**CAI-2011-13**

**UNITED STATES**
**DEPARTMENT OF LABOR**
**MINE SAFETY AND HEALTH ADMINISTRATION**

**COAL MINE SAFETY AND HEALTH**

# REPORT OF INVESTIGATION

**Underground Coal Mine**

**Fatal Machinery Accident**
**August 8, 2011**

**Century Mine**
**American Energy Corporation**
**Beallsville, Belmont County, Ohio**
**I.D. No. 33-01070**

**Accident Investigators**

**Michael Fasouletos**
**Coal Mine Safety & Health Specialist (Ventilation)**

**William Sperry**
**Coal Mine Safety & Health Specialist (Electrical)**

**Jim Angel**
**Mechanical Engineer, Technical Support (Mechanical and Engineering Safety)**

**Michael Gauna**
**Mining Engineer, Technical Support (Roof Control)**

**Originating Office**
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**District 3**
**604 Cheat Road**
**Morgantown, West Virginia 26508**

**Bob E. Cornett, District Manager**

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## PHOTO of BASE LIFT JACK

## OVERVIEW

On Monday, August 8, 2011, at approximately 10:50 a.m., Keith Baker (Victim), a 41-year old Longwall Mechanic, was struck in the chest by the top of a base lift jack cylinder, resulting in fatal injuries. Baker was conducting maintenance work on the No. 22 Shield of the 11 West Longwall when the accident occurred. Baker was leaning over the base lift jack in the process of evaluating a defective ram cylinder and damaged relay bar at the No. 22 Shield. The shield was lowered from the roof and the incoming pressure turned off in the shield. After the midnight shift on August 6, 2011, the shield was being advanced by the movement of the conveyor by chains connecting the shield to the conveyor. There were no witnesses to the accident.

The primary cause of the accident was the mine operator's failure to ensure that the base lift jack cylinder was protected from over-pressurization. No relief valve or other means was installed to protect the cylinder when the shutoff valve in the hydraulic hose was closed.

## GENERAL INFORMATION

The Century Mine, I.D. 33-01070, is located near Beallsville, in Belmont County, Ohio. American Energy Corporation operates the underground coal mine, which employs 518 persons

of which 467 are underground employees working 10 hour shifts for 3 production shifts per day, 7 days per week. The mine's production averages 22,000 tons per day. Coal is extracted by 5 advancing Mechanized Mining Units (MMU's), using continuous mining machines and one retreating longwall unit. The coal is transported from the working faces by shuttle car to belt conveyors for transport to the surface. Battery powered, rail-mounted, and rubber tired vehicles are used to transport supplies and mine personnel.

The mine accesses the Pittsburgh No. 8 coal seam, which averages 72 inches in height, by ten shaft openings and one slope. The mine liberates 3.5 million cubic feet of methane every 24 hours and was entered into 103(i) status for hazardous spot inspections on October 04, 2004.

The principal officers at this mine at the time of the accident were:

Robert E. Murray …….....President, Murray Energy Corp., American Energy Corporation
Kevin Hughes ……Superintendent, American Energy Corporation, Century Mine
Richard L. Leasure ……....Safety Director, American Energy Corporation, Century Mine

A regular safety and health inspection (E01) by the Mine Safety and Health Administration (MSHA) was ongoing at the time of the accident. The previous E01 inspection conducted by MSHA was completed on June 29, 2011. The Non Fatal Days Lost (NFDL) incident rate for the first quarter of 2011 was 0.67, compared to a National NFDL rate of 3.21.

## DESCRIPTION OF ACCIDENT

On Monday August 8, 2011, the day shift crew entered the mine at 8:00 a.m. under the direction of Randy McKelvey, Section Foreman and traveled to the 11 West Longwall Section. The crew arrived on the section at approximately 8:45 a.m. The midnight shift parked the longwall shearer at the headgate for routine servicing by the day shift upon their arrival. McKelvey assigned Baker, along with Brian McConnell, Mechanic Helper; Chase Kaldor, Shearer Operator (headgate side); Zach Davis, Longwall Helper/Shieldman; and Justin Allen, Shearer Operator (tailgate side), to service the shearer. After the servicing of the shearer was completed, Baker was to change a defective ram bar on the No. 22 Shield.

