

**Grant AFC719-31:** Analysis of Coal Mine Seal Integrity from Explosively Driven Projectiles

**Organization and Principal Investigator:** Missouri University of Science & Technology (Kyle Perry)

**Focus Area:** Health and Safety Interventions

**Priority Area:** Evaluation of Current Seal Design Criteria Concerns Related to Projectile Damage to a Seal

**Problem Statement and Research Approach:** The MINER Act provided new regulations for both unmonitored and monitored seals. Monitored seals are now required to withstand a 50 psi overpressure for a four second duration and unmonitored seals are required to withstand a 120 psi overpressure for the same four second duration. Several seals have been approved by MSHA to withstand these overpressures. However, no criteria have been published on the effect of projectile damage to these seal designs.

This proposed research will directly investigate the performance of approved 50- and 120 psi seal designs when they have sustained impact from an explosively-driven projectile. Previous research conducted by the National Institute of Occupational Safety and Health (NIOSH) at the Lake Lynn Laboratory (LLL) has shown that explosions containing 5.3%-15% methane will propagate at velocities between 4,954 to 6,102 feet per second (ft/s). While the pressure front of an explosion is travelling along a mine entry, it may encounter objects along the entry such as: handheld tools, wood, steel, equipment, and machine parts. As the pressure front passes over these objects, energy will be imparted to that object, and it will likely be lifted and projected along the entry with the pressure front. However, due to the high speed that the explosion is traveling, this energy transfer will happen in a fraction of a second. Therefore, the object will be traveling at lower velocity than the propagating explosion. The team has conducted preliminary modeling and found that these objects will be traveling in the range of 440 to 733 ft/s, dependent upon mass and geometry of the object.

A cannon-style projectile generator driven by explosives will be used to provide projectile testing of the seal. The projectile generator will consist of a 12 inch diameter steel pipe attached to a breech where explosives can be loaded to produce the thrust to move the projectiles down the pipe (barrel). As the mass of the object increases, the impact effect should change from penetration to cracking and spallation of the seal due to the decrease in the velocity of the object. The experimental design will also allow for a variety of different material compositions for the projectiles which will behave as different types of missiles. Each seal will be subject to a minimum of five tests of commonly found objects susceptible to coal mine explosions. This will give each projectile category five trials, for a minimum of 15 tests conducted on each seal.

**Specific Aims:** The proposed research has three primary objectives with corresponding tasks.

- Objective #1 – Preparation of testing facilities and purchasing of necessary instrumentation.
- Objective #2 – Perform projectile impact tests on 50 psi and 120 psi seals using common light, medium, and heavy objects as explosively-driven projectiles.
- Objective #3 – Analyze results from both 50 and 120 psi seal designs.