Elements to Consider When Designing a Pneumatic Lockout/Tagout System

There are a number of published safety standards to draw from when considering the design of a lockout/tagout (LOTO) system. Here are a few:

- U.S. Occupational Safety and Health Administration (OSHA) 1910.147: The Control of Hazardous Energy — Enforcement Policy and Inspection Procedures.
- Canadian Centre for Occupational Health and Safety (CSA) Z460 (2005): Control of Hazardous Energy — Lockout and Other Methods.
- American National Standard Institute (ANSI) Z244.1 – 2003: Control of Hazardous Energy — Lockout/Tagout & Alternative Methods.
- International Organization for Standardization (ISO) 14118:2000: Safety of Machinery — Prevention of Unexpected Start-Up.

LOTO applies to various energy sources: electrical, mechanical, hydraulic, chemical, radiation, thermal, gravitational and pneumatic. Pneumatics has its own particular issues based on the physical properties of the energy involved.

This article will highlight only a few areas to consider when designing a LOTO system. A proper and complete LOTO system requires a full understanding of the above safety standards and how they apply to the unique applications in your mill.

The following basic design guidelines and best practices from the above safety standards should be kept in mind when setting up a pneumatic lockout system:

- The energy isolation device should dump hazardous energy quickly (large exhaust capacity).
- The energy isolation device should be unique in appearance compared to other ON/OFF devices.
- The energy isolation device should only be lockable in the OFF position.
- The energy isolation device should have two operating positions (ON or OFF).
- The system should include a visible indication of a SAFE condition (no hazardous energy present).
- The overall circuits should be understood by engineers and operators — not just the basic mechanical/pneumatic interface, but the complete electrical control system as well.

Conducting a risk assessment is a recommended starting point for any safety program. Even though formal risk assessments are normally associated with more complex subjects, it is still prudent to use the spirit of the thought process for LOTO. Risk (safety) is subjective and people's perceptions of risk can vary. If a potential risk is identified in a component, or within the LOTO procedure, and it can be eliminated from the system, then it is best practice to do so.

Best Practice (ANSI B11.0): Exhaust Hazardous Pneumatic Energy Quickly — There are a number of pneumatic energy isolation devices on the market with various exhaust rates. As part of a well-thought-out LOTO procedure, most of these devices can be applied safely in your circuits. However, if a potential hazard can be engineered

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.


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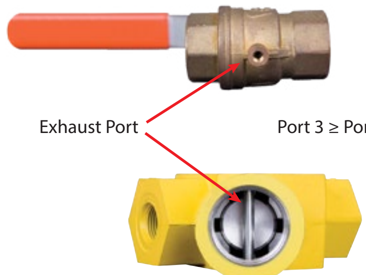
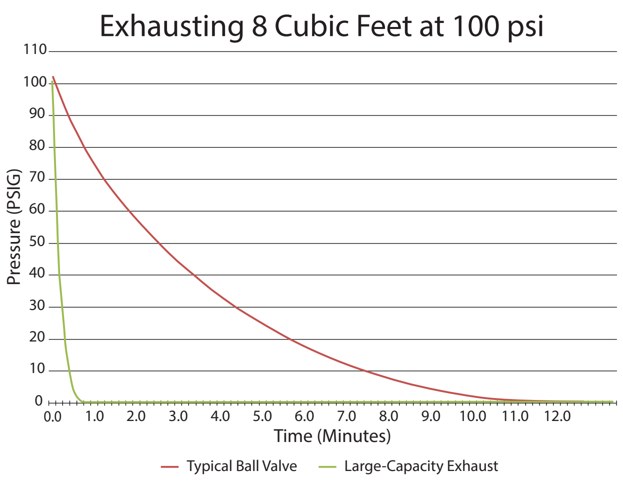
out of a circuit by selecting a different device, then it is best practice to do so.

Figure 1



Comparison between a small vent (bleed) hole (top) and large-capacity exhaust (bottom).

Figure 2



All air is removed from the system in about 35 seconds with a large-capacity exhaust versus 11 minutes with a typical ball valve.

For example, in the case of a pneumatic circuit with 8 cubic feet at 100 psi, using a large capacity exhaust versus a small vent (bleed) hole (Fig. 1). The general results were as follows:

- Complete dissipation of air is accomplished in about 35 seconds versus about 11 minutes (Fig. 2).
- Increase in productivity: maintenance workers can safely enter work area almost immediately.
- Safety improvements:
  – Avoid false sense of security: maintenance workers do not unknowingly enter work area thinking hazardous air has been exhausted after their lock is applied.
  – Avoid lockout shortcut: maintenance workers are not tempted to shortcut the lockout procedure by knowingly not waiting the needed time before entering work area.

