SECTION 7

Safety Hazards

Section Contents

Electrical Hazards

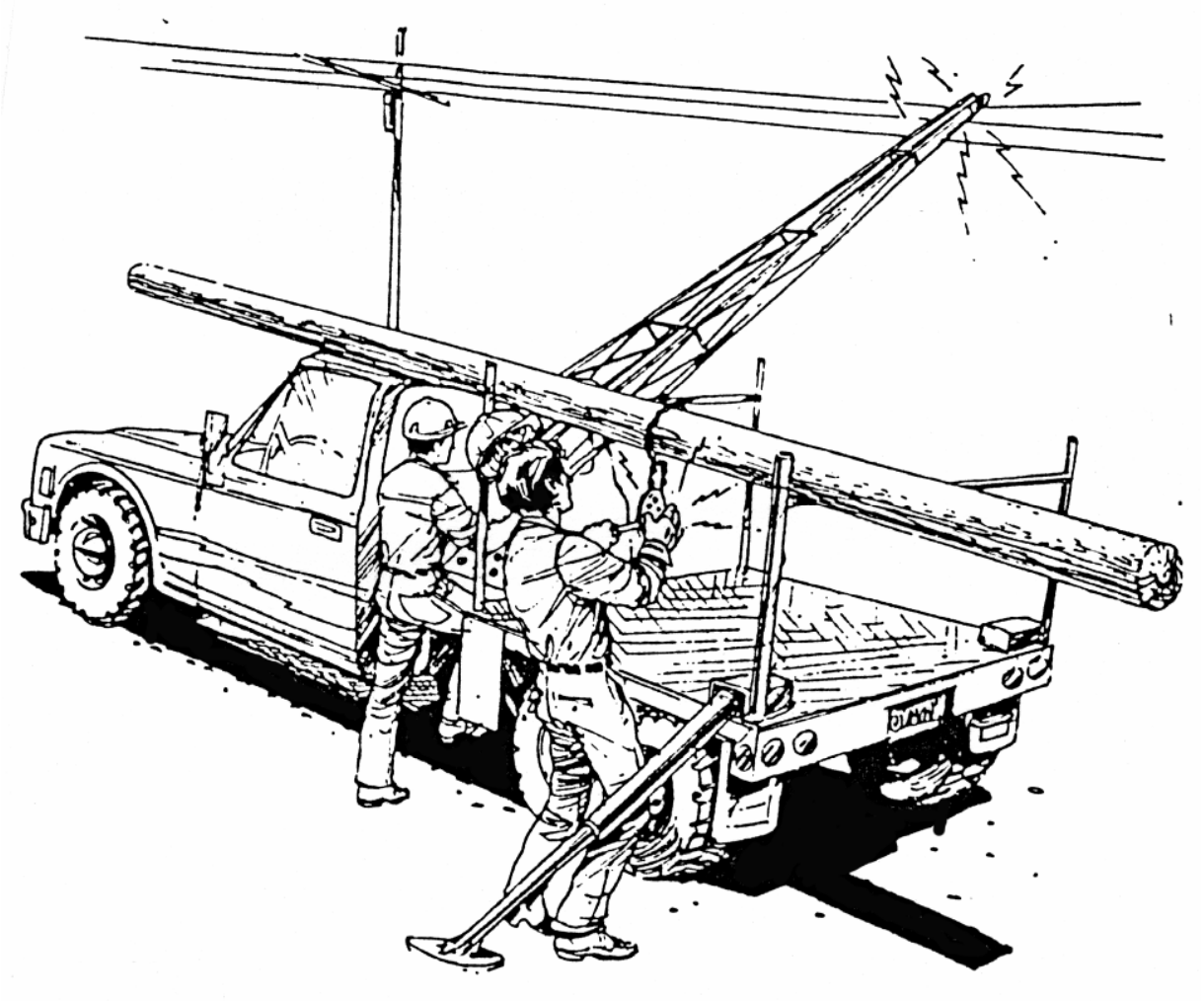
Most industrial plants use large amounts of electricity to operate equipment and to provide lighting. The voltage of industrial equipment (220 or 440 volts) is usually higher than household appliances. The amount of electrical current, measured in “amperes,” is also higher in factories than homes.

Electricity, electrical cables and cords, and electrical equipment can produce very harmful health effects including:

- death by electrocution or from falls after shocks
- non-fatal shocks, burns and falls
- fires caused by sparks and overheated equipment
- tripping hazards caused by cords, cables and other equipment

The amount of electricity needed to cause harmful health effects is not very high. For example, a normal television set uses about 1.3 to 1.5 amperes of current. One ampere (A) can be divided into a thousand parts, called “milli-amperes” or mA. That is, there are 1,000 mA in one ampere (A).

So a normal television is energized at 1,300 to 1,500 milli-amperes (mA).



Health Effects of Electricity

The harmful health effects of being exposed to milli-amperes of electricity are below:

Amount of Electricity	Health Effect
1 milli-ampere (mA)	Slight sensation on hand
2 mA	Numbness in hand
3.5 mA	Painful shock (possibly causing a fall or other accident)
5 mA	Uncontrollable tremors in hand
7 mA	Uncontrollable muscle spasms in forearms and upper arms
10–20 mA	"No-let-go" threshold where flexor muscles will not open to allow the hand to release an energized cord, cable or part
30+ mA	Temporary breathing failure
75-250 mA	Irregular heart beat, which is usually fatal

Compare this to the power level of an ordinary television set – 1,300 mA.

Specific Hazards

Live wires and parts:

- exposed and damaged wiring must be replaced and guarded
- openings to energized “bus bars” inside of circuit breaker panel boxes must be guarded
- open junction boxes and outlets must be closed
- energized equipment or metal parts must be grounded

Electrical equipment:

- damaged equipment must be replaced
- all equipment must be protected against physical damage
- equipment in damp or wet locations must have special protections
- power circuits must not be overloaded

Grounding issues:

- electrical outlets must be wired correctly, that is, no “reversed polarities” between ground and neutral wires
- all equipment plugs must have ground pins
- all electric hand tools must be grounded and the metal casings must not become energized

Circuit breaker panel boxes:

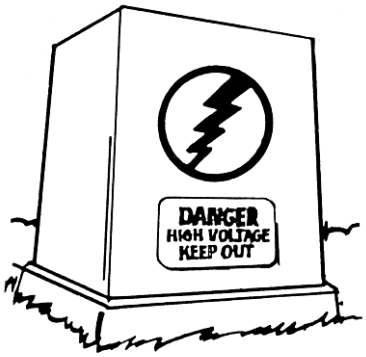
- must be marked with the voltage and current
- all circuits must be marked for their purpose, and with an indication of the “on” and “off” positions
- all circuit breaker panel boxes must have open space of 92 centimeters (36 inches) in front and 19 centimeters (7.5 inches) on either side

Flexible electric cord issues:

- flexible cords (such as extension cords) must not be used instead of permanent wiring because such cords can generate electrical shock, become overheated and cause fires, and can be a tripping hazard
- flexible cords must not run through walls, doors, or ceilings
- flexible cords must not be concealed in walls or ceilings
- flexible cords must be regularly inspected for slices and damage, and taken out of service if damaged
- flexible cords must have “strain relief” at junction boxes or equipment to prevent damage to the cords and exposure of live wiring inside

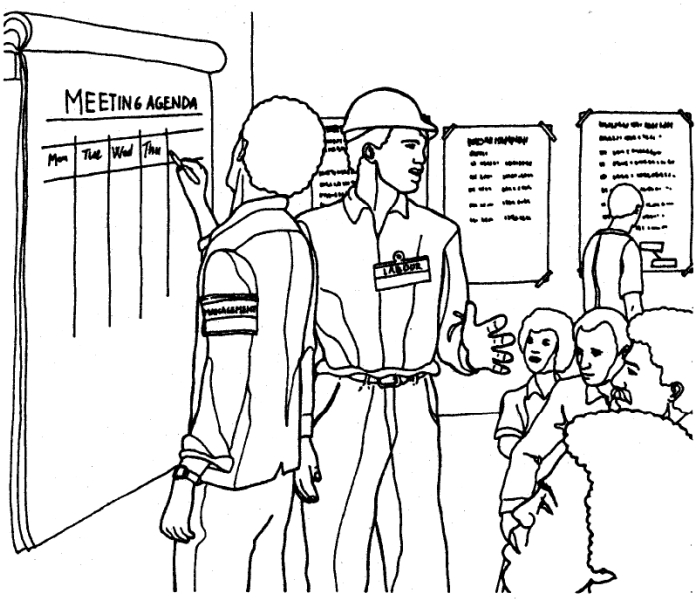
Storage around electrical equipment and switches:

- there must be no storage of flammable materials in the vicinity



Signs:

- All high voltage equipment (over 600 volts) must be marked



Employer Responsibilities

The employer has the responsibility for providing a workplace free of recognized hazards, including electrical hazards. The employer is responsible for:

- Providing the correct electrical equipment needed for the job, regularly inspecting and maintaining this equipment;
- Providing workers with the correct personal protective equipment (PPE), such as gloves, face shields, etc., needed for assigned tasks, and for maintaining or replacing this PPE as needed;
- Establishing written procedures for routine maintenance tasks involving electrical equipment, especially high voltage equipment;
- Providing workers with training on electrical hazards present in the workplace, on safe work practices (such as lockout/tagout procedures and equipment grounding), and on the use of PPE.

Some of the key requirements in China for electrical safety in the workplace are in Articles 32 to 48 of the July 1994 Labor Law (effective January 1, 1995).

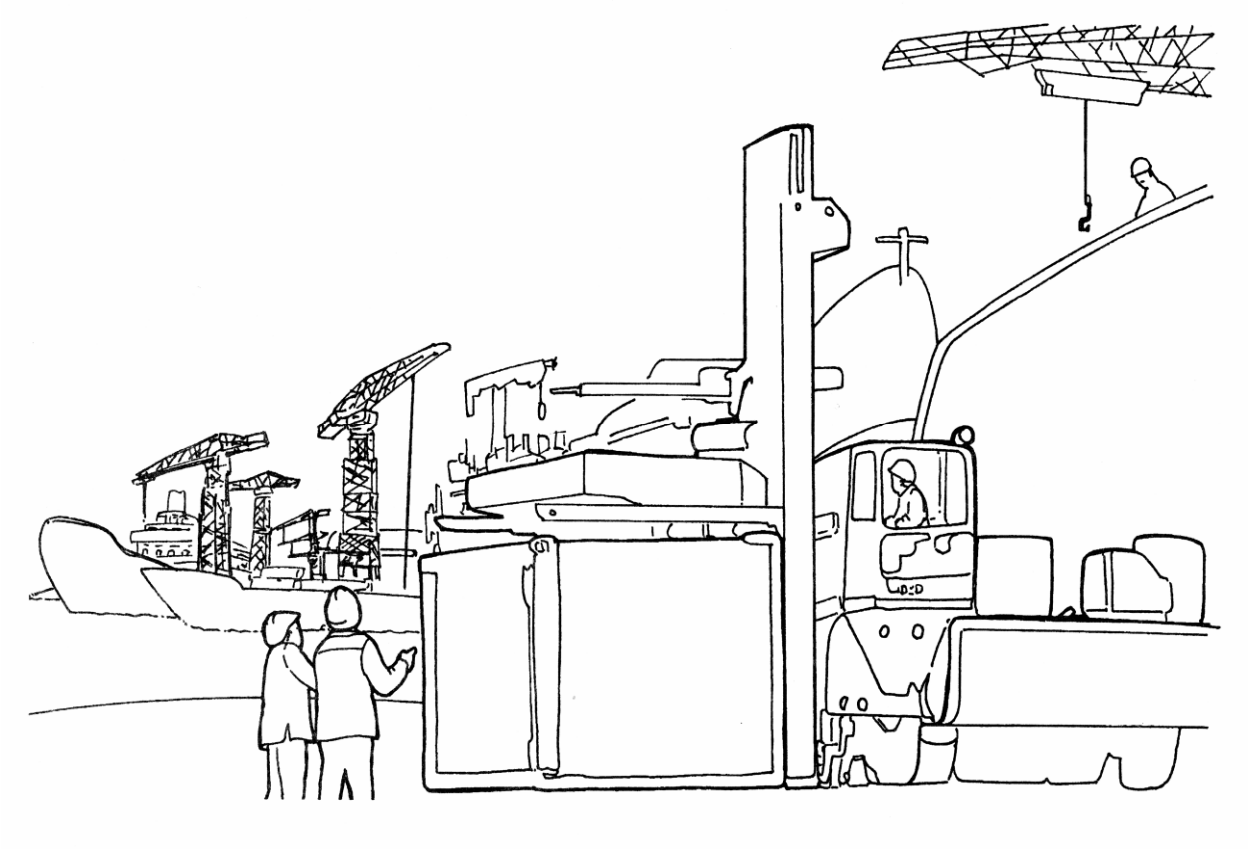
Special Hazardous Locations

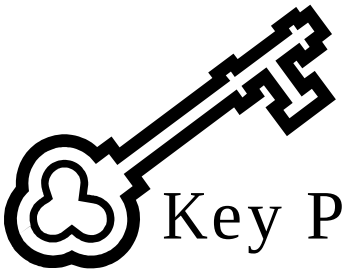
Using the right electrical equipment is particularly important in flammable, combustible or explosive atmospheres because a spark or a piece of overheated equipment can cause fires and explosions. Specially designed equipment, called "intrinsically safe" or non-sparking equipment, must be used in "hazardous locations." There are six types of hazardous locations where this equipment must be installed and used:

- Class I – Division 1: atmosphere where explosive concentrations of flammable gases or vapors normally occur;
- Class I – Division 2: atmospheres where flammable liquids or gases are handled, but are usually in closed containers or systems;
- Class II – Division 1: atmospheres where explosive concentrations of combustible dusts normally occur;
- Class II – Division 2: atmospheres where explosive concentrations of combustible dust do not occur normally but might occur under specific circumstances
- Class III – Division 1: atmospheres in which easily ignitable fibers or "flyings" are handled, manufactured or used;
- Class III – Division 2: atmospheres in which easily ignitable fibers are stored or handled.

If any of these types of atmospheres exist in a plant, intrinsically safe electrical equipment and lighting must be used. There are different types of equipment designed for use in each of these types of atmospheres.

Another “hazardous location” which requires special equipment and work practices are high voltage areas where equipment using more than 600 volts of electricity are in use. The employer is responsible for establishing special work practices, providing special PPE and providing specialized training for workers in these areas.





Key Points

1) Electricity can cause death and serious injuries in a variety of ways, and not very much electricity is required to cause harmful health effects.

2) There are specific hazards related to the design and use of electrical equipment in the workplace, which can be recognized and corrected.

3) The employer has the responsibility to provide the correct electrical equipment for plant operations, personal protective equipment (PPE) for workers, and safe work practices and worker training.

Simple Checklist for Electrical Hazards

- ❑ Are there any recognized hazards with electrical equipment (frayed or exposed wires, overheated equipment, tripping hazards, etc.) in the workplace?

- ❑ Are there any "live parts" (parts that are carrying electrical energy) in equipment, fixtures, lamps, outlets, etc., which workers can contact?

- ❑ Have discontinued circuits and outlets been de-energized or maintained as if they were still in use?

- ❑ Are flexible cords used only as permitted – that is, no cords instead of permanent wiring; no splices or taps; and provided with strain relief?

- ❑ Does all electrical equipment with plugs have a ground pin (third pin) to prevent the metal parts of the equipment from becoming "energized" or "live"?

- ❑ Are all electrical outlets wired correctly so that there are no "reversed polarities" between ground and neutral wires?

- ❑ Do all circuit breaker panel boxes have the required free access space in front and on either side of the panel?

- ❑ Do all circuit breaker panel boxes have the energized "bus bar" guarded and not open to worker contact?

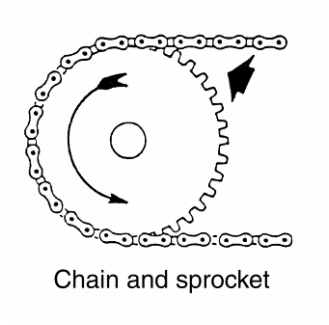
- ❑ Do all circuit breaker boxes have directories for the purpose of the switches, do they have an indication of "on" and "off" positions, and are the boxes marked with the voltage and current flowing through the circuit?

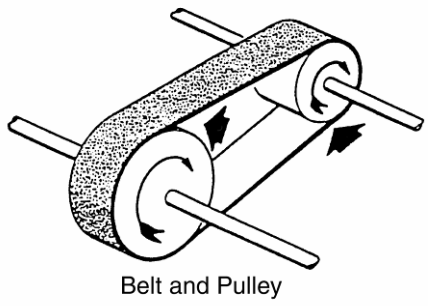
Machine Guarding

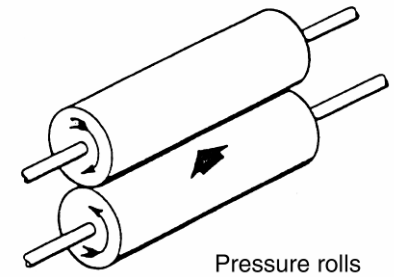
Hundreds of workers around the world lose fingers, hands, limbs and their lives every week in accidents involving industrial machines. Almost all of these accidents, injuries and deaths can be prevented by adequate guarding of machinery and by following safe work practices.