Servicing of the shearer was completed at approximately 10:20 a.m. and the shearer operators began mining toward the tailgate. Davis left the face and returned to the dinner hole as the shearer was mining towards the tailgate. Meanwhile, McConnell, who was assisting Baker, left the longwall face and was attempting to locate a replacement advancing ram for installation in the No. 22 Shield. When McConnell returned to the headgate area, the headgate operator requested that McConnell relieve him temporarily. During the time McConnell was looking for a replacement ram, Baker was assessing the scope of work to repair the No. 22 Shield and preparing the area by removing debris from the advancing ram area.

Davis returned to the longwall face to assume his duties pulling shields, when he found Baker unconscious in a sitting position, facing toward the conveyor on the headgate skid of No. 21 Shield. Davis actuated the emergency stop on the face conveyor and utilized the face

communication system to summons help. McConnell responded immediately and traveled to the No. 21 Shield to assist Davis. McConnell conducted a patient assessment and no vital signs were detected. Other crew members also responded to assist in administering aid to the victim. CPR was started, the victim was placed on a back board with a C-collar, and transported to a track-mounted, battery powered portal bus and then to the surface. When the surface received notification of the accident, Rick Turner, Rich Hoffman, Randall Curry, and Ernie VanDyne, EMT's (Emergency Medical Technicians), departed the surface and met the vehicle containing the victim outby the South Mains D belt drive. The EMTs entered the portal bus and continued CPR and administrating oxygen enroute to the surface.

Information obtained during the interview process revealed the victim arrived on the surface at approximately 11:32 a.m. The victim was then transferred to the awaiting Somerton Emergency Service and transported to Barnesville Hospital, where he was pronounced dead.

## INVESTIGATION OF THE ACCIDENT

The MSHA Emergency Call Center was notified of the accident on August 08, 2011, at approximately 11:12 a.m., who then notified Gregory Fetty, District 3 Staff Assistant, at approximately 11:22 a.m. Fetty issued a 103(j) Order verbally via the telephone that was later modified to a 103(k) Order upon arrival at the mine site by the accident investigation team. Fetty notified District 3 personnel, and then notified MSHA Headquarters in Arlington, Virginia.

An MSHA investigation was initiated immediately by Michael Fasouletos, Coal Mine Safety and Health Inspector (Ventilation); William L. Sperry, Coal Mine Safety and Health Inspector (Electrical); James L. Angel, Mechanical Engineer, Mechanical and Engineering Safety Division, Approval and Certification Center; and Michael Gauna, Mining Engineer, Roof Control Division, Pittsburgh Safety and Health Technology Center. The investigation was conducted in cooperation with mine management and included persons who represent the miners at this mine, and the Ohio Department of Natural Resources.

Upon arriving at the mine, the investigation team was briefed regarding the circumstances of the accident. The parties agreed to conduct interviews with miners having knowledge of the accident prior to traveling underground. After the interviews were completed, the parties traveled underground to the accident site and began the physical investigation. A preliminary inspection of the accident scene included digital photographs of the accident area. Additional accident information was collected on Monday, August 08, 2011.

The accident investigation team returned to the mine on Tuesday, August 09, 2011, to investigate further the cause of the failed base lift cylinder. Cut off valves were tested for leakage and longwall pressure pumps were tested to determine outgoing pressures. During the investigation, it was determined there was an excessive amount of overtravel in the stroke of the piston in the cylinder of the base lift jack involved in the accident. A representative number of base lift jacks were inspected along the longwall face for damage, condition, and over travel of the base lift piston in the base lift cylinder. The mine operator agreed to complete the testing of the remainder

of the base lift jacks and develop safety precautions to prevent a re-occurrence of a similar type accident.

On Wednesday August 10, 2011, the mine operator completed testing of the base lift jacks, which resulted in 130 jacks being removed from service or repaired. The accident investigation teams returned to assess the overall condition of the base lift jacks on the longwall face. The mine operator submitted a plan to identify all base lift jacks with piston overtravel or any other mechanical or hydraulic problems, remove them from service, and remove all shut off valves connected to the base lift jacks.

