Selecting & Integrating Safety Exhaust Valves White Paper

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Selecting and Integrating Safety Exhaust Valves

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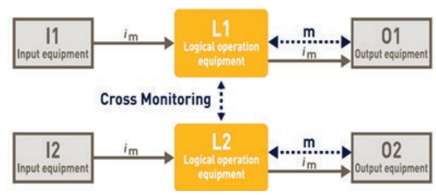
In industrial environments, pneumatic lines can pose significant hazards to workers and associated equipment; these hazards are associated with both the pneumatic lines themselves and the moving components they operate. Systems that minimize these hazards have been developed to comply with two ISO safety standards, EN ISO 13849 and ISO 13118:2000, which mandate the dissipation of pneumatic energy to prevent unintended startup or movement in a machine.

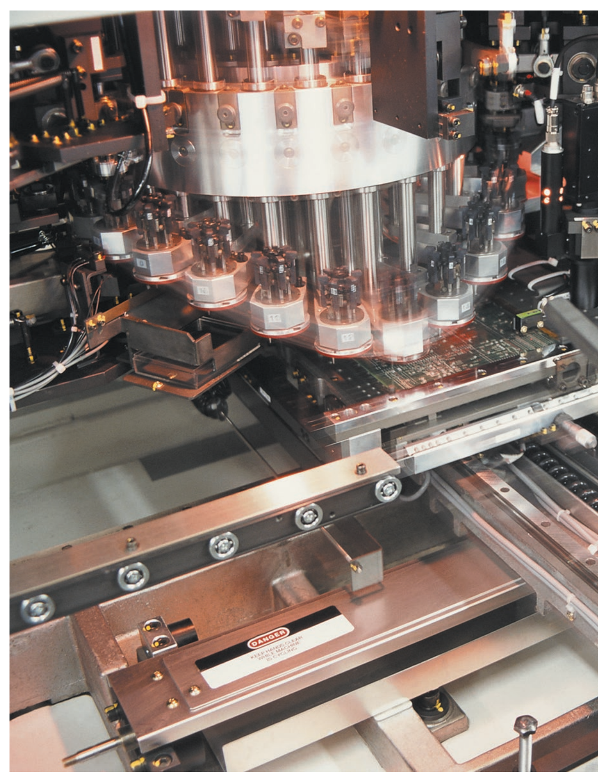
As manufacturers increase their focus on equipment safety, design engineers need a clear understanding of these standards and how to comply with the required safety levels. Adding a pneumatic safety exhaust valve into an air preparation system offers one simple, cost-effective way to accomplish this.

Traditionally, the air trapped in the pneumatic lines had to be exhausted with pneumatic circuits with two valves to provide redundant safety. The downsides of this pneumatic circuit approach included the need to purchase the valves and other peripherals, and the plumbing and space needed to ensure safe evacuation of the machinery; unfortunately, this traditional approach was also relatively slow to exhaust. Today, a handful of manufacturers have combined this pneumatic circuit into a compact product called a safety exhaust valve. These valves allow users to shut off the pneumatic energy safely and reliably, stopping the flow of compressed air to the machine and allowing the downstream pressure to exhaust out. For example, the safety function can be activated when operators are reaching into hazardous areas or during an e-stop condition.

Today, Safety exhaust valves are designed to ensure fail-safe operation and ensure rapid exhaust of any pneumatic equipment on an e-stop, and they are available in single-channel or two-channel (redundant) configurations. High-risk safety applications (based on a risk assessment in accordance with ISO 13849-1) employ safety exhaust valves that are integrated into a control circuit and monitored with a safety-rated device.



(Architecture for redundant two channel safety valve's)



Internally or Externally Monitored

Safety exhaust valves are available. Let's review the advantages and disadvantages of each.

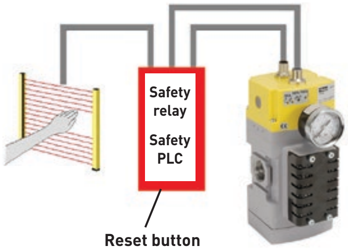
Internally monitored safety exhaust valves tend to be more expensive than the externally monitored type because the monitoring logic is programmed inside the valves, using either electric or pneumatic logic. Although internally monitored valves are easier to integrate, they respond more slowly and typically deliver a reduced service life in terms of both switching cycles (B10 values) and Mean Time to dangerous failure ($MTTF_d$). This reduced service life is the result of using on-board electronics that are contained and give off heat, so they tend to fail earlier than mechanical components. Internal diagnostics add further complexity because they must be run each time the valve pressurizes, which results in a longer start time and, therefore, a longer cycle time. If the machine's internally monitored valves are not grounded, there may be further problems caused by electromagnetic interference (EMI). Just as with laptops, internally monitored valves must be shut down and restarted properly or they will lock out the machine, which makes resetting and repressurizing the machine a challenge.