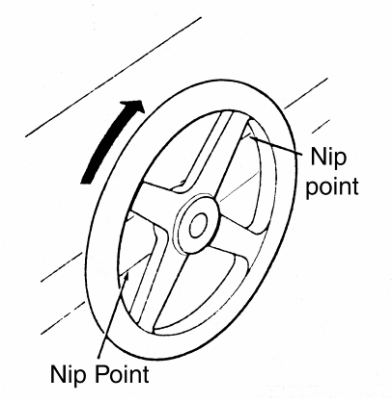
Mechanical hazards, which are illustrated later in this section, include:

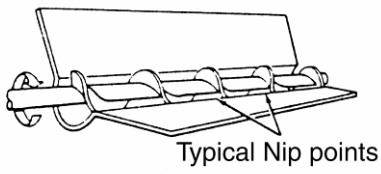
- point of operation hazards
- pinch points
- shear points
- nip points
- rotating parts
- reciprocating parts
- ejected parts
- sharp edges
- flying chips
- sparks
- exposed electrical wiring and energized parts

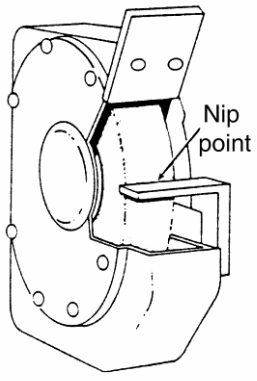

Chain and sprocket


Belt and Pulley


Pressure rolls




Typical Nip points



There are three particular areas of machinery where most injuries occur:

- point of operation – the point where the work is performed, that is where materials like metal, wood, plastics, fabrics are cut, bent, shaped, fastened, bored, etc.
- power transmission systems – components of a mechanical system that transmit mechanical energy from the motor or energy source to the parts of the machine that perform the work, that is components like flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains and sprockets, cranks and gears, etc.
- Other moving parts – all other parts of a machine that move while the machine is in operation, such as rotating, reciprocating and transversing parts.

Most injuries occur when operators or maintenance workers:

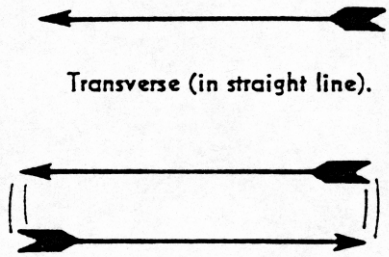
- are running the equipment and exposed to point of operation hazards and hazards from other moving parts;
- have to un-jam energized and running equipment;
- must perform “dynamic servicing” when the guards are removed and the machine is still energized or running;
- are doing regular servicing or repairs and have to place some part of their body in the path of moving parts.

Some of the key requirements in China for machine guarding in the workplace are in:

1) GB 8196-87 “Safety Requirements for Guarding on Machinery” (1987); and
2) Articles 32 to 48 of the July 1994 Labor Law (effective January 1, 1995).

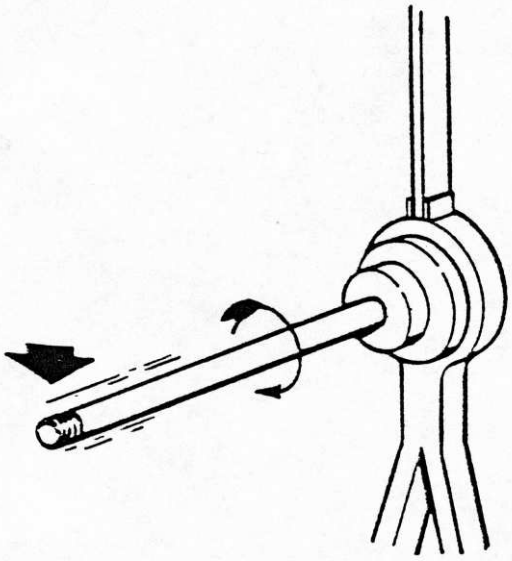
Examples of Typical Rotating, Reciprocating, and Transverse Mechanisms

Rotating.

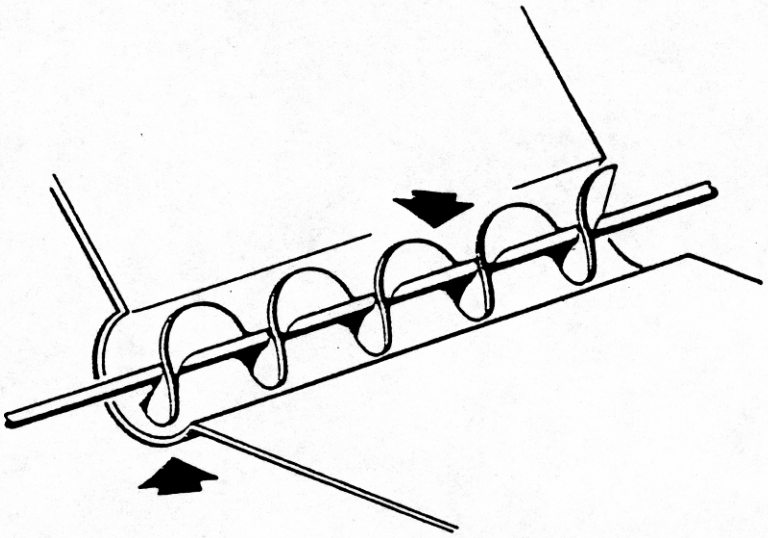


Transverse (in straight line).

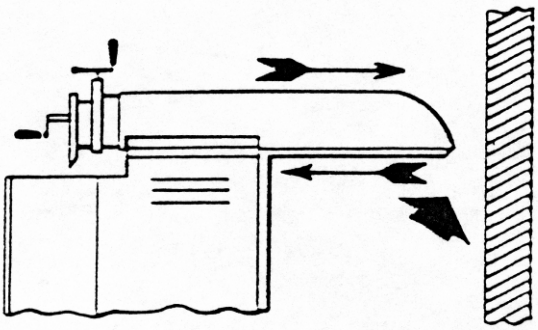
Reciprocating.



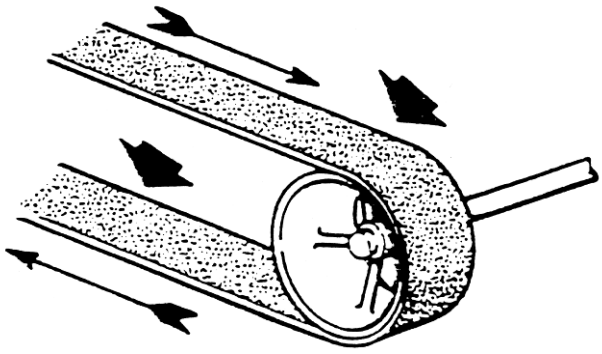
Rotating bar stock at end of screw machine.



Rotating screw conveyor.



Reciprocating action of machine creating pinch point at fixed object.



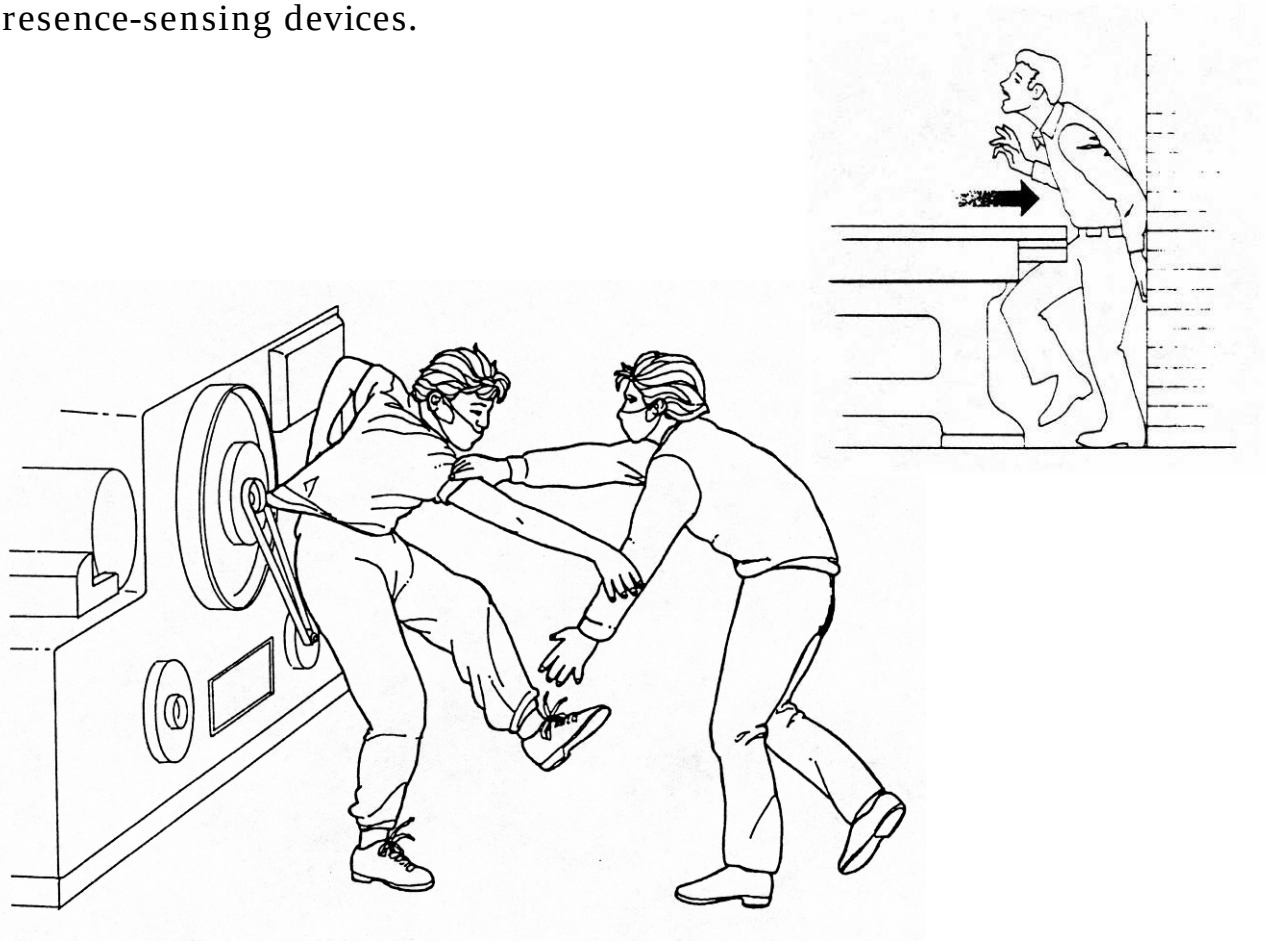
Transverse motion of belt and rotating pulley.

Requirements for Machine Guarding

Machine guards are effective when they:

- prevent contact between the worker and hazardous parts of the machine
- do not create new hazards for operators or maintenance workers
- do not interfere with operation
- allow for safe lubrication and inspection of equipment
- are secure and durable enough to withstand normal operations

There are various types of machine guarding – mechanical guards, safety controls, guarding by location, pull backs and restraints, and presence-sensing devices.



Mechanical Guards

Fixed barrier enclosures

This guard's action is to place a fixed barrier between the operator and the machine. The advantages of fixed barriers are that they: have a wide variety of applications, provide maximum protection for operators; in-plant fabrication and installation are possible, are relatively inexpensive, require minimal maintenance, and are suitable for high production, repetitive operations. The limitations of fixed barrier guards are that they: may interfere with visibility, may not suit some operations, and that repairs to the machine may require removal of the barriers first.

Adjustable barrier guard

This guard's action is to place an adjustable barrier between the operator and the machine. The advantages of adjustable guards are that they: can be constructed to suit many operations, are adjustable to fit varying sizes of material, and in-plant fabrication and installation are possible. The limitations of adjustable barriers are that they: may not always provide complete protection, may require frequent maintenance or adjustment, may interfere with visibility, and the operator may damage the guard.

Self-adjusting barrier guard

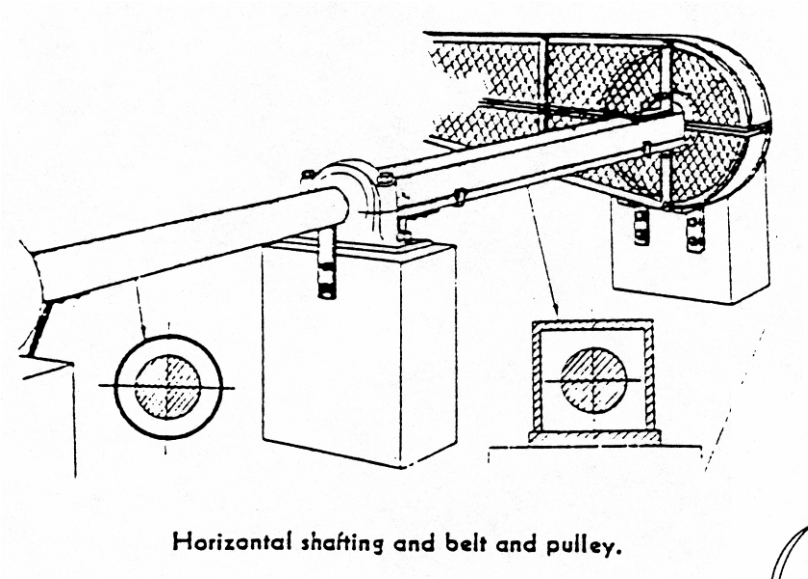
This guard's action is to place a self-adjusting barrier between the operator and the machine. The advantages of self-adjusting guards are that they: do not require operator adjustment, can be constructed to suit many operations, are adjustable to fit varying sizes of material, pre-fabricated guards are readily available while in-plant fabrication and installation are also possible. The limitations of self-adjusting barriers are that they: may not always provide complete protection, may require frequent maintenance or adjustment, and may interfere with visibility.

Interlocked barrier guard

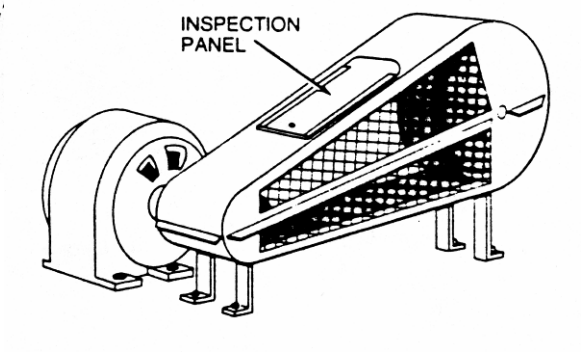
This guard's action is to cut off power and stop the machine when the guard is opened or removed. The advantages of interlocked barrier guards are that they: provide maximum protection; allow access for servicing or repairs without having to remove the entire guard. The limitations of interlocked barrier guards are that they: require adjustment and maintenance to prevent malfunctioning, can be expensive, and can be by-passed by operators.

Interlocked mechanical gate

This guard's action is to activate a sliding gate, which is interlocked to the operating mechanism, which creates a barrier between the operator and the machine every time the machine cycles or "trips." The advantages of interlocked mechanical gates are that they prevent operators from reaching into or walking into the danger zone. The limitations of interlocked mechanical gates are that they: require frequent maintenance and adjustment, can be expensive to fabricate and install, and can be by-passed by operators.

