APPENDIX U-10

EXECUTIVE SUMMARY OF INVESTIGATION OF MACHINE-MOUNTED METHANE MONITORS

U.S. Department of Labor

Mine Safety and Health Administration
Approval and Certification Center
765 Technology Drive
Triadelphia, West Virginia 26059

November 18, 2011

MEMORANDUM FOR NORMAN G. PAGE
Accident Investigation Team Leader

FROM: JOHN P. FAINI
Chief, Approval and Certification Center

SUBJECT: Executive Summary of Investigation of Machine-Mounted Methane Monitors Recovered from Performance Coal Company's Upper Big Branch – South Mine

The Approval and Certification Center (A&CC), as requested by Upper Big Branch Mine Accident Investigation Team Leader, Norman Page, conducted a laboratory investigation of machine-mounted methane monitoring systems and related components recovered from a fatal mine explosion at the Upper Big Branch Mine-South on April 5, 2010.

The investigation began with a preliminary inspection of all the exhibits. The preliminary inspection included documenting visual observations, and photographing as-received conditions of the methane monitoring systems. These inspections were followed by performance checks ('bump tests') and thermal ignition tests.

None of the methane monitoring systems had datalogging capabilities.

Where feasible, performance tests were conducted on operational methane monitoring systems to determine the operation of the systems when tested in the methane-air mixtures specified in 30 CFR 27.

A detailed inspection of each system was conducted. This included comparison with the certification documentation.

The results of the preliminary inspections, tests, and evaluations are summarized below.

CSE Model 140B LD IR Systems

1.1 Exhibit Number PE-0213 Control Unit and Power Supply; Exhibit Number PE-0169 Sensor Assembly, A CSE Model 140B LD IR Machine-Mounted Methane Monitoring System with Control Unit from longwall headgate and Sensor from longwall tailgate.

1.1.1 The system was tested with added laboratory resistors to simulate the long cable between the Sensor Assembly and the Control Unit. Without calibration, its power shut-off component operated when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air. The final display reading with this test gas mixture was 2.6.

1.1.2 There was no obvious evidence that suggested that the components of the system had been intentionally by-passed.

1.1.3 This sensor assembly did not cause an ignition of a 7.5% methane-in-air mixture when energized in that test gas. Additionally, the inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.1.4 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.2 Exhibit Number PE-0166, Control Unit; Exhibit Number PE-0167, Power Supply; and Exhibit Number PE-0170, Sensor Assembly. A CSE Model 140B LD IR Machine-Mounted Methane Monitoring Systems, Certification 32A-15/MS-8, System from longwall Shearing Machine.

1.2.1 Without calibration, the power shut-off component of this system operated when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air. The final display reading with this test gas mixture was 2.0.

1.2.2 There was no obvious evidence that suggested that the components of the system had been intentionally by-passed.

1.2.3 This sensor assembly did not cause an ignition of a 7.5% methane-in-air mixture when energized in that test gas. Additionally, the inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.2.4 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.2.5 There was minor damage to the polycarbonate lens of the control unit. The cause is unknown.

General Monitors Model S800 Systems

1.1 Exhibit Number PE-0256. A General Monitors Model S800 Machine Mounted Methane Monitoring System Components and Relay from Barrier Section Continuous Mining Machine, Serial Number JM5849.

1.1.1 Before the system was calibrated, its power shut-off component did not operate when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air. The final display reading with this test gas mixture was 1.4. The test gas concentration that caused the power shut-off component to operate was 3.00% methane-in-air.

1.1.2 After the system was calibrated, its power shut-off component operated when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air.

1.1.3 There was no evidence that suggested that the power shut-off components of the system were intentionally by-passed.

1.1.4 No thermal ignition testing was requested. The inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.1.5 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.2 Exhibit Number PE-0313, A General Monitors Model S800 Machine Mounted Methane Monitoring System Components from TG22 Section, Serial Number JM6053.

1.2.1 Before the system was calibrated, its power shut-off component did not operate when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air. The final display reading with this test gas mixture was 1.4. The test gas concentration that caused the power shut-off component to operate was 3.00% methane-in-air.

1.2.2 After the system was calibrated, its power shut-off component operated when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air.

1.2.3 The wires connected to terminals 4 and 8 of the 12 position connector included areas that were missing insulation; that area of the wire connected to terminal 4

was wrapped with electrical tape. That area of the wire connected to terminal 8 was bare and dirty with several wire strands broken, suggesting that the area had been manipulated. Terminal 4 is "+15V" and terminal 8 is "CR", or 'Contactor Return'. Under normal operation of the system, terminal 8 is connected to terminal 9 which is "CD", or 'Contactor Drive', which is 12 Vdc. This voltage energizes the coil of the power shut-off component, Relay K1.

