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

REPORT OF INVESTIGATION

Fatal Underground Mine Explosion
April 5, 2010

Upper Big Branch Mine-South, Performance Coal Company
Montcoal, Raleigh County, West Virginia, ID No. 46-08436

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EXECUTIVE SUMMARY

On April 5, 2010, at approximately 3:02 p.m., a massive coal dust explosion occurred at the Upper Big Branch Mine-South (UBB), killing 29 miners and injuring two. UBB is operated by Performance Coal Company (PCC), a former subsidiary of Massey Energy Company (Massey) (together PCC/Massey), and is located in Montcoal, West Virginia. This tragic explosion was the largest coal mine disaster in the United States in 40 years.

Immediately following the explosion, President Barack Obama called Secretary of Labor Hilda Solis and Assistant Secretary for Mine Safety and Health Joseph Main to the White House and charged them with conducting the most thorough and comprehensive investigation possible. The President directed Secretary Solis to work with the Justice Department to ensure that the government also investigated any potential criminal activity.

The Department of Labor's Mine Safety and Health Administration (MSHA) conducted its investigation under the authority of the Federal Mine Safety and Health Act of 1977 (Mine Act), which requires that authorized representatives of the Secretary of Labor carry out investigations in mines for the purpose of obtaining, utilizing, and disseminating information relating to the causes of accidents. This report is the product of that investigation, which included a comprehensive underground examination, 269 individuals interviewed, review of some 88,000 pages of documentary evidence, detailed mapping of the mine, inspection and testing of thousands of pieces of physical evidence, and the commissioning of outside experts to study the disastrous explosion. It describes the events leading up to the UBB explosion, rescue and recovery operations, the investigative process, the physical causes of the explosion, the root cause and contributory causes, and the citations and orders issued for safety and health violations. MSHA and the Department of Labor's Office of the Solicitor continue to cooperate with the Department of Justice in the criminal investigation of the tragedy.

MSHA conducted the underground investigation in coordination with the West Virginia Office of Miners' Health Safety and Training (WVOMHST), the Governor's Independent Investigative Panel (GIIP), and PCC/Massey. The United Mine Workers of America (UMWA) participated in the investigation in its capacity as a representative of miners designated pursuant to the Mine Act, as did Moreland & Moreland, l.c.

Many witnesses tragically lost their lives on April 5, 2010. In addition, a number of witnesses exercised their rights under the Fifth Amendment to the U.S. Constitution and declined to be interviewed. Despite the unavailability of their testimony, MSHA has determined the likely causes of the explosion.

Overview of the UBB Accident Investigation Report's Findings

The 29 miners who perished at UBB died in a massive coal dust explosion that started as a methane ignition. The physical conditions that led to the explosion were the result of a series of basic safety violations at UBB and were entirely preventable. PCC/Massey disregarded the resulting hazards. While violations of particular safety standards led to the conditions that caused the explosion, the unlawful policies and practices implemented by PCC/Massey were the root cause of this tragedy. The evidence accumulated during the investigation demonstrates that PCC/Massey promoted and enforced a workplace culture that valued production over safety, including practices calculated to allow it to conduct mining operations in violation of the law.

The investigation also revealed multiple examples of systematic, intentional, and aggressive efforts by PCC/Massey to avoid compliance with safety and health standards, and to thwart detection of that non-compliance by federal and state regulators.

Witness testimony revealed that miners were intimidated by UBB management and were told that raising safety concerns would jeopardize their jobs. As a result, no safety or health complaints and no whistleblower disclosures were made to MSHA from miners working in the UBB mine in the approximately four years preceding the explosion. This is despite an extensive record of PCC/Massey safety and health violations at the UBB mine during this period.

PCC/Massey established a practice of using staff to relay advance notice of health and safety inspections to mine personnel when federal and state inspectors arrived at the mine. The advance notice allowed PCC/Massey employees to conceal violations from enforcement personnel. PCC's chief of security was convicted in federal court for lying to MSHA about whether advance notice was a practice at UBB; the evidence at the trial showed that it indeed was a practice and he had directed UBB personnel to provide advance notice of inspectors' arrival on the mine property. His conviction underscores the extent to which practices designed to hide PCC/Massey safety and health violations were engrained at UBB.

PCC/Massey kept two sets of books with respect to safety and health hazards in the UBB mine. The first set was the required examination book mandated by the Mine Act, which was open for review by MSHA and miners and was required to include in it a complete record of all hazards identified by PCC examiners and other company officials. PCC/Massey also maintained a second set of books that reported on production and maintenance, as well as hazards and violations of law. PCC/Massey noted some hazards in this second set of books that it did not record in the required examination books. PCC/Massey did not make this second set of books available to mine employees or inspectors.

PCC/Massey allowed conditions in the UBB mine to exist that set the stage for a catastrophic mine explosion. The tragedy at UBB began with a methane ignition that transitioned into a small methane explosion that then set off a massive coal dust explosion. If basic safety measures had been in place that prevented any of these three events, there would have been no loss of life at UBB.

PCC/Massey could have prevented the methane ignition and explosion had it maintained its longwall shearer in safe operating condition. A longwall shearer is part of a longwall mining machine and has large rotating cutting drums equipped with bits that cut coal as it moves on a track across the working face. A system of water sprays suppresses dust as well as “hot streaks,” which are smears of metal found on rock when metal is heated to near its melting point from friction caused by the shearer’s bits hitting into layers of rock above or below the coal seam. PCC/Massey operated the shearer at UBB with worn bits and missing water sprays, creating an ignition source for methane on the longwall.

Had PCC/Massey followed basic safety practices, the small methane explosion that set off the dust explosion would have been contained or prevented. PCC/Massey did not take proper measures to detect methane concentrations throughout the mine. PCC/Massey’s failure to comply with UBB’s approved ventilation and roof control plans exacerbated the risk of methane accumulation. The law requires adequate ventilation of underground coal mines to prevent unsafe levels of methane and other dangerous gasses, and provide miners with breathable air. PCC/Massey ventilation practices led to erratic changes in air flow and direction. Its failure to install supplemental roof supports as required by UBB’s plan led to a roof fall in an airway that limited airflow, contributing to the accumulation of methane in the area where the explosion originated.

Finally, PCC/Massey violated fundamental safety standards by permitting significant amounts of float coal dust, coal dust, and loose coal to accumulate in the mine. This became the fuel for the explosion. Sufficient rock dust, used to make coal dust inert and prevent it from catching fire or fueling an explosion, would have prevented a coal dust explosion from occurring. PCC/Massey did not follow the fundamental safety practice of applying rock dust adequately to eliminate this hazard.

PCC/Massey knew or should have known about all of these hazards but failed to take corrective action to prevent a catastrophic accident. For example, UBB’s required examination books showed records of hazards that PCC/Massey did not correct. The examination books also showed that PCC/Massey failed to perform required pre-shift, on-shift, and weekly examinations to find and correct hazards. When the books indicated PCC/Massey examiners did conduct exams, they failed to identify obvious hazards, such as accumulations of loose coal, coal dust, and float coal dust in the area where the explosion occurred.

<u>Specific Accident Investigation Conclusions – PCC/Massey's Management Practices that Led to the Explosion</u>

PCC/Massey failed to perform required mine examinations adequately and remedy known hazards and violations of law

MSHA regulations require mine operators to examine certain areas of the mine on a weekly basis, as well as before and during each shift, to identify hazardous conditions. MSHA's accident investigation found that PCC/Massey regularly failed to examine the mine properly for hazards putting miners at risk and directly contributing to the April 5 explosion. At UBB, PCC/Massey examiners often did not travel to areas they were required to inspect or, in some cases, travelled to the areas but did not perform the required inspections and measurements. For example, PCC/Massey conducted no methane examinations on the longwall tailgate, the area of the longwall where the explosion began, in the weeks prior to the explosion. Even when PCC/Massey performed inspections and identified hazards, it frequently did not correct them. Because of these practices, loose coal, coal dust, and float coal dust accumulated to dangerous levels over days, weeks, and months and provided the fuel for the April 5 explosion.

PCC/Massey kept two sets of books, thus concealing hazardous conditions

During the course of the investigation, MSHA discovered that PCC/Massey kept two sets of books at UBB: one set of production and maintenance books for internal use only, and the required examination books that, under the Mine Act, are open to review by MSHA and miners. MSHA regulations mandate that the required examination books contain a record of all hazards. Enforcement personnel must rely on their accuracy and completeness to guide them in conducting their physical inspections.

PCC/Massey often recorded hazards in its internal production and maintenance books, but failed to record the same hazards in the required examination book provided to enforcement personnel to review. Some of the hazards described in the hidden "second set of books" were consistent with conditions that existed at the time of the explosion, including the practice of removing sprays on the longwall shearer. Testimony from miners at UBB revealed they felt pressured by management not to record hazards in the required examination books. Furthermore, even when PCC/Massey recorded hazards in the required examination books – such as belts that needed to be cleaned or rock dusted – it often failed to correct the identified hazards.

In addition to undocumented hazards in the required examination books, PCC/Massey failed to report accident data accurately. MSHA's post-accident audit revealed that, in 2009, UBB had twice as many accidents as the operator reported to MSHA.

PCC/Massey intimidated miners to prevent MSHA from receiving evidence of safety and health violations and hazards

The Mine Act protects miners if they are fired or subjected to other adverse employment actions because they reported a safety or health hazard. These whistleblower protections give miners a voice in the workplace and allow them to protect themselves when mine operators engage in illegal and dangerous practices. Testimony revealed that UBB's miners were intimidated to prevent them from exercising their whistleblower rights. Production delays to resolve safety-related issues often were met by UBB officials with threats of retaliation and disciplinary actions. On one occasion when a foreman stopped production to fix ventilation problems, Chris Blanchard, PCC's president, was overheard saying: "If you don't start running coal up there, I'm going to bring the whole crew outside and get rid of every one of you." Witness interviews also revealed that a top company official suspended a section foreman who delayed production for one or two hours to make needed safety corrections.

MSHA did not receive a single safety or health complaint relating to underground conditions at UBB for approximately four years preceding the explosion even though MSHA offers a toll-free hotline for miners to make anonymous safety and health complaints. PCC/Massey also had a toll-free number for safety and health complaints, but miners testified that they were reluctant to use it for fear of retaliation.

PCC/Massey failed to provide adequate training for workers

Records and testimony indicate that PCC/Massey inadequately trained their examiners, foremen and miners in mine health and safety. It failed to provide experienced miner training, especially in the area of hazard recognition; failed to provide task training to those performing new job tasks; and failed to provide required annual refresher training. This lack of training left miners unequipped to identify and correct hazards at UBB.

PCC/Massey established a regular practice of giving advance notice of inspections to hide violations and hazards from enforcement personnel

Under the Mine Act, it is illegal for mine operators' employees to give advance notice of an inspection by MSHA enforcement personnel. Despite this statutory prohibition, UBB miners testified that PCC/Massey mine personnel on the surface routinely notified them prior to the arrival of enforcement personnel. Miners and others testified they were instructed by upper management to alert miners underground of the arrival of enforcement personnel so hazardous conditions could be concealed. UBB dispatchers testified they were told to notify miners underground when MSHA inspectors arrived on the property, and if they did not, there would be consequences.

Advance notice gave those underground the opportunity to alter conditions and fix or hide hazards immediately prior to enforcement personnel's arrival on the working section. PCC/Massey also made ventilation changes in the areas where MSHA inspectors planned to travel, concealing actual production conditions from enforcement personnel.

On October 26, 2011, Hughie Elbert Stover, PCC's former head of security for UBB, was found guilty in the United States District Court for the Southern District of West Virginia of a felony count of making false, fictitious and fraudulent statements to MSHA regarding company policy on advance notice. In an interview with the MSHA accident investigation team, Stover testified that Massey had a policy prohibiting security guards from providing advance notice of MSHA inspections; however, the evidence indicated that he had personally directed guards to provide advance notice.

Specific Accident Investigation Conclusions – Physical Causes of the Explosion

A small amount of methane, likely liberated from the mine floor, accumulated in the longwall area due to poor ventilation and roof control practices

Based on physical evidence, the investigation concluded that methane was likely liberated from floor fractures into the mine atmosphere on April 5, the day of the explosion. The investigation team subsequently identified floor fractures with methane liberation at longwall shields (a system of hydraulic jacks that supports the roof as coal is being mined) near the tailgate, the end of the longwall where the explosion began. This methane liberation occurred because PCC/Massey mined into a fault zone that was a reservoir and conduit for methane. MSHA believes that this is the same fault zone associated with methane inundations at UBB in 2003 and 2004, and a 1997 methane explosion.

PCC/Massey's failure to comply with its roof control plan allowed methane to accumulate in the tailgate area. UBB's roof control plan required placement of supplemental supports, in the form of two rows of 8-foot cable bolts or posts, between the primary supports in the longwall tailgate. PCC/Massey installed only one row of these supplemental supports. This lack of roof support contributed to the fall of the tailgate roof, which in turn restricted the airflow leaving the longwall face. The reduced air flow allowed methane to accumulate in the tailgate without being diluted or ventilated from the mine. As a result, an explosive mixture of methane was present in this area.

PCC/Massey failed to maintain the UBB longwall shearer, creating an ignition source for accumulated methane

MSHA has identified the longwall shearer as the likely source of the ignition of the methane accumulated in the tailgate area. PCC/Massey was using the longwall shearer to mine in the area near the tailgate. Evidence showed that methane likely migrated from behind the longwall shields to the longwall shearer, and that an accumulation of methane developed near the tailgate. Evidence also revealed that the longwall shearer was not properly maintained by PCC/Massey. Two of the cutting bits on the tail drum were worn flat and lost their carbide tips. The dull, worn shearer bits likely created an ignition source by creating hot streaks while cutting sandstone.

Well-maintained longwall shearers, which include sharp bits and effective water spray systems, protect against these kinds of ignitions and also control the dust during the mining process. The water sprays create air pressure to move methane away from the area where the shearer is cutting and prevents ignitions by spraying water to suppress hot streaks on the longwall face. At the time of the accident, PCC/Massey's longwall shearer was cutting through both coal and sandstone with seven water-spray nozzles missing. As a result, the shearer did not have the minimum required water pressure. The ineffective sprays failed to move the methane away from the shearer bits and cool the hot streaks created during the mining process. As a result, methane ignited.

The evidence indicated that the flame from the initial methane ignition then ignited a larger accumulation of methane. However, the ignition of the larger body of methane did not happen immediately. Approximately two minutes elapsed between the ignition and the explosion. The electronically recorded event log indicates the shearer was shut off with the remote control just before 3:00 p.m. MSHA has concluded that the tail shearer operator stopped the shearer shortly after the initial ignition, which continued to burn near the longwall tailgate. Realizing that the ignition could not be controlled, the miners in the tailgate area began evacuating. At approximately 3:02 p.m., the flame encountered a larger methane accumulation in the tailgate area, triggering a localized explosion.

PCC/Massey allowed coal dust to accumulate throughout UBB, providing a fuel source for a massive explosion

The small methane explosion near the tailgate immediately encountered fuel in the form of dangerous accumulations of float coal dust and coal dust, which propagated the explosion beginning in the tailgate entry. The resulting coal dust explosion killed the 29 miners. PCC/Massey records demonstrate that examiners allowed these and other accumulations in the mine to build up over days, weeks, and months. Loose coal, coal dust and float coal dust were abundant in all areas of the mine, including the area affected by the explosion. Many of these accumulations were left from the initial development of this area of the mine, indicating a long-established policy of ignoring basic safety practices.

PCC/Massey failed to rock dust the mine adequately to prevent a coal dust explosion and its propagation through the mine

If the mine had been rock dusted so that the coal dust had contained sufficient quantities of incombustible content, the localized methane explosion would not have propagated, or expanded, any further. According to testimony and other evidence, PCC/Massey applied grossly inadequate quantities of rock dust. Miners stated that areas were not well dusted, that the walls, roof and floor in areas of the mine were dark-colored – which indicates a lack of rock dust. There is no evidence that during the mining of the longwall, PCC/Massey ever applied rock dust in the tailgate entry -- the entry where the mine's ventilation system carried coal dust from the mining process. The mine's rock dusting equipment frequently failed As a result of a systematic failure to properly apply rock dust, the coal dust explosion continued to propagate through the mine, killing miners as far as approximately 5,000 feet from the point of ignition.

Rescue and Recovery Efforts at UBB

Intensive rescue activities involving more than 20 rescue teams – including teams from MSHA, PCC/Massey, the WVOMHST, and other mine operators – mobilized and began to search for missing miners soon after the accident occurred on April 5. The presence of combustible gasses in the mine prompted rescue teams to evacuate at least three times during the rescue efforts. On April 9, rescue teams located the last of the victims and determined that none of the 29 miners reported missing had survived. On Tuesday, April 13, the last victim was recovered from the mine.

During rescue and recovery efforts, MSHA family liaisons – pursuant to a program established under the Mine Improvement and New Emergency Response (MINER) Act of 2006 – served as the agency's primary communicators with the families of the missing miners. The liaisons remained with the families continuously from April 5 through April 10. Assistant Secretary Main, Coal Administrator Kevin Stricklin, then-Governor Manchin and, at times, company representatives, gave regular updates to the families on the search for their loved ones.

Specific Accident Investigation Conclusions - Alternate Theories Tested and Found Insufficient

The MSHA accident investigation team carefully considered other possible scenarios to explain the events of April 5, 2010, but a lack of supporting evidence disproved these alternative explanations. One theory tested was that a massive inundation of methane caused the explosion. However, the flame path, pressures generated by the explosion, and the limited quantity of methane detected prior to and after the explosion were inconsistent with that theory. In addition, previous methane inundations at UBB in 2003 and 2004 were localized at the point of gas discharging from fractures in the mine floor and gas release would dissipate within a few days. The volume and pressure of gas and the size of the floor fractures were relatively small. Thus, the volume of gas released from the floor was also small. Similarly, the team could find no evidence to support the theory that the explosion was caused by cutting into a gas well or by a seismic event.

Specific Accident Investigation Conclusions – Citations and Orders Issued

Associated with the issuance of this accident investigation report, MSHA issued 12 citations and orders to PCC/Massey for violations of the Mine Act and its implementing regulations that contributed to the April 5 explosion. MSHA also issued 357 violations of the Mine Act and regulations to PCC/Massey for conditions and practices discovered at UBB that did not directly contribute to the explosion.

MSHA designated 9 of these contributory violations as "flagrant." Flagrant violations, the most serious violations MSHA can issue, are eligible for the highest penalty possible under the Mine Act. The flagrant violations committed by PCC/Massey are:

- illegally providing advance notice to miners of MSHA inspections (a violation of Section 103(a) of the Mine Act);

- failing to properly conduct required examinations and to identify, record, and correct hazards (4 flagrants for violations of 30 CFR sections 75.360, 75.362, 75.363(a), and 75.364);

- allowing hazardous levels of loose coal, coal dust, and float coal dust to accumulate (violation of 30 CFR section 75.400);

- failing to adequately apply rock dust to the mine (violation of 30 CFR section 75.403);

- failing to comply with the approved ventilation plan by operating the shearer with missing and clogged water sprays (violation of 30 CFR section 75.370(a)(1)); and

- failing to adequately train its miners (violation of 30 CFR part 48.3).

PCC/Massey also committed three contributory violations that were not flagrant:

- failing to maintain the longwall shearer (worn bits) in safe operating condition (violation of 30 CFR 75.1725(a));

- failing to comply with its approved roof control plan in the 1 North Panel tailgate entry, as required by the approved roof control plan (violation of 30 CFR 75.220(a)(1)); and

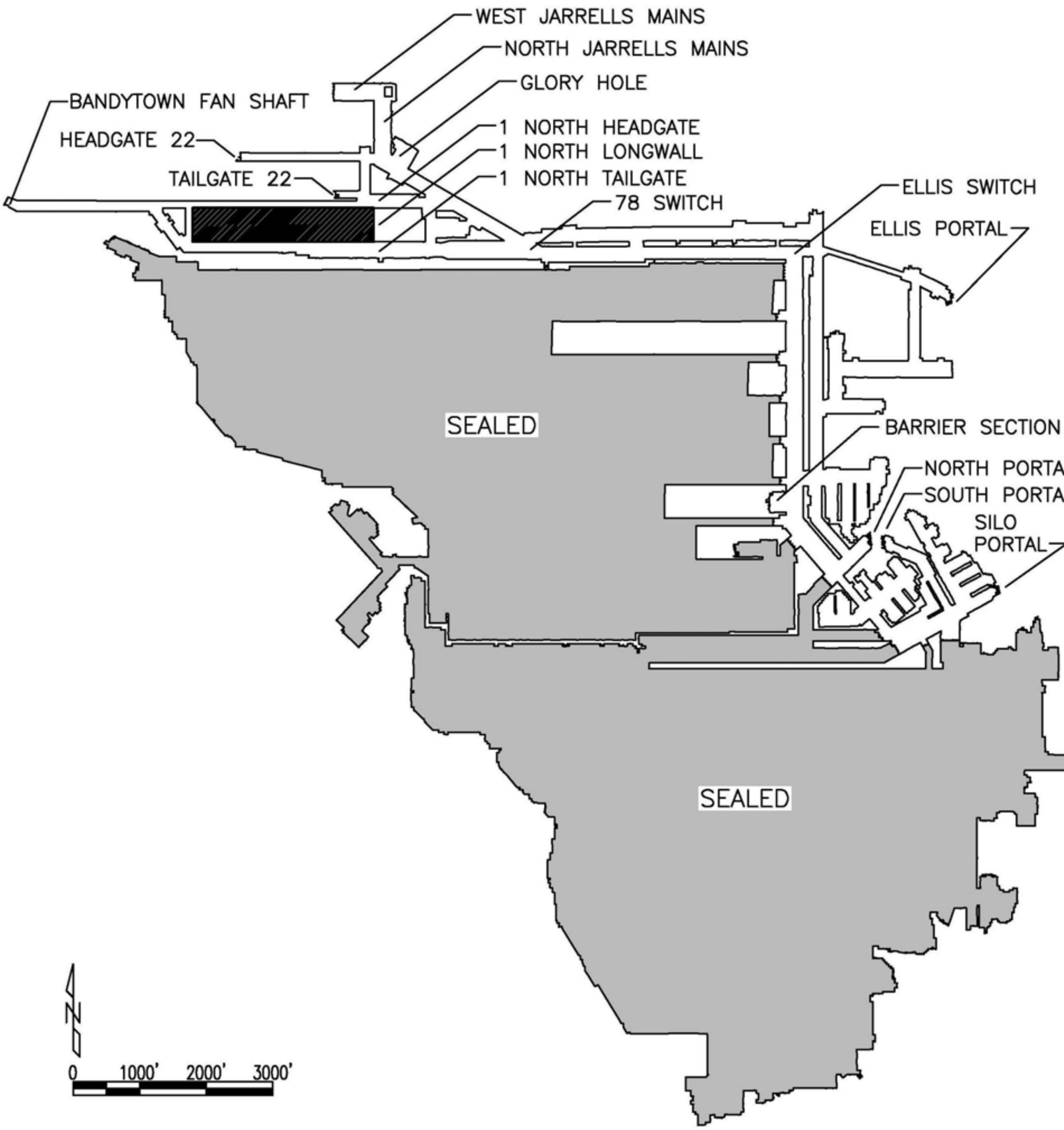
- failing to maintain the volume and velocity of the air current in the areas where persons work or travel at a sufficient volume and velocity to dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, dusts, smoke, and fumes (violation of 30 CFR 75.321(a)(1)).

MSHA also issued two contributory violations to David Stanley Consulting, LLC, a contractor that supplied examiners and other miners to work at the UBB, for its examiner's failure to properly conduct examinations.

MSHA Internal Review

In addition to the accident investigation, a separate internal review is examining MSHA's actions related to UBB prior to the explosion and during the rescue and recovery operation. The internal review will evaluate the quality of MSHA's enforcement activities, including any weaknesses, and the adequacy of regulations, policies and procedures. A report and recommendations will be provided to the Assistant Secretary for appropriate action with the aim of better improving the agency's performance and helping prevent the occurrence of future accidents.

MINE MAP



WEST JARRELLS MAINS
NORTH JARRELLS MAINS
GLORY HOLE
BANDYTOWN FAN SHAFT
HEADGATE 22
1 NORTH HEADGATE
1 NORTH LONGWALL
TAILGATE 22
1 NORTH TAILGATE
78 SWITCH
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GENERAL INFORMATION

On April 5, 2010, at approximately 3:02 p.m., a massive coal dust explosion occurred at Upper Big Branch Mine-South (UBB), resulting in the deaths of 29 miners and injuries to two miners who survived. A list of the victims and injured is provided in Appendix A.

Mine Information

The Upper Big Branch Mine-South (UBB), I.D. No. 46-08436, is an underground bituminous coal mine located approximately one mile west of Montcoal, off State Route 3 in Raleigh County, West Virginia. At the time of the accident, the mine was owned and operated by Performance Coal Company (PCC) of Naoma, West Virginia, a subsidiary of Massey Energy Company (Massey). The mine had opened as the Montcoal Eagle Mine on September 1, 1994, operated by Peabody Coal Company. PCC acquired the mine and began production shortly after October 15, 1994 as Upper Big Branch Mine-South. Alpha Natural Resources acquired PCC and Massey in June, 2011.

PCC mined coal at UBB from the Eagle coal seam. The average thickness of the seam was 54 inches, including sandstone partings. PCC achieved an average mining height of approximately 84 inches by mining the immediate roof and floor, predominantly composed of shale and sandstone. In 2009, PCC produced 1,235,462 raw tons of coal. At UBB, PCC utilized a longwall, a method of mining in which a cutting machine known as a “shearer” cuts coal in a long, single slice. Typically, the longwall operated seven days per week and development sections operated five to six days per week. There were two overlapping 10-hour longwall production shifts and a 9-hour maintenance shift. According to company records, PCC employed 186 underground and four surface employees at UBB on the day of the accident. There were also 16 labor contractors working for David Stanley Consultants, LLC. (DSC) and Mountaineer Labor Solutions, LLC (MLS). At the time of the accident, no labor organization represented employees; nor was there a miners’ representative designated under the Mine Act.

At the time of the accident, the mine had four sets of drift openings and a fan shaft. Miners generally entered the mine from the Ellis portal or the North or South (known as UBB) portals. Four active sections were producing coal, including the 1 North Longwall Panel, Headgate 22 (HG 22), Tailgate 22 (TG 22), and one advancing room-and-pillar section (known as the “Barrier Section”). A detailed mine map is shown in Appendix B. There was also one deactivated super section located in the southern area of the mine. The approximately 1,000-foot wide, active longwall panel had mined approximately 5,450 feet, with about 1,240 feet remaining in the panel. Previously-mined longwall panels ranged from 3,000 feet to 17,000 feet in length. In the course of this previous mining, a non-fatal ignition or explosion occurred in 1997 on the 2 West Panel, and gas inflow incidents occurred in 2003 on Longwall Panel 16 and in 2004 on Longwall Panel 17. These events will be discussed in subsection “Outburst History at UBB” later in this report.

PCC transferred personnel, mining equipment, and supplies throughout the mine using battery-powered mantrips and supply motors. PCC transferred coal from the respective sections to the surface by a series of conveyor belts, which were in turn connected to overland belts. The overland belts carried the coal through adjacent mine workings in the Eagle Seam to the Marfork preparation plant near Packsville, West Virginia. PCC used an Atmospheric Monitoring System (AMS) on the conveyor belts for fire-detection and for individual conveyor belt status reports. An AMS operator monitored the system from the surface. Underground employees used a "leaky feeder" radio system installed at all active sections and along the primary and secondary escapeways for two-way communications. Underground employees would report their locations periodically to the dispatcher for tracking purposes. Underground employees were also tracked using wireless radio frequency identification (RFID) tags and a network of RFID tag readers. At the time of the accident, the tracking system was installed to just inby crosscut 101 of the North Glory Mains.

Management Structure

Testimony indicated that the upper management officials at UBB on April 5, 2010 were:

- Christopher L. Blanchard, President
- Jamie Ferguson, Vice President
- Wayne Persinger, General Manager
- Everett Hager, Superintendent - North
- Gary May, Superintendent - South
- Terry Moore, Mine Foreman - North
- Rick Foster, Mine Foreman - South
- Paul Thompson, Maintenance Manager
- Jack Roles, Longwall Coordinator
- Berman Cornett, Safety Director
- Jim Walker, Safety Director
- Jason Whitehead, Vice President of Route 3 Operations

In addition to these individuals, PCC maintained a separate list of "Corporate Officers" on April 5, 2010:

- Christopher L. Blanchard, President
- Tammy L. Tomblin, Chief Accounting Officer
- Jeffrey M. Jarosinski, Treasurer
- Richard R. Grinnan, Secretary
- Andrew B. Hampton, Assistant Secretary
- M. Shane Harvey, Assistant Secretary
- Phillip C. Monroe, Assistant Secretary
- Larry E. Palmer, Assistant Secretary

Massey also provided significant oversight and involvement at the mine in engineering, production, and safety issues. A list of Massey's corporate structure as reported to the Securities and Exchange Commission (SEC) can be found in Appendix C. Some of these key officials include:

Don L. Blankenship, Chairman and Chief Executive Officer
Baxter F. Phillips, Jr., President
J. Christopher Adkins, Senior Vice President and Chief Operating Officer
Mark A. Clemens, Senior Vice President, Group Operations
Michael K. Snelling, Vice President, Surface Operations
Michael D. Bauersachs, Vice President, Planning
Jeffrey M. Gillenwater, Vice President, Human Resources
Richard R. Grinnan, Vice President and Corporate Secretary
M. Shane Harvey, Vice President and General Counsel
Jeffrey M. Jarosinski, Vice President, Treasurer and Chief Compliance Officer
John M. Poma, Vice President and Chief Administrative Officer
Steve E. Sears, Vice President, Sales and Marketing
Eric B. Tolbert, Vice President and Chief Financial Officer
David W. Owings, Corporate Controller and Principal Accounting Officer

The management officials of DSC (which provided contract labor to UBB) on April 5, 2010 were:

Jim Hayhurst, President/Chief Executive Officer
John Bevilock, Executive Vice President
Jim Gump, Director/Operations & Safety
Beth Straton, Regional Manager

The management officials of MLS (which provided contract labor to UBB) on April 5, 2010 were:

Brian Buzzard, Owner
Kim Buzzard, Owner

DESCRIPTION OF THE ACCIDENT

Events Preceding the Explosion

The longwall began production at UBB in September 2009, several years earlier than planned, because three longwall panels that were to be mined at the Castle mine were, in fact, not mineable due to thin coal. The longwall began production at UBB in September, 2009 even though the tailgate for 1 North Panel at UBB was not designed for a longwall. Instead, it was planned to be used to access continuous miner panels.

Water in the area behind the longwall was a persistent problem at UBB. Water leakage due to subsidence into a flooded area in the overlying Castle mine resulted in accumulations in several areas in the bleeders and, early on in development, on the longwall face. The operator employed pumps to maintain the water depth at a level which would not affect ventilation.

What follows is a chronological summary of the movements of miners and mining events just prior to the explosion. While much is now known, some events cannot be detailed with precision; many witnesses to events tragically lost their lives on April 5. Additionally, a number of key management officials exercised their Fifth Amendment rights and declined to talk to MSHA investigators. All personnel who exercised their Fifth Amendment rights can be found in Appendix D.

April 4, 2010 was Easter Sunday and UBB was reportedly idle most of the day in observance of the holiday. Preshift examinations for the midnight shift began at approximately 8:00 pm, and no hazards were recorded. At about 11:00 p.m., the UBB midnight maintenance crews began working to prepare the mine for the resumption of production on Monday's day shift. The midnight shift reported no hazards, unusual conditions or events. Prior to the arrival of the day shift production crews on Monday morning, the preshift examinations for the longwall and two gateroad development sections were called out of the mine between 5:16 a.m. and 5:51 a.m. on April 5, 2010. According to the preshift report for HG 22, two entries required cleaning and rock dusting. No other hazards were reported; however, there was no report that the belt was examined. No hazards were reported for the longwall or TG 22 section. Between 3:00 a.m. and 6:00 a.m. on April 5, the preshift examinations were conducted on the conveyor belts in the northern part of the mine. The records for those examinations indicated that six of the nine belts examined required rock dusting and five of the belts required cleaning.

On April 5, 190 UBB employees and 16 contract miners were working or scheduled to work. The day-shift production crews included miners working on the longwall, HG 22, TG 22, and Barrier sections; the support crews included those on pumping and track maintenance. At times throughout the day, additional managers, examiners and miners entered and exited the mine. The starting times for the day shift production and support crews were staggered.

The longwall and HG 22 crews entered the mine at the Ellis Portal at approximately 6:00 a.m. Longwall Section Foreman, Richard "Rick" Lane, had a crew consisting of Rex Mullins, Headgate Operator; Joel Price and Gary Quarles, Jr., Shearer Operators; Dillard Persinger, Shield Operator; and Christopher Bell, Utility. They were accompanied by the longwall maintenance/utility crew, including Charles "Timmy" Davis, Assistant Longwall Coordinator; Grover Skeens, Maintenance Foreman; Nicholas McCroskey, Electrician; Cory Davis and Adam Morgan, red hats (trainees); and Joshua Napper, red hat (contractor trainee).

The HG 22 Section Foreman, Edward “Dean” Jones had a crew that consisted of William Griffith and Joe Marcum, Continuous Miner Operators; James “Eddie” Mooney and Ricky Workman, Shuttle Car Operators; Howard “Boone” Payne and Kenneth Chapman, Roof Bolt Operators; Gregory Brock, Electrician; and Ronald Maynor, Scoop Operator.

Michael Elswick, Belt Examiner, entered the mine through the Ellis Portal at 6:03 a.m. At 6:36 a.m., Elswick traveled inby the 78 switch, which is located at the mouth of the North Glory Mains.

Jeremy Burghduff, Outby Foreman, took his crew, David Farley and Jason Stanley, into the mine from the Ellis Portal at 6:28 a.m. to pump water behind the longwall and to conduct the weekly examination of the area and the preshift examination for the crew that was with him. Both members of Burghduff’s crew were contractors employed by DSC. Stanley was a red hat miner. Burghduff’s assignment included examining and maintaining a series of compressed air pumps behind the 1 North Panel.

The Barrier Section Crew (Jack Martin, Section Foreman; Jeremy Rife and Eddie Foster, Continuous Miner Operators; Chris Cadle and Danny Williams, Roof Bolter Operators; Melvin Lynch and Wes Curry, Shuttle Car Operators; and James Bailey, Electrician) entered the mine from the North portals at approximately 6:40 a.m.

The TG 22 Section Foreman, Steve Harrah, took his crew into the mine at 6:42 a.m. from the North Portal. This crew included Robert Clark, Continuous Miner Operator; William Lynch and Deward Scott, Shuttle Car Operators; Carl Acord, Timmy Blake, and Jason Atkins, Roof Bolters; Benny Willingham, Scoop Operator; and James K. Woods, Electrician.

Ralph Plumley, Track Coordinator, and his crew entered the mine at approximately 7:26 a.m. from the Ellis Portal. Plumley’s crew consisted of Eric Jackson and Tommy Owen Davis, both track workers. The destination of this crew was HG 22, where they were to continue advancing the track into the section.

Interviews of the dayshift miners indicated that April 5 was not unusual until the time of the explosion. Mike Kiblinger, Tim Sigmon, and Matt Warden went to the HG 22 mother drive installation area around 9:30 a.m. to move their tools from that location to the new development near the Ellis Portal. Mark Gilbert, John Cox and Jerry Weeks delivered supplies to HG 22 at approximately 11:00 a.m. Scott Halstead started his examination from the longwall headgate at approximately 12:40 p.m. and he walked out of the Ellis Portal at approximately 2:25 p.m. Thomas Sheets and Virgil Bowman installed electric cables at the HG 22 mother drive and left the area at approximately 2:15 p.m. Billy Massey and Bruce Vickers delivered supplies to HG 22 and left the section about 2:15 p.m. None of these individuals indicated that they were aware of any problems or unusual conditions.

Billy Massey said that he saw Everett Hager, Mine Superintendent, at HG 22 shortly before 2:00 p.m. Electronic tracking data showed that Hager and Jack Roles, Longwall Coordinator, traveled outby the tag reader at 6 North starter box near 78 Switch at 1:55 p.m. These UBB managers exercised their Fifth Amendment rights and declined to be interviewed. Therefore, their exact routes of travel and activities can not be definitively determined.

Toward the end of the day shift, a series of reports were called out of the mine. The evening preshift report for HG 22 indicated one entry that required rock dusting but no other hazards. The maximum reported methane level was 0.3 percent; however, the air quantity was not recorded as required. Although the pre-shift report was called out to Patrick Hilbert, evening shift foreman for HG 22, neither the certified person who performed the pre-shift exam nor the time of the exam was recorded. Steve Harrah called out the TG 22 pre-shift examination at 2:38 p.m. to Brian Collins, the evening shift TG 22 foreman, who recorded the report. The TG 22 examination listed "0 %" methane, 32,360 cubic feet per minute (cfm) air quantity in the last open crosscut (LOC), and no hazards. The longwall pre-shift examination was called out by Rick Lane at 2:40 p.m. and was recorded by Kevin Medley, the oncoming evening shift foreman for the longwall. The longwall pre-shift examination listed 0.0 percent methane, 56,840 cfm air quantity in the intake, and air velocity readings of 776 feet per minute (fpm) at longwall shield 9 and 513 fpm at shield 160, and no hazards. Michael Elswick, fireboss, phoned out the pre-shift report for the conveyor belts at 2:30 p.m. and the report listed that eight of ten belts needed rock dusting and six belts needed cleaning.

Normal production was reported for HG 22 and TG 22 during the day shift. However, the longwall was not running for much of the day due to mechanical problems. The first production report was called out at 7:30 a.m. The longwall made two passes and ran until 11:00 a.m. The longwall was down from 11:00 a.m. to about 1:30 p.m. because of a lost "B-Lock" on the ranging arm of the longwall shearer. Rex Mullins called outside at 2:30 p.m. to report that the longwall shearer was at shield 115 and cutting toward the tailgate.

Jeremy Burghduff and his pumping crew left the tailgate area of the longwall in their mantrip around 2:30 p.m. and called out for clearance to use the track at 78 switch at 2:36 p.m. Ralph Plumley and his track maintenance crew left the HG 22 section around 2:30 p.m. and called out for track access at 78 switch at 2:42 p.m.

Elswick had called his examination out of the mine at 2:30 p.m. and was waiting near the longwall mother drive to catch a ride out of the mine. The TG 22 crew left the section about 2:50 p.m. and at 3:00 p.m. called for track access at 78 switch. The HG 22 crew was in the process of boarding its mantrip at the time of the explosion, while the longwall crew was still in the process of mining coal.

Investigation of the longwall shows that it was operating near the tailgate up until a minute or two prior to the explosion. The shearer was shut off by the tailgate side remote control at approximately 3:00 p.m. The pan line was shut down by someone on the longwall face. The headgate operator manually cut off the water to the shearer and manually disconnected the high-voltage power to the shearer. The longwall personnel near the shearer traveled about 400 feet from the tailgate prior to the explosion. The distance between the miners and the shearer indicates that the miners realized that an uncontrollable event was occurring and they were traveling away from that area at the time of the explosion.

Description of the April 5, 2010 Accident

A massive explosion occurred in the northern portion of UBB at approximately 3:02 p.m. At this time, the electrical power went off to the Ellis Portal; this portal's power was supplied from underground. Phone communications with the longwall, HG 22, and TG 22 sections were disrupted. Witness testimony, various digital records, and post-explosion analyses of the electronic timing devices confirm the timing of the explosion.

Individuals who were either in the mine or near the portals about 3:00 p.m. described their observations of the conditions including the magnitude of the explosion. The evening shift longwall crew and the HG 22 crew were boarding mantrips about three crosscuts inside the Ellis Portal. They felt a reversal of the air direction, and subsequently, the air flow from inside the mine increased in intensity to the point where the miners were pelted with dirt and debris, their hard hats were blown off, and some miners were knocked over. Mike Kiblinger, an outby maintenance foreman, who was standing by the Ellis Portal at the time of the explosion, recalled "It was blowing crib blocks out and just like a real strong wind, like a hurricane wind. And… a couple people. It blew them out. They were rolling."

Adam Jenkins, Dispatcher at the UBB office, described the event:

> …at three o'clock…called me from 78 Break, asked for a road outside… And a couple minutes later that's when it happened. All the dust started—just a white smoke started pouring out the portals, and it sounded like thunder. It was constant. And I didn't know what happened. And Gary May, he said, Oh, Lord,… something's bad happened…
>
> That all happened at the same time. That's when all that dust started gushing out here and the COs [AMS] went all crazy all at the same time. It all happened within seconds of each other. So I turned around and the COs started going off, and then the dust started coming out the portals, because you could see it from the window…

Greg Clay, Purchasing Agent, witnessed the results of the explosion at the UBB Portals:

> I was trying to get ahold [sic] of the headgate operator because I was waiting on the three o'clock report. And I guess about three minutes after 3:00, I just heard this bam (indicates noise). I thought the fan had thrown a blade or something because it's making a real bad noise. And I raised

> up out of my chair…I looked out the window and I could just see rock dust and debris blowing out of the portals. And it just sounded like jet engines at each portal. The air was just gushing out of the portals.

Several witnesses testified that mine fans at the UBB Portals stalled from the air pressure. Thomas Sheets, Maintenance Foreman said:

> …the fan's…sounds like it's going to come off the foundation [fan at UBB Portal]. So I start running towards the fan. John Henline come down and started running towards the fan with me. Dust started coming out the track entry. We got to the fan house. I started to shut the fan down. I didn't know what happened. I just didn't think that quick, but I thought the fan was coming off the foundation, and I don't want the fan blades going. That's quite a mess, and then just in a matter of minutes it was all over. Pressure came down…That was basically it. We knew we had an explosion at this point. John Henline said ‘She's blew up’…

At the time of the explosion, a crew that had been setting up a miner section near the Ellis Portal was traveling inby in a mantrip on the way back to the North Portal at the end of their shift. Joshua Williams, Roof Bolter, described the experience:

> We was coming up the track, and the guy I was bolting with, he said, ‘Man, it's dusty.’ I said, ‘Yeah.’ Then he said, ‘Do you feel a lot of air coming down the track?’ I said, ‘Yeah.’ He said, ‘It wasn't doing that this morning.’ We kept on going, and my ears popped and I couldn't hear nothing. And then that's when we hit air… started pushing our mantrip back. It was throwing blocks, foam. That's when I laid down on the mantrip and threw my jacket over my head and was starting to get my rescuer out because I didn't know what in the world was going on. …It blew our mantrip. It blew it probably five crosscuts [outby]…we rode the track all the way back out to the Ellis Portal, and then we went outside…

Several miners near the portals were able to evacuate the mine. Surface personnel began notifying underground personnel to evacuate and initiated the mine’s emergency response plan.

