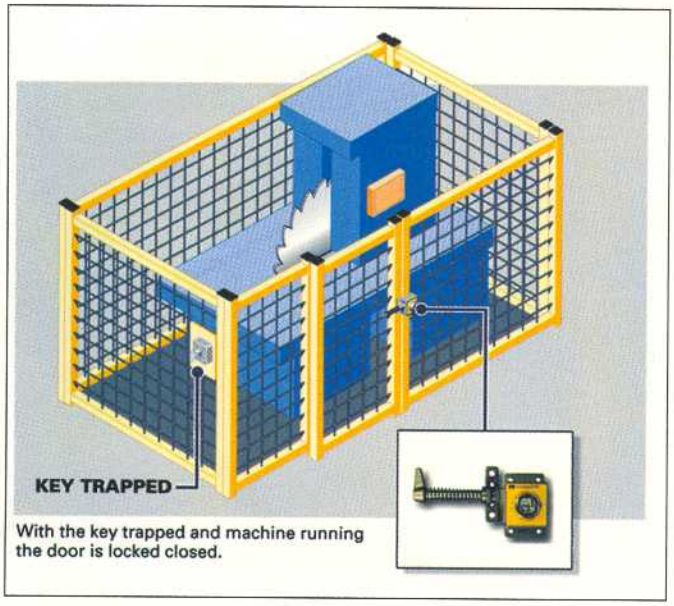
Controlling The HUMAN ELEMENT

How can we control the human element in industrial settings and thereby improve our safety performance?

by Pat Kanis



With the key trapped and machine running the door is locked closed.

With the key free and machine shut down, the door can now be safely opened.

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Despite the best efforts of safety professionals, accidents happen. Most studies of industrial accidents cite human error as the root cause. In the oil and gas industry, human error has been found to be responsible for 70 percent of all accidents—and it accounts for 90 percent of the value of all resulting losses. Studies in other industries have similar conclusions.

As human beings, and particularly given our culture here in North America, we are driven by production concerns and are likely to pursue work methods that allow us to get the job done faster or with less effort. This, along with other human frailties such as memory lapses, cause us to circumvent or ignore our training in the methods of how to interact safely with hazardous equipment and processes. These tendencies and limitations are the real culprits in the breakdowns in our safety programs and procedures that result in accidents.

How can we control the human element in industrial settings and thereby improve our safety performance? The answer can be found by an analysis of the risks presented by our industrial machines and processes.

Hazard Elimination and Control

When assessing the risk present in a machine or process, the hazards are typically easy to identify: energy sources, stored energy, pinch points, ergonometric concerns, and so forth. The best (safest) approach is to remove the hazard from the design. By eliminating the hazard, we eliminate any risk of an accident. Unfortunately, this is often impossible. Also, many processes and pieces of equipment are already in existence, and replacing or upgrading them is not economically feasible.

Most often, when removing the hazard by design is not possible, we try to limit the chances of an accident by some means of administrative control. These means consist of operator training, permit to work procedures, and lockout/tagout programs. All of these programs are largely dependent on human performance, which leaves them vulnerable to human error and, therefore, accidents.

So, as a society, we most often fall back on administrative control methods while admitting that the primary cause of accidents, human performance, is at the core of these methods of control. We should not allow ourselves to live with this paradox.

The Middle Ground

There is a middle ground between designing out the hazard and using administrative control. Alternative technologies such as

trapped key interlocking eliminate human error by physically denying people access to the equipment or process until all the hazards are neutralized.