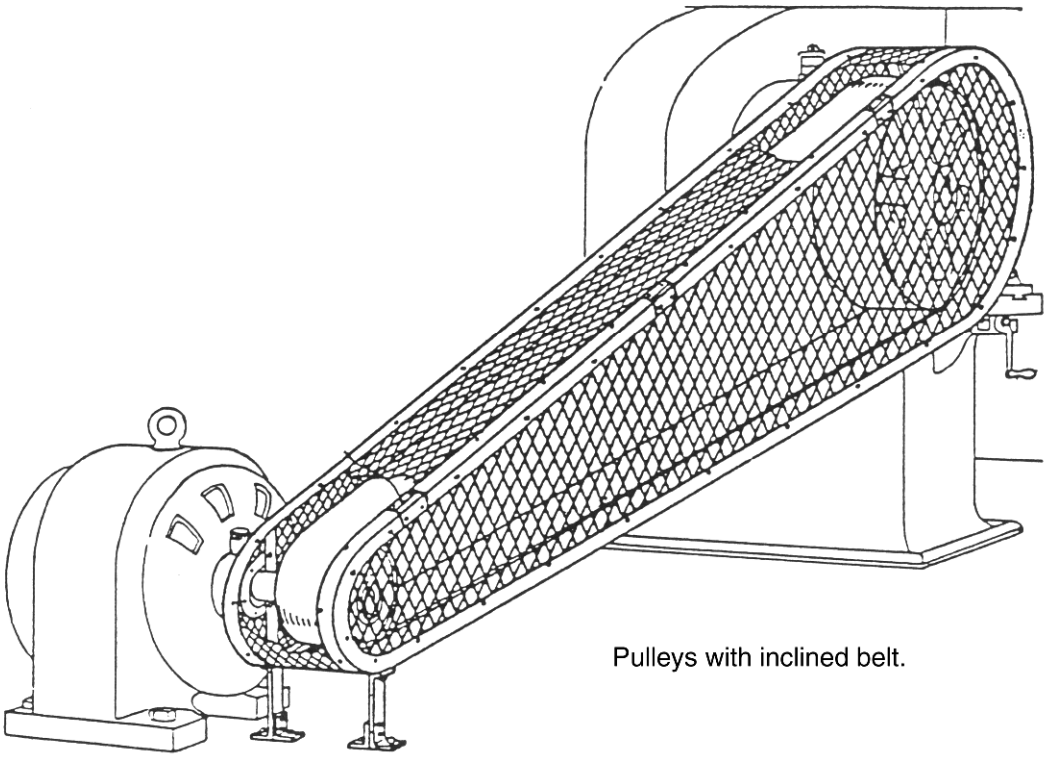


Horizontal shafting and belt and pulley.

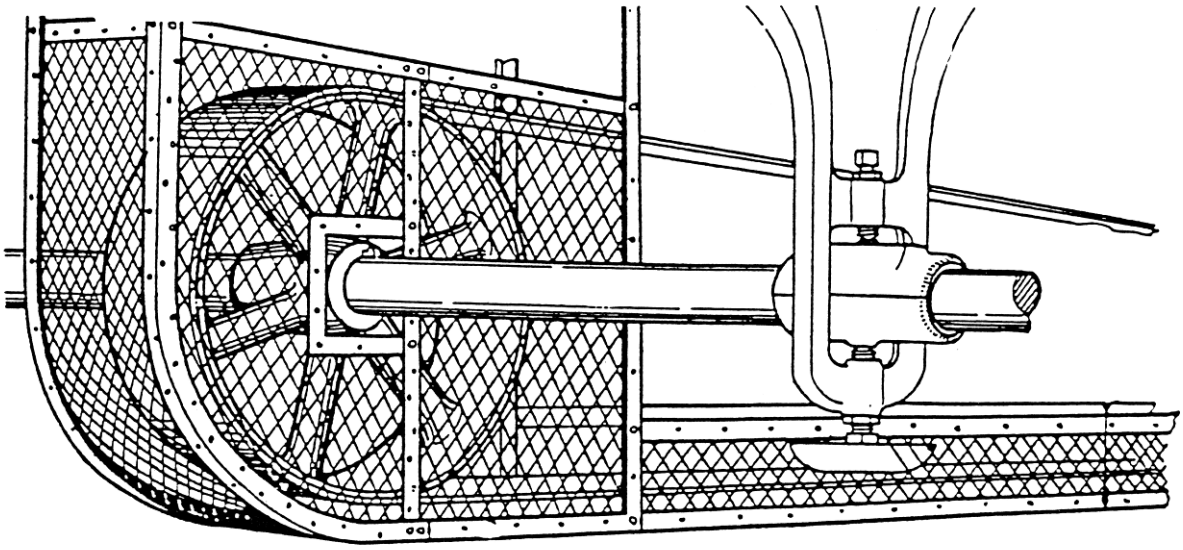


Barrier Guards

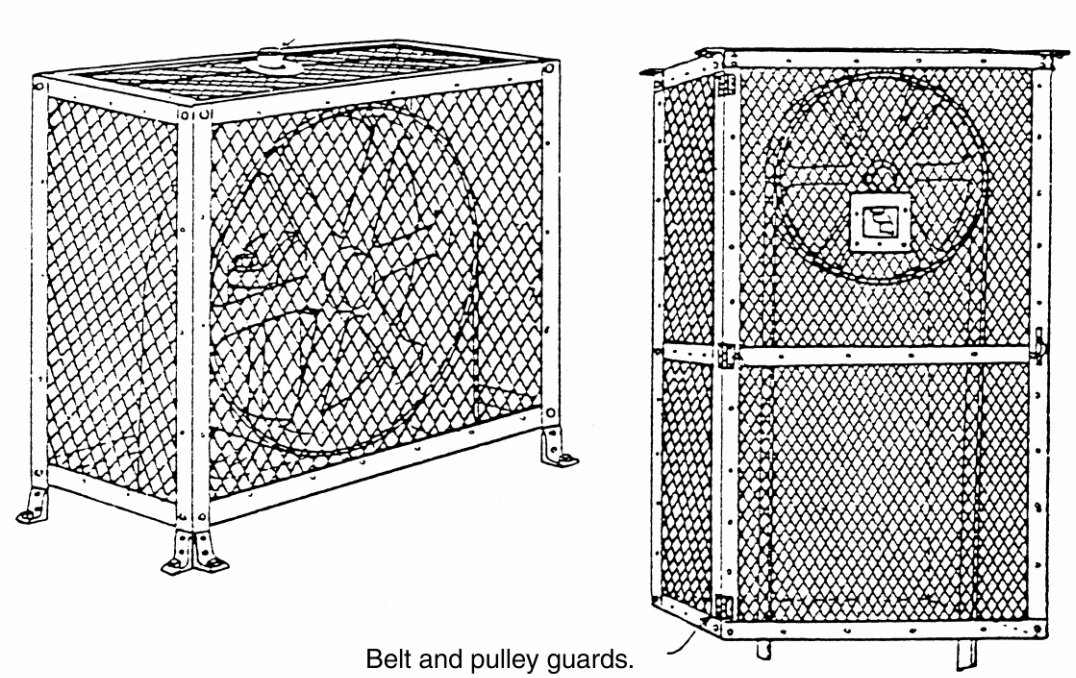
Guarding Rotating and Transverse Motions by Enclosure Guards



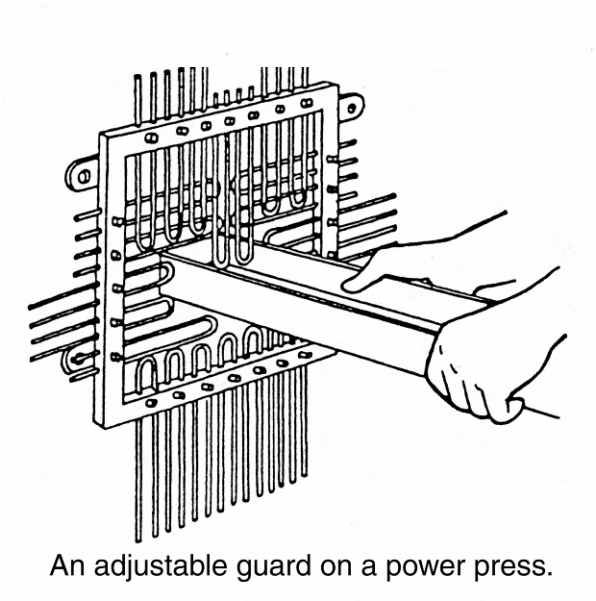
Pulleys with inclined belt.



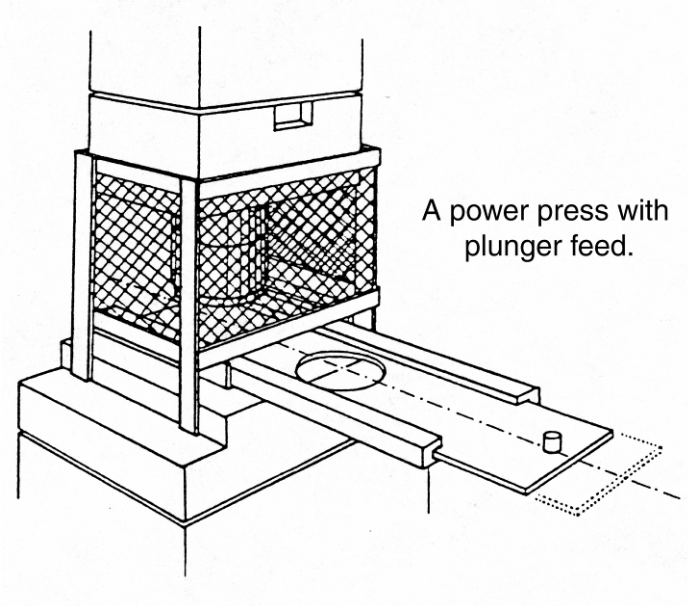
Overhead horizontal belt and pulley.



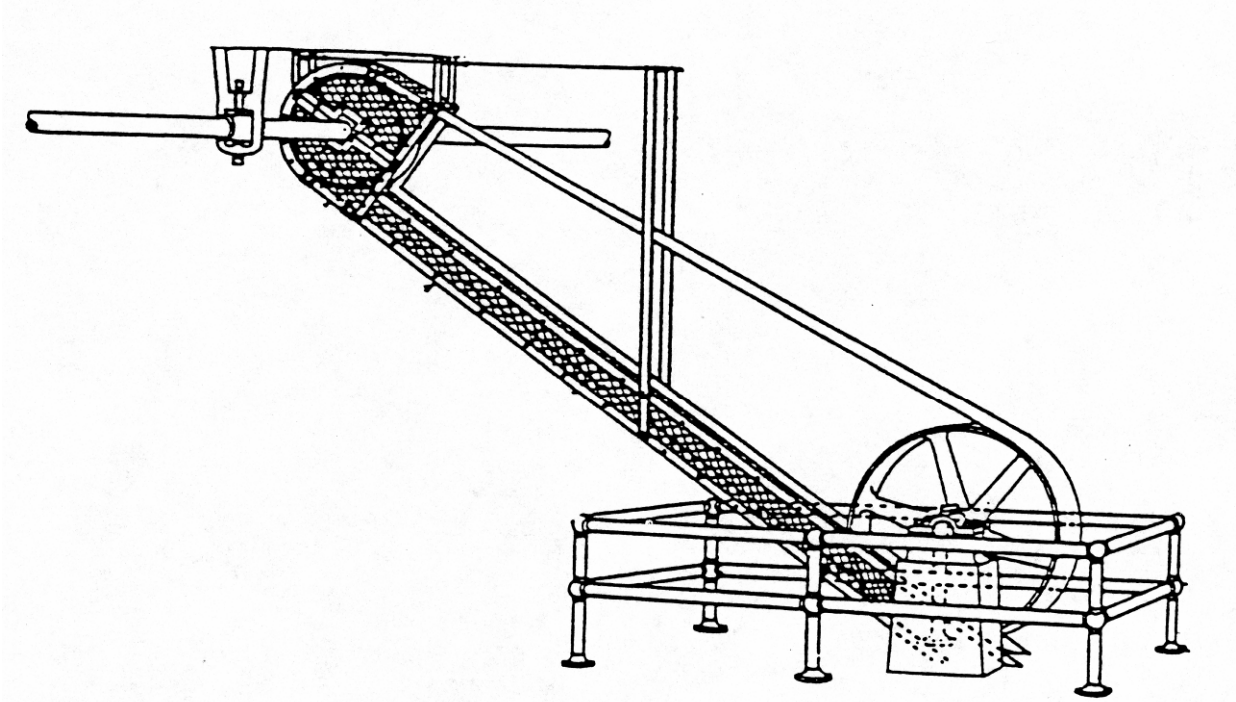
Belt and pulley guards.



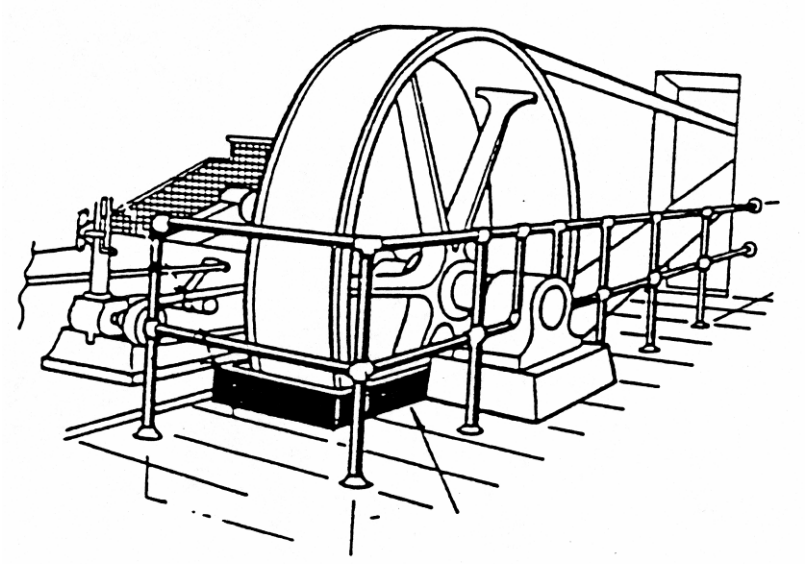
An adjustable guard on a power press.



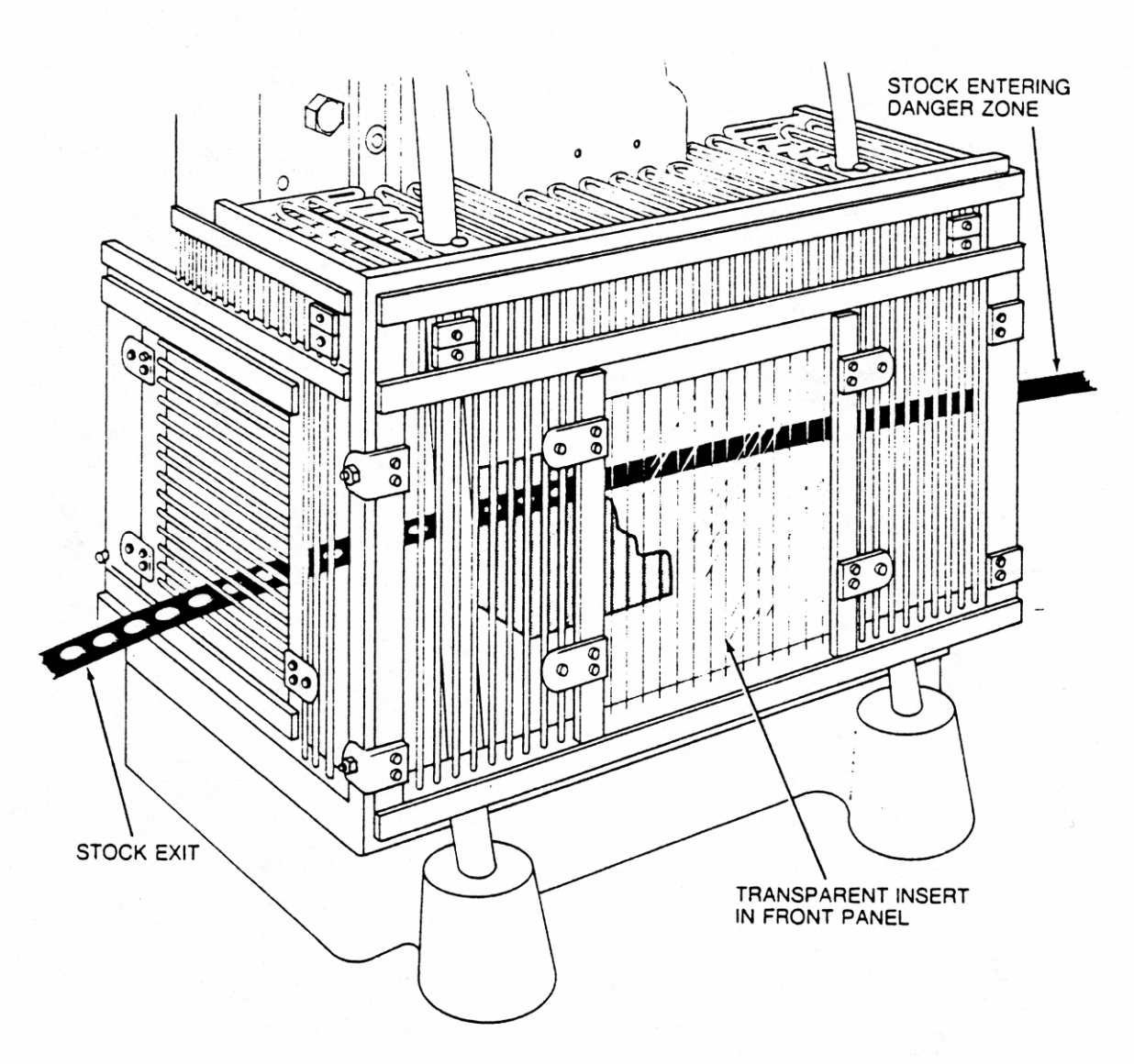
A power press with plunger feed.