Accident Notification, Mine Evacuation and Initial Emergency Response

Accident Notification

The Mine Act and regulations require that a mine operator report a serious accident to MSHA within 15 minutes of the occurrence. This notification is essential so that MSHA can properly assess and respond to the accident. PCC and Massey delayed reporting the accident to MSHA and failed to properly inform MSHA of its magnitude. Chris

Blanchard called Jonah Bowles, Safety Director at Massey's Marfork mine, at 3:27 p.m. and asked him to report this occurrence to MSHA. Bowles called MSHA's Call Center Hotline at 3:30 p.m. and reported an inundation of carbon monoxide (CO) at UBB. He reported CO concentrations of 50 to 100 ppm and an air reversal on the beltline at the Ellis Portal. He was asked if anyone was trapped or injured and responded "no." He was also asked if there was a fire or any fatalities, and again responded "no." He stated that the CO readings might indicate a fire.

The MSHA hotline operator called MSHA Coal Mine Safety and Health District Four (D4) at 3:42 p.m. and relayed this accident information. Robert Hardman, D4 Manager, phoned UBB and issued a verbal control Order under Section 103(j) of the Mine Act to David Taraczkozy, UBB Chief Electrician at 4:00 p.m.

Mine Evacuation

The Barrier Section Crew exited the mine at the North portal at approximately 3:35 p.m. Clifton Earls-Supplyman and Jeremy Woods-Supplyman were removing track at the East Mains area inby the South Portal. They were not informed that an explosion had occurred and exited the mine at about 4:10 p.m.

Initial Emergency Response—Arrival of Rescuers and Other Personnel to the Accident Scene

At the Ellis Portal, approximately 25-30 minutes after the explosion, Chris Blanchard, another top company official, Jack Roles, Everett Hager, Wayne Persinger, and Patrick Hilbert (all of whom were upper management at UBB, except for Hilbert), took a mantrip into the mine. All of these individuals were bare-faced (i.e. without mine rescue apparatus) and some had Solaris handheld multi-gas detectors. At the Ellis switch, they called out their location and proceeded inby slowly. At crosscut 42, they saw the light from a miner's cap lamp approaching them. Continuing inby, at about crosscut 47, they encountered Timothy Blake, the source of the light, walking out of the mine. He was wearing his self-contained self rescuer (SCSR). Chris Blanchard asked what had happened and Blake stated that there had been an explosion. Blake said that his crew was inby about 20 crosscuts. Blake told them that he had put SCSRs on everyone he could (he was unable to do so for Deward Scott because it could not be located). During his interview, Blake stated, "So I went around to each man again, felt for a pulse. Everybody had a pulse but one man. I couldn't find no pulse on him. That's the man I couldn't find a rescuer. And I had to leave them. That was the hardest thing I ever done."

Immediately after the dust stopped blowing out of the UBB Portals, Gary May walked into the North Portal intake entry. Rick Foster took a mantrip into the mine. Jim Walker and Berman Cornett, Safety Directors, started walking in the track entry from the North Portal and met Foster at Plumley switch. Foster, Walker, and Cornett continued inby via the mantrip and caught up with Gary May at the Ellis switch at approximately 3:55 p.m. After making the turn onto the Old North Mains track, Rick Foster proceeded inby via the mantrip, followed by Walker, Cornett, and May on foot.

Meanwhile, Blanchard, another top company official, Persinger, Hager, and Roles, who were ahead of Foster's mantrip, continued inby on foot and left Hilbert (an emergency medical technician) with Blake at the mantrip. Persinger, Hager, and Roles carried extra SCSRs with them. Blanchard and another top company official reached the TG 22 mantrip and flagged the others behind them to hurry. Blanchard and another top company official told Roles to go back and get the mantrip that was left with Blake and Hilbert. Persinger opened the SCSR cache, removed SCSRs from the injured miners and put new SCSRs on them. Persinger provided a written statement on April 6, 2010, which was later provided to the accident investigation team, that James Woods was laboring heavily and that he did not detect a pulse on the remaining TG 22 miners. Foster, Cornett, and Walker arrived in another mantrip. Cornett told Foster to call the dispatcher and request several ambulances.

Soon afterward, Foster was told to get his mantrip out of the way, so he started out of the mine. The injured miners were loaded into the two remaining mantrips. The first mantrip included Harrah, Woods, Lynch and Acord and was operated by Hilbert. Persinger boarded the first mantrip and worked with Woods who was still responsive. The remaining TG 22 miners were loaded back into their mantrip, which was operated by Everett Hager. All three mantrips traveled out of the mine carrying the victims and rescuers, except for Chris Blanchard and another top company official who proceeded inby on foot.

Greg Clay called the Raleigh County 911 Dispatch at 4:22 p.m., requesting several ambulances at UBB. Clay stated they had several injured. Clay said they were in the process of removing the miners from the mine.

The Boone County E-911 was notified at 4:26 p.m. about a possible roof cave-in, with possibly ten miners involved. At about 4:30 p.m. units were en-route from the Whitesville Volunteer Fire Department (WVFD). WVFD paramedics and first responders traveled to the Ellis Portal mine site, arriving before the victims were brought outside. As victims were brought out of the mine, the paramedics attempted resuscitation using defibrillators and CPR. Seven of the miners were unresponsive. Blake came out with the first mantrip and refused treatment by the paramedics. When Woods was brought outside he was loaded into an ambulance and transported to the Whitesville High School football field for transport by medical helicopter.

Jim Hodges, Boone County Medical Examiner, arrived at approximately 5:45 p.m. and the remaining victims on the mantrip from the TG 22 crew were declared dead. The helicopter arrived at Charleston General with Woods at 5:57 p.m. Blake was later transported via ambulance to Raleigh General Hospital, arriving at 7:55 p.m.

Members of Massey's Southern West Virginia Mine Rescue Team were the first to arrive at the Ellis Portal, arriving between 3:30 and 4:00 p.m. Shortly after 4:00 p.m., Chris Adkins, Senior Vice President of Massey Energy Company, and Elizabeth Chamberlin, Vice President of Safety and Training for Massey Coal Services, arrived by helicopter and traveled to the UBB mine office.

Hardman and Michael Dickerson, D4 Staff Assistant and Family Liaison, traveled from the Mount Hope district office to the UBB mine location, arriving at approximately 5:00 p.m. Hardman modified the initial Section 103(j) Order to a Section 103(k) safety Order at 5:20 p.m.

Kevin Stricklin, MSHA Administrator for Coal Mine Safety & Health (CMS&H), had landed at Yeager Airport in Charleston, WV (arriving there on other MSHA business), at 4:20 p.m. After he checked his voice mail and learned of the event, he traveled directly to UBB. Stricklin arrived at UBB at approximately 5:30 p.m. and met Hardman near the Ellis Portal. Hardman told Stricklin that there were six confirmed fatalities and approximately 20 missing miners. Hardman also said that a command center for mine rescue was being organized at the UBB Portal because electric power and communications were not functional at the Ellis Portal. Stricklin and Hardman then drove to the UBB portals.

The West Virginia Office of Miners' Health Safety & Training (WVOMHST) was conducting training for its mine rescue teams at Logan, WV on April 5. Steve Snyder, Inspector at Large, received a call from the state homeland security hotline at 3:50 p.m. informing him of the initial incident report for UBB. Snyder then called the Oak Hill WVOMHST office for more information. At 4:45 p.m. Snyder was told that there had been an explosion at UBB and there were confirmed fatalities. The state mine rescue teams and equipment arrived at the Ellis Portal at 6:10 p.m.

Virgil Brown, Mine Emergency Unit Specialist, and John Urosek, Chief of Mine Emergency Operations for MSHA, received calls from D4 Assistant District Manager Lincoln Selfe sometime before 4:00 p.m. and 4:15 p.m., respectively, requesting mine rescue and technical support assistance at UBB. Brown was at the Pittsburgh Safety and Health Technology Center (PSHTC). Brown suggested that Selfe notify Jerry Cook, Mike Hicks, Mike Shumate, and other MSHA mine emergency team members from the D4 area. Brown gave instructions to move the MSHA Mine Emergency Command vehicle and Mine Rescue Team truck from the Mine Academy in Beckley, West Virginia to the mine site. The MSHA mine emergency command vehicle arrived at UBB at 6:30 p.m.

Bob Hardman, Chris Adkins, and Steve Snyder established a mine rescue command center at the UBB office around 7:00 p.m. Hardman was in charge of the mine rescue operation for MSHA, while Stricklin assisted with the media and families of the victims.

Brown and Urosek started mobilizing other members of MSHA's mine emergency response team and other mine emergency equipment. Brown arrived at the mine at approximately 8:30 p.m.

On April 6, 2010, personnel from MSHA's Directorate of Technical Support including specialists from the Physical and Toxic Agents Division and the Ventilation Division, arrived at the mine at approximately 1:00 a.m. with a portable gas chromatograph. Urosek, who had been at a lead mine in Missouri, arrived at UBB at about 1:30 a.m. The mobile gas laboratory arrived at approximately 3:00 p.m., with additional gas chromatographs.

Rescue Operations

From April 5 to April 9, over 20 mine rescue teams (Appendix E), including those from Massey, other mine operators, MSHA, and WVOMHST, worked around the clock in an attempt to locate and rescue the missing miners. The rescue efforts were prolonged and difficult due to the presence of combustible gases (which required evacuating the teams at times) and the necessity to restore ventilation controls, which the explosion had destroyed. By the end of the day on April 9, rescuers had determined that none of the missing miners survived the explosion.

Monday, April 5, 2010

Robert Asbury and Jim Aurednik, Massey mine rescue team members, loaded their mine rescue equipment on a mantrip and started in from the Ellis Portal. About five crosscuts into the mine, Aurednik saw lights coming from inby on the track and reversed the mantrip that he was driving. The lights were from the mantrip driven by Patrick Hilbert bearing the first known victims (see discussion in "Initial Emergency Response", above). Once outside, Asbury, Aurednik and other members of the mine rescue team removed the victims from the mantrips and, with the Whitesville Fire Department personnel, assisted in providing CPR.

At approximately 6:00 p.m., Asbury, Aurednik, and Mark Bolen, another Massey mine rescue team member, loaded their mine rescue equipment on a mantrip and headed back into the mine. They rode to the Ellis Switch, where Asbury and Aurednik then started walking ahead of the mantrip to check for gas and other hazards. At crosscut 78, they had to abandon the mantrip because of debris on the track. About five or six crosscuts inby crosscut 78, they encountered a broken fresh water line that was flooding the area, causing them to turn around and go back to crosscut 42 on the Ellis track to turn off the main water valve. Asbury, Aurednik, and Bolen returned to crosscut 78 and established a fresh air base (FAB) at this location because ventilation controls inby were damaged and blast damage limited further rail travel.

Massey mine rescue team members Shane McPherson, Mike Alexander, and Larry Ferguson were sent underground a short time later; they met Asbury, Aurednik, and Bolen at the FAB. The combined team continued to advance communications up the North Glory Mains toward the longwall "mother drive." The team encountered Chris Blanchard and another top company official walking toward them a few crosscuts inby the FAB. Blanchard and another top company official were escorted back to the FAB. Evidence of activated SCSRs was found in the tailgate entry four crosscuts outby the face and in 1 North Headgate at the mantrip. It is believed these rescuers were worn by Chris Blanchard and another top company official. Because they exercised their Fifth Amendment rights, the route or extent of their travel is unknown. After they finished briefing the mine rescue team on inby conditions and victim locations, another top company official and Blanchard were told to stay at the FAB while mine rescue team members traveled inby, repairing phone lines and doing basic exploration.

By 7:05 p.m., a total of nine mine rescue teams from Massey and other coal operations were at the mine. In addition, four WVOMHST and one MSHA mine rescue team were on site. One exploratory drill rig and three bulldozers had been mobilized to assist with the rescue operation. At 7:19 p.m., another top company official and Blanchard called out from a mine phone at the FAB and reported that they had been to the tailgate and almost to the headgate of the longwall, but had to retreat as a result of excessive carbon monoxide levels. They reported three victims in the longwall track entry outby crosscut 15.

At 7:40 p.m., Massey's Knox Creek and East Kentucky mine rescue teams and the Northern and Southern WVOMHST mine rescue teams were briefed by Adkins and Hardman at the mantrip barn on the surface of the mine. The teams then traveled into the mine from the North Portal on two mantrips. These teams were accompanied by MSHA mine rescue team members Fred Wills, Mike Hicks, and Jerry Cook. These teams arrived at the FAB at approximately 8:30 p.m. Both teams helped advance the FAB to crosscut 98, near the longwall mother drive. After advancing the FAB, the Knox Creek team began advancing toward the HG 22 section, through the crossover. Another team began exploring the longwall face and found one victim near the longwall mother drive, four victims along the track entry of the longwall, one victim beside the longwall stage loader, two victims near longwall shield 85 and four victims between longwall shields 103 and 106. The maximum carbon monoxide that this team encountered was 280 ppm; they did not encounter low oxygen levels and they did not see any smoke. This team explored from the longwall headgate toward the longwall tailgate, to shield 125.

Meanwhile, the Southern WVOMHST team began exploring the rooms immediately outby the active longwall panel. This team traveled across the North Glory Mains from the FAB and entered the roomed area outby the longwall panel, where it intersected the mains at crosscut 98, to look for missing miners. It advanced inby in entries 3-5 until it encountered the solid longwall block. They encountered extensive soot deposits, carbon monoxide levels of up to 45 ppm, and blown-out stoppings. The team then split up and explored the remaining entries back to the North Glory Mains. Some team members explored a portion of the longwall tailgate entries between crosscuts 30 and 33. They observed that ventilation controls in the tailgate entries were destroyed and the debris was blown outby. After exploring the Panel 1 crossover, the team traveled back to the FAB. This exploration was done bare-faced.

The Knox Creek team members traveled inby in the North Glory Mains. At 9:31 p.m., they were at the longwall mother drive in breathable air. At 9:50 p.m. they had advanced within about two crosscuts from the Glory Hole and donned breathing apparatuses due to encountering 50 ppm CO. They advanced to the mouth of HG 22 at 10:10 p.m. The CO levels had increased to 122 ppm with 0.0 percent methane and 20.7 percent oxygen. At 10:40 p.m., the Knox Creek team started back to the FAB due to their apparatuses having low oxygen reserves. They arrived at the FAB at 11:47 p.m.

At 9:30 p.m., Jamie Ferguson left the FAB with the East Kentucky mine rescue team to relieve the Knox Creek team and explore toward the HG 22 section. At 11:22 p.m. this team had advanced to crosscut 3 on HG 22 and, while under apparatus, reported 14.7 percent oxygen[1], 3.3 percent methane[2] and 8,676 ppm CO[3]. Ferguson reported thick smoke at crosscut 16. At 11:55 p.m. six victims were found in a mantrip just outby crosscut 19. At 12:16 a.m., on April 6, the team started retreating from the section after encountering 3.2 percent oxygen, more than 5.0 percent methane, more than 9,999 ppm CO (over range), and smoke. At 12:45 a.m., on April 6, the command center instructed all teams to evacuate the mine due to explosive levels of methane on the HG 22 section and the presence of smoke, which suggested the presence of fires or hot spots.

Records indicate confusion over the number of victims and missing miners from the time of the event until after the mine rescue teams left the mine on Tuesday morning, April 6. Factors that may have contributed to this confusion include the use of the partially installed Pyott-Boone tracking system in lieu of a traditional tag-in, tag-out board, inoperability of the tracking system north of Ellis switch after the explosion, the

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[1] Oxygen levels below 19.5% are considered deficient. When levels decrease to a range of 16 to 12%, a person can experience increased heart rate, fatigue, impaired judgment and coordination, nausea and vomiting. When levels decline to 10%, one breath can cause loss of consciousness and quickly result in death.

[2] Methane is a colorless, odorless, non-poisonous, and flammable gas, which is explosive between 5% and 15%. According to regulations, when 1% or more of methane is present, the operator is required to cease production and make changes or adjustments to the ventilation system in order to reduce the methane levels to less than 1% prior to resuming production.

[3] Carbon Monoxide is a colorless, odorless, poisonous gas, which attaches to the hemoglobin in blood 200 times easier than Oxygen. Carbon Monoxide is also explosive from 12 to 75% (10,000 ppm would equal 1%). Long-term workplace exposure levels to less than 50 ppm averaged over an 8-hour period are considered acceptable. Exposure levels at 100 ppm are considered dangerous to human health. Carbon Monoxide levels between 35 and 400 ppm can result in dizziness and mild to severe headaches with exposure times of eight hours to one hour respectively as the levels increase. Carbon Monoxide exposure can result in death at 1,600 ppm in less than 2 hours, at 3,200 ppm within 30 minutes, at 6,400 ppm in less than 20 minutes, and at 12,800 ppm after 2-3 breaths in less than three minutes.

use of multiple portals to enter and exit the mine, and Massey's failure to designate a responsible person (RP) to oversee the evacuation of the mine and the mine rescue effort. At 8:10 p.m., Massey reported seven dead and 19 missing miners. At 12:32 a.m. on April 6, the number of missing miners was thought to have been one on the longwall and four on HG 22. At 1:40 a.m., on April 6, Massey reported 25 dead, two injured and four missing miners.

Tuesday, April 6, 2010

All of the mine rescue teams, as well as Blanchard and another top company official, exited the mine by 2:30 a.m. The teams were debriefed and sent to get some rest. Gas monitoring continued at the fans and portals. At 5:50 a.m., MSHA modified the Section 103(k) Order to allow three boreholes to be drilled into the mine to better assess the atmosphere. MSHA Technical Support personnel arrived at UBB about 1:00 a.m. Two boreholes were started and continued to be drilled for the remainder of the day.

Wednesday, April 7, 2010

The first borehole (Hole 1A) intersected the mine at 4:00 a.m. at crosscut 35 on HG 22. MSHA modified the Section 103(k) Order at 6:41 a.m. on Wednesday, April 7, to allow installation of a diesel-powered exhaust fan on borehole 1 (BH 1A). MSHA modified the Section 103(k) Order at 4:10 p.m. to allow installation of a similar exhaust fan on borehole 3 (BH 1B) at 4:10 p.m. An exhausting fan was installed on this borehole in an attempt to ventilate the HG 22 methane accumulation. Gas levels from this borehole and from the Bandytown fan were monitored to determine when safe re-entry of the mine would be possible. Re-entry mine rescue plans were developed while waiting for hazardous gas levels to decrease.

Thursday, April 8, 2010

After determining gas levels had decreased to an acceptable level, MSHA modified the Section 103(k) Order at 3:50 a.m. to allow implementation of an exploration and recovery plan. At 4:55 a.m., four mine rescue teams entered the mine and traveled by rail to crosscut 78. By 7:51 a.m., teams advanced to crosscut 105 in the North Glory Mains in fresh air. By 9:03 a.m., teams advanced to the longwall mule train. Rescue team advance was slow because phone lines were being installed to ensure that teams could communicate in the event of an emergency. Teams advanced to the longwall stageloader at 9:18 a.m. At 9:29 a.m., an explosive level of combustible gases was detected at borehole BH 1A. All teams were instructed to evacuate the mine due to explosive levels of combustible gases at borehole BH 1A. All of the rescue teams evacuated the mine by 10:55 a.m.

Friday, April 9, 2010

At 12:13 a.m., MSHA approved a plan to re-enter the mine for exploration and recovery with two mine rescue teams. The plan objective was to explore the crossover area between TG 22 and HG 22. Two mine rescue teams entered the mine at 12:42 a.m. and traveled by rail to crosscut 78. The teams reached crosscut 78 at 1:23 a.m. and reestablished a FAB. One team stayed at the FAB as backup and one team traveled inby in the longwall track entry arriving at the mule train at 2:43 a.m. The FAB was advanced to the longwall headgate track entry just inby the longwall face. One team stayed at the new FAB and one team started exploring the Panel No. 2 Crossover between TG 22 and HG 22. At 3:36 a.m., the team had advanced approximately four crosscuts inby the FAB and measured 300 ppm carbon monoxide, 20.8 percent oxygen and 0.0 percent methane. The team donned their apparatuses due to the CO level. At 3:42 a.m. the team advanced to the TG 22 refuge alternative. This refuge alternative had not been deployed. The team returned to the FAB to reevaluate its exploration plan. The command center directed a team to continue exploration after the reevaluation was completed. By 4:12 a.m. the team had advanced approximately two crosscuts into the crossover and reported light smoke, 250 ppm carbon monoxide, 20.8 percent oxygen and 0.0 percent methane. The team advanced two more crosscuts into the crossover and encountered more smoke and 940 ppm CO. A fire was suspected in HG 22, and the team was instructed to return to the FAB. At 4:43 a.m., both teams were instructed to evacuate the mine, exiting at 6:12 a.m.

At 9:02 a.m., inert gas was injected into borehole BH 1A. At 2:32 p.m., Nitrogen trucks completed pumping into borehole BH 1A and changed to a nitrogen generator at 2:40 p.m. and continued pumping. A quantity of nitrogen equal to approximately twice the volume of the HG 22 mine workings had been injected into BH 1A. At 4:15 p.m., it was then determined safe for mine rescue teams to reenter the mine.

At 4:18 p.m., two mine rescue teams entered the mine to explore HG 22 and the longwall. At 4:28 p.m., two additional teams entered the mine. At 4:58 p.m., teams arrived at crosscut 78. At 6:17 p.m., teams arrived at the FAB, located at the longwall headgate track entry just inby the longwall face. At 6:33 p.m., the first team donned their apparatuses while advancing into the crossover. The first team advanced to approximately two crosscuts outby the mouth of HG 22 and measured 282 ppm CO, 18.0 percent oxygen and 0.2 percent methane. At 7:40 p.m., two additional mine rescue teams entered the mine to relieve the initial teams. At 8:01 p.m., the first team started retreating due to low oxygen levels in their apparatuses. At 9:18 p.m., the fourth team went under oxygen. At 10:10 p.m., a victim was found just outby crosscut 22 (three crosscuts inby the mantrip) in the No. 2 entry of HG 22. Another victim was found at crosscut 23 in the same entry at 10:15 p.m. At 10:21 p.m., a third victim was found in the same entry at crosscut 26. At 10:24 p.m., the team reached the HG 22 refuge alternative and found that it had not been deployed, then began retreating back to the FAB.

At 10:27 p.m., three mine rescue team members began searching the longwall for the remaining miner. At 10:50 p.m., the team on HG 22 returned to the FAB. At 11:04 p.m., the team on the longwall reported 23 ppm CO, 20.6 percent oxygen and 0.3 percent methane at shield 130 on the longwall. At 11:10 p.m., the team on the longwall reported 0 ppm CO, 20.8 percent oxygen and 0.95 percent methane on the tailgate end.

Two additional mine rescue team members were sent from the headgate toward the tailgate along the longwall face to search between shields for the missing miner. At 11:20 p.m., the last victim was found under debris near shield 3 and the rescue efforts ceased. At 11:24 p.m., MSHA and State personnel left the command center to inform the families that they had found the bodies of all missing miners.

Location of the Victims

The 29 victims died in five separate areas: the TG 22 crew was on its way out of the mine on a mantrip, the longwall crew was working along the longwall face, the HG 22 crew was in the process of boarding the mantrip at the end of its shift, a number of miners on the HG side of the longwall were doing maintenance work, and an examiner was waiting at the longwall mother drive.

William Lynch, Carl Acord, Benny Willingham, Robert Clark, Jason Atkins, Steven Harrah and Deward Scott were found on the TG 22 mantrip heading out of the mine at crosscut 67.

Rex Mullins, Nicholas McCroskey, Richard “Rick” Lane, Grover Skeens, Joel Price, Gary Quarles, Jr., Christopher Bell, and Dillard Persinger were on the longwall face.

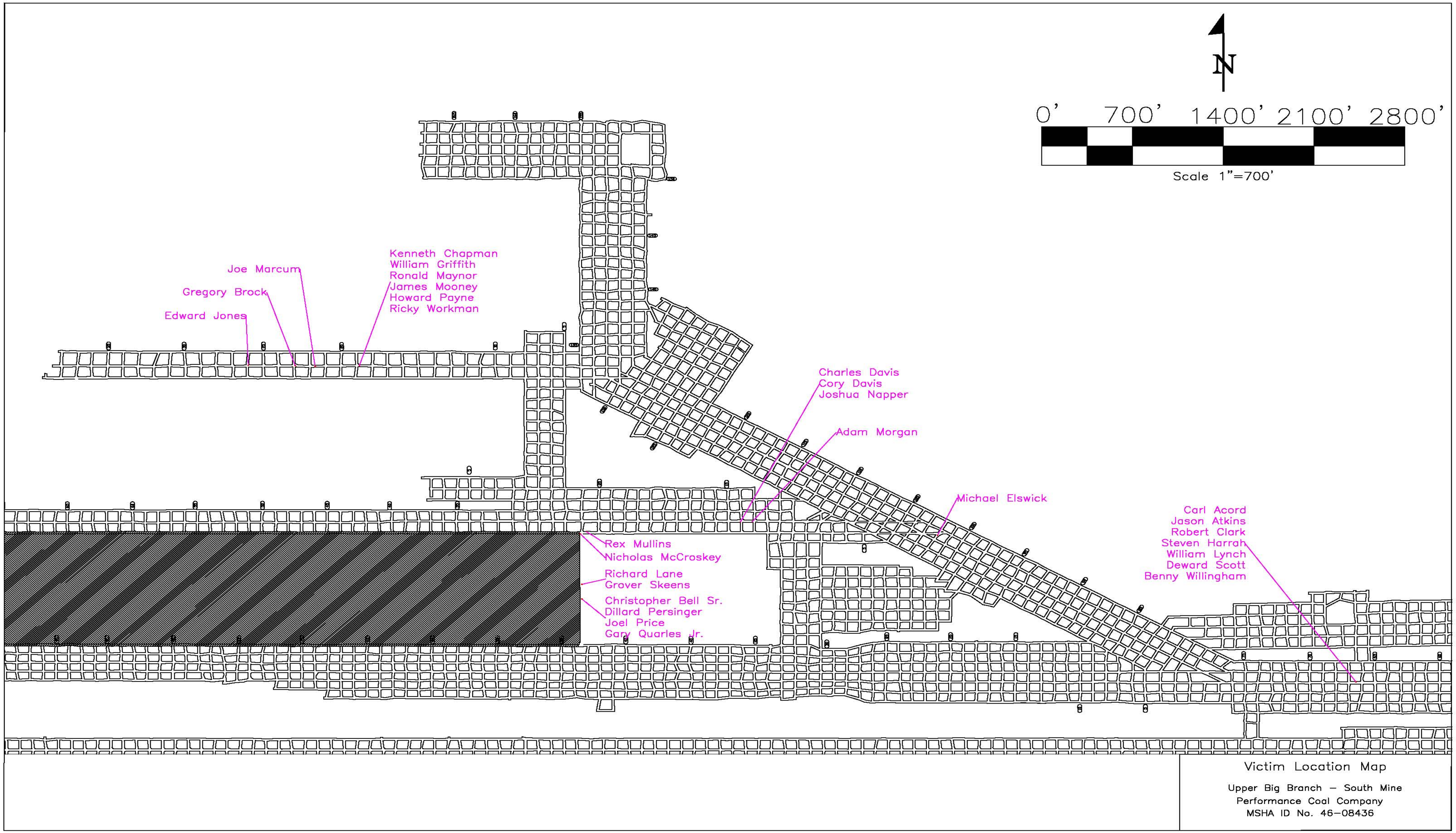
Ricky Workman, Howard “Boone” Payne, Ronald Maynor, James “Eddie” Mooney, Kenneth Chapman, and William Griffith were found on the mantrip in the HG 22 area. Located inby the HG 22 section but away from the mantrip were Joe Marcum, Gregory Brock, and Edward “Dean” Jones.

Cory T. Davis, Joshua Napper, Charles “Timmy” Davis, and Adam Morgan were on the headgate side of the longwall.

Michael Elswick was located in the North Glory Mains at the longwall mother drive.

Victim locations are depicted in Figure 1.

Figure 1: Victim Location Map



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Family Liaisons

Pursuant to the Mine Improvement and New Emergency Response (MINER) Act of 2006 and policies promulgated afterward, MSHA established a family liaison program to be able to effectively communicate information to families of miners who are victims or otherwise unaccounted for during a mine emergency. Mike Dickerson, serving as the lead UBB Family Liaison, traveled to the mine with Hardman and arrived at the Ellis Portal at approximately 5:00 p.m. on the day of the explosion. Charles Thomas, MSHA Deputy Administrator for CMS&H, contacted Norman Page, CMS&H D6 District Manager, at approximately 5:30 p.m. to request two additional family liaisons. Page instructed Kenneth Fleming, CMS&H Inspector, and James Poynter, CMS&H D6 Assistant District Manager, to travel to the mine. A Family Center was established at the company Safety Office at approximately 9:40 p.m. by Dickerson. Fleming and Poynter arrived at approximately 10:30 p.m. and reported to the Command Center for a briefing by Selfe. Dickerson met with Fleming and Poynter and briefed them on the scheduled times of the family briefings and introduced them to the Company Representative.

Joseph Main, Assistant Secretary of Labor for Mine Safety and Health, arrived at the mine site at approximately 10:00 a.m. on April 6 and, together with Stricklin and the family liaisons, met with the families of the miners to brief them on the progress of the search for their loved ones. The Family Liaisons remained on duty at the Family Center continuously through Saturday, April 10. They briefed the families every four hours and provided information relayed from the Command Center to the Family Center. The family liaisons maintained contact with the families throughout the rescue/recovery operations and investigation and assisted with many of the family briefings.

Recovery of Victims

Extensive damage caused by the explosion complicated the recovery of the victims. Rail travel was blocked inby crosscut 78 by debris on the track. Many ventilation controls were destroyed inby crosscut 75 of the Old North Parallel Mains. Potentially explosive levels of combustible gases were encountered several times during mine rescue attempts and some areas of the mine had an irrespirable atmosphere. Walking was hazardous because of debris in the mine entries. The area of the mine containing the victims was re-ventilated using temporary ventilation controls to permit the recovery to be conducted bare-faced. The logistics of the recovery were difficult; 22 victims were carried distances of up to 1.5 miles, victims locations were mapped, and forensic evidence was gathered prior to recovery of the victims.

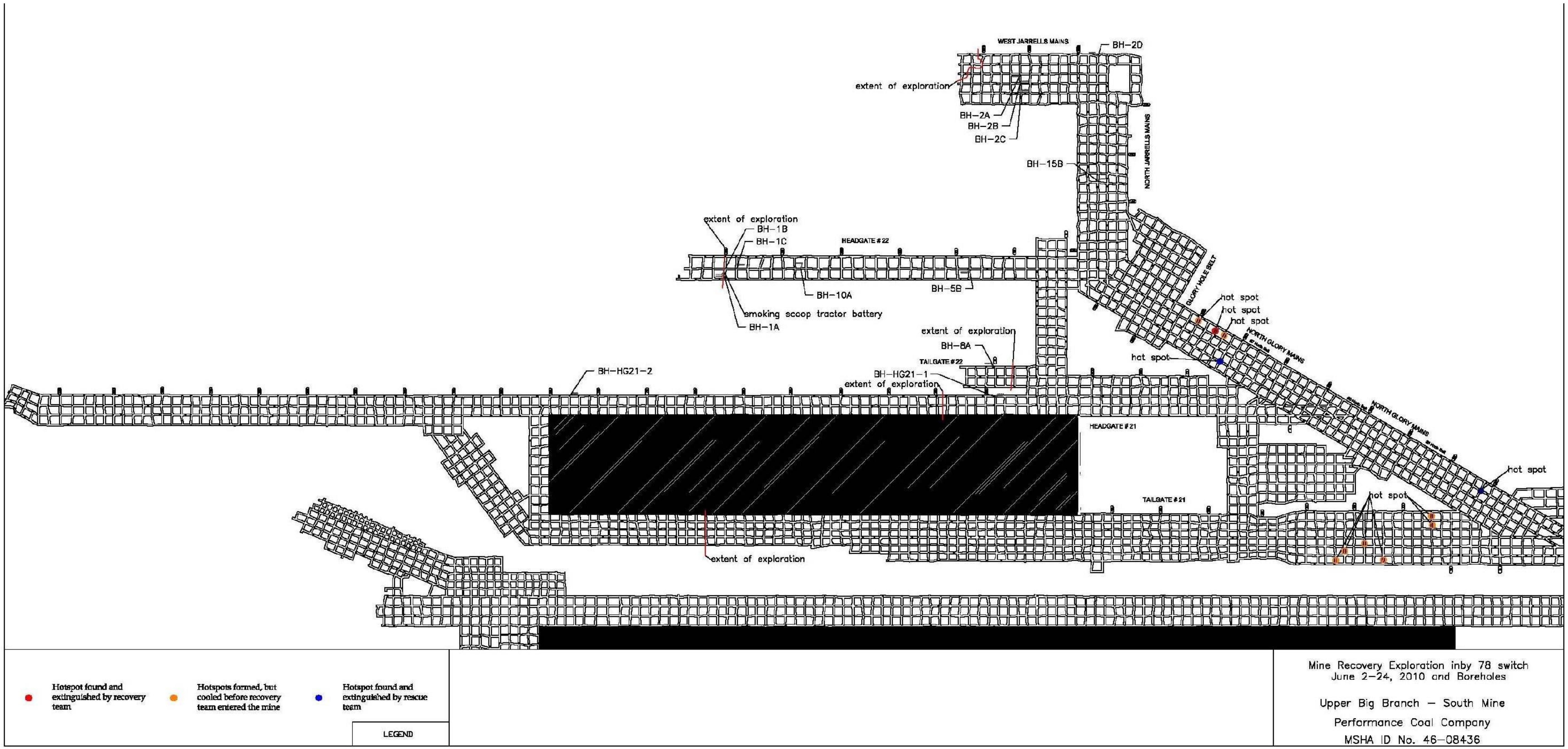
Multiple mine rescue teams worked from the time when the last victim was located at 11:20 p.m. on Friday, April 9 until all of the victims were recovered. On Tuesday, April 13, the last victim was removed from the mine at 12:57 a.m. and the last mine rescue team exited the mine at 3:30 a.m.

Mine Recovery Operations (April 13 - June 24)

Because the stability of the mine's atmosphere continued to be a cause for concern, Massey adopted (with MSHA and WVOMHST's concurrence) an approach for continuing monitoring at all existing sampling locations and drilling additional boreholes to provide monitoring locations in other areas of the mine. Monitoring continued from the North, South and Ellis Portal return entries, the Bandytown bleeder fan, borehole BH 1A, and from other boreholes as they were completed.

Several boreholes were drilled, some of which missed the intended mine entry, as shown on Figure 2. Other boreholes were stopped during drilling and never completed. See Appendix F for a description of each borehole drilled post accident at UBB.

Figure 2. Map of borehole locations and “hot spots” encountered during recovery exploration



On May 27, all parties agreed that the mine atmosphere had stabilized sufficiently to allow re-entry, pending the finalization and sampling of borehole "HG 21-1" near the longwall. Problems arose with HG 21-1, however, when the drill intersected an inactive area of a mine above UBB, causing a delay in the completion of the borehole until June 6. Nonetheless, because of the distance separating the longwall and the portals, exploration of the portal areas began on June 2, with the anticipation that borehole HG 21-1 would be completed prior to any exploration in the longwall area. All parties agreed that the mine atmosphere would continue to be sampled for stability during exploration and recovery work. PCC submitted a plan on June 1, 2010 and MSHA modified the Section 103(k) order on June 2 to allow the mine rescue teams to begin exploration and recovery. The plan required mine rescue teams to enter the North Portal and Ellis Portal and explore the track entries advancing toward each other. The teams explored the mine systematically, identifying hazards, such as ventilation inadequacies, water accumulations, and adverse roof conditions, and corrected these hazards as directed.

Another re-entry plan was submitted by PCC on June 7 and MSHA modified the Section 103(k) Order to allow for additional exploration of the mine. This plan allowed for an orderly exploration progressing through the entire mine. A potentially hazardous elevated temperature area ("hot spot") was found on the mine floor/coal rib interface in crosscut 118, between the No. 4 and No. 5 entry in the North Glory Mains. This hot spot required water to be piped from the surface down borehole 15B so that rescue team members could apply water in sufficient quantities to eliminate the hot spot hazard. Also, two additional hot spots identified by mine rescue teams after the explosion were checked and found to be at ambient mine temperature. Eight other areas in the mine were previously identified as having had elevated temperatures but had subsequently cooled to ambient mine temperatures. Six of these areas were found in Tailgate 1 North between crosscuts 11 and 24.

In HG 22 at crosscut 31, the teams encountered a personnel carrier battery that had smoke rising from it. To remove this possible ignition source, team members disconnected (cut) the negative battery lead from the battery charger to the battery to allow the battery to be moved. The battery was submerged in water at that location.

Mine exploration teams were not able to advance in Headgate 1 North inby crosscut 39½ or in Tailgate 1 North inby crosscut 87 because these areas were determined to be unsafe for travel. Therefore, no exploration occurred in the area of the mine inby those two points, which included the Bandytown fan shaft and the longwall bleeder dewatering system. Other areas of the mine, including parts of the TG 22 and HG 22 sections, were found to be flooded, requiring dewatering to make them accessible before the investigators could begin their work. On June 24, the mine rescue teams completed exploration of the travelable areas of the mine.

The UBB Accident Investigation team began their investigation on April 12, 2010; on June 25, 2010, the team began the underground portion of the investigation.

INVESTIGATION OF THE ACCIDENT

MSHA's accident investigation began on April 12, 2010. MSHA conducted a thorough investigation in the accessible underground areas of the mine affected by the explosion. The investigation included detailed mine mapping and collecting and analyzing evidence. MSHA prepared an investigation protocol in conjunction with WVOMHST to ensure the safety of the underground phase of the investigation; input was solicited from other investigative parties. A copy of the protocol is included in Appendix G.

Involvement with Other Investigations

The accident investigation involved six different investigative entities; MSHA, WVOMHST, PCC, the West Virginia Governor's Independent Investigation Panel (GIIP), the United Mine Workers of America (UMWA) and Moreland & Moreland, l.c., representatives of the miners. MSHA and WVOMHST led the investigation underground, with PCC, GIIP, and UMWA accompanying and assisting them.

WVOMHST and GIIP

Cooperation with WVOMHST began shortly after MSHA's accident investigation team assembled on April 12, 2010. MSHA and WVOMHST conducted interviews jointly. The two agencies also evaluated and approved action plans submitted by PCC. This cooperation was necessary to ensure a thorough investigation and the safety of the investigators. MSHA and WVOMHST established office space at the UBB Portals during the underground investigation to facilitate meetings and planning sessions, information sharing, and communication throughout their respective investigations. Additionally, MSHA cooperated with the GIIP, allowing it access to the MSHA/WVOMHST interviews.

Miners' Representatives

Miners separately designated both the UMWA and Moreland & Moreland as miners' representatives under Section 103(f) of the Mine Act. The UMWA began its involvement on April 23, 2010. UMWA representatives participated fully in the underground portion of the investigation. Moreland & Moreland began its involvement in the investigation on August 11, 2010.

Underground Investigation Teams

The underground portion of the investigation did not begin until the end of June because of hazardous conditions in the mine, including elevated CO concentrations, potential hot spots, and inaccessible areas. MSHA, accompanied by WVOMHST, GIIP, UMWA, and company representatives, mobilized several teams to conduct mine dust surveys, mapping, electrical, ventilation, geologic, flames and forces, evidence collection and inspection activities. In addition to the 105 accident investigation personnel involved with the on-site investigation, MSHA also utilized an additional 45 Technical Support personnel to perform testing and technical work and other personnel to guard the three portals during the investigation.

Mine Mapping Teams

Mine mapping began on June 29 and continued through November 18, 2010. Mapping served to document the mine conditions after the explosion and notate where evidence was found and collected underground. Mapping teams were usually comprised of one or two MSHA personnel, one WVOMHST member, one representative of the mine operator, one miners' representative, and, at times, one GIIP team member. Each mapping team produced a map for separate, referenced mapping areas. MSHA later compiled individual areas to produce a single composite map included in Appendix H. The mapping team conducted all mapping by the distance and offset method, from spad to spad. If no spad was available, the team used the center of an intersection as a reference point. The teams did not map the rib lines, except where inaccuracies in the base map prevented mapping of the objects. The teams made notations when objects appeared to sustain heat damage from the explosion. All team members signed and dated each completed map. The parties typically made copies of team maps at the conclusion of each shift and distributed them to the other investigation teams. The investigators sent up to ten teams when underground mapping was conducted.

Mine Dust Survey

MSHA takes a mine dust survey after every underground coal mine explosion to determine coking and the incombustible content of the post-explosion dusts. The test for coking can be used to determine the extent of flame that occurred during the explosion and help investigators to determine the fuel, ignition source, and origin of the explosion. The incombustible content can be used to establish the condition of the mine dust prior to the explosion.

Flames and Forces Team

MSHA assigned a "flames and forces" team the task of establishing the origin of the explosion, the ignition source, the extent of flame, and the magnitude and direction of primary explosion forces. This team went underground starting July 13, 2010. It consisted of MSHA and WVOMHST personnel, along with GIIP, UMWA and company representatives.

Electrical Teams

Electrical inspections began on May 13, 2010 on the surface area of the mine. The electrical team inspected all surface equipment located near the portals and the surface substations and checked all cables entering the underground mine to ensure the electrical equipment was properly de-energized and grounded. These activities were completed to ensure that the mine was safe from electrical hazards before beginning the underground accident investigation. A maximum of three electrical teams were used throughout the accident investigation, with two teams normally working inside the explosion area. The teams consisted primarily of personnel from MSHA and WVOMHST, but also included one or two company employees, along with a UMWA representative serving as observers. The first electrical teams went underground on June 28, 2010. One team with an additional MSHA Technical Support engineer worked outside of the explosion zone, re-energizing electrical circuits to pump water, install communication devices, and energize other electrical equipment. The team completed the electrical work outby the explosion zone by the end of October 2010. The electrical portion of the investigation in the explosion zone continued until May 4, 2011.

