Grant: AFC316-49
Title: Experimental Testing and Design of Protective Measures for Communications and Tracking Systems Subjected to Catastrophic Events in Underground Coal Mines

Organization: The University of Kentucky

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Partnerships: None

Topic: Mine Escape, Rescue, and Training
Priority Area: Communications and Tracking Survivability

Problem Statement and Justification: Post-accident emergency communications and tracking (C&T) systems are now installed in all underground coal mines, as required by the Mine Improvement and New Emergency Response Act (MINER Act) of 2006. However, many questions remain about whether C&T installations will survive catastrophic events, as intended by the MINER Act. To date, no in-depth testing has occurred to answer these questions or to make recommendations to help ensure the operational survival of these systems. The proposed research will investigate experimentally the forces created by catastrophic events, particularly explosions and roof falls, and their effects on the survivability of C&T systems. Additionally, practical measures will be investigated and recommended to improve survivability based on these findings.

Impact of the Research: Practical measures for protecting C&T systems will be defined to improve their survivability following explosions and roof falls. Improving the survivability of C&T systems following a mine catastrophe will increase the probability of miners escaping or being rescued in a shorter period of time, compared to a scenario where no in-mine information is available because the C&T system is not operational. Knowing the exact locations of miners, or having communications with them after a disaster, will significantly expedite search and rescue efforts. Also, if trapped miners can communicate with rescue teams, the safety of the teams will increase considerably.

Objectives and Research Approach: The overarching objective of the proposed work is to improve a miner's chance for self-escape or being rescued following a catastrophic event by investigating and improving the post-accident survivability of C&T systems. The proposed research will focus on investigating the forces created by catastrophic events (explosions and roof falls) and their effects on C&T systems. To accomplish this, the following objectives are proposed:

- To identify the common installation techniques and system layouts presently being used for the various types of communication systems, e.g. wireless nodes, wired nodes, and leaky feeder systems.
- To find the ideal detonation in a shock tube, equivalent to the MSHA recommended pressure curve time of 15 psi for C&T system elements.
- To assess the damage extent and failure modes of the C&T system elements using as minimum the explosive force of design.
- To assess the post-explosion survivability of the C&T system elements.
- To identify practical protection measures to improve the survivability of the C&T system components against explosions.
- To improve the survivability of the C&T system elements for flying debris.

Several tests will be developed in the explosives research facility at the University of Kentucky. Various components of C&T systems will be subjected to a series of explosions (non-destructive and destructive) in a shock tube that simulates the most likely methane and/or coal dust explosions that may occur in an underground coal mine. Initially, the C&T system elements will be subjected to explosions for different orientations and without any level of protection. Once the failure mechanism and level of damage of the C&T components, and the magnitude and characteristics of the explosive forces, are determined, different protection techniques will be investigated. Furthermore, to simulate flying debris associated with explosions and roof falls, the C&T elements will be subjected to impact tests in a modified Hopkinson-Bar apparatus. Based on the test results, protection schemes will be generated. These schemes must be practical while maintaining the functionality of the C&T system.