Project Title: Early-Warning Safety Hazard Predictor for Preventive Ventilation Management

Organization: University of Nevada, Reno, Department of Mining and Metallurgical Engineering

Partnerships: Barrick Goldstrike Mines, Inc., Turquois Ridge Joint Venture, Ohio Automation, Inc.

Investigator(s): George Danko, Davood Bahrami

Focus Area: Safety

Problem Statement and Justification: Recognition of safety hazard is difficult because of the complex nature of information from atmospheric and other conditions underground. Large amount of monitored data may be available from measurement by sensors such as air velocity, pressure, hazardous gas contaminants, temperature, and roof stability. However, it is difficult to recognize problem-causing trends from the measurement data with time-dependent variations. In addition, the combined effects of various signal trends must be interpreted simultaneously with their cross-effects. Safety hazard recognition and prediction algorithms are needed to foresee the possible outcomes of intertwined signatures of various problems by continuous observation. For example, a steady, continuous CH_4 concentration measurement together with a sharp drop in barometric pressure from the monitoring sensors may indicate a potential hazard in future time due to pressure-induced methane increase from the coal seam or the gob. A computer algorithm extrapolating the possible outcomes from real-time monitored data can predict this future increase. A forward-in-time and forward-in-space prediction then may trigger a safety-warning message to mine management to prevent the accident from happening.

Impact of the Research: Our research objective is to develop Early Warning Predictor (EWP) software that forward- predicts ventilating air conditions at an early time before the hazard actually fully develops in real time. The EWP will provide informed prediction forward with space and time based on a calibrated Ventilation and Air contaminant Model (VAM) as well as sensor inputs from the monitoring system. The innovative EWP will be able to determine and flag a warning alarm for the management to act for resolving a hazardous condition before the actual safety hazard will have developed. The early-warning signal will provide time for safety management that may include directing the miners to the nearest emergency rescue chambers.

Objectives and Research Approach: The EWP system are to run five real-time processes simultaneously for: (1) interpreting the mine monitoring signals in comparison with the VAM transport model; (2) validating both the model and the sensor readings in their relationship to each other; (3) identifying plausible source changes as reasons for differences other than model error or sensor malfunction as unexpected changes in the model boundary conditions; (4) evaluating the hazard conditions at critical locations; and (5) extrapolating the trend with time and flag crossing points with maximum threshold values for issuing an EWP alarm. The EWP system will be tested for a suit of disturbances in the computer laboratory at UNR to provide controlled test conditions. The VAM model (either VnetPC, Ventsim, MineVent, or MULTIFLUX) of the partner mines will be imported for the studies to create the internal simulation model for the perturbations in the EWP. The mine monitoring system layout and the measurement accuracy as well as uncertainty range will be acquired from the partner mines for the development and test runs of the EWP. The EWP system will be tested for correct forecasts of hazardous scenarios during their development but before the thresholds for accidents have been crossed due to such as: partial collapse of a hazardous roof section; methane inburst from the strata; booster fans malfunctions; fan starts or stops to cause barometric pressure variation that may trigger pressure unbalances and methane inflow from sealed areas, seams, or gob. We may add further scenarios upon request from our mining partners as a follow-up study.