Geology Team

MSHA conducted geologic observations between May 2010 and December 2010. MSHA made surface observations where old contour strip mines, as well as the active Progress Pit strip mine, afforded outcrop exposure. MSHA also observed underground geological conditions in portions of the Castle Mine and the Black Knight II Mine.

Underground at UBB, there was one geology team composed of MSHA and WVOMHST, with observers from the mine operator and the UMWA. MSHA documented geological conditions in UBB by conducting multiple parallel traverses in various entries of Headgate 1 North and Tailgate 1 North, the Panel 1 and Panel 2 crossover, the HG 22 and TG 22 sections, and the North and West Jarrells Mains. MSHA made several traverses across the longwall face, with detailed observations conducted in the tailgate entry. MSHA also documented geological observations on maps and in photographs, which were further supported by the collection of rock and gas samples.

Ventilation Survey

On September 28, MSHA personnel started a mine ventilation air quantity and air pressure survey, with participation from representatives from WVOMHST, UMWA and the mine operator. This survey determined post-explosion air velocities in the mine using either vane anemometers with wands in the one-half area traverse method or using the smoke-cloud method with aspirators and chemical smoke tubes. Investigators then calculated air quantities from the determined velocities and corresponding area of the mine entry in which the velocity was determined. Investigators measured air pressure differentials between air courses and across regulators or partial ventilation controls using magnehelic gauges and digital manometers. Investigators also used altimeters which were used to determine the total pressure at specific locations within the mine.

Evidence Collection and Testing

During the course of the investigation MSHA obtained about 88,000 pages of documents, 1,028 maps, over 24,000 photos, 18 videos, and more than 1,050 separate pieces of physical evidence. MSHA collected evidence at UBB in accordance with the protocol set forth by MSHA in conjunction with WVOMHST. When available and requested, MSHA provided duplicate samples to all investigation parties (Appendix G). Evidence was tagged, photographed, and removed from mine property, accompanied by a "Chain of Custody" form or an "Itemized Receipt", as applicable. The MSHA Accident Investigation team provided PCC itemized receipts for evidence removed from the mine.

Photography

A photographer or group of photographers was frequently present during investigation activities by the accident investigation team. All parties involved during the investigation activities by individual teams were given the opportunity to request additional photographs and examine any evidence prior to its removal from the location. Photos taken were copied per PIL NO. 110-V-08 (Appendix I) which outlines the approved procedure for the copying of digital images from the SD (Secured Digital) card, contained in the camera, to a compact disc or hard drive memory for storage and filing during an accident investigation. MSHA provided a copy of these images to all investigation parties, along with a copy of the signed Photo Log.

Evidence Testing

MSHA CMS&H Mount Hope and Standard Laboratories

The MSHA Mount Hope National Air and Dust Laboratory and the private Standard Laboratories conducted analyses of mine dust surveys collected from the mine to assist investigators in determining the cause and origin of the explosion, the area affected by the flame of the explosion, and the incombustible content of mine dust throughout the sampling area. Each lab processed a total of 1,803 mine dust samples for incombustible content and the presence of coke. As samples were collected, each party accompanying the mine dust survey teams was offered a portion of the same sample collected by MSHA. After the collection team transported samples to the surface, investigators checked each uniquely identified sample against the collection sheet and gave the samples to a member of the evidence collection team, along with a collection data sheet signed by all members of the mine dust survey team.

Investigators then transported samples from the mine site directly to the Mount Hope laboratory for the initial analysis, following MSHA's chain of custody procedures throughout this transfer. The Mount Hope laboratory retained possession of the samples for the duration of the initial analysis test. MSHA stored the remaining portion (except for the small amount consumed during analysis) in a uniquely identified container, locked in a secure room within the laboratory, until investigators transported them to Standard Laboratories for a comparison analysis. A side by side comparison of the results from both laboratories showed that the variation of the results varied only slightly, by an average of only 1.82 percent in the incombustible content (Appendix J). Further evaluation of this data is explained in the subsection “Mine Dust Survey” located in the “Physical Causes of the Accident” portion of the report.

Electrical Testing

MSHA tested numerous physical pieces of evidence recovered from the mine. On a number of occasions, MSHA arranged for the manufacturer of the equipment to conduct the testing in MSHA’s presence. MSHA invited WVOMHST, GIIP, UMWA, Miners Representative and the mine operator to attend all of this testing. Throughout the testing, MSHA retained custody of the evidence.

Joy Manufacturing and Matric Limited Facilities

MSHA arranged for the testing of components removed from the longwall equipment with Joy Manufacturing (Joy), the manufacturer of the equipment, at Joy’s facilities. Joy performed tests on the following components:

- Joy Network Architecture (JNA) control units
- Chock Interface Unit (CIU)
- Automatic Chain Tensioner (ACT)
- Support Control Centre (SCC)
- Shearer Remote Controls

Approval and Certification Center (A&CC)

Investigators used the MSHA Technical Support Approval and Certification Center (A&CC) for testing of multiple items collected throughout the course of the investigation. A&CC testing included equipment checks against approved drawings, functional testing of equipment and safety systems, data recovery, and evaluation of evidence as potential ignition sources during detailed inspections. Investigators also documented grain size for material collected from spray nozzles in the longwall shearer.

State Electric Supply Company Facility

The State Electric Supply Company Facility was involved in the testing and data recovery of certain equipment manufactured by Allen-Bradley, including the PLC-5 and SLC 500 Processor Modules, the Panel View Operator Interface, and the Dataliner DL40 electrical equipment recovered from the mine.

SMC Electrical Products, Inc. Facility

Representatives of SMC Electrical Products used their facility for visual inspection, data recovery and functional testing of the Multilin 239 overcurrent relays, SMC SGF-25 relays, SMC ground fault relay display units, and Multilin SR735 overcurrent relay collected from the longwall track mounted equipment known as the “mule train.” The testing performed by manufacturers’ representatives of these items included visual inspection of the equipment, functional and data recovery.

Mine Safety Appliance Company (MSA) Facility

Investigators conducted data retrieval activities and a time-drift study of item PE-0118, a MSA Solaris hand-held gas detector, at this facility. The Solaris detector was damaged to the point where testing was not possible at A&CC. The visual inspection of the detector was conducted at A&CC.

UBB Mine Site

At the UBB mine site, members of the accident investigation team, with assistance of A&CC personnel, conducted data downloads from gas detection equipment used at UBB prior to the accident and during rescue activities. Present during the download procedure were WVOMHST and the mine operator. Miners representatives from the UMWA were afforded the opportunity to participate. MSHA established protocols for downloads of a Solaris gas detector (used at the mine prior to and after the mine explosion) and Industrial Scientific MX6 gas detectors (used during rescue operations) and invited the mine operator and members for each of the investigation parties to attend the downloads.

Gas Sampling

Investigators collected samples of gas emanating from fractures in the floor from locations on the longwall face and the development sections for chemical and isotopic analyses to determine the source of gas entering the mine. Investigators collected gas using an SKC permissible dust pump, as well as an Industrial Scientific MX6 handheld multi-gas detector with a built-in pump, filling 1-liter Teflon-coated sample bags. In standing water, investigators used a capped length of large-diameter poly-vinyl chloride (PVC) pipe, equipped with a tube fitting, to allow gas to accumulate for sampling. In dry conditions, investigators inserted copper tubes into floor fractures and packed them off with mud and debris to create a seal. Together, with the results of gas analyses obtained at Speed Mining, LLC’s American Eagle Mine, investigators compared the results of gas analyses to samples of methane collected from wells in the vicinity of the mine.

Interviews

As noted earlier, MSHA and WVOMHST conducted interviews jointly, usually with the participation of GIIP. The agencies conducted 310 formal interviews before a court reporter, and 38 individuals were called back for additional testimony. To help facilitate the interviews, WVOMHST issued 116 subpoenas; the other witnesses appeared voluntarily. The Mine Act limits MSHA ability to issue subpoenas, only providing for subpoenas should there be public hearings. Nineteen individuals from Massey or PCC who received subpoenas from WVOMHST exercised their right under the Fifth Amendment of the U.S. Constitution to not testify. MSHA remains willing to interview any of these individuals, even after the release of this report, should any choose to voluntarily share information with the agency. Information from these individuals or others may prove important in better understanding the events leading up to the accident and how it occurred. Such additional evidence could result in MSHA being better informed and could lead MSHA to reexamine findings contained in the report..

PRACTICES AT UBB THAT LED TO THE EXPLOSION

The information in this section is based on testimony and physical evidence obtained during this investigation.

In the days, months, and years prior to April 5, 2010, PCC and Massey management set the stage for the explosion by allowing and encouraging mining practices that resulted in violation of federal law. PCC regularly hid hazards present in the mine from MSHA, noting some of them in one set of production and maintenance books, but failing to note them in required examination books that MSHA examined. PCC's failure to identify and correct the hazards of coal dust accumulations and inadequate rock dusting led to the coal dust explosion on April 5. PCC and Massey inadequately trained their examiners and foremen (and other miners as well), contributing to their failure to identify and correct hazards. In addition, PCC and Massey engineers themselves could not handle the engineering challenges present at UBB and made a series of mistakes that made the mine hazardous.

By April 5, an alarming number of accidents had occurred, many unreported to MSHA in violation of law. PCC illegally provided its employees with advance notice of MSHA inspections, severely limiting the effectiveness of the inspections. Additionally, PCC and Massey intimidated miners from voicing complaints, either internally or to MSHA.

Examinations

PCC regularly failed to properly examine the mine for hazards, putting miners at risk and directly leading to the April 5, 2010 explosion. MSHA regulations, codified at 30 CFR §§ 75.360- 75.364, make plain that a mine operator must examine certain areas of the mine on a weekly basis, as well as before and during each shift, for hazardous conditions. The operator must identify, record, and immediately correct the hazards. At UBB, examiners often did not travel to areas they were required to examine, or, in other cases, did travel to the areas but did not perform the required measurements. Examiners also failed to identify hazards when they did perform examinations. In many instances, management officials noted hazards in a production or maintenance record, but failed to record them as required by the Mine Act in the required book. The failure to properly record hazards denied MSHA and miners the opportunity to understand and assess the hazards and ensure that they were corrected before production resumed. Finally, even where examiners did identify and record hazards, the mine operator frequently did not correct them. Because of these practices, accumulations of loose coal, compacted coal, and coal dust built up over weeks and months to dangerous levels and provided the fuel for the April 5 explosion. Similarly, because of the operator's failure to identify, record and correct the hazard of insufficient application of rock dust, the rock dust that was present in the mine failed to halt the explosion. These are just a few of the hazards that were not corrected and contributed to the April 5 explosion.

Failure to Perform Examinations

On many occasions, PCC failed to conduct or complete required examinations prior to miners entering the mine or work areas. Several of these failures occurred in the 24-hour period prior to the explosion on April 5. For example, during the preshift examination for the midnight shift on April 4, the examiner responsible for examining the longwall face (who had never conducted a longwall preshift prior to April 5) failed to examine the face. The examiner only took an air reading at the intake to the longwall and examined to shield 1. The examiner failed to travel the length of the longwall face to examine for hazardous conditions, test for methane and oxygen deficiency, determine if the air was moving in its proper direction, or take air velocity measurements at shields 9 and 160. The midnight maintenance crew worked on the face as scheduled.

An examiner was responsible for examining the longwall tailgate entries on April 5 prior to the start of pumping work in those areas. The examiner permitted his pumping crew, comprising of two contract laborers, to travel with him as he conducted his examination, a practice which is impermissible under the regulations.

PCC failed to comply with the requirement that weekly examinations be performed once every seven days. Between December 29, 2009 and March 10, 2010, it was common practice for the examination of the return entry at the Bandytown fan to be conducted every eight to nine days.

Examiners routinely did not energize their multi-gas detectors when required during examinations, and the detectors often remained de-energized for extended periods of time during their shift.

On the day of the explosion, an examiner was required to perform a weekly examination on the longwall bleeder system. This bleeder was in the area behind the longwall that draws noxious gases and dusts away from the active areas and ultimately exhausts these contaminants through the Bandytown fan. After the explosion, investigators determined that the examiner's multi-gas detector had not been turned on since March 18, 2010, approximately two weeks prior to the explosion. As a result, during this time period, the examiner could not take adequate air quality measurements.

In addition, section foremen failed to keep their multi-gas detectors energized throughout their shifts. The longwall section foreman failed to energize his detector during the first part of the shift, from 8:45 a.m. to 11:08 a.m., on April 5.

PCC's examiners did not perform complete examinations by failing to take air readings required by the mine's approved ventilation plan. For example, PCC's weekly examiners did not take air quantity measurements at a required evaluation point in the longwall headgate entries because water had blocked access to the location. Rather than remove the water or establish an alternative measurement point, PCC simply failed to take measurements. Examiners did not take air readings in a number of other locations, including the Ellis Portal return air courses, the longwall section belt, the Ellis Portal belt/track, and measuring points inby the longwall headgate and tailgate.

Required examinations of dust control parameters for the longwall shearer were not being performed. Air measurements were not taken at proper locations to determine the actual quantity of air ventilating the longwall face. The air quantity in the longwall belt entry was not being measured. Water sprays, pressure and flow rates, were not being examined as required for each shift.

Failure to Identify Obvious Hazards

MSHA found hazardous conditions throughout the northern area of the mine (i.e., the area affected by the explosion), including:

Accumulations of Loose Coal[4], Coal Dust[5], and Float Coal Dust[6]

MSHA investigators found that PCC examiners failed to identify accumulations on the mine floor and against the ribs left from initial mining or roadway spillage, accumulations that had been scooped and placed in piles shown in Figure 3, and accumulations from rib sloughage. Accumulations were found consistently along every single air course. The location and placement of these coal accumulations indicated that they pre-dated

[4] Loose coal is defined as coal fragments larger in size than coal dust, as per 30 CFR 75.400-1(c).
[5] Coal dust is defined as particles of coal that can pass through a 20 mesh sieve, as per 30 CFR 75.400-1(a).
[6] Float coal dust is defined as coal dust consisting of particles of coal than can pass through a 200 mesh sieve (100 times smaller particles than those passing through a 20 mesh sieve), as per 30 CFR 75.400-1(b). Float coal dust is the most dangerous because it is easily suspended in the mine atmosphere and only requires a thin observable layer to provide the fuel for the propagation of a dust explosion.

the explosion. Miners working in these areas testified these accumulations existed prior to the explosion.

Figure 3. Accumulations of loose coal, coal dust, and float coal dust were measured up to 7 feet wide by 12 feet long by up to 4 feet in depth. These were found consistently along every single air course.

Rock Dust[7]

The MSHA Accident Investigation Team's mine dust survey revealed that 90.5 percent of the affected area[8] was inadequately rock dusted at the time of the explosion. Testimony indicated that the Longwall Tailgate entries, the crossover between HG 22 and TG 22, and the Glory Hole area were black or needed to be rock dusted. In addition evidence indicates that the Longwall Tailgate entries had not been rock dusted since the longwall went into production in September 2009. (The "Rock Dusting"

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[7] Rock dust is defined as pulverized limestone, dolomite, gypsum, anhydrite, shale, adobe, or other inert material, preferably light colored, 100 percent of which will pass through a sieve having 20 meshes per linear inch and 70 percent or more of which will pass through a sieve having 200 meshes per linear inch, as per 30 CFR. Rock dust must be continuously applied in order to neutralize float coal dust, which inherently occurs during the mining process.

[8] The "affected area" is the area of the mine that was exposed to flame as indicated in Appendix Z.

section discusses in more detail PCC's inadequate rock dusting practices). Only the belt examination books listed inadequate rock dusting as a hazard; the other examination books from the working sections did not.

<u>Inadequate Roof Support</u>

PCC's roof control plan required two rows of posts or two 8' cable bolts in the No. 7 entry in the longwall tailgate as supplemental support. This requirement was intended to maintain adequate roof support in that entry. PCC only installed one row of posts in the entry as shown in Figure 4. Both the single row of posts and the resulting roof control issues were obvious; examiners testified that they did not like to travel in that entry due to the bad top. PCC never recorded the hazard in any of its examination books. Poor roof conditions led to a roof fall in the No. 7 entry, which likely restricted air flow coming off the longwall face, and allowed methane to accumulate prior to the explosion. The investigation indicated that this fall was present prior to the explosion; blackened dust from the explosion was present on the fall and could only have occurred after the explosion.

Figure 4. Photograph of Tailgate 1 North No. 7 entry showing only one row of posts installed. The approved roof control plan required two rows of 8' cable bolts or posts.

Failure to Record Hazards

PCC engaged in a practice of failing to record all hazards in books required to be made available to MSHA and any interested persons. Several witnesses testified that they felt pressured by mine management not to record hazards in the required examination books. PCC instead recorded certain hazards in its internal production and maintenance reports. These reports were prepared by shift or section foremen and provided to PCC upper management (including Massey Energy Company officials for the production reports). Some of the hazardous conditions described in this “second set” of books relate to conditions that existed at the time of the explosion. For example, Figure 5, which is an entry in a PCC maintenance book from March 1, 2010, indicated that eight sprays were removed from both the head and tail drum and the shearer was operated in that manner for the remainder of the shift. This information was not recorded in the required examination book.

Use Indelible Pencil or Ink

DAILY AND ONSHIFT REPORT
MINE FOREMAN OR ASSISTANT

Report shall be signed when made

Date 3-1-10 Shift Eve Area or Section Longwall

Violations and other Hazardous Conditions Observed and Reported

	Location	Violation or Hazardous Condition	Action taken
1.	Face	CH4 0% O2 20.8% None Observed	None
2.	Roof Supports	" " " "	"
3.	Power Center	" " " "	"
4.	Chargers	" " " "	"
5.	Track	" " " "	"
6.	Travelways	" " " "	"
7.	Barricade Station	" " " "	"
8.			

Examinations for Methane in Working Places

	Location	Time	Methane Content		Location	Time	Methane Content
1.	Face	4:45 PM	0%	11.			
2.		6:45 PM	0%	12.			
3.		8:43 Pm	0%	13.			
4.		10:42 Pm	0%	14.			
5.		12:40 AM	0%	15.			
6.				16.			
7.				17.			
8.				18.			
9.				19.			
10.				20.			

Examinations for Methane in Return Aircourses

	Location	Time	Methane Content		Location	Time	Methane Content
1.	Return	5:50 Pm	0%	6.			
2.		7:48 Pm	0%	7.			
3.		9:48 Pm	0%	8.			
4.		11:45 Pm	0%	9.			
5.				10.			

Number of Bolts Tested
Number of Bolts Torqued Above Range Below Range
If majority of bolts tested in any working place falls outside approved torque range, state what action was taken

Remarks (Statement as to General Conditions of Mine or Area of Mine) discussed Lonwall dust & methane

[redacted]

Performance
UBB Longwall
Monday, 3/1/2010
B Crew, Shift Chief

Equipment	Job Description	Estimated Time	Comments/Initials
ace Conveyor	Utilize the bretby gauge to check the bretby trough to insure bretby will clear. If not wide enough, repair and record locations where repairs were made. ______ Hang gauge at #5 shield when complete. (On-Shift)	20 minutes	TE
	Check slim line in cable handler, especially near couplings looking for fatigue do to movement, replace as needed. (On-Shift)	20 minutes	TE
	Did you put ACT in manual mode on your shift ______, if so explain why. Did you put yellow handle detent valve in and set to 1500 PSI? (On-Shift)	5 minutes	
eneral Longwall	Check oxygen and acetylene tanks. Record the number of empty oxygen tanks 1, full oxygen tanks 3, empty acetylene tanks 2, full acetylene tanks 5 (On-Shift)	10 minutes	TE
lonorail	Check cooling water manifold board confirm all flows are at least 8 gallons per minute, head#1, head#2, tail, crusher, stageloader #1 and stageloader #2 (On-Shift)	5 minutes	TE
	Check push-pull for leaks, repair as needed (On-Shift)	5 minutes	TE
ower Center	Verify that chirp alert is working at power center and splice box (On-Shift)	5 minutes	TE
aw Oil Tanker	Check oil level and record inches of oil, 24 inches, record name of foreman notified if less than 12 inches of raw oil in tanker, ______ name (On-Shift)	5 minutes	TE
hearer	Check cowl blade bolts, replace if more than one is missing (Pre-shift)	5 minutes	TE

Added 5 gal oil to T/E ranging Arm
Had no water on either drum, cleaned several and stopped right back up, removed 8 on each end, ran like that rest of shift to try and Flush drums, told 3rd shift

Figure 5 . Excerpt from PCC Maintenance Report dated 3/1/2010.

Below is a list, separated by working section, of some of the hazards that were recorded in the production reports but were not recorded in the required examination records that were made available to MSHA. (Also see Figures 6 and 7, which follow.)

<u>HG 22:</u>

- “230 minutes [down time], intake air going in wrong direction off old intake.” January 7, 2010, day shift.
- “Lost air in face return had very little pull to it. Found return stopping out. Had to build back.” January 11, 2010, day shift.
- “Adverse roof conditions.” February 12, 2010, evening shift.
- “At 24 break between 1-2 top broke up 2’, 3’, 4’, 6 ½’ spot bolted with cable bolts. Adverse roof conditions 1-3.” February 16, 2010, day shift.
- “Adverse roof conditions 1-3. Bolting ribs.” (Production Report Noted: down 101 minutes-roof conditions). February 18, 2010, day shift.
- “No air lob [last open break]. Went to glory hole fixed problem where air was leaking, put curtains across return overcast+ fly pads going to old intake, found 5 stoppings with holes in them, finish stopping on return side + plaster.” February 23, 2010, day shift.
- “120 minutes [down time] holes in intake to get air to the section.” March 1, 2010, evening shift.
- “Inspector had section down low air. Shut down by inspector not enough air in lob only. Section down for low air.” March 2, 2010, day shift.
- “25 min reventelating [sic] to get methane out of # 3 1.5 % reduce to .30” down 60 minutes.” March 2, 2010, evening shift.
- “Lob [last open break] low air in it. Found problem outby double door open.” March 11, 2010, day shift.
- “Low air on lob. Doors outby going to back to HG 22 tail open 7:00-8:00. Adverse roof conditions coal streaks four? 5’ up.” March 16, 2010, day shift

Use Indelible Pencil or Ink

DAILY AND ONSHIFT REPORT
MINE FOREMAN OR ASSISTANT

Report shall be signed when made

Date 3-16-10 Shift Day Area or Section HG 22

Violations and other Hazardous Conditions Observed and Reported

	Location	Violation or Hazardous Condition	Action taken
1.	1	none obs	none
2.	2	none obs	none
3.	2nd	part bolted	bolted
4.	3	none obs	none
5.			
6.			
7.			
8.			

Examinations for Methane in Working Places

	Location	Time	Methane Content		Location	Time	Methane Content
1.	1-3	7:00 7:50	.20	11.			
2.		9:00		12.			
3.	1-3	9:50	.20	13.			
4.		11:00		14.			
5.	1-3	11:50	.20	15.			
6.		1:00		16.			
7.	1-3	1:50	.20	17.			
8.				18.			
9.				19.			
10.				20.			

Examinations for Methane in Return Aircourses

	Location	Time	Methane Content		Location	Time	Methane Content
1.	Ret	8:00	.20	6.			
2.				7.			
3.	Ret	12:00	.20	8.			
4.				9.			
5.				10.			

Number of Bolts Tested 12
Number of Bolts Torqued Above Range 0 Below Range 0

If majority of bolts tested in any working place falls outside approved torque range, state what action was taken

Remarks (Statement as to General Conditions of Mine or Area of Mine) discussed fire #5 of Roc #21 at 6:43 AM Dust control plan 16,17

[redacted] Assistant Mine... Certificate No. T. Moore Mine Foreman-Mine Manager 33359 Certificate No. Superintendent or Assistant

32BK

Massey Energy Production Report

Mine: UBB (for all 4 sections)
Section: HG22 Crew: A
Foreman: [redacted]
Shift: Day
Date: 3-16-10

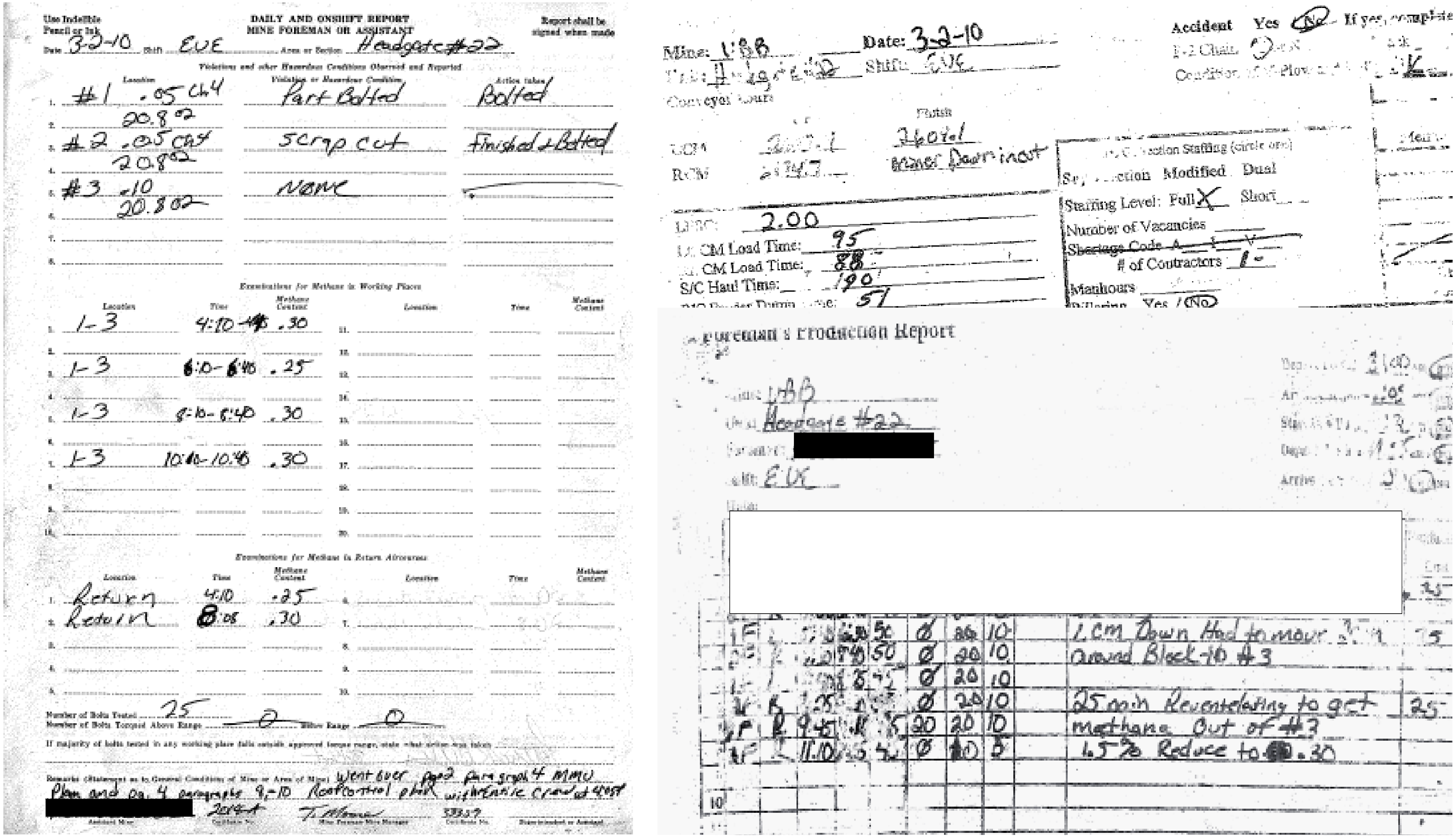
Below Times in Minutes
Portal In: 60 Min.
On Coal: 80 Min.
Portal Out: 60 Min.
(On Coal = Total Time It Takes To Start Up Production)

Depart Portal: 6
Arrive on Section: 7
Start Loading: 8
Depart Section: 3
Arrive Outside: 4

	Place	L or R CM	Time In	Time Out	Total Time	Move Time	Cut Depth	# Of SC's	Quality Issue	Delay's and Remarks	Produ... Los...
1	1	L	8:42	9:30	48	2	18	10		PM, Dust parameters	3
2	1N	L	11:52	12:28	36	7	10	6	16	Low Air In LOB. Doors	
3	1N	L	2:08	2:45	37	10	15	7	23	outby going back to HG22 Tail	8
4		L								open 7:00-8:10	
5		L								R&S/C Hangup on Dump	
6		L									
7		L								Adverse Roof condition their	
8		L								coal streak four ?5' up.	
9		L								Falling out to it In #1	
10		L								2.	
11		L									
12		L									
1	2	R	8:20	8:45	20	—	10	7		wait on Bolter to clean	
2	2	R									
3	3	R									
4	2	R									
5	2	R								2:50	2
6	3	R								tracks	
7		R								Top back	
8		R									
9		R									
10		R									
11		R									
12		R									

"Low Air in LOB. Doors outby going to HG22 Tail open 7:00-8:10...Adverse Roof condition their coal streak four ?5' up. Falling out to it in #1 2."

Figure 6. Comparison of HG 22 on-shift report and production report dated 3/16/10.



Use Indelible Pencil or Ink

DAILY AND ONSHIFT REPORT
MINE FOREMAN OR ASSISTANT

Report shall be signed when made

Date 3-2-10 Shift EVE Area or Section Headgate #22

Violations and other Hazardous Conditions Observed and Reported

	Location	Violation or Hazardous Condition	Action taken
1.	#1 .05 CH4	Part Bolted	Bolted
2.	20.8 O2		
3.	#2 .05 CH4	Scrap cut	Finished + Bolted
4.	20.8 O2		
5.	#3 .10	None	
6.	20.8 O2		
7.			
8.			

Examinations for Methane in Working Places

	Location	Time	Methane Content		Location	Time	Methane Content
1.	1-3	4:10-4:45	.30	11.			
2.				12.			
3.	1-3	6:10-6:40	.25	13.			
4.				14.			
5.	1-3	8:10-8:40	.30	15.			
6.				16.			
7.	1-3	10:10-10:45	.30	17.			
8.				18.			
9.				19.			
10.				20.			

Examinations for Methane in Return Aircourses

	Location	Time	Methane Content		Location	Time	Methane Content
1.	Return	4:10	.25	6.			
2.	Return	8:05	.30	7.			
3.				8.			
4.				9.			
5.				10.			

Number of Bolts Tested 25
Number of Bolts Torqued Above Range 0 Below Range 0

If majority of bolts tested in any working place falls outside approved torque range, state what action was taken

Remarks (Statement as to General Condition of Mine or Area of Mine) Went over page paragraph 4 MMU Plan and pg. 4 paragraphs 9-10 Roof control plan with entire crew at 4:05

[redacted] 2014-A T. [illegible] 33327
Assistant Mine Foreman / Certificate No. / Mine Foreman Mine Manager / Certificate No. / Superintendent or Assistant

Mine: UBB Date: 3-2-10
Shift: EVE
Conveyor Hours
Accident Yes No If yes, complete

		Finish
LCM	[illegible]	360 total
RCM	[illegible]	Miner Down in out

Section Staffing (circle one)
Modified Dual
Staffing Level: Full X Short
Number of Vacancies
~~Shortage Code~~
# of Contractors 1
Manhours
Pillaring Yes / No

2.00
LCM Load Time: 95
RCM Load Time: 88
S/C Haul Time: 190
57

Foreman's Production Report

Mine: UBB
Unit: Headgate #22
Foreman: [redacted]
Shift: EVE

1	F		50	Ø	20	10	1 CM Down Had to move 3 [illegible]	15
2			50	Ø	20	10	around Block to #3	
3				Ø	20	10		
4	R			Ø	20	10	25 min Reventelating to get	25
5	F	9:45		20	20	10	methane Out of #3	
6	F	11:10		Ø	10	5	1.5% Reduce to .30	

Figure 7. Comparison of HG 22 on-shift and production report dated 3/2/10.

TG 22:

- "Air coming up belt had to build airlock # 2 had about 24" of water for about 100 feet." March 16, 2010, dayshift.

Headgate 1 North (Longwall):

- "Shot at Ellis punch out, set CO's off." September 30, 2009, evening shift.
- "Had a fall from #1 shield to about 15 foot outby crusher. Had to build cribs down by s/l and into LOB also the rock was in crusher and back to head was about 10 feet high 16 foot wide, crew had to drill and shoot rock up to 4 times to get to run. It took 45 minutes each time we had to drill and shoot. 180 minutes to drill and shoot." December 4, 2009, evening shift.
- "No production took in 13 hp pump and put at supply doors, Both pumps on face were down. Had to put new discharge lines on both due to shields being pulled in and gob smashed both lines. Water was approx 8" from top of shields." January 3, 2010, evening shift.
- "No production, 4 North belt tail went down while coming underground at 43 br, we went over to the belt head, and saw a lot of smoke, we got the water hose and started putting water on tail roller, I left 4 men at tail piece, I took 4 men to longwall to fix pump in swag." January 10, 2010, evening shift.
- "Water gets bad cutting from head back to 115 while pump is running while cutting." January 18, 2010, evening shift.
- Maintenance report "the tip sprays that need to be every 20 shields, most are not working." March 6, 2010, "A" crew,

Failure to Correct Hazards

PCC engaged in a practice of failing to correct recorded hazards. For example, belt examination records repeatedly indicated that the belts needed to be cleaned and/or dusted. From March 5, 2010 through April 5, 2010, examiners recorded, but did not correct, the following hazardous conditions for the six conveyor belts where the explosion propagated:

- HG 22 #1 belt - 15 consecutive shifts reflect the belt needed cleaning and dusting with no corrective action taken. Of 90 producing shifts, 83 percent of the shifts reflect the belt needed cleaning and 96 percent of the shifts reflect the belt needed dusting.

- TG 22 #1 belt - 24 consecutive shifts are recorded needed cleaning and 18 shifts needed dusted, with no corrective action taken. Of 73 producing shifts, 92 percent of the shifts reflect the belt needed cleaning and 99 percent of the shifts reflect the belt needed dusting.
- TG 22 #2 belt - 14 consecutive shifts are recorded needed cleaning and 18 shifts needed dusted with no corrective action taken. Of 54 producing shifts, 48 percent of the shifts reflect the belt needed cleaning and 78 percent of the shifts reflect the belt needed dusting.
- North #6 belt - six consecutive shifts are recorded needed cleaning and 15 shifts needed dusted with no corrective action. Of 90 producing shifts, 100 percent of the shifts reflect the belt needed cleaning and 86 percent of the shifts reflect the belt needed dusting.
- North #7 belt - 3 consecutive shifts are recorded needed cleaning and 21 shifts needed dusted with no corrective action taken. Of 90 producing shifts, 36 percent of the shifts reflect the belt needed cleaning and 97 percent of the shifts reflect the belt needed to be dusting.
- Longwall Belt - six consecutive shifts are recorded needed cleaning and 15 shifts needed dusted without any corrective action taken. Of 89 producing shifts, 67 percent of the shifts reflect the belt needed cleaning and 83 percent of the shifts reflect the belt needed dusting.

During the underground investigation, MSHA identified accumulations in over 50 locations along the conveyor belts. These accumulations were allowed to pile up below and around the belt and belt structure, and along portions of ribs that were not cleaned up during initial development. Examples of this are shown in Figures 8 and 9. The size and number of these accumulations demonstrate that the hazards existed for a long period of time.


Figure 8. Accumulations of loose coal with the top of the pile flattened due to rubbing the moving belt.

Figure 9. Accumulations of loose coal built up to the point that the belt roller is turning in the accumulations.

Another example taken from production reports demonstrated poor roof conditions:

- January 5, 2010: "return #1 entry off of 2 section, bad top, cut down both ribs and breaking around bolts, 54-55 bk."
- January 23, 2010: "bad top in return going out Bandytown at 53-55 bk, is cut down both ribs and busted up in the middle and falling out."
- February 23, 2010: "bad top in return next to overcast, spad no. 23960, going out old 2 section and 1 section return."

These records indicate PCC's failure to take corrective action. Examiners testified that the repetition of the hazards in the books was based on a failure to correct the hazards, rather than a failure to record corrective action.

In addition, the examination record book from January 5, 2010 to March 31, 2010 for airways inby Ellis switch documents more than 75 separate instances of hazardous conditions. Only six hazardous conditions were recorded as corrected. The documented hazards ranged from adverse roof conditions to the presence of rock and material in the travelways.

Inadequate Training

MSHA found widespread deficiencies in PCC's efforts to comply with its approved training plan. The training plan, approved March 29, 2007 pursuant to 30 C.F.R. § 48.3(a), described several training programs, including those for experienced miner training, task training, and annual refresher training. MSHA interviewed miners and reviewed various PCC and contractor training functions that included plans, classes, curriculum materials, and records. MSHA reviewed employee training files covering the two-year period from April 5, 2008 to April 5, 2010, compiled from employee and contractor labor employee lists, for compliance with Parts 48A and 48B of the approved training plan.

PCC failed to provide any training records for 30 miners as required by 30 C.F.R. §48.6, including PCC President Chris Blanchard and another top company official. Based on the information available, MSHA found that 112 miners either did not receive experienced miner training or received incomplete experienced miner training; 44 miners did not receive task training before performing the task as mobile equipment operators or performing other new job tasks; and 21 miners did not receive annual refresher training. In addition, 22 miners received experienced miner training from individuals who were not MSHA-approved instructors. Nine different individuals certified these miners' training records despite not being MSHA-approved instructors.

PCC was aware of many of these deficiencies because Massey Coal Services, a subsidiary of Massey Energy Company, performed an audit in September 2009 and identified a number of training deficiencies in PCC's efforts to comply with its approved training plan. These deficiencies included PCC's failure to provide experienced miner training and task training to a number of individuals, including several miners who worked on the longwall. As of April 5, 2010, PCC had failed to correct or address most of these deficiencies and Massey Coal Services had failed to take any steps to ensure that PCC corrected the deficiencies.

Experienced Miner Training

Training records and interview testimony indicated that 112 miners either did not receive experienced miner training or received incomplete experienced miner training. The miners who failed to receive experienced miner training received hazard training only or no training; this group of miners included members of the longwall crew that were transferred to UBB from Logan's Fork in 2009.

All miners received Massey Initial Training (MIT) when they started working for PCC. On May 5, 2010, MSHA observed the MIT program conducted at the Marfork Coal Company (Marfork) training center. The training lasted approximately three hours and was predominantly related to Massey policies. After the MIT program, the instructor completed a MSHA Form 5000-23 (record of training) for individuals in the training session as having received the experienced miner training. When interviewed, the instructor stated that prior to April 5, the courses of instruction consisted mostly of Massey policy.

The MIT program covered only one subject (self-rescue and respiratory devices) of the 12 subjects listed in their approved training plan and required in 30 CFR Section 48.6(b). The MIT program ignored 11 subjects:

- Introduction to work environment
- Mandatory health and safety standards
- Authority and responsibility of supervisors and miners' representatives
- Entering and leaving the mine; transportation; communication
- Mine map; escapeways; emergency evacuation; barricading
- Roof or ground control and ventilation plans
- Hazard recognition
- Prevention of accidents
- Emergency medical procedures
- Health
- Health and safety aspects of the tasks to which the experienced miner is assigned

The MIT program deferred to the individual operator (i.e. PCC) to complete the other requirements of experienced miner training, including the introduction to the work environment. It was determined that 112 of these employees did not receive this training as required.

MSHA determined that PCC's failure to train its miners in hazard recognition contributed to the conditions which were involved in the explosion on April 5. The miners' lack of training in hazard recognition was corroborated by the existence of extensive accumulations of loose coal, coal dust, and float coal dust which went unidentified and uncorrected prior to the explosion. In addition, testimony and underground observations corroborated that miners were not aware of the requirements of the roof control and ventilation plans. Many miners had no knowledge of the 1997 explosion, which involved an ignition of gas in the gob near the tailgate side of the longwall face behind the shields in the 2 West Longwall panel, nor of the 2003 and 2004 methane feeders, all of which shared characteristics with the April 5, 2010 explosion. Knowledge of past accidents is a required part of training and is a crucial part of accident prevention.

Task Training

Training records and interview testimony indicated that 44 miners did not receive task training before performing the task as mobile equipment operators or performing other new job tasks, including those related to performing preshift, on-shift, and weekly examinations, working on the rock dusting crew, and working on the longwall during production shifts. PCC's failure to train its miners in a number of these tasks contributed to the conditions which were involved in the explosion on April 5. A number of preshift and belt examiners testified that PCC never trained them how to perform such examinations, which means they did not receive training on specific hazard recognition and roof control and ventilation plans. PCC did not train a number of rock dusting crew members on the amount of rock dust which must be applied to a given area. PCC did not provide task training to certain individuals on the longwall crew on the operation and maintenance of the longwall shearing machine.

Annual Refresher Training

Training records and interview testimony indicated that 21 miners did not receive annual refresher training over the past two years. In 2009, three miners did not receive annual refresher training, while in 2010. Eighteen miners did not receive annual refresher training. PCC conducted its annual refresher training in March, 2010. Many hazardous conditions and practices which existed prior to the annual refresher training persisted up until the time of the explosion and contributed to the explosion.

Other Training Deficiencies

PCC's training records and miner testimony indicated additional deficiencies:

- Under 30 C.F.R. § 48.9, mine operators must retain copies of training certificates for various lengths of time. PCC failed to provide any training records for 30 miners, including PCC President Chris Blanchard and another top company official. Based on PCC's failure to provide these training records, it is unclear whether these 30 miners received any of the required training.

- Under 30 C.F.R. §48.3(g), certain training courses "shall be conducted by MSHA approved instructors." 23 miners received experienced miner training from individuals who were not MSHA-approved instructors; nine different individuals certified these miners' training records despite not being MSHA-approved instructors.

- Ten members of management were designated as "responsible persons" as of April 5, 2010, but there were no records to indicate they had received the training required by Section 75.1501(a)(2).

- PCC provided the names of six individuals who had received training for the examination and sampling of seals, as required by Section 75.338. The mine seal examination record books, covering the dates from June 29, 2009 through April 5, 2010, showed that 17 individuals signed the books indicating they had examined seals. The training records showed that only two of the 17 employees received the training. One of the individuals had not received the annual training under Section 75.338 which was due in January 2010.

- PCC identified five employees that operated the AMS frequently. AMS operators are required by Section 75.351(q)(2) to travel to all working sections underground every six months in order to retain familiarity with the underground mining system at their operations. During an interview, one of the five employees stated that he had not been to a production section in three years.