## DISCUSSION

Accident Scene

The accident occurred on the 11 West Longwall Section (MMU-012), which began production on June 24, 2011. At the time of the accident, there were 231 longwall roof support shields installed on 1.5 meter spacing along the longwall face. Each shield is equipped with a base lift cylinder. Mining height on the face was 66 inches. The shearing machine was at No. 144 Shield when the accident occurred.

Based upon physical evidence observed at the accident scene and statements obtained during interviews, it was determined the victim was preparing to replace the ram and relay bar assembly in the No. 22 Shield when the accident occurred. The victim's mining belt was located on the base of the tail side skid of the No. 21 shield, to facilitate work in the restricted area of the defective shield. The victim was most likely in close proximity, leaning over the base lift cylinder on the No. 22 shield, when the cylinder failed.

The No. 22 Shield was chained to the face conveyor, due to a defective ram and relay bar. Slack was observed in the attachment chains pulling the shield. The slack in the attachment chains was due to other shields being used to pull the conveyor back. Approximately six inches of stroke was exposed on the ram of the adjacent No. 21 Shield, indicating the panline had been pulled away from the face to facilitate work on the No. 22 Shield relay bar-ram assembly.

During the accident investigation, the incoming hydraulic pressure was confirmed as being turned off in No. 22 shield and base lift cylinder. The failed base lift cylinder was painted red in color and had a predominant marking of "DHI," on the separated top of the cylinder, indicating Dover Hydraulics Inc., which was the last vendor to rebuild the base lift jack. Visually, it was determined that that rod of this hydraulic cylinder could not retract fully into the cylinder. The drawing provided of the base lift cylinder illustrated the base lift cylinder as being retracted fully. Physically, the piston of the failed hydraulic base life cylinder would contact the bottom of the cylinder internally and not retract fully. Oxidization was observed on the exposed surface on the top of the hydraulic cylinder and the outer edge of the cap portion that separated from the cylinder. No hydraulic pressure relief is provided in the base lift hydraulic circuit.

General Machine Information

The 4160 volt, 3-phase, 60 hertz longwall mining system involved in the accident was assembled by the American Coal Company. It received MSHA Approval No. 2G- 3856A-2 on April 18, 2002. The approval covered a Joy shearer, SE-18612-0, 400 hp (horsepower) or 250 hp stage loader and crusher motors, and up to 1000 hp face conveyor motors (3 max.). The maximum face was specified at 1500 ft. There were 231 shields (1.5 meters width) on the 1138 foot, 11 West Panel. At the time of the accident, the face conveyor advance cycle had been completed. The shearer was located at the No. 144 Shield and reported to have been mining towards the tailgate.

Mine personnel reported that the longwall mining system used approximately a 97% water – 3% hydraulic fluid emulsion in the system's hydraulic circuit. Three pumps provided hydraulic pressure. One pump's relief valve was reportedly set at 4500 psi (pounds per square inch), the second at 4300 psi, and the third was set at 4100 psi. When the pressure was measured directly at the discharge of the pumps, the maximum pressure that the three pumps could generate was found to be 4700 psi.

Each shield assembly included a base lift jack. The base lift jack is vertically mounted on the steel bridge (also called the tombstone) between the two pontoons of the shield base and positioned above the shield's relay bar. During the shield advance cycle, when the shield canopy is lowered away from the roof, this jack is automatically pressurized and a downward force is applied to the shield's relay bar which presses it against the floor. This action lifts the front of the shield's pontoons during the forward movement of the shield. Lifting of the front of the pontoons assists in sliding through rubble and prevents the pontoons from digging into soft floor as the shield is moved forward.

The relay bar rests on the floor between the shield's two pontoons. It connects the shield's advancing ram (hydraulic) cylinder to the face conveyor. The shield end (rear) of the relay bar is connected to the piston end of the ram cylinder. The cylinder body is connected to the shield structure. The front end of the relay bar is connected by linkage to the base of the conveyor. When the piston connected to the relay bar is extended, the relay bar is placed in tension and the shield, when depressurized from the roof, can be moved closer to the conveyor. When the piston is retracted, the relay bar is placed in compression and the shield and conveyor can move away from each other when the shield is pressurized against the roof. If the relay bar is not forced to the ground by the base lift jack pressing down on it, the relay bar can move several inches up off the floor and toward the shield. This movement is limited by the looseness of the connections between the relay bar and the conveyor.

