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Technical Advisory for **Safe Use of Power Presses and Press Brakes**

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WSHCOUNCIL

Contents

1. Introduction

This Technical Advisory provides information on the usage of power presses and press brakes. It also highlights the hazards associated with the use of these machines, and provides methods for proper safeguarding during operation.

The objectives of this Technical Advisory are to:

- Incorporate safety and health requirements and measures during the installation, commissioning, relocation, modification, setting up, operation and maintenance of power presses and press brakes;
- Inform on how to manage any risks that may arise from the use of these machines;
- Highlight the training requirements for personnel working with these machines.

Compliance with this Workplace Safety and Health Technical Advisory does not, by itself, confer immunity from legal obligations.

2. Terms and Definitions

Clutch (full revolution)	A type of clutch, when tripped or actuated, cannot be disengaged until the slide has completed a complete stroke.
Clutch (part revolution)	A type of clutch which can be engaged or disengaged at any point during the stroke of the slide.
Die	The tool used in a press for cutting or forming material.
Safety block	The prop that prevents the ram from falling when inserted between the upper and lower dies, or between the die bed and the face of the ram.
Feeding	The process of placing or moving material into the point-of-operation.
Hazard	A source of possible injury or damage to health.
Lockout procedure	A set of action plans to ensure that all energy sources to the relevant plant, machinery, equipment or electrical installation are isolated, disconnected or discharged; and to prevent any part of the plant, machinery, equipment or electrical installation from being inadvertently initiated or energised.
Risk	A combination of the probability and degree of possible injury or damage to health in a hazardous situation.
Point-of-operation	The danger area on the material on which the die is set on, positioned, and on which work is being performed on during any process such as shearing, punching, forming or assembling.
Power press	A machine that shears, punches, forms or assembles metal or other materials by means of tools or dies attached to slides.
Press brake	A machine that generally limits to linear bending and forming of materials.
Safe distance	The distance between a guard and the nearest hazard point the guard is intended to protect.
Shall	Indicates that a requirement is mandatory.
Should	Indicates a recommendation.
Single stroke	Each engagement of the clutch initiates the travel of the ram to complete one cycle or stroke.
Repeat stroke	Non-initiated power stroke occurring as a malfunction in the press mechanism.
Use	Any activity involving machinery, including starting, stopping, installing, commissioning, relocating, modifying, setting up, operating and maintaining.

3. Power Press and Press Brake Hazards

There are many hazards when operating a power press and press brake and this chapter will focus on some of the obvious ones, in particular during the point-of-operation. The 12 main hazards to look out for are:

No.	Hazards	Example	Production	Die Setting	Trouble Shooting	Removing Jam	Maintenance
1.	Caught in between objects	For power press, punching and forming For press brake, the stock 'whips' or bends up and can cause the operator's hand to be caught in between the stock and the slide	X	X	X	X	X
2.	Cut by sharp edges	Loading and unloading the material can cause cuts	X	X	X	X	X
3.	Struck by falling objects	Die drops during set up		X	X	X	X
4.	Struck by flying objects	Chips released during punching can hit operators	X	X	X	X	X
5.	Struck by moving objects	For press brake, the stock 'slaps' the operator if he is in the path of the rising material	X	X	X	X	X
6.	Drag towards danger zone / entanglement	Loading and unloading at automatic feeder	X	X	X	X	X
7.	Excessive noise/ vibration	• Power presses are inherently noisy and the noise level can be as high as 95-115 dB(A) • Sources of noise are pneumatic and mechanical • Vibration is related to noise and it is the cause of the mechanical noise • Wear and tear of machine and die can be a source of noise	X	X	X		X

No.	Hazards	Example	Production	Die Setting	Trouble Shooting	Removing Jam	Maintenance
8.	Energy source failure: electrical, mechanical, hydraulic and pneumatic	• Failure of single stroke linkage • The loss of air pressure to the clutch/ brake • Presence sensing device power failure	X	X	X	X	X
9.	Unintended energisation	• Failure to properly disable, isolate energy sources and implement lockout procedures before employee performs servicing • Controls of a single-operator press bypassed by having a co-worker activate the controls while the operator positions or aligns parts in the die, or repairs or trouble shoots the press • Foot pedal activation without proper guarding. Operator inadvertently places his hand at the point of operation while his foot presses the pedal	X	X	X	X	X
10.	Unsafe work behavior	• Guards and devices are by-passed to increase production • Two-hand controls are bridged to allow initiation with one hand • Two-hand controls are activated with the help of co-workers • Failure to isolate or de-activate energy sources and lockout / tagout before employee performs servicing and maintenance works • Devices are not properly adjusted • Devices are muted	X	X	X	X	X

No.	Hazards	Example	Production	Die Setting	Trouble Shooting	Removing Jam	Maintenance
11.	Poorly designed guarding/ devices design and poor maintenance	• Barrier not designed according to Safety Distance Requirement • Part of the presence-sensing devices are muted by design • Safety devices and guardings are not properly maintained. Workers tend to assume that the safety devices and guardings work. But when they fail without the knowledge of the workers, severe accidents may happen	X	X	X	X	X
12.	Fatigue due to working long hours	Working long hours can affect concentration. During peak demand period, workers tend to work long hours. For maintenance staff, sometimes extremely urgent repairs may require them to work unlimited long hours. Without control, this type of working pattern can be very hazardous	X	X	X	X	X

3.1 Being Caught in Between Objects

Power presses are used to punch, bend, or shear a metal work piece using a tooling or die attached to the slide and the bed (Figure 1). During a point-of-operation, severe crushing, amputation and even death may occur should "a caught in between" hazard occur.

Press brakes are used to bend metal sheets. While the actual operation of the press brake does not require the operator's hands to be placed at the point-of-operation, the close proximity to the closing dies still poses a significant risk.

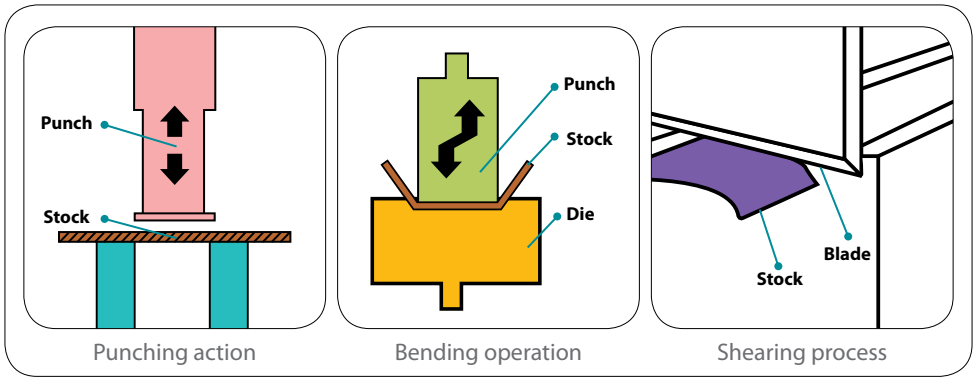

Figure 1: Power press operation

"Caught in between" hazards happen when the stock "whips"' or bends up, creating a pinch-point hazard between it and the front face of the slide (Figure 2). Risk assessments must be performed when a new work activity or a change of work activity is introduced to the production and control measures must be taken accordingly.

The installation and removal of tooling provides the most direct exposure at the point-of-operation as the operator has to place his hands or even his head between the dies (Figure 3). The hand or head can be severely crushed if the ram were to fall during setup. The use of a safety block (Figure 4) is necessary when performing this task.

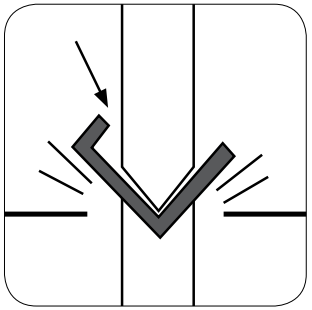

Figure 2: Metal sheet bends and creates "caught in between" hazards

Figure 3: Die setting

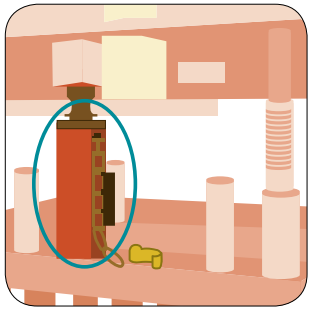

Figure 4: The use of a safety block

3.2 Cut by Sharp Edges

Attention should be paid to the loading and unloading of materials and work pieces as the sharp edges of a sheet metal can cause cuts.

3.3 Struck by Falling Objects

Lifting of the die is needed during power press setup. During this time, due care must be taken to prevent the die from dropping. If the die drops, the operator risks severe injury and even death as the usual weight of a die is more than 500kg.

3.4 Struck by Flying Objects

During punching operations, metal chips from either material or die may break and fly out, especially if the power press is not aligned with the die. These flying metal chips can potentially hit the operator and other workers in the area and cause serious injury.

3.5 Struck by Moving Objects

This hazard can occur when operating a press brake. This happens when the sheet metal bends and its tip "slaps" the die-setter or troubleshooter during trial sample making (Figure 5).

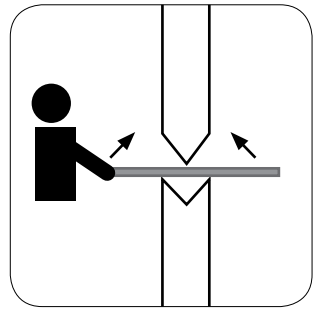

Figure 5: Metal piece "slapping" operator

3.6 Dragged Towards Danger Zone

This is particularly hazardous for automatic feeding set-ups. Operators should take special care when using the machine (Figure 6).

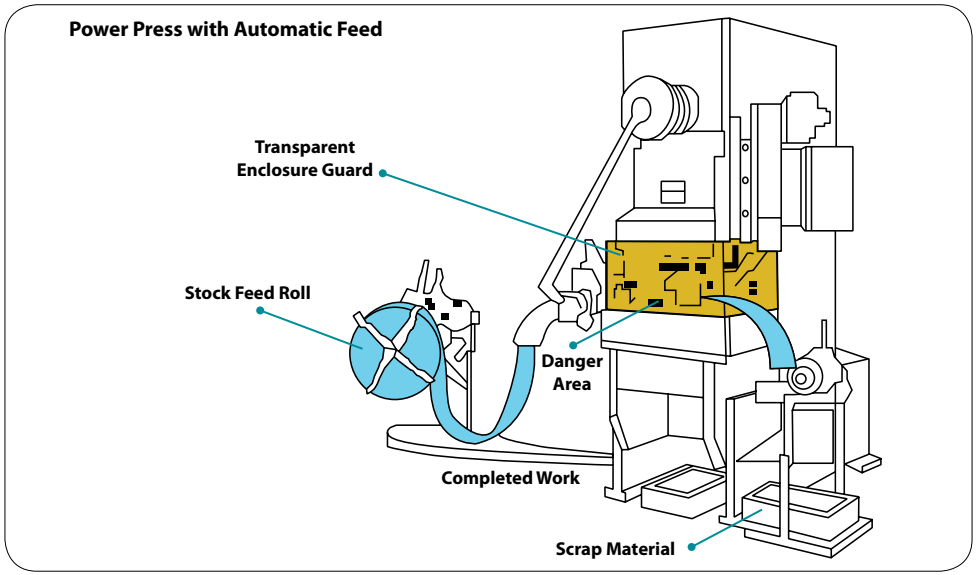

Figure 6: **Entanglement can happen during a stock feed**

3.7 Noise-induced Deafness

Power presses are inherently noisy and noise levels can be as high as 95~115dB(A). The sources of noise are likely to be pneumatic and mechanical vibrations. Machines with worn out parts also contribute to the high noise level. This can cause noise-induced deafness (NID).

