frame press.

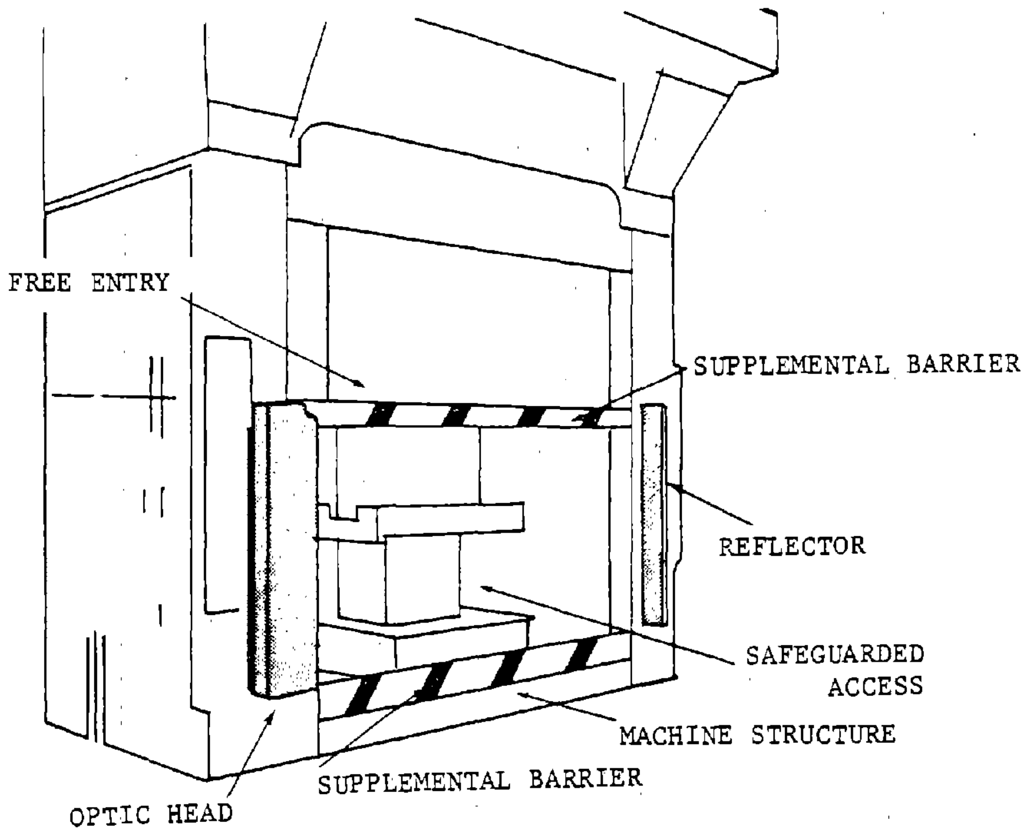


Figure 21. - A presence sensing system safeguarding the point of operation on a straight side frame press.

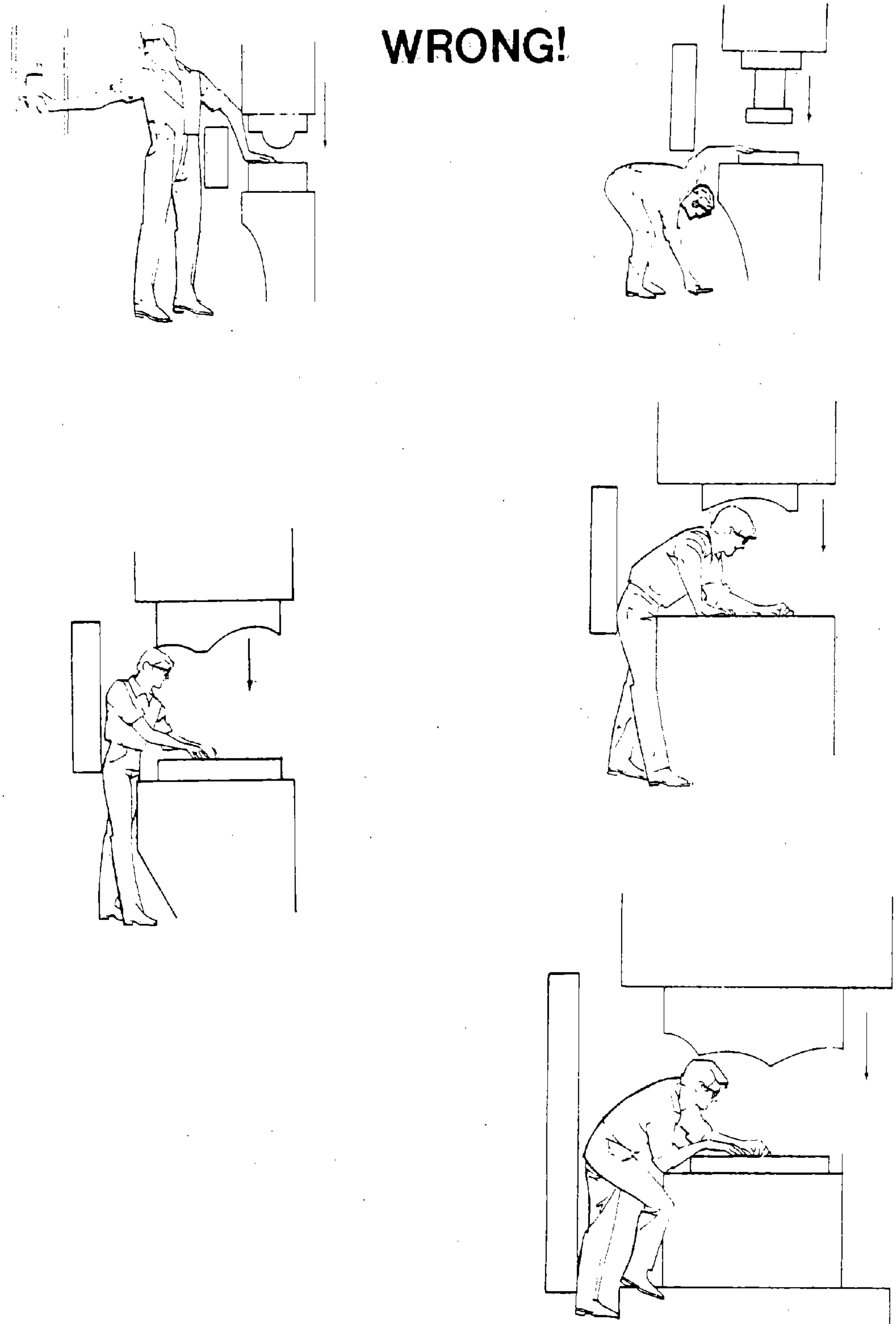


Figure 22. - Improper installation of a presence sensing device.

PRESENCE SENSING SAFEGUARDING SYSTEMS INSTALLATION CHECKLIST

This checklist must be completed when a presence sensing safeguarding system is installed.

Does the system:

Yes	No		
___	___	1.	Meet the general safeguarding system requirements for power presses (page B-2)?
___	___	2.	Have a part revolution friction clutch?
___	___	3.	Prevent tripping whenever a worker's presence is sensed?
___	___	4.	Quickly disengage its clutch and apply its brake whenever a worker's presence is sensed?
___	___	5.	Remain unaffected by external fields, foreign materials, or ambient conditions?
___	___	6.	Provide a sensitivity sufficient to detect the presence of a hand or a 2-inch object at any point in its sensing field?
___	___	7.	Have an effective position of the sensing field which meets the following requirement for every die or work set-up: Safety distance (in inches) = [sensing device reaction time (in seconds) + press system stop time + brake monitor time increment] x 63 inches/second?
___	___	8.	Incorporate a brake monitor?
___	___	9.	Have its sensing device marked by the manufacturer to indicate the effective position of its sensing field?
___	___	10.	Have supplemental safeguarding to prevent entry into the point of operation from over, under, or around the sensing field?
___	___	11.	Prevent the worker from standing between the sensing field and the press?
___	___	12.	Have all gaps created in the sensing field protected by supplemental safeguarding means?
___	___	13.	Interlock or permanently attached all supplemental barriers?
___	___	14.	Eliminate all shearing and pinching hazards between the supplemental barriers and the slide and dies?

Yes No

___ ___15. Have "dependable" design?

___ ___16. Have a safeguarding system used during die setting, maintenance, and other operations if necessary?

___ ___17. Have visible indicators and energy sources associated with the presence sensing system which automatically extinguish whenever the system is not in use?

___ ___18. Provide a non-adjustable sensitivity, or a means of supervising sensitivity adjustment, and a system of inspections, records, and supervisory controls and a training program to inform all workers of the safety requirements for "sensitivity" adjustments?

___ ___19. Have a system of daily inspections, records, and supervisory controls ready for daily use and have a training program to inform those workers responsible for die setting, maintenance, die design, supervision, and location of the actuators? If sufficient safety distance is provided by fixed mounting of the actuators, these inspections need be made only monthly.

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR PRESENCE SENSING SAFEGUARDING SYSTEMS

This safety inspection checklist is a sample that includes the information that must be recorded:

1. When a presence sensing system is relocated.
2. If a sensitivity control is furnished, complete this checklist at the beginning of each shift, after each die change, whenever operators or helpers are changed, and after each modification, adjustment, or maintenance procedure is performed.
3. If not mounted in a fixed position, complete this checklist at the beginning of each shift, after each die change, whenever operators or helpers are changed, and after each modification, adjustment, or maintenance procedure performed.
4. If mounted in a fixed position, complete this checklist monthly.
5. When a presence sensing system related accident occurs.

CHECKLIST

Yes	No		
___	___	1.	Does the system prevent tripping whenever a worker's presence is sensed?
___	___	2.	Does the clutch quickly disengage and the brake quickly apply whenever a worker's presence is sensed?
___	___	3.	Does the presence sensing remain unaffected by external fields, foreign materials, or ambient conditions?
___	___	4.	Does it provide a sensitivity sufficient to detect the presence of a hand or a 2-inch diameter object at any point in its sensing field?
___	___	5.	Does the system have supplemental safeguarding to prevent entry into the point of operation from over, under, or around the sensing field?
___	___	6.	Does the system prevent the worker from standing between the sensing field and the press?
___	___	7.	Are all gaps created in the sensing field protected by supplemental safeguarding means?
___	___	8.	Are supplemental barriers interlocked or permanently attached?
___	___	9.	Are all shearing and pinching hazards between the supplemental barriers and the slide and dies eliminated?
___	___	10.	Does the system incorporate a supplemental safeguarding system during die setting, maintenance, and other operations if necessary?

Yes No

___ ___11. Are all visible indicators and energy sources associated with the presence sensing system automatically extinguished whenever they are not in use?

___ ___12. Does the system provide a non-adjustable sensitivity, or a means of supervising sensitivity adjustment, and a system of inspections, records, and supervisory controls and a training program to inform all workers of the safety requirements for "sensitivity" adjustments?

If the answer to any of the above questions is "No", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state):____________________

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___system relocated
___sensitivity device required check
___no fixed position required check
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature:____________________________
Title:____________________________
Date:____________________________
Shift:____________________________
Time:____________________________
Machine No.:____________________________
Serial No.:____________________________

PRESS OPERATED SWEEP AND PUSHAWAY SAFEGUARDING SYSTEMS

1. DESCRIPTION OF PRESS OPERATED SWEEPS AND PUSHAWAYS

A press operated sweep (operated by the slide, Figure 23) can protect operators, helpers, and passersby from the hazards of the point of operation. They do not protect die setters and maintenance men. Some other means of safeguarding must be used for these persons.

A press operated sweep is a mechanism that protects the press operator by removing his hands to a safe position if they are inadvertently located in the point of operation as the dies close. A press operated sweep must have a barrier attached to the sweep arm in such a manner as to prevent the operator from reaching into the point of operation, past the trailing edge of the sweep arm as the dies close.

Some devices called "sweeps" have been built which act before the clutch is tripped. These devices are really gates and must meet all the requirements of gates. They are not covered in this discussion. Only those sweeps which are operated by the slide are sweeps, and they are covered herein.

Pushaways protect the operator in a manner similar to the press operated sweep by pushing him away from the point of operation as the dies close. Pushaways are rarely used in the United States and their coverage herein will be brief.

2. USE OF PRESS OPERATED SWEEPS

Sweeps can be used as a supplemental safeguarding system on any press. Sweeps cannot be used as a sole safeguarding means after December 31, 1976. Refer to Tables 3 and 4 for more information as to the use of sweeps.

3. INSTALLATION OF PRESS OPERATED SWEEPS

The sweep device must be so installed that it is activated by the slide. It must be installed and operated so as to prevent the operator from reaching into the point of operation as the dies close. It must be installed in such a manner that it will not itself create an impact or shear hazard between the sweep arm and the press tie rods, dies, or any other part of the press or barrier. The sweep can be mounted to sweep the operator's hand from the die area in a front-to-back, right-to-left, left-to-right, or two sweeps moving in a criss-cross motion. The sweep should be mounted to move right or left as related to the hands of the operator. The sweep should move to the left for right hand feeding and to the right for left hand feeding.

Sweeps must be so installed that they in no way present, in themselves, a hazard to workers.

4. MAINTENANCE OF PRESS OPERATED SWEEPS

Sweeps should be inspected for proper adjustment, general condition, wear and tear, and proper fastening when the die is changed, when the sweep has not been used for one day or more, when a new sweep is installed, when a new press is placed in service that will use a sweep as a safeguarding means, and when a sweep related accident occurs. Worn or damaged sweeps must be repaired or taken out of service immediately. When there is any doubt as to whether or not they can be safely repaired, they must be taken out of service. Some sweeps have points that require lubrication. Refer to the manufacturer's literature for lubrication recommendations.

Records of inspections, maintenance, and replacement must be kept. The "Safety Inspection Checklist for Sweep Safeguarding Systems", shown at the end of this discussion, can be used for such records.

5. ADVANTAGES AND DISADVANTAGES OF PRESS OPERATED SWEEPS

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4 will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Press Operated Sweeps

1. Low initial cost is involved compared to some other safeguarding systems.

B. Disadvantages of Press Operated Sweeps

1. Frequent inspection and adjustment is required.
2. Sweeps create pinching, impact, and shearing hazards.
3. The operator resents having his hands forcibly removed.
4. If not properly manufactured and adjusted, sweeps can allow operator to after-reach into the point of operation.
5. Sweeps cannot be used alone after December 31, 1976.

6. SAFETY CONSIDERATIONS

The regulations require the use of supplemental barriers to preclude the operator reaching around the sweep's arm and into the die during the "downward stroke". The regulations also require that the sweep device shall not "create a shear or impact hazard between the sweep arm and the press tie rods, dies, or any other part of the press or barrier". However, the fact remains that injuries take place because of these hazards.

This problem is especially acute since sweeps are moved by the force of the slide. Obviously, any impact or shearing hazard which exists as a result of the sweep will be a much greater danger if its closing force is measured in tons rather than pounds. It is primarily for this reason that sweeps are prohibited as the sole safeguard as of December 31, 1976.

The sweep is sometimes called a pushaway, although this is inaccurate since its action is more a "push aside" motion than a "pushaway" motion. The pushaway protects a worker from point of operation hazards by moving a large metal barrier up and away from the press bolster as the slide descends. Thus, if a worker has his hands inadvertently in the point of operation, he is pushed away by the barrier.

Like sweeps, these devices are moved by the slide, and thus are capable of creating a pinching or impact hazard as forceful as that of the slide. This pushing action has been responsible for numerous accidents such as entrapment between the guard and a die truck or stack of material, and falls. Obviously, if the press were to be tripped without the knowledge of everyone in the path of the barrier, the pushing action would be extremely hazardous.

Because of the similarity of pushaway hazards to those which require the prohibition of slide operated sweeps, it is recommended that pushaways not be introduced and used as point of operation safeguarding in the united States.

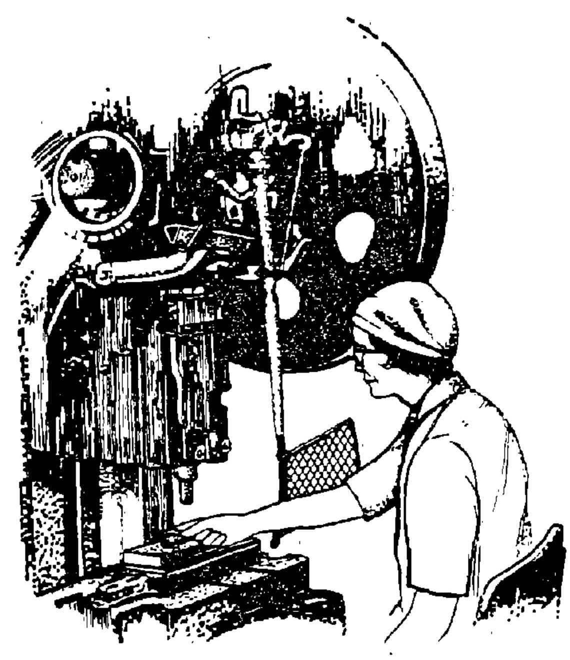


Figure 23. - An example of a sweep.

SAFETY INSPECTION CHECKLIST FOR SWEEP SAFEGUARDING SYSTEMS

This safety inspection checklist for sweep safeguarding systems is a sample that covers the information that must be recorded:

1. At the start of each shift.
2. When the die is changed.
3. When the sweep has not been used for one day or more.
4. When a sweep related accident occurs.

NOTE: Since all sweep safeguarding systems require supplemental barriers or enclosures, also complete a "Safety Inspection Checklist for Barrier or Enclosure Safeguarding Systems" (page B-43) at these times:

1. At the start of each shift.
2. When the barrier or enclosure is removed and then reinstalled.
3. When any repair work is performed on the barrier or enclosure.
4. When the barrier or enclosure is modified.
5. When dies are changed.
6. When an adjustable barrier or enclosure is adjusted.

CHECKLIST

Yes No

___ ___ 1. Is the sweep properly designed for the application?

___ ___ 2. Is the sweep properly adjusted?

___ ___ 3. Is the sweep properly and firmly attached to the press?

___ ___ 4. Is the general condition of the sweep safe?

If the answer to any question from 1 through 4 is "No", corrective action must be taken.

___ ___ 5. Are any parts of the sweep broken or worn?

___ ___ 6. Does the sweep need to be replaced for any reason?

___ ___ 7. Has the sweep been sabotaged or otherwise rendered unsafe or ineffective?

___ ___ 8. Does the sweep action create any shearing, pinching, or impact hazard for any employee?

___ ___ 9. Does the safeguarding system allow any worker access to the point of operation through any opening during the downstroke?

If the answer to any question 5 through 9 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state):________________

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___die change
___sweep out of service for one day or more
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature:____________________
Title:____________________
Date:____________________
Shift:____________________
Time:____________________
Machine No.:____________________
Serial No.:____________________

SAFE WORKPIECE SAFEGUARDING SYSTEMS

1. DESCRIPTION OF SAFE WORKPIECE

Safe workpiece (Figure 24) can protect operators, helpers, and passersby in case (a) below; in case (b) or (c) below it can protect one worker. It does not protect die setters and maintenance men. These persons must therefore be protected by some other means of safeguarding.

Safe workpiece is a safeguarding system which employs the workpiece and its characteristics as the safeguarding means. There are three types of safe workpiece safeguarding: (a) the workpiece is of such size, shape, and material that when it is in the point of operation it alone, or the workpiece with supplemental barriers, prevents a worker from entering the point of operation, (b) the workpiece is of such size, shape, and material that it must be supported and held by a worker at such a remote point with at least one hand whenever the workpiece is in the point of operation, that the worker cannot reach the point of operation with either hand, or the workpiece will be dropped or damaged, and (c) the workpiece is of such size, shape, and material that it must be supported by both hands whenever it is in the point of operation, or it will fall and be damaged. These three types are related, since (b) and (c) are extensions of (a).

2. USE OF SAFE WORKPIECE

Safe workpiece as a safeguarding means must only be used where special workpiece considerations preclude the use of other safeguarding systems. Where safe workpiece is used it can be used as the safeguarding means on any mechanical power press set-up where any of the above conditions are met. However, its use is limited to those applications where no other type of safeguarding will work and where strict supervisory control of the above conditions is exercised. Also, this method of safeguarding may require a variance from OSHA. Safe workpiece cannot be used as the safeguarding means on presses with automatic feed and when the workpiece is too small. With safe workpiece, the operator may be required to reach into the point of operation but must be precluded from doing so during the downstroke.

Refer to Tables 3 and 4 for more detailed information as to the use of safe workpiece.

3. INSTALLATION REQUIRED BY SAFE WORKPIECE

The only special installation required that is attributable to the safe workpiece means of safeguarding the point of operation is the installation of workpiece interlocks.

4. MAINTENANCE REQUIRED BY SAFE WORKPIECE

No special maintenance is required that is attributable to the safe workpiece means of safeguarding the point of operation. The interlocks should be periodically checked for proper operation.

5. ADVANTAGES AND DISADVANTAGES OF SAFE WORKPIECE

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4, will assist in reaching a decision as to which safeguarding means is best suited for a particular power press.

A. Advantages of Safe Workpiece

1. Minimal maintenance is required.

2. Minimal cost is involved.

3. The system offers simplicity of operation.

4. Movement of the operator is not restricted by the safeguarding means.

5. The system is ergonomically acceptable.

6. No incentive to sabotage or circumvent the safeguarding means is created, except that supplemental guarding may be sabotaged or circumvented.

7. If properly applied, safe workpiece safeguards from after-reaching into the point of operation.

8. If properly applied, safe workpiece safeguards from a repeat stroke injury.

B. Disadvantages of Safe Workpiece

1. The system has limited use. Safe workpiece, of course, can be used as the safeguarding method only when the requirements of cases 1.(a), 1.(b), or 1.(c) are met. Therefore, safe workpiece cannot be used as the safeguarding means when the workpiece is small or the press is automatically fed. As previously stated, it is not intended for general use and may require an OSHA variance.