Whenever the system initiates a 'trip', an internal relay operates, disconnecting the 12 Vdc from terminal 8. This causes the coil of the power shut-off component to be de-energized.

If the bare area of the wire connected to terminal 8 was in contact with the conductors under the tape on the wire connected to terminal 4, a short circuit of the +15 Vdc supply at terminal 4 to terminal 8 would exist. This would effectively bypass the methane monitoring system, causing the K1 Relay coil to be energized at all times that the system is energized. This short circuit was not present, however, when the system was received.

1.2.4 No thermal ignition testing was requested. The inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.2.5 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.3 Exhibit Number PE-0316, A General Monitors Model S800 Machine Mounted Methane Monitoring System Components and Relay from TG22 Section, Right Miner, Serial Number JM6044.

1.3.1 Before the system was calibrated, its power shut-off component did not operate when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air. The final display reading with this test gas mixture was 1.6. The test gas concentration that caused the power shut-off component to operate was 2.64% methane-in-air.

1.3.2 After the system was calibrated, its power shut-off component operated when the sensor assembly was presented with a test gas mixture of approximately 2.1% methane-in-air.

1.3.3 There was no evidence that suggested that the components of the system had been intentionally by-passed.

1.3.4 No thermal ignition testing was requested. The inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.3.5 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.4 Exhibit Number PE-0342, A General Monitors Model S800 Machine Mounted Methane Monitoring System Components and Relay from HG22-002 Section, Left Joy Continuous Miner, Serial Number JM4918B.

1.4.1 In the as-received condition, this system did not operate properly; the only indication given by the system was "FAULT" on the readout/display/control unit. The power shut-off component was in a position that would not allow a connected machine to operate. Substitution of components with known good components indicated that the as-received Electronics Assembly and the as-received Sensor Assembly were both not functioning properly. Additionally, the resistance of closed contacts of the RC Relay assembly was high in the as-received condition. Although the Power Supply Assembly provided the necessary dc voltage to the Electronics Assembly, and its K1 Relay power shut-off component seemed to operate properly, the K2 Relay for remote light operation did not.

1.4.2 The Sensor Assembly housing was partially filled with water in the as-received condition, and all other components included the appearance of water damage.

1.4.3 The wires connected to terminals 4 and 8 of the 12 position connector included areas that were missing insulation and were wrapped with electrical tape. Additionally, very short lengths of small wire were connected to these terminals. As noted above, if the bare areas of the wires connected to terminal 8 and terminal 4 were in contact, a short circuit of the +15 Vdc supply at terminal 4 to terminal 8 would exist. This would effectively bypass the methane monitoring system, causing the K1 Relay coil to be energized at all times that the system is energized. This short circuit was not present, however, when the system was received.

1.4.4 No thermal ignition testing was requested. The inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.4.5 No set screw was found at the cable entrance gland. One of the sensor cover bolts lock washers was missing.

1.4.6 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.5 Exhibit Number PE-0343, comprising General Monitors Model S800 Machine Mounted Methane Monitoring System Components and Relay From HG22-001 Section, Right Joy Continuous Miner, Serial Number JM5811.

1.5.1 In the as-received condition, the components of this system were wet. After drying, this system did not operate properly; the only indication given by the system was "FAULT" on display. The power shut-off component was in a position that would not allow a connected machine to operate. Substitution of a known good Electronics Assembly indicated that the as-received Electronics Assembly was not functioning properly. Additionally, RC Relay assembly contacts were not fully engaging and the relay was noisy.

1.5.2 The Sensor Assembly enclosure was partially filled with water in the as-received condition, and all other components included the appearance of water damage.

1.5.3 There was no evidence that suggested that the components of the system had been intentionally by-passed.

1.5.4 No thermal ignition testing was requested. The inspection did not reveal any conditions that would suggest that the components of this system caused an explosion.

1.5.5 No set screw was found at the cable entrance gland. One of the sensor cover bolts lock washers was missing.

1.5.6 None of the discrepancies found from comparing the components of the system to the certification documentation were considered significant or would have affected the performance or permissibility of the methane monitoring system.

1.6 Exhibit Number PE-0297, General Monitors Sensor Head. This was a sensor head assembly that was not mounted in a housing. It did not have the appearance that would indicate it was in a housing at the time of the explosion. No tests were requested or performed. There were no conditions that would indicate that this component caused an explosion.