- PCC stated "all members are qualified AMS operators as the AMS system and its operation are specifically covered during annual refresher training." The operator did not have sufficient time allotted in the annual refresher training or the equipment necessary to train the AMS personnel.

Contractor Training Issues

David Stanley Consultants, LLC (DSC), Contractor ID YBV

MSHA approved training plans for DSC, covering Part 48, Subpart A, Subpart B, Part 75, and Part 77, on July 28, 2006. MSHA interviewed certain DSC employees and also reviewed employee training records covering the two-year period from April 5, 2008 to April 5, 2010, for compliance, identifying numerous deficiencies. These deficiencies were included in the deficiencies listed above.

On June 15, 2010, MSHA observed a training session conducted at the Marfork training center by James Gump, Director of Operations and Safety for DSC. The attendees were going to work at various Massey Energy Company mines for DSC. Gump provided training by using an outline which did not cover the course materials required by Section 48.6 (training of experienced miners), as specified in DSC's approved training plan. The instructor did not have available for review the mine ventilation plans, roof control plans, clean-up and rock-dusting plans, mine maps, mine transportation and communications, or health and safety of the task to which the new miner would be assigned or other required course material. Nonetheless, the instructor completed a Form 5000-23 for each attendee indicating they received experienced miner training, even though they did not receive complete training.

Mountaineer Labor Solutions, LLC (MLS), Contractor ID T025

MSHA approved training plans for MLS, covering 30 CFR Part 48 and §§ 75.160 and 77.107, on January 23, 2008. MSHA interviewed certain MLS employees and also reviewed employee training records covering the two-year period from April 5, 2008 to April 5, 2010, for compliance, identifying numerous deficiencies. These deficiencies were included in the deficiencies listed above.

The records, certified by Brian Buzzard, owner of MLS, indicated that experienced miner training had been conducted. MSHA determined that Buzzard had no training material on escapeway maps, ventilation plans, roof control plans, first aid manuals or first aid equipment. Buzzard did not have training models for the SR-100 SCSR or other course material for training experienced miners, as required by Section 48.6 and stipulated in the MLS approved training plan.

Engineering Issues

Interviews with Massey engineers reflected their confusion and unfamiliarity with the mine. PCC utilized engineering services from a Massey-affiliated engineering facility known as "Route 3 Engineering." These services included surveying, mapping, and mine design. Engineers included Chief Engineer Paul McCombs, UBB Resident Engineer Eric Lilly, Matthew Walker, Heath Lilly, and Raymond Brainard.

A number of Route 3 engineers testified that they had limited mining experience and rarely went underground at UBB. The licensed engineer who certified mine maps was more familiar with tax issues and long term planning for Massey, rather than the specific underground conditions of the mines in question.

Route 3 engineers submitted 13 proposed UBB ventilation plan revisions that were denied by MSHA D4 between September 11, 2009 and April 5, 2010. In connection with these denials, MSHA identified fundamental deficiencies in plans and on maps such as missing regulators, missing stoppings, missing air directions, missing air quantities, and other regulatory deficiencies. A more detailed description of the plans submitted can be found in the sections entitled "Recent Revision to the Approved Plan and Map" and "Disapproved Revision to the Ventilation Plan and Map" under Ventilation Plan later in the report. The number of revisions and disapprovals are an indication of the lack of planning and inadequate engineering practices employed by this operator.

Engineers testified that they did not know who was in charge of ventilation at UBB. When interviewed, Walker stated that there was not a specific person responsible. Without a clearly specified person responsible, ventilation changes were made without planning and foresight.

Intimidation of Miners

The Mine Act grants the right to request an immediate inspection when they have reasonable grounds to believe that a violation of the Mine Act, a mandatory health or safety standard, or an imminent danger exists. MSHA encourages miners (or their representatives) to do so via a toll-free hotline (1-800-746-1553) or on MSHA's Web page under Online Tools (Report a Hazardous Condition) <MSHA Hazard Complaint>. They may also report hazardous condition complaints directly to an MSHA inspector. Despite the recognition by many miners of hazards throughout UBB, no one had made a complaint to MSHA since

June 8, 2006. MSHA did not receive any complaint related to underground hazards at UBB prior to the accident.

Miners were routinely intimidated by Massey and PCC managers who created a culture in which production trumped all other concerns. Foremen were required to regularly report their production status to PCC and Massey management, as well as “downtime” reports for when production stopped.

Because of this culture, miners testified that they were reluctant to make a safety complaint to their superiors, or pursue a complaint beyond merely mentioning it to their foreman. Miners did not alert MSHA of hazards prior to April 5, 2010. Even though miners knew of safety problems at the mine, they did not make complaints or report the safety problems because they believed they might lose their jobs as a result.

A scoop operator testified that miners “know not to say anything because they know they'll probably get fired by the bosses.” He noted that even with air problems they were having, “you felt like you couldn't really say anything, because you know if you did, you'd probably be fired.”

A shuttle car operator testified that his boss instructed him not to speak to MSHA inspectors.

A foreman testified that Massey retaliated against miners who made complaints by assigning them to the hoot owl shift or to a mine with low coal.

A purchasing agent testified that mine management would threaten to fire foreman when they called out and reported that they were down because of insufficient ventilation, “He would say we was stupid, that the guys are stupid, call up there and fire them. He wanted them in the coal in a few minutes.” The purchasing agent further testified when asked about managements’ attitude when unusual problems such as water shutting down the longwall for a couple of weeks, “…tell them guys to get the coal, we got to get running. It got to the point where I’d reach for the phone---we got caller ID. I’d reach for the phone and my hand would shake. ….I was at the end of my rope almost.”

Similarly, another UBB miner, testified: “…they (miners) were scared if they took the time to ventilate that way it should be, whether they would be or not, they were scared they’d be fire or gotten rid of or taken off of that job and put on something that might not be as good for them as working on the face.” He further stated, “…you knew that you better go ahead and mine the coal or --- the atmosphere around Massey was, you know, you just keep your mouth shut and do it if you want to keep your job.”

Massey established a toll-free number for miners to internally make safety and health complaints. However, some miners testified that they were reluctant to use this phone number because they feared retaliation.

In addition, testimony established that upper management at PCC threatened foremen and miners who took time to make needed safety corrections. An employee testified that upper management threatened to fire crews when they stopped production and that Massey CEO Don Blankenship himself pressured management to immediately resume production. A foreman testified that he heard Mine Superintendent Everett Hager yell at victim Edward “Dean” Jones, a Section Foreman on HG 22, who had stopped production to fix ventilation problems. Hager relayed that President Chris Blanchard stated that “if you don't start running coal up there, I'm going to bring the whole crew outside and get rid of every one of you.” Another foreman testified that Hager threatened to fire him for stopping production and working on ventilation.

These were not idle threats. Miner testimony indicated that a top company official suspended a section foreman, who had delayed production for an hour or two to patch up leaking stoppings so that the minimum air quantity in the approved ventilation plan was available on the continuous miner section. Another foreman testified, miners who tried “to do the right thing” were “usually the people that [got] kicked in the teeth for it.”

This culture of intimidation deprived MSHA of miners’ voices. Under the Mine Act, miners play an important role in identifying hazards. The Code of Federal Regulations (30 CFR) calls for all hazards to be recorded in a book available for inspection at the surface. Section 105(c) of the Mine Act specifically recognizes the potential for a mine operator to discourage the reporting of hazards and protects miners from discrimination when they report an alleged hazard. Under the Mine Act, miners may refuse to work in unsafe or unhealthy conditions and may withdraw themselves from the mine for not having had required health and safety training.

Advance Notice of Inspections

Section 103(a) of the Mine Act provides that no advance notice of an inspection shall be provided to any person. Despite this statutory prohibition, many miners testified that PCC or Massey personnel on the surface routinely notified them prior to the arrival of inspectors. A large number of UBB miners testified that they knew in advance when inspectors were in the mine because of communication from the surface.

A UBB security guard testified that he had been instructed to call and alert personnel at the mine once MSHA inspectors were on the property. One dispatcher testified that the guard shack alerted him “every time” inspectors came on the property.

Dispatchers testified that they regularly called foremen and miners on the radio or mine phone to alert them of MSHA inspectors’ presence. Several dispatchers stated that upper management had instructed them to give advance notice of inspectors to miners; if a dispatcher failed to do so, there would be consequences. A dispatcher characterized giving advance notice as simply part of the dispatcher’s “job.”

A former belt construction worker testified, “When they hit the bridge at Mont Coal, the security guard would come up through the repeater, tell the mine manager that they was coming, then the calls went out through the sections to be ready to make sure you were legal, rock dust, whatever. It was every time that anybody was coming to that mines.”

PCC would also make ventilation changes in advance of the inspector’s arrival on the section, redirecting air and sending it to the section where the inspector was headed. A foreman testified that mine managers would call out for more air on the section where the inspector was headed, although miners only had a short time to make changes and the work was sometimes “chaos.” An examiner testified that PCC would send miners to adjust regulators and direct air to the section where the inspector headed, even though this reduced air in other parts of the mine where miners were working. Miners testified that they noticed more air on their section before the arrival of the inspector. A shuttle car operator testified that his crew would hang curtains more tightly and make sure they had air in the face.

This advance notice gave foremen and miners the opportunity to alter conditions and fix hazards prior to MSHA’s arrival on the section.

If they were unable to correct hazards, miners testified, the foreman would shut down the working section. As a result, the MSHA inspector could not observe safety problems during production. Because of PCC’s practice of providing advance inspection notice, inspectors seldom saw the way the mine actually was operated. Advance notice limited the effectiveness of MSHA’s inspection efforts at UBB.

On October 26, 2011, Hughie Elbert Stover, PCC’s former head of security, was found guilty by a jury sitting in the United States District Court for the Southern District of West Virginia of a felony count of making false, fictitious and fraudulent statements to MSHA. Stover had falsely testified in his interview with the MSHA accident investigation team that UBB had a policy prohibiting security guards from providing "advance notice" of MSHA inspections; however, evidence indicated that he himself had directed guards to provide such advance notice. He was also found guilty of a second felony count of obstructing justice by ordering a miner to dispose of documents wanted in the accident investigation.

Mine Accident Incidence Rate

Accident rates for the period between 2006 and 2009 are summarized in Table 1, and compared to the national rate for all underground, bituminous coal mines. MSHA audited these accident records and determined that the accident rate for UBB was significantly higher than had been reported by PCC, as shown in Table 1. Table 2 documents the enforcement actions taken by MSHA from 2006 through 2010, based on information contained in MSHA’s Data Retrieval System. In addition, PCC and Massey’s underreporting of accident data denied MSHA the opportunity to properly investigate and assess accidents and hazards at the mine.

Table 1. Accident Incident Rates after Audits

Calendar Year	Non-Fatal Days Lost (NFDL)		
	UBB Prior to Audit	UBB After Audit	National
2006	5.55	5.55	4.79
2007	2.41	2.89	4.74
2008	6.07	11.50	4.26
2009	5.81	10.24	4.04
2010	4.16	5.82	3.58

Table 2. Citations, Orders, and Safeguards Issued at UBB.

Calendar Year	103(k) Orders	104(a) Citations	104(d)(1) Citations	104(b) Orders	104(d)(1) Orders	104(d)(2) Orders	104(g)(1)	107(a)	314(b)
2006	**2**	**148**	**1**	**4**	**11**	**5**	**0**	**2**	**0**
2007	**0**	**269**	**0**	**1**	**0**	**0**	**0**	**1**	**0**
2008	**2**	**189**	**1**	**0**	**1**	**3**	**1**	**0**	**1**
2009	**1**	**460**	**1**	**4**	**1**	**48**	**1**	**1**	**0**
2010*	**0**	**117**	**0**	**1**	**0**	**6**	**0**	**0**	0

* - Through April 5, 2010 prior to the explosion

Inspection History (1/1/09 to 4/5/10)

<u>Regular Inspection (E01)</u>

MSHA conducts four quarterly inspections at underground coal mines each year, with the fiscal year beginning with quarter 1 in October and ending with quarter 4 starting in July. As has been noted, the advance notice given of inspections, coupled with PCC and Massey's intimidation of miners, hampered MSHA's effectiveness in conducting its inspections. Nonetheless, the number of violations issued to UBB and the number of hours that MSHA inspectors had to spend at UBB (inspecting, citing violations, and ensuring that violations were abated) trended upward in the five quarters leading up to

April 5, 2010 as indicated in Table 3. MSHA issued more orders under Section 104(d) of the Act ("unwarrantable failure" violations, which indicate higher negligence and gravity than some other types of citations) at UBB than at any other coal mine in the country in fiscal year 2009.

Enforcement actions issued during regular inspections (E01) pursuant to Section 103(a) of the Mine Act for the time period from the second quarter of 2009 through the third quarter of 2010, are listed by quarter and summarized in Table 3. The data is sourced from MSHA's Mine Data Retrieval System.

Table 3. Regular Inspection History at UBB.

E01 Event No.	FY Inspection Quarter	No. of Citations	No. of Orders	MMU Time (hours)	Outby Time (hours)	Surface Writing Time (hours)	Surface Time (hours)	Total Hours at Mine
4119932	2009-2	91*	1*	67.50	127.75	34.25	36.00	265.50
4119936	2009-3	119*	16*	90.75	175.75	45.25	52.00	363.75
4119293	2009-4	149*	23*	129.25	196.00	62.75	140.75	528.75
6288652	2010-1	58*	9*	151.25	206.75	30.25	104.00	492.25
6286108	2010-2	101*	7*	91.00	174.50	42.50	111.75	419.75
6284327	2010-3	5	1	4.00	1.50	3.00	11.75	20.25

* - Vacated issuances are not included in the Data Retrieval System (DRS) reports; subsequent to the DRS report, there was one citation or order vacated each of these five quarters (three 104(a) citations and two 104(d)(2) orders.

Tables K-1 and K-2 in Appendix K detail the violations issued during 2009 and 2010 at UBB. During this period, there were 49 violations of 30 CFR 75 subpart E (75.400's), relating to combustible materials and inadequate rock dusting, conditions which ultimately played a role in propagating the coal dust explosion.

Spot Inspections (E02)

Spot inspections are based on the provision of Section 103(i) of the Mine Act, which states that:

> Whenever the Secretary finds that a coal or other mine liberates excessive quantities of methane or other explosive gases during its operations, or that a methane or other gas ignition or explosion has occurred in such mine which resulted in death or serious injury at any time during the previous five years, or that there exists in such mine some other especially hazardous condition, he shall provide a minimum of one spot inspection by his authorized representative of all or part of such mine during every five working days at irregular intervals.

UBB was placed on a 10-day spot inspection cycle on July 15, 2009. On April 2, 2010, the mine was placed on a 5-day spot inspection schedule because the mine liberated over one million cubic feet of methane within a 24-hour period. Table 4 provides the quarterly spot inspection history from January 1, 2009 to April 5, 2010.

Table 4. Spot Inspection History for UBB.

FY Inspection Quarter	E02 103(i) spot inspections	Citations Issued	Orders Issued
2009-2	6	12	0
2009-3	6	12	0
2009-4	9	6	5
2010-1	10	3	1
2010-2	9	8	0
2010-3	0	0	0
Total	40	41	0

Longwall Citation History

The active longwall at the time of the accident was at the 1 North Panel, which was activated in September 2009. Table 5 provides a summary of enforcement actions for the longwall panel.

Table 5. Types and Number of Enforcement Actions
for 1 North Panel between September 1, 2009 and April 5, 2010

Type of Enforcement Action	No. Issued
104(a) non-S&S citation	23
104(a) S&S citation	6
104(b) order	1
104(d)(2) order	6
Total	36

PHYSICAL CAUSES OF THE ACCIDENT

Methane was Allowed to Accumulate on the Tailgate End of the Longwall

An explosive mixture of gases was allowed to accumulate in the vicinity of the shearer which was located at the tailgate end of the longwall. There were several failures that allowed this mixture to exist. The air current at the tailgate end of the longwall and in the T-split was inadequate to dilute and render harmless, and carry away additional methane when the floor feeder occurred. The mine not only had a history of floor gas outbursts on the longwall face, including events that occurred in 2003 and 2004, but also experienced an explosion on the face and in the adjoining tailgate in 1997, which management failed to consider. A detailed discussion of these events is provided in the section entitled, “Outburst History at UBB”, below. Examiners were unable to conduct examinations as required in the longwall tailgate entry (No. 7 entry) of the 1 North Tailgate because the operator failed to ensure that this entry was properly supported. The failure to properly support this entry is also important because it affected the ventilation such that it was not sufficient to dilute and render harmless, and carry away explosive, noxious and harmful gases, dusts, smokes and fumes.

The Explosion Began as a Methane Ignition that Originated Near the Tailgate and Transitioned into a Coal Dust Explosion

The investigation team determined that the explosion was a methane ignition, which led to a methane explosion and then transitioned into a coal dust explosion. The methane ignition resulted in a fire that could not be controlled by the miners at the shearer, forcing their evacuation. The fire likely burned behind the shields for up to two minutes before entering the T-split of No. 7 Entry in the Tailgate. Upon entering this area, the fire came into contact with an explosive mixture of methane. The resulting methane explosion propagated through the first outby crosscut before the methane was consumed. However, the methane explosion suspended and ignited float coal dust and coal dust, and the propagation of the coal dust explosion commenced. The flame zone from the coal dust explosion was extensive. If all the flame throughout the workings had resulted from the ignition of methane, then the explosion pressures would have exceeded the constant volume explosion pressure of about 120 psi in all areas of the explosion zone, which they did not[9]. This indicates that the explosion was the result of coal dust propagation and not of methane alone.

The team carefully considered other possibilities, such as an explosion fueled only by methane, an inundation from a gas well, or a seismic event, but ruled them out due to lack of supporting evidence for these theories. The results of the team's mine dust survey, the explosion pressures observed in the mine, a review of the limited amounts of methane detected prior to and after the accident, testimony from interviews, and examination records all indicate that the explosion resulted from a methane ignition/explosion transitioning into a coal dust explosion.

The first step in determining what kind of explosion occurred is to understand where the explosion traveled and the "footprint" it left. Investigators determined that the flame associated with the explosion traveled throughout the northern section of the mine. A mine map showing the extent of flame, along with the incombustible contents and the quantity of coke in the mine dusts at each sampled location underground is contained in Appendix Z. Based upon the flame path, investigators concluded that the level of methane necessary to extend flames into those areas would have resulted in pressures that would have caused far more damage than was actually observed. A methane inundation originating near the tailgate also would have extended flame into more areas than it did (for example, across the longwall face, which suffered only limited heating during the accident). Finally, there was only a limited quantity of methane detected pre- and post-explosion, which was not consistent with a massive inundation of methane.

The Methane Explosion Originated in the Tailgate Entry Near the Longwall Face

The investigation team, along with independent experts, analyzed mine dust samples, looking for coking to determine where flames traveled; the impacts of heating on objects; and pressures, calculated by using affected objects as data points and running finite element computer models to determine the path of the explosion. This evidence pinpoints where the flame traveled.

MSHA's flames and forces team conducted an extensive examination of the underground areas affected by the explosion. The team also conducted work outby the Ellis Switch, as well as in all inby areas, including the 1 North Panel crossover entries.

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[9] NIOSH research has indicated that a constant volume explosion pressure of 120 psi can be exceeded with the ignition of methane accumulations that are more than 165 feet in length.

The flames and forces team considered all available evidence, including the direction of primary explosion forces, the location of victims and mining machinery after the explosion, the deposition of dust, the effects of the explosion on materials and equipment, the extent of flame, and the direction and magnitude of all explosion forces. The origin of the explosion was determined to be located at the intersection of the active longwall face and the No. 7 entry of Tailgate 1 North. This location is just inby crosscut 48. The mine map included in a subsequent section of this report addresses the direction of the primary forces and the origin of the explosion.

The Extent of the Explosion is Consistent with that of a Coal Dust Explosion

<u>Mine Dust Survey</u>

The investigative team took 1,803 mine dust samples as part of its mine dust survey underground. Investigators sent all 1,803 samples to MSHA's Mount Hope National Air and Dust Laboratory, which conducted an Alcohol Coke Test on the samples to determine the degree of coking. The exceptionally large number of mine dust samples containing coke, along with the magnitude of explosion forces, is indicative of a coal dust explosion rather than an explosion fueled entirely by methane.

All 1,803 samples were sent to MSHA's Mount Hope National Air and Dust Laboratory, where the incombustible content and degree of coking were determined. The incombustible content provides an indication of the pre-explosion conditions in the affected area of the mine, while the coking indicates the area affected by the flame of the explosion.

A mine dust survey was performed in the area affected by the explosion. Of the 1353 samples collected in the affected area, 90.5 percent were non-compliant.

Analysis results indicate that 1,412 (1,105 in intake and 307 in return entries) out of 1,803 (>78 percent) samples were not compliant with incombustible requirements in place at the time of the explosion. Analysis results indicate that 924 (684 in intake and 240 in return entries) of 1,137 (>81 percent) band samples were not compliant.

Mine dust samples were taken in return entries of nine sampling areas. The average incombustible content in all nine areas was less than 80 percent, with a range from 43.9 percent to 63.2 percent. The return entries in these nine sampling areas were rock dusted inadequately.

Mine dust samples were taken in intake entries of seventeen sampling areas. Sampling areas 1 through 6 showed average incombustible contents exceeding 65 percent, with a range from 68.6 percent to 79.9 percent. Sampling areas 7 through 17 showed average incombustible contents of less than 65 percent, with a range from 46.2 percent to 58.3 percent. The intake entries in these 11 sampling areas were rock dusted inadequately.

Taken in context with physical evidence observed and collected underground, the Alcohol Coke Test also indicated the extent of the flame. The flame engulfed the Tailgate 1 North, entered the Headgate 1 North, turning both inby and outby. It also entered HG 22 (via the crossover entries) and turned both left and right. The flame that turned left was consumed in HG 22; the flame that turned right entered the North Glory Mains, the Glory Hole Mains, the North Jarrells Mains, and the West Jarrells Mains. A full discussion of the extent of the flame is included under the subsection “Flame Travel” later in the report.

The Pressures and Flame Generated by the Explosion

The flame extent and the pressures generated by the explosion are consistent with a coal dust explosion not a massive methane explosion. For a methane explosion to have covered the area where flame passed at UBB, it would have generated pressures far in excess of what was observed and calculated for this explosion.

MSHA estimated that the explosive accumulation of methane that was eventually ignited contained approximately 300 cubic feet of methane. When diluted with air to 10 percent, this volume of methane would form an explosive volume of 3,000 cubic feet.

Importantly, the flame of an explosion generally involves a volume that is approximately five times the volume of the initial methane accumulation. The flame from this initial methane explosion affected a volume of about 15,000 cubic feet, or a linear distance of approximately 140 feet, based on the dimension of the mine openings where the ignition occurred. The methane explosion propagated away from the longwall face. With a flame speed of approximately 300 feet per second, the methane explosion would have extinguished in about ½-second while generating a maximum pressure of about 4 pounds per square inch (psi).

The flame zone that actually occurred at UBB, however, was far greater than 15,000 cubic feet; it contained a volume of about 31 million cubic feet. This flame zone can easily be achieved in a coal dust explosion that generates limited pressure. To cover 31 million cubic feet of the mine from a methane-only explosion, considering a flame extension of five times, the initial explosive methane accumulation would have to have been about 6,200,000 cubic feet. This volume of methane would have completely filled nearly 52,000 linear feet of entry. The ignition of such a volume of methane in an underground mine could have resulted in a detonation with possible explosion pressures exceeding 600 psi, many times greater than what was calculated at UBB. The ignition of such a large hypothesized accumulation of methane would have resulted in explosion forces that greatly exceed forces that actually occurred underground.

The investigation team also concluded that the absence of flame on the longwall indicated that the explosion was not a methane-only explosion. On April 5, 2010, underground activities proceeded until the time of the explosion. At the time of the explosion, the HG 22 crew was boarding a mantrip to exit the mine at the end of their shift. The TG 22 crew left their section and traveled to just outby 78 switch. The crew at the longwall was not finished with their shift, as they changed out at the face about an hour later, around 4:00 p.m.

During the investigation, 18 mine dust samples were taken from various shields across the longwall face. These samples were all subjected to the Alcohol Coke Test (to be explained in greater detail later in this report). The results indicate that flame did not travel across the longwall face. The evidence of lack of flame along the face indicates that neither suspended coal dust nor explosive quantities of methane existed across the face. It is expected that any inundation of significant volumes of methane at the shearer would result in methane accumulations, both in the tailgate entries and on the tailgate side of the longwall.

There Was Only Limited Detection of Methane Underground Prior to the Accident and During the Rescue

Investigators also ruled out a massive methane inundation based on the relatively modest levels of methane liberated, according to pre- and post-explosion measurements.

Records of examinations that occurred in the shifts prior to the accident do not indicate that significant methane was present in the active workings. A post-explosion evaluation of methane detectors does not indicate that methane was present in significant concentrations in the active workings immediately prior to the accident. The methane monitors on the tail of the longwall and on the shearer did not de-energize electrical power, which would have occurred at 2 percent methane. Information collected from the handheld gas detector located at shield 83 did not record elevated methane levels prior to the explosion. Handheld gas detectors carried by Chris Blanchard and another top company official, two hours after the explosion, recorded a maximum methane level of only 0.3 percent at approximately two crosscuts of the longwall face in the tailgate entry.

Additionally, on April 5, a rescue team member advanced to shield 120 on the longwall face. He did not report any sound emanating from the longwall face or the tailgate entry which would have indicated a large volume of gas release. Nor did he report elevated levels of methane along the longwall until he reached shield 120, where he reported 2.0 percent methane. At this time the airflow was disrupted severely from the explosion, and a large-volume gas release would have contaminated the face and tailgate of the longwall. Taken together, these facts indicate that the magnitude of the gas release was likely in the order of hundreds of cubic feet per minute, rather than a massive inundation.

The autopsy reports show that methane was not found in any examined body tissue for 22 of the victims. Of the 7 victims who did have methane in some tissue, two were on the longwall and five were on or near the mantrip in HG 22. The methane found in these victims is most likely due to decomposition given the fact that their bodies were recovered from the mine more than five days after death. The methane found in the body tissue cannot be used to quantify accurately the amount or concentration of methane that was breathed or for how long. The lack of methane in the remaining 22 victims suggests that methane was not present at any of their locations at the time of the accident.

Analysis of Methane Liberation at the Bandytown Fan

Measurements at the Bandytown fan indicated higher liberation of methane post-accident than what was recorded during pre-accident mining. Investigators determined that likely came from floor fractures, as well as a product of combustion generated by the explosion itself.

The volume of methane liberated from a coal mine is dependent on several factors including gas reservoir characteristics of the coal seam and the surrounding strata, type of mining, rate of mining, depth of overburden, and the existence of geologic structures. Methane can be released into a mine during the cutting of coal, through mining-induced fractures, and through pre-existing fractures and joints in the coal, roof and floor strata. The liberation rate may vary, depending on conditions encountered and the rate in which coal is being extracted. There may be several different sources from which the gas enters the mine. Some of these sources include coal seams, gas bearing shale and sandstone formations, and adjacent abandoned or active mines. The concentrations of hydrocarbons and other gaseous components can vary, dependent on the source.

Generally, a coal seam contains gas composed mostly of methane with trace amounts of other hydrocarbons and is referred to as coalbed methane. The coal seam is the source and reservoir of coalbed methane. Rock strata, such as shale, may contain gas composed of methane with higher concentrations of the heavier hydrocarbons than coalbed methane. A combination of these gases is commonly referred to as natural gas. The rock stratum may be a reservoir and/or source of natural gas. Sealed and worked-out areas in mines may contain gas mixtures other than coalbed methane.

Pre-Accident Methane Liberation

During each MSHA quarterly inspection of the mine, inspectors collected air samples in all of the return entries where air exited the mine and in each of the working section return entry(s). Air samples were analyzed by MSHA's Mount Hope National Air and Dust Laboratory located in Mount Hope, West Virginia. Air quantities were measured to determine the total daily quantity of methane liberated from the mine and each working section. Table 6 shows the total methane liberation rate for the two quarters preceding the accident. The samples collected as part of the 2nd quarterly inspection revealed the total methane liberation rate from the mine was 741 cfm, consisting of 681 cfm from the Bandytown shaft and approximately 60 cfm from the remaining portion of the mine.

Table 6. Methane liberation in Q1 and Q2 2010 for various mine areas.

Location	**Methane Liberation FY 10 Qtr. 1**	**Methane Liberation FY 10 Qtr. 2**
East Mains	10,217 cfd	11,212 cfd
North Portal	0	75,246 cfd
South Portal	0	0
Bandytown Fan	1,155,583 cfd	981,052 cfd
Bandytown Air Quantity	448,200 cfm	374,893 cfm
Total CH_4 Liberation (cfd)	1,165,800 cfd	1,067,510 cfd
Total CH_4 Liberation (cfm)	809 cfm	741 cfm

*cubic feet per day (cfd), cubic feet per minute (cfm)

The results of MSHA's September 26, 2010 ventilation study revealed a balanced airflow quantity at the Bandytown fan of 297,000 cfm. The pre-accident airflow quantity at the Bandytown fan was determined to be approximately 301,000 cfm. It was concluded, based on the ventilation study, that the air quantity was approximately 301,000 cfm at the time the air samples were collected during the previous quarterly inspection. Adjusting the methane liberation rate to the lesser air quantity resulted in a determination that the methane liberation from the Bandytown fan was approximately 547 cfm. In January, 2010, MMU-040 was mining in the Panel No. 1 Crossover and on January 13, the methane liberation for MMU-040 was determined to be 5.0 cfm. On March 2, 2010, MMU-040 began developing the "new" TG 22 and on March 7, the methane liberation was determined to be109 cfm. Therefore, the methane liberation rate exiting Bandytown fan would have been approximately 651 cfm, but could have been more if the liberation rate from HG 22 or the longwall had increased.

As discussed earlier, the methane detector used by the examiner responsible for examining the bleeder system had not been turned on since March 18, 2010. Methane concentrations prior to the accident may have increased undetected from March 18, 2010 to the time of the explosion because of the examiner's failure to measure methane in the bleeder system after that date. Gas released from floor fractures contained small amounts of hydrogen, which would have registered as carbon monoxide on the examiner's detector. Detecting this mixture may have provided another means of early detection if an adequate and complete examination had been performed.

Post-Accident Methane Liberation

The first reported measurements of gas concentrations at Bandytown fan were at 5:30 p.m. on the day of the explosion. These concentrations were measured with a handheld multigas detector and reportedly indicated 18.3 percent oxygen, 2.3 percent methane and >7,000 ppm carbon monoxide. Tests performed on the same model of the instrument revealed that a catalytic diffusion sensor (methane) measured all combustible gases in an atmosphere that was mixed with carbon monoxide, hydrogen, and methane. Investigators concluded that the methane and carbon monoxide concentrations indicated by the detector were elevated inaccurately due to cross-sensitivity issues on the carbon monoxide and combustible sensors. Carbon monoxide and hydrogen are combustible gases and were measured by the sensor; tests revealed that the carbon monoxide electrochemical sensor was influenced by hydrogen. The carbon monoxide electrochemical sensor on the handheld multi-gas detector used cannot distinguish between carbon monoxide and hydrogen.

Beginning at 8:30 p.m. on April 5, 2010, air samples were collected regularly at the Bandytown fan for analysis using a gas chromatograph, which is not susceptible to the cross-sensitivity of gases. Figure 10 contains a graph depicting methane liberation rate versus carbon monoxide concentrations for samples collected from Bandytown fan from April 5 – 30, 2010. Sample results indicated that the total volume of methane that exited at the Bandytown fan at 8:30 p.m. was about 1,250 cfm. The methane liberation rate declined to 890 cfm by 5:00 a.m. on April 6, 2010.

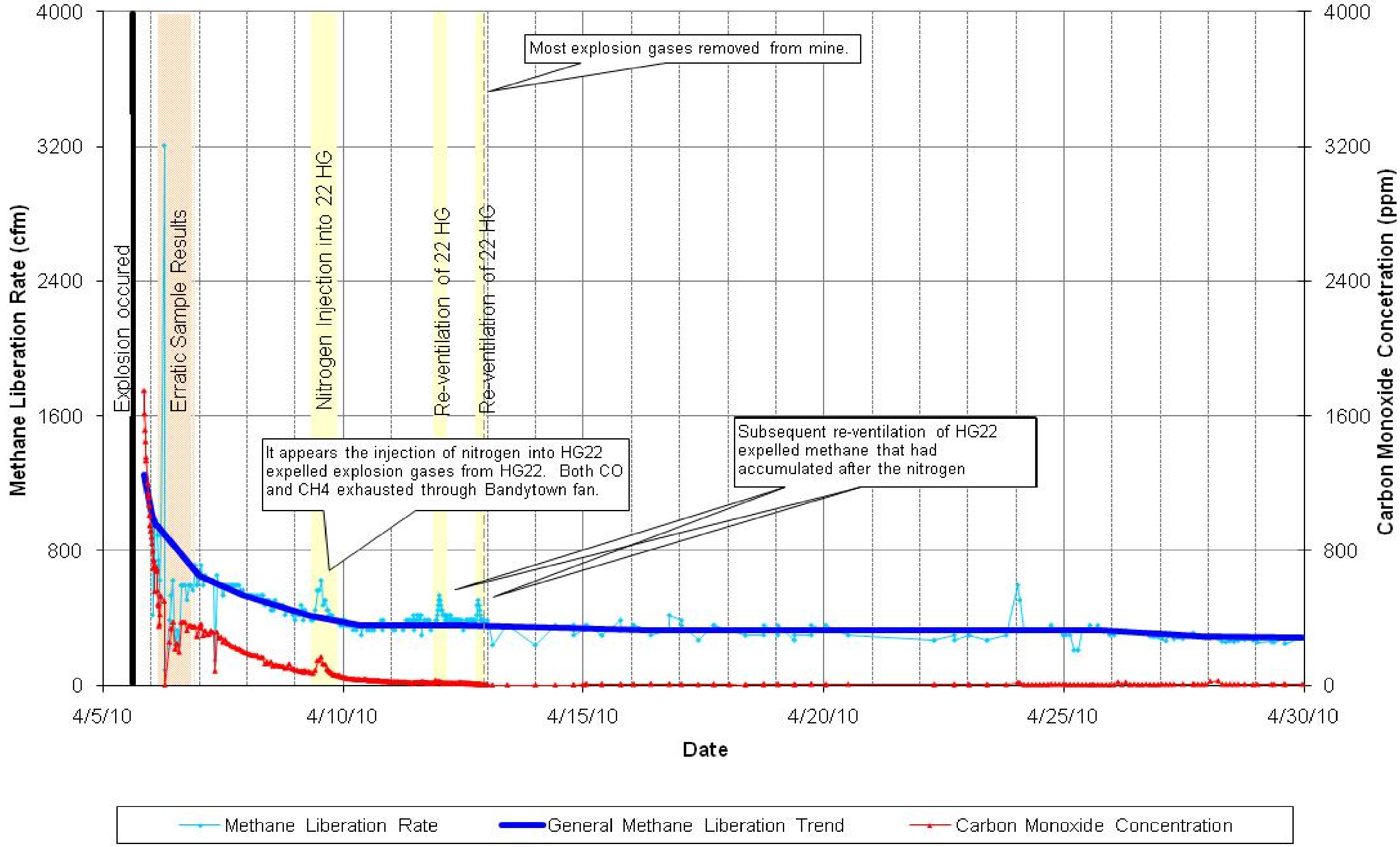

Figure 10: Methane Liberation Rate versus Carbon Monoxide Concentrations for Samples Collected from Bandytown fan from April 5 – 30, 2010

A single sample, collected at 6:40 a.m. on April 6, 2010 and analyzed by the gas chromatograph, indicated an increase in methane, ethane and carbon dioxide while carbon monoxide, hydrogen, acetylene, and ethylene decreased slightly. Analysis of air samples collected after the explosion indicated normal declining trends. The apparent short-lived change in the concentrations of methane, ethane and carbon dioxide could not be explained conclusively.

From April 8 to April 27, the total methane liberation declined to a rate of 288 cfm. In fact, by April 13, most of the gases produced from the explosion were removed from the mine as indicated by low concentrations of fire gases, such as carbon monoxide and hydrogen.

MSHA relied on the normal methane liberation (651 cfm) that was calculated for the 2nd quarter inspection and measurements collected on TG 22 in March, 2010. MSHA further assumed that the minimum liberation rate exhausted through the Bandytown fan was that which occurred during the steady post-explosion condition, which was reached on April 27, 2010 (288 cfm).

After the explosion on April 5, the methane liberation rate from the active workings was higher than the liberation rate during normal mining. Following the explosion, all gases in the mine atmosphere inby Ellis switch were removed from the mine through the Bandytown fan. The removed gases included normal methane liberation from the active workings, methane from the mined out portion of the longwall panel, methane expelled from seal sets 8 through 15, methane and other gases produced as a result of the explosion and gases released from floor fractures on the longwall. Information was not available to quantify the contributions to the total excess methane from the individual sources.

Figures 11 and 12 show graphical depictions of methane liberation rates from the Bandytown fan, based on information collected beginning 8:30 p.m. on April 5, 2010. The curve represents the total methane exhausted from the Bandytown fan from 8:30 p.m. on April 5, 2010 to April 30, 2010. The blue shaded area shown on Figure 11 represents the amount of methane exhausted as compared to the pre-explosion methane liberation. This represents the minimum amount of excess methane exiting Bandytown fan during the sampling period after the explosion. Figure 12 depicts the excess methane exhausted as compared to the post explosion steady-state methane liberation. This represents the maximum amount of methane exiting Bandytown fan during the sampling period after the explosion. Because the rate at which methane liberation from mining declines to the steady state non-mining rate is unknown, the actual amount of excess methane removed from the mine post-explosion would be between the two amounts shown on the graphs.

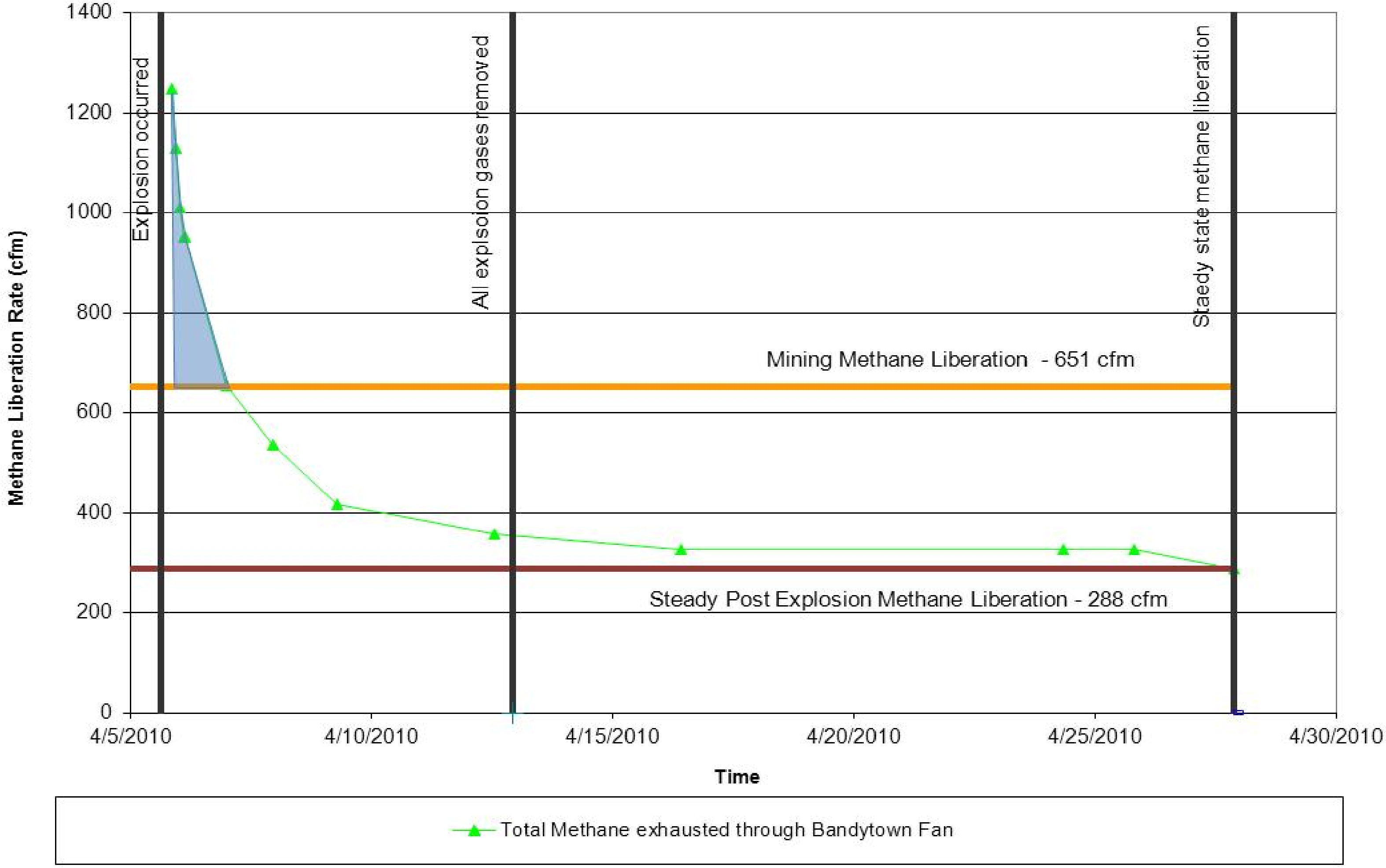

Figure 11. Graph of methane that was exhausted through the Bandytown fan for the period between April 5 and April 30, 2010. The area shaded in blue represents methane in excess of pre-explosion liberation levels.

