White Paper

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Achieving Required Safety Levels Using a Pneumatic Safety Exhaust Valve

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Achieving Required Safety Levels Using a Pneumatic Safety Exhaust Valve

As more companies increase their focus on safety of machinery, design engineers need a firm understanding of the Machinery Directive and how to comply with the required safety levels. A Pneumatic Safety Exhaust Valve can be an easy & cost effective way to accomplish this.

Understanding the Safety Standards

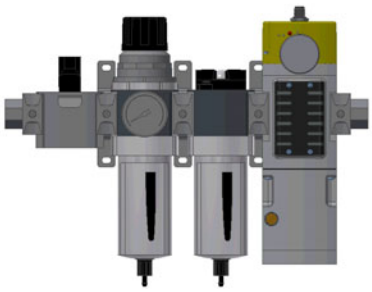
The goal of the Machinery Directive 2006/42/EC is to protect people and the environment from accidents caused from all types of machinery. The EN 954-1 standard, previously used to support meeting the directive, has now been superseded by EN ISO 13849-1 & -2 and EN 62061 standards. A significant revision with these standards is the approach that is taken to the assessment of safety-related controls systems, especially with regard to modern electronic control circuits. In essence, the new standard builds on the existing categories of safety within EN 954-1 (B, 1, 2, 3, 4) and also adds a new procedure for risk assessment. Instead of categories this new standard of control is called a Performance Level (PL) which is associated with a given safety function on the machine. Definitions for diagnostic coverage (DC) and common cause failures (CCF) are also incorporated into this calculation, as is component life (B10d). This ensures that safety is not just focused on component reliability, but also introduces common sense safety principles such as redundancy, diversity, and fail-to-safe behavior.

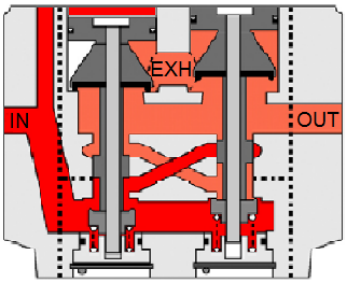
Machinery Directives' Impact to Pneumatics

Because pneumatics is part of the Safety Related Parts of the Control System (SRP/CS), as a machine builder or end user you should be thinking about adding a safety exhaust valve into your air preparation system. The use of a safety exhaust valve will allow the user to safely and reliably shut off the pneumatic energy, stopping flow of compressed air to the machine and allow 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, as well as to meet the required performance level (PLr) determined by the risk assessment. These are some of the most important considerations when selecting a safety exhaust valve:

- Easy integration with your electronic controls
- A fast response time to exhaust
- Minimal residual pressure when faulted
- Long component life (B10d)
- Small footprint

A prime example of a safety exhaust valve like this is the new P33 valve from Parker. This new valve is designed for external monitoring, incorporates series-parallel technology for high flows and fast exhausting response with minimal residual pressure in the fault condition, and has a long life with a B10d of 20,000,000 cycles. Care has been taken to provide easy wiring options for use with most brands of controls whether used with a safety relay, programmable safety relay, or high-end safety PLC. LEDs for fault indication or diagnostics are also provided. The P33 valve is modular with Parker 3/4 inch air entry filtration and pressure regulation components, and a soft-start function is available as an option that does not increase the width of the product.





Parallel

Series

Series-Parallel Design for Safe Function

The faster the machine can stop – the closer you can install the guards, light curtains, or other presence sensing devices. Stickiness of valves is one of the biggest variable factors in stopping time, as related to the valve's exhaust flow capability. Parker utilizes a patented series-parallel flow design that incorporates the best of both series and parallel arrangements to maximize safety. Essentially, the two valve elements are arranged in such a way that air from inlet to outlet must go through both valves in series (as illustrated in red), but the flow path from outlet to exhaust is in parallel (as illustrated in orange). The cross flow technology ensures that both valve elements (redundant design) must shift to supply air downstream and if either valve element were 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.

External Monitoring for Diagnostics and Reset Mode

To achieve the highest level of diagnostic coverage, one must employ all the best aspects of safety circuit architecture – redundancy (dual channel circuits) and monitoring. That monitoring will 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 done by monitoring the condition of pressure-operated sensors in the P33 valve. These sensors are hardwired into the controls and "monitored" by the external control system. 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 sensors are not bypassed and the valve is functional. Because the P33 is a mechanical fail-safe device, the monitoring could also be done via standard PLC and still attain as high as a PL d rating.

