The Effectiveness of Gas Detector Systems
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Abstract

To produce a tolerable risk for processes that have a high severity of consequence, high system reliability is required. For a typical chemical or hydrocarbons processing plant, the detector control logic and mitigation system (isolation valves, control interlocks, alarms, etc.) are designed to a high reliability standard, and the individual detectors are frequently tested and maintained to meet an availability that is consistent with the SIL rating. The methods and procedures for establishing the reliability and availability requirements for everything connected to the detectors are thoroughly described and supported by extensive reliability data. However, how do we know whether the individual detectors are placed to detect the required percentage of releases?

After identifying the causes of difficulty, recommendations for new approaches will be proposed. The difficulties include:

- There are so many potential leak sources and so many combinations of leak conditions (process conditions, leak size, leak direction, wind direction, and weather) that it is impractical to evaluate all possible leak scenarios.
- The required spacing of detectors depends on the required reliability of a detector system, depending on the potential for harm to workers and others. There is no single spacing rule that will cover all cases.
- Depending on the process and plant layout, the gas detection system could activate a very effective mitigation system, or could result in very little risk reduction.
- Near a leak, a jet of gas or volatile liquid is driven by momentum and tends to go in the direction of the escape path, regardless of wind direction or gas density. This means that a leak can easily bypass a detector that is placed close to the leak source.
- Leak dispersion models typically assume that the released fluid flows from a round opening, but in fact, many releases flow through narrow cracks.
- CFD (computational fluid dynamics) dispersion modeling can accurately simulate flow around or against obstacles in the path, but a great amount of 3D design information and computation time are needed.
- High-reliability systems require more detectors, which therefore require more testing and maintenance. However, more worker presence in areas of potential harm can strongly influence the overall risk.