The relay bar is approximately 12 ft. long from its connection at the rear of the shield, to its connection at the conveyor. At the accident site shield, the base lift jack was located approximately 5 ft. from the shield end (rear) of the relay bar. When the linkage that connects the relay bar to the conveyor causes the relay bar to rise off the bottom, the relay bar acts as a lever that pivots at its rear end. For the shield at the accident site, any upward force that is generated at the conveyor connection is then increased by a factor of approximately 2.4 at the base lift jack.

Longwall Shield Controls and Operation

Each shield was provided with a Joy Mining Machinery (Joy) electronic control panel positioned below the canopy and above the base lift jack. At the time of the accident, there was ample room for the victim to position himself between the top of the base lift jack and under the control panel. In a re-creation of the likely position of the victim at the time of the accident, with his chest over top of the base lift cylinder, the victim could have reached behind and above his body to place his hand in the control panel. The buttons on the control panel could not be seen, but could be activated by feel. Through activation of the panel controls, it was demonstrated that an adjacent shield's relay bar cylinder could be extended to pull the adjacent shield closer to the conveyor. In doing so, it also moved the conveyor closer to the No. 22 Shield involved in the accident. This caused the No. 22 Shield's relay bar that was attached to the conveyor to move back toward the shield and rise up off of the floor.

Longwall Plumbing Design and Base Lift Jack Information

The mine operator stated that the shield was manufactured by the Montgomery Equipment Co. The shield was reportedly manufactured about 2001. The base lift jack had been replaced by one manufactured by the Morgantown Machine Co., now a part of Swanson Industries. The replacement jack was most likely manufactured after 2006. The mine operator provided a "Westmoreland Piping Diagram" for the shields. This schematic did not include a title block, drawing number, or date. The drawing did not specify the working pressure of the system. The drawing appeared to represent the base lift jack circuit at the time of the accident.

The original design of the hydraulic schematic could not be confirmed at the time of this report. The Westmoreland Piping Diagram likely refers to a longwall system designed by the Westmoreland Coal Co. that was likely produced by the Gallick Co., which, through several acquisitions, may now be owned by Joy. Montgomery Equipment Co. stated that the shields were manufactured by Midwest Equipment Co. which has gone out of business and the hosing for the hydraulic system was purchased from United Mining Equipment. Information on the design of the hydraulic system has been requested from all of these companies, however, no confirmation on the piping diagram has been provided to date. The MSHA approval documentation does not cover the longwall's hydraulic system.

The base lift jack is supplied with pressure through a connection to the retract side of the shield leg cylinders. When the shield is lowered, the base lift jack is also pressurized (piston extended) to force the relay bar against the mine floor and raise the shield's pontoons. There is a ball valve between the leg cylinder and the base lift jack to shut off flow to the jack. There is no relief valve between the ball valve and the jack. Therefore, the jack is not protected from any pressure increase that may occur on the top of the piston as a result of the ball valve being closed and a mechanical force being exerted to push the piston into the cylinder.

When no pressure is provided to retract the leg cylinders, the leg cylinder hoses (retract) and the base lift jack hose (extend) are open to the tank. However, since the base lift jack is below the hoses to the tank, the pressure would be relieved, but fluid would remain in the cylinder and the

connecting supply hose. Consequently, when the ball valve in this hose is closed, the fluid in the hose and jack is trapped.

The retract side hose of the base lift jack is always open to tank. In this arrangement, the retract side of the cylinder can not be pressurized in order to hydraulically retract the jack's piston. In normal operation with the extend hose open to tank, the piston only retracts (floats) when an upward force from the relay bar is applied to the bottom of the piston. Note that the piston extends approximately 1 and 3/8" out of the cylinder when it is fully retracted. Therefore, the top of the piston would impact against the top of the cylinder, whenever the piston would be forced into the cylinder. If an upward force is applied while the jack is being pressurized, the relief valves at the pumps likely prevent any over pressurization. If however, the ball valve in the jack's extend hose is closed, then the pressure would be trapped in the top of the jack's cylinder and the connecting hose.