2. A large workpiece may limit the operator's view.

3. Interlocks must be incorporated into the control system.

6. SAFETY CONSIDERATIONS

The physical characteristics of the workpiece are the determining factors in the performance of the safe workpiece safeguarding system. In case 1.(a), only the size and shape of the workpiece need to taken into account. The requirement that the workpiece be so large that a worker cannot reach the die can be met in a number of ways. A few workpieces have large vertical surfaces so that workers must reach over them to enter the die. Most workpieces which lend themselves to this type of safeguarding are relatively wide or deep, and flat. The degree of protection provided by a given workpiece depends on the distance of its outer edge from the nearest pinch point, and the height of this edge above the floor. If the edge is chest high, it must be more than an arm's length from the hazard. If it is waist high, it must be an additional distance away to prevent workers from entering the point of operation by leaning over the workpiece while reaching.

For case 1.(b), the size, shape, and material all have to be suitable. This system relies on the worker's inhibitions to prevent him from releasing his hold on the workpiece with both hands and reaching into the point of operation. Thus, the workpiece and set-up must require the worker's support with one hand all through the downstroke. The position of this hand with respect to the pinch points must be distant enough to preclude reaching the pinch points with the other hand.

For case 1.(c), the workpiece must be so unwieldy or heavy that both hands are required to support it at all times it is in the die, thus relying on the worker's inhibitions to prevent him from releasing his hold with either hand and entering the point of operation.

The protection afforded by case 1.(a) extends to all workers, operators, and passersby, whenever the press is in a production mode. Neither case 1.(a), 1.(b), or 1.(c) provide any protection to die setter or maintenance men, who must stroke the press without workpieces in place in order to perform their work. Cases 1.(b) and 1.(c) provide protection only to that worker who is loading the workpiece. Supplemental barriers may provide some incomplete protection to other operators, helpers, or passersby, but complete protection cannot be provided without duplicating the protection of workpiece safeguarding for the loading worker through the use of another safeguarding system, such as a barrier system.

Safe workpiece safeguarding systems, when properly applied, are capable of reducing injuries from machine hazards. However, no safe workpiece safeguarding system provides any protection from the risk of an uninitiated stroke. This is because the workpiece may not be in its protective position when such a stroke occurs. Fortunately, the risk of an uninitiated stroke can, through "dependable" system design, be practically eliminated, except for those caused by poor maintenance on a positive clutch. If these clutches are inspected weekly, as current regulations require, by knowledgable workers, and repaired immediately if necessary, this risk can be substantially reduced. Thus, "dependable" design or weekly clutch inspections are necessary for all safe workpiece safeguarding systems.

Since the workpiece provides no protection unless and until it is in the die, the workpiece must be interlocked so that tripping is precluded whenever it is not in its protective position. Since system performance is degraded if a needed supplemental barrier is left off the press, such barriers must be interlocked also. A case 1.(a) system, fitted with interlocks and necessary supplemental barriers, provides complete protection against after-reach for all workers (except die setters and maintenance workers) whose body dimensions prevent them from reaching the die over the workpiece.

A case 1.(b) system, fitted with interlocks and necessary supplemental barriers, provides after-reach protection only to that worker who holds the workpiece during the downstroke, only if he does not release it with both hands, and if his body dimensions prevent him from reaching the die while holding the workpiece with one hand.

A case 1.(c) system, fitted with interlocks, provides after-reach protection only to the worker who holds the workpiece during the downstroke, and only if he does not release the workpiece with either hand.

Safe workpiece safeguarding systems, since they employ no safeguard mechanisms other than the workpiece and tools needed to form the piece, create no hazards except those associated with the needed supplemental barriers (see "Barrier or Enclosure Safeguarding Systems").

The continued performance of a safe workpiece safeguarding system depends generally upon the behavior of the press workers. The only area in which continued performance can be provided by technology is the application of "dependable" design to the interlocks, control system, and clutch and brake systems.

Even if the system incorporates a positive or full revolution clutch, "dependable" design is still required for continued performance in safeguarding from repeat, delayed, uninitiated, and unintended strokes, as well as after-reach.

The remainder of the safeguarding system, the workpiece and supplemental barriers, are incapable of monitoring their own performance, and thus must depend exclusively on human behavior.

For case 1.(a), the supplemental barriers must be correctly designed, built, and installed to provide protection for the workers. For case

1.(b), needed supplemental barriers must be designed, built, and installed for the protection of the operator or helper who holds the workpieces, and another safeguarding system must be provided for all other workers. For case 1.(c), especially, another safeguarding system must be provided for other workers. Thus human judgments must be made by supervisory and safety personnel for each workpiece, and made correctly every time, as to the applicability and design of this system or safeguarding performance will be degraded or eliminated.

Obviously, safety training of those workers responsible for this work is essential for the proper performance of safe workpiece safeguarding systems. In addition, supervisory control, with inspections and records, which are presently a requirement of the regulations, will help reduce the risks caused by worker error or sabotage in these areas. See "Safety Inspection Checklist for Safe Workpiece Safeguarding", shown at the end of this discussion, for an example of such an inspection record. The "Safe Workpiece Safeguarding System Installation Checklist", shown at the end of this discussion, should be completed when a safe workpiece safeguarding system is installed.

Once a press has been correctly set up for a given job with a safe workpiece safeguarding system, safeguarding performance, since it rests on the workpiece, does not depend on any operating adjustments. However, any change made to the workpiece, or any change to a new job or workpiece, carries the potential for loss of safeguarding performance, and thus, a new evaluation of the system is required whenever these changes are made.

Safe workpiece safeguarding does not create an incentive to sabotage or modify the system, except when supplemental barriers are used (see "Barrier or Enclosure Safeguarding Systems"), since the workpiece is the safeguarding mechanism. Also, safe workpiece leaves the die unobstructed and thus visibility and access for scrap and jam cleaning and die maintenance are not affected.

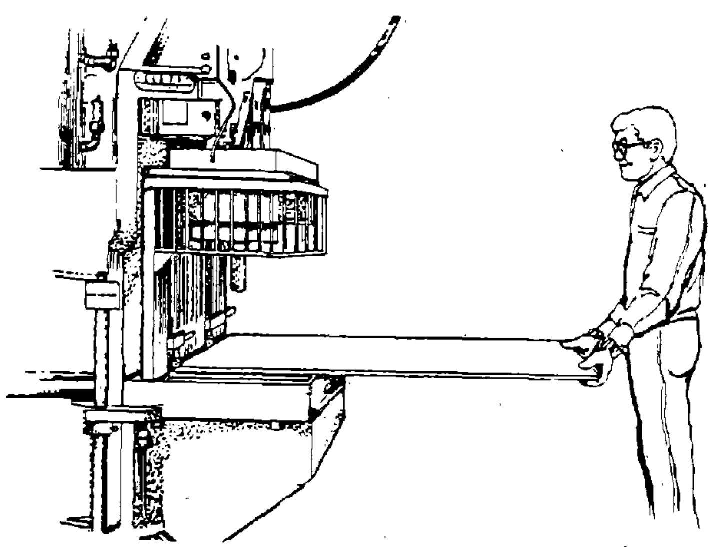


Figure 24. - An example of safe workpiece safeguarding.

SAFE WORKPIECE SAFEGUARDING SYSTEM INSTALLATION CHECKLIST

This checklist must be completed each time a safe workpiece safeguarding system is placed in service.

Does the system:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. a. Have a workpiece so large that no worker can reach into the point of operation? or

b. Have a workpiece which the worker must hold with one hand in such a manner that the other cannot reach any point of operation hazard? or

c. Have a workpiece of a size which requires the worker to support it with both hands?

___ ___ 3. Make it impossible to support the workpiece in such a manner that the worker can reach into the point of operation?

___ ___ 4. Have a die designed so there is no need for the worker to place his hand in the point of operation?

___ ___ 5. Have all dies or work set-ups interlocked with the workpiece?

___ ___ 6. Have supplemental safeguarding where needed?

___ ___ 7. Have supplemental barriers interlocked or permanently attached?

___ ___ 8. Eliminate all shearing and pinching hazards between the workpiece or supplemental barriers, and the slide and dies?

___ ___ 9. Have "dependable" design?

___ ___ 10. Have another safeguarding system for die set-up and maintenance?

___ ___ 11. Have an operating procedure to minimize work discomfort?

___ ___ 12. Have a safety training program instituted and maintained to ensure that all workers who are responsible for supervision, inspection, die design, die setting, and operation fully understand all the above design requirements?

___ ___ 13. Have daily inspections, records, and supervisory controls on each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR SAFE WORKPIECE SAFEGUARDING SYSTEMS

This safety inspection checklist for safe workpiece safeguarding systems is a sample that includes the information that must be recorded:

1. When the type or size of workpiece is changed.
2. When a safe workpiece related accident occurs.

NOTE: For safe workpiece safeguarding systems that require supplemental barriers or enclosures, also complete a "Safety Inspection Checklist for Barrier or Enclosure Safeguarding Systems" (page B-43) at these times:

1. At the start of each shift.
2. When the barrier or enclosure is removed and then replaced.
3. When any repair work is performed on the barrier or enclosure.
4. When the barrier or enclosure is modified.
5. When dies are changed.
6. When an adjustable barrier or enclosure is adjusted.

CHECKLIST

Yes No

___ ___ 1. a. Is the workpiece so large that no worker can reach into the point of operation? or

b. Is the workpiece such that the worker must hold the workpiece with one hand in such a manner that the other cannot reach any point of operation hazard? or

c. Is the workpiece of a size which requires the worker to support it with both hands?

___ ___ 2. Is it impossible to support the workpiece in such a manner that the worker can reach into the point of operation?

___ ___ 3. Is the die designed so there is no need for the worker to place his hand in the point of operation?

___ ___ 4. Are all dies or work setups interlocked with the workpiece?

___ ___ 5. Is supplemental safeguarding in place where needed?

___ ___ 6. Are the supplemental barriers interlocked or permanently attached?

___ ___ 7. Are all shearing and pinching hazards between the workpiece or supplemental barriers, and the slide and dies eliminated?

Yes No

___ ___ 8. Is another safeguarding system available for die setup and maintenance?

If the answer to any of the above questions is "No", corrective action must be taken.

___ ___ 9. Has the safeguarding system been sabotaged or otherwise rendered unsafe or ineffective?

___ ___ 10. Does the safeguarding system in any way create any hazard in itself?

If the answer to question 9 or 10 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state): __________________

____

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___ new size or type of workpiece
___ accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature: ____________________
Title: ____________________
Date: ____________________
Shift: ____________________
Time: ____________________
Machine No.: ____________________
Serial No.: ____________________

SAFE OPENING SAFEGUARDING SYSTEMS

1. DESCRIPTION OF SAFE OPENING

Safe opening (Figures 25 and 26) can protect operators, helpers, and passersby from the hazards of the point of operation. It does not protect die setters or maintenance men. Some other form of safeguarding must be used to protect these persons.

Safe opening is a safeguarding method whereby (a) the point of operation opening accessible to the worker is 1/4-inch or less in height with no workpiece in place (Figure 25); or (b) the opening is 1/4-inch or less with the workpiece in place [figure 26 (c); an opening 1/4-inch or less from the workpiece in place is considered a safe opening only when interlocks are provided to prevent slide motion unless the workpiece is in place]; or (c) when the setup, workpiece size, or operation is such that the slide, dies, or attachments will not close to a position which would create a hazard when the workpiece is either in or out of place [Figure 26 (b)].

A 1/4-inch or less opening will not permit any part of the worker's body to enter the point of operation; thus all are protected from a point of operation injury.

2. USE OF SAFE OPENING

Safe opening can be used as the safeguarding means on any mechanical power press setup that meets the requirements given in 1(a), 1(b), and 1(c) above. Refer to Tables 3 and 4 for more detailed information as to the use of safe opening.

3. INSTALLATION REQUIRED BY SAFE OPENING

The only installation required by the safe opening means of safeguarding the point of operation is the installation of interlocks as required by 1(b) above and supplemental safeguarding required by 1(a), 1(b), and 1(c) above. On some presses, the stroke can be adjusted to 1/4-inch or less. In most cases a die set is used to provide the safe opening.

4. MAINTENANCE REQUIRED BY SAFE OPENING

No special maintenance is required that is attributable to the safe opening means of protecting from point of operation hazards. The interlocks should be periodically checked for proper operation.

5. ADVANTAGES AND DISADVANTAGES OF SAFE OPENING

The following list of advantages and disadvantages, used in conjunction with Tables 3 and 4, will assist the safety professional in reaching a decision as to which safeguarding system is best suited for a particular mechanical power press.

A. Advantages of Safe Opening

1. Minimal maintenance is required.

2. There is no possibility of injury due to after-reaching into the point of operation.

3. The system is simple in operation.

4. There is no danger in the event of a repeat stroke or an uninitiated stroke.

5. No adjustments are necessary after press is initially adjusted to 1/4-inch point of operation opening or less.

6. Movement of the operator is unrestricted (both hands are free).

7. The system is ergonomically acceptable.

8. Work space around the operator is not obstructed due to safeguarding means.

B. Disadvantages of Safe Opening

1. The system has limited use. (Safe opening cannot, of course, be the safeguarding means on a press unless the conditions outlined in 1(a), 1(b), or 1(c) are met.)

2. Very careful die design is required.

3. The system may create incentives to sabotage or circumvent it.

6. SAFETY CONSIDERATIONS

The protection afforded by safe opening applies to the hands of every person, since the 1/4-inch opening allows none to enter. Thus both the worker operating the press and the passerby are equally protected.

Safe opening is particularly adaptable to primary operations and other blanking operations where flat, thin sheets are cut into blanks, and the opening necessary for loading and unloading is very small. This is true whether the material is fed manually, samiautomatically, or automatically. Safe opening can also be used on some secondary operations when the workpiece geometry allows die design with a 1/4-inch opening or less. Workpiece geometry is the controlling factor in the application of safe opening.

The safe opening safeguarding system also finds application in jobs where the material is thick or where secondary operations are performed on certain shapes of workpieces. This system allows the die opening to be larger than 1/4-inch when empty. Placing the workpiece in the die, however, reduces all openings to less than 1/4-inch. Since no safeguarding exists unless a workpiece is present, this system requires that the workpiece be interlocked with the control system to prevent the clutch from tripping if it is not in its protective position.

These interlocks can also provide a degree of protection from projectiles caused by mispositioned parts and doubleheaders, through detecting the proper positioning and ejection of workpieces. However, they must be included, for obvious reasons of practicality, in the initial design of the die. Since worker protection now depends on the continued proper functioning of these interlocks, they must meet the performance requirement of "dependable" design.

A related type of safe opening safeguarding is that which relies on a certain minimum opening which is intrinsically safe. This system is primarily applicable to straightening operations. Here the worker cannot injure his hand in the point of operation because: (1) with no workpiece in place, the moving dies never approach close enough to create a pinch point and, (2) with the workpiece in place, all pinch points are less than 1/4-inch. Since this system provides protection whether the workpiece is present or not, the workpiece does not need to be interlocked.

Any type of safe opening system can only be employed so long as the press is in a production mode. It is not possible to protect workers engaged in die setting and maintenance work by a safe opening, since until the die is set for 1/4-inch opening the protection does not exist, and die work is impossible with so small an opening.

When it can be used, however, an ordinary safe opening safeguarding system involves no components at all, except those needed to form the part, and thus when a part of the barrier die fails, production must cease until die repairs are made.

Safe opening is particularly useful in providing safeguarding on presses with positive or full revolution clutches, where inherent delayed, repeat, and uninitiated strokes may produce die damage and projectiles, but cannot cause amputations if fingers cannot enter the die.

For the same reasons, the protection afforded against injuries from after-reach and unintended strokes is complete.

Attaining this performance, however, requires a thorough understanding of special die design principles, careful die setting, and continued supervisory control to keep shortcuts and modifications from compromising safety.

Since very few mechanical presses are built with a fixed 1/4-inch stroke, which would be impractical, safe opening requires either an adjustable stroke press, a stripper, or the use of unitized tools which have an adjustable means of limiting the movement of the upper die shoe.

All accessible openings must remain narrower than 1/4-inch throughout the stroke. The pinch points created by the motion of the punches toward the stripper, or between the slide and the unitized tooling, are of course, a hazard, and must be safeguarded. Since the parts are fed elsewhere, this is easily accomplished through the use of supplemental barriers.

A very few presses in the United States are equipped with adjustable stroke. With such presses, special tooling is not needed. The stroke length is simply adjusted for a 1/4-inch die opening or less.

In either case, a multitude of other shearing and pinching hazards may exist; for example, the hazards posed by the punch holder's movement toward the stripper, lower die, scrapcutters, or feeding equipment. Like the spanker plate hazard, these areas need not be accessible, since they do not form the material, and thus the worker may easily be safeguarded from them by supplemental barriers.

One die hazard which must be given special attention regarding safe opening is the hazard of a bending edge of the workpiece. As any part of the workpiece is formed by the tools, it creates a pinching hazard between itself and the die or possibly the bolster or bed. In some cases, this hazard is accessible to the worker, even though the maximum die opening is 1/4-inch. If the die cannot be designed to eliminate these hazards by enclosing them or positioning them where they are not accessible to the worker, some other safeguarding system which provides protection from them must be provided.

Workers must correctly use those parts suitable for safe opening, design dies which fully eliminate hazards access, and in some cases, design and build special limited stroke tooling. The dies must then be correctly set and supplemental barriers installed. A mistake in any of the above jobs could compromise or eliminate the safeguarding system's effectiveness.

When safe opening is employed as the safeguarding system, the worker's visibility of the point of operation is poor, because of the restricted feed opening. As the size of the workpiece increases, visibility becomes poorer. The restricted opening also makes die access for jam clearing and die maintenance impossible, unless the safeguarding is removed by enlarging the opening. The needed supplemental barriers also create visibility problems, but these can be reduced through the use of flat black paints and vertically slotted materials or clear, abrasion resistant acrylics. The restricted visibility and access increase worker fatigue, especially if the workpieces are hand fed. Thus safe opening safeguarding creates incentives for workers to sabotage or modify the system, and almost ensures that any change will compromise the system's safeguarding performance. Thus the risk of loss of safeguarding performance is high.

There are no known mechanisms capable of reducing the effects of these human actions on the performance of a safe opening safeguarding system. Worker safety training and supervisory controls coupled with inspection and records such as the "Safety Inspecion Checklist for Safe Opening Safeguarding Systems", shown at the end of this discussion, are the only available means of reducing these risks. Also complete the "Safe Opening Safeguarding System Installation Checklist", shown at the end of this discussion, when a safe opening safeguarding system is installed.

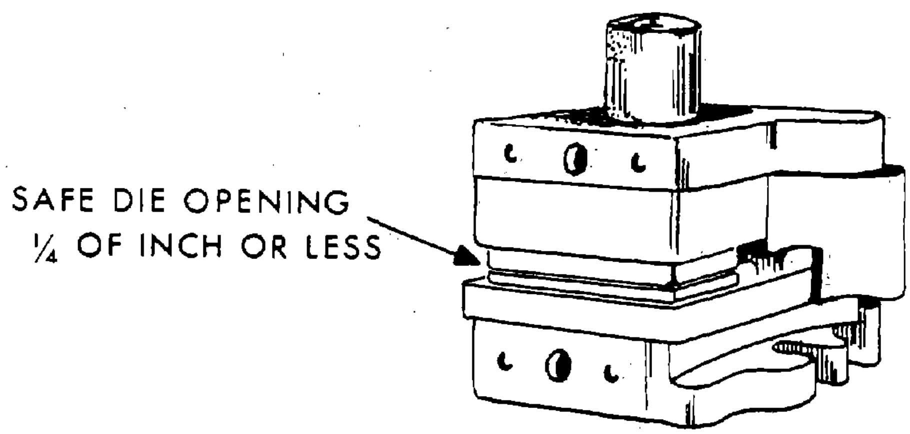


Figure 25. - An example of safe opening safeguarding.

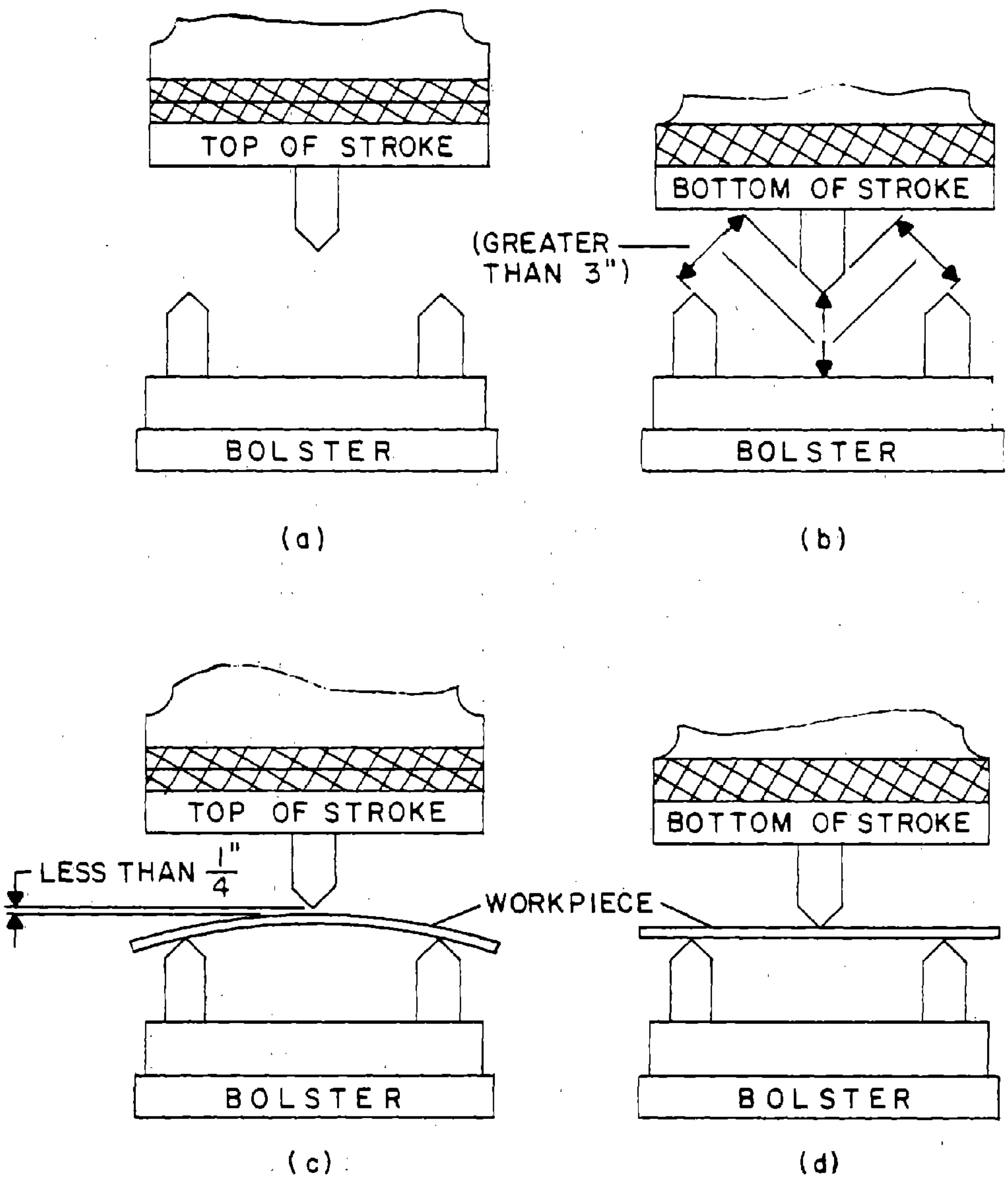


Figure 26. - Examples of safe opening safeguarding.

