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Risk-Based Approach Issue

Methods, Tools, and Resources

Linking Risk Analysis and Functional Safety Concepts

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An Introduction to Safety Instrumented Systems

Safety Instrumented Systems (SIS) are a specific layer of protection that requires detailed knowledge and criteria for proper definition and installation based on functional safety principles and associated standard requirements. This paper focuses on providing guidance and criteria for conducting the following tasks: (1) how to link risk analysis results with functional safety concepts, (2) basics for systems verification via calculating the average Probability of Failure on Demand (PFDavg) and (3) available techniques to be used when verifying complex SIS.

“When the actual risk level is higher than the applicable tolerable risk level, then risk reduction measures shall be considered.”

Introduction

Reference [1] provides an overview of layers of protection suitable to reduce the risk level of a process facility, i.e., measures intended to prevent and/or mitigate the identified hazardous scenarios. The cited paper [1] explains that based on the results of a risk-based quantitative assessment, zones or locations and their associated hazardous scenarios having the most significant intolerable risk level can be identified. . As a result, sensitivity and cost-benefit analyses can be performed with the aim to decide which safeguards achieve to reduce the risk to an acceptable level at the most reasonable cost.

From all layers of protection considered in reference [1], the Safety Instrumented Systems (SIS) and performance-based Fire and Gas Detectors Systems (FGS) are safeguards that should comply with very specific requirements based on the following standards; i.e., IEC 61508 [2], IEC 61511 [3] and ISA 84.00.TR.07 [4], respectively. While performance-based FGS selection, verification and mapping guidance can be found in reference [5], the main purpose of this paper is to address SIS intended to comply with standards [2] and [3]. A SIS consists of at least three subsystems:

- **Sensor subsystem:** One or more sensors that are installed to detect the demand and to send the signal to the logic solver subsystem. Examples of input systems may be switches, sensors, transmitters, transducers.
- **Logic solver subsystem:** One or more logic solvers that receive the signals from the sensor subsystem, interpret these signals and decide which actions should be taken. Examples of logic solvers may be based on electrical relays, electronic components (e.g., printed circuit boards), programmable logic controllers (PLC), computers.
- **Final element subsystem:** One or more final elements (i.e., actuating devices) that take a prescribed action from the logic solver subsystem to prevent the hazardous scenario/ demand from occurring. Examples of final

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