3.8 Energy Source Failure

Electrical, mechanical and pneumatic machine components might fail. For example, the failure of a single-stroke linkage (mechanical), the failure of control relay (electrical) and the loss of air pressure (pneumatic) might pose hazards that are likely to cause accidents.

3.9 Unintended Energisation

Examples of unintended energisation include:

- The failure to properly disable, isolate energy sources or apply lockout procedures before a person performs servicing.
- Unprotected foot pedals that can introduce the possibility of accidental cycling. The risk occurs when the operator's hands are inadvertently placed at the point-of-operation when the foot pedal is initiated.
- Bypassing controls of a single-operator press by having a co-worker initiate the controls while the operator positions or aligns parts in the die, or repairs or troubleshoots the press. This is an example of concurrent work which should be avoided.

3.10 Unsafe Work Behaviour

Unsafe behaviour is common in the workplace and can cause accidents. Some examples are:

- Guards and devices are bypassed;
- Two-hand controls are bridged to allow initiation with one hand;
- Two-hand controls are initiated with the help of co-workers;
- Failure to isolate or de-activate energy sources and to comply with lockout procedures before a person performs servicing and maintenance works.

3.11 Poor Design and Maintenance of Guards and Devices

Injuries and amputations are still prevalent even though safeguards and devices have been installed on power presses. While some accidents are due to unsafe behaviour, a number are due to poorly designed guards and devices.

For example, some presence-sensing devices are sometimes partially muted in their design and do not take the safety distance or gap into consideration.

Poor maintenance of guards and devices also contributes to accidents. Workers tend to assume that safety devices and guardings work. However, severe accidents do happen when they fail without the workers' knowledge.

3.12 Fatigue Caused by Working Long Hours

During peak demand periods, workers work long hours. For maintenance staff, extreme and urgent repairs can require them to work long hours on end without rest. Moonlighting may also contribute to fatigue. Without proper control, such work patterns can result in fatigue-induced accidents in the power press environment.

4. Design and Engineering Controls: Safeguarding Mechanical Power Presses

4.1 Guards

Guards are physical barriers that are attached to the frame, die, or base of a press. Guards prevent the operator from putting his hands or fingers into the point-of-operation even when the press is not operating.

4.1.1 Design, Construction and Application of Guards

- The guard shall prevent entry of the hands or other body parts into the point-of-operation by reaching through, over, under or around the machine.
- The guard shall offer visibility of the point-of-operation, consistent with the requirements of the operation being performed.
- The guard shall be fixed with fasteners not easily removable by the operator to minimise the possibility of misuse or removal of essential parts.
- Materials used in the construction of point-of-operation guards shall be strong enough and designed to protect the operator and others from the hazards associated with the point-of-operation.
- Guards shall be constructed such that they are free from sharp edges, burrs, slag welds, fasteners, or other hazards that can cause injury when handling, removing, or using the guards or equipment.

4.1.2 Fixed Barrier Guard

- A fixed barrier guard, if used, shall be attached to the press frame, bolster plate, or other fixed surfaces (Figure 7).

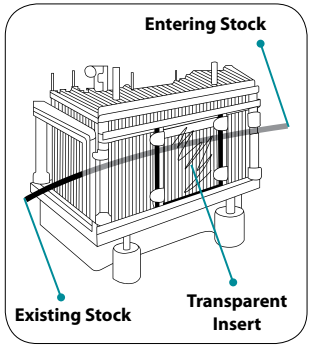

Figure 7: Fixed barrier guard

4.1.3 Interlocked Barrier Guard

- An interlocked barrier guard, if used for safeguarding the point-of-operation, shall prevent cycling (stroking) of the press when the interlocked section of the guard is not in the 'protect' position (Figure 8).
  - An interlocked barrier guard contains a hinged or movable section designed for die changing (if the die is small enough) or for removing jammed parts, materials or scrap.
  - The interlocked barrier guard is not to be confused with a movable barrier device, which opens and closes with each cycle (stroke) for placement and removal of material at the die. Interlocks are intended to prevent the operation of the press when the guards are in a non-protecting position.
  - A hinged or readily movable section that is not interlocked is not approved in this Technical Advisory.
- Interlocked barrier guards shall be designed and installed such that after the interlock is opened, closing the interlock shall not cause any motion to the press.
  - When the interlock is opened and then closed, the normal restart cycle is required to resume press cycling (stroking).
- The hinged or movable sections of an interlocked barrier guard shall not be opened for the purpose of manual feeding operations.
- The interlocked section of the guard shall prevent the operator from opening the guard until the hazardous motion has ceased. Otherwise, it shall be located at a point where the hazard cannot be easily reached before the stoppage of any hazardous motion when the interlocked section is opened.
- The interlock switch or sensor used shall be designed and constructed using reliable safety principles.

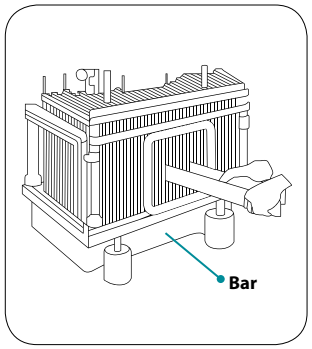

Figure 8: Power press with adjustable barrier guard

4. 2 Safeguarding Devices

These are engineering controls or safety attachments that stop normal press operations if the operator's hands are inadvertently within the point-of-operation.

Methods of controlling access to point-of-operation hazards include but are not limited to the following:

4.2.1 Presence-sensing Safety Devices

- Designed to automatically stop the press cycle (stroke) if the sensing field is interrupted. This prevents the initiation of a press cycle (stroke) or stops the cycling (stroking) of the press during the closing portion if the operator's hands are in the point-of-operation (Figure 9).
- Examples of presence-sensing safety devices include the safety light curtain and safety mat.
- The device shall be interfaced with the control circuit to prevent or stop the slide motion if there are objects within the sensing field during the hazardous portion of the cycle (stroke).
- The device should be located or adjusted such that it always responds to any intrusion at or before the safety distance.
- Care should be taken when installing the device so that it does not detect false signals from other devices or equipment around the area.
- The presence-sensing device should not be used to protect against a mechanical failure, which causes unintended cycling (stroking) action.
- The device should not be used on presses using full revolution clutches.
- When the sensing field has been interrupted, use of a normal press control is required after clearing the sensing field to resume press operation.
- Muting of the devices is permitted only during the non-hazardous portion of the press cycle (stroke).
  - Muting is typically accomplished by interface circuits or auxiliary controls. The die closing portion of the cycle (stroke) is always considered hazardous. In some instances, feeding and transfer automation or die features can cause more hazards even during the opening portion of the cycle (up-stroke).

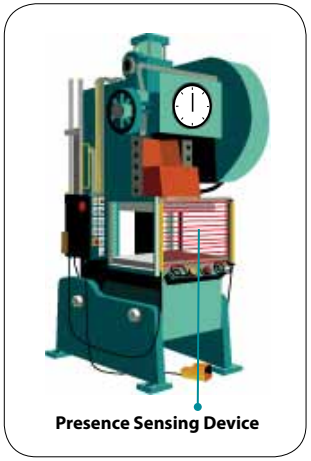

Figure 9: Presence-sensing safety device on power press

- Muting of the device shall conform to the requirement of the performance of related safety functions.
  - The muting element should incorporate a similar level of control reliability as the presence-sensing device itself. A simple cam-operated limit switch wired in parallel to the device's output is inadequate as its failure can remain undetected.
- The device shall have an identifiable minimum detection capability so that an obstruction of an equal or greater size will be detected within the sensing field regardless of the plane of intrusion.
- The device should have a minimum detection capability stated by the manufacturer.
- The device manufacturer should state the total maximum response time, including output devices of the presence-sensing device.
- Red and green indicator lamps or other means that can be easily seen by the operator and others should be provided to indicate that the device is functioning.
- An amber indicator lamp or other means shall be used to indicate to the operator and others when the device is bypassed.
- The device shall not fail to respond to the presence of the individual's hand or other body part in the event that a reflective object or work piece is present.
- The device and its interfaces shall conform to the performance requirements of related safety functions. In the event of a power failure, the device shall initiate a stop command to the press control system.
- The sensitivity of the device to intrusion shall not be adversely affected by changing conditions around the press.
  - Some devices can be affected by changes in the conditions around the press production system. These include the placement of parts and tote boxes, grounding conditions of the operator, or the movement of forklift trucks.
- The effective sensing field of the device shall be located at a distance from the nearest point-of-operation hazard so that individuals cannot reach into the point-of-operation with a hand or another body part before stopping of motion during the hazardous portion of the cycle (stroke).
  - The total stopping time of the press should include the total response time of the presence-sensing device as stated by the manufacturer, the response time of the interface, the response time of the control system, and the time it takes the press to cease slide motion.
  - The following formula shall be used when calculating safety distance:
    $D(s) = K(T(s) + T(c) + T(r) + T(bm)) + Dpf.$

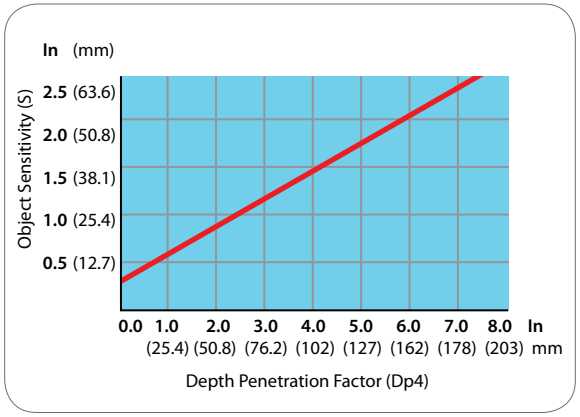

Figure 10: **Depth Penetration Factor (Dpf)**

Where:

K = 1600 mm / sec (hand speed constant)

T(s) = stop time of the press measured from the final de-energised control element, usually the air-valve

T(c) = response time of the press control

T(r) = response time of the presence-sensing device and its interface

T(bm)= additional stopping time allowed by the stopping-performance monitor before it detects stop time deterioration.

Dpf = the added distance, in mm due to the penetration factor as recommended in Figure 10.

This is related to the minimum object sensitivity of the presence-sensing device and how far an object can move through the sensing field before the presence-sensing device reacts. By knowing the minimum object resolution, S, of the presence-sensing device, Dpf is read directly from the figure.

The minimum detection capability is stated by the manufacturer. If fixed blanking or floating blanking features are used, these figures should be added to the detection capability figure before using the chart.

Notes:

- T(s) + T(c) are usually measured by a stop time device. Whenever the press cycle (stroke) STOP command or stopping - performance monitor time or angle setting is changed, the safety distance should be calculated.
- No increase in safety distance is required for fixed blanking applications if the blanked area is entirely occupied by the fixtures.

