Spotlight Topic: University of Nevada, Reno develops a new and innovative technology to recognize hazardous atmospheric conditions in a mine before their evolution toward an accident.

Alpha Foundation Grant ASTI14-3: Early-Warning Safety Hazard Predictor for Preventive Ventilation Management

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The focus area of the research project is mine safety. A new technology is developed to recognize hazardous atmospheric conditions in a mine ventilation system based on analyzing continuous mine monitoring signals from sensors and simulated information systems. New methods are developed to recognize safety hazards during their development real-time caused by inflow of combustible gases, heat, or the accumulation of poisonous gases in a mine. The Early Warning System (EWS) model has the ability to recognize threat to safety at a significantly earlier time than it can evolve to an accident at a future time. The new and innovative components are: (1) the EWS uses real-time monitoring signals for forecasting in accelerated, simulation-time from the data to predict any likely event in the near future that may compromise safety; and (2) the EWS uses the mine layout to forecasts in space, in order to evaluate safety at any critical working area, even at a place where no monitoring station is installed.

Potentially hazardous cases have been studied in detail by numerical simulation to prove the concept of early warning of dangerous conditions in their evolution toward an accident. The numerical simulations indicate that even if the individual gas concentration signals from sensors at fixed monitoring locations stay below the threshold limit value for safety, there may be dangerous concentrations due to accumulation from gas sources along the airway in other locations with a delay time. Such critical points with likely safety threshold crossings at a delayed real time can be forward-predicted by the Early-Warning Predictor (EWP) of the EWS at an accelerated simulation time. The system can notify mine management of the nature of the hazard scenario for preventive action. Since high concentration fronts travel with the air velocity in the mine, precious time may be available to prevent the disaster from happening by timely intervention. Figure 1 depicts an example for the early recognition of a safety hazard by the EWS in a mine with three methane sources at different locations. The APPS is triggered at 0.5% concentration by the threshold crossing of a monitored signal from an observed location (Location 15). The methane concentration is forward predicted at a critical location (Location 17, not necessarily monitored) by the EWP in 2 minutes and a likely threshold limit crossing at 1% concentration 32 minutes later is determined. The useful delay time for further checking or immediate preventive management actions is 31 minutes.

The early warning system is tested under controlled conditions against typical, simulated, "synthetic monitored" signals for recognizing potential hazard scenarios in computer simulations. The test results are conclusively positive. Significant time gain, in the order of 20 minutes is seen in the examples between the hazard detection time and the critical threshold crossing time at some critical locations.

Disclaimer: This study was sponsored by the Alpha Foundation for the Improvement of Mine Safety and Health, Inc. (ALPHA FOUNDATION). The views, opinions and recommendations expressed herein are solely those of the authors and do not imply any endorsement by the ALPHA FOUNDATION, its Directors and staff.

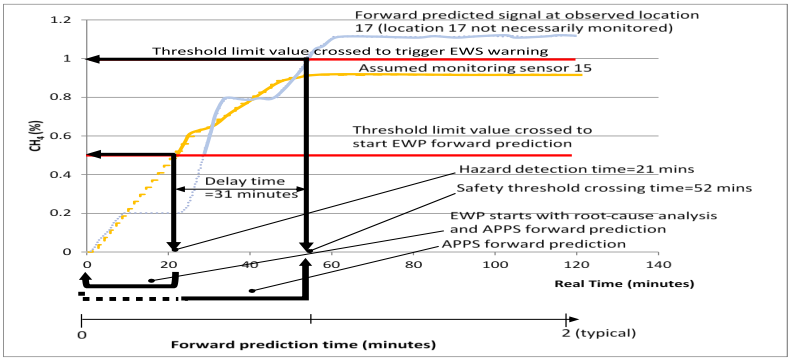

Figure 1. APPS model forward prediction at selected observed locations in real time and in fast simulation time scales in a coal mine example.