The mine operator provided two drawings for a base lift jack, a Swanson Industries Drawing No. SP-002280-000-SO, Base Lift Assembly 140/105/220, dated 3-7-09 and a BSC Downard LLC drawing, Drawing No. 5105A100, Base Lift, sheet 2 of 2 (no date). Although the drawings were similar to the jack installed on the shield, neither drawing depicted the jack accurately. Neither drawing specified the working pressure of the jack.

The base lift jack had a plate with "D.H.I." welded to it and a serial number plate with "84071 6/7/11." The number "84071" was also found stamped into the cylinder body. Information from the mine operator indicated that this jack had been repaired by Dover Hydraulics, Inc. Dover was contacted and they confirmed that they had repaired the jack. Dover also stated:

- "DHI's process for inspection of jacks is based upon the skill of the craft. A person performing the inspection of the jack will visually inspect each component of the jack."
- The following items were installed; new rod, new piston, new rod end, new head gland, new ports, hone tube, weld tube to attach DHI tag, weld ports, and replace seal kit.
- "DHI proof testing's purpose is to verify that the cylinder cycles properly and that it does not leak."
- "The basis to determine the working pressure of the jack and testing pressure of the jack was to ensure the cylinder stroked in and out properly and did not leak."
- "The base lift jacks are tested at 4000 psi in water glycol. Each one is cycled 20 times."
- "DHI did not receive any instructions or specifications for the jacks other than an approved Purchase Order to perform the work. DHI did not provide any safety information on the jack to the customer."

Swanson Industries was contacted, since they were considered the most likely manufacturer of the jack. Swanson stated that they had sold base lift jack cylinders to the Montgomery Equipment Company. Based on their evaluation of the jack, they considered the jack closely matched jacks manufactured in 2006, with the exception of the length of the piston rod, which was changed by Dover Hydraulics during their June 7, 2011 rebuild. Swanson Industries specified that the maximum operating pressure of the jack was 5000 psi.

It was also found that at an undetermined time prior to the accident, an improper weld repair was made to the cylinder by the mine operator. This repair reduced the strength of the end cap. The cylinder defect would likely have been prevented or identified by adhering to industry standards in design, proper welding, nondestructive examination, and proof testing of the cylinder in accordance with industry standards after manufacture, the weld repair, and rebuild.

Mine Operator Maintenance Records

No maintenance records for the base lift jack were available from the mine operator. It is noted that the mining of the longwall panel began on June 27, 2011 and had proceeded 4958 ft. at the time of the accident. On August 6, 2011, the shield's relay bar was reported as being defective and the shield was taken out of service by shutting off all hydraulic power (main hydraulic valve supplying pressure to all of No. 22 Shield's cylinders), but not electrical power, to the shield. In addition, the ball valve in the hose that supplied pressure to extend the base lift jack was also closed. No damage to the base lift jack extend hose (Manuli RockMaster, model 2SN DN10, 3/8" I.D., working pressure 5000 psi, burst pressure of 20,300 psi), or either of the ball valves, was observed.

The relay bar had become damaged and disconnected from the piston end of the ram cylinder that connected the relay bar to the shield's structure. Since the relay bar was disconnected from the shield, the shield could no longer be moved under its own hydraulic power. A chain was connected between each of the shield's pontoons and the conveyor. This allowed the shield to be pulled forward (towed) as the adjacent shields moved the conveyor forward. It was noted that the relay bar ram cylinder did not have any accumulations of material on it, while the cylinders on the adjacent shields were covered with debris. This indicated that the victim had been working on the cylinder.

Evaluation of the Failed Lift Jack Cylinder

At MSHA's request, the lift jack cylinder was evaluated by Constellation Technology[1] to:

- Analyze the design and build of the cylinder to estimate the design failure pressure and the as-built failure pressure.
- Analyze the weld application to determine any manufacturing defect.
- Examine the cylinder for evidence of physical damage prior to failure, and determine the failure mode and initiation site.
- Determine applicable or related industry standards for cylinder design, welds and test specifications.