In some cases, the use of blanking does not allow efficient production of certain piece parts. Horizontal placement of the sensing field, so that it detects an operator's waist area, may present a solution. In this application, the operator may freely manipulate the work-piece and operate the press as long as the operator stands outside the horizontal sensing field.

The sensing field should be located such that the operator cannot reach the point of operation prior to interrupting the sensing field and completion of the stopping action. Where possible, the sensing field should be of sufficient depth to prevent the operator from standing between the field and the point of operation.

- If the position of the device allows the operator or others to place themselves between the sensing field and the point-of-operation, additional means shall be provided to prevent anyone from exposure to any point-of-operation hazards.
- Additional means may include manual reset outside the sensing field of the devices, additional barrier guards, safety mats, presence-sensing device or other devices.
- Operator controls located outside the sensing field of the presence-sensing device may be used.
- The device shall not be affected by ambient light or by light source decay so that the increase in response time or detection capability is greater than the value used to calculate the safety distance.
- Examples of ambient light are associated with windows, light fixtures, skylights, bay doors or die lights.
- All areas of entry to the point-of-operation not protected by the presence-sensing device shall be safeguarded.
- Usually, the electro-optical presence-sensing device is used in a manner that provides a protective zone in front of the primary working area with auxiliary devices or guards protecting secondary access areas.
  - In some cases, mirrors may be used in conjunction with the device to provide two-, three- or four-sided protection.
- A stopping performance monitor is required when a device is used on a press production system in a single stroke mode, and the protection of the operator is dependent upon the stopping action of the press.

4.2.2 Two-hand Control Devices

Two-hand control devices require the use of both hands of the operator to press operating controls. These devices shall locate the controls at a distance from the point-of-operation such that the slide completes the closing portion of the cycle (stroke), or stops before the operator can reach the point-of-operation (Figure 11).

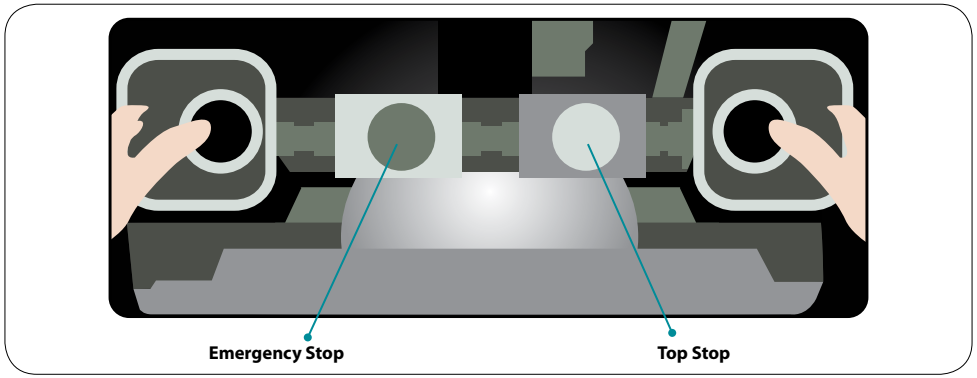

Figure 11: **Two-hand control device**

- Each hand control shall be protected against unintended initiation and shall be arranged by design, construction or separation so that the concurrent use of both hands is required to start the press cycle (stroke).
  - Rings, shrouds or flush-type buttons to prevent the use of elbows to operate may satisfy the requirement to protect palm-operated buttons from unintentional initation. Precautions in design or installation are needed to prevent initation of two buttons by the use of one hand and the elbow of the same arm, and to inhibit other circumvention of the two-hand requirements.
  - The two-hand control device switch is to be installed at least 500mm apart.
- If more than one operator has to be safeguarded by the use of two-hand controls, each operator shall have an individual set of operator hand controls. Additionally, all individual operator hand controls shall be concurrently operated before the press can be actuated.
  - There should be concurrent use of both hands of each operator to start the cycle (stroke) and to continue the closing portion of the cycle (stroke) when single cycling the press.
- The two-hand controls shall be designed to require the release and the re-initation of all controls before a press cycle (stroke) can be started.
- Means shall be taken to ensure that the hand actuating controls are not located too close to the point-of-operation than the distance determined.
- The two-hand control device shall be in compliance with performance of the safety-related functions.
- A stopping-performance monitor is required when a two-hand control device is used on a part revolution clutch press in a single stroke mode, and when the protection of the operator is dependent upon the stopping action of the press.

4.2.3 Movable Barrier Device

A movable barrier device, when used, shall enclose the point-of-operation before a press cycle (stroke) can be initiated.

- Movable barrier devices are usually used on presses which require access to the point-of-operation once per cycle (stroke).
- The device shall prevent the operator from reaching the point-of-operation hazards by reaching over, under, around or through the device when in the closed position.
- In conjunction with the press control, the device shall actuate the clutch and initiate the press cycle (stroke).
- The barrier shall be capable of being returned to the open position should it encounter an obstruction prior to enclosing the point-of-operation.
- Movable barrier devices may be powered open or closed by mechanical, electrical, hydraulic, or pneumatic means, or opened and closed physically by the operator.
- Before a successive cycle (stroke) can be initiated, the device shall require the opening of the barrier to reset the anti-repeat system of the press production system every time the press stops.
- The device is to be in compliance with the performance of related safety functions.
- The device shall provide visibility to the point-of-operation when necessary, for safe operation of the press production system.
- The device in and of itself shall not create a hazard to the operator or others.
  - **Type A Movable Barrier Device**
    The Type A Movable Barrier Device shall, in normal single-stroke operation, be designed to maintain a closed position until the slide has completed its cycle (stroke) and has stopped at the top of cycle (stroke) (Figure 12).
    a) The device should be designed such that the operator cannot easily open the movable barrier device during the cycle (stroke) when it is in a closed position. It should prevent entry into the point-of-operation in the event of a failure of the press or its related control equipment that can result in a repeat cycle.
  - **Type B Movable Barrier Device**
    This device cannot be used in a full revolution clutch press. The device shall, in normal single-stroke operation, be designed to maintain a closed position during or until cessation of slide motion during the closing portion of the cycle (Figure 12).
- The Type B Movable Barrier Device should be designed so that it is held closed during the closing portion of the cycle (stroke).
- A stopping performance monitor is required when the device is used in the single-stroke mode and when the protection of the operator is dependent upon the stopping action of the press.

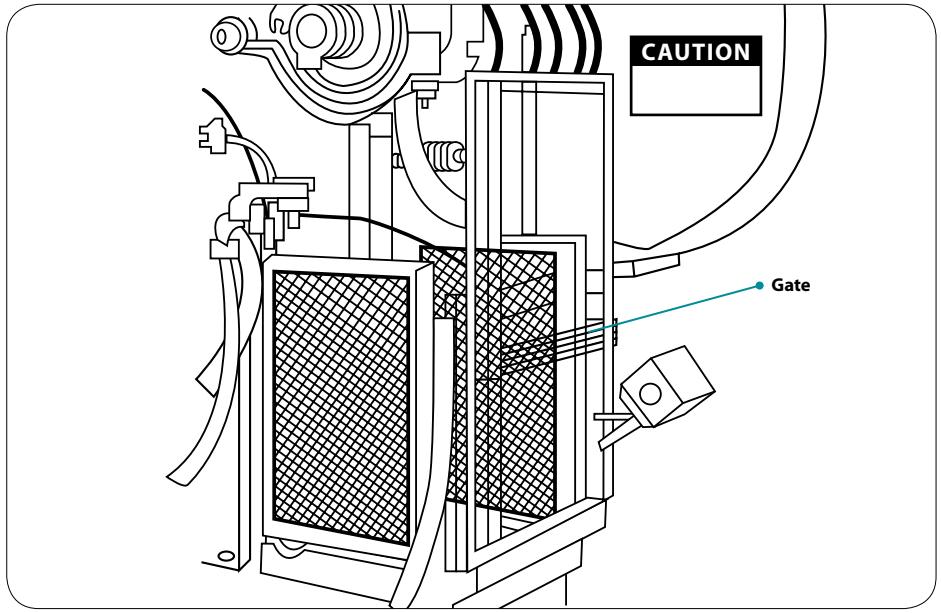

Figure 12: Moveable guard

4.3 Performance of Safety-related-functions

4.3.1 Safety-related functions of the machine control system prevent hazardous conditions from occurring. It can be a separate dedicated system or it may be integrated with the normal machine system. In order to provide the safety function, the system must continue to operate correctly under all foreseeable conditions:

- Prevent initation of hazardous machine motion (or situations) until the failure is corrected or until the control system is manually reset.
- Initiate an immediate stop command and prevent re-initiation of hazardous machine motion (or situations) at the next normal stop command until the failure is corrected or until the control system is manually reset.
- Prevent re-initiation of hazardous machine motion (or situations) at the next normal stop command until the failure is corrected or until the control system is manually reset.

4.3.2 In the event of a failure, it is recognised that some control systems or devices can be manually reset by cycling the power to the system or switching the device off and on to facilitate the diagnosis of a failed component, subassembly, device or module. A second failure may occur during the diagnostic or troubleshooting process, negating the safety-related function. Additional safeguards should be taken to protect individuals during this process.

4.3.3 Control reliability:

- Is a design strategy that can be used to meet these requirements.
- Cannot prevent a repeat cycle (stroke) in the event of a major mechanical failure or in the presence of multiple simultaneous component failures.
- Is not provided by simple redundancy. Monitoring must be done to ensure that redundancy is maintained.

4.4 Brake Monitoring System

A system for monitoring brake performance in part-revolution clutch presses and includes an overrun cam coupled to a switch to determine that the press die has entered the danger zone implying an impending brake failure. A control relay is coupled to the overrun cam switch for stopping press operations when impending brake failure is sensed.

4.4.1 Types of stopping-performance monitors include:

- Stopping position (TOP STOP) monitor;
- Stopping angle monitor;
- Stopping time monitor.

4.4.2 A stopping-performance monitor may not prevent a repeat cycle (stroke) in the event of a major mechanical failure or a multiple simultaneous component failure.

4.4.3 Factors that can affect stopping performance of the press may include, but are not limited to:

- Clutch air supply;
- Counterbalance air supply;
- Tooling weight;
- Machine cycle (stroke) speed;
- Brake wear adjustment;
- Clutch wear adjustment; and
- Exhaust restrictions.

4.4.4 When the stopping time changes as a result of these conditions, it can become necessary to change the TOP STOP limit switch position or readjust the stopping performance monitor. If such readjustments are made, the safety distance used to locate two-hand controls or presence-sensing devices shall be recalculated. If necessary, the devices should be relocated.

4.5 Emergency Stop Devices

4.5.1 Emergency stop devices are designed for use in reaction to an incident or hazardous situation. As such, they are not considered safeguards for machines. These devices, such as buttons, rope-pulls, or pressure sensitive body bars, neither detect nor prevent operator exposure to machine hazards. Rather, they stop hazardous motion when an operator recognises it and initiates them.

4.6 Lockout Devices

4.6.1 Means shall be provided to disconnect and isolate all sources of hazardous energy during the installation of the press production system (Figure 13).