Best Practice (OSHA 1910.147): Clearly Identifiable — It is always best to simplify actions needed for LOTO. An adequately trained workforce and properly marked energy isolation devices can overcome most issues, but if it is possible to engineer out variables, it is always best to do so. Standardizing on one type of energy isolation device that is unique in appearance and is of singular use throughout the mill will avoid potential confusion (Fig 3).

Best Practice (ANSI B11.0): Only Lockable in the OFF Position — According to ANSI standards, energy isolation devices should only be lockable in the OFF position. Eliminate the possibility of misapplication of a lock with your selection of energy isolation devices (Fig. 4).

Best Practice (OSHA 1910.147): Tamper-Resistant — An energy isolation valve and lockout device should not be easily defeated and overridden. There are various guards or covers that can be used to prevent unauthorized removal of locks. Some energy isolation devices are inherently designed to prevent

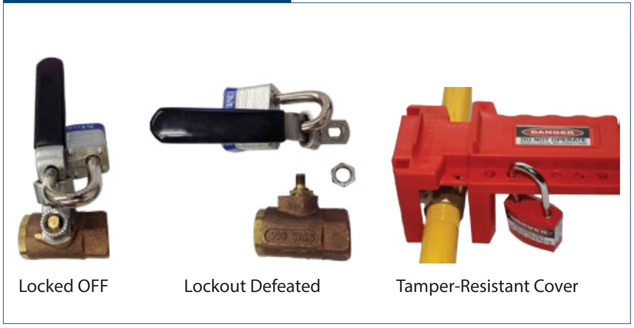
Figure 3

Maintaining a unique appearance and singular function of energy isolation devices in the mill may avoid potential confusion.

Figure 4

Examples of misapplied locks.

Figure 5



Guards and covers, such as the examples above, can be used to prevent unauthorized removal of locks.

tampering without the need for an additional and separate cover/guard.

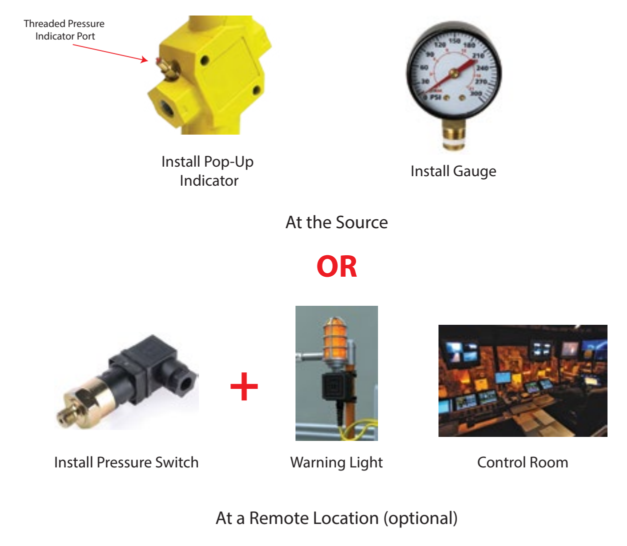
Best Practice (ANSI B11.0): Verify Energy Has Dissipated After Lockout Is Initiated — A proper lockout system should provide the worker a way to verify hazardous energy has been eliminated. This can be as simple as a pop-up indicator or pressure gauge installed in the pressure indicator port on the energy isolation device or a pressure switch installed in the same port to illuminate a light or communicate with the main process control system (Fig. 6). If the energy isolation device does not have an inherent pressure indicator port, the same can be accomplished with a tee fitting off the outlet port.

Best Practice: Know and Understand the Complete Pneumatic Circuit — Additional concerns when designing a LOTO system may reside in trapped pressure that can be hazardous. Pneumatic circuits may contain trapped pressure for normal operations, so a lockout system design should take measures to neutralize this potential hazardous energy (Fig. 7). Look for check valves and 3-position closed-center valves in your circuit.

Hazardous trapped air pressure must be exhausted safely during LOTO. It may be necessary to block movement mechanically or to lower a moving section controlled by the air to a safe position where gravity or other forces cannot cause movement.

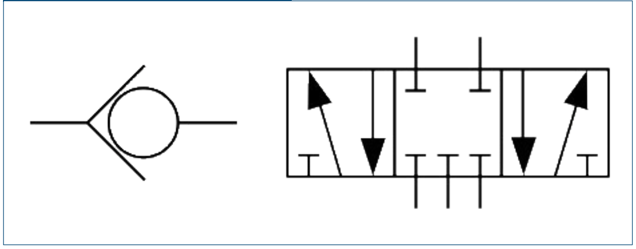
Best Practice: Restore Pneumatic Energy Safely After LOTO Maintenance Is Complete — When air is reapplied to an exhausted system, motion is likely to occur if devices (like cylinders) have been moved from their "at rest" position. In some cases this motion can be unexpected or rapid, resulting in damage to equipment. In this case, soft-start devices can be used to allow the pressure to ramp up to approximately 50% of line pressure before opening completely to allow full flow. These devices are often adjustable to control the pressure buildup, and therefore speed, during this first movement. Depending on the machine design, multiple soft-start devices may

Figure 6



Methods for visual indication of pressure at the device (above) and at a remote location (below).