SAFE OPENING SAFEGUARDING SYSTEMS INSTALLATION CHECKLIST

This checklist must be completed when a safe opening safeguarding system is placed in service.

Does the system:

Yes	No		
___	___	1.	Meet the general safeguarding system requirements for power presses (page B-2)?
___	___	2.	Have a maximum die opening width less than 1/4-inch, or, have the maximum width of the opening above the workpiece less than 1/4-inch and have workpiece interlocks?
___	___	3.	Have the minimum width of the opening between unguarded portions of the die, ram, bolster, or materials, with the ram in the closed position, greater than 3 inches?
___	___	4.	Have supplemental barriers to prevent access through openings greater than 1/4-inch with the ram open and less than 3 inches with the ram closed?
___	___	5.	Eliminate all hazards created between the workpiece or supplemental barriers and press or dies?
___	___	6.	Have all openings so small that no worker can pass any part of the body into the point of operation?
___	___	7.	Have "dependable" design?
___	___	8.	Have a separate safeguarding system provided for protection during die setting, maintenance, and jobs not meeting these requirements?
___	___	9.	Have a safety training program instituted to ensure that all workers responsible for supervision, die setting, die design, and deciding whether safe opening safeguarding will be utilized, fully understand all of the design requirements?
___	___	10.	Have daily inspections, records, and supervisory controls on each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

SAFETY INSPECTION CHECKLIST FOR SAFE OPENING SAFEGUARDING SYSTEMS

This safety inspection checklist for safe opening safeguarding systems is a sample that includes the information that must be recorded:

1. At the start of each shift.
2. When the press stroke is adjusted.
3. When the dies are changed.
4. When the type or size of workpiece is changed.
5. When a safe opening related accident occurs.

NOTE: For safe opening safeguarding systems that require supplemental barriers or enclosures, also complete a "Safety Inspection Checklist for Barrier or Enclosure Safeguarding Systems" (page B-43) at these times:

1. At the start of each shift.
2. When the barrier or enclosure is removed and then reinstalled.
3. When any repair work is performed on the barrier or enclosure.
4. When the barrier or enclosure is modified.
5. When dies are changed.
6. When an adjustable barrier or enclosure is adjusted.

CHECKLIST

Yes No

___ ___ 1. Is the maximum die opening width less than 1/4-inch, or, is the maximum width of the opening above the workpiece less than 1/4-inch with workpiece interlocked?

___ ___ 2. Is the minimum width of the opening between unguarded portions of the die, ram, bolster, or materials, with the ram in the closed position, greater than 3 inches?

___ ___ 3. Are supplemental barriers in place to prevent access through openings greater than 1/4-inch with the ram open and less than 3 inches with the ram closed?

___ ___ 4. Are all hazards between the workpiece or supplemental barriers and press or dies eliminated?

___ ___ 5. Are all openings so small that no worker can pass any part of the body into the point of operation?

___ ___ 6. Is a separate safeguarding system provided for protection during die setting, maintenance, and jobs not meeting the above requirements?

If the answer to any of the above questions is "No", corrective action must be taken.

Yes No

___ ___ 7. Has the safeguarding system been sabotaged or otherwise rendered unsafe or ineffective?

___ ___ 8. Does the safeguarding system in any way create a hazard in itself?

If the answer to question 7 or 8 is "Yes", corrective action must be taken.

Describe any maintenance, replacement, modifications, adjustments, repairs, or other corrective action taken (if "none", so state): ____________________

____

____

____

____

Reason(s) for safety inspection. Check appropriate item(s):

___shift change
___press stroke adjusted
___die change
___size or type of workpiece change
___accident - in the case of a point of operation accident, the employer shall report it in accordance with 29CFR 1910.217(g).

Signature: ____________________
Title: ____________________
Date: ____________________
Shift: ____________________
Time: ____________________
Machine No.: ____________________
Serial No.: ____________________

SAFEGUARDING SYSTEMS WHICH PROTECT ONLY DURING DIE SETTING AND MAINTENANCE

A number of safeguarding systems may be used on mechanical power presses only for die setting and maintenance procedures. These include remote actuator safeguarding systems, zero flywheel energy bar safeguarding systems, and zero flywheel energy jog safeguarding systems.

REMOTE ACTUATOR SAFEGUARDING SYSTEMS

A remote actuator safeguarding system (Figure 27) is one in which the clutch actuator is located far away from the press. Because of the great distance, it is impractical for use during production runs which require the worker to closely watch the point of operation.

Thus remote actuation, as used on mechanical power presses, is useful only for die setting and maintenance, where the worker can walk back and forth between the actuator and press.

Since a remote actuator does not prevent access to the die, it provides no protection from repeat, delayed, or uninitiated strokes, and thus may not be used on a press equipped with a positive clutch. Conveniently, most positive clutches are also full revolution clutches, and thus die setting and maintenance must be performed with the flywheel at rest, using a "bar" or "jog" mode of operation.

Remote actuator safeguarding systems must thus only be used on presses equipped with a friction clutch. The actuator must be interlocked with the control system to preclude tripping whenever it is not operated, and must be permanently mounted at a sufficient distance to prevent any part of the body from being in the point of operation while operating the actuator in order to protect against the intended stroke. When this safety distance is made sufficiently long and a brake monitor is provided, a remote actuator system also protects against after-reach.

If two hand actuators are provided, the system need not meet such a long distance requirement, if it meets all requirements of a two-hand control safeguarding system.

In order to provide continued protection without depending on human action, the remote actuator system, including actuators, press controls, clutch, brake, and brake monitor, must be of "dependable" design.

The actuator itself must be protected against unintended operation, and since the system protects only the one worker, another safeguarding system must be provided to protect operators, helpers, and passersby.

Zero Flywheel Energy

Zero energy states as a means of preventing injuries while adjusting and maintaining machinery have been advocated by safety experts for several years. Although die setting and maintenance procedures on mechanical power presses cannot be performed without some energy left in the press (the slide may fall by gravity if the brake fails suddenly) the major hazard of the point of operation is being injured from the tremendous forces generated from the energy of the heavy, rotating flywheel.

Since the flywheel need not (indeed, must not) be rotating at any speed greater than a crawl during die setting and maintenance, it can be forced to be in a nearly zero energy state by appropriate control design whenever the "bar" or "jog" modes of operation are employed.

ZERO FLYWHEEL ENERGY BAR SAFEGUARDING SYSTEMS

A zero flywheel energy bar safeguarding system forces the flywheel to be at rest before the bar mode can be used to engage the clutch with the motor de-energized. Thus when the clutch is engaged, it will move only under the force of the man turning the flywheel with the bar, and the slide movement will be so slow that it is not hazardous. Turning the press with a bar is only possible on small presses, and thus this system can generally be used only on presses of 100 tons or less.

Either a motion sensor or a timing mechanism must be provided to meet the requirement for a motionless flywheel. The system must also prevent the motor from being energized so long as the clutch is engaged in the bar mode, in order to prevent an uninitiated stroke from occuring. This system must also be of "dependable" design to perform these functions as reliably as possible.

In order to prevent the bar from becoming a projectile by being left in the flywheel when the motor is energized, only spring-loaded turnover bars must be provided and used. This also requires supervisory control and a thorough training program. Another safeguarding system is needed for all other modes of operation.

ZERO FLYWHEEL ENERGY JOG SAFEGUARDING SYSTEMS

A zero flywheel energy jog safeguarding system forces the motor to be de-energized and the flywheel to be near rest before the clutch can be engaged in the "jog" mode of operation, and automatically de-energizes the motor whenever the speed of the flywheel causes the slide to move faster than 2 inches per second. Thus whenever the slide is in motion, its movement will be so slow that it is not hazardous. Either a motion sensor or a timing mechanism must be provided to meet these requirements.

This system must also be of "dependable" design to perform these functions as reliably as possible.

Another safeguarding system must be provided for protection in all other modes of operation.

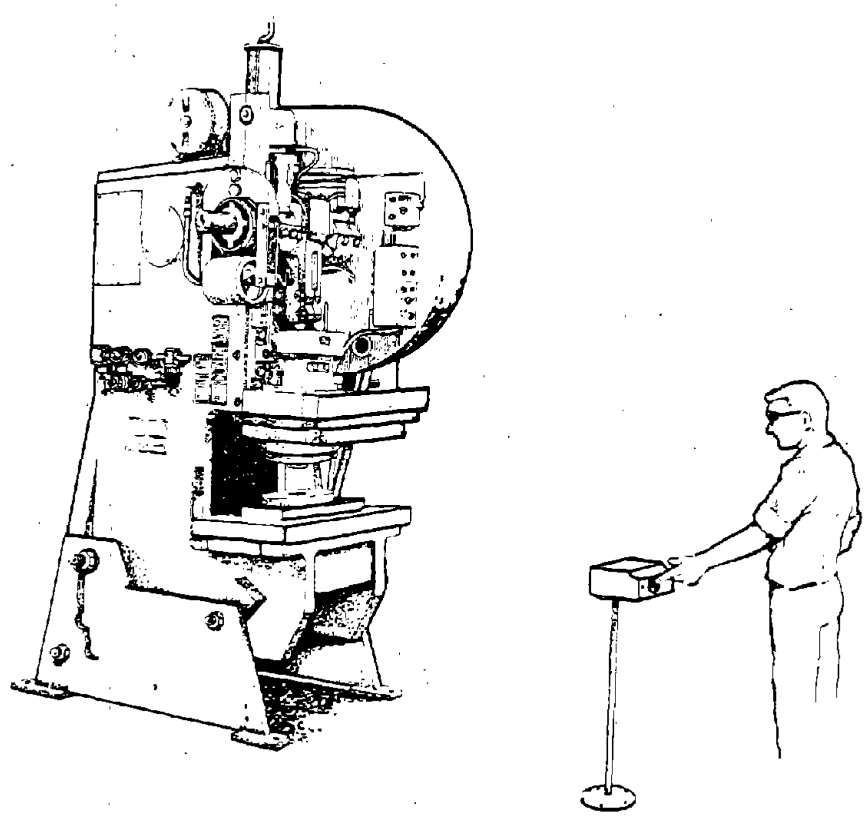


Figure 27. - An example of remote actuation.

REMOTE ACTUATOR SAFEGUARDING SYSTEMS INSTALLATION CHECKLIST

This checklist must be completed when a remote actuator safeguarding system is placed in service.

Does the system:

Yes No

___ ___ 1. Meet the general safeguarding system requirements for power presses (page B-2)?

___ ___ 2. Have a part revolution friction clutch?

___ ___ 3. Prevent the clutch from tripping whenever the actuator is not operated?

___ ___ 4. Quickly deactivate the clutch and apply the brake to stop slide motion whenever the actuator is released on any downstroke?

___ ___ 5. Have the actuator mounted at a safety distance (in inches) = [system stop time (in seconds) x 63 inches-second] + 72 inches?

___ ___ 6. Have fixed mounting of the actuator?

___ ___ 7. Have the position of the actuator so located as to prevent all parts of the body from being in the point of operation during stroking?

___ ___ 8. Have a brake monitor to prevent further stroking when stopping time has increased by a preset time increment and have this time increment added to the system stop time?

___ ___ 9. Have "dependable" design?

___ ___ 10. Have another safeguarding system to protect passersby, helpers, and other operators?

___ ___ 11. Have another safeguarding system to protect during any die setup, maintenance, or other operations not protected by this system?

If the answer to any of the above questions is "No", the system must not be placed in service.

ZERO FLYWHEEL ENERGY BAR SAFEGUARDING SYSTEMS INSTALLATION CHECKLIST

This checklist must be completed each time a zero flywheel energy bar safeguarding system is installed.

When the mode selectors are in the "bar" mode of operation, does the system automatically:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Incorporate a mechanism to prevent engagement of the clutch unless the flywheel is at rest?

___ ___ 3. Prevent energization of the motor unless the clutch is disengaged?

___ ___ 4. Have "dependable" design?

___ ___ 5. Have an additional safeguarding system to provide protection in every other mode of press operation?

___ ___ 6. Have a spring-loaded turnover bar provided for use with the system?

___ ___ 7. Have a safety training program instituted to ensure that all workers who are responsible for supervision, inspection, die design, and die setting fully understand the need for and use of the spring-loaded turnover bar?

___ ___ 8. Have a system of records, inspections, and supervisory controls ready for daily usage of each machine?

If the answer to any of the above questions is "No", the system must not be placed in service.

ZERO FLYWHEEL ENERGY JOG SAFEGUARDING SYSTEMS INSTALLATION CHECKLIST

This checklist must be completed each time a zero flywheel energy safeguarding system is installed.

When the mode selector is place in the "jog" mode of operation, does the system automatically:

Yes No

___ ___ 1. Meet the general power press safeguarding system requirements (page B-2)?

___ ___ 2. Incorporate a mechanism which prevents tripping the clutch whenever the flywheel is not at rest, and quickly de-energizes the motor whenever slide speed exceeds 2 inches per second?

___ ___ 3. Have "dependable" design?

___ ___ 4. Have an additional safeguarding system to provide protection in all other modes of press operation?

If the answer to any of the above questions is "No", the system must not be placed in service.

COMBINATION SAFEGUARDING SYSTEMS

In addition to the point of operation safeguarding systems previously discussed, numerous combinations of two or more of these systems can also be used. Various special needs may make the selection of such a combination the most practical safeguarding system. Examples of such combinations may be a two-hand control system for the operator at the front of a straight side press with a helper at the back side protected by a presence sensing system. Also, a pullout may be used on one hand with a restraint on the other hand of an operator. The important considerations for a combination system are that all the hazards are protected against by at least one of the safeguard systems, and that each system meets the necessary requirements for the hazards it protects against. (Refer to Table 3.) The best method is to have each system completely meet all the requirements as if it were the only safeguarding system.

Combination safeguarding systems are not to be confused with the concept of so-called redundant safeguards. Applying redundant safety devices without meeting the complete systems design requirements provides little increase in safety over application of a single device without complete systems design requirements. But worse, these redundant but incomplete devices have a great lack of safety when compared to a complete safety system which meets all systems requirements.

Figure 28 is an example of a combination safeguarding system.

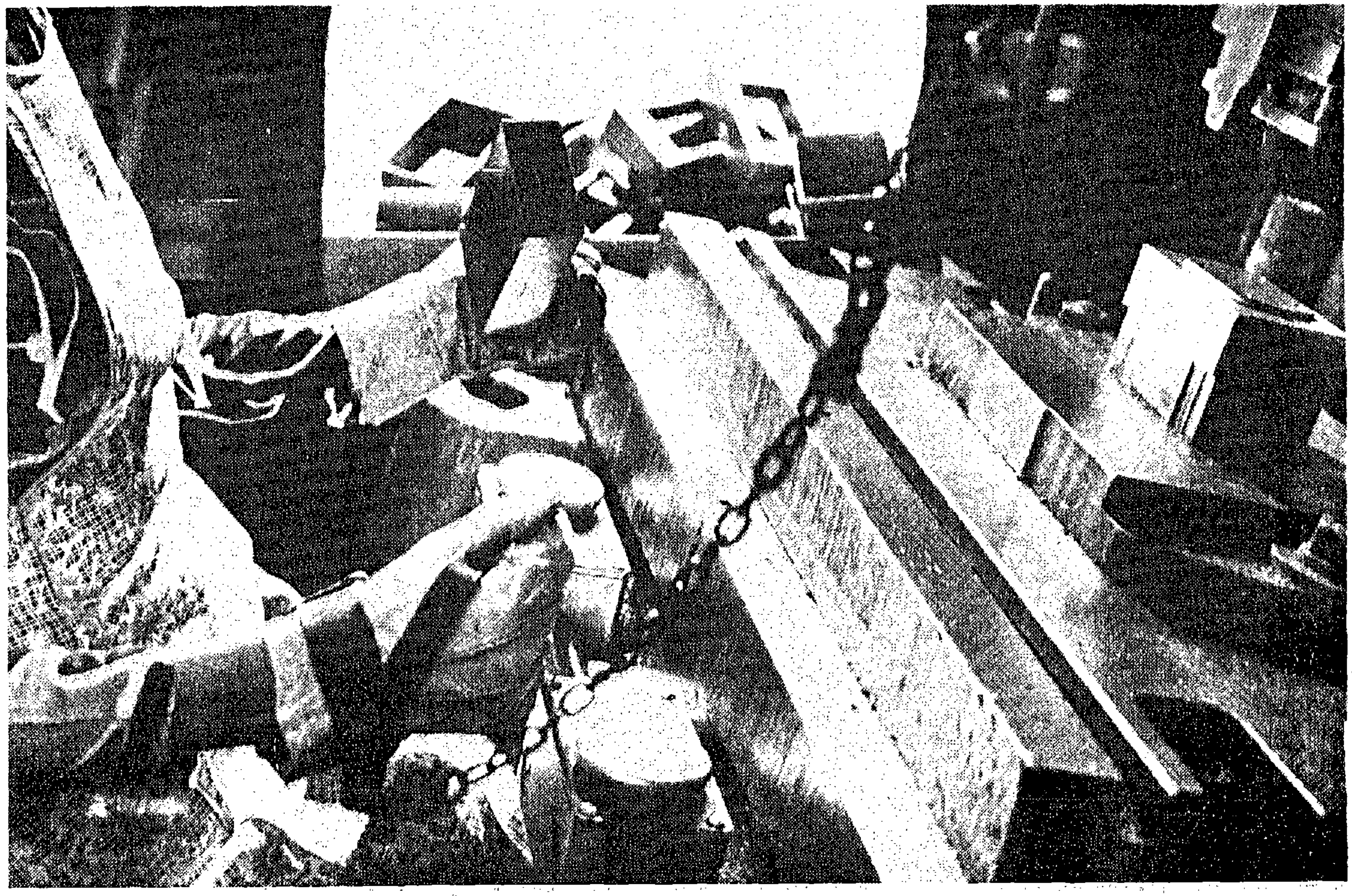


Figure 28. - A combination safeguarding system whereby the right hand is protected against after-reach by a pull-out, and the left hand is protected by a barrier that has been removed for clarity, and both hands are protected against unintended and intended strokes by a two-hand actuator.

SUBSECTION 3. - SAFEGUARDING SYSTEM SELECTION

SAFEGUARDING SYSTEM SELECTION MATRIX

Table 3 (following) is a summary of an evaluation of each of the commonly used safeguarding systems. These evaluations were made under the same contract which produced this Guide, and are not included in this Guide, but in a separate report which may be obtained from NIOSH. Those safeguarding systems which were evaluated were assumed to meet all the applicable requirements of the Safeguarding Systems Requirements list on pp. B-2 through B-29.

Use of the Matrix:

The matrix is designed to assist the safety professional in deciding which safeguarding system, or combination of safeguarding systems, provides the level of point of operation safeguarding performance needed by his workers for the particular workpieces or jobs, feeding methods, and machine hazards found in his plant. The matrix may also be used to evaluate the level of safeguarding provided by systems already in use in his plant.

Before using the matrix, the user should re-read all the pages in this Guide referenced in the first column of the matrix and all appropriate sections of the Safeguarding System Requirements lists referenced in the top row of the matrix. To evaluate a system, or combination of systems already in use, the user must first determine that the system meets all the requirements listed for them. He can then read the appropriate column of the matrix to determine how much point of operation hazard protection they provide. Whenever the user finds a matrix entry with a footnote, he must read both the appropriate footnote, and any pages of the Guide referenced there. Table 3 must be used in conjunction with Table 4, in order to check whether a given system can be used with all his detailed machine characteristics and working conditions, covered only by Table 4.