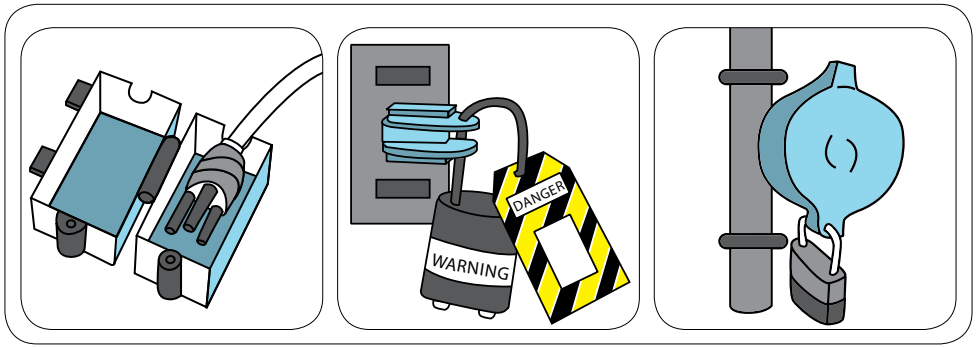

Figure 13: A variety of lockout devices

4.7 Complementary Equipment

4.7.1 Work Holding Equipment

Work holding equipment is not used to feed or remove the work-piece. It is used to hold the work-piece in place during the hazardous portion of the machine cycle to reduce or eliminate the need for operators to place their hands in a hazard area. Clamps, jigs, fixtures and back gauges are examples of such equipment.

4.7.2 Hand Feeding Tools

An operator can use tools to feed and remove material into and from machines so as to keep their hands away from the point-of-operation. However, this must be done only in conjunction with the guards and safeguarding devices as described previously. Hand tools are not safeguarding devices and need to be designed to allow the operator's hands to remain out of the danger area. Using hand tools require close supervision to ensure that the operator does not bypass their use to increase the rate of production. It is recommended that these tools be stored near the operation to promote their use (Figure 14).

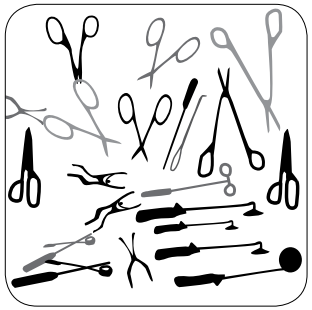

Figure 14. Hand feeding tools

4.7.3 Feeding and Ejection System

A feeding and ejection system (e.g. a gravity-fed chute, semi-automatic and automatic feeding and ejection equipment) does not constitute secondary safeguarding. However, the use of a properly-designed feed and ejection system can protect personnel by minimising or eliminating the need for them to be in the hazard area during the hazardous motion of the machine.

5. Safety During Installation, Relocation and Modification

5.1 Foundation

When preparing the foundation of the machine, dynamic force (approximately 60% of the machine weight) should be added to the machine weight. For more precise information, consult a structural engineer or manufacturer.

5.2 Space Requirements

The space requirements shall comply with CP27: 1999 Code of Practice for Factory Layout-Safety, Health and Welfare Considerations Section 1.1, or any latest revision, as shown in the extracts below:

- "Sufficient space shall be provided around the individual machines or process units to allow for normal operation, adjustments and ordinary repair, and for storage of materials supplied, in process, or completed."

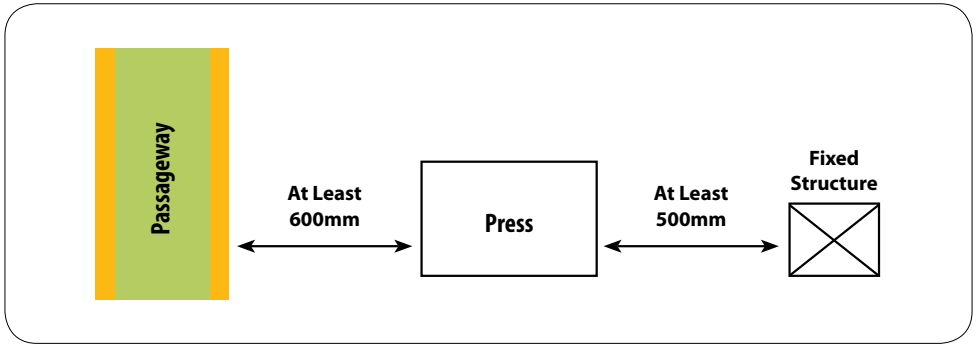

Figure 15: Space requirements

- "Traversing (moving) parts or materials carried by any machine shall not approach within 500 mm of any fixed structure, whether or not it is part of the machine." (Figure 15)

5.3 Noise

The control of noise shall comply with CP27:1999 Section 2.4, or any latest revision, as shown in the extract below:

- "Noise sources within the factory shall as far as practicable be effectively controlled such that no person in the factory is exposed to noise exceeding 85dBA over an 8-hour workday." Necessary steps to reduce noise exposure through appropriate measures are to be taken.

5.4 Installation

Considerations to take note of in the installation of a power press:

5.4.1 The engaged service provider is an authorised dealer or competent person and has the capability and capacity to carry out the installation of such machines.

5.4.2 The engaged machine mover has the capability and capacity to carry out the moving of such machines.

5.4.3 There is sufficient space for the unloading and temporary storage of the machine's components.

5.4.4 The above operation should not block fire exits, escape paths, accessibility to fire-fighting equipment or accessibility to the building for fire-fighting operations.

5.4.5 The site floor or ground bearing has to be able to withstand the weight of the machine, crane, or any other heavy equipment.

5.4.6 Ensure that safety precautions are taken for activities involving hot work.

5.4.7 Ensure that safety precautions are taken for activities involving work at height. (Reference: CP27:1999 section 1.4.7 or any latest revision).

5.4.8 The lifting equipment used should be in good condition, tested and examined by an Authorised Examiner and should not be under-capacity. For regulations on lifting equipment, please refer to:

WORKPLACE SAFETY AND HEALTH ACT 2006 (ACT 7 of 2006)
Workplace Safety and Health (General Provisions) Regulations
PART III
General Provisions Relating to Safety
20 Lifting gears
21 Lifting appliances and lifting machines
22 Register of lifting gears, etc.
or any latest revision or provision relating to this subject.

5.4.9 The site should be properly barricaded with ample warning signs to prevent injury from hot work or other falling objects.

5.4.10 Temporary safety measures should be in place for any piping, electrical wiring and dismantling of fixtures or structures, especially water sprinkler and lighting systems.

5.4.11 Debris or waste material from the unpacking of the machine and after the installation should be disposed properly.

5.4.12 Power supply cables, including earth cables, should be sized correctly. Licensed electricians and machine manufacturers should be consulted for such work. The earth cable should be connected properly at the earth terminal in the main board to prevent electric shock and noise.

5.4.13 Appropriate vibration isolators like rubber pads, cushion rubbers, cushion springs or a separate foundation for the machine's footing should be applied to eliminate or reduce any hazard that might arise.

5.5 Commissioning

Machines, including any equipment attached to the power press, should be tested and commissioned by a machine manufacturer, authorised agent or competent person. A manufacturer, authorised agent or competent person should have a comprehensive checklist for any necessary rectification for any faults or defects, to ensure safe use of the machine.

Hazards will be created if the interface between a power press and other attached equipment / machines are not properly tested or done incorrectly. Other attached equipment include feeders, pick-and-place systems, conveyor systems, robots, etc.

Guideline for commissioning a machine:

5.5.1 The machine should be levelled, positioned and placed properly on the floor or footing.

5.5.2 The machine should be properly barricaded with warning signs during commissioning and testing.

5.5.3 A visual check of the entire machine should be conducted, before any energy source is switched on.

a) The appearance of each part should be checked;

b) The machine should not have any abnormal conditions such as cracks, damages, dents, foreign items and missing items;

c) The tightness of all parts should be examined;

d) All parts should be fastened properly, including the tensioning of V-belts, timing belts, chains, etc; and

e) Ensure lubrication oil, coolant, grease, etc. are the correct type recommended by the manufacturer, and they are within the normal level.

5.5.4 Ensure that there is no leakage after the compressed air is supplied to the machine.

5.5.5 Ensure that the power supply voltage of each phase to the machine is correct, before the power supply is switched on.

5.5.6 Ensure that the direction of rotation of pumps, motors, etc. is correct.

5.5.7 Ensure that there is no leakage of oils and coolants, and that the pressure is within range with no abnormal noise after activating the pumps.

5.5.8 The manual functions of each device should be tested first, one at a time, before testing the automatic functions.

5.5.9 A check and test run of the following functions should be conducted:

a) Operational mode functions;
   i) Off
   ii) Home (for servo press)
   iii) Inch
   iv) Single
   v) Continuous
   vi) Other option modes
b) Presence-sensing device at each of the operational mode;
c) Each emergency stop;
d) Overload protector;
e) Two-hand control buttons at each of the operational mode, especially when operated simultaneously;
f) Top stop;
g) Overrun detector;
h) Sensors of safety guards, gates, doors, etc.;
i) Circuit breakers;
j) Safety blocks and plugs;
k) Pressure relief valve;
l) Pressure switches;
m) Miss feeds (if any);
n) Die clampers (if any);
o) Die cushions (if any); and
p) Parts knock out/ slide knock out (if any).

5.5.10 The following items should be checked after completion of each stage or level of test run:

a) The temperature of each device or component such as motors, pumps, gear boxes, clutch boxes, sliding, frames, etc. should be in the normal range;
b) The tightness of all mounting bolts and nuts;
c) Any leakage of gas, air, oil, water, coolants, etc.;
d) Pressure in each device should be within the safety range;
e) The current of each motor when running at full speed and load, should be within the normal range;
f) Filters and strainers should be checked for any presence of abnormal substances.

5.6 Relocation

5.6.1 Dismantling

Should there be a need to relocate a machine, all dismantling work of the machine should be done by the machine's manufacturer, authorised agent or competent person. The measures to be taken should include all pointers in section 5.4 and one or more of the following, where appropriate:

a) Implement lockout procedures before commencement of any dismantling work.
   - To ensure that all energy sources (electrical, gas, water, etc.) to the relevant machinery, equipment or electrical works are isolated, disconnected or discharged.
   - To prevent any part of the machinery, equipment or electrical work from being inadvertently initiated or energised.
b) Drain or release all pressurised gases (e.g. compressed air and nitrogen) and liquids (e.g. lubrication oil and hydraulic oil).
c) Identify and mark out all the items (including electrical control wiring, hoses of gas/lubrication oil/hydraulic oil) that need to be removed from the machine.
d) Fasten all loose items. This also applies to removing attached equipment from power presses.

5.6.2 Assembly and Installation

All assembly work and installation, including electrical control wiring, should be performed by the machine's manufacturer, authorised agent or competent person. Considerations to take note of in the assembly and installation of a power press are listed in Section 5.5. The above also applies to any equipment attached to a power press.

5.6.3 Testing and Commissioning

After relocation and before operation of the power press, testing and commissioning should be done by its manufacturer, authorised agent or competent person. Tests should be performed even if the power press has not been dismantled. This is to ensure that there are no hazards created to the power press and its attached equipment during shifting or transportation. Improper dismantling and assembling will potentially endanger the end-user.

