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Machine Safeguarding: Safeguarding the Point of Operation

Introduction

The point of operation (POO) can be the source of immediate, traumatic injury in the workplace. The fabrication of materials requires force that the human body simply cannot endure. It would seem that most people would realize they are unable to withstand the forces at the POO.

Yet frequently, when the injured are interviewed, we hear responses such as: "I was trying to straighten the piece." "I was trying to retrieve the..." "I did not realize how fast the machine was." "I just followed the piece into the machine." "I don't know what happened; I just didn't see it coming." The sum of this is that intelligent people will do things, momentarily oblivious to the risks. They have temporarily overlooked their own mortality. What can be done to account for this unfortunate failing?

Background

The OSHA regulation at 29 CFR 1910.212 (a) (3) (iii) *for all machines states*: "The point of operation of machines whose operation exposes an employee to injury, *shall be guarded*. The guarding device shall be in conformity with any appropriate standards [such as ANSI or other OSHA references] therefore, or, in the absence of applicable standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operational cycle." The requirement is clear: the POO shall be safeguarded.

The General Duty Clause of the Occupational Safety and Health Act obliges management to provide the necessary system engineering to safeguard the "recognized hazards" (punching, shearing, cutting, bending, etc.) of the POO. This must be done *before* the equipment is placed on the floor ready for production.

The system engineering for equipment safeguarding may be instituted by in-house resources or by the original equipment manufacturer (if specified in the original equipment purchase). If in-house resources are used for modifications, care must be taken so as not to introduce unexpected operational modes, defeat manufacturer safeguards, void equipment warranties, or compound liabilities of the employer. In any case, this means that early communication with occupational safety professionals must occur to assure that compliance requirements are met.

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Safeguarding Strategies

A number of safeguarding methods have been identified (in the Code of Federal Regulations) and can be used as guidance to safeguard the POO. Keeping the operator's hands occupied while the equipment cycles reduces the likelihood of hands being present during the stroke/cycle. For small pieces, a part rest table, backstop, or other fixture may be necessary to stabilize the workpiece, rather than allowing the operator to act as a human clamp. Even with larger workpieces, a part rest table and a backstop will reduce operator fatigue and ensure the accuracy of the production stroke.

Many times the operator must manipulate, place, or position the workpiece for the desired effect. The manual part placement, in concert with use of a foot pedal to initiate the cycle, is the reason many operators' hands are frequently too close to the POO. An unshielded foot pedal is a further concern. It means inadvertent cycling of the equipment (e.g., caused by a misstep, falling objects) can occur. When hands are free, they should be given a task (such as stroke initiation) that keeps them occupied at a safe distance.

Automatic Feed and Take Away

If the operator has no reason to place his or her hands into the POO, there is little risk of a point of operation incident. An automated feed system (e.g., index, shuttle, or slide) and an automated part removal system (e.g., air, mechanical, or gravity) will accomplish this. Even partial engineering, either automatic feed or automatic take away will reduce the risk of exposure by 50%, because the operator’s hands need not be present in a portion of the cycle. When an operator is in the POO, risk is high and production is shut down. Having both auto feed and take away reduces risk and improves production (less down time).

Gates

A gate is a door-like device that must be closed, following part placement, in order for the stroke to be initiated. The POO remains inaccessible during the hazardous motion cycle of the equipment. Depending on the mechanical nature of the equipment, gates can (1) be engineered to stay closed during the entire production cycle or (2) be installed so that the gate can open after the stroke has completed its closing motion.

Two Hand Controls

If the equipment is capable of stopping during midstroke, two hand *controls* can be used to occupy the operator's hands. When the controls are placed at the proper set back distance (determined from stop time measurements) from the POO, an operator cannot remove his or her hands from the control buttons and place them into the POO before the stroke stops. Hands can be removed from controls for the opening portion of the stroke as the closure hazard is gone. If more than one operator is present, each needs a set of controls.

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Two Hand Trips

Some equipment may not be capable of stopping midstroke. In this case, two hand *trips* may be used. The set back distances (determined by the time the hazardous motion ceases) for two hand trips will likely be much farther away from the POO than with two hand controls. If more than one operator is present, each needs a set of trips. Trips will cycle the equipment but will not stop the equipment when hands are removed. Equipment that continues to coast or move following shut down is inherently less safe than equipment capable of stopping midstroke. If the equipment coasts or continues to move following disengagement, a gate with a motion sensor may be the best strategy for restricting access to the POO.

Pullbacks

Using cables (attached to the stroking portion of the equipment), pulleys, and a hand harness for each hand, an operator's hands are literally pulled from the POO when the cycle/stroke is initiated (usually by a foot pedal). Use of pullbacks requires a part rest fixture or backstop. A tool for part placement is necessary so that hands will not enter the POO.