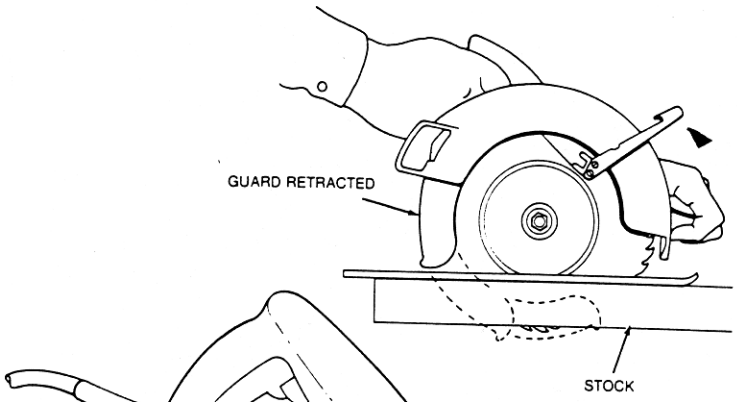
Pulleys and inclined belt.

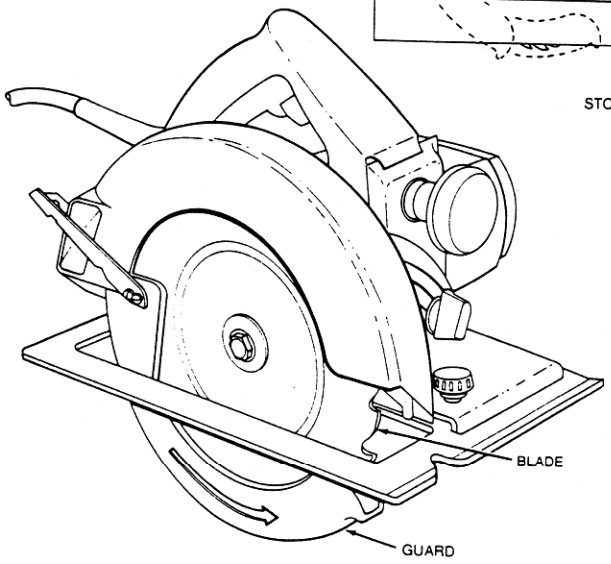


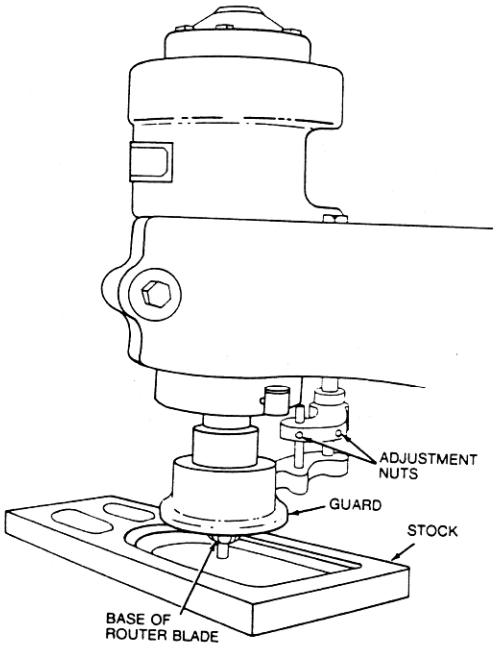
Flywheel with horizontal belt.

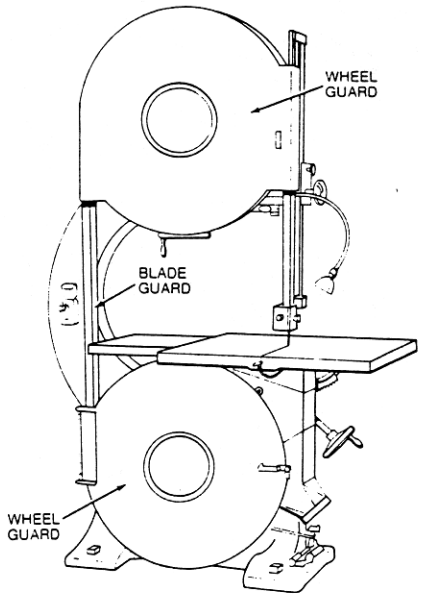

STOCK ENTERING
DANGER ZONE
STOCK EXIT
TRANSPARENT INSERT
IN FRONT PANEL

Blade Guards

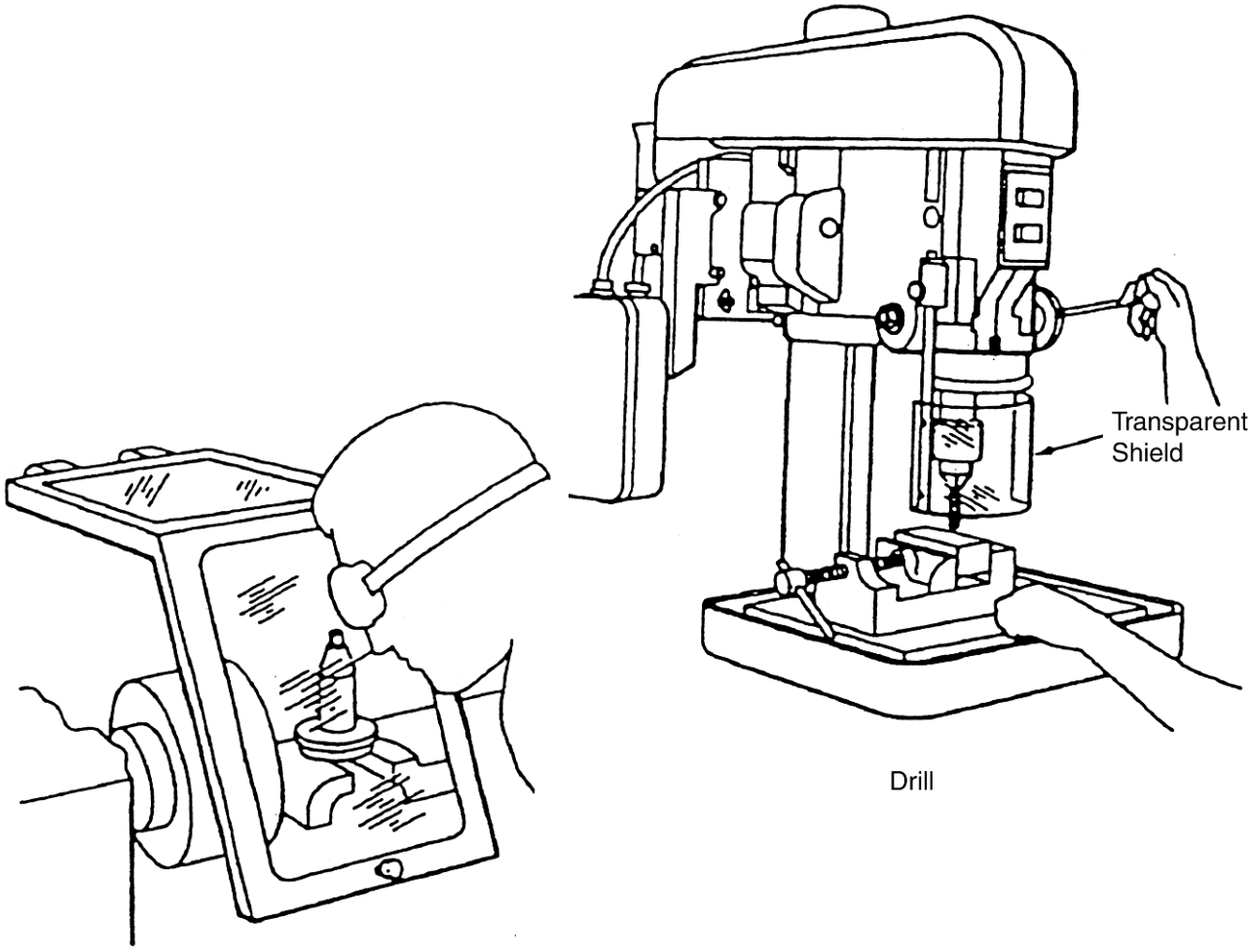




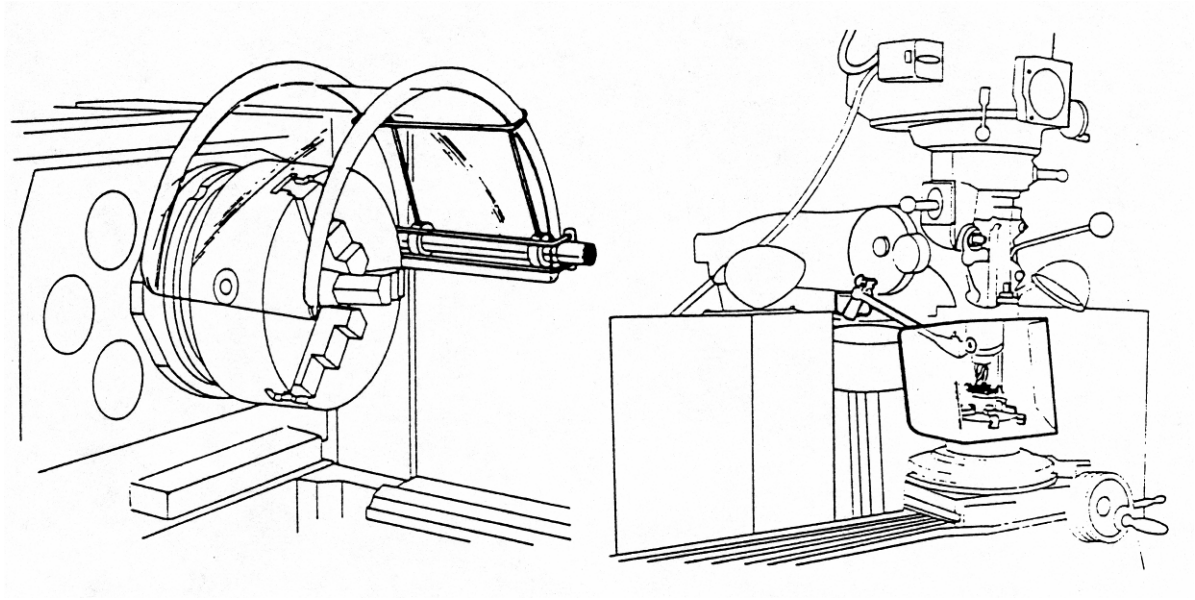




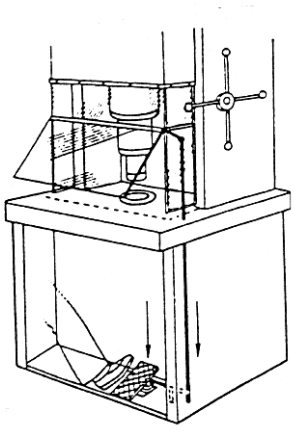
Transparent Shield



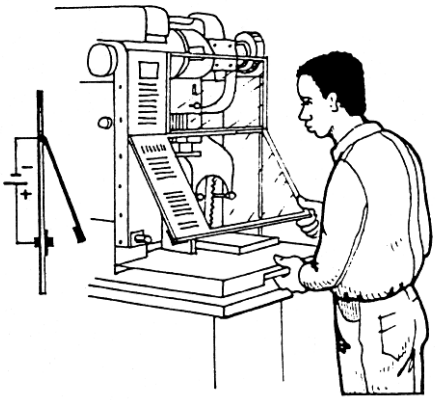
Drill



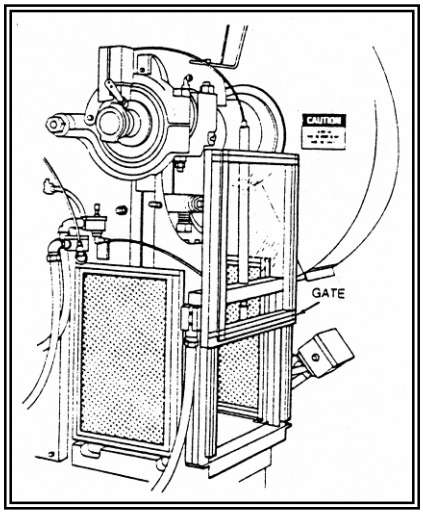
Electric Interlock Devices



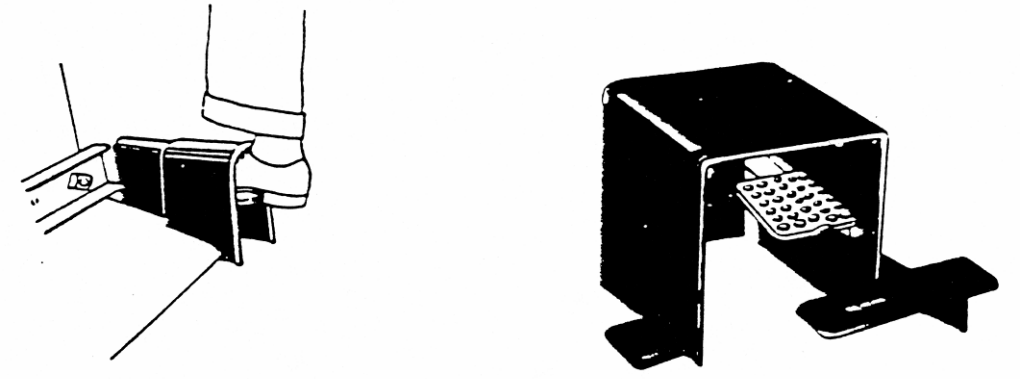
Pedal activation of an interlock guard.



An interlock guard with a shut-off device.



Foot Pedal Guard



Treadle guards for presses and shears to prevent unintentional tripping.

Safety Controls

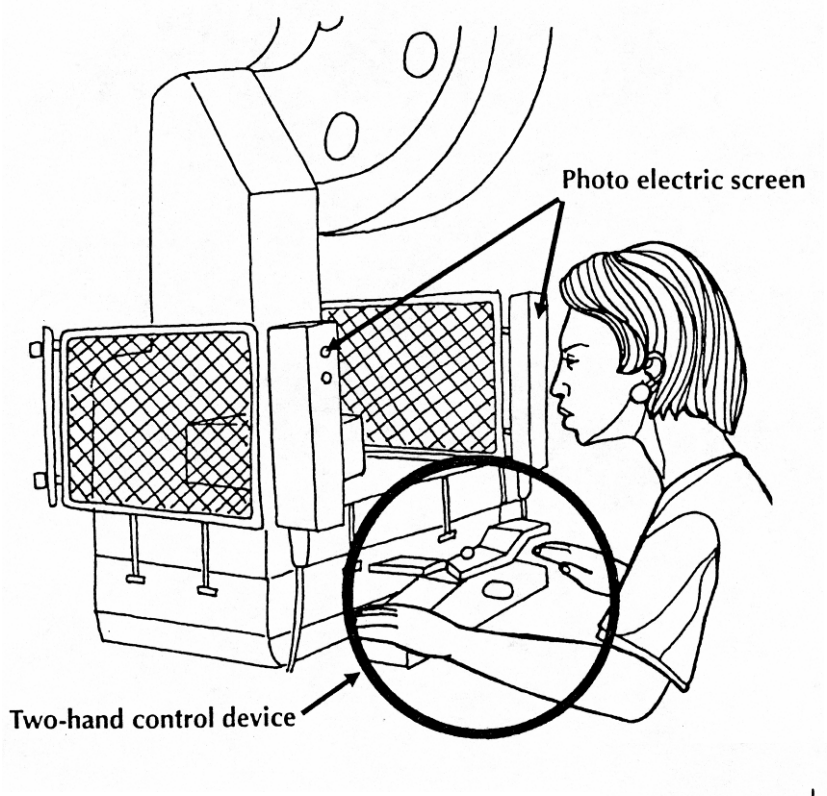
Two hand controls

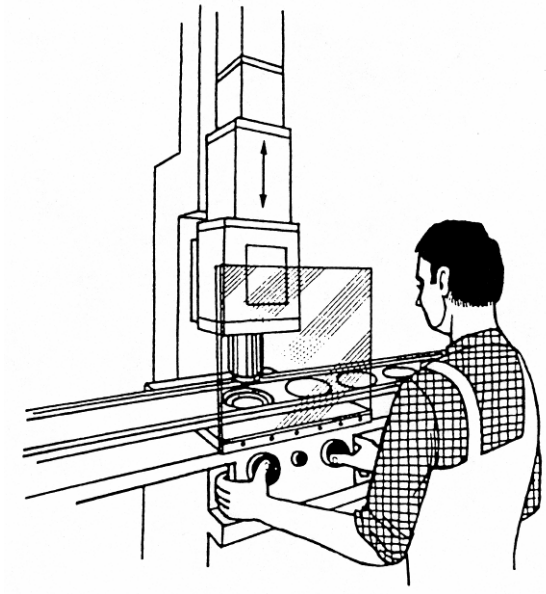
This guard's action is to require the simultaneous use of both operators' hands to activate the machine. The advantages of two hand controls are that they: remove the operator's hands from the danger zone, can be adapted to many operations, require little maintenance, and can be inexpensive to install. The limitations of two hand controls are that they: protect only the operator, require partial cycling or a break in operations, and must be designed to prevent being by-passed by operators.