5.7 Modification and Adjustment or Use of Alternative Parts

Any modifications or adjustments to a machine may introduce hazards that can cause injury to the operators. The manufacturer should be consulted for any requests of modifications or adjustments to the machine. Modifications and adjustments should also be performed by the machine's manufacturer, authorised agent or competent person with the proper training, knowledge and know-how of the machine. The following are items that should not be affected after any modification or adjustment:

5.7.1 Stopping Time

Stopping time is the time needed by a machine to cease operation completely. It is important that any modification or adjustment will not cause the power press to delay stoppage as this can cause severe injury to the user.

Some examples or items that may affect the stopping time of a power press:

- Type of presence-sensing device. Different types of presence-sensing device may have different response times.
- Clutch-activating solenoid valve
  - Type of solenoid valve device. Different types of solenoid valves may have different response times.
  - Location of the solenoid valve – the distance away from the clutch and brake assembly.
  - Size of the solenoid valve.

    Both location and size of the solenoid valve affects the time taken for compressed air to exhaust completely from the clutch.
- Clutch and brake (braking time/slipping angle)
  - Improper adjustment of the clutch and brake's stroke, use of wrong type of oil (for wet clutch), or use of different types of lining and discs will affect the stopping time of a power press.

5.7.2 Safety Distance

It is imperative that a minimum safety distance be properly calculated as in Section 4.2.1 and maintained. If the safety light curtain or the two-hand control are installed too close to the point-of-operation, the machine may not stop in time before any part of the operator's body enters the danger area (Figures 16-17). For the calculation of the safety distance, refer to Section 4.2.1.

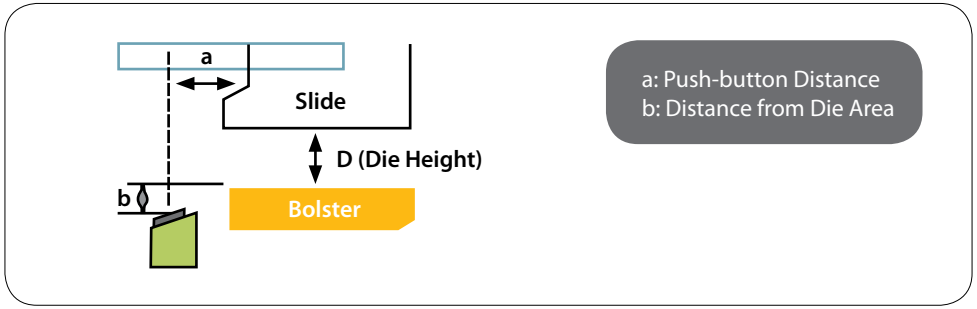

Figure 16: Distance of two-hand control away from die area.

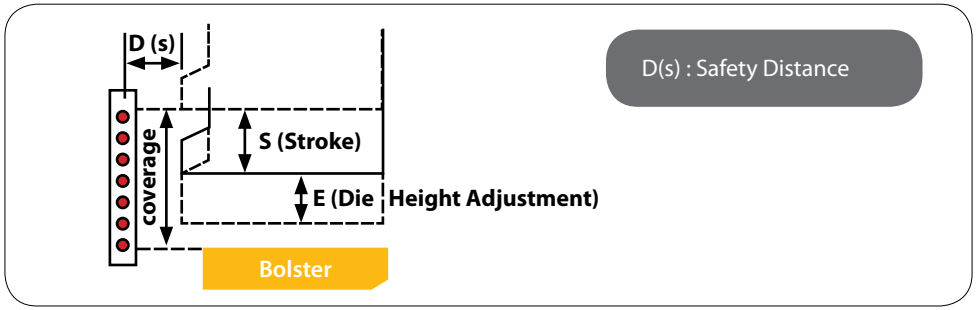

Figure 17: Distance of safety light curtain to die area

5.7.3 Interlocking Circuit

The Interlocking Circuit is a control circuit in a machine. It checks that all the conditions are in order and safe to use before allowing one to operate the machine, and should not cause any damage to the machine itself. The following are some of the examples of operational functions and safety functions in a press.

a) Operation mode (inch, single, continuous, etc.)

b) Presence-sensing device

c) Simultaneous circuit of two hand operated safety device / control buttons

d) Foot switch, which can only be used in certain conditions

e) Emergency stop (button)

f) Safety plug (if the plug is disconnected, the machine should be in emergency stop condition)

g) Quick die change, (auto die changing / die clamping system)

h) Mechanical safety guard or gate

i) Overrun detector (stops a machine from operating, if the ram/slide stops beyond the normal stop point)

j) Main motor's start, forward or reverse function

k) Lubrication system

l) Motion detector (stops a machine from operating, if the machine does not start operating within a specific time after it is initiated)

m) Overload protector

n) Reset (restores machine back to normal condition after an abnormal condition is removed)

o) Additional two-hand control buttons should be used, if there are more then one operator involved in the loading and unloading of parts or materials into and/or from the die area. Each operator should have a two-hand control button, and synchronised run buttons to operate the machine. This ensures that all operators are out of the die area (Figure 18)

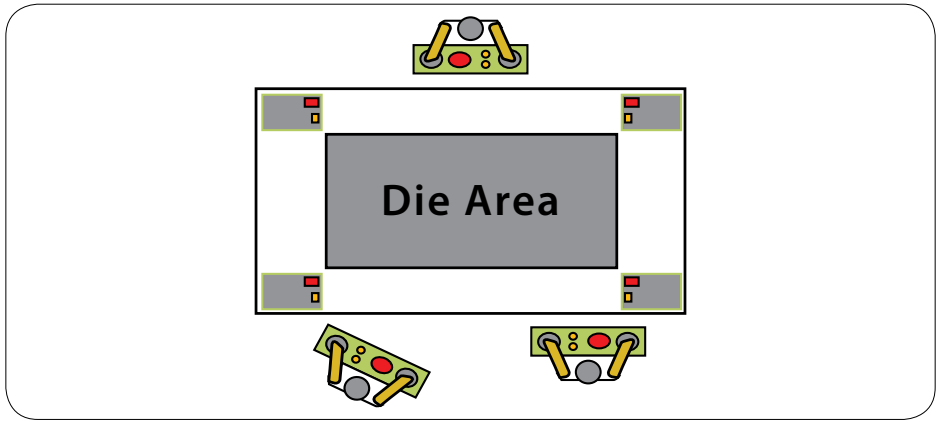

Figure 18: Two-hand control buttons

5.7.4 Other Issues to Note

a) Location of emergency stop buttons

b) Size and length of presence-sensing device (coverage)

c) Presence-sensing devices should cover the full stroke of the slide, from the upper limit of the top deal point to the top surface of the bolster (Figures 16 - 17)

d) Mechanical guards, enclosures or covers of moving parts

e) Relieve pressure of overload protector

f) Type of solenoid valve (for clutch and brake) - two-way spool valve should be used instead of a single-way spool valve

g) Warning labels - Always keep warning labels clean and legible. Replace them with new ones if signs or labels are removed or become illegible. This applies to other labels in addition to safety warnings (Figure 19)

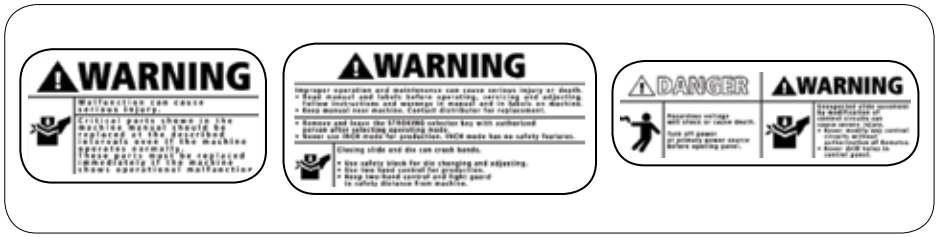

Figure 19: Examples of safety warnings

5.8 Risk Assessment

Before installation, relocation and modification, risk assessment shall be conducted.

6. Safe Work Practices

6.1 Setup Procedures

6.1.1 Use purpose-built material handling machines such as overhead cranes and forklifts with adequate capacity and capability to load tools and die sets onto the machine.

6.1.2 Only trained and authorised personnel may operate the material handling machine.

6.1.3 Keep away from the transportation path of the lifted tool and die set, and do not stay or move below a suspended tool and die set.

6.1.4 Apply lockout procedures while fastening the tool and die onto a machine. The use of safety blocks is encouraged.

6.1.5 Only trained and authorised technicians can perform the tool and die set-up.

6.1.6 Checks should be conducted upon the completion of the setup to ensure the tool and die are securely mounted.

6.1.7 If a setting bar is used as a lever to rotate the press crankshaft, it must have a spring loaded device to ensure it cannot be left unintentionally in the crankshaft during setup.

6.1.8 Any further adjustments to the tool and die after the set-up will have to be performed by trained and authorised technicians with the application of lockout procedures.

6.1.9 All safety devices provided on the press must be operational and correctly set before making a trial pressing or adjusting the tool and die.

6.2 Materials Setup (Automatic Feeding Machines)

6.2.1 While unpacking coiled sheet metals, special care should be taken to prevent injuries caused by the spring-action of the metal coil during removal of the packaging material.

6.2.2 Use personal protective equipment (PPE) such as cut-resistant gloves, arm guards and safety glasses whenever necessary.

6.2.3 Apply lockout procedures if the end of the coiled material is being manually led into the press operation area. This is to prevent accidental initiation of the power press during setup.

6.2.4 Only trained and authorised technicians may perform the material setup.

6.2.5 Ensure that all the machine guards and safety devices are in place upon the completion of the setup.

6.2.6 Always conduct a test run to ensure that the machine is in a safe condition before commencing operation or production on the machine.

6.3 Operation (Power Press)

6.3.1 Before commencing operation, functionality checks shall be performed for all safety devices on the power press and the material feeder. Examples of such safety devices include machine guards, presence-sensing device, two-hand operation devices, interlocking devices and emergency stop pushbuttons.

6.3.2 Care should be taken when handling materials with sharp edges. Cut resistant gloves should be used.

6.3.3 Care should be taken while handling heavy materials. Adopt proper material lifting postures and use mechanical aids when materials are too heavy for safe manual lifting.

6.3.4 After necessary engineering control measures are in place, use personal protective equipment such as safety glasses or goggles if there is still risk of materials being ejected during operation.

6.3.5 Hearing protectors such as earplugs or earmuffs have to be used should there be excessive noise (above 85 dB(A) over an 8 hours period) in the operation area after necessary engineering control measures are in place. All operators shall be appropriately trained in hearing conservation.

6.3.6 All operators shall be trained on the relevant safe work procedures, emergency procedures, and measures to eliminate or control the health and safety risks that are identified via the risk assessment process.

6.3.7 Anyone who is unwell should be examined by a medical practitioner and should not operate the machine until he/she is fit to do so.

6.3.8 Ensure that the machine is at a complete stop before any work piece is loaded onto the die set.

6.3.9 Ensure that no hands or any other part of the body is within the operational zone before activating the machine.

6.3.10 If there is any chemical used in the operation, ensure that the Safety Data Sheets (SDS) have been studied and the risks involved have been assessed, with safety measures being put in place and communicated to those affected by the operation.