It was determined that:

- The minimum design specifications for the cylinder provided an estimated failure pressure of 9820 psi. For the purposes of this investigation, the failure pressure is considered the pressure at which the cylinder ruptures. More typically, the failure pressure is considered a lower pressure at which permanent deformation occurs.
- The as-built estimated failure pressure was between 6125 psi and 9800 psi. Note that the actual material tensile strength greatly exceeded the minimum design specification,

[1] Jackson, R., Swartz, W.E., Test Report – A112772, Constellation Technology, Largo, FL, 11/16/2011.

resulting in a high end failure estimate, near that provided by the minimum design specification material, even with the weld defect noted below.

- The failure initiation site occurred at an improper repair weld.
- No fatigue or impact damage to the cylinder was noted. However the improper weld repair at the failure initiation site caused hydrogen embrittlement of the original weld.
- The closing of a valve that trapped hydraulic fluid in the cylinder resulted in an over pressurization of the cylinder when the piston was subjected to external mechanical forces.
- The American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Volume VIII, Division I Rules for Construction of Pressure Vessels; Volume IX, Welding and Brazing Qualifications; Volume V Nondestructive Examination; International Organization for Standardization 10771- Hydraulic fluid power -- Fatigue pressure testing of metal pressure-containing envelopes, Parts 1 and 2; and SAE J1334, Hydraulic Cylinder Integrity Test, are applicable industry standards that specify safe design, manufacture, and testing of hydraulic cylinders.

Testing Conducted at Accident Scene

A calibrated gauge was installed at the hydraulic pumping station and 4,700 psi was available at this location. The cut off valves from the incoming pressure and to the pressure supply to the base lift cylinder were removed from the shield and installed at the pumping station for testing. Operating handles on the valves were in the normal orientation for open and closed position. No significant bypass was noted when pressure was applied to the valves, ruling out overpressure from the pumping station as a contributor to the base lift jack failure.

To simulate a possible work activity by the victim, the conveyor was pulled back by an adjacent shield. The relay bar rose up and contacted the foot of the base lift cylinder, simulating the condition that could have caused overpressure in the base lift jack. The failed base lift cylinder and a similar spare base lift cylinder were retrieved by MSHA Technical Support for further testing and evaluation.

The 103(k) Order was modified by MSHA to allow the company to test and evaluate all base lift cylinders on the face. Base lift cylinders that were non-functioning due to other hydraulic or mechanical problems were marked with blue paint. Any cylinders that would not retract fully were marked with green paint. Of the 231 base lift jacks tested on the longwall face, 103 were painted green, indicating they would not fully retract and 27 were marked blue, indicating other mechanical or hydraulic problems were encountered. All base lift cylinders suspected of over-pressurization were identified were removed from the face for evaluation by the mine operator.

Training and Experience

Baker was an experienced miner and mechanic, all at the Century mine. He had approximately ten years experience as a miner, including seven years and eight months as a longwall mechanic.

Training records for the victim were reviewed and found to be current.

## ROOT CAUSE ANALYSIS

An analysis was conducted to identify the underlying cause of the accident that was correctable through management controls. During this analysis, root causes were identified, that if eliminated, would have either prevented the accident or mitigated its consequences.

Listed below are root causes identified during the analysis and their corresponding corrective actions being implemented to prevent a recurrence of the accident.

*Root Cause:*
The mine operator failed to assure the safe operating condition of the longwall shields operating on the 11 West longwall. The investigation revealed that modification of the base lift that did not adhere to the original cylinder design. A base lift cylinder, located on the number 22 Shield, was determined to have a rod stroke that exceeded the available travel of the piston in the hydraulic cylinder. The end of the rod is exposed to upward movement of relay bars when the shields are placed in push modes, when shields are advanced, or any similar movement of the conveyor away from the face. This action can impact the structure of the cylinder physically or intensify the internal pressure of the cylinder beyond the designed working pressure. In addition, at an undetermined time prior to the accident, an improper weld repair was made to the cylinder, which reduced the strength of the end cap. The cylinder defect would likely have been prevented or identified by adhering to industry standards in design, proper welding, nondestructive examination, and proof testing of the cylinder in accordance with industry standards after manufacture, the weld repair, and rebuild.