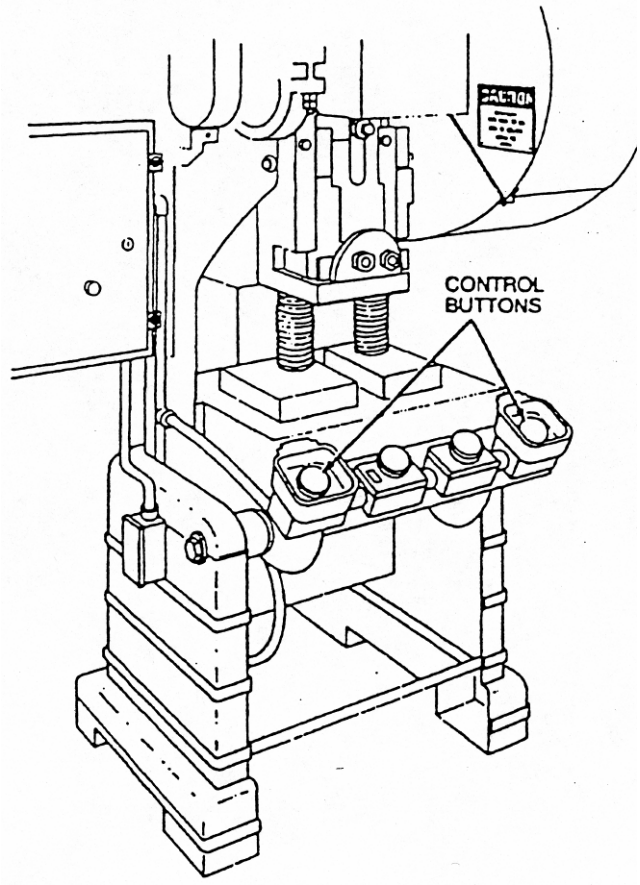
Safety trip controls

This guard's action is to stop the machine after the completion of one cycle of work when it is "tripped". The advantages of safety trip controls are that they: have a simplicity of operation which makes them reliable, and are easy to install on manually activated devices. The limitations of safety trip controls are that they: only protect the operator, all controls must be manually activated, a mechanical brake may be required, they may require a special fixture to hold the work, and may be difficult to activate because of location.

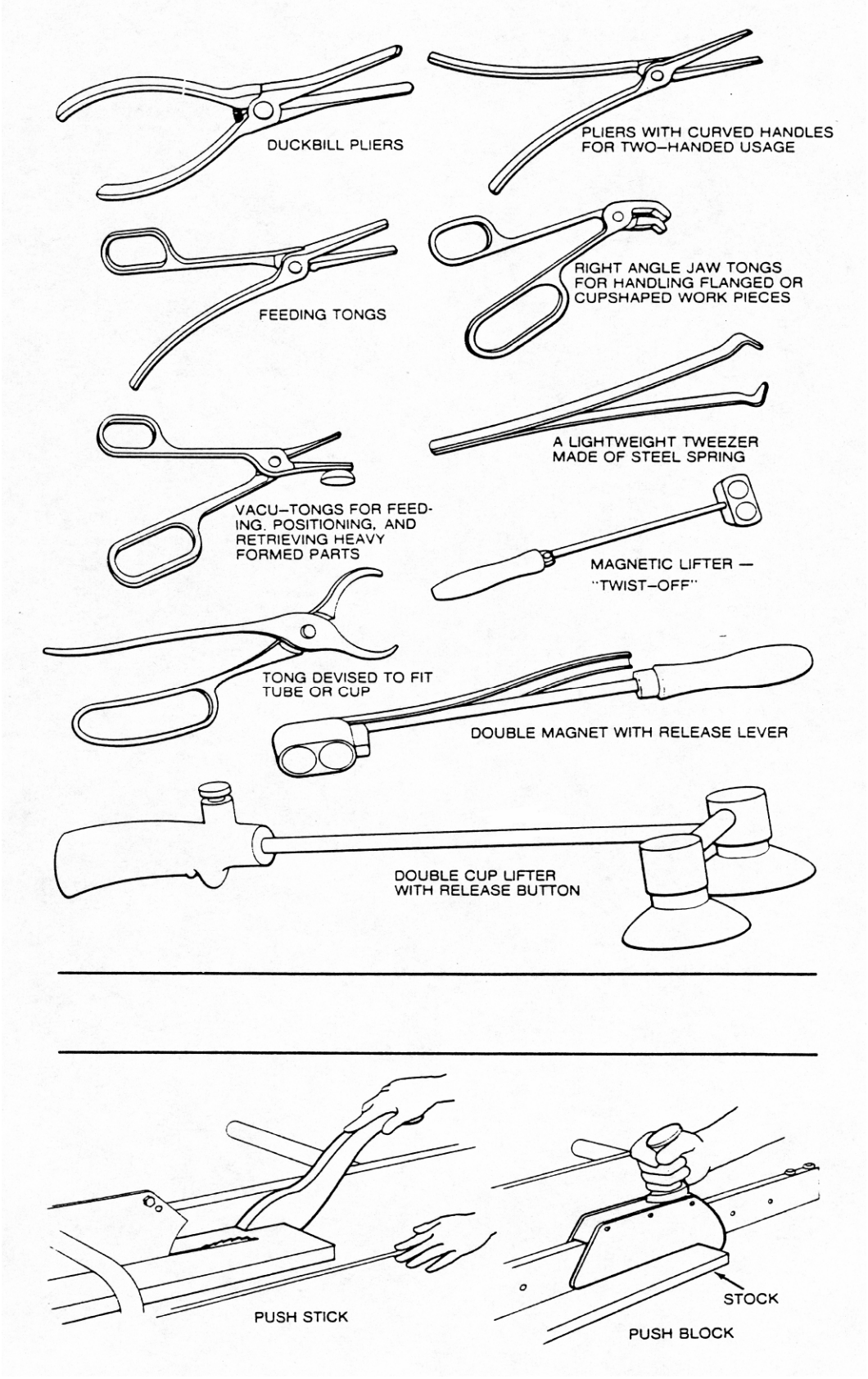
Two-Handed Controls





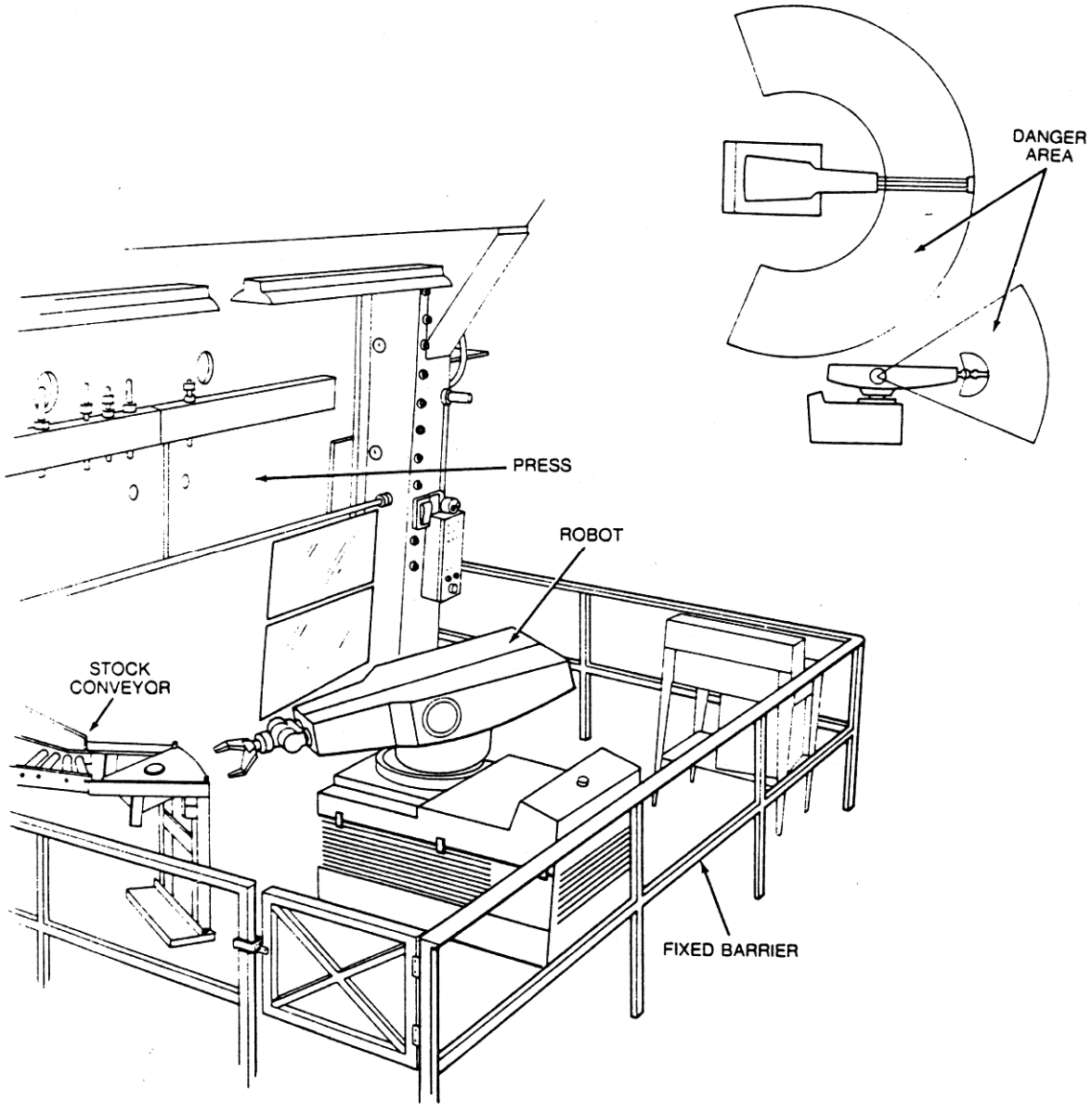


Holding and Pushing Tools



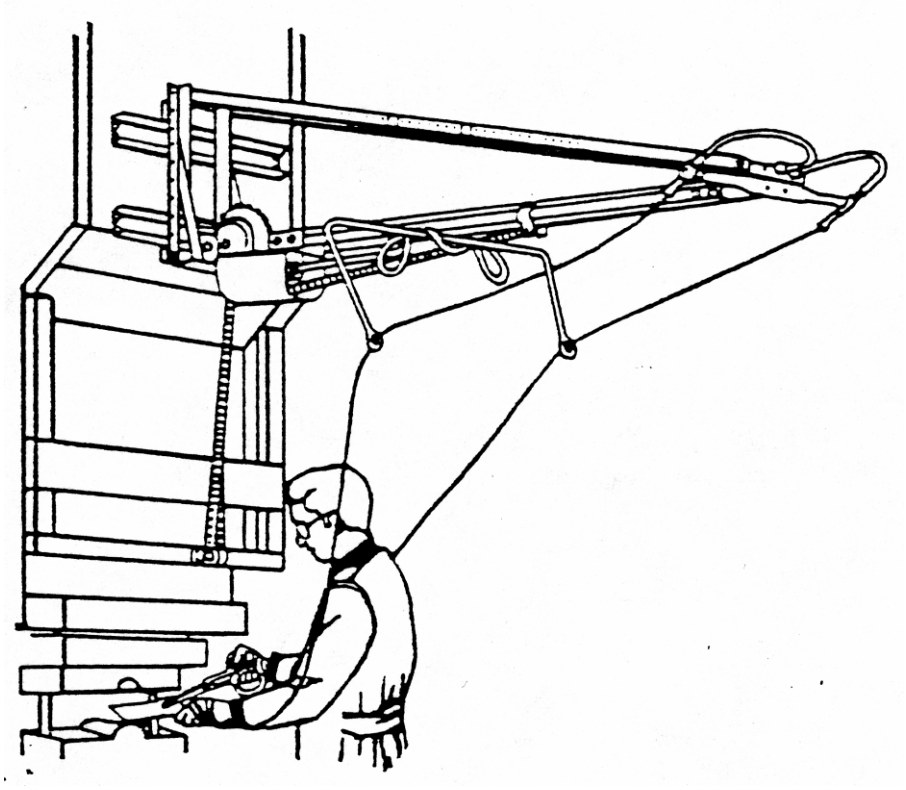
Guarding By Location

This safeguarding action is to place barriers around equipment to keep workers at least 123 centimeters (4 feet) away from machines; locating hazards (moving parts, belts, etc.) at least 2.15 meters (7 feet) above the floor or working surface; or controlling access to machines, such as locked machinery rooms. The advantages of guarding by location are that it provides maximum protection. The limitations of guarding by location are that it: may not be suitable for all operations, may interfere with visibility, can make maintenance and repairs more difficult, and can be by-passed by operators.



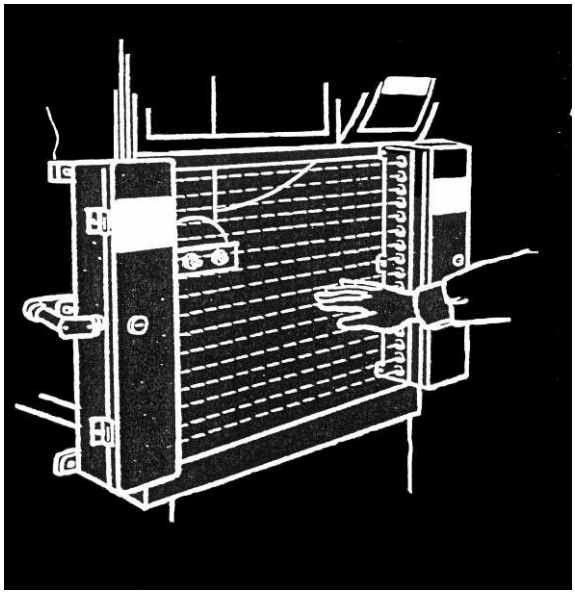
Pull-Backs and Restraints

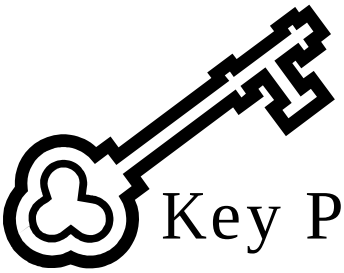
This guard's action is to automatically pull away machine operator's hands when the cycle begins or "trips," to physically restrain or (hold back) operator's hands from the danger zone, or to mechanically sweep or push away operator's hands when the cycle begins or trips. The advantages of pull-backs and restraints are that they: provide maximum protection when functioning properly. The limitations of pull-backs and restraints are that they: can result in injuries to workers due to stresses and strains; require frequent maintenance to operate effectively, and can be expensive to install.



Presence-Sensing Devices

This guard's action is to stop the machine when photoelectric cells or radio frequency field detection devices detect the presence of the operator in the danger zone. The advantages of presence-sensing devices are that they: allow for free operator movement outside of the danger zone, and provide good protection when the equipment is functioning properly. The limitations of presence-sensing devices are that they: do not protect operators from mechanical failure; are limited to machines that can be stopped immediately, require frequent maintenance to ensure alignment of detection devices; vibration can damage detection devices; radio frequency sensitivity must be properly adjusted and can be affected by other objects in the work area, and have a high initial cost.





Key Points

1) Unguarded machines cause thousands of permanently disabling injuries and deaths every year, but these accidents can be prevented.

2) There are a wide variety of guards and devices that can be installed to protect machine operators and maintenance personnel.

3) Each type of guard or device has advantages and limitations, which should be carefully evaluated when considering which guard or device to install.

Simple Checklist for Machine Guarding

- ❑ Are workers' hands, fingers and bodies kept safely away from danger zones while the machine is being operated, adjusted, serviced and maintained?
- ❑ Are the "start" and "stop" control buttons in easy reach of the operator?
- ❑ Are belts, pulleys, chains, sprockets, gears and blades properly guarded?
- ❑ Are rotating parts guarded (covered) or guarded by location (out of reach)?
- ❑ Are fan blades located within 2.15 meters of the floor, guarded?
- ❑ Are guards firmly attached so they cannot be easily removed?
- ❑ Does the design, construction or operation of a machine guard create any new dangers or hazards for the operator?
- ❑ Have the operators received training on safe work practices and the importance of not by-passing guards?
- ❑ If operators are not within sight or hearing of other workers, is an alarm system provided in case of an accident?

Lockout/Tagout Procedures

Lockout/tagout involves procedures for "locking out" and "tagging out" all energy sources for equipment and machinery before the equipment is adjusted, repaired, maintained or "un-jammed." Hundreds of workers are injured and killed every year while attempting to work on energized equipment.