TABLE 3 - SAFEGUARDING SYSTEM SELECTION MATRIX

I. Safeguarding System which meets all requirements on pg. B-2 through B-4 affords initial protection.	Die Enclosure Barrier (Pg. B-5)	Interlocked Barrier (Pg. B-5)	Adjustable Barrier (Pg. B-5)	Fixed Barrier (Pg. B-5)	Type A Gate (Pg. B-7)	Type B Gate (Pg. B-9)	Pullouts (Pg. B-11)	Restraints (Pg. B-13)	Two-Hand Trip (Pg. B-14)	Two-Hand Control (Part Revolution Clutch Only) (Pg. B-16)	Presence Sensing (Vertical Sensing Field) (Pg. B-18)	Press Operated Sweep (Pg. B-21)	Safe Workpiece (Pg. B-22)	Safe Opening (Pg. B-2[illegible])	Remote Actuator (Pg. B-[illegible])	[illegible] Flywheel Turning Bar (Pg. B-28)	[illegible] Turning [illegible] (Pg. B-[illegible])
A. To Men																	
1. Operator(s) (Pg. F-7)	yes	yes	yes	yes	yes	yes	yes[1]	yes[1]	yes[1]	yes[1]	yes	yes	maybe[2]	yes	maybe[3]	no	[illegible]
2. Helper(s) (Pg. F-6)	yes	yes	yes	yes	yes	yes	yes[1]	yes[1]	no	no	yes	yes	maybe[2]	yes	no	[illegible]	[illegible]
3. Passer(s)by	yes	yes	yes	yes	yes	yes	no	no	no	no	yes	yes	maybe[2]	yes	no	no	[illegible]
4. Die Setter(s) (Pg. F-3)	no	maybe[3]	no	no	maybe[3]	maybe[3]	no	no	no	yes	yes	no	no	no	yes	yes	[illegible]
5. Maintenance Worker(s) (Pg. F-6)	no	maybe[3]	no	no	maybe[3]	maybe[3]	no	no	no	yes	yes	no	no	no	yes	yes	[illegible]
6. Body Parts Protected	all	all	all	all	all	all	two hands	two hands	two hands	two hands	all	all	all	all[4]	one hand	all[5]	all[5]
B. With Methods of Primary or Secondary Production with Manual or Semiauto. or Auto. Feed	all	all	all	all	all	all	most[6]	most[6]	most[6]	most[6]	all	all	most[7]	all	except[3] manual feed	[illegible]	
C. With Materials (Workpieces)	small or thin[8]	small or thin[8]	small or thin[8]	small or thin[8]	small or thin[8]	small or thin[8]	most[6]	most[6]	all	all	all[9]	small or thin[8]	large, heavy	thin[8]	all	[illegible]	
D. Against Machine Hazards Created by:																	
1. Uninitiated Strokes (Pg. F-11)	yes	yes	yes	yes	no[11]	no[11]	yes	yes	no[11]	no[11]	no[11]	maybe[10]	no[11]	yes	no[11]	[illegible]	
2. Repeat Strokes (Pg. F-8)	yes	yes	yes	yes	yes	no[11]	yes	yes	no[11]	no[11]	no[11]	maybe[10]	most	yes	no[11]		
3. Delayed Strokes (Pg. F-3)	yes	yes	yes	yes	yes	yes	yes	yes	no[11]	yes	yes	maybe[10]	yes	yes	no[11]		
4. Unintended Strokes (Pg. F-11)	yes	yes	yes	yes	yes	yes	yes	yes	most[12]	most[12]	yes	maybe[10]	yes	yes	most[4]		
5. Intended Strokes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	maybe[10]	yes	yes	yes		
6. After-reach (Pg. F-1)	yes	yes	yes	yes	yes[14]	yes[13] [14]	yes	yes	yes[13]	yes[13]	yes[13]	maybe[10]	yes	yes	yes[12]	yes[5]	yes[5]
7. Projectiles	yes[15]	yes[15]	yes[15]	yes[15]	yes[15]	yes[15]	no	no	no	no	no	maybe[10] [15]	no	no	no	no	[illegible]
8. System Itself	no[16]	no[16]	no[16]	no[16]	no[16]	no[16]	no	no[16]	yes	yes	yes	no[10]	yes	yes[17]	yes	yes[illegible]	yes

TABLE 3 - SAFEGUARDING SYSTEM SELECTION MATRIX (concluded)

II. Safeguarding Systems which meet all the requirements on pp. B-2 through B-4 give continued point of operation protection as follows: *System*	Die Enclosure Barrier (Pg. B-5)	Interlocked Barrier (Pg. B-5)	Adjustable Barrier (Pg. B-5)	Fixed Barrier (Pg. B-5)	Type A Gate (Pg. B-7)	Type B Gate (Pg. B-9)	Pullouts (Pg. B-11)	Restraints (Pg. B-13)	Two-Hand Trip (Pg. B-14)	Two-Hand Control (Part Revolution Clutch Only) (Pg. B-16)	Presence Sensing (Vertical Sensing Field) (Pg. B-18)	Press Operated Sweep (Pg. B-21)	Safe Workpiece (Pg. B-22)	Safe Opening (Pg. B-24)	Remote Actuator (Pg. B-26)	Zero Flywheel Energy Bar (Pg. B-28)	Zero Flywheel Energy [illegible] (Pg. B-39)
A. Technical																	
1. Retains function in the event of any single system component failure	no	no	no	no	yes[20]	yes[20]	no	no	yes[20]	yes[20]	yes[20]	no	yes	yes	yes[20]	yes[22]	yes
2. Precludes further strokes in the event of any single component failure	no	no	no	no	yes[20]	yes[20]	no	no	yes[20]	yes[20]	yes[20]	no	no	no	yes[20]	yes[22]	yes
3. Eliminates need for inspections and records of clutch/brake	no	no	no	no	yes[18][20]	yes[18][20]	no	no	yes[19][20]	yes[18][20]	yes[18][20]	no	no	no	yes[18][20]	yes	yes
4. Precludes operation if rendered ineffective	no	no[21]	no	no	no[21]	no[21]	no	no	yes[20]	yes[20]	yes[20]	no	no	no	yes[20]	yes[22]	yes
5. Is difficult to render ineffective	no	no	no	no	no	no	no	no	yes[20]	yes[20]	yes[20]	no	no	no	yes[20]	yes[22]	yes
B. Ergonomic																	
1. Is immune to inadvertent loss of function	no	no[21]	no	no	no[21]	no[21]	no	no	yes	yes	yes	no	no	no	yes	yes[22]	yes
2. Retains function throughout range of operating adjustments	yes	yes	no	yes	no	no	no	no	yes[23]	yes[23]	yes[23]	no	yes	no	yes[23]	yes	yes
3. Provides a high level of die visibility	no[15]	no[15]	no[15]	no[15]	somewhat[15]	somewhat[15]	yes	yes	yes	yes	yes	somewhat[15]	yes	no	yes	yes	yes
4. Provides a high level of die accessibility	no	no	no	no	somewhat	somewhat	yes	somewhat	yes	yes	yes	somewhat	yes	no	yes	yes	yes
5. Minimizes worker effort and fatigue	somewhat	somewhat	somewhat	somewhat	somewhat	somewhat	no	no	somewhat	somewhat	yes	no	sometimes[24]	yes	no	no	no
C. Behavioral																	
1. Creates little incentive sabotage or modification	no	no	no	no	no	no	no	no	somewhat	somewhat	yes	no	yes	no	somewhat	yes[22]	somewhat
2. Provides low level of reliance on supervisory control	no	no	no	no	no	no	no	no	somewhat	somewhat	yes	no	no	no	somewhat	no[22]	yes
3. Provides low level of reliance on worker training	somewhat	somewhat	no	somewhat	somewhat	somewhat	no	no	yes	yes	yes	no	no	no	somewhat	no[22]	yes
4. Is highly immune to unsafe acts	no	no	no	no	somewhat	somewhat	no	no	yes[12]	yes[12]	yes	no	no	no	somewhat	yes[22]	yes

FOOTNOTES TO TABLE 3:

1. If provided and used.
2. Case (a) yes; Case (b) or (c) only one worker is protected. (Refer to page B-120.)
3. Greatly increases time and effort for job, but can be used.
4. If "minimum openings of 3 inches" are not safeguarded, only body parts smaller than three inches are protected. (Refer to page B-120.)
5. Since slide movement is very slow, worker can react quickly enough to avoid injury.
6. Generally impractical for automatically fed jobs.
7. Generally impractical or not applicable to anything except manually fed jobs. (Refer to page B-120.)
8. Can be used with large workpieces if designed for them or adjustable for them.
9. Bending operations on pieces which have flanges greater than two inches in the sensing field require a horizontal sensing field, which is not evaluated here.
10. If the system is designed to protect from this hazard , it creates a hazard in itself, which cannot be safeguarded by system design.
11. No protection is afforded from uninitiated, repeat, or delayed stroke should it occur. However, if the system has a friction clutch and "dependable" design, its probability will be nearly zero (Refer to pp. C-1 to C-4 and pp. C-14 to C-23.)
12. No protection is afforded from the unintended stroke if a passerby or helper operates an actuator.
13. If a part revolution friction clutch and sufficient safety distance are provided. (Refer to pp. C-5 to C-6.)
14. If gate is held closed throughout all slide motion in the downstroke.
15. Performance level depends on construction and materials.
16. Creates hazards which can be eliminated by design.
17. Safe opening must not be used unless there are no accessible hazards. (Refer to page B-128.)
18. If a friction clutch and brake monitor are used. (Refer to pp. C-1 to C-4.)
19. If a friction clutch and a "starting monitor" or "start time monitor" are used. (Refer to pp. B-14 to B-15 and page B-93.)
20. Because of "dependable" system design. (Refer to pp. C-1 to C-4.)
21. Precludes further stroking only if barrier is interlocked and simply removed.
22. Except and because of the spring-loaded turnover bar.
23. If sufficient safety distance is provided by fixed mounting of the actuator(s) or sensing device.
24. Case (a) yes; Case (b) and (c) force the worker to support an awkward workpiece which could otherwise be mechanically supported.

SAFEGUARDING SYSTEM SELECTION WORKSHEET

Table 4 (on the next page) is a worksheet to be used to assist in making a decision as to which type of safeguarding system is best suited for a particular mechanical power press, or which press characteristic or working condition is acceptable with a particular press. Table 4 should be used in conjunction with Table 3 in making the decision.

To use Table 4, go to the "Worksheet Column" and in it place a checkmark opposite each appropriate press characteristic or working condition shown in the "Press Characteristics or Working Conditions" column that describes your particular press or working condition. For every checkmark entered, refer to the right in the "Safeguarding System" section. If the entry in the "Safeguarding Systems" column is "Go on" it means that safeguarding system can be used for that press characteristic or working condition and you should go on to the next entry. If considering a safeguarding system, go vertically. If considering a press characteristic or working condition, go horizontally. When you reach an entry that gives a reference page (e.g. pg. A-47) you should refer to that page in this Guide for more information that will assist you in making a decision.

In the "Press Characteristics or Working Conditions" column are two characteristics entitled "Start Time Characteristics" and "Stop Time Characteristics". These characteristics apply only to those safeguarding systems where start and stop time is a factor in selecting a safeguarding system. If you are contemplating such a system, then record the press start or stop time in the "Worksheet Column" opposite these characteristics and proceed vertically under that system.

"N/R" (not recommended) or "N/A" (not applicable) means that safeguarding system cannot be used with that press characteristic or working condition, or conversely, that press characteristic or working condition is not compatible with that safeguarding system.

In the "Safeguarding Systems" column a reference page is given for each safeguarding system. Go to that reference page for a complete description of each safeguarding system.

TABLE 4 - SAFEGUARDING SYSTEM SELECTION WORKSHEET

PRESS CHARACTERISTICS OR WORKING CONDITIONS	WORKSHEET COLUMN	SAFEGUARDING SYSTEM: FIXED BARRIER Pg. B-35	ADJUSTABLE BARRIER Pg. B-35	INTERLOCKED BARRIER Pg. B-35	DIE ENCLOSURE BARRIER Pg. B-35	TYPE A GATE Pg. B-45	TYPE B GATE Pg. B-45	PULLOUT Pg. B-64	RESTRAINT Pg. B-75	TWO-HAND TRIP Pg. B-82	TWO-HAND CONTROL Pg. B-82	PRESENCE SENSING Pg. B-101	PRESS OPERATED SWEEP Pg. B-115	SAFE WORKPIECE Pg. B-120	SAFE OPENING Pg. B-128	REMOTE ACTUATION Pg. B-137	ZERO FLYWHEEL ENERGY BAR Pg. B-138	ZERO FLYWHEEL ENERGY JOG Pg. B-138
PART REV. FRICTION CLUTCH (Pg. C-18)		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Pg B-14	Pg B-16 B-82	Pg B-18, B-101	N/R Pg B-21	Go on	Go on	Pg B-26 B-137	Go on	Go on
POSITIVE OR FULL REV. CLUTCH (Pg. C-14)		Pg B-3	Pg B-3	Pg B-3	Pg B-3	Pg B-3	Pg B-45	Pg B-3	Pg B-3	N/R, Pg B82, B14	N/R Pg B82, B16	N/R Pg B18, B101	N/R Pg B-21	Go on	Go on	N/A Pg B-137	Go on	Go on
STRAIGHT SIDE		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	Go on	Go on
GAP		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	Go on	Go on
SINGLE ACTION		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B 137	Go on	Go on
MULTIPLE ACTION		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	Go on	Go on
MANUAL FEED, PRIMARY OPER.		Pg B-5	Pg B-5	Pg B-36 B-5	Pg B-5	Pg B-45 B-7	Pg B-45 B-9	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	N/A	N/A
MANUAL FEED, SECONDARY OPER.		Pg B-5	Pg B-5	Pg B-16 B-5	Pg B-5	Pg B-45 B-7	Pg B-45 B-9	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	N/A	N/A
AUTOMATIC FEED		Pg B-5	Pg B-5	Pg B-36 B-5	Pg B-5	Pg B-45	Pg B-45	N/A Pg B-64	N/A Pg B-75	N/A Pg B-82	Pg B-16	Go on	N/R Pg B-21	N/A Pg B-22	Go on	N/A Pg B-137	N/A	N/A
SMALL WORKPIECE		Go on	Go on	Go on	Go on	Go on	Go on	Pg B 64	Pg B-75	Go on	Pg B-82	Go on	N/R Pg B-21	N/A Pg B-22	Go on	N/A Pg B-137	N/A	N/A
LARGE WORKPIECE		Go on	Go on	Go on	Go on	Pg B-48	Pg B-49	Go on	Go on	Go on	Pg B-82	Go on	N/R Pg B-21	Pg B-122	Go on	N/A Pg B-137	N/A	N/A
MORE THAN 75 STROKE/MIN.		Go on	Go on	Go on	Go on	Go on	Go on	Pg B-16	Go on	Pg B-82	Pg B-82	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	N/A	N/A
LESS THAN 75 STROKE/MIN.		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Pg B-82	Pg B-82	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	N/A	N/A
STARTING CHARACTERISTICS		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Pg C-5	Pg B-82	Go on	N/R Pg B-21	Go on	Go on	N/A Pg B-137	N/A	Pg B-138
STOPPING CHARACTERISTICS		Go on	Go on	Go on	Go on	Pg B-45	Pg B-45 C-5	Go on	Go on	Go on	Pg C-5	Pg C-5	N/R Pg B-21	Go on	Go on	Pg C-5	N/A	Pg B-138
MORE THAN 100 TON		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	Go on	N/A Pg B-138	Go on
LESS THAN 100 TON		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B-21	Go on	Go on	Go on	Go on	Go on
MORE THAN 1/4" DIE OPENING		Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	Go on	N/R Pg B 21	Go on	N/A Pg B-129	Go on	N/A	N/A
1/4" OR LESS DIE OPENING		Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	Pg B-128	N/R Pg B-21	Pg B-128	Pg B-24	Pg B-128	N/A	N/A

SUBSECTION 4. - SAFEGUARDING FROM OTHER HAZARDS

SAFETY BLOCKS

Safety blocks is the term used to describe a prop that, when inserted between the face of the slide and the bolster plate, prevents the slide from falling of its own dead weight. Sometimes the terms die blocks and safety blocks are used interchangeably. Die blocks are essentially the same thing but since they are intended to be inserted between the upper and lower dies they must usually be of a design fitted to the die.

The use of safety blocks is required by current regulations when adjusting or repairing dies while in the press. The use of safety blocks, however, poses some very serious safety problems that must be dealt with before using them.

The first problem is that of a possible powered stroke with the safety blocks under the ram. Usually the safety blocks do not have sufficient strength to withstand the tonnage pressure of a powered stroke. If these shatter, not only will the ram descend but a danger created of flying broken parts. Even if so-called "full tonnage" safety blocks are used, the danger of broken parts flying off of the machine is very great. For this reason all safety blocks must be interlocked.* These interlocks must be in the main drive motor circuit so as to cause drive to cease and the flywheel to come to rest whenever the safety blocks are used.

These interlocks usually consist of an electrical plug mechanically attached to the safety blocks which complete the electrical circuit to the main drive motor and also the electrical clutch/brake control circuit when the safety block is in its stored position. In order to place the safety block under the ram it is necessary to remove the plug, thereby breaking the electrical connection causing the motor to stop, the clutch to be released, and the brake to be engaged. Necessary design precautions are required so that the electrical connections are not easily made with tools and wire readily available to the worker, thereby circumventing the need to store the safety blocks before power stroke can be obtained.

The second safety problem is the probable substitution of safety blocks for a safely designed and maintained press. The very statement of use of safety blocks (prevent the ram from falling of its own dead weight) is an admission of an inadequate design. When the press fully complies with the current regulation with regard to brakes, and further when the entire press meets the recommendations of this Guide, safety blocks are an added factor of safety. Until the press is in full compliance with the regulation and requirements of this Guide, safety blocks provide a vital safety function when properly interlocked.

*Exceeds 29CFR 1910.217.

A third safety problem that needs recognition is the possible substitution of safety blocks for good safety practices. When performing adjustment or repair on dies the first consideration should be to remove the dies from the press, especially if such efforts are extensive and time consuming. However, if the work is to be performed while the dies remain in the press, the method of primary safeguarding must be zero flywheel energy. The use of safety blocks (interlocked) must be supplemental to, and not in substitution of, removing drive motor power, disengaging the clutch, engaging the brake, and waiting for the flywheel to stop before beginning adjustment or repair on dies in the press. Further the upper die fasteners must not be loosened or altered except as established in die setting procedures. The use of safety blocks are not to be substituted for good die setting practices and procedures.

It is recommended therefore, that:

1. First consideration be given to remove the die from the press for adjustment and repair, if feasible.

2. Only interlocked safety blocks be used when adjusting or repairing dies while in the press.

3. The condition of zero flywheel energy be established and maintained while adjustments and repairs are performed on dies while in the press, in addition to the use of safety blocks.

4. A properly installed and applied "dependable" safeguarding system be used to protect die setters and maintenance personnel for all those procedures where the safety blocks must be removed from under the ram for the purpose of moving the dies together.

5. A proper and safe practice and procedure be used for all installation, adjustment, repair and examination of dies while in the press.

FEEDING EQUIPMENT SAFETY CONSIDERATIONS

The advantage of any type of feeding equipment is an economic consideration. Secondary safety benefits are sometimes derived by reducing the need for workers engaged in production runs to enter the point of operation to load or unload the dies. But feeding equipment does not in itself provide any worker protection from point of operation hazards. Safety precautions must be taken with or without feeding equipment.

Feeding devices can be divided into two groups: manual and semiautomatic, and automatic. Manual and semiautomatic devices require worker attention or action for each part produced. They include hand tools, chutes, plungers, and moving die devices such as dial feeds, and sliding and rolling bolsters. Hand tools are the simplest of the feeding devices. They are available from a large number of manufacturers in an array of styles, but generally fall into four subgroups: tongs, suction and vacuum lifters, magnetic lifters for loading workpieces, and prying tools for extracting stuck workpieces. The worker picks up the workpiece with a hand tool, places it in the die, and then releases it before tripping the press. After forming, the workpiece may also be unloaded by means of the hand tool, and sometimes, the part is pryed out of the dies with a special extractor tool. Thus, in theory, the worker does not place his hands in the dies, only his tools. The use of the tool does not prevent him from doing so, however.

The hand tool often feels unnatural to the worker and he must use it until he "gets the feel" of the tool, the part, and the series of movements necessary to place the part accurately in the die. Also, the parts which must be nested in the dies, or are formed in the die, generally require a degree of force and touch to be loaded and unloaded which is very difficult to obtain with a hand tool. Workers have been observed holding a workpiece with a hand tool in the right hand and placing it in the die, only to force it down into the nest with the free left hand. Even those workers who do feed completely by means of the tool will drop the tool and use their hands if they encounter difficulty and may not even realize they have done so. If incentive based pay rates are used, the worker will use his hands whenever he thinks it is necessary because his hands are faster than tools. Thus hand tools alone cannot be relied on for point of operation safeguarding, making other forms of safeguarding necessary.

The safeguarding means most often used with hand tools is the barrier or enclosure safeguarding system. At first reflection, this may seem a poor choice, since the requirement for small opening size to preclude placing a hand in the die would seem to be very difficult to satisfy, without making it impossible to feed the part with the hand tool. Of course, this is impossible for large parts; however, some press users have achieved success using specially designed barrier openings which so conform to the part so that both hand tool feeding and safeguarding are achieved. This method, however, relies heavily upon supervisory controls and requires a different barrier for almost every die and part. More commonly, adjustable barriers are used, and so adjusted for each part and die that feeding with the hand tool is possible. A problem with adjustable barriers and hand tools is the poor visibility associated with most adjustable barriers which greatly increases the risk of midadjustment by creating an incentive to sabotage the safeguarding system.

An inherent hazard in the use of hand tools is that of projectiles produced if the tool is in the dies when the dies close. Some safeguarding systems, such as gates and presence sensing and, to a limited extent, two-hand control, are capable of reducing the risk. Others, especially barriers, pullouts, and restraints cannot. If the worker feels no danger when using the tool, his tendency to minimize movement causes him to withdraw the tool after loading only as far as necessary. This distance is often just far enough to clear the die. As these motions are repeated, mistakes eventually occur, and hand tools are caught by the die. When this occurs there is great danger of a finger or hand being crushed between the hand tool and the bolster plate. In some shops the hand tool is used to hold the part while it is being stamped. To avoid destroying an excessive number of hand tools, recesses are ground into the die to accommodate the tool. However, human error will inevitably result in the tool being mispositioned at the moment the dies close. Requiring the worker to hold his hand tool in the die greatly increases the risk of injury due to misplacement of the hand tool.

The use of hand tools is in general not recommended. There are many reasons for this. Some of them are:

1. Worker safety must be present without consideration of the hand tool, thus it adds nothing.

2. The risk of injury from the misuse of the hand tool is so great that it adds a large negative safety factor.

3. The hand tool is ergonomically wrong. It produces worker fatigue and frustration, and induces a high degree of incentive to circumvent, sabotage, or misuse.

A chute can be used for both loading and unloading some workpieces. Since the part must be shaped to accurately slide into the die, chute loading and unloading is possible; however, barrier safeguarding is usually used, since the worker does not need to enter the die. However, chutes are susceptible to mispositioned workpieces, resulting in jamming. Other types of safeguarding may be a better choice than barriers to facilitate removing jams.

Plunger loaders are similar to chutes, but do not rely on gravity. The plunger forces the part into the die nest, providing more accurate positioning. In addition, the plunger can be interlocked with the control system to preclude a press stroke unless the workpiece is correctly positioned in the die.

Another group of feeding devices which require worker action with every press stroke are revolving, sliding, and rolling dies and bolsters. These mechanisms move the lower die out from under the press slide toward the worker, allowing him to load the die without entering the point of operation. Since the die is thus subject to mispositioning when it is placed under the slide for stamping, the hazards of projectiles exists. Commercially built models use control interlocks which preclude tripping the clutch unless the die is correctly positioned. Because damage done by a misplaced die can cause an extreme hazard , these interlocks must operate in the most reliable manner. The need for interlocks makes the use of gates or movable barriers with these devices a very common combination. However, special care must be taken to avoid any shearing hazards caused by the motion of the mechanism and die in proximity to the movable barrier and supplemental barriers. Other safeguarding systems, such as two-hand trip, two-hand control, and presence sensing are also used successfully.