*Corrective Action*
All base lift cylinders suspected of over-pressurization were identified and removed from the face for evaluation. The mine operator has designed and installed hydraulic protection to limit the pressure in the base lift cylinder hydraulic circuit. The design and modifications were reviewed by a professional engineer.

The mine operator developed safety precautions to prevent a reoccurrence of a similar type accident and trained the affected miners on the safety precautions.

## CONCLUSION

The most likely accident scenario is that in preparation to repair the damaged end of the relay bar, the victim leaned over the top of the base lift jack to evaluate the damage. Since all hydraulic power to the shield had been shut off and the conveyor advance cycle had been completed, the victim had no reasonable expectation that any No. 22 Shield hydraulic component movement or any hydraulic component failure would occur. It is believed that the victim reached behind and above his body to activate the buttons on the Joy control panel. This moved the relay bar of one of the adjacent shields to bring the shields and face conveyor closer together. When the conveyor moved, the No. 22 Shield's relay bar moved up, striking the bottom of its base lift jack piston rod. The position of the relay bar in relation to the base lift jack caused it act as a lever to multiply the upward force on the lift jack's piston rod. This upward movement caused a hydraulic pressure spike in the top of the cylinder. This pressure spike, estimated at between 6125 psi and 9800 psi, caused the failure of the cylinder's cap. The cap struck the victim in the chest, resulting in fatal injuries.

The primary cause of the accident was the mine operator's failure to ensure that the cylinder was protected from over-pressurization. No relief valve or other means was installed to protect the cylinder when the shutoff valve in the hydraulic hose was closed. Information was not available to determine if the original design of hydraulic system included a means to prevent over-pressurization of the cylinder.

Additionally, at an undetermined time prior to the accident, an improper weld repair was made to the cylinder, which reduced the strength of the end cap. The cylinder defect would likely have been prevented or identified by adhering to industry standards in design, proper welding, nondestructive examination, and proof testing of the cylinder in accordance with industry standards after manufacture, the weld repair, and rebuild.

Bob E. Cornett
District Manager

6-18-2012
Date

## ENFORCEMENT ACTIONS

1. A 103(k) Order was issued to ensure the safety of the miners until the investigation could be completed.

2. A 104(a) Citation was issued for a violation of CFR 30, § 75.1725(a):

The mine operator failed to maintain the base lift cylinder jack for the No. 22 longwall Shield in a safe operating condition. On Monday, August 8, 2011, at approximately 10:50 a.m., Keith Baker, a 41 year old Longwall Mechanic was struck in the chest by the top of a base lift jack cylinder, when the end cap blew off, resulting in fatal injuries. Baker was in the process of conducting maintenance work on the No. 22 Shield of the 11 West Longwall when the accident occurred. Baker was leaning over the base lift jack in the process of evaluating a defective ram cylinder and damaged relay bar at the No. 22 shield. The investigation revealed that at an undetermined time prior to the accident, an improper weld repair was made to the cylinder. This repair reduced the strength of the end cap. The cylinder defect would likely have been prevented or identified by adhering to industry standards in design, proper welding, nondestructive examination, and proof testing of the cylinder in accordance with industry standards after manufacture, the weld repair, and rebuild.