Externally monitored safety exhaust valves are less expensive than internally monitored ones simply because the user programs the monitoring logic into the programmable safety device or standard programmable logic controller (PLC). Some Safety Exhaust Valve manufacturers offer function blocks to help make this programming easier. This reduces the internal complexity of the product, making the valves easier to integrate and restart; it also provides a higher B10 value for longer service life. The disadvantage is the necessity of doing the monitoring logic programming and taking control, but there is significant cost savings with greater functionality and longer life, which many engineers feel far outweigh the work of programming.

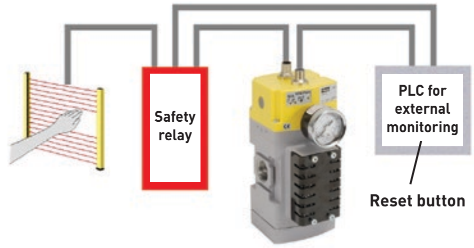
The purpose of monitoring is to ensure that faults are not present in the control circuit (such as a wiring short) and that the safety exhaust valve is operating correctly. Monitoring a safety product requires a safety-rated device and a means of programming. This can be accomplished in several ways via the products integration.

Integrated Guidance

Cat 4, PL e



Cat 3, PL d



Integration for Cat 4, P/L e provides the highest level of safety. The safest (but costlier) way to do this is to use a safe PLC that is fully programmable and offers independent processors to manage the two (redundant) channels of monitoring. By selecting the correct safety devices and with proper integration this arrangement allows you to achieve up to a Category 4, performance level e safety rating. Those who need a less expensive alternative can opt for a programmable safety relay that still supports achieving the highest safety level of Category 4, PL e.

Integration for Cat 3, P/L d
A redundant control circuit with the lowest cost can be built using a standard PLC and a safety relay. While this allows for safe monitoring, it will not meet the Category 4 criteria; the maximum rating achievable would be Category 3, PL d.

Valve integration is critical because a safety valve rated for Category 4 and a safety device rated for Category 4 will not always produce a Category 4 safe solution. The secret to achieving the desired Category and Performance Level is in the design of the safety exhaust valve and its $MTTF_d$, the diagnostic coverage of the control system and the proper integration and wiring of the monitoring and control system.

Safety Exhaust Valve

5 Key Selection Guidelines

Several important questions should be considered when specifying a safety exhaust valve:

1 Measure the Exhaust Time in Faulted Condition

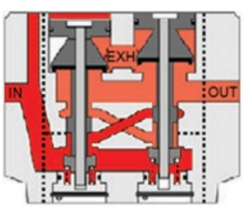
Take the time to understand the worst-case scenario; when a safety valve is in faulted condition, standard exhaust times (assuming normal stop) do not apply. In this situation there is a failure in the valve or control system and the exhaust flow may be restricted thereby increasing exhaust time.

2 Switching Time is Important

The faster a machine can stop, the closer to the machine that the guards, light curtains, or other presence-sensing devices can be installed. Your switching time off impacts your calculations for safe stopping distance. Your switching time on impacts the lag time to fill the machine.

3 Product Design

A series-parallel flow design (as shown) for safety exhaust valves incorporates the best of both



Parallel to Series Parallel

series and parallel arrangements to ensure that both valve elements (redundant design) must shift to supply air downstream and if either valve element were to be out of position with the other, the downstream air will be dumped to exhaust in parallel. This arrangement allows higher exhaust flow capability and ensures very low residual pressure during a fault, eliminating the danger of residual energy making its way into the machine.

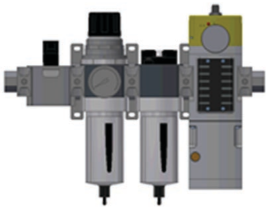
Consequently, if two exhaust valves are used in series, the air supply to the first valve flows through to the second valve and then downstream. When in exhaust mode this design flows most of the exhaust through the second valve creating a lag in exhaust time.

4 Know the B10 Value

The valve's B10 value is its life expectancy in switching cycles and is based on B10 testing (the point at which 10 percent of a sample lot has failed). It's an important consideration when determining the $MTTF_d$. The higher the quality of the components is, the longer the B10 life of the machine into which they are built will be. This is an important consideration for Category 4 applications where a high diagnostic coverage is needed.

5 Monitoring

To achieve the highest level of diagnostic coverage, it's critical to employ all the best aspects of safety circuit



architecture – redundancy (dual channel circuits) and monitoring to detect faults or failures in control systems and check for short circuit faults. The monitoring portion of the safety system must check to see if both sides of the valve are shifting together every time. This is generally done with most versions of safety relays and safety PLCs that can also perform pulse test monitoring. These types of safety relays and safety PLCs make for very reliable systems with high diagnostic coverage – especially, short circuit faults in dual channel systems. The use of sophisticated controls and monitoring ensures the valve is functional.

Conclusion

Safety allows no room for error. If the risk assessment requires a safety rating of PL c or higher for the pneumatic system, a dual redundant safety exhaust valve offers a simple-to-implement and cost-effective way to attain the required safety level. Take the time necessary to find a safe exhaust valve that has been designed to fit well into both mid- and high-level safety circuits to ensure the machine is properly protected.

Additional integration details are available for Parker products at www.parker.com/pdn/safetyvalve

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