A reset function is usually required to recover from a fault in the safety system. When a valve fault is detected (one pressure sensor not in the correct state) incorporating a reset function is a good way to prevent further operation. This prevents the valve from continuing to be operated, which could lead to a build-up of faults and a loss of the safety function. Detection of any fault, though, must shut off the actuating signals to the valve and they must remain off until a reset is performed. Whether or not a dedicated, separate valve reset or an automatic valve reset is appropriate for a specific application should be determined by a risk assessment and/or by available machine-specific safety standards.

Component Life - B10d

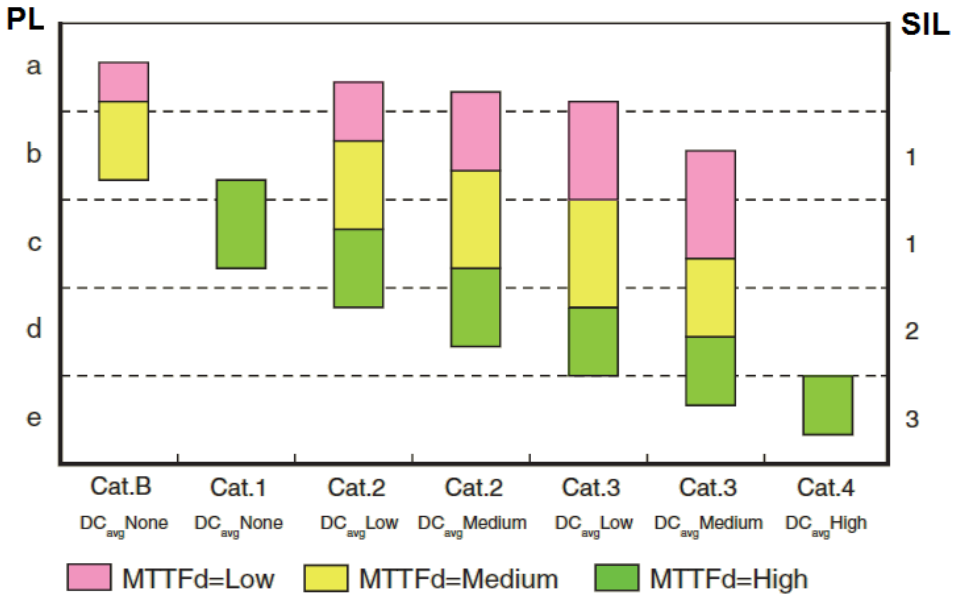
One characteristic of any safety component is statistical component life - B10d. When designing a safety system according to ISO 13849-1, a B10d or a Mean time to dangerous failure (MTTFd) is needed for each component in the system. A B10d value, along with the number of operations (nop) is used to determine the MTTFd of the component for the application (MTTFd = B10d / nop). Valves that use electromechanical components for monitoring are usually limited by the life of the monitoring components. Use of solid state electronic pressure sensors for monitoring greatly improves the B10d numbers as there are no mechanical wear components. Therefore, the P33 Safety exhaust valve is given as 20,000,000 cycles for B10d.

Evaluating Performance Level

The required Performance Level (PLr) should be determined by a risk assessment. Once a required PL is determined, application statistical component life (MTTFd), circuit architecture (Category), monitoring (DC), and consideration of common cause failures (CCF) can be used to determine the system PL. The system PL must be equal to or better than the required Performance Level (PLr). This is similar when working with Safety Integrity Levels (SIL) as well. (See MTTFd chart)

For applications where the severity of injury and level of exposure are high the percentage of diagnostic coverage of the monitoring system must be high as well. Depending on the safety relays or safety PLCs used to control command and monitoring, the system can achieve a very high Performance Level, up to PL e and Safe Integrity Level, up to SIL 3.

MTTFd Chart



What it All Means

If your risk assessment requires a safety rating of PL c or higher for the pneumatic system, a dual redundant safety exhaust valve is a simple to implement and cost effective way to attain the required safety level. Parker's P33 safe exhaust valve has been designed to fit well into both mid and high level safety circuits to ensure the machine is properly protected.