Grant: AFC518-23

Title: Intrinsically Safe Underground Aerial Reconnaissance Platform Development

Organization: United Mine Workers of America Career Centers, Inc.

Principal Investigator: Mr. Marlon Whoolery

Topic: Explosion Permissible Mobile Vehicles and Platforms

Concept Summary: In response to a major underground mine emergency, mine rescue and recovery personnel require timely, accurate, and reliable information upon which to base their actions. An Underground Aerial Reconnaissance (UAR) system would convey sensors and/or communication equipment into the mine prior to and/or ahead of entry by rescue personnel to provide detailed measurement of underground atmospheric and ground conditions, assess the condition of mine ventilation controls, advance or re-establish damaged underground wireless communication or monitoring systems, and possibly locate trapped miners. An aerial system approach potentially offers a faster, more agile, longer range, and more economical means of information collection than ground-based reconnaissance options which may encounter impassible or dangerous post-event conditions. Four major subsystems have been identified as necessary for the UAR system to provide these benefits: (1) Aerial Vehicle Platform, (2) Underground Navigation, (3) Data Communications, and (4) Sensor Payload(s).

A major technical barrier to UAR application is certification of the Aerial Vehicle Platform (AVP) and its payloads for use in potentially hazardous atmospheres likely to exist during mine rescue operations. A three-task technical approach founded upon thorough understanding and analysis of actual UAR mission needs is proposed to develop and demonstrate an effective, mission specific, intrinsically safe AVP design to begin the work of overcoming this barrier. The first task consists of a high-level system engineering evaluation. Through consultation with MSHA Mine Emergency Operations and NIOSH personnel, mine operators, mine rescue teams, and other subject matter experts (SMEs), a realistic concept of operation (CONOP) based upon a clearly defined mission and an associated list of threshold and objective AVP system performance and operational requirements will be developed. Key requirements include desired vehicle mission duration, payload capacity, maneuverability, and operational range. These requirements will bound AVP design considerations including aerial vehicle type, propulsion means, and on-board energy storage needs. Within these design bounds, the second task shall identify as candidates for AVP application currently available propulsion, power, and on-board control equipment that is either intrinsically safe (IS) or nearly so. During the third task, representative candidate AVP equipment will be down-selected for IS evaluation and platform integration for an actual flight demonstration, the culmination activity of this proof-of-concept phase.

Note that while discussion of the Underground Navigation, Data Communications, and Sensor Payload subsystems will also be an element the proposed SME consultations, their in-depth investigation is outside the scope of this proposal which focuses only on developing an AVP capable of safely maneuvering through hazardous underground atmospheres. Should a second development phase be funded, components for the remaining subsystems would be identified and integrated with the AVP to develop, deliver, and test a working prototype of a complete, effective Underground Aerial Reconnaissance (UAR) system.