**APPENDIX A –** Persons Participating in the Investigation

Listed below are the persons furnishing information and/or present during the investigation:

**MINE SAFETY AND HEALTH ADMINISTRATION**

| | |
|---|---|
| Michael A. Fasouletos | Coal Mine Safety & Health Inspector (Ventilation) |
| William L. Sperry | Coal Mine Safety & Health Inspector (Electrical) |
| James L. Angle | Mechanical Engineer, Mechanical & Engineering Safety Division, Approval and Certification Center |
| Michael Gauna | Mining Engineering, Roof Control Division, Pittsburgh Safety & Health Technology Center |

**OHIO DEPARTMENT OF NATURAL RESOURCES**

| | |
|---|---|
| John Ziants | DMRM Underground Supervisor |
| Craig Corder | DMRM Mine Safety Manager |
| Mel Byers, Jr. | DMRM Mine Safety Inspector II |
| Richard Hurley | DMRM Mine Safety Inspector II |

**MINING COMPANY OFFICIALS**

| | |
|---|---|
| Robert Moore | Executive Vice President, Chief Financial Officer and Member of the Board of Directors |
| Ryan Murray | Vice President, Operations |
| John R. Forrelli | Vice President, Engineering & Planning |
| Jim Turner | Vice President, Operations Engineering |
| Pat Brady | Manager of Regulatory Affairs |
| Jeff Wirth | Corporate Safety Director |
| Allen McGilton | Assistant Corporate Safety Director |
| Kevin R. Hughes | General Manager and Superintendent |
| Ron VanHorne | Manager of Injury - Prevention/Compliance |
| Jerry M. Taylor | Manager Plan Approval & Assessments |
| William Mullett | Assistant Safety Director (Century) |
| Bill Benline | General Mine Foreman (Century) |
| Mike McKown | Senior Vice President, Secretary & General Counsel |
| Bill Williams | Vice President AEMI |
| Ed Lane | Foreman, Long Wall Production (Century) |
| Mathew H. Nelson | Counsel |
| Gary Broadbent | General Council |
| John Artz | Counsel |

**APPENDIX B –** Persons Interviewed

| | |
|---|---|
| Zach Davis ..... | Longwall Helper (Shieldman) |
| Brian McConnell..... | Longwall Mechanic |
| Randy McKelvey ..... | Longwall Foreman |
| Tim McKelvey..... | Longwall Helper (Shieldman) |
| Justin Allen ..... | Tailgate Shear Operator |
| Chase Kaldor..... | Headgate Shear Operator |
| Rick Turner..... | EMT |
| Rich Hoffman..... | EMT |
| Randall Curry..... | EMT |
| Ernie VanDyne..... | EMT |

## **APPENDIX D –** Victim Information

Accident Investigation Data - Victim Information

Event Number: 6 2 6 0 8 9 1

**U.S. Department of Labor**
Mine Safety and Health Administration

Victim Information: 1

| 1. Name of Injured/Ill Employee: | 2. Sex | 3. Victim's Age | 4. Degree of Injury: |
|---|---|---|---|
| *Keith A. Baker* | *M* | *41* | *01 Fatal* |

| 5. Date(MM/DD/YY) and Time(24 Hr.) Of Death: | 6. Date and Time Started: |
|---|---|
| *a. Date: 08/08/2011 b.Time: 10:50* | *a. Date: 08/08/2011 b.Time: 8:01* |

| 7. Regular Job Title: | 8. Work Activity when Injured: | 9. Was this work activity part of regular job? |
|---|---|---|
| *004 Mechanic _ Longwall* | *039 Machine maintenance/repair* | Yes \| X \| No \| |

| 10. Experience | Years | Weeks | Days | | Years | Weeks | Days | | Years | Weeks | Days | | Years | Weeks | Days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. This Work Activity: | *6* | *24* | *0* | b. Regular Job Title: | *6* | *24* | *0* | c: This Mine: | *9* | *49* | *0* | d. Total Mining: | *9* | *49* | *0* |

| 11. What Directly Inflicted Injury or Illness? | 12. Nature of Injury or Illness: |
|---|---|
| *067 Longwall supports; jack* | *370 Multiple injuries* |

13. Training Deficiencies:
Hazard: | | New/Newly-Employed Experienced Miner: | | Annual: | | Task: | |

14. Company of Employment: (If different from production operator)
*Operator*
Independent Contractor ID: (if applicable)

15. On-site Emergency Medical Treatment:
Not Applicable: | | First-Aid: | X | CPR: | X | EMT: | X | Medical Professional: | | None: | |

16. Part 50 Document Control Number: (form 7000-1) *220112290034* 17. Union Affiliation of Victim: *9999* *None (No Union Affiliation)*