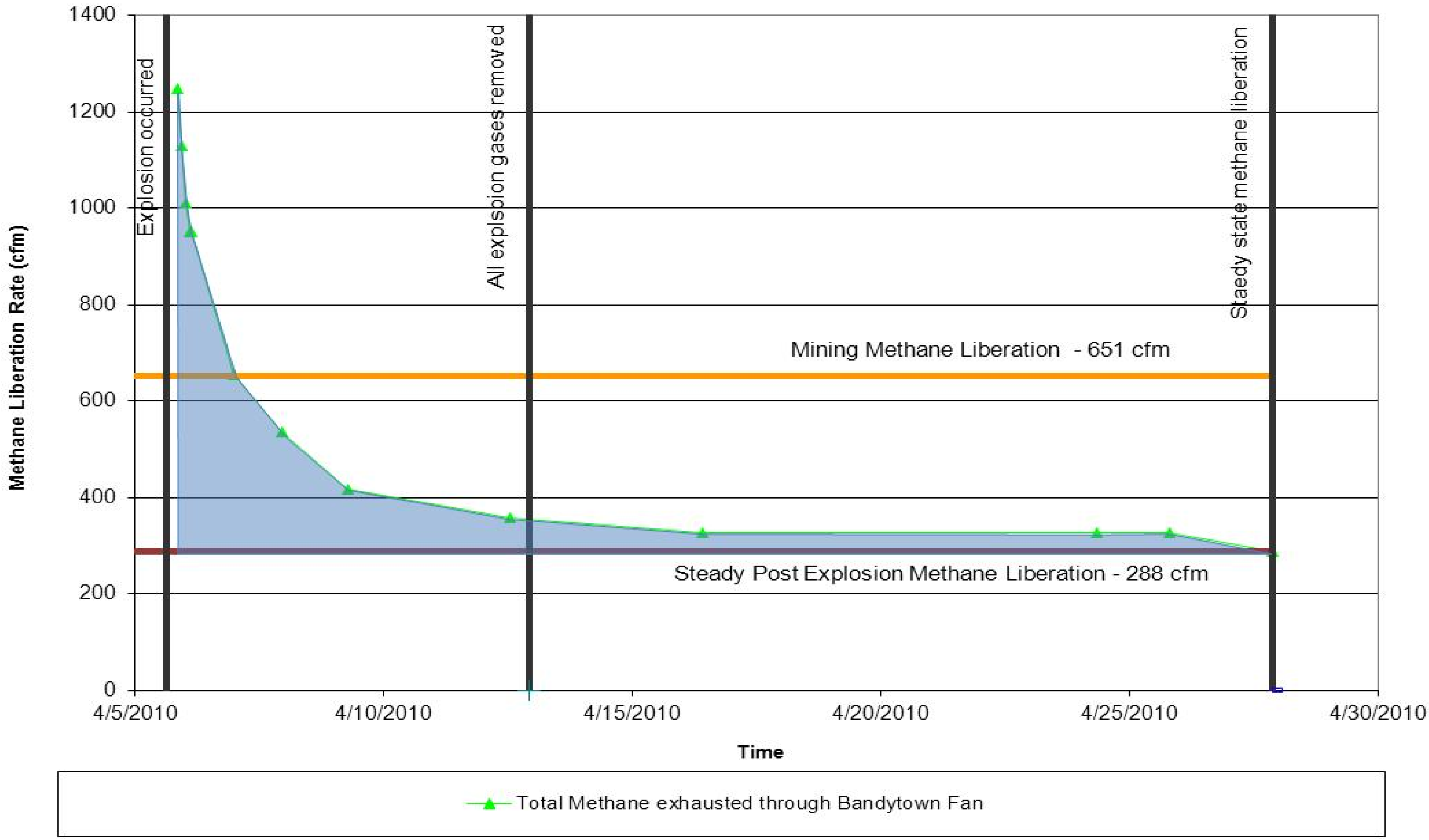

Figure 12. Graph of methane that was exhausted through the Bandytown fan for the period between April 5 and April 30, 2010. The area shaded in blue represents post-explosion methane versus steady state liberation levels.

Source of Gas Measured at the Bandytown Fan

The gas measured at the Bandytown fan likely came from floor fractures, as well as from the explosion itself. A portion of the excess methane measured at the Bandytown fan was likely to have been emitted from floor fractures, in which a gas shale formation was the source, especially since fractures were found on the longwall in the area of shields 160 and 170. (These fractures, and the geological conditions which created them, will be discussed in the next section.) Shale matrix permeability is extremely low and gas production typically requires natural or hydraulically induced fractures. Reservoir pressure is sub-normal, typically ranging from 1,000 to 2,000 psi.

An abundant volume of gas could exist as gas in shale formations, but a small volume may exist as free gas in a naturally occurring fracture system. The amount of free gas available is dependant on the extent of the fracture system, which is associated with geologic structures. The liberation rate from the fracture depends on the volume and pressure of the gas in the fracture system and on the size of the opening where the gas was released. The liberation rate can vary in magnitude from tens to thousands of cubic feet per minute of methane. Turbulence created by gas flowing through a small opening generates sound. Previous high volume gas releases from floor fractures in the 2003 and 2004 inundations resulted in loud noises that have been described as sounding like a "jet engine."

Prior methane inundations at UBB and other mines operating in the Eagle seam resulted in mining disruptions. Generally, the affected area would be localized at the point of gas discharging from the floor fracture, and the gas release would dissipate within a few days. The volume and pressure of gas contained in the fracture system and the size of the floor fractures were relatively small, which limited the volume of gas that was released into the mine.

Another source of methane measured at the Bandytown fan was the explosion itself. Research has shown that methane is a product of combustion that can occur during a coal dust explosion. The formation of products of combustion is typically related to the concentration and type of fuel that is ignited The critical concentration of coal that would be entirely consumed during a combustion reaction without producing methane is 0.123 ounces per cubic foot. When igniting suspended concentrations of coal dust at 2 ounces per cubic foot, over 1 percent methane can result as a product of combustion. It is likely that similar coal dust concentrations were ignited throughout the explosion zone. Consequently, significant quantities of methane were likely produced in this manner.

The Explosion Was not Caused by Cutting into a Gas Well

The investigation team considered the hypothesis that one of the working sections mined into a gas well, but ruled this out for lack of supporting evidence. Investigators reviewed several sources of data to identify any gas wells not included on PCC's official mine map. The team reviewed the WVGES "Oil and Gas Wells of West Virginia" website, which graphically displays known locations of gas wells, and compared it to the U.S. Geological Survey (USGS) topographic map. Investigators also searched the West Virginia Department of Environmental Protection's (WVDEP) "Oil and Gas Well Information" website to obtain additional information about known gas wells. The WVDEP and WVGES systems and the mine map did record all wells indicated on the USGS topographic map.

The investigation team also conducted several traverses in the field to confirm the absence of wells above the faces of the 1 North Panel longwall, HG 22 and TG 22, and the West Jarrells Mains. The investigation team found no evidence of well structures, pipes, or drill pads above the faces of the 1 North Panel or development sections.

The investigation team met with members of Equitable Gas, along with a representative of WVOMHST, regarding the gas well (API 005-00810, shown on the mine map as Well No. 7645) isolated by a barrier on the North Jarrells Mains. The well was of interest because of its close proximity to the underground workings and the observation that, according to production records maintained by the WVDEP, the well displayed an apparent significant increase in flow rate beginning in the summer of 2008. Prior to 2008, the well exhibited a fairly consistent flow of approximately 200-500 thousand cubic feet of gas (mcfg). No production was reported for February through March of 2008. Beginning in July 2008, production records indicated a radical increase of over 1,200 mcfg, a rate that was maintained through most of 2009, with a gradual decrease toward the end of the year.

Company personnel indicated that the metering device on the well was found to be non-functional in early 2008. Company personnel indicated that the meter had been replaced in the winter of 2008 after which time a much higher production rate was being recorded. The change in recorded gas volume from the well was due to faulty equipment.

The investigation team also met with representatives of EXCO-North Coast Energy Eastern, the current controllers of natural gas resources on property corresponding to the HG 22 and 1 North Panel areas. Maps at EXCO-North Coast Energy Eastern's Maben, WV office did not show any additional gas wells, besides those already identified by review of information available from Equitable Gas, the WVDEP, or the WVGES.

As a result of this investigation, the team ruled out an existing gas well as the source of the methane/natural gas.

A Seismic Event Did not Cause the Explosion

The investigation team considered the hypothesis that a seismic event triggered the explosion. Based on data supplied by the USGS, two rare seismic events occurred in southern West Virginia in the weeks preceding the UBB explosion. Because they occurred prior to the explosion and many miles from the mine, the investigation team ruled them out as playing any role in these events.

The first was a 2.9 Richter Scale magnitude event that occurred on March 27, 2010 in Logan County, approximately 27 miles away from UBB. The shallow depth and location in a historically bump-prone area of West Virginia suggests that the seismic event represents a coal pillar bump, rather than an earthquake. The investigation team's review of old mine maps, downloaded from the WVGES, identified an old mine with extensive pillared works within one mile of the plotted location of the seismic event. The extensive pillared works in the abandoned mine surrounded large, square barrier-style pillars that may have experienced rapid failure after decades of degradation to reach a critical size.

The second seismic event occurred on April 4, 2010 in Braxton County, approximately 60 miles from the face of the 1 North Panel. Despite the seemingly close temporal relation between the April 4 seismic event (5:19 a.m.), and the April 5 explosion (3:02 p.m.), the 60-mile interval and 34-hour time difference does not support any recognizable relationship between the two events (Appendix M).

Seismographs monitored by the WVDEP's Office of Explosives and Blasting recorded surface blasting shots conducted on April 5, 2010 (Appendix N). The locations of surface blasts were plotted in a GIS, using coordinates provided by the WVDEP Office of Explosives and Blasting along with the times of surface blasting. Four surface blasts were recorded, approximately 2 ½ miles from the face of the 1 North Panel, but the earliest was over one hour after the 3:02 p.m. time of the explosion.

The Geochemistry of Natural Gas and Coal Bed Methane

As discussed above, investigators concluded that the explosion was a natural gas/methane ignition and explosion which transitioned into a coal dust explosion, rather than an explosion solely fueled by natural gas/methane. Investigators also concluded that the methane that triggered the initial ignition and explosion derived from natural gas, rather than coal bed methane. The information below describes how investigators determined that the source of the explosive mixture came from floor feeders on the longwall face.

MSHA collected gas samples from four locations: UBB, Speed Mining LLC's American Eagle Mine, and gas wells producing from the Greenbrier Formation and Marcellus Shale within seven miles of the 1 North Panel. The hydrocarbon content and stable isotope ratios were compared and plotted on discrimination diagrams to determine the sources of gas entering the UBB mine (Appendix O).

MSHA collected gas samples at different times from floor feeders located behind the shield pontoons on the longwall face at shields 160 and 170. The immediate vicinity of the floor feeders was characterized by a distinctive smell similar to that noted at the American Eagle Mine. Investigators registered high values of methane and carbon monoxide. The samples were characterized by gas content of 40.61% (90.15% normalized to 100% hydrocarbons) methane, 2.7% (5.99%) ethane and 1.21% (2.68%) propane, as well as 0.135% (0.3%) and 0.188% (0.41%) iso-butane and n-butane, respectively; 0.04% (0.08%) and 0.0202% (0.04%) iso-pentane and n-pentane, respectively, and; 0.018% (0.04%) hydrocarbons, including or heavier than hexane. The sample also contained 0.279% hydrogen and no carbon monoxide; however, a hand-held methane detector indicated the presence of several hundred parts per million of carbon monoxide. Although subsequent analyses indicated that no carbon monoxide is actually present in any of the samples, a carbon monoxide reading of several hundred parts per million may be a proxy for hydrogen, which the handheld detector is incapable of discerning from other fire gases. These samples are chemically and isotopically very similar to those collected from the American Eagle Mine and are representative of organic shale-derived thermogenic gas, rather than biogenic gas derived from coal.

MSHA collected samples from small feeders emanating from the floor, throughout the HG 22 and TG 22 sections. Analytical results indicate a different kind of gas than that sampled at longwall shields 160 and 170 or at the American Eagle Mine. In contrast to those samples, which contained significant ethane and other heavier hydrocarbons, the HG 22 and TG 22 samples were characterized by methane content of 75-78 percent, with only 0.01-0.02 percent ethane and insignificant or non-detectable contents of C_{2+} hydrocarbons. Furthermore, the samples contained no hydrogen and during the sampling process, the handheld gas detector indicated no carbon monoxide.

Methane Accumulations that Led to the Explosion

As covered in the previous section, MSHA investigators concluded that the most likely scenario initially involved a methane ignition. The ignition source was located at the shearer. This section explores how the methane likely entered the mine and how PCC and Massey's failure to abide by the roof control plan likely contributed to the methane accumulation that led to the initial methane explosion.

PCC's mining progressed into a geological fault zone that was a reservoir and conduit for methane. Indications of this fault zone prior to April 5, 2010 include methane outbursts at the mine in 2003 and 2004, a methane explosion in 1997, and problematic ground conditions. When mining progressed into the fault zone beneath deep overburden, existing fractures in the zone dilated and released previously trapped methane.

On April 5, 2010, gas was released from the fault zone as a floor feeder near the back of the shields, characterized by a flow rate of several hundred cubic feet per minute. The intersected expression of the fault zone conduit was represented by a series of fractures between shields 160 through 171, on the tailgate side of the face, where the longwall shearer was operating at the time of the explosion. During the investigation of the longwall, investigators found that methane was emanating from these fractures. Investigators concluded that these fractures supplied the methane that started the April 5 explosion. This methane likely migrated a short distance into the tailgate entry, where it accumulated.

PCC's roof control practices contributed to the accident, by failing to adequately support the tailgate entry as required by the roof control plan. PCC failed to either set two rows of posts or install two 8' cable bolts down the tailgate entry. Prior to the explosion, the roof of the tailgate entry caved inby the face, restricting the airway through the next inby crosscut, referred to in ventilation terms as the T-split. This failure to install required support contributed to a roof fall in the tailgate entry behind the shields that allowed methane from the floor feeder to accumulate. The tailgate roof fall inby the face restricted airflow to the extent that it was not possible to dilute the additional gas inflow behind shields 160 through 171. On April 5, a small portion of this gas volume ignited, most likely on the fringe of a gas body, providing the initial explosive energy to suspend float coal dust in the tailgate entries that allowed transition to a coal dust explosion.

Geological Background

Geology and Previous Mining

Near the 1 North Panel, the Eagle seam is a single coal bed 26-40 inches in thickness that is sometimes separated into two benches by a several-inch-thick sandstone parting. Although the coal seam is considered to be 4 ½ feet, actual mining height is approximately seven feet. The seam is overlain by brown-to-black shale or medium-grained, white sandstone where the shale is absent. Where shale is present in the immediate roof, bedding-parallel faults are sometimes present. In other areas, bedding-parallel movement is indicated by pinched-off teardrops of sandstone entrained in coal, as well as by small thrust faults that disrupt the sandstone binder. Coal cleat (naturally occurring parallel planes) is commonly indistinct although it is roughly parallel to the locally dominant joint orientations of N 70-80° E and N 10° W. Uncommon joint orientations of roughly N 45° E and N 35-55° W are also present but are localized to restricted zones.

The mine floor is generally hard and consists of a 3 to 10-inch thick layer of medium-grained white sandstone. Floor heave is generally widespread and is characterized by slabs of sandstone cantilevered up to define jagged brows with several inches of offset, forming rootless cracks that bottom out in more easily deformed mudstone and sandy shale (Figure 13). Less commonly, floor heave is localized along structural geologic zones of weakness defined by joints, pot-outs, and slickensides.

Figure 13. Cantilevered slab of floor sandstone forms broken brow with rootless, open aperture fracture. This style of floor heave is typical throughout Tailgate 1 North, the Panel 1 crossover and adjacent rooms, TG 22, and HG 22.

The UBB workings are variably overlain by up to six mined coal seams. The Eagle seam is separated by an interburden that ranges between 8-20 feet from the approximately two-foot thick Lower (Little) Eagle seam. In the 1 North Panel, the Little Eagle seam is 10 feet below the Eagle seam at the Panel No. 1 crossover. Core holes in the crossover area indicate a strata sequence comprised of 0.5-2.4 feet of gray shale, 5.5-5.7 feet of gray sandstone and finally 2.5-4.2 feet of gray sandy shale progressing downward from the base of the Eagle seam.

The face of the 1 North Panel is beneath approximately 1,075 feet of overburden at mid-face, with maximum overburden of 1,275 feet encountered near the start-up room at the back of the panel. Review of mine map overlays indicates that a remnant pillar configuration is present above the southern quarter of the current position of the longwall face, characterized by two rows of pillars flanked by gob represented by split pillars in the Powellton seam (determined to be the No. 2 Gas seam by the West Virginia Geologic and Economic Survey (WVGES)), 170 feet above. Three thick layers of massive sandstone, each 20-30 feet, are present between the Eagle and Powellton seams, although floor heave and roof potting in UBB can often be correlated to remnant pillars surrounded by gob in the overlying Powellton seam. Additionally, there are several other mined coal seams above; see Figure 14 below.

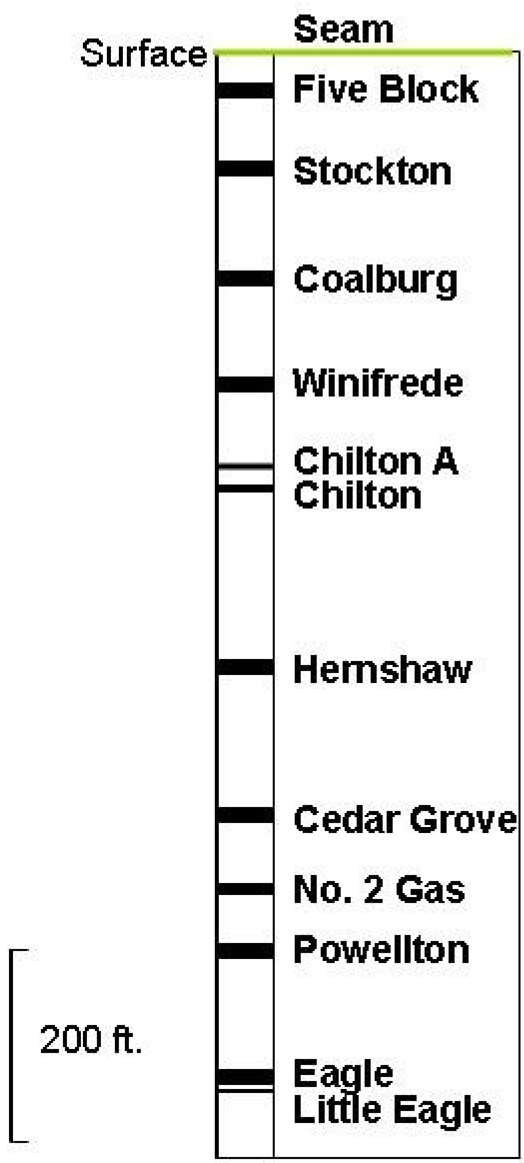

Figure 14. Stratigraphic column of coal seams present above the 1 North Panel longwall face. Note that WVGES names are offset, beginning with the Powellton.

Outburst History at UBB

As a result of a gas outburst from a 240-foot long floor fracture at mid-face of Longwall Panel 17, MSHA conducted a ground control evaluation at UBB in 2004 (MSHA Technical Support, Roof Control Division Memorandum 04AA34, dated March 4, 2004). Formation of the fracture was associated with floor heave that tilted the shearer away from the coal face, a loud thump commonly associated with failure of sandstone in the roof (according to mine personnel), and longwall shields that were taking weight and yielding at mid-face. A gob/solid boundary in pillared works of the overlying Powellton seam was located directly over the outburst area. The overburden depth at the outburst site was 1,155 feet.

In the 2004 outburst, the shearer had been down for 20 minutes prior to the event and the face was idle. MSHA inspection notes on February 8, 2004 documented that the measured intake air to the longwall was 72,000 cubic feet per minute (cfm). The measured velocity at shields 17 and 160 was 340 feet per minute (fpm) and 210 fpm, respectively. On June 28, 2004, the measured intake air to the longwall was 79,040 cfm, according to inspection notes. The measured velocity at shields 17 and 160 was 542 fpm and 375 fpm, respectively. MSHA concluded, in June 28, 2004 notes, that the ventilation plan required minimum intake air quantity of 60,000 cfm and a velocity at shields 17 and 160 of 300 fpm and 175 fpm, respectively.

Mine personnel reported that a similar event had occurred on July 3, 2003 on the adjacent, previously mined Longwall Panel 16 at an overburden depth of 1,175 feet. Witnesses described this outburst as a high pressure event with voluminous gas released, comparable to the sound of a jet engine. MSHA indicated, in January 29, 2003 inspection notes that the measured intake air to the longwall was 70,297 cfm in the last open crosscut (LOC) and 45,798 cfm in the conveyor belt entry. UBB's senior mining engineer in 2004 concluded that at overburden depths exceeding 1,100 feet, especially beneath barrier pillars in the overlying Powellton seam, sufficient stress might be transmitted to the longwall shields at mid-face, where stress is already theoretically highest, to fracture a critical interburden thickness of 12 feet between the Eagle and Lower Eagle (Little Eagle) coal seams, thereby releasing the methane outburst. The longwall coordinator in 2004 also reported that shield monitoring data indicated the shields in the center of the face went into yield just prior to the event.

An MSHA CMS&H D4 accident investigation report indicated that an explosion occurred in January 1997 in the 2 West Longwall Panel, which was the first longwall panel of the first longwall district. MSHA determined that the event involved an ignition of gas in the gob on the tailgate side of the face behind the shields. Witnesses reported hearing what they thought was a roof fall behind the shields, followed by a bright red glow and smoke coming from behind the shields. Other witnesses reported seeing an arcing flash in the gob behind the shields after the apparent roof fall. Witnesses also reported that the caving or falling material sounded much more intense than usual. The longwall foreman at the beginning of the shift measured 450 fpm air velocity at shield 17 and 345 fpm at shield 160.

In discussions with MSHA during the 2004 investigation, the mine's senior mining engineer indicated that degasification wells were planned for the next longwall panel (Panel 18) in an attempt to bleed off any gas prior to encroachment of the longwall face. The mine had already constructed interburden thickness maps between the Eagle and Lower Eagle seams, and had constructed a structure contour map for the surface of the Lower Eagle seam, in an attempt to identify structural highs beneath which gas may have accumulated. Subsequent to that investigation, members of the Roof Control and Ventilation Divisions of MSHA Technical Support attended a meeting with UBB and D4 personnel to discuss additional outburst mitigation measures. During the current accident investigation, it was determined that the mine did not have a degasification plan and the measures discussed in 2004 had not been implemented. However, the mine map indicates that Panel 18 was terminated short of its intended length. This termination coincides with a projected (imaginary) diagonal line connecting the 2003 and 2004 outburst locations.

Eagle Seam Outbursts

MSHA D4 personnel indicated to MSHA investigators that the only other known example of methane inundation reported in the Eagle seam, besides UBB, occurred in the Horse Creek Eagle Mine, located approximately six miles southeast of UBB. Witnesses interviewed during the 2004 UBB investigation also reported that floor bursts had occurred at the Harris No. 1 Mine. An engineer from Harris No.1 Mine indicated to investigators that the floor was prone to fracturing and releasing varying volumes of gas in conditions of higher overburden, although he stated that voluminous, high pressure "jet engine" style outbursts had not occurred. During the course of the UBB accident investigation, several gas floor feeder events occurred at Speed Mining, LLC's American Eagle Mine in the same seam, located 15 miles north-northeast of UBB; MSHA investigated these events.

UBB has a Geological Fault Zone, which Serves as a Conduit for Methane

Description of the Fault Zone

The investigation team concluded that a fault zone trends N 40° W across UBB, and dips 30° to the northeast (Figure 15). This is based on: 1) the locations of gas outbursts or explosions in 1997, 2003, and 2004, discussed above; 2) underground observations conducted at UBB in the 18 Headgate during the 2004 investigation; 3) extensive underground observations conducted between July 2010 and October 2010; 4) the face positions of Longwall Panels 11 and 12 when they were terminated; 5) observations of structural features in the overlying Powellton (Castle Mine) and Coalburg (Black Knight II Mine) seams; and 6) observations of structural features on the surface. To understand the conditions associated with the initial gas release, it is also critical to understand the interplay between the fault zone, the depth of overburden, and the redistribution of stress caused by longwall mining.

The fault zone passes through the 2003 and 2004 gas outburst locations and the 1997 explosion, and projects through the face of the 1 North Panel, TG 22 development section, and West Jarrells Mains, as well as intersecting the HG 22 development section. This indicates a strike (compass bearing of geological feature) length of at least 4.5 miles. Mapping on the surface and in mines above the Eagle Seam indicates that the fault zone extends from the Eagle seam to the ground surface. The fault zone is interpreted to represent a ramp-and-flat system, in which the fault rides along the surfaces of weak strata such as coal before periodically cutting up across more competent layers. Individual structures within the fault zone include drag folds, bedding plane faults, reverse faults, and overturned anticlines (A-shaped geological folds) that exhibit a strike of N 40° W in or directly above the coal seams. Zones of vertical jointing, which also strike N 40° W, are present in thick sandstone layers that overlie the coal seams. The zone also localizes linear pot-outs in the roof and zones of floor heave (Figure 16).

Investigators interpret the fault zone to represent a conduit for methane migration into the Eagle seam from a reservoir that was ultimately sourced in organic-rich Devonian shale. PCC and Massey stopped several longwall panels along the projected fault zone.

Another factor (discussed further below) in the release of methane appears to be the overburden present above the fault zone. While other panels mined through the fault zone without experiencing a methane outburst, those panels encountered overburden depths much less than 1,000 feet within the fault zone. The panels that experienced methane outbursts encountered overburden values of over 1,150 feet. It appears that several longwall panels, including Longwall Panels 11, 12, and 18 and Longwall Panels 16 and 17, were terminated in the vicinity where the projection of the fault zone intersected the 2,000-foot topographic contour. This corresponds to between 1,125 and 1,200 feet of overburden, depending on seam elevation (Figure 17).

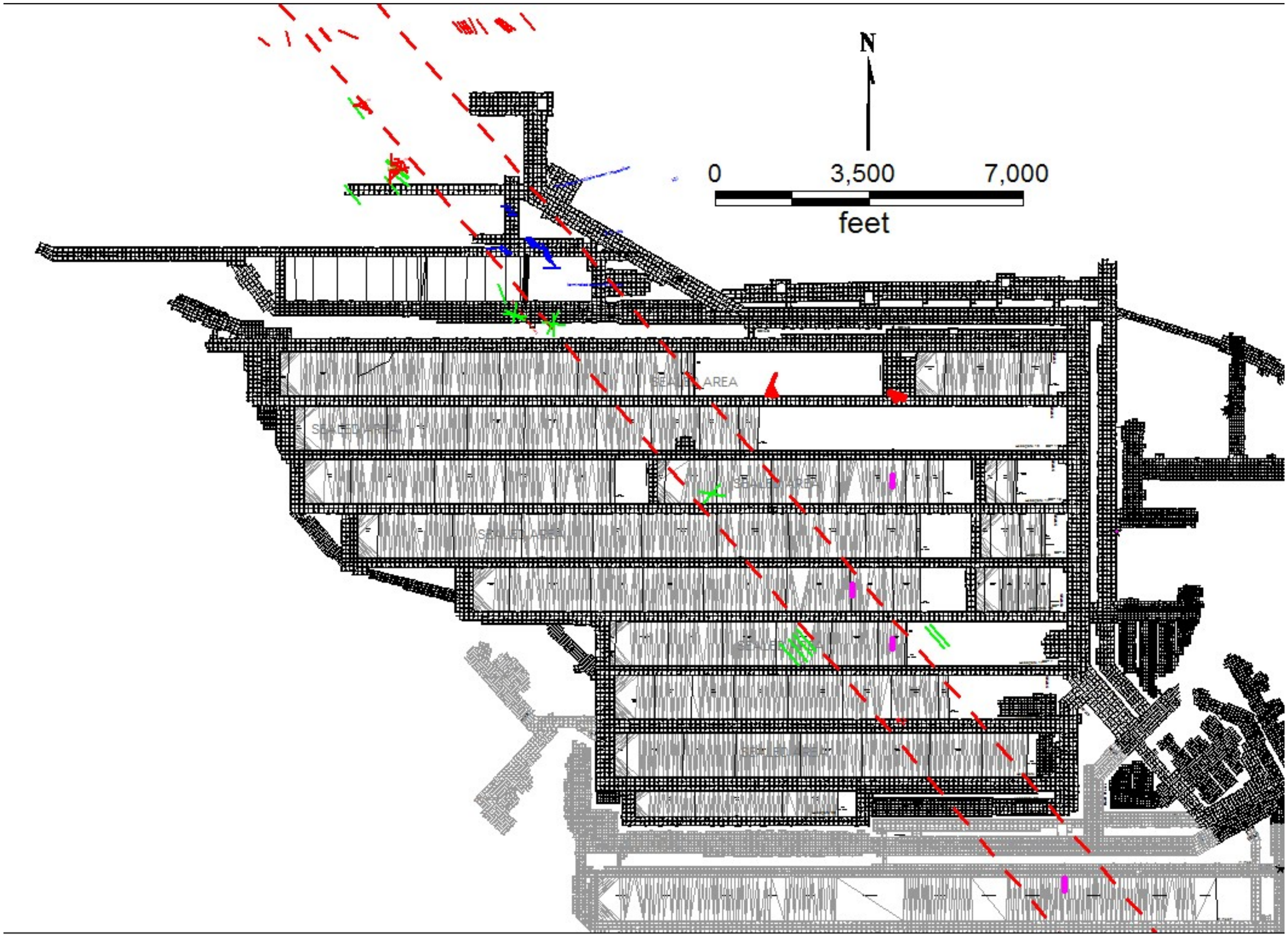

Figure 15. Upper Big Branch Mine with projected fault zone, and locations of joints (green, blue), slickensides (red), and floor burst locations (purple) used to constrain the location and trend of the fault zone.

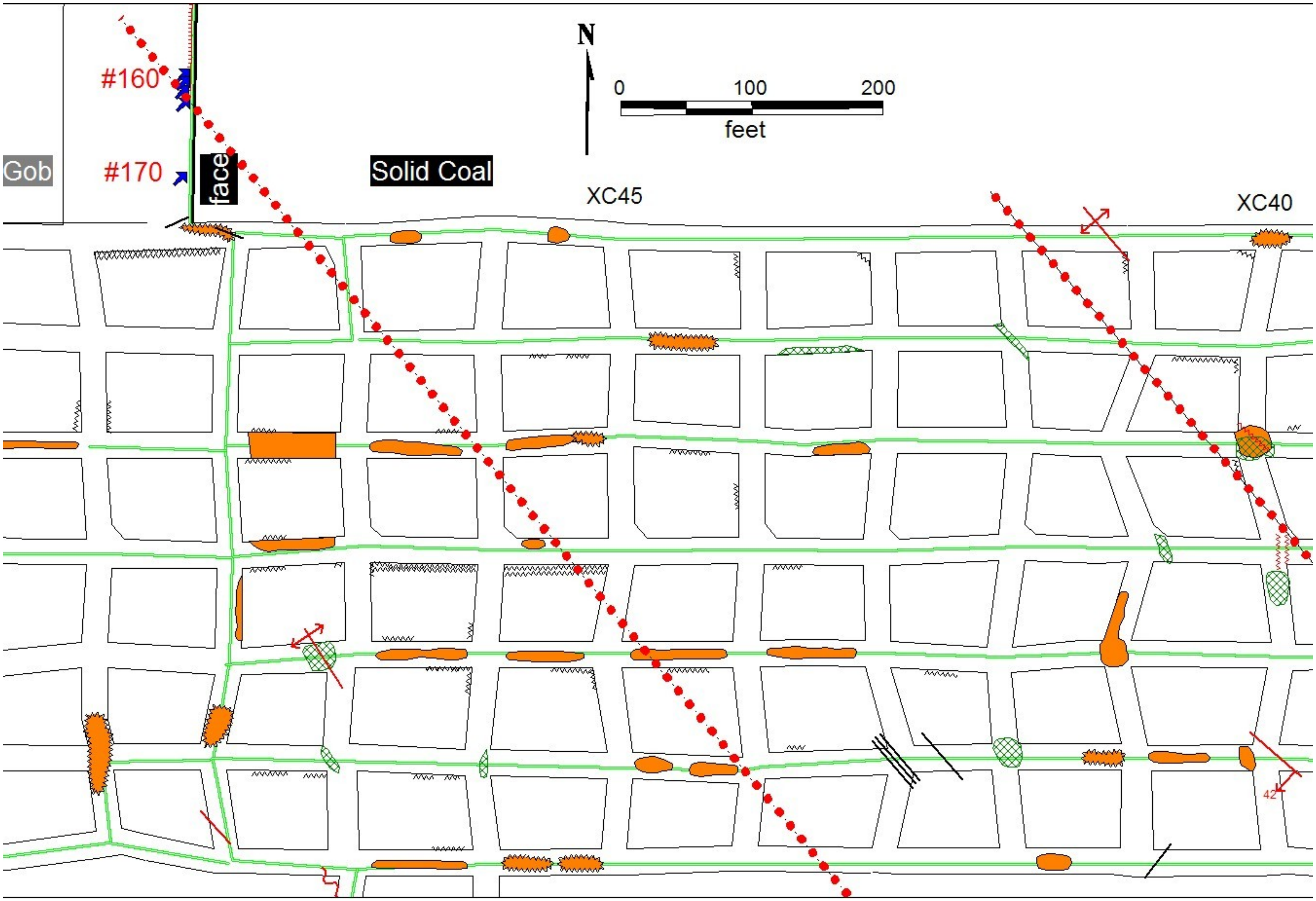

Figure 16. Detailed mapping in Tailgate 1 North, showing trend of floor heave (orange), joints (heavy black lines), pot-outs (green hatch), rib sloughing (jagged lines), and slickensides (red lines) projecting into the longwall shield 160-171 gas feeder zone. Heavy red, dashed lines indicate individual fault zone projections. Blue arrow symbols represent floor feeders inby longwall face.

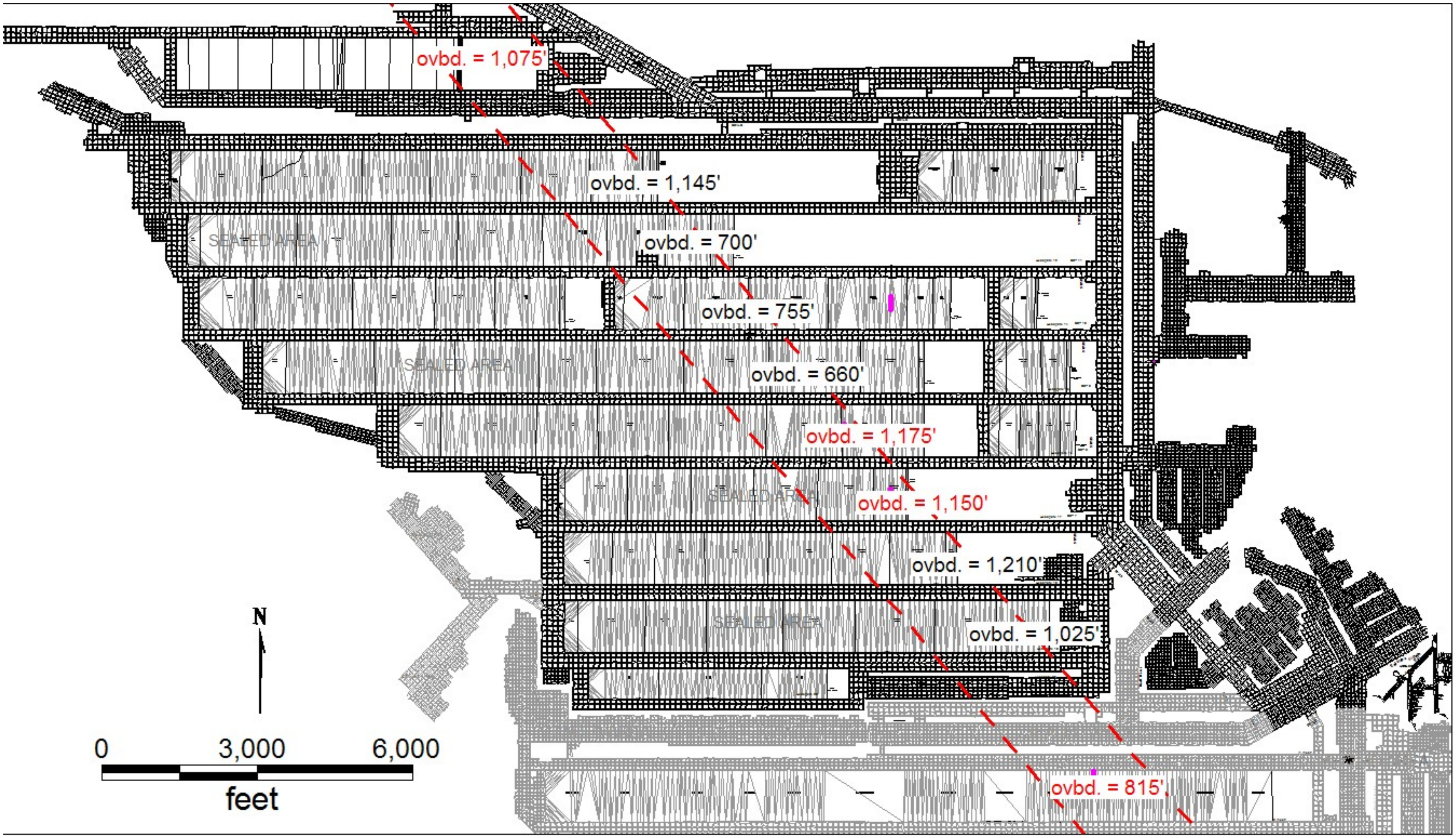

Figure 17. Panels in which outbursts or explosions occurred are highlighted in red and lie along projected fault zone. Several panels were terminated upon intersecting the fault zone. Panels that encountered overburden of only 660-755 feet appear to have crossed the fault zone without incident, suggesting a critical overburden depth of 1,150 feet related to stress.

The Role of Overburden and Stresses in Opening the Fractures

MSHA investigators explored whether overburden and stresses were a determinative factor in causing the outbursts. The evidence indicated that stress alone did not cause the outbursts, but did play a role in dilating the fractures along a fault zone. Nor did stresses cause a fracture to extend all the way down to the Little Eagle seam (the seam below the Eagle seam). Rather, mining into the fault zone beneath a critical depth threshold, corresponding to a stress value, represents the necessary condition to dilate the fractures in the fault zone and release the trapped methane into the mine.

Overburden Stress

MSHA investigators contracted an independent expert, Professor Keith Heasley of West Virginia University, to perform a LaModel (boundary element model) analysis of UBB to assess the effect of multiple seam interaction and overburden stress on mine stability and to assess whether a critical stress threshold might be associated with gas outbursts.

Dr. Heasley’s model was used to assess the in-situ (in place) stress on the Eagle seam prior to mining to identify any high-stress areas and to assess any correlation between high stress areas and floor gas outbursts. Figure 18 represents a map of in-situ stress on the Eagle seam, including the vertical stress derived from the weight of overlying rock combined with stress associated with multiple seam interaction with the overlying Powellton seam mining. Although there appears to be a loose correlation between in-situ stress exceeding 1,200 pounds per square inch (psi) and the locations of the 2003 and 2004 gas feeder events, they are not associated with the highest stress values of 1,800 psi or greater.

At the time of the April 5 explosion, the longwall face was beneath a narrow swath of greater-than-1,200 psi stress associated with two rows of remnant pillars flanked by gob or thin, split pillars. Therefore, the documented outburst locations do not correspond to the highest stresses (>1,800 psi), and therefore, do not appear to be entirely stress-driven.

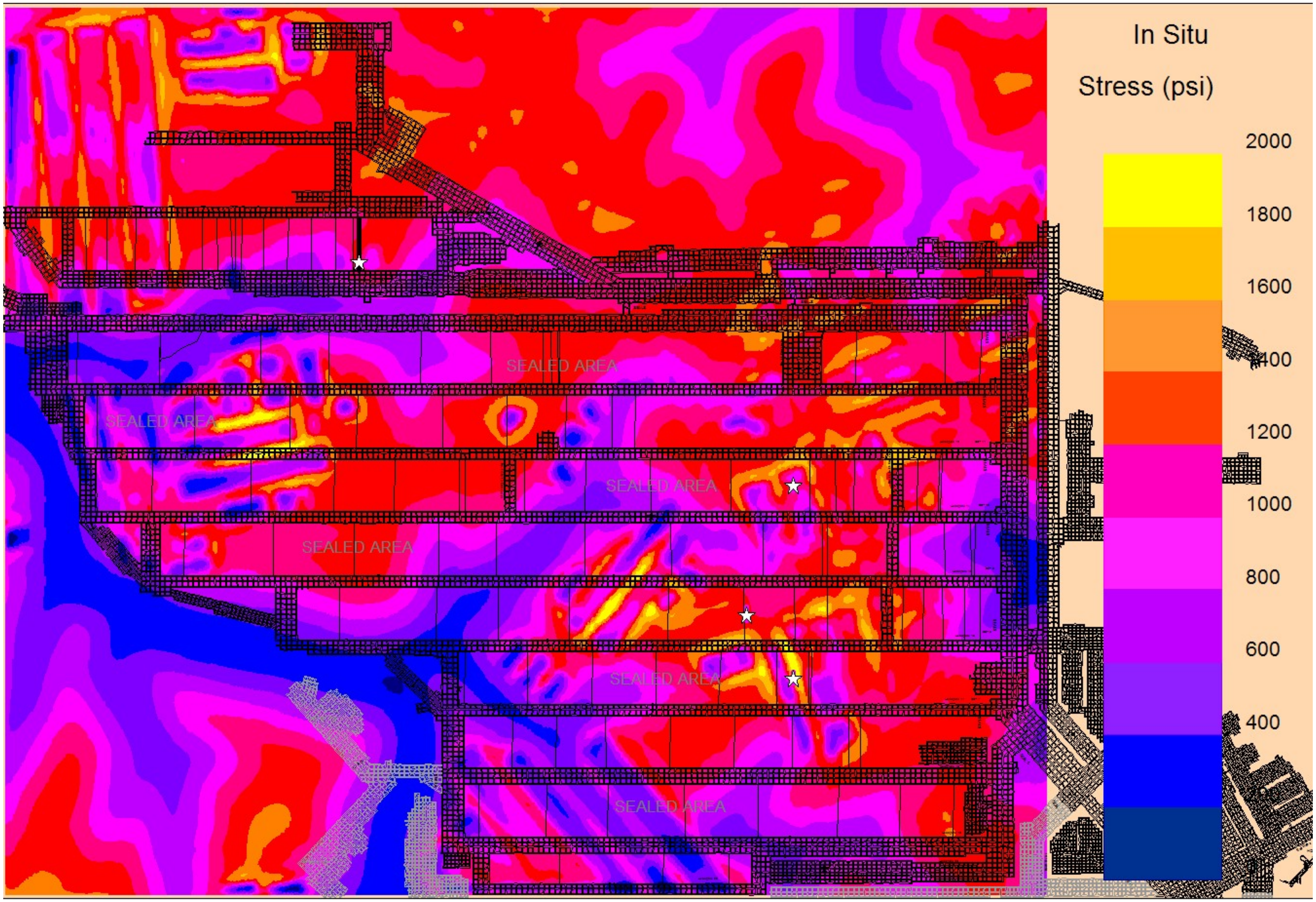

Figure 18. Map of in-situ stress on the Eagle seam, incorporating stress attributable to overburden and multiple seam interactions with the Powellton seam. White stars indicate locations of gas outbursts, with heavy black line on 1 North Panel (label), representing April 5, 2010 face position. Bright yellow patches represent >1,800 psi, with subsequent colors spaced at 200 psi intervals.