Strip and roll feeding equipment is often used in primary operations to feed a long piece of material into the dies for blanking operations. These mechanisms are generally powered by either the press crank or auxiliary electric motors or pneumatic cylinders. They incorporate control systems which supply the right amount of material to the dies automatically with each press stroke. Thus the press is allowed to run continuously, without pausing in the dies open position for each part produced. The main purpose is to produce parts faster than is possible with manual loading. This eliminates the need for workers to enter the dies or perform any operation except lead the strip in for the first hit and replenish the supply of material thereafter, so long as the system performs properly. The feeding mechanism does not, however, prevent workers from entering the dies, and thus some safeguarding system is necessary.

Transfer mechanisms on part revolution clutch presses are often combined with roll feeds and multiple dies to perform both primary and secondary operations sequentially in the same press. Transfer mechanisms are of the "mechanical hand" type, picking up workpieces, lifting, moving, and placing them in the next die. Because they, like hand tools, create the hazard of projectiles if they fail and remain between the dies as the dies are closing, their mechanisms must be interlocked with the control system to stop the press if they are out of position. Since positive or full revolution clutch presses cannot be stopped, once started, except at the top of the stroke, transfer mechanisms are unsuitable for use with them.

An inherent hazard with transfer mechanisms, roll and strip loaders, moving die and bolster devices, and plunger feeds, is the additional pinch, shear, and impact hazards associated with their mechanisms. These hazards, which would not exist if manual loading was employed, are usually much closer to and thus are as great a risk to the worker as the point of operation hazard. This is especially true of those mechanisms which are driven by the press crank, and thus have great operating force, but also those which are air or electrically operated, since they must push and pull large masses of heavy material or tools in and out of the press. Careful design can eliminate some, but not all, of these hazards. However, the technology for safeguarding them does exist, and they should be safeguarded as if they were in the point of operation.

Automatic unloading devices have long been used to speed production for economic reasons. Strippers and knockouts are devices incorporated in the die to eject the workpiece after stamping by stripping it off the punches or knocking it out of the die nest. Air blasts, spring loaded "flickers", and sometimes transfer mechanisms are mechanisms commonly employed to remove the loose parts from the die area. Moving trays can be used to catch the parts as they fall and carry them out of the dies. Small OBI presses are often inclined to facilitate unloading by gravity. Unloading mechanisms are used more extensively than loading mechanisms and are often used when parts are loaded by hand, for the purpose of higher productivity. Parts are most conveniently unloaded out the dies or back of the press, away from the worker's position. When unloading mechanisms are used they are usually adequately safeguarded by location or barriers. Those parts which move in the die area can be safeguarded by the same means used to safeguard the point of operation.

The means of safeguarding most commonly used with feeding equipment is barriers. Barriers, of course, only protect the worker during normal production. The barriers must be removed for clearing jams, die setting, and feeding equipment setup and thus the barriers must either be interlocked to preclude tripping the clutch when they are removed or some other form of safeguarding must be selected. Presence sensing safeguarding has been found very useful where die access is required such as for scrap removal. It is usually impractical to use interlocked barriers when transfer mechanisms, roll or strip feeds, or unloading mechanisms are adjusted, thus other safeguarding systems are preferred for such operations.

In summary, the use of feeding mechanisms is an economic consideration. Safety considerations for the worker must recognize that point of operation hazards exist with or without such feeding equipment. The use of feeding equipment in lieu of a proper point of operation safeguarding system must not be done. Often the use of feeding equipment makes safeguarding more difficult for not only must the point of operation hazards of the press be considered but all the hazard points of the feeding mechanisms must be adequately safeguarded.

SAFEGUARDING FROM HAZARDS OTHER THAN POINT OF OPERATION HAZARD

Section 29CFR 1910.212 of the Occupational Safety and Health Standards states, "One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area, from hazards such as those created by. . . ingoing nip point, rotating parts, flying chips and sparks. . . Guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself. . . Machines designed for a fixed location shall be securely anchored to prevent walking or moving." Section 29CFR 1910.217(b)(1) states, "Machine components shall be designed, secured, or covered to minimize hazards caused by breakage, or loosening and falling or release of mechanical energy (i.e. broken springs)." Refer to 29CFR 1910.219 for information on how to protect from hazards of mechanical power transmission apparatus.

Most mechanical power press manufactureres build in guards on new presses for ingoing nip points and moving parts such as flywheels, gears, sheaves, shafts, belts, chains, and pinch points between the slide and stationary components of the machine. Presses built before 1971 usually require upgrading to meet the current regulation.

Unfortunately, many presses are being operated with no guards for ingoing nip points and rotating parts, manufacturer built or otherwise. Even where guards exist they are often removed and left off the press because it is considered inconvenient to remove and replace the guard each time the press has to be serviced or repaired. The user of unguarded or improperly guarded presses is subject to at least two unpleasant consequences: accidents and OSHA penalties.

Certain precautions are necessary when designing and installing guards for moving parts of the press. Often the proper consideration is not given to visibility of the crank angle for setting of dies and other needs. Further, convenient access to the flywheel for the purpose of barring must be provided. Care must also be taken not to have a guard enclosure trap the oil-laden exhaust air from the clutch/brake control valve around the clutch/brake friction plates. Great loss of clutch and brake torque can result, with greater danger to the operator from increased stopping time as a consequence.

Guarding of ingoing nip points and moving parts is usually accomplished by (a) location, (b) fencing, and (c) guards. The current regulations do not state where or when these methods may be used. However, the regulations do require that the method chosen given adequate protection from the hazard during all normal working conditions.

Guarding by location simply means that the nip point or moving part is so located that it is impossible, during normal operation, for anyone to have access to the hazard.

Fencing is guarding by means of a fence or rail that makes it impossible for anyone to reach the hazard. Fences or rails must be so located that no person can lean over, reach under, reach through, or reach around them into the hazard.

Guards are enclosures that obstruct entry to the hazard area. They must be so constructed and affixed that it is impossible for any part of the body to reach the hazard area by reaching around, under, over, or through them. Refer to "The Principles and Techniques of Mechanical Guarding", published by the U.S. Department of Labor, for examples of guarding for ingoing nip points and moving parts.

Shields may be used to protect from flying chips, sparks, and splashing lubricants. These shields should not be confused with point of operation protection. When shields are used, visibility is often still necessary. Therefore many shields are constructed of chemical and impact resistant plastic which will allow observation and at the same time protect against these hazards. The shield can be the stationary or moving type, depending on the job and type of press.

Projectiles are not a common occurence on mechanical power presses, although they do happen. A projectile is usually produced when a die shatters or when a doubleheader occurs. Doubleheading is overloading the press by cycling it when two parts are simultaneously positioned in the die. This usually occurs when the completed workpiece is not removed from the die and another workpiece is fed in on top of it.

Barriers and gates offer partial protection from projectiles. However, where projectiles are a prominent hazard, special consideration must be given to this hazard over and above that of point of operation safeguarding. Often a heavy steel plate is used for construction of movable barriers, with other safeguarding such as two-hand control used to protect the worker from the hazards of the movable barrier.

SECTION C

TECHNICAL AND OTHER CONSIDERATIONS OF MECHANICAL POWER PRESS SAFETY

DEPENDABLE SAFEGUARDING SYSTEM DESIGN

"Systems analysis" is a modern method of problem solving. By using this approach for safeguarding, the entire system can be analyzed instead of small sections. Many techniques can be used but the basic underlying item is the definition of the system and its components. The initial system is broad in nature and as the levels of detail are uncovered the nature becomes more specific. This method can be used to analyze the system at all levels of complexity.

The mechanical power press system can be defined as the man, machine, and work method with an input and outpout which is material. The need for the system is to produce. The man is necessary to feed and unload the machine, the machine is necessary to do the work, the material is necessary to make a product, and the work method is necessary to complete the job.

The sole consideration of safety is to protect the man. Therefore a safeguarding system is the second level of detail to be considered. The strength of any system depends on its weakest link. To strengthen the system the weak link is either designed stronger or eliminated. In this system the man is the weakest link. It is impossible to redesign him and training can only reduce the number of mistakes, never eliminate them. Therefore the man should be eliminated as much as possible from the system. The method of doing so is to design the machine, material, and work method in a manner as to make the man safe. This technique is called dependable design and involves several important concepts. The definitions of these concepts are as follows:

A safeguarding system has dependable design if it allows the press operator to rely on it to prevent him from receiving a point of operation injury in all phases of the work cycle (including production, maintenance, and die setting) and especially in the event of a functional component failure within the system. A dependable system incorporates all the design features of RELIABILITY, FAIL-SAFE, REDUNDANCY, and SELF-CHECKING.

RELIABILITY is a design feature of the safeguarding system which allows the system to perform for an extended period of time without a failure. It is usually expressed as mean time between failures (MTBF).

FAIL-SAFE is that feature of a press safeguarding system that ensures that the most probable mode of failure of each and every system component will result in a safe condition for the worker.

REDUNDANCY is a design feature that provides multiple components and/or signal paths such that the failure of one component or circuit may be "masked" by the redundant element and the system continues to perform properly as though no failure had occurred. Thus redundancy is one means of greatly improving reliability. However, redundancy falls short of providing dependable design. Its major shortcoming is that if the failure is "masked", once a failure occurs redundancy no longer exists and by continued operation a subsequent failure may result in an overall failure and possible unsafe conditions. Redundancy is a valuable factor but taken alone is far from assuring dependability.

SELF-CHECKING is the design feature of the system which enables it to monitor itself, and which indicates any failure, usually by precluding continued operation of the system.

Technically the work method and material are inherently safe. Therefore the dependable design must go into the machine.

At the safety system level the interaction between the individual components and mechanisms must be so designed as to always fail to a safe condition.

The first step is to design with components and mechanisms that have high reliability. Reliable components give the system initial safety due to their low failure rate. Designing these components so they will most likely fail-safe adds a second dimension to the control. A system designed with reliable components and to most likely fail to the safe condition will eventually fail to an unsafe condition and present a potential safety hazard.

Thus, the third step is to add redundant or multiple components doing the same work. However, once a redundant component has failed to an unsafe condition it will go unnoticed and the system can still operate and the safety derived through redundancy is eliminated to basically a single channel awaiting for that other redundant component to fail unsafe.

The final step of dependable design is self-checking. This feature incorporated with the others completes the safety system design. Using self-checking, each component is checked by itself or by other portions of the system at least once each cycle of the press. If all components are self-checked once each cycle and the design is arranged to inhibit further operation when a failure signal is given, if redundant components are used in all circuits that control the crank rotation, and if reliable components designed to fail safe are used, then the press is of dependable design.

The normal mechanical power press has several mechanisms which are not doubled or redundant, the most important of these being the clutch and brake.

The positive or full revolution clutch has always been plagued with the problem that breakage of mechanical components can cause catastrophic failures. For this reason these machines cannot be of dependable design. Part revolution friction presses are must less susceptible to this type failure. However, they have only one clutch and brake. These mechanisms are the important means of controlling the ram movement. Since they are not redundant system elements they must have redundancy in their internal design and not be susceptible to catastrophic failure. Gradual deterioration of effectiveness can be taken care of by monitoring.

The clutch must be designed so that it will not suddenly fail by sticking or jamming. The brake must be designed to not suddenly fail, such as by loss of a single engagement spring. Now only the gradual loss of performance need be checked. This is done with a brake monitor.

A brake monitor is a part of the control system that is designed to monitor the effectiveness of the clutch, brake, and control system in bringing the slide to a stop. By monitoring the braking performance, many obvious and common faults of the brake, clutch, and control system can be detected. These faults are normally gradual and are not easily detected by human observation. Incorporating the brake monitor into the system increases the effectiveness of the safeguarding system.

All of the "dependable" safeguarding system is dynamic (acting every cycle) components are interlaced in a manner that prevents any one failure during any one press cycle from causing a point of operation accident. The probability of two simultaneous failures occuring and thus causing an accident is small in fact, so small, as to be unbelievable.

The final aspect of safety systems is interlocks. An interlock is a mechanism that serves to prevent the operation of the press when some condition is not met, such as a barrier out of place, and also serves to make it difficult for the worker to circumvent the safeguarding system.

Presently many interlocks are static devices that cannot easily be checked every cycle. They do, however, add a great deal of safety, for example when someone accidently forgets to install a portion of a safety system. Unfortunately interlocks often are easy to defeat by tying down. Therefore the incorporation of interlocks into a safety system must be carefully designed so as not to be easily circumvented.

The technical description of a dependably designed safety system so far covers only the basis of the interlacing of the system components to function in a manner so the system will always fail to a safe condition. A further look into the system must be at the component level to ensure that all elements physically, mechanically, electrically, or pneumatically have the ability to perform their intended function properly and not cause secondary failures due to their failure in any possible mode. The technical aspects of component level dependable design will not be covered, as it is a subject beyond the scope of this Guide.

Dependable safeguarding system design is the best means to protect all workers from point of operation hazards, since the human element is eliminated and the system protects the worker.

SETTING SAFETY DISTANCE

Safety distance is the minimum distance between a safeguarding mechanism and the nearest point of operation hazard which will preclude injuries after the press is tripped (after-reach injuries).

It is of utmost importance that the safety distance be properly set for two-hand control safeguarding systems, Type B gate safeguarding systems when the gate can be opened while the slide is in motion, two-hand trip safeguarding systems, presence sensing safeguarding systems, and remote actuator safeguarding systems.

In setting the safety distance for two-hand controls and two-hand trips, the distance must be measured from the part of the hands nearest the point of operation hazard when the hands are in their normal operating position on each actuator, to the nearest point of operation hazard.

In setting the safety distance for presence sensing, the distance must be measured from the EFFECTIVE position of the sensing field to the nearest point of operation hazard. The effective position of the sensing field is the position of the part of the hand that is nearest the point of operation hazard when the hand is inserted in the sensing field just far enough to be sensed.

In setting safety distance for the Type B gate, the safety distance must be measured from the nearest part of the gate opening to the nearest point of operation hazard.

NOTE: The point of operation hazards of a press are defined as follows: "Point of operation hazards of a press include all pinch points above the bolster and below the slide which are hazardous as a result of the closing of the slide."

When setting safety distance, always use the die or work set-up which brings the nearest point of operation hazard closest to the safeguard. If you do so, you are assured that every die and work set-up will automatically provide sufficient safety distance.

1. The safety distance formula for two-hand control safeguarding systems and those Type B gate safeguarding systems which allow the gate to open while the slide is in motion is:

   Safety distance (inches) = [press system stop time + brake monitor increment (seconds)] x 63 inches/second.

2. The safety distance formulas for two-hand trip safeguarding systems are:

(a) if the system has a mechanism which monitors system start time and prevents further stroking when preset start time has been exceeded,

Safety distance (inches) = [start time (seconds) + start monitor increment (seconds) + 1/2 stroke time (seconds)] x 63 inches/second, or

(b) if the system has a mechanism which requires the continued presence of each hand on each actuator until one-half maximum rotational crank velocity is reached,

Safety distance (inches) = [1/2 stroke time (seconds)] x 63 inches/second.

3. The safety distance formula for presence sensing systems is:

Safety distance (inches) = [sensing device reaction time (seconds) + press system stop time (seconds) + brake monitor increment (seconds)] x 63 inches/second.

4. The safety distance formula for remote actuator safeguarding systems is:

Safety distance (inches) = {[system stop time (seconds) + brake monitor increment (seconds)] x 63 inches/second} + 72 inches.

Refer to the "Press Start and Stop Time Measurements" section of this Guide to determine start and stop times.

PRESS START AND STOP TIME MEASUREMENTS

Measurement of Stop Time

Press stop time measurements are necessary when power press worker safety depends on the press ram to stop before a hand can reach the point of operation. Presses using two-hand control or presence sensing safeguarding systems as the primary protection means require that they be so located that a press worker cannot accidently reach the point of operation before the press has stopped. The two dominating factors are hand reach speed and press stopping time. The hand reach speed is presently defined as 1.6 meters per second. The stopping time must be measured to determine the safety distance. Many stop time measuring devices are commercially available that may be used for press stop time measurement. The basic means are as follows:

Procedure

1. Inspect the clutch/brake or brake for proper adjustment and operation. Check the brake for ample lining. Correct any deficiencies to ensure proper results.

2. Measure the press stopping time as per manufacturer's instructions for the device supplied, starting press stopping at the 90° point of crank angle rotation. Make several measurements and take the average of them. Also, make several measurements at 70° and 110° to determine that there is no significant change in stopping time. This is now the press stop time and sets the first limit of where a safeguarding system is physically located and the setting of brake monitors.

Measurement of Start Time

The measurement of press start time is an important factor when using only one specific type of safeguarding system. The type is a two-hand trip safeguarding system. The present formula calculates the safety distance as the hand speed times the sum of the closing time of the press (at full speed), plus the maximum engagement time.

Positive or Full Revolution Clutch Presses

Tests on positive or full revolution clutches have shown that their acceleration time from zero velocity to full speed is very small and as a practical matter can be ignored.

Procedure:

Start time, or engagement time, is:

$$\frac{1}{\text{number of equally spaced engagement points}} \times \text{the time required for 1 full revolution of the press}$$

Part Revolution Friction Clutch Presses

On part revolution presses the engagement time has been erroneously considered zero since there are an infinite number of engagement points on a part revolution friction clutch. However, if the engagement time on a friction clutch press is ignored or assumed zero, then a dangerous condition may exist if two-hand trip safeguarding systems are used to protect workers from point of operation hazards.

Tests have indicated that several things contribute to friction clutch engagement and starting time. The additional incremental times required are: (a) control reaction time, (b) valve actuation time, (c) air-in time, and (d) acceleration time. Control reaction time may or may not be a factor, depending on control design, but the other three definitely are. Factors that affect these incremental times are (a) air pressure, (b) volume of the clutch air cylinder, and (c) condition of the clutch surface.

Procedure:

1. Use commercially available start time measuring device according to manufacturer's instructions or use a test set-up that measures the start time from the instant of actuator operation to the time the crankshaft has reached 50% of its maximum rotational velocity.

2. Use this start time in the formula when calculating safety distance for two-hand trip on a part revolution friction clutch machine.

SETTING BRAKE MONITORS

Application

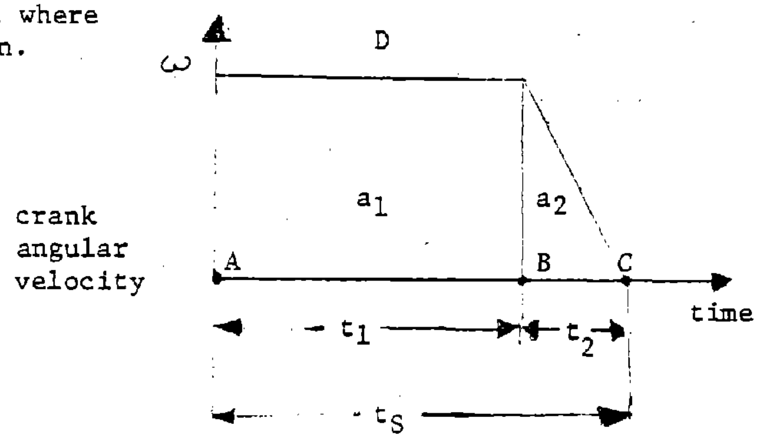
Brake monitors are control system mechanisms that monitor the stopping time of the press crankshaft and hence the effectiveness of braking performance. This discussion covers on-line brake monitors or those which are an integral part of the safety system. There are two types of on-line brake monitors, the Full Cycle brake monitor and the Top Stop brake monitor.

The use of brake monitors is directly related to the type of safeguarding system used. It signals the press control when the stopping time becomes too long, which means the safety distance is too short. Therefore brake monitors are only needed with safeguarding systems that depend on the machine stopping within a specified time. These systems include two-hand control, presence sensing, and Type B gate.

Theory

The times required to stop a part revolution friction clutch press can be divided into parts. The first is the total time required to switch control components and exhaust air while the crank is running at full velocity. The second is the time required during friction braking. The total stopping time, T_s, is the sum of the full velocity time, t_1, and the friction braking time, t_2, or $T_s = t_1 + t_2$.

View 1 shows a graph of a theoretical press crank shaft stopping characteristics. A is the point where the stop signal is intially given. From A to B is the time the crank travels at full speed while the valve and controls are reacting plus the amount of time it takes for the air to exhaust. The time from B to C is the time required during friction braking. Tests have shown that the slope of the friction braking is very close to a straight line and can be assumed to be so in the future.



View 1

From View 1 the number of degrees of crank rotation can be determined. Since t_1 and t_2 are known, the number of degrees of crank rotation can be determined by converting the press RPM into angular velocity, ω, in degrees per second.

Example 1: t_1 = .1 sec. t_2 = .05 sec.

ω = Angular velocity = 100 RPM

$$\frac{100 \text{ revolutions}}{\text{minute}} \times \frac{360^\circ}{\text{revolution}} \times \frac{1 \text{ minute}}{60 \text{ sec.}} = \frac{600^\circ}{\text{sec.}}$$

The total crank travel at full velocity is the area, a_1, of View 1.

$$\text{or } \frac{600^\circ}{\text{sec.}} \times .1 \text{ sec.} = 60^\circ$$

The total crank travel during friction braking is the area, a_2, of the triangle connecting points B, C, and line D.

$$\text{therefore } \frac{1}{2} \times \frac{600^\circ}{\text{sec.}} \times .05 \text{ sec.} = 15^\circ$$

T_S = .150 sec. and the total travel = 75°

However, it may not be possible to measure the times of t_1 and t_2. This can be modified to show the approximate curve of the press performance during stopping since the total stop time, T_s, and the crank angular travel can normally be measured.