The goal of lockout/tagout (LO/TO) procedures is to prevent injuries and death by ensuring that machines will not accidentally move or operate when workers are servicing them.

The purpose of LO/TO procedures is to de-energize ALL power sources and stored power in machinery and equipment before they are worked on. The possible sources of power and stored power for machinery and equipment include:

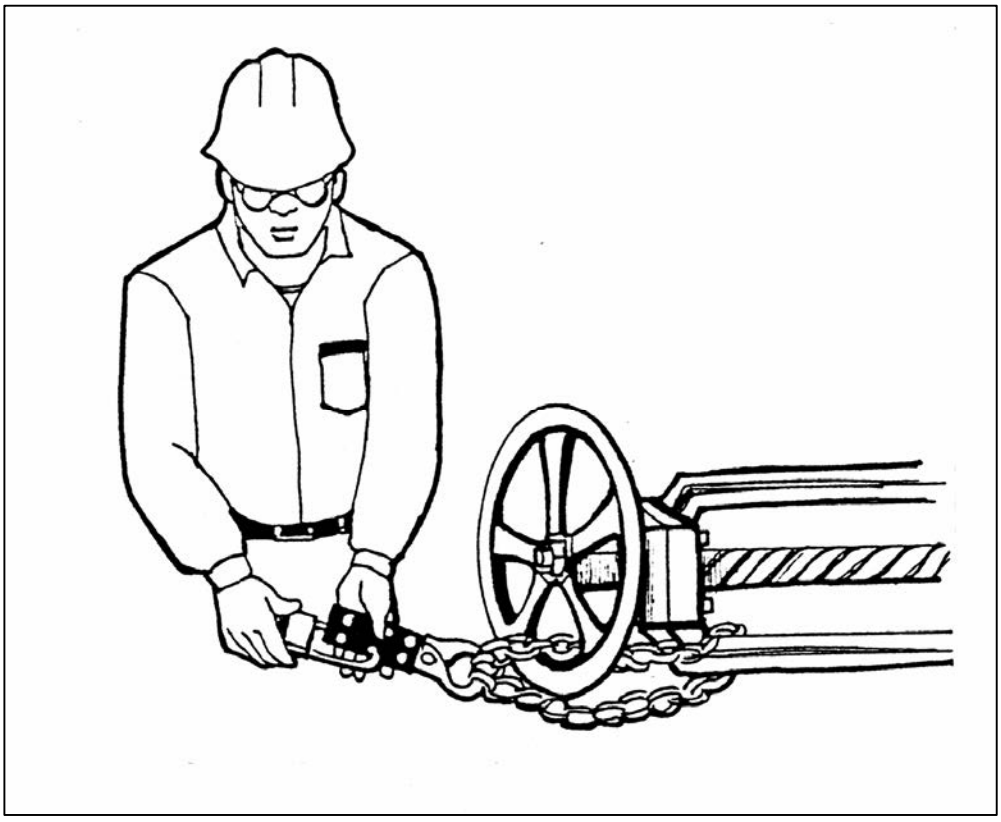
- electrical
- hydraulic
- pneumatic (air pressure)
- mechanical
- steam
- metal springs

Often simply locking out a power source is not enough because hydraulic and pneumatic cylinders may have stored energy, electric batteries and capacitors may still be connected and energized, mechanical systems, and springs may also have stored energy.

How Lockout/Tagout is Done

To "lockout" a power source each worker who will be working on the machine, equipment or system places a padlock on the "disconnect" or "off switch" of the power source. Each worker has the only key for the padlock he or she placed on the power source. In some cases, one member of a team of workers will place a padlock for the entire team, but extreme care must be taken not to remove the lock until all members of the team are accounted for.

To "tag out" a power source each worker who will be working on the machine, equipment or system places a tag next to the padlock on the disconnect of the power source which states who placed the padlock and how long the "lock out" will last.

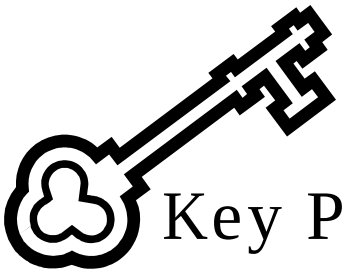


In some cases where it is not possible to

lock out a power system, a tag will be placed on the disconnected power source indicating who placed the tag and for how long the system should not be energized. Extreme care must be taken not to re-energize any "tagged out" power system until all workers have been accounted for.

Unless the work cannot be done in any other way, no equipment should be worked on while it has any source of power or any stored energy. If work must be done on energized equipment, extreme care should be taken to protect workers against electrical shock, amputations and crushing.

Workers must receive initial and annual training on lockout/tagout procedures and the importance of following these safe work practices. The employer must provide the padlocks and tags necessary for the LO/TO programs and ensure that supervisors follow these procedures on every occasion.



Key Points

1) Thousands of workers have been killed and injured when lockout/tagout procedures have not been followed during maintenance, repair, servicing and “unjamming” operations with machinery and equipment.

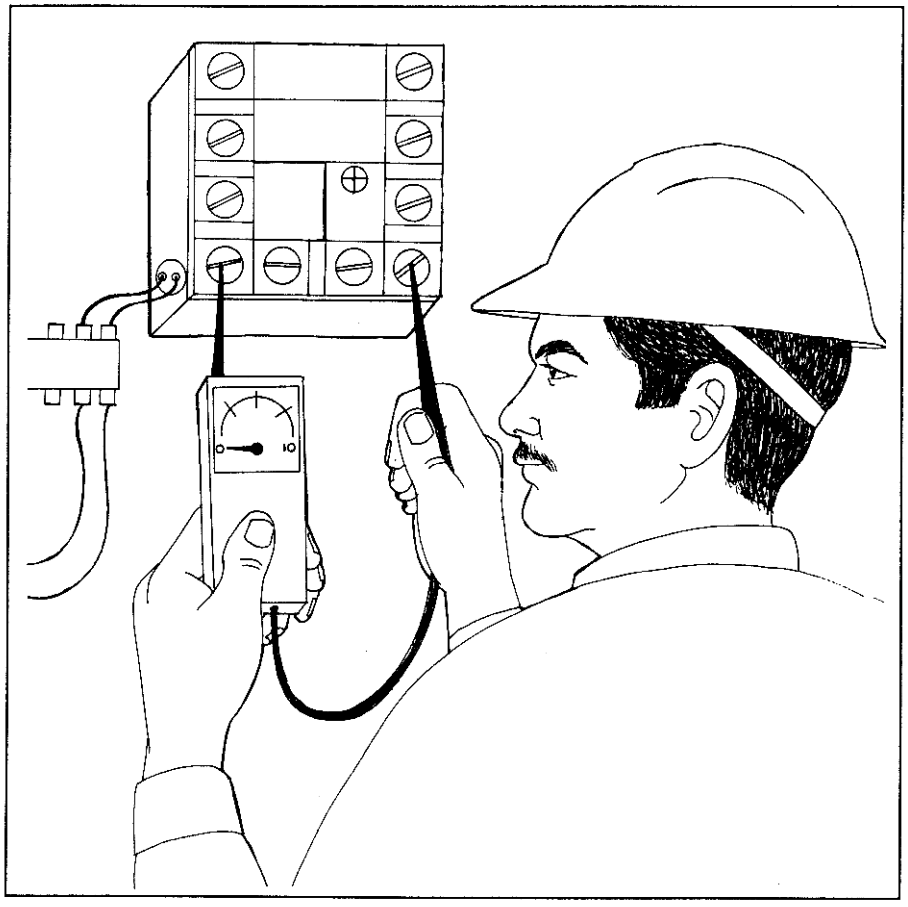
2) There are simple and effective means to prevent these injuries and deaths which are “lockout” and “tagout” procedures.

3) Workers must receive the equipment and training they need to implement these procedures and must refuse attempts by supervisors or managers to take “short-cuts” or ignore these procedures.

Simple Checklist for Lockout/Tagout Procedures

- ❑ Does the employer have written procedures for implementing lockout/tagout procedures for all machinery and equipment where they are necessary?
- ❑ Have all workers "authorized" to lock out power sources received training on these written procedures and do they understand them?
- ❑ Are all workers "affected" by the lockout of power sources, machinery and equipment familiar with the purpose and importance of the procedures?
- ❑ Are all operators and maintenance workers provided with a padlock during service operations?
- ❑ Does each workers have the only key for this padlock?
- ❑ Do workers check to see if no one is operating the machinery before locking out the power (a sudden loss of power can cause accidents)?
- ❑ Are pneumatic (air), hydraulic and steam lines bled, drained and cleaned out after the power has been locked out but before service work begins?
- ❑ Do workers check that there is no pressure or energy left in pneumatic (air), hydraulic and steam lines before service work begins?
- ❑ Are all mechanical systems under tension or pressure (such as springs) released or blocked out before service work begins?
- ❑ Are electrical systems, including circuits, batteries and capacitors, checked with testers for short circuits that could energize equipment even if the switch is in the "off" position?
- ❑ Does machinery such as power presses, which have a ram that could fall, have wooden or metal safety blocks or pins to physically prevent the ram from moving?

- Are all energy sources that could activate the machinery or equipment locked out and tagged out before service work begins?
- Do workers check to see that everyone is clear of the machinery or equipment before restoring power?
- Do workers remove all padlocks and tags from disconnects after restoring power to the machinery and equipment?



The following three pages are a sample energy lockout form that can be used in the plant.

Hazardous Energies Control Procedure For Equipment With Multiple Forms of Hazardous Energy
危险能量控制程序（附有多种危险能量的机器设备）

Equipment ID: Mfgr., Model #, ID #: _____
/设备铭牌：制造商，型号#，铭牌号#:

Equipment Location(s): /设备的位置: _____ **Date Performed:** _____

Task To Be Performed: /执行的任务: _____

Hazardous Energy Forms: (check and list all that apply)
危险能量表：（请核对并列出所有适用项）

1. **Electrical /电气**
   - ☐ a. **Voltage -** Potential is> 30V RMS or DC but < 600V **List: / 电压-** 潜在电压大于 30V 但低于 600V 平均平方根或直流电压**列出:**
   - ☐ b. **Voltage -** Potentials are > 600V **List: / 电压-**潜在电压大于 600V **列出:**
   - ☐ c. **High Current -** > 25 amperes at any voltage **List: / 强电流 -** 在任何电压下大于 25 安培 **列出:**
   - ☐ d. **Static Electricity / 静电**
2. ☐ **Chemical -** Explosion, pressure, extreme heat, fire, corrosive, reactive, oxidizer, toxic **List:**
   化学药品 – 爆炸、高压、高温、火灾、腐蚀、放射性、氧化物和有毒等药品 **列出:**
3. ☐ **Pressure -** > 1 atm, pneumatic, hydraulic, liquid **List: / 压力** – 大于 1 个大气压的气体、液压和液体等 **列出:**
4. ☐ **Vacuum -** < 1 atm **List: / 真空** – 小于 1 个大气压 **列出:**
5. ☐ **Mechanical/Kinetic -** capable of crushing, pinching, cutting, snagging, striking **List:**
   机械/动力 – 可能造成压、挤、切、突出或打击等类**列出:**
6. ☐ **Thermal -** High or Low Temperature - >60°C or < 0°C surface temperature, hot liquids, steam, cryogens **List:**
   热 – 高低温– 出面温度高于 60°C 或低于 0°C，高温液体、蒸气或致冷剂 **列出:**
7. ☐ **Ionizing Radiation -** > 2mRem/hr **List: / 离子辐射-** 高於 2m 伦姆/小时 **列出:**
8. **Non-Ionizing Radiation / 非离子辐射**
   - ☐ a. **Ultraviolet -** > ACGIH TLV **List: / 紫外线–>** 警戒瓦数 **列出:**
   - ☐ b. **Infrared -** > ACGIH TLV **List: / 紅外线–>** 警戒瓦数 **列出:**
   - ☐ c. **Rf/Microwave -** > ACGIH TLV **List: / 无线电波/微波–>** 警戒瓦数 **列出:**
   - ☐ d. **Laser -** Class II, Class III, Class IV **List: / 激光–** 二级、三级或四级 **列出:**
   - ☐ e. **Magnetic Fields -** > ACGIH TLV **List: / 磁场** – 大于警戒瓦数 **列出:**
10. ☐ **Potential -** Flywheels, springs, differences in elevation, elevated parts that could drop, capacitors, batteries. **List:**
    潜在的危险能量 – 调速轮、弹簧、高度差、升起的可能落下的零件、电容器和电池等。 **列出:**

Lockout Procedure / 闭锁程序

Follow the procedure below exactly as listed - check off the block as each step is completed:
请严格遵守下述程序 - 每完成一项操作便认真进行检查:

☐ 1. Notify all Affected and Other persons of intended lockout.
/ 将闭锁事宜通知全体有关人员。

☐ 2. Turn off or shutdown and lockout and tag each energy control point listed below.
/ 关闭或切断电源，并为下述所有能量控制点贴上标签及加锁。

Specific Lockout Locations / 具体的闭锁位置

☐ 3. Dissipate any stored energy as described below {☐ N/A}.
/如下所述排除所有剩余的能量{☐不适用}。

Dissipate These Energy Sources / 请排除这些能量（源）

☐ 4. Block any mechanical parts, remove any mechanical links listed below. Lock blocking in place. (Note: Two physical blocks in the line required with the space in between depressurized and emptied to break & secure any hazardous gas/liquid line. {☐ N/A}.
卡住所有机械零件，清除下述所有机械链接，并锁定卡具。（注意：要求在消除压力和排空的管线上设两级卡具，以完全解除并确保有害气体和液体管线的安全。{☐不适用}.

Block These Parts/Remove Linkages / 卡住这些零件/清除链接

☐ 5. Verify all persons clear of Hazard Zone / 检查并确保所有人员撤离危险

☐ 6. Attempt to re-start machinery or re-energize equipment / 尝试重新启动机器或重新给设备注入能量

☐ 7. Verify no hazardous energy by the methods listed below. Use circuit tester/meter if electricity is involved. {☐ N/A} / 按下述方式检查并确保无危险能量存在。如涉及到电，应使用电流表测量。{☐不适用}

Verify No Residual Energy By These Methods / 按如下方法检验无剩余能量

☐ 8. Perform required work. / 按要求执行任务。

Procedure To Return Equipment To Operation / 设备恢复操作的程序

☐ 9. Verify Hazard Zone is clear of equipment, workers, tools, and test equipment.
确认危险区内已无设备、工人、工具和试验设备。

☐ 10. Unlock and remove any blocking devices; replace linkages.
开锁并撤掉所有锁机设备；重新链接。

☐ 11. Reposition any safety valve(s) left open to prevent re-build up of pressure.
重新设定防止压力积聚的安全阀门。

☐ 12. Remove all locks and tags from energy control points.
将所有能量控制点上的标签和锁具全部清除。

☐ 13. Re-start or re-energize the equipment.
重新启动设备或注入能量。

☐ 13. Notify all affected and other persons that the lockout has been cleared.
通知全体有关人员已除去锁具。

Names of authorized 授权执行该 persons performing 闭锁程序的 this lockout 人员名单	

Names of persons 受该加锁程序 affected by this 影响的 lockout procedure 人员名单	

Note on SHIFT CHANGES: If this procedure lasts more than one work shift, the oncoming persons will apply their locks and tags before the departing shift removes their locks and tags. / **交接班须知**: **如果该操作程序跨两班，接班人员应在离岗人员撤掉其标签和开锁之前贴好自己的标签并加锁。**

Heat Stress

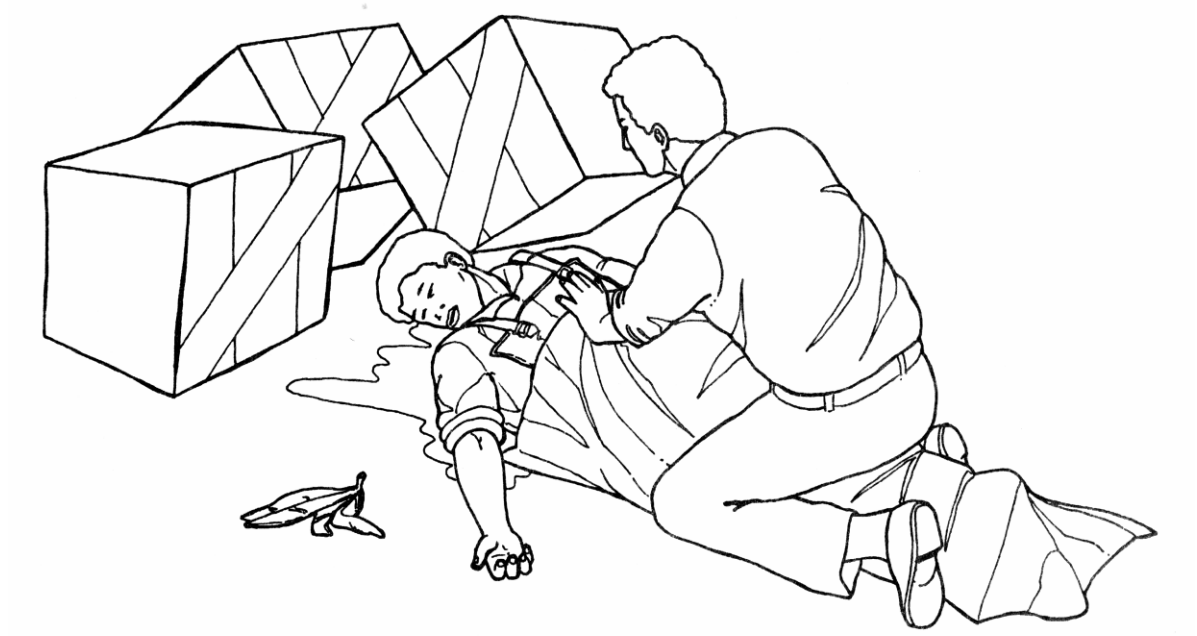
How do high temperatures affect the body?