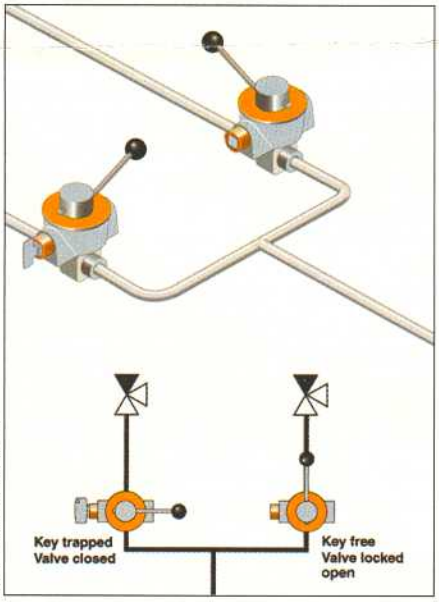
Trapped key interlocking does this by sequentially trapping and releasing keys from control device to control device (from switches to valves to access doors, and so on), literally locking people into a safe, predetermined sequence of operation. The person interfacing with the hazard has no choice but to isolate all energy sources and wait until stored energy is dissipated or controlled before they gain access.

Let's look at a couple of examples of how trapped key interlocking accomplishes this.

Consider a machine that has a hazard, a spinning blade, enclosed inside it. From time to time, it may be necessary to sharpen or change this blade. The door to the enclosure is outfitted with a *trapped key* interlock that locks the door shut. The key to this interlock is trapped in a key driven switch wired into the machine's main power circuit. As long as the power is on and the machine is operating, this key is trapped and *cannot* be removed.

By turning the key, the power is turned off, the key is released, and the power switch is safely locked into the "OFF" position. The key can then be taken to the lock on the access door of the machine. When it is inserted and turned, the key is trapped...and the bolt on the side of the lock is freed, which allows the door to open. This is the *only* way the door can be opened, and as long as the door remains open *the key is trapped* in the access interlock. This means it is impossible to re-energize the machine mistakenly while the protective door is open.

When the task is complete and it is necessary to re-energize the machine, the sequence of events is simply reversed. The bolt is re-inserted into the access interlock and the door is locked. This releases the key, which can then be taken to the switch on the main power circuit. The key is then used to re-energize the machine.



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A two-PRV system

Special Accommodations

It should be noted that trapped key devices are available to accommodate machines with run down cycles and all other kinds of stored energy. These devices will not allow access until all energy is dissipated or otherwise isolated.

In process industries, trapped key interlocks can be fitted to valves, as well. For example, many pressure vessels are fitted with two or more pressure relief valves (PRVs). These PRVs are designed to open should the pressure inside the vessels exceed a certain, safe, pressure limit. From time to time, these PRVs need to be removed from service to be checked for

CONSISTENCY IS THE ONLY ANSWER FOR LOTO SUCCESS

Which is worse, a hand smashed off or one neatly severed in a machinery accident, I was asked recently. My response was, "You lost a hand either way."

You simply cannot debate the severity of the injury with employees in a non-graphic manner! Terms such as "injury," "pain," "laceration," "disabling," and others are phrases for your employees to immediately zone out during training and think of fishing on the lake or the game on TV tonight. These terms have no lasting meaning when put across in polite language. Get graphic—scare the hell out of a few. Your efforts just may save someone!

Personally, I have seen very few machine injuries that were neat and sterile and called for polite language. Most injuries when a machine is involved are true violence with bloody residue slung for a tremendous distance as the employee has been torn, smashed, chipped, smeared, or chopped in some manner.

Granted, such language is not a replacement for a well-trained, knowledgeable staff. Lockout/tagout is tough training on a very difficult topic. It is one of those "what if" training programs, hoping and training for the best, trying to avoid the worst. You train, coax, complain, nag, bribe, and buy the best software and tools the trade has to offer for employee protection in the area of lockout/tagout. You also have emergency plans, extensive first aid kits, and darn good insurance just in case. Still, on the job site, you find noncompliance, often from long-term employees. What went wrong?