By knowing the total stopping time, T_s, and the angular travel we can set up two simultaneous equations. Since we know that:

$T_s = t_1 + t_2$ and

$A_t = a_1 + a_2$

Where A_t = total angular travel

a_1 = angular travel at full speed = $t_1\omega$

a_2 = angular travel during friction braking = $\frac{1}{2} t_2\omega$

$\omega = \frac{600^\circ}{\text{sec.}}$

$$.150 = t_1 + t_2 \qquad (1)$$

$$75^\circ = (t_1 \times \frac{600^\circ}{\text{sec.}} + \frac{1}{2} \times t_2 \times \frac{600^\circ}{\text{sec.}} \qquad (2)$$

$$75 = 600\ t_1 + 300\ t_2 \qquad (2a)$$

$$45 = 300\ t_1 + 300\ t_2 \qquad (1a)$$

$$30 = 300\ t_1$$

$$.1 = t_1$$

Substituting .1 into equation 1:

$$.150 = .1 + t_2$$

$$.05 \text{ sec.} = t_2$$

By using the procedure of example 1, a graph of the stopping characteristics can be made of the press under test.

Setting Full Cycle Brake Monitors

Full cycle brake monitors measure the stopping time of the press each time the press is stopped. Normally the stopping is done on top stop but occasionally it occurs during the downstroking portion of the cycle. Most presses with good brake systems will stop in approximately the same time in any portion of the press cycle.

Full cycle brake monitors, which measure stopping time only, are very good for air operated, friction clutch presses, since a measurement is made during any portion of the stroke.

Procedure:

1. Inspect the clutch/brake or clutch and brake for proper operation. Check the brake for ample lining and adjust the brake for the best stopping time in accordance with the manufacturer's instructions. Correct any deficiencies to ensure proper results from the brake monitor.

2. Measure the press stopping time.

3. Add 20% to measured stop time or on older presses a proportional amount, as noted below, to compensate for brake lining wear.

NOTE: Brakes with 1/2 of the original lining thickness or more can use a 20% increase in stopping time. Those with less than 1/2 of the original lining thickness should use a smaller percent increase. Thus for 1/4 of the original lining thickness, a 10% increase should be used. Linings having 1/10 or less of their original thickness should be replaced.

4. Set the brake monitor to the total time (stopping time plus wear factor used to set safety distance) according to the manufacturer's specifications and ensure, by locking or bonding, that this setting can only be changed by intentional action of a fully qualified and knowledgeable person.

5. Check to ensure that the safeguarding system used is set at the proper safety distance which includes the additional 20% of time.

Setting Top Stop Brake Monitors

The top stop brake monitor measures the angular travel during top stop only. From View 1 and Example 1 it can be seen that angular travel can be directly related to the press stopping time. This is, of course, assuming the press has uniform stopping characteristics.

There are two conditions that must be covered when calculating what the top stop over-run angle should be. Views 2b and 2c show the two conditions that must be covered, worst case and best case. As in previous calculations we used the figure of .150 sec. as the press stopping time. Assuming a 20% increase in time, then a total press stopping time for safety distance will be .150 + 20% of .150 = .180 sec.

If an increase of stopping time was due only to brake wear, only the additional travel in View 2b would need be accounted for, i.e. the number of degrees of over-travel after top stop,

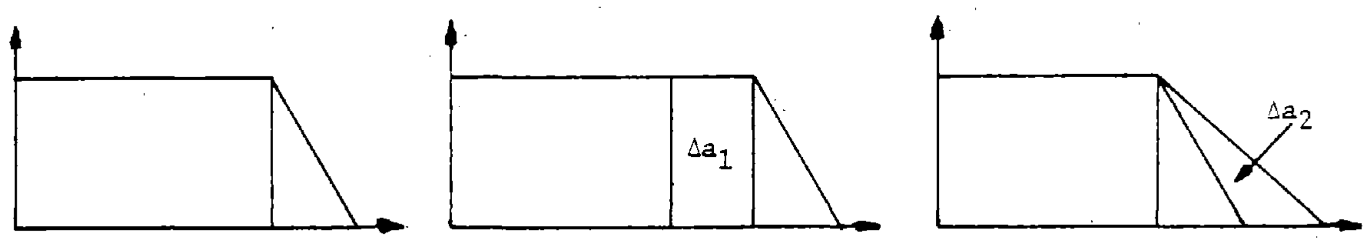
$$\Delta a_1 = \omega \times \Delta t \text{ or } \frac{600^\circ}{\text{sec.}} \times .030 \text{ sec.} = 18^\circ.$$

However, if the coefficient of friction of the brake surface changes due to contamination by oil or some other substance, the press would travel the area

$$\Delta a_2 = \omega \times \frac{1}{2}\,\Delta t = \frac{600^\circ}{\text{sec.}} \times \frac{1}{2} \times .030 \text{ sec,} = 9^\circ$$

as shown in View 2c.

Therefore, View 2c must be the procedure used when calculating the additional amount of degrees in setting top stop brake monitors. If the setting of 18° were used and only the coefficient of friction changed, the stopping time would increase .060 sec. instead of .030 sec. and create a potential after-reach hazard.



2a

NORMAL

2b

18° change due to brake wear

2c

9° change due to change in coefficient of friction

View 2

Procedure:

1. Inspect the clutch/brake or clutch and brake for proper operation and adjust the brake for the best stop time in accordance with the manufacturer's instructions. Check the brake for ample lining. Correct any deficiencies to ensure proper results from the brake monitor.

2. Make several measurements and take an average of the press stopping time.

3. a. Increase the stop time by 20% or a proportional amount, as noted below, to get Δt.

   b. Convert press crankshaft revolutions per minute to degrees per sec. or

$$\frac{\text{RPM x } 360^{\circ}}{60} = \text{degrees per sec. or}$$

$$\text{RPM x } 6 = \text{degrees per sec.}$$

   c. Multiply degrees per sec. x $\frac{1}{2}\Delta t$ to get over-run angle.

<u>NOTE</u>: Brakes with 1/2 or more of the original lining thickness can use a 20% increase. Those with less than 1/2 of the lining thickness should use a smaller percent increase. Thus linings with 1/4 original thickness remaining should use a 10% increase. Linings with 1/10 original thickness remaining should be replaced.

4. Set the over-run brake monitor that number of degrees extra past the top stop point and fix that cam with respect to the top stop initiation cam. Therefore, if the top stop cam is moved, the brake monitor cam moves with it. Or lock the cam box and only allow the cams to be changed by someone knowledgeable with this procedure.

5. Check to ensure that the safeguarding system used is set at the proper safety distance which includes the additional 20% of time.

POSITIVE OR FULL REVOLUTION CLUTCH SAFETY CONSIDERATIONS

The mechanical power press does work through the intermittent reciprocating motion of the slide. The energy required to carry the slide through the work is too great to draw instantaneously from the electrical power source. Rather the energy is stored in the rotary motion of the flywheel. Each time the press makes a stroke and work is done on the material, energy is released by the flywheel and then is restored from the electrical source during the remainder of the stroke cycle.

To facilitate workpiece loading, either piece at a time as in manual feeding or start up loading as in automated feeding, the reciprocating motion of the slide must be decoupled from the rotating flywheel. A clutch is required for such decoupling. A brake is also required to bring the slide to a stop and hold it at an open position.

For many years presses were built with full revolution clutches, that is, the crankshaft was essentially pinned to the flywheel by a mechanical means. Today this type of clutch is still being produced on smaller presses. These clutches usually take one of the following forms:

1. The radial key clutch
2. The axial key clutch
3. The rolling key clutch
4. The jaw clutch

The first three types consist of a pin or key on the crankshaft which is inserted into a hole in the flywheel, usually under the force of a spring. The means of disengaging such clutches is a wedge called an extractor which at the appropriate point in the press cycle exerts sufficient force on the key to pull it free from the flywheel even against the frictional force exerted by the flywheel pull against the key. This extraction is done near the top of the stroke. The brake then stops the crankshaft and holds the slide in the open position.

The operation of these types of clutches is characterized by several factors which bear directly upon the safety of personnel at or near the press. The hazards involved are those of repeat strokes, delayed strokes, and uninitiated strokes. Repeat strokes are those successive strokes which follow an intended stroke because the clutch did not completely or properly disengage. Delayed strokes are those strokes which start an inordinant time delay after the actuators have initiated the stroke due to the failure of the clutch to engage at the first alignment of the key and the keyway. Uninitiated strokes are those strokes which occur because the clutch engages without being initiated by the actuators, usually due to excessively worn parts in the clutch mechanism. The major reason for these conditions are as follows.

1. The acceleration load on the key at the instant of engagement is very great. Fractures or failure of the key due to this loading have occured. Further, as the key is spring engaged, any deterioration of the spring or the sliding surface to prevent the key from becoming fully engaged causes this shock load to be carried by less than the entire key. Overloading of the key can also occur during disengagement when the load is carried on a reduced effective area. Of more serious consequence, of course, is having a small portion of the key carry the entire force required by the work.

2. The keys sometimes seize in the engaged or driving position. The extractor either cannot withdraw the key or the key breaks. In either case the press will continue to stroke. This also results if, due to loading or fatigue, a portion of the key breaks off and these broken pieces become lodged in the keyway.

3. Inherent in the key design are several high stress areas. Should overloading occur the failure will occur along these stress concentrations. Such failures will result in continued uncontrollable stroking.

4. The extractor functions through metal to metal contact. As these surfaces wear the extent of the clutch disengagement becomes less. When sufficient wear has occured, the clutch is barely disengaged. Often badly worn clutches cause a clicking noise as the flywheel turns with the clutch disengaged. This is caused by the key partly moving with the keyway under the spring force. This condition is very dangerous. A slight movement (even through machine vibration) can cause sufficient clutch engagement to cause an uninitiated stroke. Presses making such a clicking noise must be taken out of use immediately for clutch repair. A series of weekly inspections is recommended for all full revolution and positive clutches with a rigid procedure for clutch repair.

5. When parts are worn such that the key does not properly align with the keyway, or the key and the keyway are badly worn on the initial engaging surfaces, or the spring is so weakened as to not move the key quickly enough, several points may pass before the clutch is capable of engaging.

No press has a brake of adequate size to stop the slide under conditions of clutch hangup. Attempts at preventing excessive overrun of the slide involve the use of overrun stops. Overrun stops are inadequate to withstand the clutch force and are of little value except to compensate for poor brake condition after the clutch is released. In cases where the clutch hangs up, overrun stops can present the hazard of projectiles caused by broken mechanical parts. Therefore, the use of overrun stops is not recommended.

The jaw clutch is a mechanical clutch with the capability of being disengaged during the stroke. Such a clutch may have a mechanical extractor which makes it function as a full revolution clutch. Other machines use pneumatic or hydraulic cylinders to engage and disengage the clutch. If the disengaging is done under load, such that the clutch is carrying the load on very little area of the jaws, then the over stress from the load can cause the jaws to fail and possibly fly out as projectiles. The engagement mechanism must therefore be of such design as to assure disengagement of a jaw clutch only at the top of the stroke.

Another consideration for operator safety is the design of the flywheel bearings and the impact a possible failure of such bearings might have. On an ungeared press, the flywheel runs on a bearing on the crankshaft. On a geared machine the flywheel is usually keyed to the high speed shaft (or backshaft) and it is the driven gear, not the flywheel, which runs on the crankshaft journal. In either case, the lack of lubrication and/or the intrusion of foreign material into this bearing will cause severe wear and possible seizure. Almost all mechanical clutch presses have plain sleeve bearings which have a tendency for seizure. Of course any seizure of the bearing will cause the crankshaft to rotate with the flywheel, resulting in an uninitiated and unintended stroking.

The few machines that have either ball or roller bearings are not nearly as prone to flywheel bearing seizure. Other bearing arrangements have also been used such as having the flywheel run on a bearing mounted on a rigid steel "quill" or tube which is supported by the press frame instead of running directly on a bearing mounted on the crankshaft. With such an arrangement, of course, a collapse or seizure of the flywheel bearing would not produce an unintended, uninitiated stroke.

All presses using a positive or full revolution clutch must have a single stroke mechanism. The purpose of such a mechanism is to automatically disconnect the extractor (or other clutch withdrawal device) from the influence of the operating control at a suitable point in the press cycle on each cycle initiated. The object is to disengage the clutch before a second stroke can occur, even if the operating control remains actuated. Thus the actuating control must be released before a subsequent stroke can be initiated. A major shortcoming of single stroke devices is the possibility that they may malfunction through breakage of parts, weakened springs, or sluggish motion. Should any such condition exist, of course, the clutch will remain engaged as long as the operating control is actuated. In spite of the performance of the single stroke mechanism, a repeat stroke, caused by a failure with the clutch itself, can occur without warning.

A secondary factor also bearing on operator safety resulting from repeat strokes, such as caused by the mechanical clutch hangup, is the danger of projectiles. These are caused by a shattered die and/or workpiece resulting from work being misaligned in the die as the slide goes through its repeat cycle.

Because of the possibility of malfunctions that expose the press operator and others to great danger, the use of positive or full revolution clutches is not recommended. Where they are used, it is recommended that the production point of operation safeguarding be limited to one of the following systems: full barriers, restraints, pullouts, Type A gates, or safe opening. The possible combination of these safeguards is allowable as long as the main objective is met, namely, the safeguarding action protects against the hazards of repeat, delayed, and uninitiated strokes. Zero flywheel energy bar or zero flywheel energy jog are recommended for maintenance and die setting.

PART REVOLUTION FRICTION CLUTCH SAFETY CONSIDERATIONS

A part revolution clutch is one that can be engaged or disengaged anywhere in the press cycle. Since the usual purpose of disengaging the clutch is to stop the slide and since almost always rapid stopping is desired, presses equipped with part revolution clutches have brakes as a companion part. Therefore the types and performance of brakes that are used with part revolution clutches are also covered herein.

Part revolution clutches usually are the friction type. A positive jaw clutch can function as a part revolution clutch when equipped with pneumatic or hydraulic actuators or extractors. These clutches are covered under "Positive or Full Revolution Clutch Safety Considerations" in the preceding section of this Guide.

Part revolution clutches may also be electro-mechanical or electro-magnetic. Most modern friction clutch presses have air operated clutches with the air being controlled by electrically operated valves. The friction clutch takes many forms. One form, the cone clutch, which consists of a tapered cone fitting into an internally tapered ring, is not commonly found on presses. Another form is the plate clutch, either wet plate or dry plate. On wet plate clutches bronze disc alternate with steel or cast iron discs and the entire assembly runs in an oil bath. The dry plate clutch, however, runs dry. It consists of a disc or discs, which either are or have attached to their faces suitable friction material, and which engage other plain discs (usually steel) in a "single-plate" arrangement (i.e. having two engaging surfaces) or a "multiple-plate" arrangement.

A third form of friction clutch is the air ring (or air tube) clutch. In this form the friction surfaces are positioned by an air tube. Two forms of this type of clutch exist, a radial acting tube and an axial acting tube. The axial tube form is very similar to the plate clutch. The air chamber is the tube rather than closely fitting mechanical parts with seals. The air volume ordinarily is much larger than for the plate clutch. The radial acting tube form is actually a drum type clutch. This tube is mounted around the periphery of the drum (or an inward acting clutch). The inner surface of the tube forces the friction surface down into contact with the drum surface. Torque loads are transmitted either through the tube or through torque bars fastened to the ends of the friction plate sections. An outward acting clutch simply has the air tube/friction surfaces mounted inside the drum and acts outwardly.

An advantage of the air ring type of clutch is, of course, greater torque capability for a fixed pressure on the friction surface as all the surface acts at the greatest radius. Also, cooling air can be directed to the underside of the drum surface to conduct away heat. Three major disadvantages of this clutch type are the increased air volume needed for actuation and de-actuation, the lack of any adjustment capability to reduce the additional air volume required to compensate for clutch wear, and the greater inertia effects of the drum whose mass is all concentrated at the greatest radius. These disadvantages result in greater stopping time for the press, producing greater safety distance setting in some safeguarding systems.

The advantages of the combination clutch/brake of the plate type are complete synchronized action of clutch and brake, minimum rotating mass, minimum air volume, and possible adjustment for brake/clutch wear to minimize stopping time.

The action of the clutch and brake linings is important. A loose lining will, of course, cause a sudden action if it should become wedged between the friction disc and the driving disc. With the long experience of the automotive industry and the history of safe bondings of linings to brakes and clutches, this difficulty should have almost zero occurrence on high quality manufactured clutches. The problem of lining wear, which will be treated later, is of much greater concern and likelihood.

Like full revolution clutches presses, almost all part revolution clutch presses have brakes, although machines have been observed with only the air counterbalance cylinders to stop and hold the slide when the clutch is released. These machines do not meet current regulations and must be updated. Numerous machines are greatly "under braked", that is, the brake has so little braking capability that it can do little more than hold the slide once it has been brought to a stop. Before dealing with this problem, a review of the types of brakes will be given.

The disc (plate) brake is used as an integral part of a combination clutch/brake and is similar in construction to the plate clutch. The disc brake as a separate unit is essentially of the same design.

The braking torque for the disc brake is determined by three factors. These are the spring pressure applied perpendicular to the brake surface, the coefficient of friction of the brake lining in contact with the metal plate, and the effective radius of the brake lining.

These three elements are all subject to design considerations. The coefficient of friction is, of course, limited to the characteristics of the materials used and is greatly influenced by the need to select materials for long life, heat resistance, and other factors. The spring pressure must be less than the force exerted by the air pressure used to release the brake. Thus the most controllable factor is the effective radius of the brake. In the combination clutch/brake this radius can be the same as the clutch radius. Since the clutch must be designed for sufficient torque to carry the slide through the work, the inherent design of the brake provides for adequate brake radius and, consequently, good braking torque.

The drum brake is a separate brake that consists of two clam (half circle) shells containing the lining, a pivot pin on one junction, and the actuator at the diametrically opposed junction of the two shells. The actuator contains an actuating rod with a captivated energizing spring and an air cylinder with a release rod. This brake requires a separate drum which usually is small to keep the added inertia load on the shaft to a minimum.

Drum brakes have major disadvantages from the standpoint of safety when used on power presses. As most stops take place at top stop, the drums and lining wear at this position more. When the brake must stop the ram at say 90^{o} position it does so rather poorly due to a poor fit of the worn drum and lining. Further, they have no redundancy in the basic design. A single pivot pin, a single mounting point to the press, a single energizing spring on a single actuator rod, and the complete loss of brake pressure should any one of these single elements fail raise serious doubts as to the desirability of their use on mechanical power presses. That the actuator rod and spring do break is attested to by the trend to captivate both the spring and the rod by enclosures or captivating chains. (See pages 40 and 45 of the National Safety Council's "Guards Illustrated, 3rd edition.") A failsafe design is also available which, in addition to enclosing the energizing spring and rod, uses a multiple spring-rod design. However, only one pivot pin and one mounting pin are used. A more redundant design could be made by the use of two complete brake units.

The braking torque of these clam shell type brakes is governed by the radius of the drum, which is selected for low inertia (small diameter), the coefficient of friction of the lining and the diameter of the air release piston and air pressure. The larger the spring engaging force, the greater the air pressure or piston diameter or both must be. While this may appear to give quicker stops, the use of more air or high air pressures produce an offsetting factor opposite the desired effects.

Other forms of brakes exist but are actually variations of the two types discussed. Older machines may have band brakes which are a variation of the clam shell brake. The use of band brakes is not recommended. In addition to all the modes of failure of the clam shell brake, the band brake has the added possibility of breakage of the band. A caliper disc brake exists which is a variation of the circular disc brake. These types are more often used in industrial control such as to be spring released and air engaged, although for press applications they can be designed the other way. Combination clutch/brake units such as a radial acting tube clutch with a clam shell brake exist. While these units may be referred to as combination clutch/brakes, precaution is necessary as these are actually separate units which may use a single drum structure.

A difficulty with separate clutch and brake units is the lack of inherent synchronization. With individual acting air pistons and springs, there exists no mechanical linkage to assure the application of either the brake or the clutch at the instant of release of the other during the engagement/disengagement function. As a result it is easy for a situation to exist in which neither has control of the slide and the slide is free to fall due to gravity. Under normal operation the transition time from clutch to brake action (or vice versa) is much too short to be a problem. However, design consideration must be given to assure that the brake releases after clutch engagement and engages before clutch release. The slide is thus always under the control of a friction coupling. Ideally the actions of clutch and brake are very nearly simultaneous, such as obtained by the combination clutch/brake unit.

Current regulations for part revolution clutch presses require that the clutch shall release and the brake shall be applied when the external clutch engaging means is removed, deactivated, or de-energized. A further requirement is that brakes must have capacity to stop the slide motion quickly.

Bringing the slide to rest is a function of the entire clutch and brake system, not merely the "capacity" of the brake (friction lining in pressure contact with the braking surface). Such systems involve the air supply and valving, the inertia of the clutch and brake engaging parts, the forces of internal springs, the friction of the sliding surface, and other factors. The effects of all these can be accounted for by specifying the time required, after signal, for the slide to come to rest (the stopping time).

The time from the signal to stop until the brake torque is applied consists of a series of reaction times. The signal to stop may consist of opening a contact on a two-hand control station, interrupting the field of a presence sensing device, breaking an interlock contact, or some other interruption in the control. The first time delay increment may be the delay in the sensing device (usually the deactivation time of a relay). The press control may or may not have another relay deactivation time depending upon its design. Usually a two-hand control contact is directly in series with the valve solenoid but may have its own activation delay. The next delay is the actuation time of the valve solenoid and moving parts. Then comes the time to exhaust the air to atmosphere, permitting the brake friction surfaces to come under pressure contact.

Testing has determined that the time for valve reaction and air exhaustion ($T_V + T_E$) is approximately twice the time of friction braking action (T_B). Many factors contribute to this but primarily the factors of the air mass (volume and air pressure) and the restriction to flow (size and length of air hose, size of exhaust parts, etc.) are responsible. Generally the lack of a requirement for short stopping times in past regulations has resulted in clutches and brakes, along with interconnecting plumbing, that require an excessive time for air exhaustion (T_E). This, coupled with the small brake radius, results in a long stopping time.

The factors of dependability, fail-safe, redundancy, and self-checking are paramount in the clutch/brake design from the standpoint of worker safety. Stopping time is also important as it makes for practical use of safeguards that are the most productive and best ergonomically suited to the worker.

Based on the foregoing evaluations, the following recommendations are made:

1. Part revolution clutch machines must not be operated with band type brakes.

2. Where part revolution friction clutch machines meet all the safeguarding design requirements, including the requirements on the clutch and brake, any safeguarding system can be used.

3. The design of brakes should involve such redundancy as to not increase the total stopping time by more than 30 percent should any part of the brake, exclusive of the linings, fail. This same redundancy concept should be applied to the clutch design to assure the dependable release of the clutch and, further, that any part failure in the clutch similarly should not increase the total stopping time by more than 30 percent.