Four environmental factors affect the amount of heat stress a worker is exposed to in the workplace:

1) temperature,
2) humidity,
3) radiant heat (such as from the sun or a furnace in the work area), and
4) air velocity.

There are personal factors which also affect heat stress to the worker, including age, weight, fitness, medical conditions, and the individual's acclimatization to the heat.

The body reacts to high temperatures by circulating blood to the skin, which increases the skin temperature and allows the body to give off excess heat through the skin. However, if the muscles are being used for physical labor, less blood is available to flow to the skin and less heat can be given off.



Sweating is another way the body gives off excess heat and keeps the body core cooler. However, sweating is only effective if the humidity level is low enough to allow evaporation of the sweat, and if the fluids and salt lost by sweating is replaced.

If the body core cannot dispose of excess heat, it will store the heat. When this happens, the body's core temperature rises and the heart rate increases. As the body continues to store heat, the individual begins to lose concentration, may become irritable or sick, and often loses the desire to drink water. The first stage of heat disorders is most often fainting, and it can progress to death in the case of untreated heat stroke.

Increasing heat stress becomes a safety problem when the worker loses mental alertness, has difficulty focusing on a task, makes mistakes and may have an accident.

Causes of heat-related illnesses include:

- high outdoor temperatures and humidity
- heat and humidity created by work operations
- inadequate or uneven ventilation
- hard and/or repetitive physical work
- lack of drinking water or lack of opportunities to drink water
- inadequate rest periods or break times
- new or returning workers not having sufficient time to re-acclimatize to the hot work environment.

What are the various types of heat-related illnesses?

Signs and Symptoms of Heat Stress

Heat Cramps

Symptoms: painful muscle spasms, often after working hours.

Cause: profuse sweating and drinking large amount of water, but without replacing lost salt.

Treatment: provide liquids with electrolytes (calcium, sodium, and potassium salts).

Heat Exhaustion

Symptoms: extreme weakness or fatigue, dizziness; pale, cool, moist skin; heavy sweating; headache; nausea; and fainting.

Cause: reduced blood volume resulting from dehydration from profuse sweating and insufficient replacement of water and salts.

Treatment: if worker is conscious, rest in cool place; replace water and electrolytes lost in sweat; if unconscious, get medical help immediately. DO NOT give liquids if the person is unconscious.

Heat Stroke

Symptoms:	very dry, hot skin with red mottled or bluish appearance; confusion; convulsions; unconsciousness; rapidly rising temperature to 41 degrees centigrade and above.
Cause:	body becomes overheated because the worker does not sweat anymore. Can be fatal.
Treatment:	call for medical help immediately; move person to cool place; remove personal protective equipment (PPE); use wet towels or water and fan to cool while waiting for help.

Heat stroke is a life-threatening emergency. Immediate medical attention is required.

How can heat stress be prevented?

Precautions and Control Measures

Heat stress may be reduced by:

1. Engineering Controls

Engineering controls such as effective ventilation, spot cooling, fans, and heat shields for radiant heat sources, can reduce excessive heat stress or isolate the worker from it. Modifying equipment and use of power tools to reduce manual labor can also reduce heat exposure.

2. Protective Clothing

Special reflective clothing or cooled suits may be necessary where the heat stress is extremely high.

3. Scheduling and Rest Breaks

Heavy work may be rescheduled to be done during the cool parts of the day. Regular work may be reorganized to provide rest periods in cool areas that allow the body to get rid of some of its heat.

4. Water

Because the thirst mechanism may not be adequately stimulated by loss of fluid in the sweat, it is important that a supply of cool water is available and workers drink about 250 to 500 mil every half hour.

5. Education

Workers and supervisors should be taught to recognize the symptoms of heat illnesses and the appropriate first aid measures. They should also know why heat illnesses occur and what can be done to prevent them.

6. Acclimatization

This is the process by which the body gradually adjusts itself to deal with heat. Acclimatization results in lower body temperature at work and rest, higher rate and volume of sweat, slower heart rate and lower oxygen consumption. Because acclimatization is lost very rapidly, workers must be re-acclimatized if away from work for a week or more. Several days are needed to re-acclimate to high temperatures, and workers should not work at 100% of normal work loads during this period.

Are there OELs for temperature?

There are OELs, both government regulations and voluntary professional guidelines, in many countries for both hot and cold temperatures. The ACGIH has TLVs for both heat and cold stress on the job, based on the health problems caused by hot and cold temperatures (see the section on safety hazards).

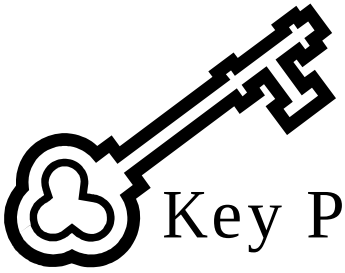
The heat stress/temperature regulations in China are:

Occupational Exposure Limits
Workplace Temperature Limits*

Outdoor Temperature in degrees Centigrade	Maximum Workplace Temperature Increase in degrees Centigrade	Maximum Indoor Temperature in degrees Centigrade
22	10	32
23	9	32
24	8	32
25	7	32
26	6	32
27	5	32
28	4	32
29-32	3	32-35
>33	2	35

***** = Limits according to GB 4200-84 “Factory Temperature Levels” (1984)

Article 21 of the July 1994 Labor Law (effective January 1, 1995) requires the employer to install air cooling equipment for all facilities with indoor temperatures higher than 35 degrees Centigrade.



Key Points

1) High temperatures and humidity in the workplace directly affect workers' health and safety, and can cause life-threatening illnesses.

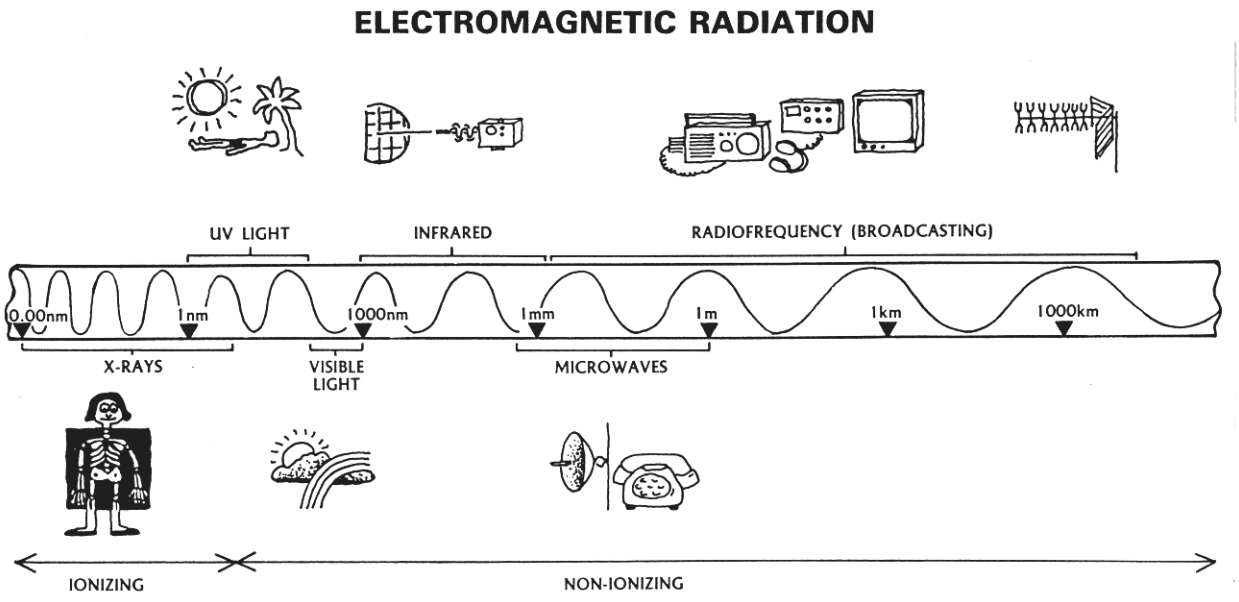
2) China has legal limits for heat exposures in the workplace.

3) There are various ways to control heat exposures and prevent health problems from developing.

Non-ionizing Radiation

Many industrial workers are exposed to radiation on the job. There are several forms of radiation, some very hazardous and some less hazardous.

Radiation is defined as energy moving through air in the form of waves or very, very small particles. All forms of radiation are invisible, except for the part of the spectrum where visible light occurs. Some forms of radiation can be felt as heat, but most forms cannot be felt at all. The most dangerous forms of radiation – called "ionizing" radiation, such as x-rays – cannot be seen or felt.



There are three basic forms of radiation: electromagnetic, acoustic or sound, and particle. Most industrial workers have exposure to acoustic radiation in the form of noise, and exposure to electromagnetic radiation.

There are two types of electromagnetic radiation:

1) "ionizing" radiation, such as x-rays or gamma rays, which penetrate the human body and damage human cells and genes; and

2) "non-ionizing" radiation, including radio frequency, visible light, ultraviolet light, and infrared radiation.

Non-ionizing radiation does not penetrate the body but causes the molecules on the surface of the body (skin, eyes and testes) to vibrate more rapidly. This vibration causes the cells to heat up, to become hotter than normal. The most common health problems from non-ionizing radiation are skin burns and eye cataracts.

What are the hazards of ultraviolet lights?

The most common source of ultraviolet light ("UV") is the sun. UV light is what gives the skin a "sunburn" from the sun. UV is used in industry for various tasks including print drying, labeling, curing and baking.

Ultraviolet light can react to chlorinated hydrocarbon solvents, paints, inks, glues and resins to form toxic gases (phosgene and chlorine), which are hazardous in high concentrations. UV light also reacts with air to form ozone, which is hazardous at high concentrations as well.

UV light can cause skin burns and eye damage, from irritation to damage to the cornea, if protective clothing and eye glasses are not worn at work. The "B" type of UV light can also cause skin cancer at high concentrations with unprotected skin.

The best control measures for ultraviolet light operations are protective eyewear, glass barriers at work stations, and effective local exhaust ventilation to remove the hazardous gases generated by UV light in air and interacting with certain chemicals.

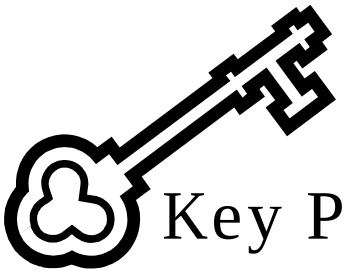
What are the hazards of radio frequency radiation?

Radio frequency radiation is used as the energy source for heat sealer machines which laminate, bond, seal, and cure materials. The heat produced can be a health hazard for the eyes and testes. Electrical burns and shocks can result from unprotected wiring.

The best control measures for radio frequency hazards are effective electrical grounding, use of heat shields at the operators' stations, and use of the lowest possible level of heat for the work task.

China has GB regulations for the following types of radiation:

- GB 8702-88: Regulations for electromagnetic radiation protection;
- GB 9175-88: Hygienic standard for environmental electromagnetic waves;
- GB 10436-89: Hygienic standard for microwave radiation in the work environment;
- GB 10437-89: Hygienic standard for ultra high frequency radiation in the work environment;
- GB 16203-1996: Health Standard for electric field in the work environment.



Key Points

1) There are different forms of radiation, with some types (ionizing) being very dangerous and others (non-ionizing) being much less dangerous.

2) The types of non-ionizing radiation commonly used in industry – ultraviolet light and radio frequency – are among the less dangerous types of radiation.

3) There are control measures available to minimize the health impacts of non-ionizing radiation.

Emergency Eyewashes and Showers

There should be an emergency eyewash and/or shower in all areas of the work site where workers handle chemicals which:

- can cause severe irritation to eyes and skin;
- can cause corrosion — permanent damage — to eyes and skin;
- are toxic by absorption through the skin or eyes.

The general rule is that chemicals with a pH value below 2 (strong acid) or above 11.5 (strong base) require an emergency eyewash to allow workers to immediately flush their eyes with clean water. However, there are chemicals with no pH value, or a pH value between 2 and 11.5, that are still very hazardous to the eyes and skin, and which also need an emergency eyewash.

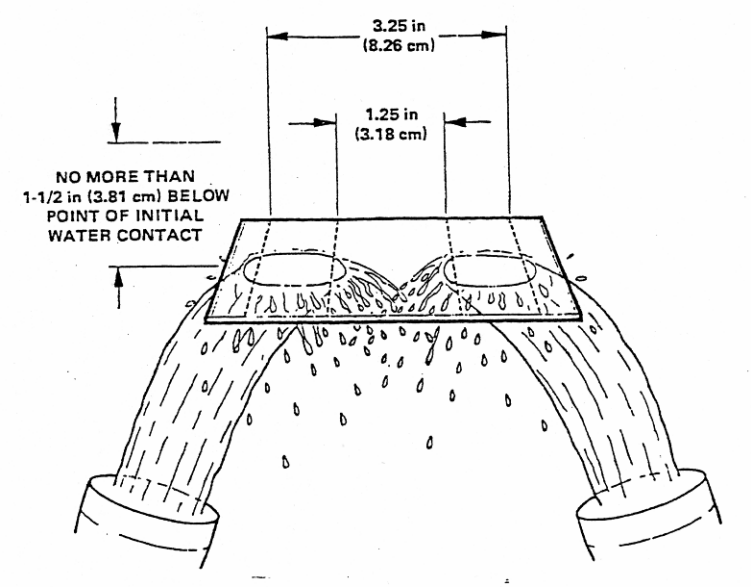
The Chemical Safety Data Sheets should have the information about the chemical's pH value and the emergency first aid procedures to take if a worker's eyes or skin come into contact with the chemical.

Chemical mixing rooms should have an eyewash, and production areas where these chemicals are used should be evaluated for the need of an emergency eyewash.

In the United States, emergency eyewashes and showers must meet the specifications of a guideline issued by the American National Standards Institute (ANSI), known as ANSI Z358.1-1998. There are two kinds of eyewashes: 1) units that are connected to a water line, and 2) "self-contained" units which have their own water tank. Both kinds of units must have enough water for a 15-minute flushing of the eyes.

The key elements of the ANSI standard for emergency eyewashes and showers are:

- Eyewashes must have a water flow of 1.5 liters per minute for a 15 minute period, while showers must have a water flow of 75.7 liters per minute for 15 minutes;



- Eyewashes and/or showers must be located on the same level and within a 10 second walk of the area where the chemicals are being used and handled;

- The pathway to the eyewash and/or shower, and the area around them, must not be blocked by materials or equipment;

- The eyewash and shower water valve must be capable of being activated with just one motion, the water must start flowing in one second or less, and the valve must stay “open” until turned off;

- The eyewash and shower, if both are needed, must be located so that they can be used at the same time by one person, and the eyewash must flush both eyes at the same time;

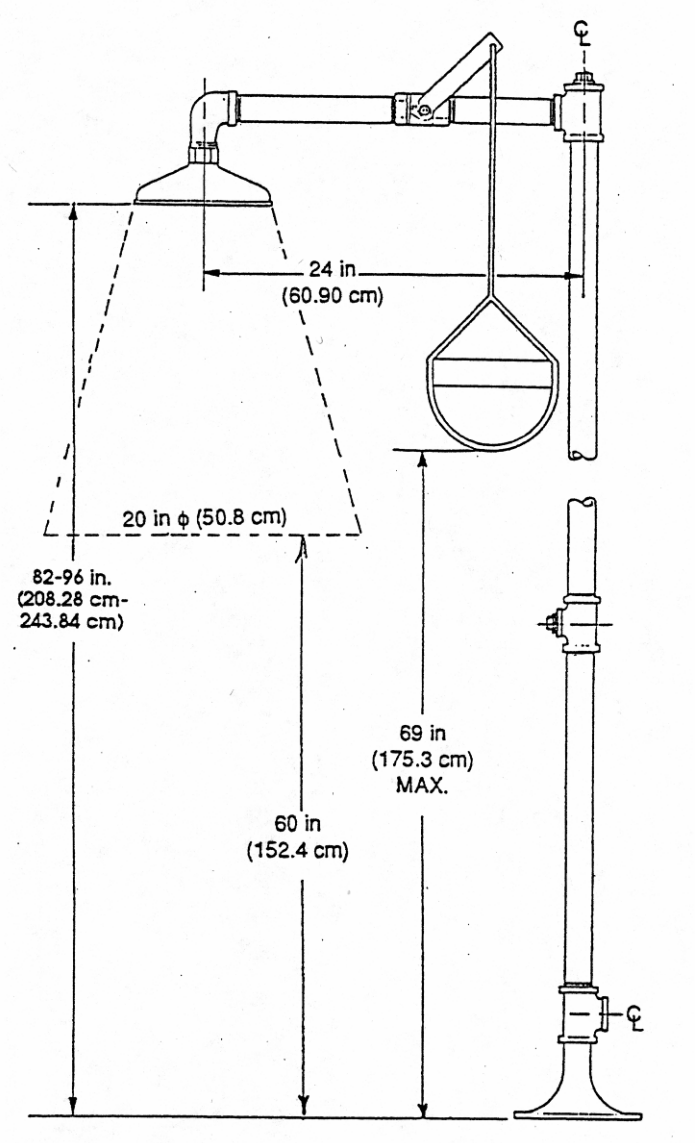
- The floors around the eyewash and/or shower must have a surface that will not become slippery and a hazard for falling when wet;

- Small personal water bottles or “drench hoses” may be used to supplement an eyewash and shower, but they cannot be used instead of emergency eyewashes and showers meeting the ANSI requirements;

- The eyewash and shower must be flushed every week to remove rust and dirt from the line, and the units must be inspected annually to ensure they meet the water flow requirements;

- Workers handling chemicals requiring an emergency eyewash or shower must receive training on how to use the equipment.