The Mine Floor and the Little Eagle Seam

The accident investigation team constructed cross sections of longwall panels where face ignitions or gas outbursts occurred previously, for analysis using the Phase^2 two-dimensional finite element modeling program. This approach differs from the boundary element model in that it is capable of incorporating geologic structures and can model the effects of mining in the floor. In contrast, the boundary element model calculated pre-mining stresses on the Eagle Seam as a result of depth and overlying mining configurations. Although there is insufficient information available to constrain all input parameters, investigators used the finite element models conceptually to visualize stress distributions associated with longwall mining beneath remnant barriers and weakened geologic zones. The models were also used in a semi-quantitative way to assess whether sufficient mining-related stress could be generated to cause failure of the approximately 10-foot interburden between the Eagle and Little Eagle coal seams, and the depth to which stability of the rock mass might be affected.

The models indicated that sufficient compressive stresses are not generated by mining to cause failure of the 8-10 feet of strata between the Eagle and Little Eagle seams. Thus, the interpretation following the 2004 event that high stress was driving the shields into the floor at mid-face and causing the rock to fail does not appear to have been correct. The models did, however, indicate that rock strength in the intervening strata is commonly reduced to failure virtually everywhere along the panel as the face advances. Therefore, if it were assumed that the source of the gas were the Little Eagle seam, and that stress was the only controlling factor, gas outbursts should occur continuously as the intervening strata is fractured. This is not the case, because the outbursts are rare events that occur at specific locations.

The models suggest that passage of the longwall face can be expected to impart stresses of several thousand psi to the strata several feet beneath the longwall face. The stresses can also be expected to routinely reach the Little Eagle seam below. As the longwall face passes, the gob floor is expected to be subjected to tensile stress as confinement is removed. Passage of the longwall face is expected to disturb both vertical and shallowly dipping joints for significant depths below the Little Eagle seam. Because some modeled panels had low strength factors at virtually every face position, outbursts cannot be explained solely in terms of stress acting on continuously lateral strata.

The Role of the Fault Zone

Having a low strength factor in the interburden (the interval of rock between the Eagle and Little Eagle seams), thus, did not by itself explain the outbursts. Investigators examined the role of the fault zone in generating outbursts.

Investigators simulated the fault zone with a 100-foot thick zone, consisting of vertical joints, that dips 30° across the stratigraphic sequence (rock layers), resulting in an intercept width of 200 feet for each layer of strata (Figure 19). This configuration matches closely the geological observations, i.e. intact rock hosting widely spaced joints or other geological structures within the shallowly dipping fault zone. Simulated vertical joints were spaced 20 feet apart within the 30° dipping zone and given a friction angle of 28°, with no tensile strength or cohesion. Joint ends were specified as being open at excavation boundaries.

Areas outside the fault zone did not incorporate joints, and when the simulated longwall face position was 250 feet inby the April 5, 2010 position, strength factors less than one extend only a calculated five feet into the floor, approximately halfway to the Little Eagle seam (Figure 20 and 21). When the longwall face had reached its April 5, 2010 position, such that the 30°- dipping fault zone was cantilevered over the face, zones of tension extend a predicted 25 feet into the floor along joint zones, and a zone of strength factors less than one extends 15 feet into the floor. This fully encompasses the Little Eagle seam and intervening interburden to the Eagle seam, with the zone extending beneath the Little Eagle seam for a short depth.

Thus, investigators concluded that the most likely explanation for the failure mechanism associated with the gas inflow at shields 160-171 is that mining into the fault zone beneath the two rows of remnant barriers at over 1,000 feet of depth resulted in a unique overlap of factors that caused the development of tension zones along pre-existing geologic structures for a calculated 25 feet into the floor.

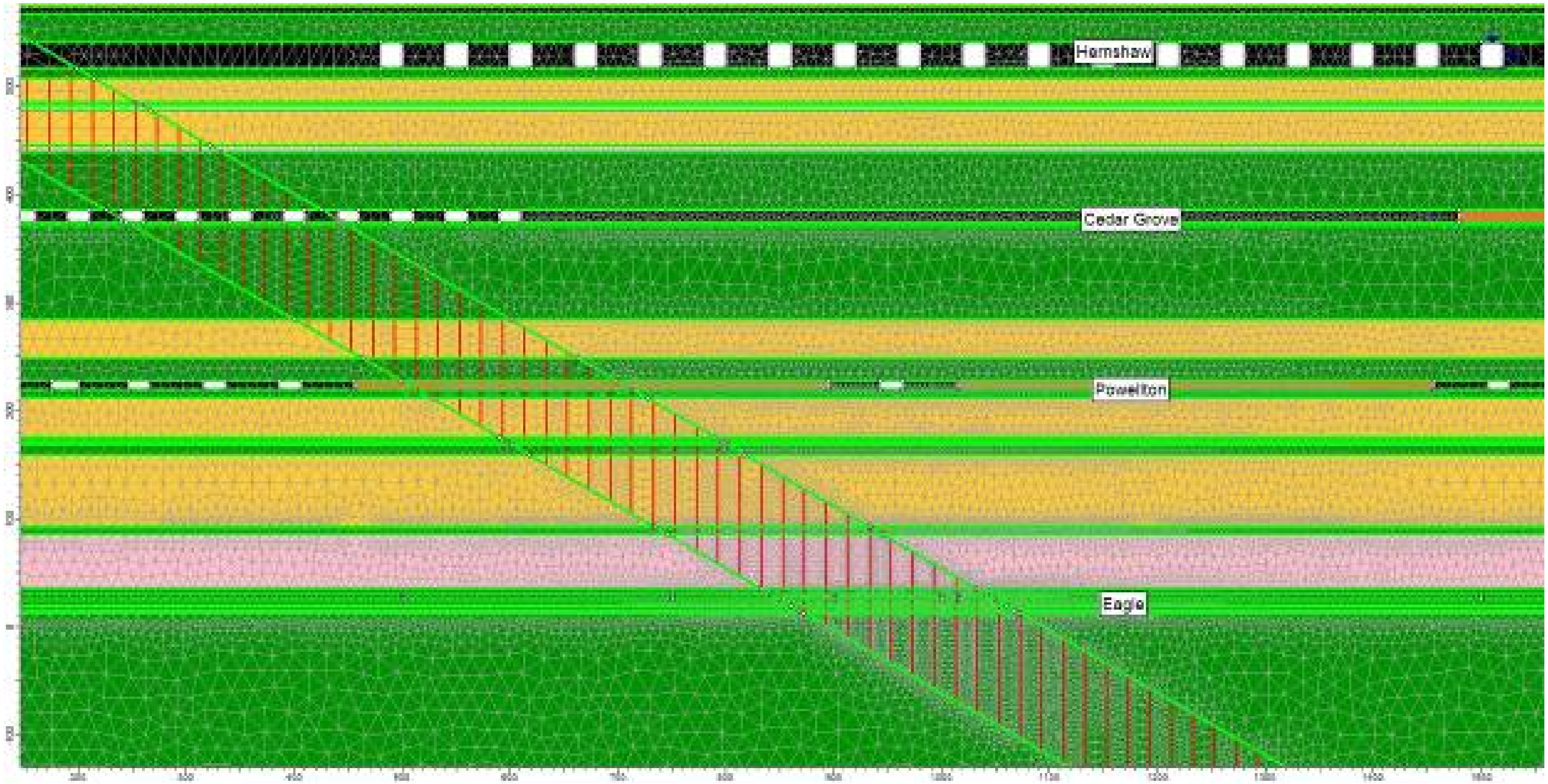

Figure 19. Stratigraphy in Rocscience showing incorporation of 30° dipping fault zone that is comprised of vertical joints spaced 20 feet apart for 1 North Panel cross section.

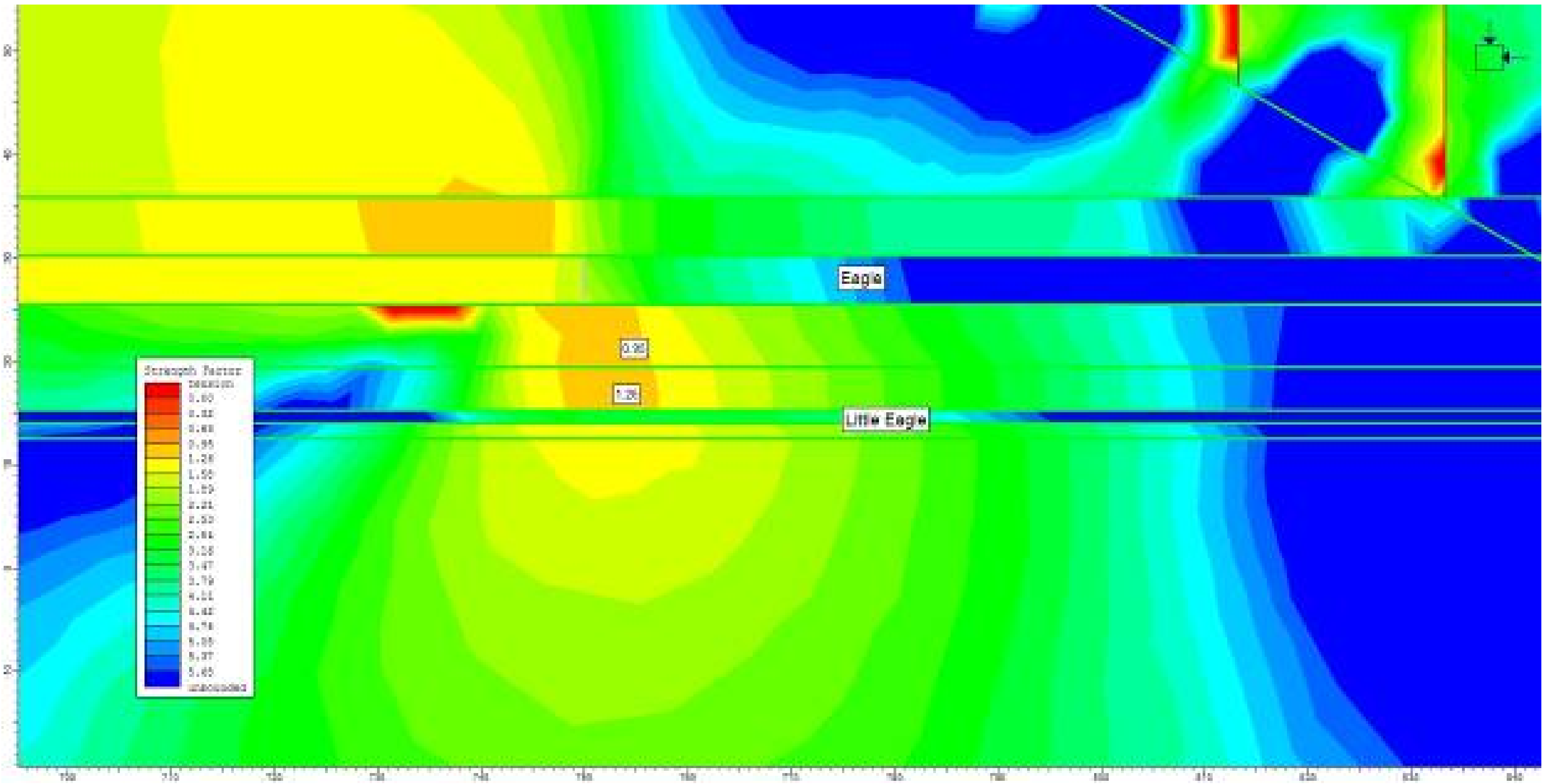

Figure 20. Distribution of strength factors when 1 North Panel longwall face is 250 feet inby the April 5, 2010 face position, outside the projected fault zone. Strength factors less than one are calculated to extend only five feet into the floor beneath the face.

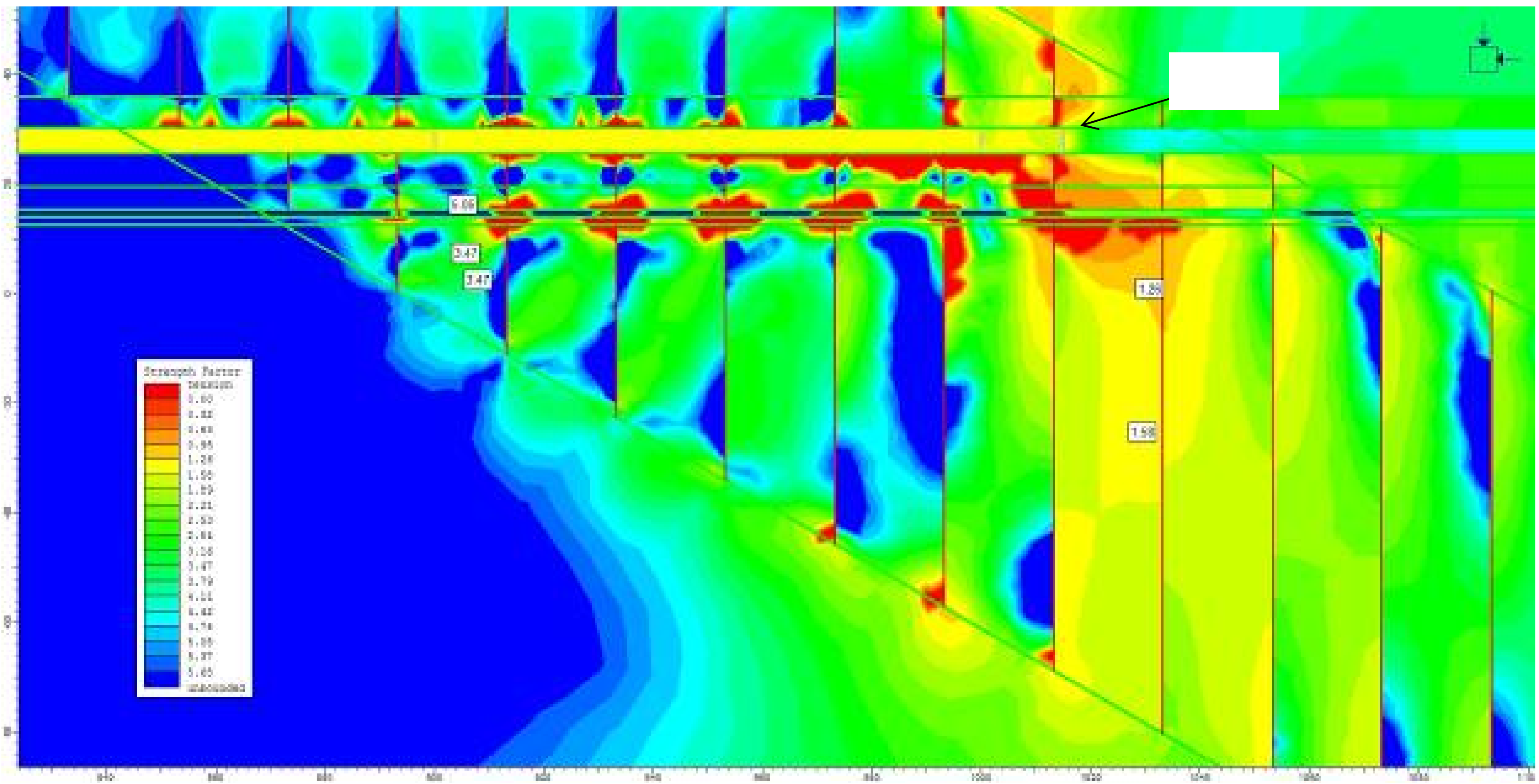

Figure 21. Distribution of strength factors when the 1 North Panel longwall face is at its April 5, 2010 position. Zones of tension are developed along joints below the Little Eagle seam, with large swath of strength factors less than one extending 25 feet into the floor, which encompasses the Little Eagle seam and underlying strata.

Methane Likely Migrated from Behind the Shields to the Shearer

During the investigation of the longwall, methane was found to be emanating from the mine floor in several locations near the tailgate end of the longwall face between shields 160-171.

As discussed later in the report, methane was present at the longwall shearer, where the initial methane ignition occurred. (It was also present at Tailgate 1 North, where the localized methane explosion occurred; this will also be considered later). MSHA investigators devised a test to observe the path the gas may have traveled as it was being released into the ventilating air stream. This test aided investigators in conceptualizing how a plume of gas from a point source behind the shields might enter the airstream and travel into the tailgate. The test also helped to assess how the plume would interact with the methane sensors mounted on the longwall shearer and tailgate drive.

The conditions on the longwall at the time of the test were different than in the moments prior to the explosion. Full details related to the ventilation system on April 5, 2010 are not presently known, as discussed elsewhere in this report. Additionally, the airflow volume and velocity crossing the face was different than reported in company examination books and the information called out of the mine for the record books.

Despite these limitations, however, the test is a useful way to visualize how air might have traveled in the shield walkway, behind or through the shields, and in the tailgate. The test involved releasing chemical smoke near the location of the fractures in the mine floor, and tracking the path the smoke traveled. Figure 22 shows the shearer, methane sensors, and shield locations. Investigators used video equipment to document the results of the tests on the longwall face and in the tailgate entry.

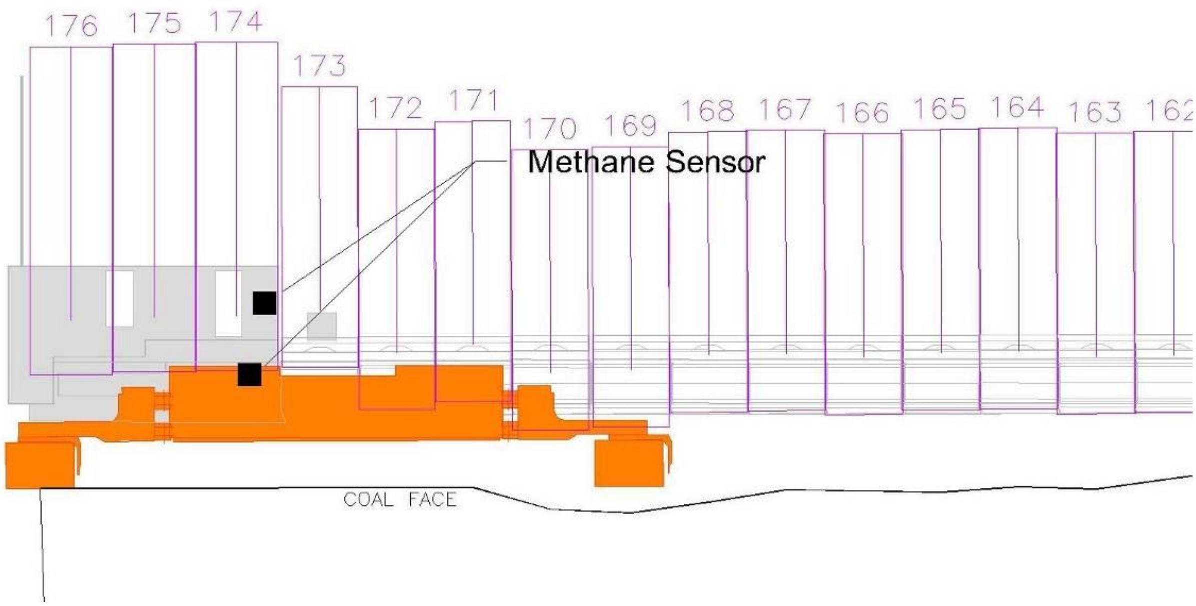

Figure 22. Diagram of UBB longwall face, showing locations of methane sensors mounted on the shearer and on the tailgate drive.

The first series of tests consisted of releasing smoke on the longwall face, with video equipment in the tailgate entry recording the path of the smoke. Investigators first released smoke behind shield 160. The smoke traveled downwind behind the shields until it reached an area where the gob had fallen tight against the shields, near shield 164. The smoke migrated from behind the shields out into the walkway and panline. The smoke moved downwind in the air current, traveling over the shearer, tailgate drive, and the methane monitor sensors.

Investigators released smoke behind shield 170, first in light amounts and then in heavy amounts. In both tests, the smoke traveled behind the shields to shield 173. At shield 173, a portion of the smoke traveled behind the shields and out into the tailgate entry. The rest of the smoke came out of the shields into the walkway. The smoke traveled toward the tail and over the shearer, toward the tailgate drum. The smoke did not pass over either of the methane monitor sensors. Smoke was observed traveling over the tailgate drum of the shearer and into the tailgate entry. Smoke was also observed entering the back of the canopy on shield 176. The smoke traveled through the canopy toward the face. It exited the canopy through a hole near the shield tip. Tests were also performed by releasing smoke in the walkway at shield 176. This smoke also traveled into the tailgate entry and across the tailgate drum of the shearer.

Smoke was then released behind shield 170 and the path of the smoke was recorded. Again, the smoke traveled across the shearer without passing over either of the methane sensors.

Although these tests cannot determine conclusively what happened on the day of the accident, the observations indicate that there may have been air flow paths by which gas, entrained in the air stream, migrated to the longwall shearer and did not encounter either of the two methane sensors mounted on the longwall shearer and tailgate drive.

A Roof Fall in Tailgate 1 North Restricted Airflow, Likely Allowing Methane to Accumulate

The roof control plan in effect at the time of the accident includes a number of diagrams that refer to roof bolting or support, indicating that the tailgate entry of the longwall panel was required to have either two rows of 8' cable bolts, or two rows of wood posts or hydraulic jacks installed between primary supports for a distance of 1,000 feet outby the face. However, underground observations revealed that two rows of cable bolts had not been installed in the Tailgate 1 North (also known as Tailgate 21) and that only a single row of posts was installed along the solid block of coal.

The failure to install appropriate tailgate support is significant because observations indicate that crosscut 49, the next crosscut inby the face, had already caved-in prior to the face reaching crosscut 48 and before the explosion based on debris on the fall rubble (Figure 23). PCC's failure to install either two rows of posts or two rows of eight foot cable bolts for support restricted the airflow in the tailgate entry inby the longwall face and contributed to the inability to adequately ventilate the tailgate area, which is discussed in the next section.

Figure 23. Caved roof in tailgate entry, as viewed in crosscut 49, which represents the next crosscut inby the face. Coatings of soot on the fallen rubble, juxtaposed against small pieces of freshly fallen, white sandstone, indicate that the intersection had caved prior to the explosion.

MSHA's Ventilation Surveys and Analysis

To explore the ventilation of the mine, MSHA investigators considered underground observations, interviews, and documents, including submitted plans, maps, record books, production reports, company ventilation studies, fan charts, and MSHA inspector notes. Higher level company officials, who should have had detailed knowledge of the ventilation system, declined to be interviewed and exercised their Fifth Amendment rights. It should also be noted that both Headgate 1 North from inby crosscut 39, as well as Tailgate 1 North from inby approximately crosscut 80, were inaccessible to the Bandytown fan because of deteriorated ground conditions. Although air readings based on company examination books are given in the following discussion, multiple inconsistencies and deficiencies were found in the books in a number of areas, including air measurements and quantities.

As stated earlier, ventilation controls for the area inby 78 switch were almost completely destroyed by the explosion. As a result, mine rescue teams had to reestablish ventilation prior to recovering the victims. The teams built framed mine brattice checks across the 7 Tailgate 1 North entries between crosscuts 11 and 12, the three connecting entries at the intersection of the intake rooms to the North Glory Mains, and across the Headgate 1 North entries to better direct air into HG 22, TG 22, West and North Jarrells Mains. Additionally, check curtains were constructed in the HG 22 section, TG 22 section, North Jarrells Mains and West Jarrells Mains to establish a ventilation circuit to ventilate the inby portion of these areas. Those controls were in place during the investigation.

Ventilation controls were also damaged outby 78 switch to the Ellis Portal. Some of those controls were repaired prior to the ventilation survey. Other small changes were made in the mine to the UBB/Lower Big Branch (LBB) area, changes which were taken into account for their impact on the system's ventilation. Considering the existing mine's ventilation system, the inaccessible areas in the Headgate 1 North and Tailgate 1 North toward Bandytown fan, and the unlikelihood that the ventilation system would be restored to pre-explosion conditions, MSHA investigators conducted an in-mine ventilation survey.

On September 9, 2010, preliminary information was gathered on the Bandytown, North, and South fans in anticipation of conducting a ventilation survey. On September 28, a mine ventilation air quantity and air pressure survey was started at the mine by MSHA personnel. A total of 33 teams collected information over a ten-day period. Representatives from WVOMHST, the company, and UMWA representatives of the miners participated in the investigation.

Investigators determined air velocities in the mine using vane anemometers with wands in the one-half area traverse method or using the smoke-cloud method with aspirators and chemical smoke tubes. Investigators measured mine opening dimensions to determine the area. Investigators then calculated air quantities from the measured velocities and corresponding calculated area of the mine entry in which the velocity was measured. Investigators measured air pressure differentials between air courses and across regulators or partial ventilation controls using magnehelic gauges and digital manometers. The fan air quantities were based upon underground anemometer measurements in the mine.

Investigators used Wallace & Tiernan altimeters to determine the total pressure at specific locations within the mine ventilation system. MSHA compiled and balanced this information to provide a computer model of the mine ventilation system, suitable for developing computer mine ventilation simulations.

Overview of the Mine Ventilation System

The mine had four sets of portals and a shaft, described briefly below:

- The North Portal consisted of five drifts. There was one blowing fan intake drift, two air drifts with track in one (air exiting) and two return drifts.
- The South Portal consisted of five drifts. There was one blowing fan intake drift, one intake drift with a stopping in place, two track haulage air drifts (air exiting), and one return drift.
- The Silo Portal consisted of four drift openings. There were two return drifts and two air drifts with belt in one. Air exited at all locations.
- The Ellis Portal consisted of five drift openings. There was one return drift, three air drifts with track in one and belt in another, and one intake drift. Air was actually exiting through the belt/track drift entries, according to witness testimony.
- The Bandytown return shaft was a 16-foot diameter shaft with an exhausting fan.

There was a 10-foot diameter coal transfer shaft, known as the Glory Hole, which connected UBB and the Castle Mine. This shaft was no longer in service at the time of the accident. It was abandoned and had been partially filled with coal and debris. Its effect on ventilation between the two mines was negligible.

UBB was ventilated with two blowing fans and one exhausting main mine fan. The North Portal blowing fan was a Joy, Model Number 12065D, Serial No. MF4110, ten-foot axial vane fan. The fan was operated with a 1,000-horsepower, 4160 volt, 900 revolutions per minute (rpm) motor. Figure 24 is a copy of the North fan chart which was on the fan pressure recorder when the explosion occurred and shows the fan was operating at about 4.8 inches of water gauge (in. w.g.).

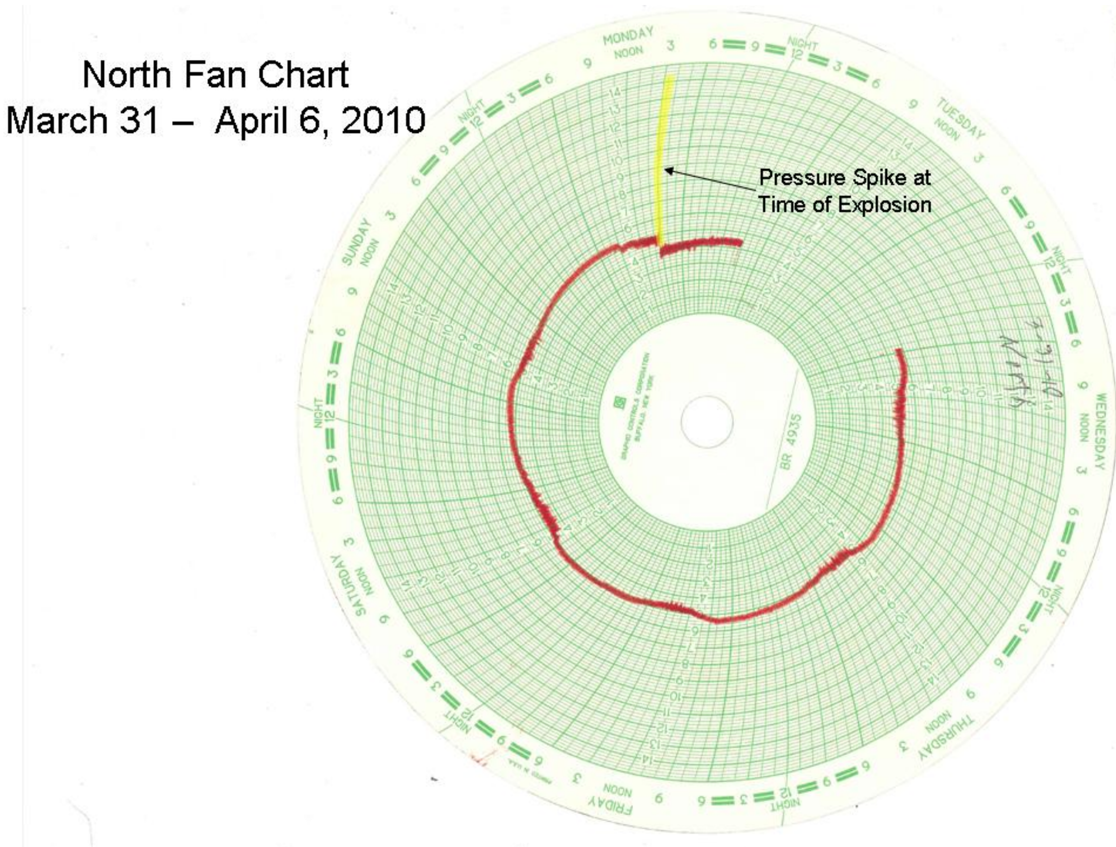

Figure 24. Chart for North Fan, showing pressure spike at time of explosion.

The South Portal blowing fan was an Industrial Welding Buffalo, six-foot diameter axial vane fan. The fan was operated with a 200 horsepower, 480 volt, 1,200 rpm motor. Figure 25 is a copy of the South fan chart which was on the fan pressure recorder when the explosion occurred and shows the fan was operating at about 1.4 in. w.g.

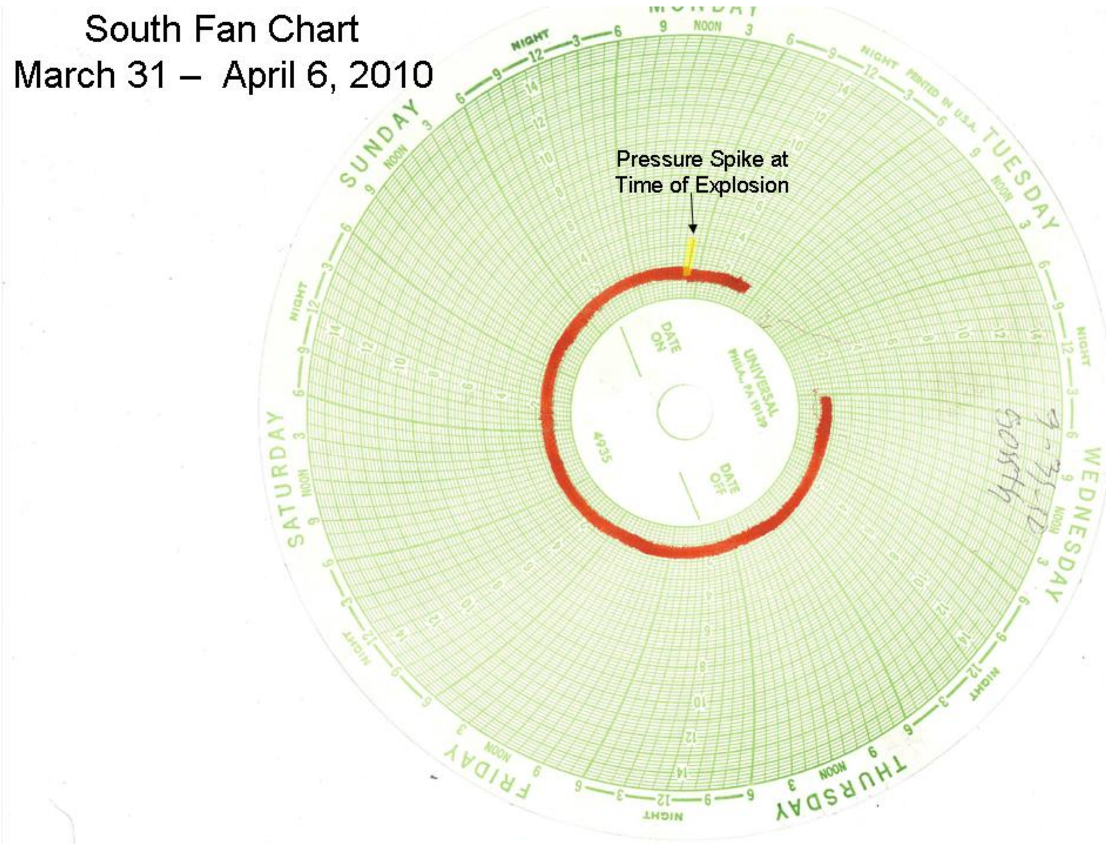

Figure 25. Chart for South Fan, showing pressure spike at time of explosion.

The Bandytown exhausting fan was a Robinson, Model Number DA-97AF1029-116, Serial No. 208-167, eight-foot centrifugal fan. The fan was operated with a 2,000 horsepower, 4160 volt, 890 rpm motor. Figure 26 is a copy of the Bandytown fan chart, which was on the fan pressure recorder when the explosion occurred and shows the fan was operating at about 5.5 in. w.g.

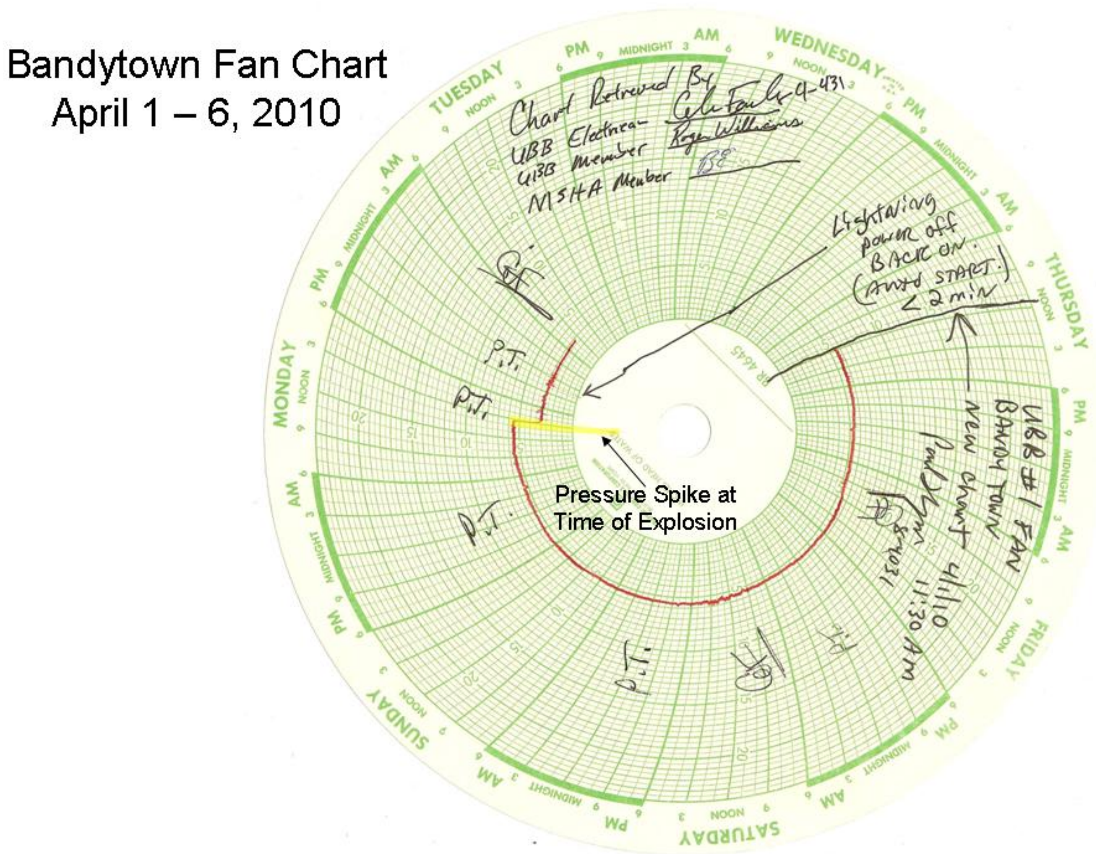

Figure 26. Chart for Bandytown fan showing pressure spike at the time of the explosion.

Although the fan charts shown in Figures 24 to 26 were not aligned correctly on the pressure recorder to correspond with actual time, each fan chart shows the pressure spike from the explosion. The North fan recorded a spike of over 9 in. w.g. over its normal pressure of 4.8 in. w.g. The South fan recorded a spike of 2 in. w.g. over its normal pressure of 1.4 in. w.g. The Bandytown fan spike went downward off the chart because this fan was exhausting and the pressure spike was positive. The magnitude of the spike cannot be determined but it was greater than the fan operating pressure. Several small variations in fan pressure were noted on the Bandytown fan chart following the explosion, although persons who were underground during that time reported no additional explosions.

The North area hosted the longwall and two continuous mining sections. The southern, UBB/LBB portion of the mine, which hosted one active and one inactive continuous mining section, was ventilated by the North and South blowing fans. The North fan provided the majority of intake air to the Ellis switch area. However, the Bandytown exhaust fan provided most of the ventilating pressure for the affected area. Near the Ellis switch intersection, the air was joined by air from the Ellis Portal. The intake from the North fan was regulated at this point, to assure the intake of air at Ellis Portal. This marked the transition from the blowing system of the North and South fans, to the exhausting system of the North area. The South fan had almost no influence over the North area.

Airflow in a separate air course to ventilate seals (intake and return air courses), on the South side of Old North Mains in the North area, was induced by the blowing ventilation system. The air from this split exited the mine at the North Portal. Prior to the explosion, all of the air from the area inby 78 switch exited from Bandytown fan.

Longwall Development Sections

The HG 22 and TG 22 sections were developed with three entries, ventilating each of the sections with a single split of air. The preshift examination record book for the HG 22 section (MMU 029-0), at 3:20 a.m. on the day of the accident, indicated that the quantity of air measured in the last open crosscut was 18,848 cfm. The preshift examination record book for the TG 22 section (MMU 040-0), at 2:10 p.m. on the day of the accident, indicated that the quantity of air measured in the last open crosscut was 32,360 cfm. Weekly air measurements recorded by the mine examiner for TG 22 were considerably higher; a measurement of 61,310 cfm was recorded on March 30, 2010. The reason for this inconsistency is unknown.

1 North Panel

The 1 North Longwall section (MMU 050-0) was ventilated with three entries on the headgate side. A majority of witnesses indicated that prior to the accident, the belt air was being directed to the longwall face, and although no air quantity measurements were recorded for the belt entry, testimony indicated that the belt air quantity was approximately 10,000 cfm. The preshift examination record book for the day of the accident indicated a measured quantity of 56,840 cfm and face velocities of 776 fpm at shield 9 and 513 fpm at shield 160. It is likely that the recorded longwall preshift quantity measurements indicate only the intake air portion of the total air that ventilated the longwall face.

The tailgate consisted of seven entries near the face location. Two of these entries were a main return from the longwall development sections. The tailgate air courses consisted of five entries, all of which were ventilated with air that had ventilated the belt entries.

The longwall panel being mined was directly in front of the bleeder fan. It would be highly unlikely that airflow across the longwall face would have been disrupted by minor changes to the system.

Barrier Section

The active continuous mining section in the South (LBB area) of the mine was called the Barrier Section (MMU 062-0). A section foreman's testimony indicated that the section had changed from a dual-split ventilation system to a single-split ventilation system three to four weeks prior to April 5, 2010.

Portal Section

This deactivated section (MMUs 066-0 and 067-0) was put in a non-producing status on March 30, 2010.

Reconstruction of Ventilation Prior to the Accident

Ventilation controls for the area inby 78 switch were almost completely destroyed in the explosion. In order to determine the location of the ventilation controls, and the air flow direction, the investigation team used the mine maps, stopping remnants and debris determined by mine mapping, as well as witness testimony. Although ventilation control locations were verified underground where possible, determination of the control type was often not possible. A map based on the available information depicts the area inby 78 switch as it was believed to be prior to the accident, and shows ventilation controls, and airflow directional arrows with recorded quantities where available, and when the measurement location could be determined (Appendix P).

The in-mine survey determined an air quantity of approximately 297,000 cfm reported to Bandytown fan. Records indicated that the fan had not been altered since the explosion and was not affected by the explosion. The operating point for the fan was determined from the underground measurements, and the pressure indicated on the fan chart during the pre-survey (6.45 in. w.g.). The pressure taken from the fan recording chart during the survey was compared with the fan pressure recorded on the chart prior to the explosion (Figure 26). The operating point was plotted on a fan performance curve for Bandytown fan. A curve was drawn through the operating point and the pre-explosion pressure was used to determine the quantity at the fan prior to the explosion. The fan performance curve is shown in Figure 27.