4. The friction linings used on the clutches and brakes should be fastened by rivets of brass or should be bonded linings furnished only by the manufacturer of the press or the clutch/brake. Further, the brake should be provided with adjustments to compensate for changes in stopping time due to lining wear but this adjustment should be limited. With less than 50 percent of the lining thickness remaining, it should not be possible to obtain the stopping time obtained with a new lining. As an alternative to such adjustment limitation, a system of minimum wear depth detection can be used if designed as a part of the brake and the brake monitor.

5. All friction clutch/brakes should be supplied from a dual source capable of being checked; either internal self-checked or checked by the press control. For the pneumatically operated clutch/brake this requirement has been satisfied by the dual self-checking air valve. This same requirement should also apply to clutch/brakes which may be hydraulically, electro-magnetically, or otherwise operated.

6. The starting time and the stopping time of the newly constructed or refurbished press should be specified by the manufacturer/refurbisher and, along with actual measurement results, should be shown on a plate that is permanently attached to the press.

7. All friction clutch/brakes must be operated with a brake monitor. This monitor must be so designed and adjusted as to effectively measure the total stopping time of the press. Such measurement must be made at such close intervals as to effectively monitor the wear and/or malfunction of the brake.

ACTUATOR SAFETY CONSIDERATIONS

Foot Actuators

A foot actuator (Figure 29) is a foot operated electrical or pneumatic control device. It is widely used to trip mechanical power presses. It should not be confused with the foot treadle, which is a lever with mechanical linkage only. Since foot treadles are not recommended they will not be treated here.

A foot actuator should never be considered a safeguard; it is an actuator only. When foot actuators are used, a point of operation safeguarding system must be provided.

Since a foot actuator must be used with a point of operation safeguarding system, there might at first appear to be no reason why it should be protected from accidental actuation. However, an accidental press stroke is an action that is best avoided at all times. In addition, such stroking may create projectiles from shattered dies and misplaced parts that could seriously injure the operator or others. Therefore, a foot actuator must be protected against actuation by falling and moving parts and unintended operation due to stepping on it. It must also be protected against failure due to foreign substances.

A foot actuator can be used on all presses that use barrier guards, Type A gates, safe opening, or safe holding as the safeguarding means. It can also be used on part revolution friction clutch presses that are safeguarded by Type B gates and presence sensing devices.

The foot actuators must be so constructed to withstand the rigors of daily use. The operating mechanisms should be redundant and capable of being self-checked, allowing complete foot actuator control if one mechanism should fail and inhibiting any further press stroking until the failure is corrected.

From an ergonomic standpoint, the foot actuator must be designed with the physical characteristics of the operator in mind. The foot actuator should be easily operated from either a standing or sitting position. From a standing position the foot actuator must require as small a foot lifting distance from the floor level as possible to prevent the operator from becoming unbalanced.

Many newer foot actuator designs have attempted to make foot actuator operation safer. The main consideration in these designs is to prevent stepping into the foot actuator and therefore preventing accidental operation. The use of these designs requires additional motion to operate. Many times operators are reluctant to remove their foot because of the difficulty encountered in entering the foot actuator again. Thus the intended greater safety in the design may be circumvented by operators.

The following conclusions regarding foot actuators can be drawn:

1. A foot treadle should never be used to trip a press.

2. Presses equipped with a foot actuator must also be equipped with an acceptable safeguarding system.

3. A foot actuator is not, in itself, unsafe.

4. A foot actuator must be protected against accidental operation from falling or moving objects and from accidently stepping on it. It must also be protected against failure due to foreign substances.

5. A foot actuator must be so designed that failure of a single operating mechanism will not override any functional control of the press and subsequent self-checking can be used so that operation will not be possible until the failure is corrected.

6. It is not recommended that foot actuators be used with sweeps and pullouts.

Push Button Actuators

Hand actuated push buttons (Figure 30) have long been used for tripping or controlling machines. On mechanical power presses they are commonly called palm buttons. The term palm button in many cases is erroneous since the addition of guards around the buttons, required by regulations, makes it difficult, if not impossible, to actuate them with the palm of the hand. There are four basic requirement classifications to be evaluated for the palm button. They are electrical or pneumatic, mechanical, environmental, and ergonomic. These classifications may tend to overlap, yet there is enough distinction to separate each.

Palm buttons must be capable of meeting the requirements of current capacity and applied voltage, supplied air pressure and flow. The palm button also must be capable of being self-checked. Additionally, it must be electrically insulated to prevent any shock hazard, or pneumatically sealed to prevent escaping air from creating a hazard. Mechanically it must be constructed to withstand the rigors of daily pressroom use. Environmentally it must be protected against outside substances and materials that could cause it to fail (usually by shorting of contacts, or causing valve spools to seize). Probably the most important aspect of palm button actuators is the ergonomic consideration, but this consideration has largely been overlooked or ignored. Palm button actuators must be protected from accidental actuation by falling objects, die loading, etc. The simplest solution to this problem is to place guard rings around the buttons. However, many actuators are mushroom shaped and using guard rings usually makes operation difficult because the finger tips will probably have to be used to actuate the buttons. In the oily environment of the pressroom, it is very easy for the worker's fingers to slip off the mushroom shaped buttons. This causes intermittent press operation, especially when the actuators are used for two-hand control. The worker can also receive minor finger injuries such as cuts and abrasions when his fingers wedge between the mushroom shaped button and the guard. With the simple addition of a guard ring around a palm button, conditions can thus be introduced that aggravate the worker and hinder production. The intent was initially better safety but the outcome adds negative factors that may affect operator attitude and productivity.

Another important ergonomic consideration is the location of palm buttons. They should be located and installed so as to not cause undue worker fatigue. For example, they should not be located high over his head so that he has to stretch to reach them. Such location would obviously become tiring to the worker in the course of a work shift. Also, locating palm buttons in a position that is inconvenient for the worker will hinder production because he will not be able to easily and quickly go from the workpiece to the point of operation and then to the palm button.

Finally, palm buttons by themselves are not to be considered as a safeguard. They can only be a part of a safeguarding system in which they play a very specific function and must be installed according to very specific rules. (Refer to "Two-Hand Control and Two-Hand Trip Safeguarding Systems", page B-82.)

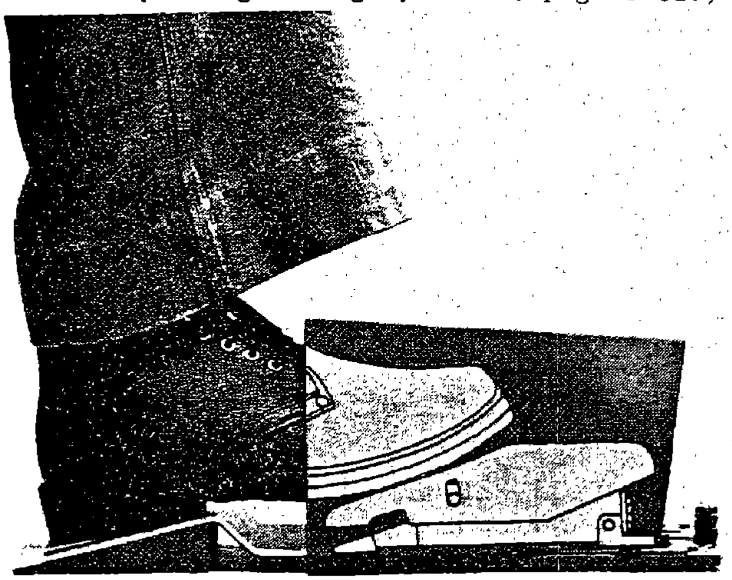


Figure 29. - A foot actuator that is ergonomically well designed.

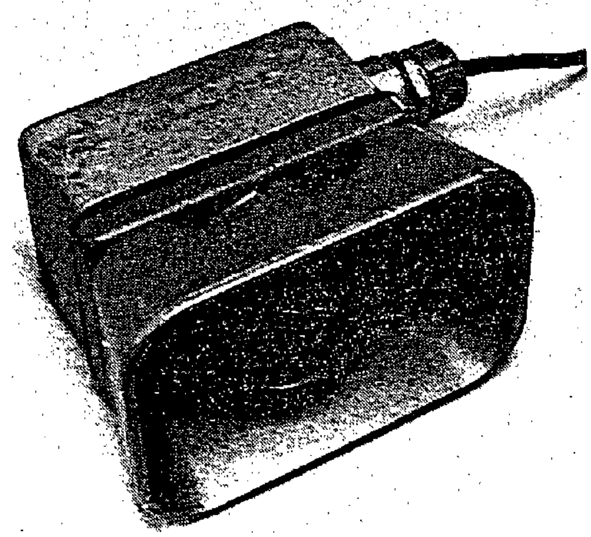


Figure 30. - An example of a hand actuator.

SECTION D

SAFETY RESPONSIBILITIES

SAFETY RESPONSIBILITIES OF MANAGEMENT

Management personnel are vital in achieving and maintaining a continuing interest in power press safety. When management demonstrates an active interest in safety, the example is usually followed by all employees. Any safety program, to be effective, must have the wholehearted support and backing of management.

The safety points that follow are supplementary to those that are required by legal regulations. They are not intended to replace or modify the regulations.

Management should:

1. Investigate and review all press accidents and "close calls". Take immediate steps to prevent further accidents or "close calls". Refer to the regulations for injury reporting requirements.

2. Properly train the employees who operate the presses, set the dies, and maintain the presses in accordance with the regulations. No employee should be given a work assignment that he does not fully understand.

3. Remove equipment from service that is not safe and cannot be properly upgraded.

4. Not allow persons who are not of legal age to operate a press or to assist the operator. Refer to the regulations.

5. Establish firm pressroom safety rules. Make sure every employee understands the rules and is aware of his responsibilities.

6. Take disciplinary action when any safeguarding device or mechanism is sabotaged or circumvented, or is modified without proper authorization.

7. Provide a safe, uncluttered, unobstructed, and clean press work area. Refer to the regulations.

8. Immediately stop use of a press if it malfunctions and correct the problem before resuming operations.

9. Allow no person to train or instruct others in power press operation, die setting, or press maintenance unless the trainer or instructor is fully knowledgeable of the press, dies, auxiliary equipment, and safety rules and can adequately communicate this information to others.

10. Adequately train supervisors on proper press operation, safety, supervision of others, and methods for achieving a high level of safety awareness among the people they supervise.

11. Use dies and operating methods designed to control or eliminate hazards to operating personnel. Refer to regulations.

12. Provide safeguarding for the point of operation. Refer to the regulations.

13. Not overload presses. Refer to the regulations.

14. Establish a die setting procedure. Refer to the regulations.

15. Provide spring-loaded turnover bars for presses designed to accept such turnover bars. Refer to the regulations.

16. Provide die stops or other means to prevent losing control of the die while setting or removing dies in presses which are inclined. Refer to the regulations.

17. *Provide and enforce the use of interlocked safety blocks whenever dies are being adjusted or repaired.

18. Provide adequate lighting in press areas.

19. Protect foot treadles, pedals, and switches with a fixed guard to prevent unintentional operation by falling objects or a foot accidently placed on them.

*Exceeds 29CFR 1910.217.

SAFETY RESPONSIBILITIES WHEN PURCHASING PRESSES

It is the responsibility of those involved in obtaining a machine to ensure that when the machine is delivered, it is in a condition which will allow it to be installed with a functional means of preventing all workers from being injured by the hazards of the point of operation.

These people must, therefore, work in conjunction with the engineering and production personnel in deciding what safeguarding system will be used, and that the characteristics of the machine are capable of meeting the design criteria for that safeguarding system. The choice of a safeguarding system can be greatly simplified by study of the rest of this Guide, and particularly by studying Tables 3 and 4.

When a choice is made, those responsible for purchasing the machine must ensure that machine characteristics required by the chosen safeguarding system are specified. If the machine is new, these requirements must be specified to the manufacturer. If the machine is used, those characteristics which don't meet the design requirements must be upgraded through refurbishing.

SAFETY RESPONSIBILITIES WHILE OPERATING PRESSES

More injuries occur at the point of operation during press operation than any other press activity. Eighty-one percent (81%) of all point of operation press injuries in the 6 month period from July 1, 1975 to December 31, 1975 were incurred by workers while operating a press. It is obvious that concern for power press safety should center on press operation. It was stated earlier in this Guide that press safeguarding systems should ideally be designed so as to remove the need for operator involvement in his own safety. Since this ideal has not been the basis for past safeguarding systems design, the focus of press safety must also involve safety responsibilities for the person who operates the press.

The safety points that follow are supplementary to any that are required by legal regulations and management and are not intended to replace or modify such requirements. The operator of a press should:

1. Never operate a press that he has not been trained to operate or that he has not been given specific instructions on how to operate.

2. Never operate a press without studying and fully understanding the safety and operating instructions given during training.

3. Obey all applicable safety rules and regulations.

4. Never sabotage, circumvent, or modify any safeguarding device or mechanism. In many companies these actions are grounds for suspension, dismissal, or other disciplinary action.

5. When starting a press, follow the start-up routine instructions established for that press with that safeguarding system.

6. Report any press malfunction, unsafe condition, or erratic operation to the appropriate person.

7. Never "beat the guard" by reaching around, over, or under it.

8. Keep the press and area around the press clean, orderly, and free from obstructions.

9. Never, while operating a press, sit, stand, or lean on anything that could cause you to slip, stumble, or fall into the press.

10. If any safeguarding device or mechanism is out of place or malfunctions, immediately stop the press and notify the proper person.

11. Never talk to others while operating the press.

12. Operate a press in a serious, business-like fashion. Never indulge in "horseplay" during the performance of duties. Never operate a press while passersby are standing around. Never tempt the safeguarding system by deliberately testing its safety features, for example, deliberately trying to reach the point of operation on the downstroke with a pullout system.

SAFETY RESPONSIBILITIES WHILE DIE SETTING

People who set dies are usually well-informed as to the operation of power presses, yet they receive press injuries. Most die setting injuries occur when the die setter is removing, installing, repairing, or adjusting dies without first turning off the drive motor, waiting until the flywheel has stopped turning, and blocking the slide.

It is important that the dies be removed, installed, repaired, and adjusted properly, but it is more important that these tasks be performed in a safe manner. When the person setting dies has completed his work with the die, he must replace any guards and safety devices and be sure that they are properly adjusted. Thus, the person setting dies is not only responsible for his own safety, he is also responsible for providing safe operating conditions for others, if others operate and maintain the press.

Dies can be dangerous. They can weigh from a few pounds to several tons, and many have sharp edges. Dropping a die is obviously physically hazardous. In addition, a dropped die can be ruined beyond repair. Many companies do not have adequate die handling equipment, and too often permit manual handing and carrying of dies. All dies should be transported on a die table, truck, or hoist of adequate rating unless the die is of such size and weight that it can be easily carried by hand.

A die should not be lifted higher than the height necessary for minimum clearance. No part of the body should ever be placed under a suspended die when it is being moved.

The safety points that follow are supplementary to any that are required by legal regulations and management. They are not intended to replace or modify the regulations or the safety rules of management.

The person who has the die setting responsibilities should:

1. Read and thoroughly understand the applicable instructions in the die setter's manual before removing, installing, repairing, or adjusting dies.

2. Obey all applicable safety rules and regulations.

3. Avoid distractions while working with dies and presses.

4. Never sabotage, circumvent, or modify any safeguarding device or guard. In many companies these actions are grounds for suspension, dismissal, or other disciplinary action.

5. Check weight of dies and be certain that transporting equipment is adequate.

6. Turn off the main drive motor, wait for the flywheel to stop turning, and block the slide before removing, installing, or repairing a die. In addition, lock the control panel or disconnect switch in the OFF position to prevent unintentional starting or unauthorized use of the press.

7. Make sure that the dies, bolster, and slide face are clean before installing the dies. Foreign material could cause misalignment and damage the dies and press and possibly injure the operator of the press.

8. Disconnect or remove point of operation barriers or safety devices only if it is absolutely necessary. Some types of barriers and sweeps will have to be removed, but not, in general, pullouts, restraints, or presence sensing devices.

9. Attach the proper die hooks, chains, or other handling equipment for safe handling of the die.

10. When clamping the bolster plate to the press, use bolts that are in good condition and tighten them securely to prevent vibration from moving the plate out of position.

11. Never install a die that will cause overloading of the press. Do not install damaged or excessively worn dies.

12. Use sufficient clamps of the proper size when clamping the dies to the press. The dies should be clamped firmly in position.

13. After installing dies make any adjustments before cycling the press.

14. Check to see that all setup tools and parts are clean before inching or cycling the press.

15. Make sure that all persons are clear of the press before inching or cycling.

16. Test run the press to insure that the press, components, auxiliary equipment, and dies are functioning properly.

17. Carefully reconnect or replace any point of operation safety barriers or devices that were disconnected or removed. Make sure that all safety barriers and safety devices that were not disconnected or removed are properly installed and adjusted and that the press, dies, and auxiliary equipment are functioning properly before releasing the press for operation.

18. If the selection switches are repositioned for a different mode of operation, cycle the press to make sure it operates as expected.

19. If possible, use both hands to hold the turnover bar.

20. Report any press malfunction, unsafe condition, or erratic operation to the proper person.

21. Be certain air is exhausted from cushions and/or cylinders before loosening any fastening bolts. When installing cushions, be certain all fastening bolts are tight and all personnel are clear before turning on air.

22. Die setting is a serious business. Never indulge in "horseplay" during the performance of duties.

SAFETY RESPONSIBILITIES WHILE MAINTAINING PRESSES

Point of operation injuries incurred while performing press maintenance are not as numerous as point of operation injuries incurred while operating a press or die setting, yet they do happen. Safety is just as important while performing maintenance on a press as it is while operating a press or die setting. The safety points that follow are supplementary to any that are required by legal regulations or management and are not intended to replace or modify such requirements.

Workers performing maintenance should:

1. Obey all applicable safety rules and regulations.

2. Study and fully understand the press maintenance manual before performing any maintenance on the press.

3. Shut off power to the press drive motor, wait for the flywheel to stop turning, and block the slide before placing any part of the body in the point of operation. Lock out the power to ensure that no person can turn on the power to the press without your knowledge. Use warning signs that can be easily seen.

4. Put the slide at the bottom dead center of the stroke before working on the clutch, brake, or any part of the drive train.

5. Disconnect any pneumatic pressure lines from the machine. Be certain that the pneumatic pressure is completely relieved before removing or working on any pneumatic components.

6. Never perform maintenance or rework or modify the point of operation safeguarding system of the press unless specifically trained for the work, with a certificate of competence from the manufacturer.

7. Not allow debris to be thrown on others or into the press, dies, and auxiliary equipment when chipping, grinding, cutting, or drilling. Use a protective screen if necessary.

8. Never use the hands to slow down or stop moving components of the press.

9. Make sure that all pneumatic press parts are properly assembled and mounted on the press before charging them with air.

10. When the press maintenance work is completed, remove all repair equipment (tools, ladders, etc.), replace all guards and safety devices, adjust them properly and clean up the press and the press area.

11. Cycle the press and be sure it is operating properly. Never release a press for operation unless it is performing correctly. Special attention must be given to the point of operation safeguarding system. The safety of others operating the press depends upon those maintaining the press.

12. Never indulge in "horseplay" during the performance of duties.

SECTION E

SAFETY PROGRAMS

A good safety program consists of more than safety equipment and catchy slogans. It must be backed and enforced by management in order to succeed. Since some aspects of a safety program are intangible, the program may quite possibly be harder to sell to employees than it is to sell the company's products to customers. If the employees can sense that management is genuinely interested in their safety and is not merely paying lip service to it, they will be more receptive to the safety rules and guidelines contained in this Guide and cooperative in adhering to these rules and guidelines.

Most companies should have some form of safety program already. The only need then is to incorporate the essentials of the safeguarding systems as part of this program.

The popular concept of a safety program is that of safety training of workers. As can be seen throughout this Guide, the performance of the safeguarding system ideally does not depend on worker training as worker performance is not an element involved in the system. Thus the worker ideally does not need specific training to avoid point of operation injuries. There are, however, other personnel involved with selection, design, installation, adjustment, maintenance and supervisory control of these safeguarding systems. The proper training of these personnel to the needed level of competency must be the major emphasis of press safety training. Training of workers who operate presses is also important since the ideal situation is often not attained, and the communication to these workers as to what safeguarding systems are used and how these provide protection is essential.

The provision of machine technical safety can be used as a positive indicator of management's action to provide a safe workplace. Further, this same approach must be used to make the worker understand that in many instances it is possible that he can undo the protection afforded him by deliberate unsafe action.

When instituting the safety program the first step is to list all of the safeguarding systems that are presently in use and likely to be used in the future. After a thorough review of these safeguarding systems requirements, a list of the necessary records and record-keeping should be made. These records should tabulate all of the inspection and installation requirements. A training list must be made that will separately train each worker as to his part and responsibility in working with or supervising that system. They should include supervisors, die setters, operators, and maintenance personnel.

Special emphasis must be made on those systems that require some form of human action to make it safe. When systems are used that do not protect all workers and passersby, all personnel and supervisors must be informed of that potential hazard. Once the training and record-keeping phase has been instituted, each presently installed safeguarding system must be inspected as if it were a new installation. All discrepancies from the installation requirements must be corrected. At this time the safety system is in effect. The continued performance must be monitored to ensure that there is not any gradual degradation of procedures. Periodically the entire program should be observed, reviewed, and updated to keep its full usefulness.

The benefits of a good safety program to employees are, of course, obvious. Another benefit is often overlooked. That is the benefit to the employer of lower insurance rates and possibly lower workmen's compensation rates. In many instances, these dollar savings more than pay for the cost of managing the safety program.

SECTION F

GLOSSARY OF MECHANICAL POWER PRESS SAFETY TERMS

ACTUATOR - An actuator is a mechanism used to initiate tripping the clutch on the press.

AFTER-REACH - After-reach is movement of the operator toward the point of operation after the press is tripped and before the dies close.

ANTIREPEAT - Antirepeat is a function of the clutch-brake control system that limits the press to a single stroke if the actuator is held after being operated. Antirepeat requires release of all actuators before another stroke can be initiated. Antirepeat is also called single stroke reset or reset circuit. Antirepeat does not prevent all repeats. See "REPEAT."