6.3.11 If an abnormality is detected, the operator should stop the machine immediately and report it to the supervisor. All troubleshooting and repairs should only be carried out by trained and authorised personnel.

6.3.12 Unloading of processed work pieces should only be carried out when the machine has come to a complete stop, unless it has been made safe through reliable engineering means.

6.3.13 For automatic feeding operations, clearing of scrap at the stamping zone should not be permitted. Should there be a need for clearing of scrap metal around the stamping zone while it is in operation, appropriate tools such as tongs and rods should be used.

6.4 Operation (Press Brake Machine)

6.4.1 Before commencing operation, functionality checks shall be performed for all safety devices on the power press and the material feeder. Examples of such safety devices include machine guards, presence-sensing device, two-hand operation devices, interlocking devices and emergency stop pushbuttons.

6.4.2 Care should be taken when handling materials with sharp edges. Cut-resistant gloves should be used.

6.4.3 Care should be taken while handling heavy materials. Adopt proper material lifting postures and use mechanical aids when materials are too heavy for safe manual lifting.

6.4.4 After necessary engineering control measures are in place, use personal protective equipment such as safety glasses or goggles if there is still risk of materials being ejected during operation.

6.4.5 Foot pedals should be avoided as far as possible.

6.4.6 All operators should be trained on the relevant safe work procedures, emergency procedures, and measures to eliminate or control the health and safety risks that are identified via the risk assessment process.

6.4.7 If the operator is required to hold the work piece when it is processed, safe holding positions should be identified and be communicated to the operator. Care should also be taken to prevent hands from being caught when the work piece is folded during the process (Figure 20).

6.4.8 Anyone who is unwell should be examined by a medical practitioner and cannot operate the machine until he/she is fit to do so.

6.4.9 As far as practicable, the gap opening between the work piece and the tool/die should be kept to the size smaller than a finger and a maximum of 4 mm (Figure 21).

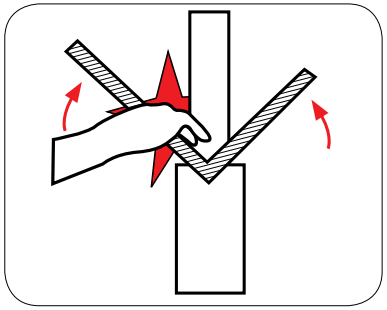

Figure 20: Folding process

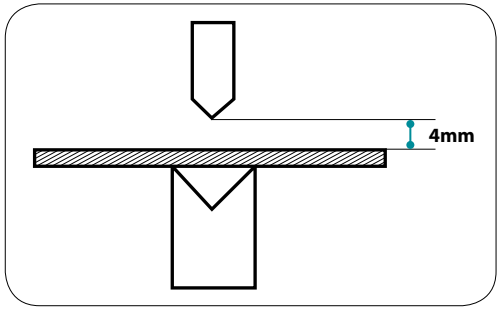

Figure 21: Gap opening between work piece and tool/ die

6.4.10 Ensure that no hands or any other part of the body is within the operational zone before activating the machine.

6.4.11 If an abnormality is detected, the operator should stop the machine immediately and report it to the supervisor. All troubleshooting and repairs should only be carried out by trained and authorised personnel.

6.4.12 Unloading of processed work pieces should only be carried out when the machine has come to a complete stop, unless it has been made safe through reliable engineering means.

6.5 Maintenance (Scheduled / Planned)

6.5.1 Periodic inspection of the machine should be conducted or as otherwise recommended in the operation or maintenance manual. Inspection interval and checklists should be based on machine and operating conditions and adjusted accordingly by experience to ensure safety. A minimum initial inspection within 3 to 4 months after installation is recommended. Inspection of the electrical control systems should also meet the recommendations by the manufacturer.

6.5.2 Use only replacement parts and devices recommended by the manufacturer to maintain the integrity and safe use of the machine. Ensure that the parts are properly matched to the equipment series, model, serial number and revision level of the machine. Alternatively, consult the manufacturer for other recommendations on parts replacement.

6.5.3 Ensure that the machine is disconnected from any energy source by first checking that no personnel is exposed to it. Then verify the isolation of the equipment by operating the pushbutton or other normal operating controls, or by testing it to verify that the equipment is non-functional. **Strictly follow the lockout procedure.**

6.5.4 Personnel involved in maintenance shall be required to go through the established risk assessment and follow all recommended actions strictly.

6.5.5 A pre-operational functionality test should be carried out before any actual operation. Tests should also include checks on all machines' safety devices.

6.5.6 Notify affected personnel upon completion of maintenance and when the machine is ready for use.

6.6 Maintenance (Breakdown / Unplanned)

6.6.1 Only trained and authorised personnel may be tasked to diagnose a machine's fault. Do not attempt to enter the operational zone when the machine is in operational mode.

6.6.2 Report and record all faults and information with proper documentation.

6.6.3 Be familiar with the lockout procedure. Ensure that co-workers within the vicinity are aware of the shutdown, especially when there is more than one worker working on the same machine.

6.6.4 The clearing of all jammed parts, debris and repairs shall only be conducted by trained and authorised personnel.

6.6.5 During machine testing, ensure that the operational zone is clear before activating the machine. A pre-check on all safety devices should be conducted.

6.6.6 A pre-operational functionality test should be carried out before actual operation. Tests should include checks on all the machine's safety devices.

6.6.7 Notify affected personnel upon completion of maintenance and when the machine is ready for use.

6.7 Notes on Lockout Procedures

6.7.1 Authorised personnel performing servicing or maintenance shall be trained to:

- Recognise hazardous energy sources and understand the energy types and magnitudes;
- Identify and properly operate the applicable energy-isolating devices;
- Safely apply and remove lockout devices.

6.7.2 Machine operators or workers in the area where lockout is performed shall be trained to:

- Recognise when lockout activities are in progress;
- Understand the purpose of the energy control (lockout procedures) programme and the importance of not tampering with lockout devices when encountered in the workplace.

6.7.3 All training should be properly documented (e.g. when the training took place, participants and the topics covered).

6.7.4 Retraining is necessary, when:

- New personnel are assigned to the job;
- Changes are made to energy control policies or procedures;
- Machinery is installed or modified, presenting any new hazards;
- The employer has reason to believe that there are problems with the employee's understanding of or use of the procedures.

6.7.5 Authorised personnel should undergo an annual review on the understanding of lockout procedures.

6.7.6 The above-mentioned safe work practices are general. Safe work practices still have to be tailored to your specific work processes.

7. Risk Management

7.1 Risk Management

Risk management is a key component of the Workplace Safety and Health Act. It entails:

1) Risk assessment of any work activity or trade;
2) Control and monitoring such risks, and
3) Communicating these risks to all persons involved.

These requirements are specified in the Workplace Safety and Health (Risk Management Regulations).

7.2 Risk Assessment

Risk Assessment is an integral part of risk management. Every workplace should conduct risk assessments for all routine and non-routine work undertaken. It is the process of :

a) Identifying and analysing safety and health hazards associated with work;
b) Assessing the risks involved based on the severity and likelihood of the occurrence; and

Severity	Description
Minor	• No injury; injury or ill-health only requires first aid treatment • Includes minor cuts and bruises, irritation, ill-health with temporary discomfort
Moderate	• Injury requiring medical treatment or ill-health leading to disability • Includes lacerations, burns, sprains, minor fractures, dermatitis, deafness and work-related upper limb disorders
Major	• Fatal, serious injury or life-threatening occupational disease • Includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning and fatal diseases

Severity categories and description: Severity is the degree of injury or harm caused by the hazards or as a result of an accident.

Likelihood	Description
Remote	Not likely to occur
Occasional	Possible or known to occur
Frequent	Common or repeating occurrence

Likelihood categories and description.

Severity \ Likelihood	Remote	Occasional	Frequent
Major	Medium Risk	High Risk	High Risk
Moderate	Low Risk	Medium Risk	High Risk
Minor	Low Risk	Low Risk	Medium Risk

Risk matrix to determine risk level: Once the severity and likelihood have been established, the risk level can be determined using the 3x3 matrix. To determine the risk level, select the appropriate row for severity and the appropriate column for likelihood; the cell where they intersect indicates the risk level.

c) Prioritising measures to control the hazards and reduce the risks. The hierarchy of control measures, from the most preferred to the least preferred, are listed as follows:
   i. Elimination;
   ii. Substitution;
   iii. Engineering controls;
   iv. Administrative controls;
   v. Personal protective equipment.

   Brief descriptions of the five control measures can be found in Page 39.

Risk Level	Acceptability of Risk	Recommended Actions
Low Risk	Acceptable	No additional risk control measures may be needed. However, frequent reviews may be needed to ensure that the risk level assigned is accurate and does not increase over time.
Medium Risk	Moderately Acceptable	A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as is practicable within a defined time period. Interim risk control measures, such as administrative controls, may be implemented. Management attention is required.
High Risk	Not Acceptable	High risk level must be reduced to at least medium risk before work commences. There should not be any interim risk control measures and risk control measures should not be overly dependent on personal protective equipment or appliances. If need be, the hazard should be eliminated before work commences. Immediate management intervention is required before work commences.

Acceptability of risk and recommended actions: Risk controls should be selected to reduce the risk level to an acceptable level. This can be done by reducing the severity and/or likelihood.

Control Measure	Description
Elimination	Elimination of hazards refers to the total removal of the hazards and hence effectively making all the identified possible accidents and ill-health impossible. This is a permanent solution and should be attempted in the first instance.
Substitution	This involves replacing the hazard by one that presents a lower risk.
Engineering Controls	Engineering controls are physical means that limit the hazard. These include structural changes to the work environment or work processes, erecting a barrier to interrupt the transmission path between the worker and the hazard.
Administrative Controls	These reduce or eliminate exposure to a hazard through adherence to procedures or instructions. Documentation should emphasise all the steps to be taken and the controls to be used in carrying out the activity safely.
Personal Protective Equipment	This should be used only as a last resort, after all other control measures have been considered, or as a short term contingency during maintenance / repair or as an additional protective measure. The success of this control is dependent on the protective equipment being chosen correctly, as well as fitted correctly and worn at all times when required by employees.

Hierarchy of control measures: It is essential for risks to be eliminated or reduced "at source". If a risk cannot be controlled completely by engineering measures, it is necessary to protect the employees by administrative control or personal protection measures.
The control measures are not usually mutually exclusive e.g. engineering controls can be implemented together with administrative controls like training and safe work procedures.

- Safe Work Procedures
  Arising from the risk assessment, safe work procedures for work which may pose safety and health risks should be established and implemented. The safe work procedures should include the safety precautions to be taken in the course of work and during an emergency, as well as the provision of personal protective equipment.

- Residual Risks
  The risk assessment team should ensure that the risk assessment is conducted properly, and that any residual risks are acceptable and manageable. Residual risks are the remaining risks for which the planned risk controls are not able to effectively remove or control. The risk assessment team should also highlight the residual risks of each of the controls.
  - A more detailed description of the three-step risk assessment process can be found in "Risk Management: Risk Assessment Guideline", published by the Ministry of Manpower (MOM).