Getting the Message Across

- *Use real attention-getters.* One company used shock tactics on occasion, such as the severed hand trick. Pick your victim (especially someone known for being one of those loudmouths at work). Have him or her place a whole hand into a large, plastic drinking cup with some filler such as cotton gauze inside. (Make sure you use the individual's dominant hand.) Tape or bandage the cup into place, creating a "stub" limb that is not usable for most duties. Let them wear that around for several hours, or even for a full day.

  Make known to employees the real cost of a machine-related injury to the company and potentially to the injured worker. Don't use names or sensitive materials, but give enough data to be meaningful, such as lost overtime wages, lost time, higher insurance costs, extra hours for other workers, lost bonuses, how much Social Security pays for a funeral, etc. Include meaningful losses to the company, to other employees, and to the injured employee. This can be a real eye-opener in many cases.
- *Train as though their lives depend on it.* Remember, they just may. Training needs to be conducted until lockout/tagout is first nature and is followed each and every time needed. Make them understand what is at risk, including their jobs!
- *Document every infraction of your policy, no matter how minor.* Here's where the problems begin. You give the employees a little leeway. The sound you then hear in the background is your LOTO program crumbling into ruins. It only takes a second to injure or kill someone. Are you willing as safety director to sacrifice that employee?

Protecting your employees can be tough when they work with dangerous machinery. Consistent, tough, no-nonsense policies on lockout/tagout will go a long way toward this goal. ■

—by Linda F. Johnson, Technical Editor

proper operation and lifting (opening) pressure. In a system where the PRVs vent to the atmosphere, there are typically blocking valves located underneath the relief valves to accommodate this operation. Should all PRVs be blocked from venting a vessel and an over-pressure event occurs, the vessel could suffer a catastrophic explosion.

In a two-PRV system, to ensure there is always a free path to vent, the blocking valves can be outfitted with trapped key interlocks. Each interlock is designed to lock the blocking valve open. Insertion of a key into the interlock allows the valve to be closed. Once the valve is closed, this key is trapped, and it remains trapped until the valve is fully opened again. By having both blocking valves outfitted with identically keyed interlocks and supplying just one key, only one blocking valve can be closed at any given time, so only one PRV can be taken off line at a time. The intermediate condition is also limited to both valves being opened.

As with trapped key interlocks for machine guarding, trapped key valve interlocks come in various sizes and configurations. They are designed to accommodate quarter-turn and multi-turn valves, as well as gear, electric, and pneumatic actuators. Valve interlocks typically are designed to mount to the valves without any modification, welding, or machining of the valve itself, thereby preserving the valve's pressure rating, as well as the manufacturer's warranty. Companion devices to accommodate branched logic and integration of switches and doors into a valve interlocking sequence also are available.

Service Life, Selection Issues

Trapped key interlocks are easily incorporated into new equipment designs or fitted to existing equipment or processes. They are ruggedly constructed to provide long service life in industrial environments. Tamper-resistant hardware and unique lock codes ensure the systems are all but impossible to circumvent.

Most often, they are relatively inexpensive. A Midwest machine tool manufacturer reports an installed cost of about $400 per access door on its automated machinery. A large chemical manufacturer reports an installed cost of about $1,600 per manually operated valve.

Please note that trapped key interlocking does not apply in all situations. Other alternative methods of control exist, including light curtains, laser scanners, two-hand control devices, and safety mats, and each has its own best fit. For example, a power press is best guarded with a light curtain, and not with trapped key interlocking.

A case is easily made that where the risk is high enough, we should not rely on administrative control methods. This means that where the probability of an accident is high enough, or the potential injury is severe enough, or the frequency of human contact with the hazard is often enough, we should pursue an appropriate alternative method of control such as trapped key interlocks.

This will result in a workplace where the human element is controlled to the maximum extent possible and the residual risk posed by our processes and machinery is kept to a tolerable level. ■

Pat Kanis is President of Castell Interlocks Inc. (www.castellinterlocks.com), a maker of mechanical and electromechanical interlocks that is based in Erlanger, Ky. The company is a wholly owned subsidiary of Halma plc.