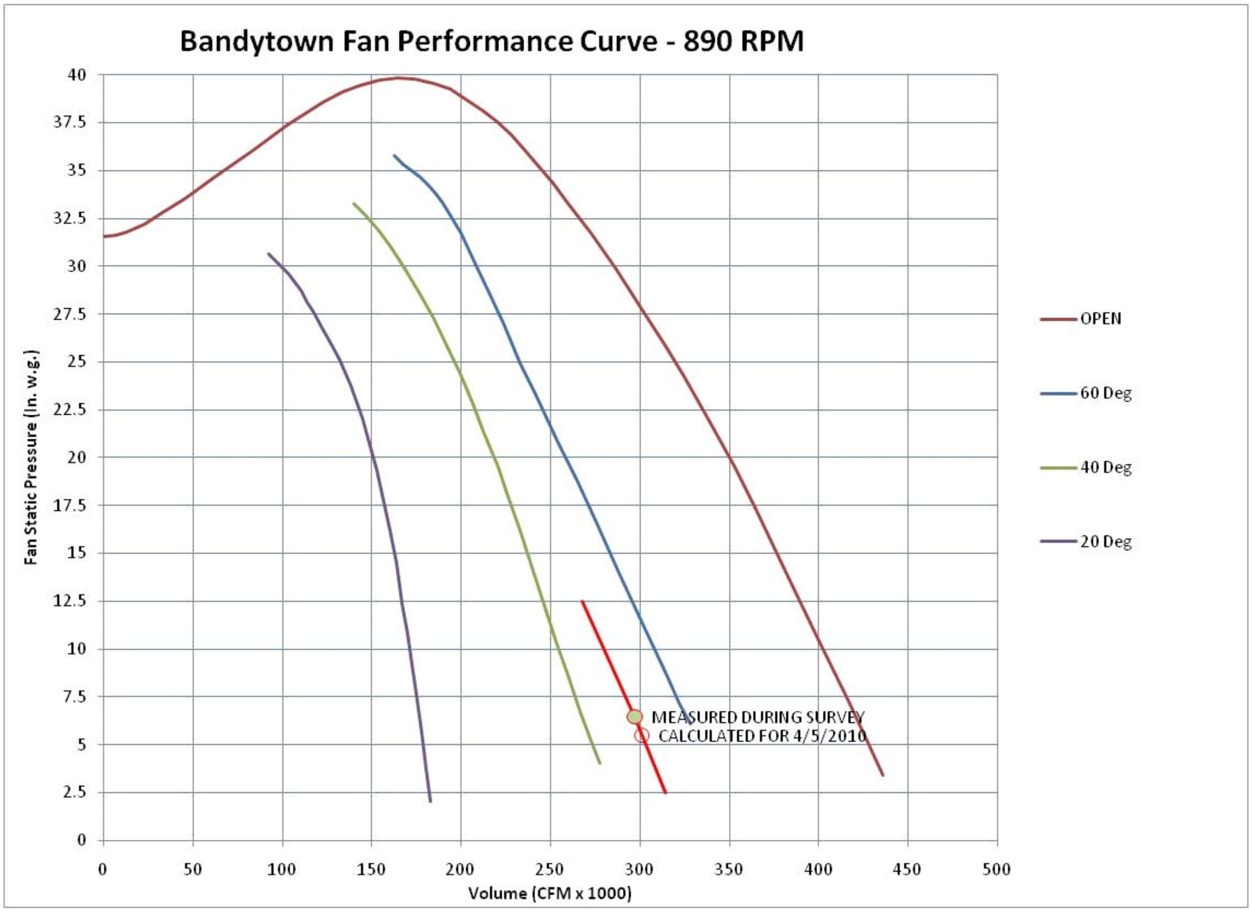

Figure 27. Graph of air volume versus fan static pressure, defining the Bandytown fan's performance curve.

The measurement recorded in the record book for Bandytown fan was approximately 400,000 cfm. The air quantity reporting to Bandytown fan during the survey was measured several times by the respective investigation teams as described in the underground mapping protocols, using careful area measurements, individually calibrated anemometers with wands, and the one-half area traverse method. This method is more accurate than typical day-to-day air quantity measurement methods used by mine personnel.

After constructing a computer model of the mine's surveyed ventilation system, a simulation was developed to recreate the ventilation system employed at the mine prior to the explosion. An average friction factor was developed from measurements in North Mains and Old North Mains, in the area of the Nos. 4 and 5 belts. A stopping leakage resistance was obtained from the literature for "average stoppings." Average mine entry dimensions of 7 ft. by 19 ft. was assumed. The air course and ventilation control location were determined from mine maps, stopping remnants, debris, and testimony. The opening sizes of some regulators were assumed due to lack of information. The accuracy of the simulation is imperfect, because of the limited information, as discussed in the report section entitled "Examinations," and because of the destruction of the ventilation controls in the affected area. Nevertheless, simulations gave insight into the expected effects of changes to the system.

The simulation of the mine prior to the explosion indicated that the HG 22 section was ventilated with 26,700 cfm in the return, TG 22 was ventilated with 63,600 cfm in the return and the longwall had an intake face quantity of 67,700 cfm. The model indicates quantities close to those believed to exist prior to the explosion. While the quantities are not exact, the model should reflect the general effect of major changes.

Several variations of the simulation were constructed in order to explore the effects of changes to the system. A simulation was made of the effect of leaving open the equipment doors near 78 switch. The results from the simulation indicated that there would not have been a significant effect on the longwall and TG 22 section air quantities and a small increase in air quantity (approximately 7 percent) in HG 22 from the change. Simulations with equipment doors at HG 22 open likewise did not significantly affect the longwall quantity.

An examination of the ventilation system indicated a change that would have a large effect on the face quantity would be leaving the Tailgate 1 North equipment doors open. The results of the simulation indicated that the face quantity would have been approximately cut in half while over 150,000 cfm short circuited directly to the fan. However, the fan pressure dropped over 2 in. w.g. in that simulation. If this scenario had occurred, the resulting fan pressure change would have been recorded on the fan pressure chart. No such change was observed on the fan pressure chart. Similarly, a simulation was made with the Tailgate 1 North equipment doors half open. The longwall face air would have cut by approximately a third and the fan pressure decreased by 1.5 in. w.g. Again, no such change was observed on the fan pressure chart.

A simulation was made to examine the effect of constructing the longwall headgate regulating doors. The simulation results indicated that the longwall quantity decreased approximately 19,000 cfm and HG 22 increased approximately 5,000 cfm. The preshift examination record books indicated that the longwall quantity decreased approximately 18,000 cfm and HG 22 increased approximately 4,000 cfm.

The "T-split"

During the ventilation survey, investigators determined that the air at the tailgate end of the longwall to be splitting both inby and outby the longwall face in the tailgate entry. This is commonly referred to as the T-split. The two crosscuts adjacent to the pillared area inby the face were found to have a total of 5,100 cfm exiting. This was with the face quantity at less than half of what was reported prior to the explosion. The flow as reported by examiners on the face would have increased the quantity of air at the T-split above 5,100 cfm.

It is important to have a functioning T-split because the air moving inby the face clears the area inby the longwall tail of contaminants and encourages airflow through and behind the last several shields, back away from the face. The solid gob shield plate size affected the overall air flow into the tailgate entry and gob.

While the T-split was likely adequate during normal mining, investigators concluded that it did not provide enough airflow to safely dilute the amount of methane released prior to the localized methane explosion. Investigators also concluded that the origin of the localized methane explosion was in the T-split area at the longwall tailgate. Additional support in the tailgate, resulting in a greater air quantity in the T-split inby the face, would have provided increased dilution capacity for a methane influx prior to the localized methane explosion.

Typically, roof support is installed in the tailgate entry to maintain an open area to provide a flow path back from the face to the bleeder entries. In the case of UBB, the plan called for two rows of floor to roof supports or two 8' cable bolts. As noted earlier, it was observed that no cable bolts and only one row of propsetters (supports) was installed. The additional supports would have aided in keeping an airflow path open behind from the face, creating a larger air quantity in the T-split.

The Methane Ignited at the Shearer, then Created a Methane Explosion in Tailgate 1 North

An ignition source must contain sufficient temperature or energy to ignite methane. Methane can be ignited by a minimum ignition temperature of approximately 1,000º F. For comparison, this is the temperature where components in an electric circuit may begin to glow. In addition, the minimum ignition energy for methane is 0.3 millijoule.

MSHA determined that the cutting bits on the tail drum of the longwall shearer likely generated hot streaks on the sandstone roof or floor. These hot streaks can exceed the ignition temperature of methane. Investigators concluded that this was the most likely ignition source. MSHA also examined potential ignition sources deriving from faulty or non-permissible electrical equipment, and other physical items, but ruled them out as an ignition source after testing hundreds of items. MSHA also found that other sources (such as a roof fall or friction generated by the pan line) were not likely ignition sources.

This ignition of methane did not begin to propagate immediately. The flame from the ignition burned near the longwall tailgate for a short period of time, approximately two minutes. The methane ignition then triggered a localized methane explosion in the Tailgate 1 North.

Frictional Ignition from the Longwall Shearer

Once the methane reached the shearer on April 5, the poorly maintained longwall shearer likely caused an ignition. The shearer was cutting into sandstone at both the roof and the floor and the mineral content of the sandstone posed a high potential for a frictional ignition. Two of the cutting bits on the tail drum had worn flat and had lost their carbide tips. The conditions of these bits thus had a high incendive potential. The abrasion of the cutting bits striking the sandstone likely created hot streaks.

Additionally, the "last line of defense" against an ignition, the water spray system, was effectively absent because seven water sprays were missing from the tailgate drum of the shearer. A maintenance report (Figure 5) from March 1, 2010 indicates that sprays were intentionally removed in order to flush the tail drum of sediment from poorly filtered river water and other debris. Subsequent testing by MSHA revealed that with the seven sprays missing, the water pressure on the remaining sprays dropped to 0 psi and the water spray system was unable to cool the cutting bits and surrounding rock surfaces and push methane away from the shearer bits.

<u>The Sandstone Had a High Potential for Frictional Ignition</u>

Underground observations indicated that the tail drum was cutting sandstone in the roof and floor, while the head drum was cutting sandstone in the floor. Accordingly, MSHA collected samples of the roof and floor from the tailgate side of the 1 North Panel face for petrographic analyses (Appendix Q). Based on the mineral contents determined by thin section petrography, the samples were plotted on the diagram below for comparison with the incendivity index developed for rocks in Australian coal mines (Figure 28).

The sandstone that the longwall shearer was cutting into on April 5 had a high potential for frictional ignition. The layers of coarse siltstone, which contain high mica content, plot in Category 1, indicating a low potential for frictional ignition. In contrast, the sandstone plots in Category 4 indicating a high potential for frictional ignition. The floor sandstone very nearly plots in the Category 5 zone, because of its high quartz content. Compared to the sample collected from the roof, the floor sample contains much greater quartz, and is characterized by a much greater degree of grain interlocking. Rocks with an incendivity index of 4-5 were shown in tests to have a high potential for frictional ignition, for rock-on-rock and metal-on-rock ignitions.

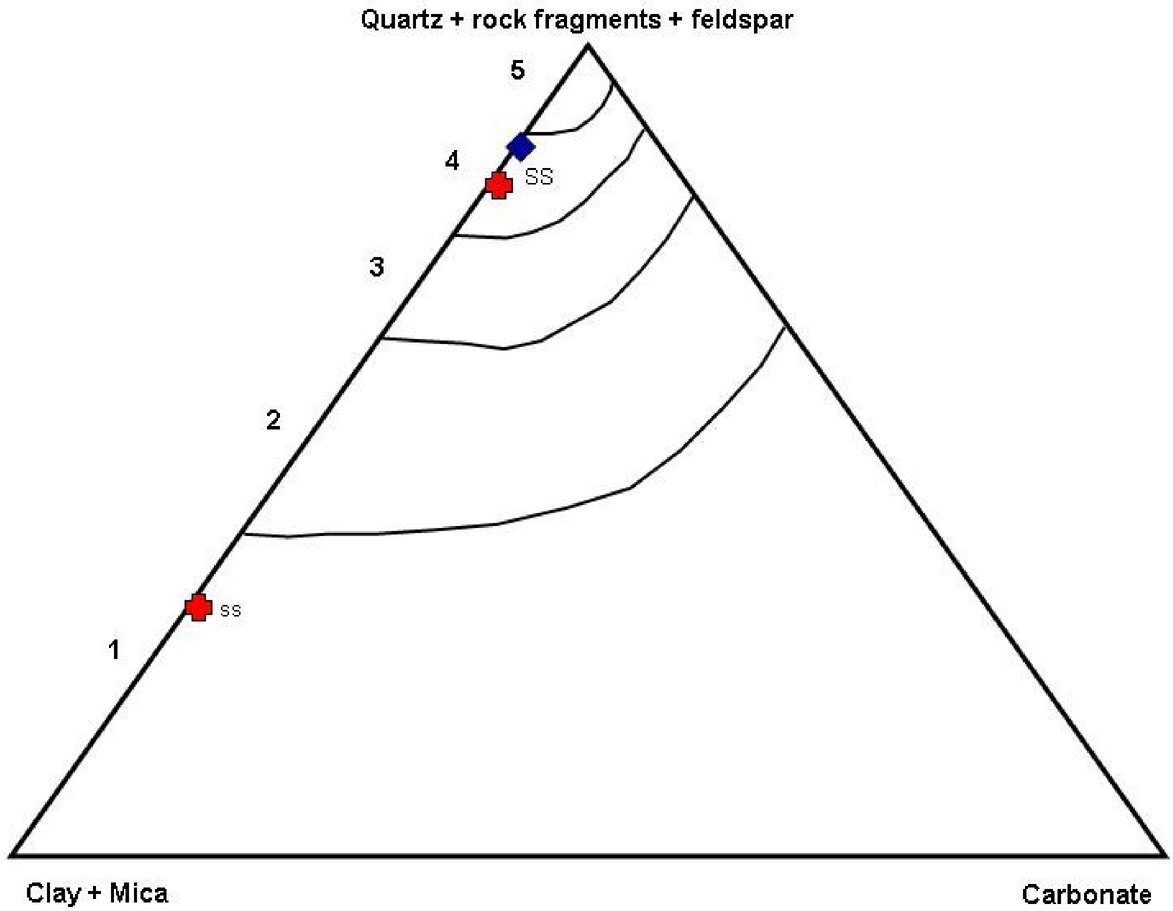

Figure 28. Diagram showing relation of UBB roof (red crosses) and floor (blue diamond) sandstone (SS) and siltstone (ss) to contour lines of incendivity index.

Cutting Bits can Generate "Hot Streaks"

In the laboratory, frictional ignitions have been initiated by metal-on-rock and rock-on-rock contact. To initiate a methane explosion, a minimum of time, temperature, and surface area of a source are required in order to heat the necessary minimum volume of gas to a sufficient temperature.

Experiments involving metal-on-rock friction have shown that combustible concentrations of methane can be ignited by "hot streaks," which are smears of metal found on rock where the metal has been heated near its melting point. Sandstone, which the longwall crew was mining at the time of the explosion, generates hot streaks.

In addition, experiments have revealed that bit surface area is significantly related to the incendive potential of a hot streak. Large wear flats on the cutting bits are more likely to cause an ignition, especially when the carbide tip has worn off and as little as 3 mm of the steel shank has been abraded away (Figure 29).

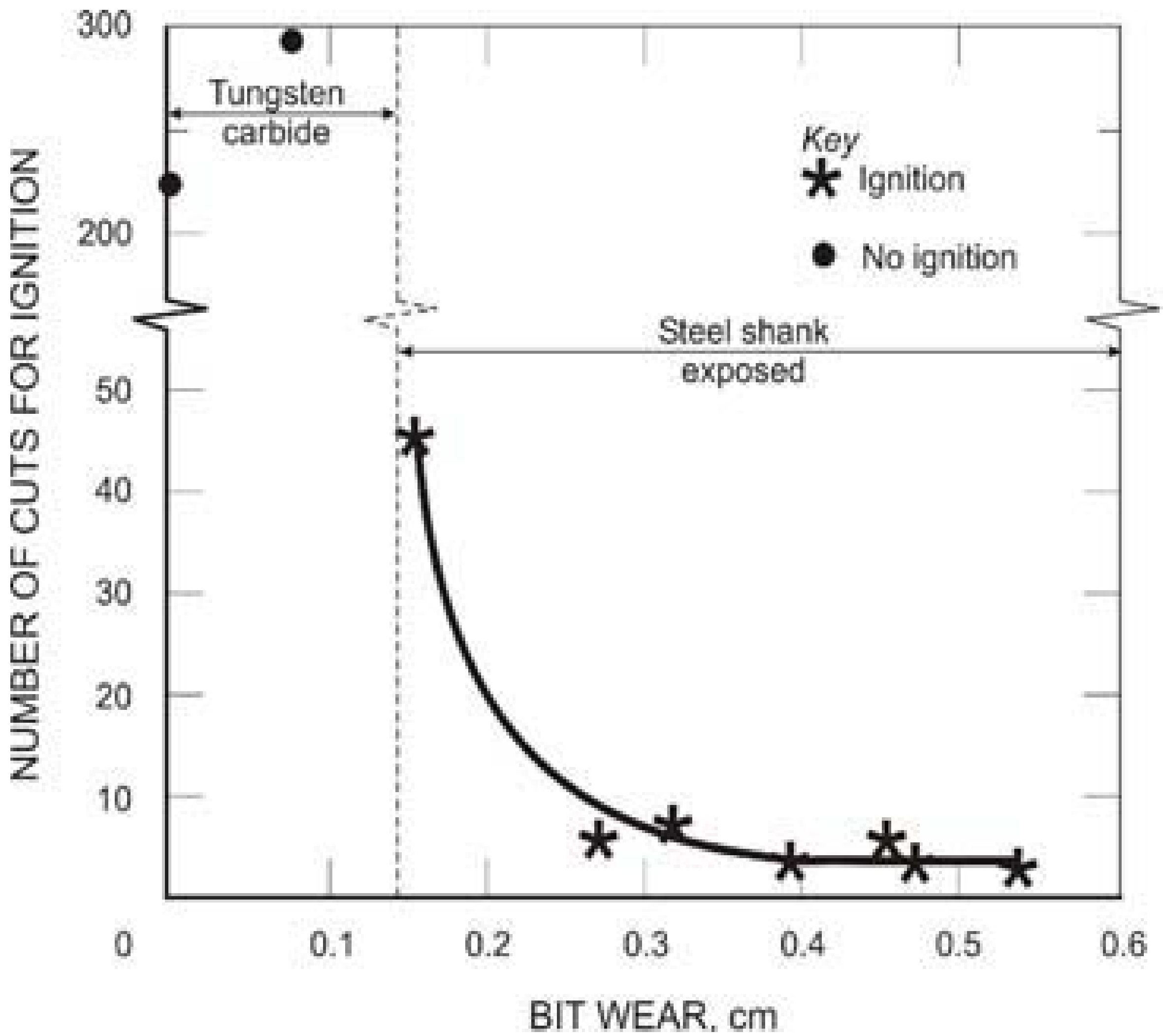

Figure 29. Relation between bit wear, in centimeters, and the number of cuts required to induce a frictional ignition, from Kissell et al. (2007).

During the underground investigation, MSHA found that at least two cutting bits on the tail drum showed signs of excessive wear, including total erosion of the carbide tip and a large wear flat developed in the steel shank. One such bit is shown in Figure 30. Bits with large wear flats worn down to the steel shank striking quartz-rich sandstone, which is characterized by a high incendive potential, represents the most likely source of the initial methane ignition. While only a few bits were worn to the steel shank, one worn bit can provide an ignition source.

Figure 30. 1 North Panel tailgate drum, showing configuration of water sprays used in the pick-point flushing system. Note that sprays are directed toward the front of the bits, one missing water spray, and two bits exhibiting extreme wear.

<u>The Water Spray System Failed to Prevent the Ignition</u>

One of the purposes of a longwall shearer water spray system is to reduce the likelihood of a frictional ignition. Water sprays can reduce the likelihood of frictional ignitions by cooling the cutting bits and/or the surrounding rock surface, and by pushing methane away from the cutting surface of the bits.

The shearer drums on the 1 North Longwall Panel were equipped with a pick-point water spray flushing system, which uses nozzles mounted in the bit blocks or in blocks immediately in front of the bits to direct water at the bit-coal interface (Figure 30). This wets the coal prior to cutting (it also functions to suppress dust that would be discharged into the mine atmosphere).

MSHA D4 approved the Ventilation Plan for the MMU 050-0 (longwall mining unit) on June 15, 2009. The plan stipulated that water must be applied to the longwall shearer, the stage loader area, and the shield canopy tips during active operations. A fourth stipulation required shield washing on a weekly basis in order to prevent accumulations of coal dust. Information relating to the stage loader area and the shields can be found in the “Other Plans” Section below. The plan required that 109 functioning Conflow 650 2801 CC Staplelock drum sprays (full cone type) on the longwall shearer. A minimum operating pressure of 90 psi was required at the spray block. At the 90 psi pressure each spray would have a flow rate of approximately 0.82 gallons per minute (gpm) or a total flow rate of 89 gpm at the shearer. The plan required each shearer drum to have

43 sprays. In addition each ranging arm had to have three sprays. two body spray (sawtooth) blocks, with two sprays on the first block and six sprays on the second block, and one rack spray on the tailgate side.

River water supplied the shearer methane and dust control water system. PCC pumped this water into two 100,000 gallon holding tanks on the surface, above the Silo Portal. PCC then routed the water through the mine, utilizing a 6 to 8-inch diameter waterline to the mule train of the longwall section. Appendix R shows the location of the waterline supplying the mule train. A 4-inch diameter flexible hose was connected to the 6-inch water line that connected to four Rosedale strainers. PCC boosted the water supply through a Sunflo P3000 pump, located on the mule train. There were two 2-inch diameter flexible hoses extended inby from the pump to the stageloader area, where the lines split to supply water to the shearer, conveyor couplings, motor cooling water, and shield water. PCC supplied the shearer via 1,200 feet of 2-inch diameter flexible hose, connected from a valve bank between the stageloader and headgate box.

There were at least four different types of sprays on the shearer, which resulted in three different spray patterns. There were three types on the drums and ranging arms, and at least nine different models of water sprays, representing three different water spray patterns and eight different flow rates in the longwall supply area. Several sprays on the shearer showed signs of excessive wear, and at least three from the tailgate side of the shearer showed signs of being mechanically altered by enlarging the outlet orifice.

MSHA investigators set up a test, with PCC's assistance, to recreate the functioning water system on the longwall shearer at the time of the explosion. Because of damage to the waterlines in the explosion zone and the need for electrical power on the longwall, investigators could not use the original water system for testing purposes. A pressure gauge was utilized at the inlet side of the filter assembly; gauges were placed across each filter assembly to provide an indication of when the filters needed to be changed, and a pressure gauge was placed at the shearer inlet. Two flow meters were used to verify water flow to the shearer.

In preparation for the water test at the shearer on December 20, 2010, PCC provided MSHA with the water spray configuration used on the longwall at the time of the explosion. The distribution of nozzle locations indicated that 112 Flow Technologies 791C sprays, with a 3/32" orifice diameter, were being used on the longwall shearer, with 43 each on the headgate and tailgate drums of the shearer, ten on the headgate and tailgate ranging arms, and three on one block, located on both the headgate and tailgate sides. A total of 27 BD-5 sprays were used on the shearer, with ten each on the second body block of both the headgate and tailgate sides, three pan sprays on the headgate and tailgate sides of the shearer, and one rack spray on the tailgate side of shearer. PCC investigators reported that the average operating pressure at the sprays was 125 psi, and that the flow rate for the 791C (3/32") sprays at this operating pressure was 1.58 gpm, with a 1.76 gpm flow rate for a BD-5 sprays at the given pressure. PCC reported that their average flow was 224.30 gpm. PCC contends that they used sprays that exceeded methane and dust control plan requirements.

When MSHA investigators restored water to the shearer to test the water sprays, they found a different configuration than described in the plan or by PCC investigators. MSHA discovered that seven sprays were missing from the tail drum of the longwall shearer. Testing on December 20, 2010 revealed that, when seven sprays were missing, the remaining sprays on the tail drum could not maintain the pressure that was required in the approved ventilation plan. In fact, the water gauge on the tailgate drum read 0 psi throughout the test. The majority of the water on the tailgate drum simply discharged out of the openings on the bottom half of the drum where water sprays had been removed. When six of the seven missing sprays were replaced, operable pressure as required by the approved plan was restored to the tail drum once the pressure coming into the shearer reached approximately 186 psi. On April 5, the removal of seven sprays similarly would have caused the water pressure to be removed from the remaining sprays.

The water sprays were most likely missing from the tail drum at the time of the explosion. MSHA determined that it is highly unlikely that the explosion forces were responsible for displacing the sprays because of the design of the sprays (which are attached by staple locks) and because of the magnitude and direction of the forces. Instead, the most likely explanation is that PCC employees had removed the water sprays sometime prior to the ignition at the shearer in order to flush the tail drum.

PCC experienced clogging problems with water sprays due to the use of poorly filtered river water. This is evident in PCC records, as shown in Figure 5. Mine personnel removed sprays in an attempt to flush out the drum, as confirmed by company records and in interviews.

More detailed information concerning the Methane/Dust Suppression plan, and the water spray configuration in particular, may be found in the section, “Other PCC Plans.”

<u>Analysis of Sediment in Filter Baskets and Spray Nozzles</u>

The results of sediment analyses, documented in Appendix S, indicate that the longwall shearer’s tailgate drum was being operated with missing water sprays. Measurements of the size and type of sediment found in water line filters and shearer nozzles reveal that rock chips were falling out of the roof into open nozzle ports as the drum was cutting. These rock chips were too large and angular to have come from the river water supply or even passed through filters in the water line. A cement-like paste that clogged the insides of many spray nozzles was composed of clay and coal, generated from pulverizing rock with dull bits. This paste was in place prior to the introduction of rust-stained water during testing after the accident. Thus, the tailgate drum was being operated with dull bits while cutting hard sandstone, with missing and clogged water sprays.

Other Ignition Sources

MSHA also addressed several other potential ignition sources, either ruling them out conclusively or finding that they were much less likely to be sources than frictional ignition from the longwall shearer.

Roof Falls (Frictional Ignition)

Some explosions have been attributed to roof falls. MSHA could not rule this ignition source out since roof falls inby the longwall face could have occurred immediately before the explosion in either the longwall tailgate or behind the tailgate shields. The 1997 explosion at this mine on the longwall tailgate was attributed to a roof fall. Roof falls can ignite explosive methane-air mixtures by heat and releasing energy. During roof falls, rocks rub against each other and produce heat. Explosive methane-air mixtures have been ignited by rubbing friction between shale-sandstone, sandstone-metal, and shale-metal in Bureau of Mines laboratory tests. However, this frictional heat rarely reaches temperatures that will ignite methane in an underground coal mine.

In addition, this mine had sandstone bed(s) in the roof which contain quartz crystals. Crystals in rocks may produce electric charges on parts of their surface when they are compressed in certain directions. The release of this energy during roof falls is called a piezoelectric discharge. The greater the quartz content, crystal size and bond strength, the greater the potential for incendiary sparks which can ignite methane.

However, because of the deficiencies found with the tailgate shearer drum it is most likely that the ignition was caused by the shearer cutting sandstone rather than a roof fall behind the shields.

Pan Line (Frictional Ignition)

Frictional ignitions from pan lines have been documented. However, these have occurred much less frequently than ignitions from shearers. The pan line conveyor represents a much less likely source of ignition than the longwall shearer.

MSHA believes that it is much more likely that the poorly maintained longwall shearer cutting sandstone and repeatedly generating hot streaks provided the ignition source.

Smoking Articles

Smoking articles, which would have provided a potential ignition source, were not discovered in the underground portions of the mine during the investigation.

Electrical Ignition Sources

MSHA eliminated the following electrical ignition sources (see Appendix T - original report section - for a complete discussion of these eliminated electrical ignition sources):

An Executive Summary of all electrical equipment tested at MSHA's Approval and Certification Center can be found in Appendices U-1 through U-15.

Lightning - Vaisala's National Lightning Detection Network showed no lightning strikes within a ten mile radius of the mine site between 10:09:42 a.m. and 7:07:02 p.m. (See Vaisala Report 258028 in Appendix V).

Welding and Cutting - There was no evidence of welding or cutting being performed at the time of the explosion, and no cutting equipment was found in the area of the longwall face.

Shearer Electrical Components - The electrical components on the shearer included explosion-proof enclosures (motors, main controller enclosure, shearer power cable connection enclosure, and solenoid valve enclosure), a methane monitoring system with warning light enclosure, various intrinsically safe circuits, components and sensors, and all associated cables. MSHA examined these components and performed tests and found no evidence that any of the components were the ignition source.

Shearer Remote Control Transmitter - Shearer functions were controlled by two operators with handheld radio remote transmitters (Appendix U-1), designated by the JNA control system as left- and right-hand stations. The right-hand transmitter was a Matric Limited, Model TX1, Remote Control Transmitter, MSHA Approval No. 9B-220-0, and was found at shield 100. After testing was conducted at the manufacturer's facility and at A&CC, MSHA found no evidence that the right-hand transmitter could have been the ignition source. The left-hand remote control transmitter was never found, but there was no indication that it was not functioning properly. The last record on the JNA event log prior to the explosion showed that the right-hand transmitter caused the shearer to stop.

Automatic Chain Tensioning System - A Joy Automatic Chain Tensioning System (ACTS) was installed at the tailgate area of the face to automatically control the face conveyor chain tension. The ACTS components included: an explosion-proof controller enclosure, a connection enclosure for the intrinsically safe circuits (referred to as a "marshalling box"), and various intrinsically safe transducers, sensors, display beacon, and solenoids. MSHA examined this system and performed tests of these components and found no evidence that any of the components were the ignition source.

Tail Conveyor Drive Motor - MSHA examined and performed testing of the motor and found no evidence that it was the ignition source.

Electrical Cables along the Longwall Face - Electrical cables along the longwall face were located either in the cable handling system of the panline or hung along the longwall shields. MSHA examined and performed tests of the cables and found no evidence that any of the components were the ignition source.

Lighting System Components - MSHA examined these components and performed tests of these components and found no evidence that any of the components were the ignition source. (See Appendix U-2)

Electrohydraulic Shield System - The Joy MS40 electrohydraulic system, consisting of a Master Supply Unit (MSU) and a Support Control Centre (SCC) at the headgate, controlled the movement of the shields. This system also included various other components (Appendix U-3). MSHA examined and performed tests of these components and found no evidence that any of the components were the ignition source.

Comtrol Communication System - The Comtrol longwall face communication/conveyor lock-out system consisted of Longwall Loudmouth Model LM115 phones positioned at the headgate area and typically, every eighth shield. Investigators noted that some phones were not in their original positions (i.e. mounted on shields). The phone at shield 173, the last in the system, was missing, as was the phone at shield 117. At least four phones were missing on the headgate side of the longwall. Electrical investigators that have traveled the face area did not observe any components or cables that showed signs of being an electrical ignition source. MSHA examined and performed tests of the Comtrol system and found no evidence that any of the components were the ignition source. (See Appendix U-4)

Multi-Gas Detector - A MSA Solaris multi-gas detector (Exhibit No. B-15-B), carried by Richard Lane, Longwall Section Foreman, was retrieved from mid-face for examination and testing at A&CC. Testing determined that it was in working order. Downloaded data indicated that the device was energized at the time of the explosion and continued operating for several hours thereafter. MSHA tested the detector and found no evidence that the detector was the ignition source. (See Appendix U-5)

Tracking Tags - MSHA tested all of the tracking tags that belonged to victims on the longwall face and found no evidence that any of the tags were the ignition source. (See Appendix U-6)

Cap Lamps - Many intact cap lamps and components were retrieved. 33 individual items were subjected to further examination and testing at A&CC (Appendix U-7). MSHA examined and performed tests of these cap lamps and found no evidence that any of the cap lamps were the ignition source.

Air-Purifying Helmet Components - UBB's Methane and Dust Control Plan provided that all members in the face would be offered the use of Air Stream helmets, but required examiners to use respirators on the return side of the longwall shearer for an extended period of time. On April 5, miners on the longwall panel were using these helmets. Seven components from the air purifying helmets including four batteries, a portion of a battery case, and pieces of the helmet and cable were retrieved for further examination and testing at A&CC (Appendix U-8). MSHA examined and performed tests of these components and found no evidence that any of the components were the ignition source.

Watches and Calculators - Several non-permissible electrical items, including six watches and two calculators, were recovered from the longwall face and subjected to examination at A&CC. These items were all disassembled and inspected (Appendix U-9). MSHA examined all of these items and found no evidence that any of the items were the ignition source.

Methane Monitor Sensors - Two permissible methane monitor sensors were retrieved from the longwall tailgate area and sent to A&CC for analysis and testing. MSHA examined and performed tests of these components and found no evidence that any of the components were the ignition source. (See Appendix U-10)

The Ignition on the Longwall Shearer

For a description of the Mine Electrical System at UBB see Appendix W.

The information in this section describes the events that took place immediately after the tailgate shearer drum ignited a localized methane mixture when the shearer cut into the tailgate entry. These activities indicate that there was a short period of time between this ignition and when the flames from this ignition encountered a larger body of methane resulting in a methane explosion which ultimately suspended float coal dust in the tailgate entries and transitioned into a massive coal dust explosion.

<u>The Longwall Crew Stopped the Shearer and Left the Area</u>

At about 3:00 p.m. on April 5, the tail shearer operator shut off the shearer using his remote control, and the longwall crew working near the shearer started moving away from the shearer toward the headgate. A longwall crew member, who was on the headgate side of the longwall, then opened the visible disconnect de-energizing the power to the longwall shearer and shut off the water to the longwall face. About 3:02 p.m., the explosion propagated through the northern part of the mine, killing the 29 miners, including the longwall crew, and injuring two on the TG 22 crew.

Investigation interviews with longwall crews from different shifts and underground observations indicate that the longwall crew's actions at approximately 3:00 p.m. were atypical. The condition of the longwall shearer after the accident, with the shearer turned off by remote, the visible disconnect switch open, and the water shut off at the headgate, demonstrates that the longwall crew was reacting to an event at the shearer. In addition, during this two-minute gap, the ignition made its way back to an accumulation of methane in the tailgate entries inby the longwall face, where it caused a localized methane explosion.

The Tail Shearer Operator Remotely Shut Off the Shearer

Investigators removed the JNA computer control system from the shearer and took it to Joy Mining Machinery's facility in Franklin, PA, where the electronically recorded event log was examined. Evaluation of the event log revealed that the shearer was shut off by an e-stop command from the handheld remote control of the tail shearer operator between 2:59:32 and 2:59:38 p.m. (Appendix X-JNA Event Log and Fault Codes). Analysis of additional items removed from the mine indicated that power in the mine was lost at approximately 3:02 p.m. (Appendix Y-DVR Evaluation Report), from damage inflicted upon the high voltage cables by the explosive forces.

The shearer's on-board controls were set to the position that required both operators to be at the machine for it to run. MSHA concluded that both operators were at the shearer when the tail side operator shut off the shearer between 2:59:32 and 2:59:38 p.m. with an e-stop command from the handheld remote control. Four victims, the two shearer operators, the jack setter, and the utility man, were found between shields 103 and 106, approximately 400 feet from the shearer toward the headgate.

The Longwall Crew Manually Opened the Visible Disconnect Switch

The power cable extending from the longwall starter to the shearer was provided with a manually operated visible disconnect switch installed in an explosion-proof enclosure just outby the headgate controller. After the accident, investigators found the disconnect switch in the open and grounded position. With the switch in the open and grounded position, power was not being provided to the shearer. This disconnect had to be in the closed position for the shearer to operate.

The handle that operated the disconnect switch was located on the exterior of the explosion-proof enclosure. A mechanical push-button rod prevented the handle from being operated when the disconnect was closed. In order to rotate the handle and open the disconnect switch, this push-button had to be depressed and held. Depressing the push-button also opened an electrical interlock switch inside the enclosure that caused the 4,160 Vac vacuum contactor in the longwall starter to open thereby de-energizing the shearer cable. When tested during the investigation, the mechanical and electrical components of the disconnect switch functioned properly.

The explosion covered the longwall equipment, including the visible disconnect, in a layer of dust. This residue on the push-button and handle of the shearer disconnect switch was undisturbed, indicating that the disconnect had not been operated after the explosion.

Given that the visible disconnect was found open, indicating that the shearer was de-energized, and that the visible disconnect had not been disturbed after the explosion, MSHA determined that the forces generated by the explosion did not cause the shearer disconnect switch to open. MSHA also determined that a longwall crew member, who was on the headgate side of the longwall, manually opened the shearer visible disconnect switch during the period of time between the shearer being shut off with the remote control and the coal dust explosion.

MSHA eliminated other possibilities before arriving at these determinations. A possible reason given in testimony for opening the visible disconnect switch was to set bits on the shearer. The tail drum of the shearer had just cut out of the coal block into the tailgate entry at shield 176. The tail drum was still against the roof and had not been lowered to cut out the mine floor. The head drum was against the bottom, with the cowl blade positioned on the headgate side of the drum. Neither drum was located such that bits could be set. Therefore, setting bits was ruled out as the reason for the visible disconnect switch to be open. Additionally, repair to a damaged shearer cable was ruled out as the reason for the visible disconnect switch being open as testing proved that the cable was not damaged.

The Water Was Shut Off at the Headgate

The cooling and dust suppression water for the shearer was controlled at the headgate end of the face. There was no water shutoff valve installed onboard the shearer. Two 2-inch water lines from the pump car at the mule train entered a manifold near the headgate controller. Each line had a ball valve installed on it before it entered the manifold. Both water lines' valves were found in the closed position. The valves and manifold were covered in a layer of undisturbed, explosion-related dust, indicating the valves were turned off prior to the explosion. In the closed position, these valves are consistent with the shearer and face conveyor being off. Several miners stated during interviews that during normal operations, when the face conveyor shut down, it was standard practice to close these valves to shut off the water.

The Longwall Crew Working Near the Shearer Left the Shearer Because of an Abnormal Event

The investigators concluded that the most likely reason the four victims evacuated the area of the shearer was because they saw or heard an abnormal event and could not control it. In this case, the abnormal event was most likely the initial methane ignition on the tail drum of the shearer.

MSHA eliminated other possibilities before arriving at this conclusion. Testimony indicated that one reason for these employees to leave the shearer was because of shift change. The day shift and evening shift crews normally "hot seated," meaning that the day shift crew stayed on the face until the evening shift crew arrived on the section. At the time of the explosion, the evening shift longwall crew was boarding a mantrip at the Ellis Portal for travel into the mine. Because it was not time for the day shift crew to leave the face, investigators ruled out shift change as the reason for leaving the shearer.

Another reason personnel might have left the shearer was because of a mechanical or electrical breakdown. An analysis of event logs stored electronically on the shearer and at the longwall starter did not indicate any electrical faults in the shearer circuits. Therefore, investigators ruled out an electrical problem. Because no obvious mechanical failures were observed when the shearer was inspected, investigators also ruled out a mechanical breakdown.

To address the possibility that personnel could have left the tailgate because of encountering methane, investigators removed the methane monitor components on the longwall shearer, the methane sensor near the tailgate end of the face, and the methane monitor components in the headgate controller for testing at MSHA's Approval and Certification Center (Appendix U-10). The two methane monitor systems functioned properly. The shearer's JNA event log listed no methane monitor faults on the shearer for the period covered in the log, from March 30, 2010, to the time of the explosion. An analysis of the stored data on Programmable Logic Controls (PLCs) in the headgate controller (PLC Appendix U-15) and the longwall starter did not indicate that the tailgate methane monitor shut down the longwall prior to the explosion.

After the ignition occurred at the shearer, a fire likely followed small accumulations of methane and burned behind the shields. The flame from this fire eventually came into contact with the accumulation of methane in the # 7 entry of TG 1 North inby the longwall. MSHA estimated that the explosive accumulation of methane that was ignited contained approximately 300 cubic feet of methane. Research has shown that the ignition of as little as 13 cubic feet of methane is sufficient to suspend and ignite coal dust. When diluted with air to 10 percent, this 300 cubic feet of methane would form an explosive volume of 3,000 cubic feet. It is feasible that two minutes passed during this burning process. The flame generated by the ignition of this 3,000 cubic feet of methane-air mixture extended approximately 140 feet (15,000 cubic feet) to just outby the stopping in crosscut 48.

The Localized Methane Explosion Transitioned into a Coal Dust Explosion, Caused by Dangerous Coal Accumulations and Inadequate Rock Dusting

The methane explosion on the tailgate, discussed in the previous section, almost instantaneously gave rise to a massive coal dust explosion which swept through the mine.

The initial flame extended in the tailgate from just inby the longwall face, to just outby the stopping in crosscut 48. The flame and force of the localized methane explosion suspended and ignited coal dust prior to the flame from the localized methane explosion being extinguished. If float coal dust had not accumulated and the mine dust had contained sufficient quantities of incombustible content, the localized methane explosion would not have propagated any further. However, float coal dust accumulated and the incombustible content of the mine dust was insufficient and as a result, coal dust was ignited. The incombustible content of the mine dust is discussed in the subsection “Mine Dust Survey” earlier in the report. Once the coal dust was ignited, the flame generated a shock wave that placed additional mine dust into suspension.

The mine dust sampling provides evidence of the extent of the flame and indicates where coking was present. Coal dust and float coal dust provided the fuel for the propagation of the explosion. Extensive sampling and analysis by MSHA, substantiated by witness testimony and company documents, revealed that rock dusting was inadequate.

Coking in Mine Dust and Visual Observation Led Investigators to Determine the Path of the Flame

<u>Flame Travel</u>

Flame is produced during an explosion when an ignition source of sufficient temperature or energy ignites a suspended fuel within its explosive range. Immediately after ignition, a fireball typically develops and rapidly begins heating the mine atmosphere. Within seconds, a flame front begins propagating through the suspended fuel. The propagating flame continues to heat the mine atmosphere, resulting in a rapid expansion of the mine atmosphere. The expansion of the mine atmosphere creates a force, known as a shock wave, which continues to travel ahead of the flame.

The magnitude of the shock wave is typically determined by the speed of the propagating flame. The faster the flame travels, the higher the pressures from the shock wave become. Flame speeds as high as 5,000 feet per second have been measured in experimental explosions. The flame of an explosion will continue to propagate as long as there is sufficient fuel, heat, and oxygen. In addition, the fuel must remain suspended and the explosion must remain confined. If any of these five conditions is lost, then the flame of the explosion will extinguish. For example, if confinement is lost, the air speed will begin to decelerate. A coal dust explosion will generally die out if the air speed is less than 150 feet per second.

Additionally, the explosion flame and shock wave generally result in overpressures which cause the destruction of mine ventilation controls and damage to mining equipment, the suspension of mine dust from the roof, ribs, and floor, and the formation of various products of combustion such as carbon monoxide, carbon dioxide, hydrogen, etc.

MSHA determined the extent of flame travel primarily through an evaluation of the samples taken during a post-explosion mine dust survey. MSHA also evaluated additional evidence including observations of the post-explosion condition of various combustible materials, the results of testing additional samples of mine dust, and a review of the autopsy results, (Appendix Z).