Once all the risk controls are selected and their residual risks highlighted, the risk assessment team needs to identify the action officers and follow-up dates. In this way, the specific action officers to implement the controls can be clearly identified, and the follow-up dates will help to ensure timely implementation.

A written description of risk assessment must be kept for reference for 3 years. All records must be concise and kept in a register. The standard Risk Assessment Form can also be found in the MOM guideline. The results of risk assessment must be endorsed and approved by the organisation's top management, and recommended risk control measures must be implemented before work commences.

7.3 Review of Risk Assessment

It is essential that all risk assessments are reviewed:

- Every 3 years in reference to the previous risk assessment;
- Whenever new information on safety and health risks surface;
- When there are changes to the area of work;
- After any accident or serious incident.

Every power press task probably has some sort of risk and it is the responsibility of the management to ensure risk to employees is minimised. More information on risk management can be found in "Risk Management: Risk Assessment Guideline", published by the Ministry of Manpower (MOM) and available on the MOM Website.

7.4 Risk Assessment Example and Controls

ABC Metalworking Pte Ltd
Page 47 shows an approach described in MOM's Risk Assessment Guideline.

The exercise begins with a listing of inventory of processes and activities in the power press operation. Risk assessment is performed for each activity in the process. Risk control is then determined according to the principle of hierarchy of control measures. After the elimination, substitution and engineering control of risk, a safe work procedure and a checklist are generated.

Overview of Risk Assessment and Risk Management

Inventory of Processes/Activities

Company: ABC Metalworking Pte Ltd

NO	Process / Location	Work Activities	Risk Assessment ID	Risk Assessment Date	Safe Work Procedure ID
1.	Mount (Setup) die-set	Move die to machine Place the die Tighten the die Make trial parts Notify ready for	RA-08-001	1-Jul-08	Procedure-08-001

Risk Assessment

Company	ABC Metalworking Pte Ltd	Conducted by: Name Designation Date	
Process			
Approved by: Name: Designation: Date:	Low Su Lin Director 10 jul 2008	Last review date	1-Jul-08

1. Hazard identification				2. Risk Evaluation	
1a	1b	1c	1d	2a	
No.	Work Activity	Hazard	Possible Accident / Ill Health & Persons-at-Risk	Additional Risk Control Control Measures	Pre-requisite Tr
1.	Move the die to the machine with overhead crane	Struck by falling die	Fatality	Adequate die handling equipment, such as forklift or overhead crane Lifting gears must be inspected by qualified personnel yearly	- SOC - Forklift driver training - Lifting training
		Strain from awkward postures	Injury	Adequate die handling equipment, such as lift truck or overhead crane	
		Clamp in between	Permanent disability, amputation	Shut off power, LOTO; use safety block any time die adjustments are made	
		Falling due to slipping, die-setter	Injury	Floor at die setting area should be non-slippery; safety shoe	- SOC

Safe Work Procedure and Checklist

Date: 8 Jul 2008
Doc ID: PROCEDURE-08-001
Ref RA id: RA-08-001
In-charge: Michael Chong
Approved by: Low Su Lin

Process: Setup the die

1. Pre-requisite training:
   1. SOC metalworking
   2. Forklift driver training, Training Doc No:xxxx
   3. Lifting training, Training Doc xxxx
   4. Powerpress training, Training Doc xxxxx
   5. OJT, Training Doc xxxxxx
2. General Safety Precautions
3. Tools and Equipments
   1. Forklift or overhead crane

Inventory of Work Activities - Register of Risk Management

Company: ABC Metalworking Pte Ltd

NO	Process / Location	Work Activities	Risk Assessment ID	Risk Assessment Date	Safe Work Procedure ID
1.	Mount (Setup) die-set	Move die to machine	RA-08-001	1-Jul-08	Procedure-08-001
		Place the die			
		Tighten the die			
		Make trial parts			
		Notify ready for production			
2.	Produce parts	Start production	RA-08-002	8-Jul-08	Procedure-08-002
		Produce parts			
		Remove jams			
		Stop production			
3.	Preventive/ breakdown maintenance	Start maintenance	RA-08-003	28-Aug-08	Procedure-08-003
		Do maintenance			
		Complete Maintenance			
....	.....		.....	.....	.....

In this example, three of the processes are shown in the inventory of work activities. For each process, a respective Risk Assessment document number and Safe Work Procedure document number are registered. As such, the inventory of work activities functions as the register of the risk assessment in the power press workplace.

Activity-Based Risk Assessment Form - For Die Setup Process

Doc No: RA-08-001

Company	ABC Metalworking Pte Ltd	Conducted by: Name Designation Date	Michael Chong Manager 8 Jul 2008		
Process					
Approved by: Name: Designation: Date:	Low Su Lin Director 10 Jul 2008	Last review date	1-Jul-08	Next Review Date	1-Jul-11

1. Hazard identification				2. Risk Evaluation						3. Risk Control	
1a	1b	1c	1d	2a		2b	2c	2d		3a	
No.	Work Activity	Hazard	Possible Accident / Ill Health & Persons-at-Risk	Additional Risk Control: Control Measures	Pre-requisite Training	Severity	Likeli-hood	Risk Level		Additional Risk Control	Action Officer Designation (Follow-up Date)
1.	Move the die to the machine with overhead crane	Struck by falling die	Fatality	Adequate die handling equipment, such as forklift or overhead crane	- SOC - Forklift driver training - Lifting training	Major	Remote	Medium			Technician
		Strain from awkward postures	Injury	Lifting gears must be inspected by qualified personnel yearly Adequate die handling equipment, such as lift truck or overhead crane		Moderate	Remote	Low			
2.	Place the die	Clamp in between	Permanent disability; amputation	Shut off power, LOTO; use safety block any time die adjustments are made	- SOC - Powerpress training - OJT	Major	Remote	Medium			Technician
		Falling due to slipping, die-setter	Injury	Floor at die setting area should be non-slippery; safety shoe		Moderate	Remote	Low			
		Struck by falling die due to space constraint	Fatality	Layout and ergonomic considerations		Major	Remote	Medium			
		Struck by falling die due to die slipping	Fatality	Housekeeping; Weight of die indication		Major	Remote	Medium			
		Cut by sharp edge or sharp object	Injury	Hand glove Clean grease, chips, slugs from press table and clamping surface		Moderate	Remote	Low			
3.	Tighten and align the die	Slip due to improper tools during tightening hit object	Severe injury	Use proper tool (torque wrench) and proper die holding methods	- SOC - OJT - Powerpress training	Major	Remote	Medium			Technician
4.	Make samples	Clamp in between	Amputation	Ensure that all guardings are fixed and all safety devices work	- SOC - Powerpress training - Product requirements - OJT	Moderate	Remote	Low			Technician
		Hit by flying objects	Injury	Before trial run - Do dry run - Re-tighten every bolt and nut - Re-check all alignments - PPE: Safety goggle		Moderate	Remote	Low			
		Noise	Noise-induced deafness	- Regular maintenance on machine and noise enclosure - Regular noise monitoring - Regular audiometric test and hearing conservation programme - Ear plug with warning sign	Noise-induced Deafness awareness	Moderate	Remote	Low			Factory Manager
5.	Notify ready for production	Negligence due to forgetting to complete critical step such as screw is not tightened, safety devices is not functioning, poor house keeping	Injury	- Before passing the machine to operator or notifying that the machine is ready for production; - Do housekeeping e.g. clear all tools, flashes, etc - Re-check that all guardings are fixed with checklist	- SOC	Moderate	Remote	Low			Technician

The next step is to conduct a risk assessment for the 'Mount (setup) die-set' process. Details of the explanation can be found in the guideline. The table shows an example of the risk assessments on typical activities of the setup process.

Safe Work Procedure - Examples for Die Setup Process

Date: 8 Jul 2008
Doc ID: PROCEDURE-08-001
Ref RA id: RA-08-001
In-charge: Michael Chong
Approved by: Low Su Lin

Process: Setup the die

1. Pre-requisite training:
    1. SOC metalworking
    2. Forklift driver training, Training Doc No:xxxx
    3. Lifting training, Training Doc xxxx
    4. Powerpress training, Training Doc xxxxx
    5. OJT, Training Doc xxxxxx
2. General Safety Precautions
3. Tools and Equipments
    1. Forklift or overhead crane
    2. Torque wrench
    3. Safety block
4. PPE
    1. Safety shoe
    2. Safety goggle
    3. Hand groove
    4. Ear plug
5. Procedure

No.	Activities	Tools	Safety Precaution
1.	Move die to machine	Forklift or crane	Ensure that lifting gears have been inspected yearly
2.	Place die onto machine	Forklift or crane safety block	- Housekeeping - LOTO - Weight indication
3.	Tighten the die	Torque wrench	- Re-check all alignment - Re-tighten die - Check all guarding are fixed - Check all safety devices
4.	Make trial parts		- Do dry-run
5.	Notify ready for production		Do housekeeping

A Safe Work Procedure (SWP) is generated after every risk assessment. This should include important controls identified from the risk assessment. Page 44 shows an example of SWP for a die setup. Page 45, Page 46, Page 47 and Page 48 show the respective risk assessments and SWPs for another two processes.

Activity-Based Risk Assessment Form - For Produce Part Process

Doc No: RA-08-002

Company	ABC Metalworking Pte Ltd	Conducted by: Name Designation Date		Michael Chong Manager 8 Jul 2008	
Process					
Approved by: Name: Designation: Date:	Low Su Lin Director 10 Jul 2008	Last review date	8-Jul-08	Next Review Date	8-Jul-11

1. Hazard identification				2. Risk Evaluation				3. Risk Control	
1a	1b	1c	1d	2a	2b	2c	2d	3a	3b
No.	Work Activity	Hazard	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control (if any)	Severity	Likeli-hood	Risk Level	Additional Risk Control	Action Officer Designation (Follow-up date)
1.	Start production	Clamp in between	Amputation	Before starting production: Daily inspection or start up inspection of safety devices by technician. Checklist must be established. The use of Checklist is required	Major	Remote	Medium		Supervisor
				Present sensing device must be designed according to Danger Zone requirement					Equipment Engineer
2.	Produce part	Struck by flying object	Injury e.g. eye	- Daily inspection on machine guarding and holding devices - Eye protection with warning sign	Major	Remote	Medium		Technician
		Clamp in between	Amputation	Daily inspection on machine guarding and holding device	Major	Remote	Medium		Technician
		Vibration	Poor health	Regular maintenance on vibration insulator and damper	Major	Remote	Medium		Factory Manager
		Noise	Noise-induced Deafness	- Regular maintenance on machine and noise enclosure - Regular noise monitoring - Regular audiometric test and hearing conservation programme - Ear plug with warning sign	Major	Remote	Medium		Factory Manager
		Fatigue	Poor health, fatality	Maximum work hour per day rule	Major	Remote	Medium		Supervisor
		Space, ventilation, lighting	Poor health	During layout design, space, ventilation and lighting must be considered	Major	Remote	Medium		Factory Manager
3.	Remove jam parts	Clamp in between	Amputation	Hand feeding tools such as tongs must be used. WARNING SIGN is necessary	Major	Remote	Medium		Equipment Engineer Operator
		Cut	Injury		Moderate	Remote	Low		
4.	Stop production	Fall	injury	Housekeeping	Moderate	Remote	Low		Operator

