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Re: Instrument Air Pressure Can Cause Dangerous SIS Failure

To Our Customers:

During a recent Pre-Startup Acceptance Test (PSAT) of a safety instrumented system (SIS) a dangerous failure occurred that is a reminder of the importance of considering the instrument air system and its potential adverse impacts on the performance of SIS. Depending on the design of the instrument air system and the ability of the associated instruments to handle the full range of potential pressure conditions, failure of instrument air handling systems may result in dangerous failures of safety instrumented functions.

Background of the Failure

A chemical plant operator was in the process of performing an upgrade of its instrumentation and control systems for an operating unit, including both basic process control systems and safety instrumented systems. As a part of this upgrade, the plant also elected to improve the performance of its controls by increasing the pressure of its instrument air system from roughly 35 PSIG to 60 PSIG. During the engineering of the upgrade the designers noted that many of the control valves were not rated for 60 psig and were equipped with pressure reducing regulators to decrease instrument air pressure upstream of their positioners. Many of the shutoff valves were capable of withstanding the full 60 PSIG due to the robust design of their actuators, and were not fitted with regulators.

The Incident

About a day into the PSAT process the cut over team was permitted to implement the change that resulted in the increase in instrument air pressure. The interlock test that immediately followed the change in air pressure resulted in the failure of a valve to move to the closed position that had worked during tests earlier in the day. Troubleshooting began with checking the output of the safety PLC which indicated that the output had been de-energized, through the maintenance software. Next the electronic signal to the solenoid was checked to determine its state, yielding a verification that the output circuit to the solenoid valve was de-energized. Finally, a check of the pressure in the actuator allowed the determination that while the solenoid's power had been interrupted, the SOV did not move to allow the actuator of the shutoff valve to de-pressure because the valve actuator was still pressurized.

The Cause

While it was determined that the shutoff valve actuator was adequately sized to withstand the new increased instrument air header pressure, not all of the components that were deployed in instrument air service were checked. In this case, the solenoid was not appropriately sized for the increased pressure. Once the instrument air pressure was increased, the solenoid's return spring no longer had sufficient force to push the plunger through the newly increased air pressure, resulting in the plunger being stuck in the open position.

The Resolution

In order to allow the system to operate properly, one of two options had to be implemented.

1. The solenoid valve would have to be replaced with another model that was capable of operating at the elevated instrument air pressure, or,

2. The instrument air pressure would have to be reduced to a pressure range that the existing solenoid valve was capable of operating in utilizing a pressure reducing regulator.

Due to the time criticality, the existence of spare pressure regulators, and the lack of readily available solenoid valves that were properly rated for the service at hand, the project team elected the second option. Use of this second option resulted in the need to re-perform the SIL verification for the affected loops and update the SIS design basis documentation accordingly. The reason that a revision to the SIL verification calculations was required was that a new component was added to the SIF that has a dangerous failure mode that will result in dangerous failure of the SIF. Specifically, if the pressure regulator were to fail to the open position the solenoid will again get stuck open, preventing the SIF from being able to take its safety action.

Recommendations

Based on the case history presented above, it is clear that excessive instrument air pressure can have a detrimental effect on the performance of safety instrumented systems and its effect on the SIS should be considered during SIL verification and testing.

1. All pneumatic components associated with a SIF should be reviewed to verify that they are suitable for use in full instrument air header pressure, and validated with a physical test. If any component of the pneumatic circuit is not capable of operating in full instrument air header pressure, then the failure of the pressure reducing equipment must be considered in the SIL verification calculations.

2. All SIS functional tests should be conducted utilizing the normal instrument air supply of the plant at normal operating pressures. In the case of this example, if the test were conducted using a lower pressure external source of air, or at a reduced header pressure, this important dangerous failure mode would not have been identified.

Keep Safe,

Edward M. Marszal, PE, CFSE
President, Kenexis

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