Machinery safety control systems and fluid power Part 6

This article is the final of a six-part series providing an overview of requirements, principles, applications and technology for pneumatic and hydraulic safety systems of machinery. In the last issue we dealt with the practical application of appropriate control methods of the safety-related parts of a control system which have been identified in the hazard identification/risk assessment.

Our sixth topic deals with the practical application within the hierarchy of control and appropriate control methods of the safety-related parts of a control system which contain stored energy and have been identified in the hazard identification/risk assessment.

Energy sources or power mediums which need to be addressed within the safety-related parts of control systems include electrical, electronic, pneumatic, hydraulic, water, steam etc.

Our focus being fluid power, we would incorporate the identification of circuits likely to contain stored energy. The most obvious would be compressed air tanks and accumulators.

As previously discussed in earlier editions of this series, we reviewed the requirements of the risk categories which clearly stated that when dealing with the higher levels such as risk category two, three and four we must detect any single component failure that can lead to the loss of the safety function.

Under the hierarchy of control there are five levels in order from lowest to highest:

PPE: Personnel protective equipment.

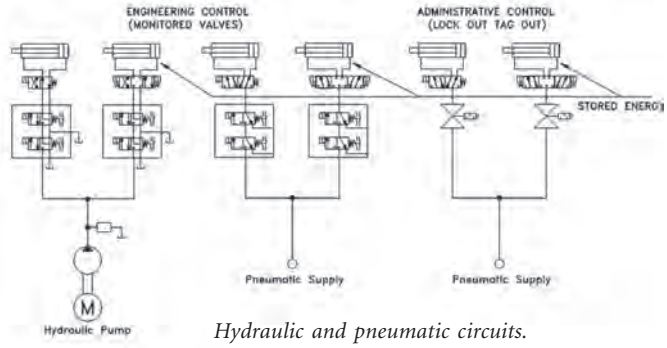
Administrative control: Generally applied in the form of signage and procedural operation such as LOTO (lock out tag out).

Isolation: Isolate the dangers of machinery from personnel, generally not a practicable solution where maintenance or operators are required to access machinery.

Engineering control: Requires the application of monitored control components to ensure the safety function has been achieved to the appropriate risk category, used for frequently accessed machinery.

Elimination: Can the process or operation be eliminated or removed to eliminate the risk of injury or exposure to personnel?

The risk categories are generally related only to an application where engineering controls have been employed; however, when it comes to stored energy the risks are still extremely high where administrative or engineering controls have been adopted due to the inherent design of control systems. Although the engineering control is used only for certain access conditions and the administrative control is then applied for minor maintenance and breakdown scenarios, the stored energy is most dangerous in these inadvertent operating conditions due to the potential of the circuit being disassembled and the fittings being undone and stored energy being suddenly released to atmosphere.



Hydraulic and pneumatic circuits.

In pneumatic systems where a five-port two-position valve controls a cylinder and a dual redundant monitored valve system has been installed, the safety control function can be monitored by safety systems and maintain the appropriate risk category. If we now change this spool configuration to a five-port three-position valve with a closed centre, the safety valves will still perform the same function but will not dissipate the stored energy between the process control valve and the cylinder. This creates a whole new scenario which now needs to be identified in the hazard identification/risk or an FMEA (failure modes and effects analysis) assessment as well as being taken into account and incorporated into any access requirements.

Similar situations exist within hydraulic systems when we compare a four-port two-position valve with a four-port three-position valve having a closed centre ie, all ports blocked.

When we consider oil compressibility at approximately 0.1%, generally this would not be an issue with closed centre valves due to spool leakage. However, when these devices are connected to flexible hoses the hoses themselves can expand and become an accumulator; once again this should be identified and appropriate risk control measures adopted.

Stored energy is also of high risk where machinery may be stopped part way through processes and therefore creating a load-holding application on the cylinder.

General maintenance and minor intervention are the most critical times when accidents occur, irrelevant to which of the levels of the hierarchy of control have been adopted.

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