Figure 7



Symbols for check valve (left) and 3-position closed-center valve (right) in a circuit.

be needed. Note: soft-start devices may be needed downstream of 3-position valves.

Alternative Lockout Measures (ANSI B11.19): Safeguarding During Temporary Stops Not Included in a Normal LOTO System — You may have applications that are safety protected with electrical door interlocks, light curtains, safety mats, limit switches, or other devices that temporarily stop a machine or process (Fig. 8). If this is not part of your LOTO procedure, then care should be taken to understand the complete circuit and how these devices are connected. An example of a temporary stop controlled by electrical interlock would be the in-process inspection area on a galvanizing line.

Safety does not end at the wire. If that wire is connected to a pneumatic valve that controls hazardous energy, then the pneumatic valve should be Control Reliable, if a worker is in harm's way during the temporary stop. What is a Control Reliable pneumatic valve? In basic terms, it is a redundant (dual) valve with status monitoring (Fig. 9). Depending on the application, Category 3 or Category 4 protection may be needed. Piping two valves together in series or in parallel is not an acceptable substitute.

Machine guarding has always been required to protect people, but with the advancement of machine guarding devices, alternative measures of lockout have grown tremendously for production-related activities. Productivity and safety benefits can be realized by grouping multiple electrical and pneumatic controls into a safety system that is under exclusive control at the point of use or entry. This could include a trapped key or one single low-voltage lockout due to their ability to provide exclusive control to cover large areas. By using alternative measure versus lockout you can reduce the number of lockouts, thereby decreasing the chances a worker might miss or skip locking out an energy source. Utilizing well-designed safety systems properly can increase operator and equipment protection by preventing unsafe actions performed in the name of productivity. Additionally, alternative measures can shorten the time required to put the machine into safe mode and reduces the time to bring the machine back into service once the problem is resolved. Depending on the application, alternative measures can save hours of production time in a given week or month.

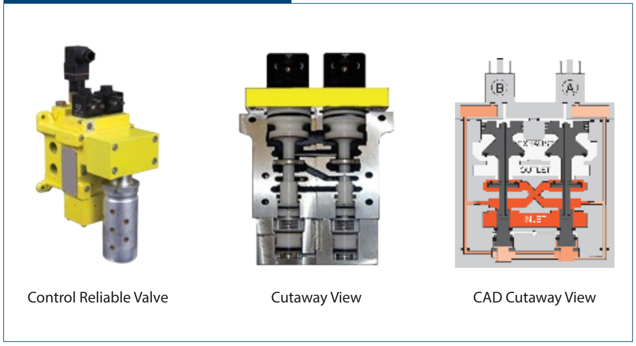
Alternative measures as defined by ANSI Z244 require a risk assessment to identify and control hazardous energy. ANSI B11.0 provides a standard for risk assessment. OSHA has agreed with this risk assessment approach but requires Control Reliable systems be used to provide a safe working condition. ANSI B11.19 and ISO 13849-1:2006 provide insight and direction for properly designed safety systems.

There are a number of qualified integrators providing design assistance to mills to accomplish the gains associated with single-point lockout.

Figure 8

Care should be taken to understand how other safety devices that temporarily stop a machine or process fit into the complete circuit.

Figure 9



A Control Reliable safety valve consists of a redundant (dual) valve with internal status monitoring.

Conclusion

Safety is only as strong as the weakest link in the safety chain, so details matter. A risk assessment is a recommended starting point for any safety program. What level of risk is acceptable? Since risk is subjective, people's perceptions of risk can vary. One rule of thumb is "when in doubt, engineer it out."

Advances in pneumatic safety technology are constantly being introduced to the market in response to new application requirements and to comply even further with safety standards. For instance, Control Reliable approaches to load holding, returning cylinders to the safe position, status monitoring and real-time electronic feedback are among the new technologies being introduced to the market. As you consider upgrades to safety in your mill applications, it may be effective to consult a pneumatic safety expert to optimize your circuit with the latest in pneumatic safety technology and equipment.

A properly designed pneumatic lockout system and procedure can provide improvements in both safety and productivity. Safety is the overriding driver for implementing a proper lockout procedure, but the return on investment will be enhanced by adding the productivity improvement factors. Clearly, safety is a win-win for any business.

Additional Information

Additional information on safety standards can be found at www.osha.gov, www.ccohs.ca, www.ansi.org or www.iso.org. ✦