Example of Safe Work Procedure for Produce Part Process

Date: 8 Jul 2008
Doc ID: PROCEDURE-08-002
Ref RA id: RA-08-002
In-charge: Michael Chong
Approved by: Low Su Lin

Process: Produce Parts

1. Pre-requisite Training:
    1. SOC metalworking
    2. Forklift driver training, Training Doc No:xxxx
2. General Safety Precautions
    1. Daily inspection on safety devices by technicians or mechanics or operators
3. Tools and Equipments
    1. Hand feeding tools, e.g. tong
4. PPE
    1. Safety shoe
    2. Safety goggle
    3. Hand groove
5. Procedure

No.	Activities	Tools	Safety Precaution
1.	Start production	Daily inspection checklist	Check the functioning of safety devices
2.	Produce parts		Max no of hours work per day
3.	Stop production		Housekeeping
4.	Notify production stop		

6. Relevant personnels
    1. Technicians
    2. Mechanics
    3. Operators

Activity-Based Risk Assessment Form - For Maintenance Process

Doc No: RA-08-003

Company	ABC Metalworking Pte Ltd	Conducted by: Name Designation Date	Michael Chong Manager 28 Aug 2008		
Process	Repair and Preventive Maintenance, Machine				
Approved by: Name: Designation: Date:	Low Su Lin Director 1 Sep 2008	Last review date	28-Aug-08	Next Review Date	28-Aug-11

1. Hazard identification				2. Risk Evaluation					3. Risk Control	
1a	1b	1c	1d	2a		2b	2c	2d	3a	3b
No.	Work Activity	Hazard	Possible Accident / Ill Health & Persons-at-Risk	Additional Risk Control Measures	Pre-requisite Training	Severity	Likeli-hood	Risk Level	Additional Risk Control	Action Officer Designation (Follow-up date)
1.	Start Maintenance	Preparation: Material/ Spare Part, Manpower, and Tools Not Available	Unnecessary work stress	Shop Floor Management: Preventive maintenance must be planned and updated to production schedule so that early preparation is possible		Moderate	Remote	Low		Supervisor, Technician
2.	Do Maintenance	Fatigue resulted from long hours of work	Poor health, accidents due to lack of concentration	[Employment Act] No more than 12 hour/day work	- Machine Manufacturer Maintenance Instruction Manual - WorkPlace Safety and Health Act, General Provisions Regulations	Major	Remote	Medium		Supervisor, Technician
		Electrical shock	Fatal	Lockout Tagout (LOTO)		Major	Remote	Medium		Technician
		Clamp in between	Amputation, fatal	LOTO, Shut down energy source Safety block		Major	Remote	Medium		Technician
		Hit by object	Eye injury, fatal	LOTO, Shut down energy source Safety glass		Major	Remote	Medium		Technician
		Fall from height	Fatal	Height work permit for > 2m height work		Major	Remote	Medium		Technician, Safety Officer
		Fire hazard	Fatal	Hot work permit for welding		Major	Remote	Medium		Technician, Safety Officer
		Pass-by	Fatal	Repair/maintenance in-progress sign		Major	Remote	Medium		Technician
3.	Complete Maintenance	Miss activity, e.g. miss to tighten one screw	Fatal to user	Inspection checklist Proper placement of dismentled parts		Major	Remote	Medium		Technician
		Negligence due to perceived completion of work, pass the machine to operation without confirmation	Injury	Re-energisation calibration		Major	Remote	Medium		Technician

Example of Safe Work Procedure for Maintenance Process

Date: 28 Aug 2008
Doc ID: PROCEDURE-08-003
Ref RA id: RA-08-003
In-charge: Michael Chong
Approved by: Low Su Lin

Process: Preventive/Repair Maintenance

1. Pre-requisite Training:
    1. SOC metalworking
    2. OJT, Training Doc xxxxxx
    3. Machine Manufacturer Instruction Manual
2. General Safety Precautions
    1. Daily inspection on safety devices by technicians or mechanics or operators
3. Tools and Equipments
    1. General tools
4. PPE
    1. Safety shoe
    2. Safety goggle
    3. Hand groove
5. Procedure

No.	Activities	Tools	Safety Precaution
1.	Start maintenance		Put up a sign "Maintenance in Progress"
2.	Do maintenance	Height Work Permit	For height work > 2m
		Hot Work Permit	For welding work
		Lockout-Tagout	To lock energy source
		"Repair work in-progress" sign	To inform others the status of the machine
		Safety block	For work in between platens
3.	Complete maintenance	Re-energisation procedure	To ensure machine is functioning well
		Daily Inspection Checklist	Check the functioning of safety devices
			Remove sign "Maintenance in Progress"

6. Relevant personnels
    1. Technicians
    2. Mechanics

Example of Daily Safety Inspection Checklist

Date:
Time: 1st shift of the day
Machine:
Product No:

Doc ID: Checklist-08-001

No.	Activities	Parameter	Checked by Operator		Confirmed by Mechanic or Technician	
			Name	Signature	Name	Signature
1.	Check in-coming air supply	5.5 to 6 bar				
2.	Housekeeping	na				
3.	Check safety devices working conditions					
	- Emergency switch	na				
	- Two hand control					
	- Light curtain					
	-					

Example of Repair and Maintenance Inspection Checklist

Date:
Time:
Machine:

Doc ID: Checklist-08-002

No.	Activities	Checked by Mechanic or Technician	
		Name	Signature
1.	Preparation		
	- Manpower		
	- Tools, e.g. LOTO		
	- Spare parts		
	- etc.		
	" Maintenance in Process" sign		
	- Boundary and barrier		
	- Height work permit		
	- Hot work permit		
2.	Doing repair / maintenance		
	Special precaution, if any		
3.	Complete repair / maintenance - Check working conditions of safety devices using Daily Safety Inspection Checklist		
	- Carry out re-energisation procedure		
	- Remove " Maintenance in Process" sign		
	- Do housekeeping		
	- ...		

8. Training

Training is important to ensure that personnel are provided with the knowledge and skills to work competently and in a safe manner. This ensures that personnel are not injured or made ill by the work they do and to develop a positive health and safety culture in general.

8.1 Grouping of Personnel

Personnel working with power presses may be grouped by the following responsibilities to identify their training needs:

S/N	Personnel Group	Responsibilities
1.	Project Engineers, Production Managers	Planning of new production lines, purchasing of power presses and press accessories, machines layout, etc.
2.	Tool Makers, Tooling Engineers, Tooling Specialists, Tooling Supervisors, Tooling Experts	Assembly of tooling, testing, troubleshooting, repair, modification and maintenance of stamping die.
3.	Tool Setters, Die Setters, Machine Setters, Production Supervisors	Setting up of machines, loading dies to machines, setting up of feeders, uncoiler, coils and materials, and running the machine for operators.
4.	Operators	Switching on and off machines, loading and unloading of materials and products, etc.
5.	Maintenance Personnel	Installation and maintenance of power presses.

8.2 Training Requirements

Training requirements for personnel working with power presses may be grouped into the following training areas:

S/N	Personnel Group	Responsibilities
1.	Technology Competency	a) Machine layout and safety b) Understanding of functions, controls and capabilities of the power press c) Understanding the safety devices of the power press d) Operating the press e) Die-setting and alignment f) Loading and unloading of materials g) Handling peripheral equipment and materials h) Other relevant topics specific to application i) Die maintenance j) Troubleshooting of stamping dies
2.	Safety and Health	a) Basic Industrial Safety and Health for Supervisors b) Safety Orientation Course for Workers (Metalworking) c) Noise Monitoring Course d) Other relevant topics specific to application

8.3 Training Methods

Training methods may include the following:

S/N	Personnel Group
1.	In-house or on-the-job training by supervisors or competent personnel
2.	Training by machine suppliers
3.	Training by accredited training providers
4.	Daily safety briefing
5.	Periodic refresher training
6.	Sharing sessions
7.	Any other relevant methods of training to develop competency and awareness to ensure safe operation of power presses

8.4 Training Matrix

The following table provides a guideline on the training needs for various groups of personnel working with power presses.

	Project Engineers, Production Managers	Tool makers, Tooling Engineers, Tooling Specialists, Tooling Supervisors, Tooling Experts	Tool Setters, Die Setters, Machine Setters, Production Supervisors	Operators	Maintenance Personnel
Machine layout and safety	1	1	2	2	1
Understanding functions, controls and capabilities of the power press	2	1	1	2	1
Understanding the safety devices of the power press	2	1	1	2	1
Operating the press	2	1	1	1	1
Die setting and alignment	2	1	1	2	2
Loading and unloading of materials	2	1	1	1	2
Handling peripheral equipment and materials	2	1	1	2	1
Maintenance of stamping dies	2	1	NA	NA	NA
Trouble-shooting of stamping dies	2	1	NA	NA	NA
Basic Industrial Safety and Health for Supervisors	1	1	1	2	1
Safety Orientation Course for Workers (Metalworking)	1	1	1	2	2
Noise Monitoring Course	1	1	1	2	1
Understanding the risks of activities involved	1	1	1	1	1

Level 1 proficient and Level 2 familiar.

9. References

AS 1219: 1994 Power Presses - Safety Requirements

BS EN 692: 2005 Machine Tools – Mechanical Presses - Safety

Code of Practice 21: 1981 Code of Practice for Safeguarding of Mechanical Power Presses

Code of Practice 27: 1999 Code of Practice for Factory Layout – Safety, Health and Welfare Considerations

SS537: Part 1: 2008 Code of Practice for Safe Use of Machinery
Part 1: General Requirements

Ministry of Manpower Singapore, Workplace Safety and Health Act

Ministry of Manpower Singapore, WSH (Risk Management) Regulations 2006

Ministry of Manpower Singapore, Guide to the Workplace Safety and Health (Risk Management) Regulations

Ministry of Manpower Singapore, Risk Management: Risk Assessment Guidelines

Ministry of Manpower Singapore, Workplace Safety and Health (General Provisions) Regulations 2006

Accidents at Presses and Press Brakes 2003, Sector Information Minute, Health and Safety Executive

Control of Noise at Power Presses 1998, Engineering Sheet No 29, Health and Safety Executive

Kentucky Labour Cabinet, Mechanical Power Press Safety

National Institute for Occupational Safety and Health, Injuries and Amputations Resulting from Working with Mechanical Power Presses, Current Intelligence Bulletin 49, Centres for Disease Control, Atlanta, Georgia

Occupational Safety and Health Administration U.S. Department of Labor Mechanical Power Presses, Machinery and Machine Guarding

Occupational Safety and Health Administration U.S. Department of Labor 2007, Safeguarding Equipment and Protecting Employees from Amputation

Oregon Occupational Safety and Health Administration U.S. Department of Labor 2006, Machine Safeguarding at the Point of Operation, Craig Hamelund

Oregon Occupational Safety and Health Administration U.S. Department of Labor, Principles of Machine Guarding

Precision Metalforming Association, PMA Mechanical Power Presses Checklist

Power Presses: A Summary of Guidance on Maintenance and Thorough Examination 2003, Health and Safety Executive

Procedure for Daily Inspection and Testing of Mechanical Power Presses and Press Brakes 2003, Health and Safety Executive

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Workplace Safety and Health Council

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