Protection of Hazardous Areas Using High Sensitivity Early Warning Aspirating Smoke Detection

The use of high sensitivity Aspiration Smoke Detection (ASD) systems originated in the protection of mission critical, high value environments of Telecom switches and Electronic Data processing centres. These areas typically have large Air Handling Units (AHU) for cooling the electronic equipment and, due to the dilution of any smoke by the large airflows; effective smoke detection is only possible using dynamic instead of static smoke detection such as ASD. However, the technology has been applied successfully in many other areas where business continuity is critical and where risks for material losses and/or human safety are high. Examples include warehousing, mines, petrochemical plants, power plants, cold stores, clean rooms, industrial manufacturing, underground tunnels, production machinery, museums, cathedrals, hence even prison cells.

APPLICATION OF ASD IN HIGH RISK AREAS

One specific example of the growing adoption of ASD systems is in hazardous areas. Generally these areas by their very nature fall into the category of "Ex" environments under the ATEX directive for CE marking in Europe. Petrochemical plants have many hazardous areas; warehouses storing solvents and alcohol also have classified areas, which require specialised fire detection equipment. Essentially these are areas where volatile mixtures of gases or vapours can accumulate and ignite resulting in catastrophic circumstances. Other aspects of safety can be found under SCIC's 'Guidebook on Warehousing & Storage of Hazardous Materials & Dangerous Goods'.

ASD IN HAZARDOUS AREAS

In Europe they have historically been different approaches to Ex environments within different member states. However, with the imminent mandatory CE marking of electrical equipment installed in hazardous areas under the ATEX directive there is some harmonisation and renewed emphasis on the suitability and application of electrical equipment in such areas.

In summary equipment installed in hazardous areas must have appropriate Ex rating. There are a number of alternative approaches to Ex ratings (ref. EN50014).

- Intrinsically safe (Exi) equipment limits the electrical energy in the devices installed in the area so that no significant spark or overheating can occur, which may ignite an explosive atmosphere.
- Pressurised apparatus (Exp) prevents explosive mixtures reaching the potential source of ignition but means of a positive pressure within the electrical enclosure.
- Flameproof enclosures (Exd) contain ignition sources in such as way that any ignition of the hazard inside the enclosure will not be transmitted to the atmosphere outside the enclosure.
- Increased Safety (Exe) used mechanical construction safeguards to ensure that the apparatus does not contain normally arching or sparking devices, or hot surfaces that might cause ignition.
- Oil immersion (Exo), Powerder filling (Exq) and encapsulation (Exm) are other approaches that may be used.

Fire detection products generally use either Exi or Exd protection. Most common are intrinsically safe smoke and heat detectors. Flame detectors and linear systems such as pressurised pipe or temperature cable/fibre are also available for such environments. However, none of these technologies can provide the Early Warning smoke detection capability of an ASD system.

HIGH SENSITIVITY ASD SYSTEMS

In their simplest form ASD systems are easy to understand; they continually draw samples of air (Figure 1) from the equipment or area requiring protection and assess these samples for the presence of smoke. Naturally the fan or aspirator used to transport the samples into and along the sampling pipe is sized to reflect the maximum pipe runs (which can be up to 200m) but more importantly, the sensitivity of the central detector is key to its performance capability.

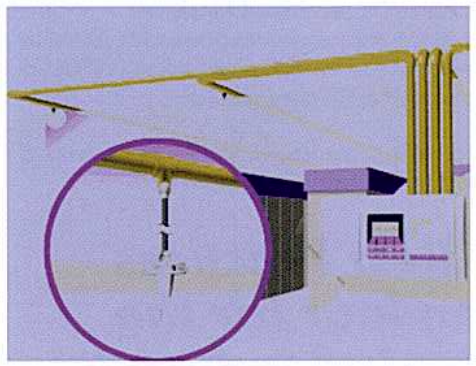

Figure 1: Aspiration Smoke Detection

Early Warning ASD should not be confused with Pre-alarm conditions. Pre-alarm provides an indication that an Alarm condition is approaching and probably too late to prevent. Early Warning provides an indication that normal conditions are no longer present - something unusual is happening and therefore triggers a preventive response. Let's look at the detection concept with aspiration systems. ASD systems can have many holes in the sampling network. In order to have confidence that each hole has at least the equivalent performance to a point detector the scenario of smoke only entering one hole must be considered. In this case all other holes will be drawing clean samples (plus dirt in some situations) and the sensitivity of the central detector must be sufficient to account for this dilution.

Illustrating this with figures; consider a 20 hole system with equal quantities of air entering each sampling point. To have an effective sampling point sensitivity of 4%/m - which is widely considered to be normal for a standard point detector - the central detector must have a Fire Alarm threshold of 0.2%/m.

In the case the smoke concentration at the central detector is less diluted. As a result, Aspirating Systems have a sensitivity to detect diffused smoke - the more diffused the smoke is the more sampling holes it enters. This is known as the cumulative effect. However, one of the unique benefit of an aspirating system is its ability to detect lower concentrations of smoke than a normal point detector when smoke enters more than one sampling point.

Now, let's consider the multiple alarm outputs available using an Aspiration Detection System in combination with your conventional fire alarm system.

MULTIPLE ALARM THRESHOLDS

ASD systems can provide up to 4 stages of detection and response in the following sequence (Figure 2):

- Early Warning activation
- Pre-Alarm activation
- First Fire Alarm activation
- Second Fire Alarm - Suppression activation

First level, Early Warning indication alerts key personnel to assist towards an abnormal smoke condition. The response to this Early Warning might be smoke detected from soldering activities, thereby avoiding an unnecessary evacuation of the premises. However, in the event the soldering activities are performed within a hazardous compound, then the Early Warning detection would prevent potential chain reaction leading to fire conditions.

Figure 2: Fire Growth Curve

When the smoke density builds up a second stage namely Action Warning is activated. This condition triggers the Pre-Alarm warning to a central fire alarm panel. Safety personnel would conduct relevant prevention actions to identify and respond to the source of this smoke while anticipating possible fire alarm evacuation. In some instances, processes are in place to perform emergency procedures to insure all air ventilators are switched off, windows are closed, and more importantly shutting down IT related equipments and/or electrical machinery.

The thirds stage after these vital early warnings there is the First Fire condition. A Fire Alarm output to the central fire alarm panel is triggered and is considered to be equivalent to the standard point detector response. Some ASD systems equipped with a wide sensitivity range using a Second Fire condition can be interfaced to automatic suppression activation systems. Each detector can therefore provide multiple alarm outputs that can initiate the desired response.

CONCLUSION

For any safety matters, the best response is prevention and Early Warning Aspiration Smoke Detection is the solution. Sensitivity to detect low density smoke in all kinds of environments ensures the best possible protection particularly for high risk, high value areas. Careful design considerations are important before deploying such solution specially under Exd proof conditions.

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