Medical studies have concluded that it is very important to flush the eyes immediately after exposure to damaging chemicals. Likewise it is important to wash off chemicals from clothing and exposed skin with an emergency shower if large portions of the body come into contact with damaging chemicals.



Other Safety Issues

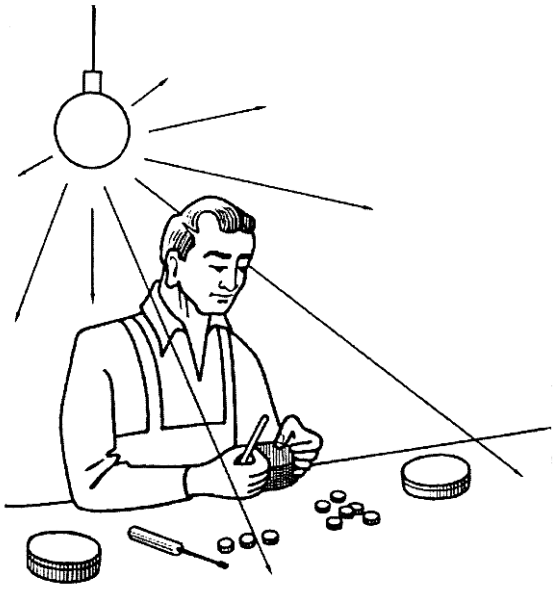
Workplace Lighting

Good lighting in the workplace is important for several reasons:

- to be able to see the work area and exit passageways;
- to prevent accidents
- to reduce eye fatigue and related harmful health effects.

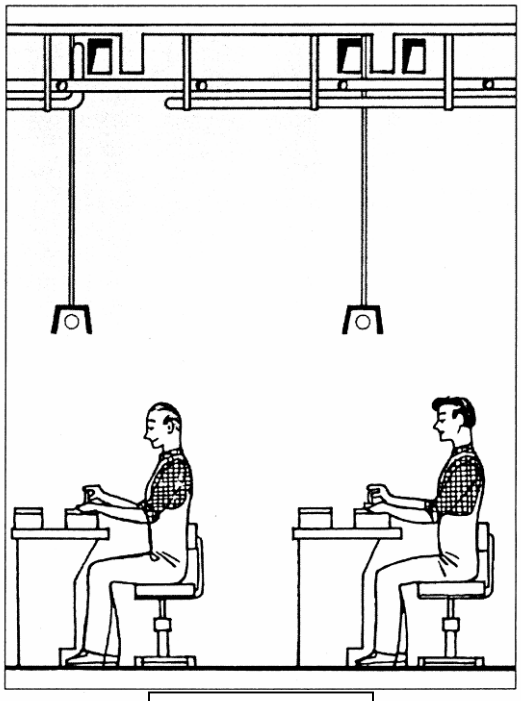
Emergency lighting, powered either by a generator or by a battery system, is required for all workplaces where workers are inside a building structure after daylight hours. Emergency lighting systems should be tested once a month.

Examples of placement of lights are illustrated below.



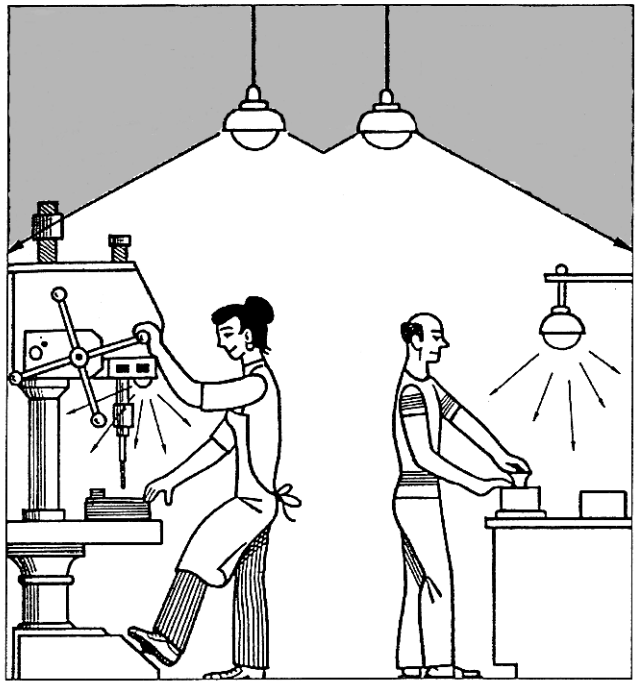
Avoid lighting that can create shadows.

Bad lighting

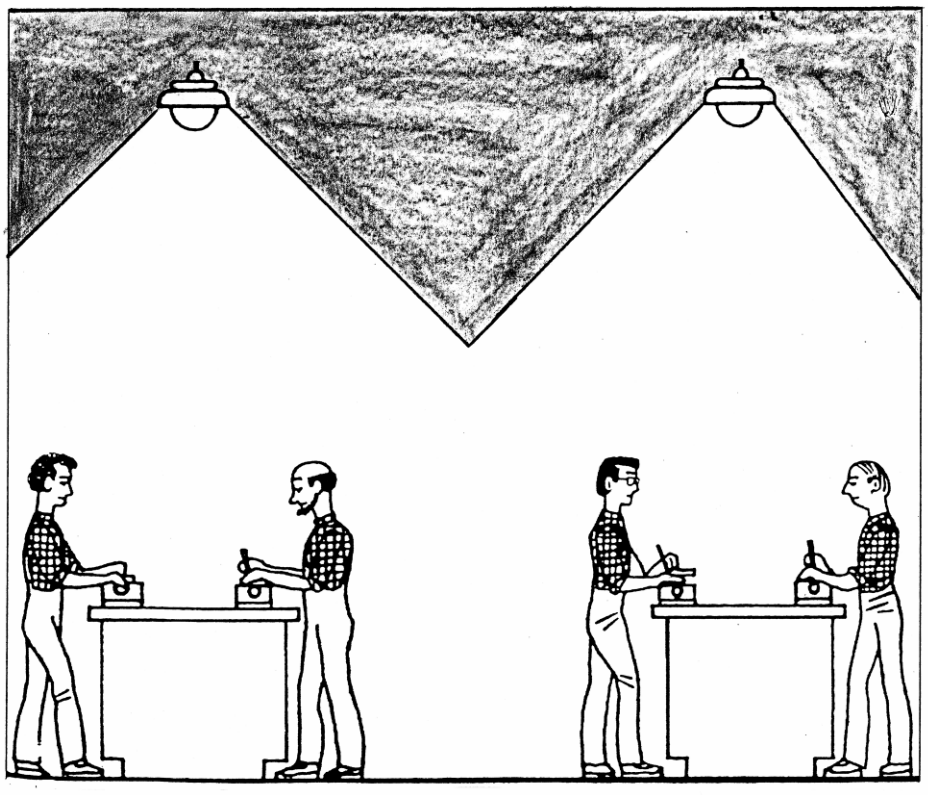


Good lighting

Best light for general tasks



A combination of general and local lights helps to meet the specific requirements of different jobs.

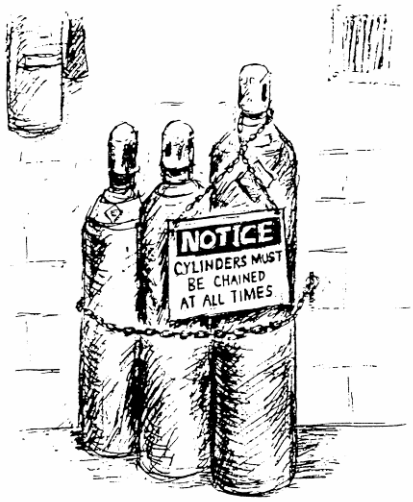


Compressed gas cylinders

Cylinders of compressed gases (such as oxygen, nitrogen, hydrogen or acetylene) are under very high pressure. If the cylinders or valves become damaged, for example from falling over, the cylinders will shoot across a room like a rocket. Cylinders have been known to go through walls and destroy equipment, causing fires and explosions. Workers have been seriously injured and killed by flying cylinders.

To prevent accidents with compressed gas cylinders there are several important rules:

- ? Cylinders must be securely chained to a wall or cart to prevent falling;
- ? Cylinder's valve protection caps must always be in place whenever the cylinder is not in use;
- ? Cylinders of flammable gases and oxygen must always be separated by 4.6 meters (15 feet) or by a fire wall at least 1.5 meters (5 feet) high;
- ? Cylinders of acetylene must <u>never</u> be stored on their side;
- ? There is no such thing as an "empty" cylinder - cylinders are under pressure even when empty and can still rocket across rooms or through walls.



Gas Tanks Secured to Prevent Explosions

(The warning sign should hang on the wall, not on the tank.)

Compressed air tanks

Metal tanks of compressed air can explode violently if not correctly manufactured and maintained.

Important items to check with compressed air tanks are the following:

- ? Air tanks must have safety relief valves to prevent explosions;
- ? Air tanks must not have any other valves on piping between the tank and the safety relief valve;
- ? Employers must have a regular inspection and maintenance schedule which includes opening drain valves to prevent liquids from collecting inside the tank, and testing pressure gauges and controllers.

General Safety Hazards

Equipment: flashlight, tape measure, thermometer, current tester

OBSERVE OR MEASURE

Heat Stress

Select three sections of work area.

Name of Work Area Section	Temperature (centigrade)	Number of employees in section	Drinking water available	Number of breaks per shift	Air conditioning or fans
1.			” Yes ” No Describe:		” Yes ” No Describe:
2.			” Yes ” No Describe:		” Yes ” No Describe:
3.			” Yes ” No Describe:		” Yes ” No Describe:

Sanitation

4.	How many employees in this department:	Men _____ Women _____
5.	How many toilets are immediately accessible for men:	Toilets/Men: _____
6.	How many toilets are immediately accessible for women:	Toilets/Women: _____
7.	How many wash basins are immediately accessible for men:	Basins/Men: _____
8.	How many wash basins are immediately accessible for women:	Basin/Women: _____
9.	How many drinking fountains are immediately accessible:	Number of drinking fountains:_____
10.	If no drinking fountains present, how do workers get water during the shift?	Describe:

Safety Hazards

11. Look for the following safety hazards in each selected section. Describe any problems:

Safety Hazards	Work Area #1	Work Area #2	Work Area #3
a. slip and trip hazards (uneven floors, wet floors, raised edges)			
b. floor openings			
c. wall openings			
d. unstable storage (hazard from falling materials)			
e. no railings on stairs or platforms			
f. uneven or broken stairs			
g. elevated work locations (need fall protection)			
h. poor housekeeping			
i. poor lighting			
j. power and/or hand tools broken or malfunctioning			
k. inadequate protective equipment (gloves, eyewear, clothing)			
l. machinery not secured to floor (hazard from falling machine)			
m. unsecured cylinders of compressed gas			
n. forklift hazards (untrained operators, poor equipment, poor maintenance)			

Ultraviolet Radiation		
12. Are any workers exposed to ultraviolet lights?	” Yes ” No	Number of workers:
13. Are the workers provided with protective eyewear?	” Yes ” No	
14. Have the workers received any training about the hazards of ultraviolet light?	” Yes ” No	If yes, when was the last training:
15. Have the workers had any health problems they think are related to the lights?	” Yes ” No	If yes, describe:
Radio Frequency Radiation		
16. Are any workers operating radio frequency machines (such as sealers)?	” Yes ” No	Number of workers:
17. What is the distance between the operator and the machine’s point of operation?	” Yes ” No	Number of centimeters:
18. Have the workers received any training about the hazards of radio frequency radiation?	” Yes ” No	If yes, when was the last training:
19. Have the workers had any health problems they think are related to the radio frequency machines?	” Yes ” No	If yes, describe:
ASK SUPERVISORS OR MANAGERS		
20. Have there been any complaints about health problems from the ultra violet light?	” Yes ” No	If yes, what was done in response:
21. Have there been any complaints about health problems from the radio frequency machines?	” Yes ” No	If yes, what was done in response:
22. Have the workers received any training about the hazards of ultra violet light and/or radio frequency machines?	” Yes ” No	If yes, where was the last training:

Electrical Hazards
Machine Guarding and Energy Lock Out

Equipment: flashlight, tape measure, current tester

OBSERVE OR MEASURE

Electrical Hazards

Select 2 types of machines and look for these common electrical hazards:

A. exposed live wires

B. frayed/damaged wires

C. flexible cords used instead of permanent wiring

D. plugs without ground pins

E. panel boxes without 1 meter clearance

F. openings in panel boxes

G. no directory for panel boxes

H. wet/damp locations

I. locations where flammable liquids or gases are used

Type of Machine	Energized Circuit	Problem (A through I)	Number of exposed employees
1.	” Yes ” No		
2.	” Yes ” No		

Machine Guarding

Type of Machine	Number in use	Number of exposed employees
1.		
2.		

Hazard	Machine #1	Machine #2
3. Are there point of operation guarding hazards in “danger zone”?		
4. Are there moving parts hazards: (fly-wheels, shaft ends, conveyor belts)?		
5. Are there pinch point hazards: (v-belts, pulleys, chain & sprocket under 2.2 meters above floor)?		
6. Is there enough room around the machine for operation?	” Yes If no, which machines ” No	” Yes If no, which machines ” No
7. Are control buttons clearly marked?	” Yes If no, which machines ” No	” Yes If no, which machines ” No

Energy Lock-out Program

8. Look for one electrically powered and non-electric machine (if any).
Types of energy sources: a. Electrical, b. Mechanical, c. Hydraulic, d. Pneumatic

Type of machine	Energy Source (a, b, c or d)	Can energy source be "locked-out"?	Number of exposed employees
1.			
2.			

Question	Answer/Comments
Ask Workers	
9. What is the procedure for reporting electrical hazards?	
10. How are reported hazards corrected?	
11. Do you know how to lock-out power when employees adjust, clean, service or unjam a machine?	” Yes ” No
12. Are padlocks available?	” Yes ” No
13. Have they received any training on machinery hazards and how to "lock-out" power sources?	” Yes ” No

Ask Supervisors or Managers		
14.	What is the procedure for reporting electrical hazards?	
15.	How are reported hazards corrected?	
16.	Are records of hazard correction kept (such as maintenance work orders)?	” Yes ” No
17.	How often are the machines serviced and inspected?	Date of last serviced/inspection:
18.	Are there written procedures for locking out power when employees adjust, clean service or unjam machinery?	” Yes ” No
19.	Have workers been trained on the procedures to “lock-out” power sources before working on machines?	” Yes ” No
20.	Are these procedures reviewed annually with maintenance employees?	” Yes If yes, date of last review session: ” No
21.	Are there individual padlocks and keys for locking-out energy sources?	” Yes ” No
22.	Have workers been trained on the hazards of machines?	” Yes ” No

Ask management for the following documents:		Are these documents available?
23.	Hazard reporting procedures	” Yes ” No
24.	Records of hazard corrections	” Yes ” No
25.	Written lock-out/tag-out procedures	” Yes ” No
26.	Records of annual review of procedures with authorized employees	” Yes ” No
27.	Records of inspection of machinery	” Yes ” No
28.	Records of employee training: machine guarding hazards; lock-out procedures	” Yes ” No

Notes