Pullbacks must be adjusted for each operator for each shift. This can be an issue if a company is using job rotation to reduce ergonomic exposures. Each rotated operator must be refitted (mandatory) for their set of pullbacks; this may restrict production time somewhat. Each operator present needs a set.

Restraints

Restraints are pullbacks that do not move with each stroke cycle. The operator's restraint cables are tied off at a rigid, fixed point behind the operator. A foot pedal can be used to initiate the stroke. As with pullbacks, the same provisions apply: part rest fixture or backstop, a tool for part placement, and individual adjustments.

Many operators do not like the restriction of movement that either pullbacks or restraints require. For this reason, without adequate supervision, operators may remove or readjust either, defeating the safeguard measure. Sometimes one restraint and one pullback can be used in combination.

Light Curtains

Light curtains have become a popular safeguard choice. They can only be used on equipment capable of midstroke stopping. When light curtains are placed at the proper set back distance from the POO (determined from stop time measurements), an operator cannot move his or her hands through the light curtain and into the POO before the equipment stops.

Operators like light curtains because of the full visibility and easy access they provide. Maintenance staff prefer light curtains because of the immediate access allowed, as no guards need to be removed or forgotten for replacement.

Light curtains can be "blanked"; that is, individual sensory cells can be shut off. This allows the side profile shape of the workpiece to block the curtain without shutting the equipment off. Blanking must be used carefully, as too much will allow hands into the POO. The blank may "float," which allows for the pitch up of the workpiece without stopping the cycle. Blanking must not be used if too many sensors are shut off, allowing entry of an operator's hand to the POO before stopping the stroke.

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Light curtains can also be "muted". This means that once a die is within 1/4 " of the part, the curtain can be shut off for the remainder of the stroke and allow any pitch up or motion of the part that could activate the light curtain unnecessarily. (OSHA standards do not recognize openings at the POO of 1/4" or smaller as a hazard.)

Fixed Guards

Preventing access to the POO can be accomplished by using a physical, fixed guard. A fixed guard is a rigid enclosure that may suit any piece placed into the POO. Because of this, the fixed guard must be sized large enough to fit all expected pieces. The set back distance from the POO or gaps in the guard must restrict fingers from entering the POO.

Fixed guards are most frequently associated with equipment that is automatically fed the stock. Fixed guards are also frequently seen covering the power transmission apparatus (belts, pulleys, chains, sprockets, rollers, gears, etc.).

Adjustable Guards

An adjustable guard can vary, on demand, as the parts change or it may require tailored adjustment in accord with the workpiece dimensions. When the part is placed into the POO through the opening, a foot pedal can initiate the stroke. If tailored to suit the size of the workpiece, a singular adjustment specific to the part must be made at the beginning of the job.

Interlocked Guards

If routine access to the POO is required, an interlocked guard will prevent equipment cycling. This prevention will only occur if the interlock is integrated to disengage critical functions (e.g., clutch or other electrical, mechanical, hydraulic, or pneumatic engagements). When the interlock is open, the equipment stroke cycle/motion cannot be initiated.

Furthermore, a true interlock requires a reset action. In other words, closing the interlock switch will not reinitiate the stroke without a second, deliberate, reset action. Otherwise, the interlock switch would be a start switch which defeats the safeguard function of the interlock at the exposure.

Safeguarding by Distance

The previous device and guard strategies control or prevent access to the POO. Sometimes the large size of the workpiece keeps the operator from reaching the POO. This an acceptable (though not preferable) method. However, it only is useful when the parts are consistently large and the operator cannot reach (~42" set back) the POO when positioned at the equipment. When parts are small, this method is useless.

Other Means of Protection

Other strategies include trip wires, pull cords, and body bars, pressure sensitive mats, emergency stop buttons, etc.

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Pressure sensitive mats have improved in reliability. These are acceptable if anchored to prevent their walking. Their size and placement on the floor must prevent operators from reaching over the mat to the POO. Combinations of these methods are also possible.

Emergency stop buttons should be easily accessible within the operator's work envelope, whether the equipment is capable of midstream stopping or has a coast down period.

Access to the equipment can be controlled using warning signs. This can be done in low traffic areas simply by placing a cable with a sign saying "Do not enter!". However, this is the least effective choice and is inappropriate for high traffic areas. For high traffic areas, such as that adjacent to a walkway, a physical, hard guard will be a cost-effective choice.

Conclusion

The strategies described above are intended to safeguard operators. Helpers and passers by must also be considered. Whatever strategy is selected, it should be chosen while keeping human failings in mind. The lessons learned by many unfortunate operators need not be repeated.

References

1. 29 CFR 1910.212 (a) (3) (iii) "General Requirements for All Machines"
2. *Occupational Safety and Health Act.* L. 91-596 Sec. 5 (a) (1) (General Duty Clause)
3. 29 CFR 1910.217 (c) (1) (I) "Mechanical Power Presses; Safeguarding the Point of Operation: General Requirements"

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