

Air Sampling Smoke Detection on Mobile Mining Equipment

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Background

Very early warning air sampling smoke detection has traditionally been thought of as a technology only suited for clean environments. Many fire industry professionals believe that factors such as dirt, dust, moisture, vibration and other harsh conditions preclude the use of air sampling smoke detection because false alarms and detector maintenance issues can be a problem. This is unfortunate because harsh industrial environments have a much greater risk of fire than the standard clean environment. Possible fire hazards in industrial facilities include very high voltage electrical cabinets, large motors, conveyor belts, lubricants, flammable liquids, moving parts causing friction, and less than ideal housekeeping. Industrial facilities also tend to have on-going maintenance activities such as welding and metal cutting that can set in motion smoldering and a possible fire situation well after the work has been completed. For these reasons and others, very early warning air sampling smoke detection would provide great value to an industrial facility.

Installation Driver

Because of a worldwide risk audit of major mobile mining equipment, an international mining company was interested in evaluating secondary smoke detection options in one of their P&H 4100 electric rope shovels. This type of equipment has both very high voltage and hydraulic / lubricant potential fire hazards, and has all the aforementioned operational challenges for air sampling smoke detection. The electric rope shovels are the beginning of the ore processing chain and any disruption would cause problems throughout the production process. The production loss would be much greater than the cost of the lost equipment.

Installation

This was a proof of concept test, and because the engineering plans from the shovel manufacturer could not be easily obtained, site surveys and hand measurements had to be taken. Two different site visits were made to survey the piece of equipment and ask about standard operational parameters. The management was convinced of the value of the system, but the complete success of the system also depends on in depth discussions with and input from the “hands-on” maintenance and operations staff. The first site visit was to prepare an initial installation plan, and the second visit was for input and changes. Then the initial design was developed with particular emphasis placed on the vibration experienced on this type of equipment.

The system was designed with two zones. The first zone was designed to protect the electrical cabinets with both in cabinet sampling and cabinet ventilation sampling. The second zone was designed to protect the lubrication/hydraulic room and the vents of the hoist and swing motors. ¾” Blazemaster CPVC pipe was used as the main sampling air transport pipe with 3mm sampling holes field drilled and labeled. Capillary tube and sampling bulkheads were used to

sample in the electrical cabinets. The detectors, 24DCv power supply and battery back-up were pre-wired and attached to a single mounting plate. The detectors were offset from the main mounting plate with anti-vibration spindles. External dust filters were installed in the pipe network 18 inches before the detectors. The displays with annunciators were installed in the operators cab, but all indicators were turned off so not disturb the operator with false alarms during the test period.

The installation was performed during the week of June 20, 2011 coinciding with a major maintenance “down” scheduled for 4 days. Working in an active mining environment presents a number of challenges for the installation team. Federal mine safety regulation and company safety policies are strictly enforced and can create unexpected time delays. One example is that at 1:00 pm every day the worksite had to be cleared for a 2:00 pm blast and a 3:00 pm all clear signal. Another challenge was that the installation was secondary to the maintenance goals of the mine and the team had to work around the mines maintenance staff and wait when assistance was required. These factors contributed to long hours for the team and deviations from the original design.

Data Collected

The test period lasted from 6/25/11 to 1/31/12. This was a test to collect data on normal operational background levels on the shovel, so the detector’s alarm levels were left at factory settings. The alert level was set at 0.0250% obscuration. The action level was set at 0.0450% obscuration. The fire 1 level was set at 0.0625 and the fire 2 level was set at 0.6000% obscuration. During the test period the shovel experienced an “arc-over” in an electrical bus that automatically shut down the shovel. After an examination of the detector’s recorded data it was determined that the incident was detected 1 minute before the shutdown.

There were other alarm events during the test period that did not have readily identifiable causes. Zone #1 experienced two action and three fire 1 events that lasted over 1 minute. The highest percent obscuration for the action events was 0.0512% and the highest for the fire 1 events was 0.0975% obscuration. Zone #2 experienced two alert events, 5 action events, and one fire 1 event that lasted over 1 minute. The highest obscuration for the alert events was 0.0391%, the action event was 0.0584% and the fire 1 event was 0.2759%. The possible causes for these events are still being investigated, but the alert, action and fire 1 alarm levels will have to be elevated to reflect possibly benign operational events and prevent false alarms.

Lessons Learn

The complete analyses of the test data has not been completed but a couple of changes have already been identified. Although the ridged ¾” CPVC pipe appears to be holding up, it has been decided that ¾” flexible hose will be used for the final installation. It is felt that the flexible hose would last much longer in this high vibration environment. The detectors used in the test were capable of covering a much larger footprint than required. The current detectors will be removed and sent to the factory for complete component analysis. They will be replaced with a different model with the same sensitivity but designed for smaller areas. The anti-vibration

mountings will be changed to a different model by a different manufacturer. It was felt that this critical component can be improved upon.

Conclusion

This test has shown that an ADS system has the potential to be deployed to protect industrial equipment in harsh environments. The most important part of a successful deployment is to determine the operational background levels of smoke and dust in the space to be protected. Where many industrial environments would have a relatively stable background levels, the test on the electric rope shovel shows that some industrial operations experience unexplained spikes in smoke or dust levels. In these types of environment a longer “learning” period is required to determine the proper alarm set points. During this “learning” period it is highly recommended that all annunciators are turned off as not to create a negative perception in the minds of the operational staff. In this type of application the “buy-in” by the operational staff is much more important than a traditional ADS application. From the physical layout of the system to the actions taken when an alarm condition is present, these workers have much more interaction with the system and it cannot make their job more difficult.