ARRESTOR BRAKE - An arrestor brake is designed to "arrest" (stop) the motion of the flywheel, crankshaft, and slide of a press in the event of a repeat stroke, however caused.

BAR - Bar means moving the slide manually by means of a lever or bar inserted in the flywheel with the flywheel at rest and the clutch engaged.

BARRIER - A barrier is a safeguarding mechanism that prevents entry of the worker into the point of operation or other hazard area.

BARRIER, ADJUSTABLE - An adjustable barrier is a barrier that is attached to the press frame and requires adjustment for each job or die setup.

BARRIER, DIE ENCLOSURE - A die enclosure barrier is a barrier attached to the die shoe or stripper, or both, in a fixed position.

BARRIER, FIXED - A fixed barrier is a barrier attached to the press frame or free standing which need not be changed when dies are changed.

BARRIER, INTERLOCKED - An interlocked barrier is any barrier that is interlocked so that the press stroke cannot be started unless the barrier itself and any of its hinged or movable sections, enclose the point of operation.

BASE - The base is the cradle or fixture that supports the press.

BED - The bed is the work area of the press frame that supports the bolster with the lower dies.

BEHAVIORIAL SAFETY - Behaviorial safety consists of those considerations which allow initial and continued safety to depend on human action.

BLANK - A blank is a piece of material formed by a press in primary operations and modified by further operations.

BLANKING - Blanking is the press operation whereby blanks are made.

BOLSTER PLATE - The bolster plate is attached to the top of the bed of the press and has drilled holes or T-slots for attaching the lower die or die shoe.

BRAKE - The brake is the mechanism used on a mechanical power press to stop the crankshaft and slide and hold them, either directly or through a gear train, when the clutch is disengaged. The brake may be a constant drag type (typical on a positive or full revolution clutch press), or may be a type disengaged while the clutch is engaged (typical on a part revolution friction clutch press).

BRAKE MONITOR - A brake monitor is a part of the control system that is designed, constructed, and arranged to monitor the effectiveness of the clutch, brake, and control system in bringing the slide to a stop.

CLUTCH - The clutch is the coupling mechanism used on a mechanical power press to couple the flywheel to the crankshaft, either directly or through a gear train. A full revolution clutch is a type of clutch that, when tripped, cannot be disengaged until the crankshaft has completed a full revolution and the slide a full stroke. Positive type clutches are almost always full revolution types. A part revolution friction clutch is a type of clutch that can be disengaged at any point before the crankshaft has completed a full revolution and the slide a full stroke. Other types of clutches, such as magnetic or hydraulic engaging, are sometimes used for part revolution operation. See "DIRECT DRIVE".

COINING - Coining is cold flowing metal, wherein the metal is forced by protrusions into cavities in the die.

CONCURRENT - "Concurrent" means acting in conjunction. This word is used to describe a situation wherein two or more mechanisms exist in an operated condition at the same time. Specifically, as applied to the operation of two hand control or two hand trip, the word means that the clutch will not be activated unless each hand of the operator is holding a mechanism in the operated position. The word is intended to exclude any inference that the operation of the individual two hand mechanisms must be simultaneous.

CONNECTING ROD - The connecting rod is a member that is fastened to the crankshaft by a bearing at one end and to the slide at the opposite end by an adjustment screw or bearing. The connecting rod changes the rotary movement of the crankshaft to the up and down movement of the slide. The working height of the slide can be adjusted by means of the adjustment screw. Other terms used for the connecting rod are pitman, strap, or screw.

CONTINUOUS - "Continuous" means uninterrupted multiple strokes of the slide without intervening stops (or other control system action) at the end of individual strokes. See "ON THE HOP" and "ON THE HUMP".

CONTROL - See specific type of control such as "FOOT CONTROL", TWO HAND CONTROL", etc.

CRANKSHAFT - The crankshaft converts the rotary motion of the flywheel to the up and down movement of the connecting rod and attached slide.

CRANKSHAFT JOURNAL - The crankshaft journal is the part of the crankshaft that turns on the bearing.

CUSHIONS - Cushions provide holding pressure for draw jobs and workpiece ejection. They are located in the press bed and transmit their pressure through the bolster plate by pins. In some cases they may be built into the slide. Cushions can obtain their pressure by pneumatic, hydro-pneumatic, or hydraulic means.

CYCLE - A press cycle is a start followed by one or more strokes, and then a stop.

DELAYED STROKE - A delayed stroke is a press stroke which occurs after an abnormal time delay following operation of the actuator.

DEPENDABLE DESIGN - A safeguarding system has dependable design if it allows the worker to rely on it to prevent him from receiving a point of operation injury in all phases of the work cycle, and especially in the event of a functional component failure within the system. A dependable design incorporates all the design features of redundancy, reliability, fail-safe, and self-checking. Dependable design is required on a mechanical power press whenever the press safeguarding system is required to prevent or stop the closing motion of the slide in order to provide safety.

DEVICE - A device is a mechanism or part of a point of operation safeguarding system. The common usage of the term "device" refers to all safeguarding mechanisms, other than barriers, but must be considered only a part of the safeguarding system.

DIE - The die is the tooling used in a press for cutting or forming material. Quite commonly, the plural "dies" is used to describe the complete die, consisting of an upper element and a lower element, therefore both "die" and "dies" mean the same thing.

DIE CLOSING - Die closing is that portion of the press stroke where the dies are approaching each other and the point of operation opening exposed to the worker is greater than 1/4 inch.

DIE SET - A die set is a tool holder held in alignment by guide posts and bushings. It consists of a lower shoe, an upper shoe or punch holder, and guide posts and bushings.

DIE SETTER - A die setter is a worker who places or removes dies in or from presses and who, as a part of his duties, makes the necessary adjustments to cause the dies to function properly.

DIE SETTING - Die setting is the process of placing or removing dies in or from a press, and the process of adjusting the dies, other tooling, and safeguarding means to ensure that they function properly.

DIE SHOE - A die shoe is a plate or block upon which a die holder is mounted. It functions primarily as a base for the complete die assembly and, when used, is bolted or clamped to the bolster plate or face of the slide.

DIE STOP - A die stop is a protrusion on the bolster that prevents the die from sliding off the bolster of an inclined press.

DIRECT DRIVE - A direct drive is one wherein no clutch is used. Coupling and decoupling of the driving torque is accomplished by energization and deenergization of a motor.

DOUBLEHEADING - Doubleheading is overloading the press by cycling it when two parts are simultaneously positioned in a common die. This usually occurs when the completed workpiece is not removed from the die and another workpiece is fed in on top of it.

DRAWING - Drawing is press operation whereby a workpiece is formed between a male and female die making the material flow as the two dies meet.

EJECTOR - An ejector is a mechanism for removing the workpiece or material from between the dies.

EMPLOYER - An employer is any person who contracts, hires, or is responsible for the personnel associated with power press operations.

ERGONOMIC SAFETY - Ergonomic safety consists of those considerations whose initial and continued safety performance depends on both machine action and human action.

ERGONOMICS - Ergonomics is the science that seeks to adapt work or working conditions to suit the worker.

EXTRACTOR - An extractor is a mechanism which disengages a positive or full revolution clutch at the appropriate point in the press stroke by exerting force on the clutch key(s) to pull it free from the flywheel.

FACE OF SLIDE - The face of the slide is the bottom surface of the slide to which the punch or upper die is usually attached.

FAIL-SAFE - Fail-safe is that feature of a press safeguarding system that ensures that the most probable mode of failure of each and every system component will result in a safe condition for the worker.

FEEDING - Feeding is the process of placing or removing material within or from the point of operation.

FEEDING, AUTOMATIC - In automatic feeding the material or part being processed is placed within or removed from the point of operation by a method or means not requiring action by any worker on each stroke of the press.

FEEDING, MANUAL - In manual feeding the material or part being processed is handled by any worker on each stroke of the press.

FEEDING, SEMIAUTOMATIC - In semiautomatic feeding the material or part being processed is placed within or removed from the point of operation by an auxiliary means controlled by any worker on each stroke of the press.

FLYWHEEL - The flywheel is a device used to store energy until needed to turn the crankshaft during a stroke of the press. It is usually belt driven by an electric motor and runs continuously.

FOOT CONTROL - A foot control is a foot mechanism commonly used as an actuator.

FOOT PEDAL (TREADLE) - A foot pedal (treadle) is a foot control used to operate the mechanical linkage that trips a positive or full revolution clutch.

FRAME - The frame is the heaviest part of the press on which are mounted all working parts of the machine. On larger presses, the frame is composed of several parts, commonly called the bed, the uprights, and the crown. All are secured together with tie rods or bolts.

FULL REVOLUTION CLUTCH - See "CLUTCH".

GATE OR MOVABLE BARRIER - A gate or movable barrier is a mechanism arranged to enclose the point of operation before a press stroke can be started. A <u>Type A gate</u> encloses the point of operation before a press stroke can be initiated and maintains this closed position until the motion of the slide has ceased. A <u>Type B gate</u> encloses the point of operation before a press stroke can be initiated, so as to prevent a worker from reaching into the point of operation prior to die closing or prior to cessation of slide motion during the downward stroke.

GIBS - The gibs guide the slide and hold it in correct alignment with the bed and bolster.

GUARD - See "BARRIER".

GUIDE POST - A guide post is a pin attached to the upper or lower die shoe, operating within the bushing on the opposing die shoe to maintain the alignment of the upper and lower dies.

HAND FEEDING - See "FEEDING, MANUAL".

HAND FEEDING TOOL - A hand feeding tool is any hand tool used for placing or removing material or parts to be processed within or from the point of operation.

HANDS IN DIE (HID) - Hands in die is a method of feeding a press that <u>requires</u> a worker to enter the point of operation.

HANDS OUT OF THE DIE (HOOD) OR NO HANDS IN DIE (NHID) - These two terms have the same meaning. HOOD or NHID is a method of feeding a press where there is no need for the worker to enter the point of operation, but he may or may not do so.

HELPER - A helper is a worker who assists in production work at a press, but does not control the slide.

HOLDOUT OR RESTRAINT - See "RESTRAINT OR HOLDOUT".

INCH - Inch is an intermittent motion imparted to the slide (on machines using part revolution friction clutches) by momentary operation of the "inch" actuator(s). Operation of the "inch" actuator(s) engages the driving clutch so that a small portion of one stroke or indefinite stroking can occur, depending upon the length of time the "inch" actuator(s) is held operated. "Inch" is a function used for setup of dies and tooling, but is not intended for use during production operations. Sometimes a timing mechanism is used within the inch control circuit to give a predetermined maximum time interval to each inch actuation. This is usually called "timed inch". Under any circumstances, it should be noted that the increment of slide travel obtained at each actuation is dependent upon time, speed of press, and position of slide within stroke, and that inch, as used herein, has no relationship to the common unit of linear measure. Inch is sometimes accomplished through a separate motor driving the press directly at low speed. Inch is sometimes called "jog", but "jog" has a different meaning (see "JOG").

INTERLOCK - An interlock is a mechanism that serves to prevent the operation of the press when some condition is not met such as a barrier in place and also serves to make it difficult for the worker to circumvent the safeguarding system. Interlocks are essentially "monitors for the safeguards".

JOG - A jog is an intermittent motion imparted to the slide by momentary operation of the drive motor, after the clutch is engaged with the flywheel at rest.

KNOCKOUT - A knockout is a mechanism for releasing material from the die. The word knockout refers to the complete mechanism, from the external (or internal) press parts to and including the pin in the die which contacts the part to be knocked out or off the die or punch.

LIFTOUT - See "KNOCKOUT".

LOAD MONITOR - A load monitor is a device that monitors the load (tonnage) on a press and indicates when the press is overloaded.

MAINTENANCE PERSONNEL - Maintenance personnel are workers who care for, inspect, and maintain power presses.

MANUFACTURER - A manufacturer is any person who manufactures, reconstructs, or modifies power presses.

MECHANISM - A mechanism is an arrangement of parts so designed to perform a desired function.

MODE SELECTOR - The mode selector is that part of the control that determines the type of cycling when the actuator is operated.

MUTING - Muting is bypassing the protective function of a safeguarding system during the nonhazardous portion of the press stroke.

ON THE HOP - On the hop is a mode of press operation which requires the timely operation of the actuator(s) once during each press stroke and results in uninterrupted stroking of the slide. Failure to operate the actuator(s) within the specified time causes the slide to come to rest in the full open position at the end of the stroke.

ON THE HUMP - On the hump mode of press operation is identical to the on the hop mode except that the entire control system and clutch/brake must also operate once each press stroke.

OPERATOR - An operator is any worker controlling the movement of the slide on a power press.

OPERATOR'S STATION - The operator's station is the complete complement of actuators and controls used by or available to an operator on a given operation for stroking the press.

OVERLOADING - Overloading is employing a press to deliver more tonnage than the press is specified to deliver.

OVERRUN ANGLE - Overrun angle is the angle traversed by the crankshaft from the position the stop signal is given to the position at which motion ceases.

OVERRUN DISTANCE - The overrun distance is the distance that the slide travels from the position the stop signal is given to the position at which the slide actually stops.

OVERRUN STOPS - Overrun stops are a positive means for stopping overrun past the stop dead center position.

PART REVOLUTION CLUTCH - See "CLUTCH".

PINCH POINT - A pinch point is any point at which it is possible for a part of the body to be caught between the moving parts of the press or auxiliary equipment, or between moving and stationary parts of a press or auxiliary equipment, or between the material and moving parts of the press or auxiliary equipment.

PITMAN - See "CONNECTING ROD".

PLATEN - See "SLIDE".

PLUNGER - See "SLIDE".

POINT OF OPERATION HAZARDS - Point of operation hazards of a press include all pinch points above the bolster and below the slide which are hazardous as a result of the closing motion of the slide.

POSITIVE OR FULL REVOLUTION CLUTCH - See "CLUTCH".

POWER PRESS (MECHANICAL) - A mechanical power press is a mechanically powered machine that shears, punches, forms, or assembles metal or other material by means of cutting, shaping, or combination dies attached to the slides. A press consists of a stationary bed or anvil, and a slide (or slides) having a controlled reciprocating motion toward and away from the bed surface, the slide being guided in a definite path by the frame of the press.

PRESENCE SENSING - Presence sensing is a mechanism designed, constructed, and arranged to create a sensing field and to signal the control system when a worker is within such field.

PRESS CONTROL - The press control is the collection of mechanisms which control energization and de-energization of the clutch and brake.

PRIMARY OPERATION - A primary operation is the first press operation with respect to material to be subsequently processed. (See "SECONDARY OPERATION".)

PULLOUT - A pullout is a mechanism attached to the worker's hand(s) and connected to the slide or upper die of the press, that is designed, when properly adjusted, to withdraw the hand(s) as the dies close, if the hand(s) are inadvertently within the point of operation.

PUSHAWAY - A pushaway is a safeguarding mechanism that serves to protect the worker(s) by pushing him away from the point of operation as the slide descends and the dies close.

PUNCH - See "SLIDE".

RAM - See "SLIDE".

REDUNDANCY - Redundancy is a system design feature that provides multiple components and/or signal paths such that the failure of one component or circuit is "masked" by the redundant element and the system continues to perform properly as though no failure had occurred.

RELIABILITY - Reliability is a design feature of the safeguarding system which allows the system to perform for an extended period of time without failures. It is usually expressed as mean time between failures (MTBF).

REPEAT STROKE - A repeat stroke is an uninitiated successive stroke of the press resulting from a malfunction.

RESTRAINT OR HOLDOUT - A restraint or holdout is a mechanism, including attachments for the operator's hand(s), that when anchored and properly adjusted, prevent the operator's hand(s) from entering the point of operation.

SABOTAGE - Sabotage is the deliberate, calculated, and intentional efforts to render ineffective or circumvent the protection afforded by the press safeguarding system.

SAFEGUARDING SYSTEM - A safeguarding system is the necessary and functionally complete set of parts, components, mechanisms, and subsystems designed, constructed, and arranged to operate together as a unit so as to prevent the worker from receiving injury from the point of operation hazards.

SAFE OPENING - Safe opening is a safeguarding method whereby (a) the point of operation opening accesible to the worker is 1/4 inch or less in height with no workpiece in place, or (b) the point of operation opening is 1/4 inch or less with the workpiece in place. An opening 1/4 inch or less from the workpiece in place is considered a safe opening only when interlock(s) are provided to prevent slide motion unless the workpiece is in place or when the setup, workpiece size, or operation is such that the slide, dies, or workpiece will not close to a position which would create a hazard when the workpiece is either in or out of place.

SAFETY BLOCK - A safety block is a prop that, when inserted between the upper and lower dies or between the bolster plate and the face of the slide, prevents the slide and attachments from falling.

SAFETY DISTANCE - Safety distance is the minimum distance between a safeguarding mechanism and the nearest point of operation hazard which will preclude after-reach injuries.

SAFE WORKPIECE - Safe workpiece is a safeguarding method whereby (a) the workpiece being handled by the worker is of such size or shape that the worker cannot go near the point of operation during the closing movement of the dies, or (b) the worker has to hold the workpiece with his hand(s) during the closing movement of the dies, and the size, weight, or shape of the workpiece precludes after-reach. Safe workpiece is considered a safeguarding method only when an interlock is provided to prevent slide motion unless the workpiece is in place.

SCREW - See "CONNECTING ROD".

SECONDARY OPERATION - Secondary operation is press operation in which a preworked part is further processed. (See "PRIMARY OPERATION".)

SELF-CHECKING - Self-checking is the design feature of the control system which enables it to monitor itself, and which indicates any failure, usually by precluding continued operation of the system.

SHIELDS - A shield is a point of operation barrier that also serves to protect the worker from flying chips, splashing lubricants, sparks, etc.

SHUT HEIGHT - Shut height is the distance between the face of the slide and the bolster, with the crankshaft at the bottom of the stroke and the slide adjustment adjusted for maximum opening.

SIMULTANEOUS - As used in discussing power presses, simultaneous means that the actuation of two mechanisms takes place within a fraction of a second.

SINGLE STROKE - A single stroke is one complete stroke of the slide, usually initiated from rest in the full open (or up) position, followed by closing (or down), and then a return to rest in the full open position.

SINGLE STROKE MECHANISM - A single stroke mechanism is an arrangement used on a positive or full revolution clutch to provide an antirepeat function.

SINGLE STROKE RESET - See "ANTIREPEAT".

SLIDE - The slide is the working member of the press that is connected to the lower end of the connecting rod and moves up and down in relation to the bolster plate and lower die. The upper die is mounted to the underside of the slide. The slide is also called the ram, plunger, platen, or punch.

SLIDE FACE - See "FACE OF SLIDE".

SLIDING BOLSTER - A sliding bolster is a feeding device.

SNAP THROUGH SHOCK - Snap through shock is the reverse shock loading that occurs when material shears and the load on the press is suddenly released.

SPANKER PLATE - The spanker plate is the top surface of the upper die or die set, and is not bolted to the slide, but rides on springs and guides above the lower die. In order to close the dies, the spanker plate is struck by the moving slide.

STOP CONTROL (EMERGENCY) - A stop control is a manual control designed to immediately disengage the clutch and activate the brake to stop the motion of the slide.

STOPPING TIME (OVERRUN TIME) - The stopping time or overrun time is the elapsed time from the moment the stop signal is given to the moment the slide actually stops.

STRAP - See "CONNECTING ROD".

STRIPPER - A stripper is a mechanism or die part for removing the parts or material from the tools.

STROKE OF THE SLIDE - The stroke of the slide is the distance the slide moves from top of the stroke to the bottom of the stroke.

STROKING SELECTOR - See "MODE SELECTOR".

SWEEP - A sweep is a mechanism having a single or double arm (rod) attached to the upper die or slide of the press and designed to move the worker's hand(s) to a safe position as the dies close, if the hand(s) are inadvertently in the point of operation.

TECHNICAL SAFETY - Technical safety are those considerations which make initial and continued safety performance depend only on the machine itself.

TIE RODS - Tie rods extend from the top of the press crown through the uprights to the bottom of the bed. They prevent the crown from lifting off the uprights and also maintain alignment of press components.

TRIP (OR TRIPPING) - Tripping is the activation of the clutch to run the press.

TURNOVER BAR - A turnover bar is a bar used in die setting to manually turn the crankshaft of the press.

TWO HAND CONTROL - A two hand control is a mechanism that is designed, constructed, and arranged to signal the control system whenever concurrent pressure is maintained by one hand on each of two actuators.

TWO HAND TRIP - A two hand trip is a mechanism designed, constructed, and arranged to preclude tripping the press unless concurrent pressure is applied by one hand on each of two actuators.

TYPE A GATE - See "GATE".

TYPE B GATE - See "GATE".

TYPE TESTING - Type testing is the act of testing a particular type or class of safeguarding system.

UNINITIATED STROKE - An uninitiated stroke is a stroke that takes place when the actuator has not been operated.

UNINTENDED STROKE - An unintended stroke is a stroke which results from operation of the actuator, not intended by the operator.

UNITIZED TOOLING - Unitized tooling is a type of die set in which the upper and lower members are incorporated into a self-contained unit so arranged as to hold the die members in alignment.

WORKER - A worker is any person who sets dies in, operates, or maintains a press or serves as a helper during these operations.

WORKPIECE - A workpiece is the material fed into the dies which the dies then work into the desired part.

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15. Supplementary Notes

16. Abstract (Limit: 200 words) This Guide explores the technical, behavioral, and ergonomic aspects of mechanical power press safety as it pertains to workers who set dies on, operate, and maintain presses. Various safeguarding systems are evaluated and recommendations are given for proper use to safeguard the press worker from various hazards including the inherent hazard of a press, which is the hazard of being injured at the point of operation. Each safeguarding system is described. Installation instructions and recommendations are outlined. Maintenance instructions are covered in order to assure that the system is properly maintained so as not to compromise its safeguarding performance. Advantages and disadvantages of each system are given as an aid to the safety professional when he has to make a safeguarding system decision. An installation checklist is provided to ensure proper installation. A safety inspection checklist is provided and must be completed at specified intervals to ensure continued proper operation and safeguarding integrity of the system. A special section is devoted to information that will aid the safety professional to reach a decision as to which safeguarding system is best suited to his particular presses. A safety responsibilities section delineates the particular responsibilities of each group of people who are involved with presses in the hope that their involvement will be both safe and productive.

17. Document Analysis a. Descriptors

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