MSHA divided the underground workings into 22 separate sampling areas, as shown on the mine map in Appendix L. Sampling locations, on 500-foot centers in areas outby crosscut 67 of Old North Mains and 100-foot centers in areas inby crosscut 67, were designated on a mine map for each area. Sampling on 100-foot centers has been shown to offset any dust transport that may have occurred during an explosion. MSHA determined that the force of the explosion in outby areas was minimal and that dust transport was negligible.

MSHA identified 2,207 locations for band sampling. A band sample is taken around the entire perimeter of any point location, including the roof, both ribs, and the floor. If an area was too wet or inaccessible due to hazardous conditions, MSHA did not take a sample. Of the 2,207 intended locations, MSHA took samples at 1,803 locations because actual mine conditions at 404 locations were either too wet or otherwise inaccessible for sampling. MSHA did not take samples from any previously wet locations in the event that significant drying occurred prior to the end of the underground investigation.

MSHA took band samples at 1,132 of the 1,803 locations, or 62.8 percent of all sampled locations. In areas where an entire band was not possible to collect, MSHA sampled as much of the band as was possible. For example, if the floor was too wet, MSHA still took a sample from the roof and ribs. MSHA marked each sample to indicate what portion of a complete band was taken.

Whenever MSHA took a full mine dust band sample, MSHA mixed and separated the sample into quarters, each of which was representative of the mine dust at that location. MSHA placed one quarter in a sealed plastic bag with a tag identifying the sampling location. MSHA offered each of the other three quarters of the sample to representatives from WVOMHST, UMWA, and Massey traveling with MSHA's Mine Dust Sampling team.

MSHA sent all 1,803 samples to MSHA's Mount Hope National Air and Dust Laboratory (Mount Hope), which determined the incombustible content and degree of coking. The incombustible content provides an indication of the pre-explosion conditions in the affected area of the mine, while the coking indicates the area affected by the flame of the explosion.

Mount Hope subjected each of the 1,803 mine dust samples to the Alcohol Coke Test. This test determines the quantity of coke in each sample. Coking of coal occurs as the coal is subjected to heat for a period of time. The temperature required for coking to commence varies with the rank of coal, but is on the order of 700º F. Flame temperatures during an explosion can be nearly 1800º F, however the flame may only be at each location for approximately 45 milliseconds.

The amount of coking that occurs is related directly to the exposure temperature and the duration of that temperature. When objects are exposed to flame for a sufficient duration of time, heat is transferred and produces coking. However, even within the area affected by the flame, coking of the coal does not occur at all locations.

Research on alcohol coke testing indicates that coke is found whenever coal particles are dispersed into a flame, and therefore the presence of coke is a good indication of flame travel. Coke, as measured by the Alcohol Coke Test, is found after explosions at an incombustible content of up to 80 percent.

The Alcohol Coke Test indicates the quantity of coke in each sample as either none, trace, small, large, or extra-large. Large and extra-large quantities of coke are indicative of flame. The results of the Alcohol Coke Test are shown on the mine map in Appendix Z and in Table 7 for the 1,803 mine dust samples collected. The results of the coke analysis on all mine dust samples showed that 85.5 percent of all mine dust samples taken displayed evidence of coking. The results of the coke analysis on only band samples showed that 86.5 percent displayed evidence of coking.

Table 7. Amount of Coke in Samples taken During Mine Dust Survey

	Intake Entries					Return Entries				
Sampling Area	**None**	**Trace**	**Small**	**Large**	**X-Large**	**None**	**Trace**	**Small**	**Large**	**X-Large**
1	15	0	0	0	0	15	0	0	0	0
2	11	0	0	0	0	-	-	-	-	-
3	15	0	0	0	0	-	-	-	-	-
4	8	0	0	0	0	-	-	-	-	-
5	76	22	15	3	0	15	4	15	5	0
6	96	48	4	0	0	-	-	-	-	-
7	7	43	129	115	3	-	-	-	-	-
8	0	0	4	44	8	-	-	-	-	-
9	0	1	2	116	5	-	-	-	-	-
10	0	0	0	60	53	-	-	-	-	-
11	0	0	4	73	2	0	0	4	18	0
12	0	1	20	8	0	0	3	5	0	0
13	0	0	4	61	17	3	8	6	32	20
14	0	0	3	25	43	-	-	-	-	-
15	0	1	9	16	0	0	1	2	8	0
16	0	3	17	202	5	0	0	0	2	0
17	0	0	1	68	9	0	0	0	55	52
18	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	0	0	1	34	0
20	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-
Total:	228	119	212	791	145	33	16	33	154	72

In addition, MSHA sent 29 mine dust samples to the NIOSH facility in Morgantown, West Virginia for the samples to be placed under a Scanning Electron Microscope to identify presence or lack of coke in each sample. MSHA chose these 29 samples because of their underground locations near the perimeter of the flame zone and because the Alcohol Coke Test indicated large or extra-large quantities of coke in each of the selected samples. The results of the examination proved definitively that coke was present in each of the 29 samples.

MSHA determined that the coal dust explosion began approximately at the intersection of crosscut 48 and entry No. 6 in Tailgate 1 North. Explosion forces were generated by the flame in all directions, including back across the longwall face. Evidence indicates that approximately 14 psi traveled back to the longwall tailgate from the coal dust explosion. Explosion damage indicates that the coal dust explosion initially propagated inby in entries 5 and 6 and outby in entries 5, 6, and 7. Eventually, all entries and crosscuts in Tailgate 1 North from as far inby as crosscut 77 exhibited evidence of flame. The flame traveled inby at about 1,000 feet per second (fps) while generating a pressure exceeding 18 psi. While underground, investigators were unable to take mine dust samples any farther inby in the Tailgate 1 North entries and, consequently, could not determine the extent of flame in those inby entries. However MSHA's Mine Emergency Operations Group lowered a camera into the mine at two inby locations, through borehole BH A, located in the No. 1 entry at 94 crosscut of Headgate 1 North, and also down the Bandytown fan shaft. Observations made with the camera indicated that the flame of the explosion most likely did not propagate to either of these locations. Flame propagated outby from crosscut 48 and involved all entries and crosscuts of Tailgate 1 North, outby to the Old North Mains. The flame also propagated to crosscut 67 in Old North Mains in entries 1, 2, and 3.

The explosion flame traveled outby at the same time as it was traveling inby in the tailgate entries. Flame initially traveled outby in the tailgate entries at about 600 fps, generating a pressure of nearly 6 psi. Several hundred feet before reaching the crossover entries, additional coal dust became involved and flame speeds accelerated to over 1,000 fps in all tailgate entries. As the flame continued outby in the tailgate entries, eventually it propagated to the locations where the tailgate intersects the North Glory Mains. The flame speed dropped dramatically at this intersection due to the additional entries and the increased incombustibles in the mine dust. The flame extinguished in this direction about 11 crosscuts outby the tailgate entries. As the flame propagated outby in the Tailgate 1 North entries, it turned 90º to the left and entered the crossover between Tailgate 1 North and Headgate 1 North. All entries and crosscuts of the crossover were engulfed in flame, including the entries and crosscuts that turn 90º and head towards and into the North Glory Mains entries. Flame propagation did not occur along the length of the North Glory Mains but small pockets of flame extinguished as they projected a short distance into the North Glory Mains.

From the crossover entries, the explosion flame propagated into Headgate 1 North and turned both inby and outby. The outby portion propagated towards and into the North

Glory Mains. The inby portion propagated inby as far as crosscut 32. MSHA was unable to take mine dust samples any further inby in the Headgate 1 North entries and, consequently, could not determine the extent of flame in those inby entries. As flame entered Headgate 1 North, the destructive pressures propagated inby with a flame speed of about 1,200 fps, generating over 20 psi, as indicated by damage to several monorail sections. Although flame did not enter the longwall face, pressures ranging from 7 to 14 psi did travel along the longwall from the headgate.

The flame of the coal dust explosion also traveled toward the face of the TG 22. As the coal dust explosion propagated into TG 22, explosion pressures increased to near 20 psi. Just before entering TG 22, the flame also turned 90º right and entered the crossover entries between TG 22 and HG 22. Initially, the flame resulted in large and extra-large deposits of coke. However, as the flame continued through the crossover entries, coke was not produced. MSHA believes that the flame increased in speed as it continued through these crossover entries. Increased flame speeds decreased the duration of the flame at these locations and coke formation was not possible. This increase in speed could likely be attributed to the increased fineness of the coal dust and the lack of sufficient rock dust through these entries. The flame slowed as it turned into crosscuts. Mine dust samples taken in the crosscuts of the crossover entries included large and extra-large quantities of coke, indicating flame travel.

The flame entered HG 22 at the mouth of the section and turned 90º left and right. The portion of the flame that turned left traveled into HG 22 and propagated to the faces. The flame propagated into HG 22 at speeds approaching 1,500 fps generating a pressure of approximately 25 psi. Additional coal dust caused increases in the flame speed and pressure. Calculations have shown that explosion pressures were on the order of 52 to 65 psi. Pressure piling occurred as the flame and forces continued to push against the dead end of HG 22. This resulted in a reflected overpressure traveling outby that could have reached a maximum pressure of 105 psi. The flame consumed available oxygen in HG 22 and, after reaching the faces, was unable to propagate outby as it extinguished from the lack of oxygen.

The flame that turned right traveled outby to near crosscut 115 in the North Glory Mains, into all entries and crosscuts of the Glory Hole Mains, and turned again and propagated into all entries and crosscuts of the North Jarrells Mains, and all entries and crosscuts in West Jarrells Mains. Pressures throughout these areas averaged about 20 psi with flame speeds of over 1,000 fps. The flame of the explosion extinguishged at the dead ends of West Jarrells mains due to lack of sufficient oxygen for continued propagation.

A mine map showing the direction of the primary explosion forces is contained in Appendix L.

Accumulations of Coal Dust and Float Coal Dust

As noted in the examinations section, MSHA identified extensive and obvious accumulations of coal dust and float coal dust throughout its underground investigation. The coal dust and float coal dust provided the initial fuel for the coal dust explosion. Coal dust and float coal dust along the flame path continued to fuel the explosion.

MSHA sent several teams underground to travel each air course in order to take representative measurements of the accumulations. MSHA's measurements were consistent with their initial determination that the accumulations were extensive and obvious. The accumulations were found consistently along travelways, belt conveyors, intake air courses and return air courses inby crosscut 54. Many of these accumulations were left from the initial mining process. Section roadway spillage, feeder piles, and coal along the ribs was not cleaned up as normal mining continued. In addition, their location and placement indicated that they had pre-dated the explosion, i.e., that the accumulations were not the result of explosion forces. Testimony corroborated the presence of many of these accumulations pre-explosion, especially in the belt entries.

Proximate Analysis and Explosibility of the Coal

The coal at UBB was explosive. In order to verify the explosibility of the coal, MSHA removed separate channel samples from near the headgate and the tailgate of the active longwall. MSHA sent the samples to Standard Laboratories, Inc. in Freeburg, Illinois, which subjected the samples to a Proximate Analysis. The Proximate Analysis determines the moisture, ash, volatile content, and fixed carbon of each sample. The volatile content can be used to identify the rank of the coal. The volatile content and the fixed carbon can be used to calculate the volatile ratio of the coal. The moisture and ash can be used to determine the amount of rock dust necessary to reach incombustible contents of 65 percent and 80 percent. In addition, the British thermal units (Btu) and sulfur contents of each sample were determined.

The results of Proximate Analysis testing on the as-received sample from the headgate revealed the following: moisture = 1.77%, ash = 7.98%, volatile content = 32.77%, and fixed carbon = 57.48%. The headgate sample had a Btu content of 13,890 and a sulfur content of 0.83%. The results of Proximate Analysis testing on the as-received sample from the tailgate revealed the following: moisture = 2.23%, ash = 6.82%, volatile content = 32.81%, and fixed carbon = 58.13%. The tailgate sample had a Btu content of 14,010 and a sulfur content of 0.88%. The results of the Proximate Analysis identify this coal as a high volatile bituminous coal which is highly explosive. The results of testing are contained in Appendix AA.

The volatile ratio of the coal is a value independent of any inherent or added incombustible. The volatile ratio is calculated by dividing the volatile content of the coal by the summation of the volatile content and the fixed carbon. Any coal with a volatile ratio of 0.12 or less is defined as an anthracite coal and is not explosive. It has been established that all U. S. coals having a volatile ratio in excess of 0.12 are considered to present an explosion hazard. Bituminous coal is defined as any coal with a volatile ratio greater than 0.12. Bituminous coal is subject to all the requirements of the § 75.400, including the incombustibility requirements contained in § 75.403. The volatile ratio of the headgate sample was calculated to be 0.36 and the volatile ratio of the tailgate sample was calculated to be 0.36.

Rock Dusting

The use of rock dust to limit explosions in underground coal mines was pioneered by the U.S. Bureau of Mines in the 1920's. Rock dust in coal mines is defined in 30 CFR Subpart A, § 75.2 as follows:

> Pulverized limestone, dolomite, gypsum, anhydrite, shale, adobe, or other inert material, preferably light colored, 100 percent of which will pass through a sieve having 20 meshes per linear inch and 70 percent or more of which will pass through a sieve having 200 meshes per linear inch; the particles of which when wetted and dried will not cohere to form a cake, which will not be dispersed into separate particles by a light blast of air; and which does not contain more than 5 percent combustible matter or more than a total of 4 percent free and combined silica (SiO_2), or, where the Secretary finds that such silica concentrations are not available, which does not contain more than 5 percent of free and combined silica.

This definition has been in place for decades and was the requirement for rock dust composition on April 5, 2010.

The initial research supporting the rock dust particle size effects on coal dust explosion propagation was performed in 1933 and reported in Bureau of Mines Bulletin 369. Rock dust, an inert material, is intended to prevent explosions. The mechanism by which this is accomplished is that, when dispersed in sufficient quantities, inert material will quench explosion flame, partly through absorption of heat and radiant energy, and partly by hindering diffusion of oxygen and gases into and from the burning coal particles. The effectiveness of an inert dust in inhibiting ignition or explosion of a combustible dust increases with decrease in particle size of the inert dust. As a result, a lesser percentage of fine inert dust is required than for coarse inert dust. Small-scale laboratory tests, conducted by NIOSH, showed that the larger the rock dust particle size, the more rock dust is required to inert and prevent a coal dust explosion from propagating. It has been shown in various small chamber tests that by reducing the size of the rock dust particles, the surface area of the rock dust increases and promotes greater radiant heat absorption, thereby improving the prevention of underground coal dust explosions.

At UBB, four methods were used to apply rock dust: hand dusting, a scoop-mounted slinger duster, a rail-mounted duster, and trickle dusters.

Hand dusting from 40-pound bags was used for the initial application of rock dust during advance on continuous miner sections, and was also used for some supplemental applications. Scoop-mounted slinger dusters, using bulk bags and 40-pound bags, were used for supplemental dust applications. A rail-mounted duster was used inconsistently to dust the track and belt entries in the outby areas of the mine. The dual pod, rail-mounted duster had a capacity of approximately 1.6 tons of bulk rock dust. Trickle dusters, which had capacities of 200-280 pounds of rock dust, were used at some belt transfer points. Bulk rock dust was stored in two bins near the UBB Portals.

Miners stated that areas were not well dusted, areas were dark, and the only areas that were regularly dusted were track and belt entries. An examiner stated that the crossover between HG 22 and TG 22 was never dusted. The scoop-mounted slinger duster on HG 22 was found 18 crosscuts outby the face in the return entry. Other miners described the color underground as gray to black. In addition, several witnesses said that the tailgate of the longwall needed rock dusting. There is no evidence or testimony from the interviews to indicate that any additional rock dust was applied in the longwall tailgate after the longwall started retreating. Few had been trained on what adequate rock dust quantities should be. Finally, PCC never sampled its' mine to determine compliance with the rock dust regulations.

At UBB, a rail-mounted duster was used to dust the track and belt entries. Hoses were used to convey the rock dust to the belt entries. Because the longwall and development sections were approximately 5 miles from the bulk rock dust bins at the UBB Portals, the time to get a load of rock dust and transport it into the active mining areas limited the bulk duster to approximately one trip per night. Simply moving one of the bulk rock dust bins to the Ellis Portal would have decreased the time to reload the rail-mounted duster. Installing a rock dust borehole near the active production sections switch would have further reduced the reload time for the rail-mounted duster. A single rock dust crew, consisting of a motor operator and a helper, was responsible for bulk dusting the track and belts of the entire mine. The crew of the rail-mounted duster would often perform other outby work, including setting timbers, building stoppings, or supplying a section.

The rock dust equipment frequently failed. The rail-mounted duster was over 20 years old, hoses frequently clogged and multiple breakdowns took days or weeks to complete. The hoot owl crew was often without the duster altogether or spent hours trying to unclog hoses to keep dusting during their shift. The crew also had limited time to dust assigned areas of the mine, often only completing about 10 breaks of area, about 1000 feet, in a mine covering more than 7 miles. The crew and the rail-mounted duster had to be off the track and outside before the day shift production crew arrived. The complications with equipment maintenance, the distance to travel to load and unload the duster, and the time limits on use of the track often left only three hours for the dust crew to apply dust. A notebook kept by the crew (Appendix AB) summed up problems with an entry two weeks prior to the explosion: "No ride. No help. No spotter… I'm set up to fail here."

A UBB miner testified:

> We never rock dusted. I mean, very seldom…I growed up in a Massey affiliated mine and I thought it was like that everywhere. I mean, until you can see a difference, you don't have something to compare it to…

Despite the evidence that some miners were unaware of what a properly rock-dusted mine looked like, other miners were aware and were concerned about the lack of rock dust. Included in the latter group were examiners who repeatedly reported the lack of dust on reports up to the time of the explosion. The belt examination that was phoned out of UBB immediately prior to the explosion showed that eight of ten conveyor belts that were examined required rock dusting (Appendix AC). Belt examination reports for March 15, 2010 through the time of the explosion show that belts requiring rock dusting were listed 443 times but rock dust was shown as being applied only 58 times (Appendix AD).

The belt examiners' report for March, 2010 showed consistent, hazardous conditions concerning belts that required additional rock dusting. Some belts showed as high as 90 consecutive shifts when the examiner reported additional dust was needed. From December 28, 2009 to April 5, 2010, 291 belt exams were recorded for the longwall belt. On ten occasions, the record indicated "Idle belts," leaving 281 examination records. Of these recorded examinations, 96 percent (270) had a hazard recorded. Of the 281 recorded examinations, 86 percent (244) indicated that the belt entry needed at least spot dusting.

Rock dust purchase orders, provided by PCC as Bates Stamped documents PCC-MSHA 00060740 to 00060846 and PCC-MSHA 00068810 to 00069433, show that between October 26, 2009 and March 8, 2010, no bulk dust was purchased at this mine, even though production increased at this time. In September, 2009 and October, 2009, 648 tons of rock dust was purchased. During the following four months, a total of only 520 tons was purchased. In March, 2010, there was a slight increase in the amount of dust purchased.

In the course of its investigation of the accident, MSHA sampled rock dust from three separate bags of rock dust located at UBB. The tests determined that this rock dust was not compliant with 30 CFR 50.2, which requires that 70 percent of the rock dust particles must pass through a 200-mesh sieve. A few of these rock dust samples fell significantly short of the 70 percent requirement. MSHA is investigating whether the manner of storing the rock dust affects its quality. MSHA subsequently tested other samples obtained directly from the manufacturer of the rock dust, the Limestone Dust Corporation of Bluefield, Virginia. Some of these samples were compliant with 30 CFR 50.2; others were marginally below the 70 percent requirement for a 200-mesh sieve, although not to the degree noted in the rock dust sampled from UBB.

It is MSHA's conclusion that the non-compliant nature of the rock dust did not contribute to the explosion at UBB. Based on MSHA's investigation, MSHA determined that there was almost no rock dust in the tailgate entry of the longwall. Had there been rockdust present in sufficient quantities in this area, MSHA believes that the methane explosion would not have propagated into the resulting coal dust explosion.

OTHER PCC PLANS

Mine operators, including PCC, are required to develop and follow various plans in accordance with the MINER Act and applicable standards to ensure the safety and health of the miners. Those include ventilation, roof control, and emergency response – which covers communications and tracking. Additionally, PCC met the criteria to require compliance with atmospheric monitoring system standards. Plans must address the conditions and mining methods at a specific mine to protect the health and safety of the miners.

Ventilation Plan

The Approved Plan in Effect April 5, 2010

In addition to the information provided above, the approved ventilation plan included four general statements; three of which address maintenance and examination of the bleeder system:

- The roof in the bleeder entries and at the bleeder evaluation points shall be supported in accordance with the approved roof control plan.
- Accumulations of water will be controlled primarily by natural drainage supplemented by pumping to prevent accumulations of water from affecting the bleeder ventilation system.
- The effectiveness of the bleeder system shall be determined by the methane and oxygen content, the direction of airflow, and quantity at the bleeder evaluation points located as shown typically on the drawings or as previously approved on the mine ventilation map submitted under 30 CFR § 75.372.

The fourth statement addresses the installation of mechanized mining equipment:

- During installation and removal of mechanized equipment, 9,000 cfm will be maintained at the last open crosscut of the section being set up or abandoned and at the intake end of a pillar line. Ventilation controls will consist of permanent stoppings, check curtains and brattice material, as necessary, to maintain the required ventilating current. The system of installing controls will be similar to those on face sketches.

These statements show PCC's knowledge and recognition of unique conditions and issues to be addressed at UBB.

Five regulatory compliance statements are contained in the ventilation plan:

- § 75.371(g),(m) – Volume of air required in last open crosscut – Permanent stoppings will be maintained up to, but not including, the third connecting crosscut outby the working face. In order to insure that adequate ventilation is maintained, a minimum of 13,500 cfm in the last open crosscut will be provided when the last open crosscut is three crosscuts inby the permanent stopping. A minimum of 9,000 cfm will be maintained with one or two open crosscuts.
- § 75.371(x) – A description of the bleeder system to be used, including its design (see § 75.334) – Blowing ventilation with outcrop punch-outs or ventilation holes and cut-throughs into mains on the back end of panels or rooms is proposed for the bleeder system evaluation for this mine. Typical bleeder designs are attached [in the plan]. Existing bleeder systems are shown on the § 75.372 mine ventilation map.
- § 75.371(z) – Weekly examinations – Non-Pillared, Worked Out Areas – In addition to the requirements of § 75.364(a)(1), measurements of methane, oxygen, air quantity, and air direction will be made in the last open crosscut or in the immediate return outby the last permanent stopping in each panel or mains.
- § 75.371(hh) – Ambient Level of Carbon Monoxide – The ambient level of carbon monoxide in all areas where carbon monoxide sensors are installed is 0 ppm. This ambient level is determined using a handheld, calibrated CO detector. Current settings are 5 ppm and 10 ppm, respectively, for alert and alarm levels. CO monitors will be spaced at maximum 2,000 foot spacing.
- § 75.371(uu), (vv), and (ww) – Diesel Equipment – At this time, there is no diesel equipment in service at this mine.

The plan further stipulates how belt air will be monitored as it is fed through a regulator:

1. Belt Air – Where intake air is regulated into the belt, it will have a CO monitor upwind on the intake side and another one will be installed both inby and outby in the belt air course. The regulator feeding the air from the intake into the belt air course will have the capability of being adjusted remotely from outby the regulator in the intake and also outby in the belt air course. This is considered point feed. At this time, there is no point feed in the mine. A revision will be submitted and approved before adding a point feed.

Recent Revisions to the Approved Ventilation Plan and Map

From September 11, 2009 until April 5, 2010, UBB submitted 38 revisions (referred to by UBB as addendums) to the ventilation plan, of which 18 were approved and two seal completions were acknowledged. There were 13 revisions to the ventilation plan and map that were disapproved, five revisions to the plan and map pending approval and one which was withdrawn. The December 23, 2009 revision described how belt air would be used on the longwall, with the operator stating that within 30 days, a long term plan would be submitted to show how belt air would be coursed outby, away from the longwall while more intake air courses would be opened up. This was submitted after the company was unable to implement the December 18, 2009 approval, referring to a company submission showing the belt air coursing outby, away from the longwall.

Prior to the installation of the Bandytown fan, the Headgate 1 North and Tailgate 1 North development sections were ventilated with the North fan. The ventilation of these sections was reported to be poor, and likely represented the extent of the effectiveness of the North fan. The ventilation history of this area is presented below, based on a review of the approved ventilation changes and other applicable records, beginning with the inception of the longwall section. The longwall dust control plan, approved on June 15, 2009, required "40,000 cfm volume of air intake to longwall," with minimum face velocities of 400 fpm at shield 9 and 250 fpm at shield 160. The dust control plan required 15,000 cfm for the MMU-029 (HG 22) and MMU-040 (TG 22) sections in the last open crosscut.

- Addendum B4-A56, approved August 6, 2009. This was a three-phase plan. Phase 1 concerned the activation of Bandytown fan and development of the north longwall district. The plan proposed a quantity of 300,000 cfm for Bandytown fan. Phase 2 plan concerned the start-up of the 1 North Longwall Panel. The longwall tailgate outby the face was ventilated with belt/track air. This phase also established the measurement points (MP) and evaluation check points (EP) for the longwall. The Panel 2 crossover unit was proposed to be ventilated by a return, directed to the Bandytown shaft and separated from the worked-out longwall area along Headgate 1 North. This unit became HG 22 at a later date. The Panel 1 crossover was ventilated by return air, isolated from the worked-out longwall area, along Tailgate 1 North to Bandytown fan. This return later became the main return for the development sections. The approved plan showed the longwall using belt air. The map included as part of Phase 2 included a 30,000 cfm minimum air quantity for the longwall. This would have superseded the minimum quantity in the dust control plan. Phase 3 depicted projections for developing 2 North (HG 22) and 3 North. The plan also included four typical face ventilation sketches, showing the ventilation of the longwall face and the MP and EP locations.

During an inspection conducted while the plan was being implemented, multiple ventilation citations were issued. Phase 1 had been completed with the activation of the Bandytown fan. On September 1, 2009, as the longwall ventilation system was being adjusted to meet the approved Phase 2 plan requirements, MSHA inspectors found airflow across the longwall face to be traveling in the wrong direction (tailgate to headgate). MSHA identified that other ventilation controls needed to be constructed and controls had been constructed that were not approved by the Phase 2 plan. While these ventilation revisions were in progress, miners not necessary to make these changes were in the mine producing coal on other continuous mining sections and performing other nonrelated work. Miners were withdrawn from the mine and the appropriate violations were issued.

- B4-A61, approved September 4, 2009. Doors were installed in Tailgate 1 North between crosscuts 9 and 11. This was designed to regulate intake airflow entering Tailgate 1 North entries from the belt/track air course in the Old North Mains.

- B4-A62, approved September 4, 2009. Intake regulators were installed at the overcasts over Ellis Mains near Ellis switch. These regulators were designed to cause air to travel inby in the intake and belt/track entries at Ellis Portal.

- B4-A65, approved September 18, 2009. Regulators were installed in Tailgate 1 North between crosscuts 33 and 34 in No's. 4 and 5 entry. This was designed to regulate intake airflow entering Tailgate 1 North entries from the belt/track air course in the Old North Mains.

- B6-A6, approved November 13, 2009. The plan depicted the beginning of HG 22 (Headgate 2 North). Mine record books indicated the HG 22 section started on or about November 30, 2009.

- B6-A13, approved December 18, 2009. Ground control failure damaged the stoppings in Headgate 1 North separating the return from the worked-out area. This plan depicted the HG 22 return air course, directed outby in the North Glory Mains and through Panel 1 crossover to Tailgate 1 North. At that time, the conveyor belt from the Panel 2 crossover was dumping on the longwall conveyor belt. The longwall intake expanded to two entries inby the Panel 2 crossover conveyor belt. Inby the longwall face, the No. 3 entry became common with the air that ventilated the worked-out area of the longwall. The plan established the location of air pumps and stated that water was not roofed to impede ventilation or travel. The plan also depicted a regulator to course intake belt air into the Panel 1 crossover return. This was intended to reverse the belt air direction away from the longwall face. A continuous mining section (MMU 040-0) was depicted mining rooms off the Panel 1 crossover.

- B6-A7, approved December 23, 2009. This plan was approved following a failed attempt to implement the B6-A13 plan, approved December 18, 2009, to reverse the direction of the air in the longwall belt entry. This plan depicted the longwall belt air splitting near crosscut 25, with air travelling to the longwall face and outby.

- B6-A14, approved January 5, 2010. This plan depicted the mining of pillars to install a belt drive to enable the HG 22 belt to transfer coal onto the 7 North conveyor belt.

- B6-A16, approved January 20, 2010. This plan depicted the reversal of the HG 22 intake to bring intake air around North Jarrells and West Jarrells Mains to HG 22 and direct the air to Headgate 1 North.

- B6-A15, approved January 22, 2010. This plan depicted new projections shown for the development of TG 22. The route of the HG 22 return changed to the Panel 2 crossover. The HG 22 intake route was changed to North Glory Mains. At this point, the intake air course split and went to HG 22 and TG 22, returned from HG 22 and TG 22, then joined and split again, with return air going inby at Headgate 1 North and outby in Headgate 1 North to the Panel 1 crossover, and out the isolated return to Bandytown fan. The TG 22 conveyor belt is depicted dumping coal on the Panel 2 crossover conveyor belt, which then dumped onto the HG 22 conveyor belt. Mining on TG 22 began about March 2, 2010.

- B6-A25, approved March 11, 2010. This revision was submitted in response to a closure order, issued on March 9, 2010 for not following the plan approved for the longwall. The longwall tailgate air was travelling in the wrong direction. The plan depicted ventilation controls to ensure previously approved airflow direction.

- B6-A26, approved March 22, 2010. This revision depicted a revised, typical longwall face sketch to be utilized after the longwall had passed the Panel 2 crossover. The face sketch showed the longwall belt air direction going outby and noted that the stoppings separating the travelable return from the longwall gob air would be kept intact.

Disapproved Revisions to the Ventilation Plan and Map

There were 13 revisions to the ventilation plan and map that were disapproved, five revisions to the plan and map pending approval and one which was withdrawn. On November 20, 2009, MSHA disapproved a revision to the plan that proposed to dump belt air from the longwall into the return after the Panel 1 crossover was cut through and completed. It also proposed to dump intake air into the longwall belt air course at crosscut 13. MSHA disapproved this proposal because the company was proposing a point-feed at crosscut 13, without addressing the requirements of 30 CFR §§ 75.350(c) and (d).

On December 4, 2009 a proposed revision to the map was disapproved. This revision would have modified ventilation controls, so pillars could be mined to install a new longwall belt was disapproved because of deficiencies on the submitted map, and due to the potential for return air to contaminate the belt air course.

On the same day, MSHA disapproved another revision to the map. This revision proposed to reroute the return off the HG 22 section, down the left side of North Glory Mains, crossing overcasts on Headgate 1 North and up the Tailgate 1 North isolated return (not a part of the longwall ventilation air courses); change the No. 3 entry of the Headgate 1 North to a return air course common with the worked out area inby the location of the longwall; convert the No. 3 entry of Headgate 1 North to an additional intake air course common with the existing primary escapeway outby the longwall face; and revised face sketches for both longwall gate road development and the longwall face. MSHA disapproved this proposal because of deficiencies on the map, including ventilation controls that conflict with plan revisions approved previously (September 4, 2009, October 29, 2009, and November 13, 2009), roof falls that impeded travel and eliminated the potential for compliance with 30 CFR § 75.384 for the second longwall panel were not shown, nor addressed; water accumulations within the active areas and within adjacent areas were not shown; a means for compliance with § 75.334(c) was not provided, actual air readings were not provided (production had been ongoing since September 2009); belt air from the development section was shown to be ventilating the longwall face; and belt air from the No. 1 entry of the Headgate 1 North did not meet the requirements of the newly promulgated regulation (December 2008).

In addition the submittal did not clarify how the return stopping line shown on the longwall face sketch was to be traveled or maintained. The submittal lacked adequate details addressing whether the air courses were to become common or if the return stopping line was to be reconstructed. The submittal also did not indicate whether the measuring points (MP) shown on the face sketch must be checked for proper air direction. The gate road development face sketch (3-entry) contained a statement, “number of entries may vary provided the ventilation scheme does not change,” which was inappropriate for the projections and system shown on the attached maps in the disapproval letter.

On December 9, 2009, MSHA disapproved a revision to the map that proposed to route the travelable return air course from the active HG 22 section into a common entry with the section mining rooms off of the Panel No. 1 crossover (MMU 040-0); make the No. 3 headgate entry a common intake air course with the existing primary escapeway; provide dewatering information; and project a future gateroad. MSHA disapproved this proposal because, among other deficiencies, it did not indicate that an isolated, tailgate entry would be available or re-established for the second longwall panel, and statements with the ventilation scheme provided did not comply with the existing base plan, and ignored the requirements of 30 CFR §§§ 75.334, 75.384, and 75.364.

The December 9, 2009 disapproval letter also addressed the company's request that the August 6, 2009 approval be honored with respect to ventilation with belt air. The disapproval letter reminded the company that a request was made to the company by D4, for a ventilation revision subsequent to new belt air regulations on August 6, 2009, and the current longwall plan was approved to allow additional time to develop and submit a plan. As of the December 9, 2009 disapproval letter, this request was not answered. The disapproval letter further reminded the company that an additional request was sent on November 20, 2009, which also had not been addressed, and subsequently, another written notice was provided on December 4, 2009, which also resulted in no additional information provided to justify the continued use of belt air. In all the company was provided with a verbal request on August 6, 2009, and written requests on November 20, 2009 and December 4, 2009, in addition to the request made in the December 9, 2009 disapproval. In each case the company failed to submit justification for use of belt air on the longwall face.

Methane/Dust Control Section of the Ventilation Plan

The ventilation plan contained a general dust control section for the mine that addressed the use of water to control dust along conveyor belts, transfer points and haulageways. It also addressed the use of ventilation to course dust to the return, and stated that 3M brand dust and mist respirators would be available upon request. The approved ventilation plan for each MMU within the mine had an approved methane and dust control plan that was site-specific. The ventilation plan also addressed the belt lines and specifically identified the Designated Areas (DAs), their sampling status, and the methods of dust control to be used at each location. The Designated Area (DA) methane and dust control plan, part of the approved ventilation plan for the belt lines was approved January 22, 2010, and contained details regarding the use of water to control respirable dust and methane along the belt lines at each DA specified in the approved plan. The plan specified the location and sampling status at each DA and how respirable dust would be controlled. Provisions of the approved ventilation plan for the control of methane and dust on the longwall are discussed below. Additional information on mechanized mining units utilized in continuous miner sections MMU 040-0, MMU 029-0, and MMU 062-0 is contained in Appendix AE.

MMU 050-0 (Longwall Shearer) Plan Requirements

The approved methane and dust control plan had the following ventilation requirements:

Volume of Air at Intake to Longwall	40,000 cfm
Required Velocity at Shield #9	400 LFM
Required Velocity at Shield #160	250 LFM

An addendum on a map later reduced the minimum volume of air in the intake to the longwall to 30,000 cfm.

The approved methane and dust control plan had the following water spray requirements at the shearer:

Minimum Operating Pressure at the Spray Block	90 psi
Type of Water Spray	Conflow Staplelock 650 2801CC or equivalent
Total Number of Sprays on the Shearer	109
Sprays at Headgate Drum	43
Sprays at Headgate Ranging Arm	3
Sprays at 1st Headgate Body Block	2
Sprays at 2nd Headgate Body Block	6
Sprays at Tailgate Drum	43
Sprays at Tailgate Ranging Arm	3
Sprays at 1st Tailgate Body Block	2
Sprays at 2nd Tailgate Body Block	6
Sprays at Tailgate Rack Spray	1

The approved methane and dust control plan had the following water spray requirements at the stage loader and crusher:

Minimum Operating Pressure at the Spray Block	60 psi
Type of Water Spray	Unspecified
Total Number of Sprays on the Stageloader / Crusher	14
Sprays at Headgate Motor	3
Sprays at Crusher Intake	3
Sprays at Crusher Exit	3
Sprays at Crusher	3
Sprays at Stageloader Exit	2

The approved plan contained a schematic that showed the typical longwall face ventilation, and contained the following safety precautions and can be found in Appendix AF.

Water Spray Configuration in Use as Reported by Massey Energy

On 12-3-2010 investigators from Massey Energy reported that the following configuration was in use on the longwall:

		Type of Water Spray
Operating Pressure at the Spray Block	125 psi	
Total Number of Sprays on the Shearer	139	
Sprays at Headgate Drum	43	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at Headgate Ranging Arm	10	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at 1st Headgate Body Block	3	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at 2nd Headgate Body Block	10	BD-5 Brass Hollow Cone Spray
Headgate Pan Sprays	3	BD-5 Brass Hollow Cone Spray
Sprays at Tailgate Drum	43	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at Tailgate Ranging Arm	10	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at 1st Tailgate Body Block	3	Flow Technologies 791C Staplelock Spray 3/32" orifice Full Cone
Sprays at 2nd Tailgate Body Block	10	BD-5 Brass Hollow Cone Spray
Sprays at Tailgate Rack Spray	1	BD-5 Brass Hollow Cone Spray
Tailgate Pan Sprays	3	BD-5 Brass Hollow Cone Spray

This information was collected in preparation for the water test at the shearer on December 20, 2010.

Water Test – Compliance with the Ventilation Plan

Tables 8 and 9 show the results of the water spray test that was conducted on December 20, 2010. Table 8 shows the number, type and conditions of the sprays on the longwall shearer, while Table 9 shows the water pressures that were measured at certain spray locations.

Table 8. Number, Type and Conditions of the Sprays found on the UBB Longwall Shearer

		Type of Water Spray	Condition of Sprays
Total Number of Sprays on the Shearer	157		
Sprays at Headgate Drum	45	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	9 clogged
Sprays at Headgate Ranging Arm	10	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	6 clogged 1 missing inlet insert
Sprays at 1st Headgate Body Block	3	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	
Sprays at 2nd Headgate Body Block	10	BD-5 Brass Hollow Cone Spray	8 clogged
Headgate Pan Sprays	4	BD-5 Brass Hollow Cone Spray	2 clogged
Headgate Rack Sprays	3	BD-5 Brass Hollow Cone Spray	
Sprays at Tailgate Drum	45	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	15 clogged 9 missing inlet inserts 7 missing (open port on shearer)
Sprays at Tailgate Ranging Arm	10	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	7 clogged 4 missing inlet insert 1 hollow cone insert
Sprays at 1st Tailgate Body Block	3	Various Flow Technologies 791C Staplelock Spray 3/32" orifice	Block is missing open 1/2" hose discharging
Sprays at 2nd Tailgate Body Block	10	BD-5 Brass Hollow Cone Spray	4 clogged
Sprays at Tailgate Rack Spray	6	BD-5 Brass Hollow Cone Spray	
Tailgate Pan Sprays	8	BD-5 Brass Hollow Cone Spray	6 clogged

Table 9. Water Pressures Measured on the UBB Longwall Shearer

Water Test Data from 12-20-2010

Pressure Gauge at Spray Position #6 on Tailgate Drum

PSI coming into shearer	PSI on Tailgate Drum
50	0
100	0
150	0
200	0
250	0

Pressure Gauge at Spray Position #14 on Tailgate Drum

PSI coming into shearer	PSI on Tailgate Drum
50	0
100	0
150	0
200	0
250	0
300	0
350	0
400	0
450	0

Pressure Gauge at Spray Position #14 on Tailgate Drum
Six of the Seven Missing Sprays replaced on Tailgate Drum

PSI coming into shearer	PSI on Tailgate Drum
100	58
200	95
300	100
400	100
450	120

Pressure Gauge at Spray Position #14 on Tailgate Drum
Six Sprays for Previous Test are Removed
Seven Clogged Sprays are Replaced

PSI coming into shearer	PSI on Tailgate Drum
100	0
200	0
300	0
400	0
450	0

Difference in Water Nozzles Used by the Operator on the Shearer

The BD-5 sprays as well as the hollow cone and jet Staplelock sprays were not approved for use on the shearer. The operator used a FT 791C Staplelock drum spray with a full cone pattern and a 3/32” orifice (although several 1/16” orifice sprays were found). The approved methane and dust control plan required a Conflow 650 2801 CC or equivalent (this is a full cone spray with a 1/16” orifice). There are differences in the inlet for these full cone sprays. The inlet pieces for the 2801 CC and 2801 DC are identical. Table 10 summarizes the differences between the spray inlets made by the manufacturers. This information was obtained from the respective manufacturers during interviews and from design drawings.

Table 10. Summary of Differences between Spray Inlets Manufactured by Flow Technologies and Conflow.

	FT	Conflow	% Difference
Middle Hole Diameter	**0.0393”**	**0.032”**	**20.5%**
Angled Side Holes Diameter	**0.0468”**	**0.078”**	**50%**
Angle of Side Holes	**67º**	**35º**	**62.7%**

The larger middle hole caused a much courser water droplet to be discharged from the Flow Technologies spray which made it less efficient for dust suppression. In addition, the 1/16” full cone Staplelock spray had a 30º spray angle at the outlet orifice, while the 3/32” full cone Staplelock spray had a 45º spray angle at the outlet orifice. This caused the 3/32” spray to have a greater overspray that contributed to turbulence around the shearer and potentially pushed dust into the walkway. The 3/32” full cone spray had a larger water droplet size which made it less likely to wet the surface being cut adequately and collect dust out of the air. A more in-depth discussion on the specifications of the water sprays can be found in Appendix AG.

Shield Tips

The ventilation plan required water sprays (does not specify a type) on the underside of the shield tips every 20 shields that were manually activated as the longwall passed. The plan did not specify the type of water sprays, shield numbers where sprays were located or minimum operating pressure, and did not provide sufficient technical information about the water sprays. MSHA investigators found that these sprays were brass hollow cone sprays and that many of these sprays were damaged or missing.

Stageloader/Crusher

MSHA investigators found both Staplelock sprays and brass hollow cone sprays in use in the stage loader. The plan did not specify a spray type at this location and only specified a minimum psi (60).

UBB Clean-up Program

UBB's clean-up program for coal dust accumulations pursuant to 30 CFR § 75.400-2 consisted of only three items:

- Load cut of coal;
- Bolt cut of coal;
- Clean and dust cut of coal;
  Rock dust within 40' of face, and;
  Equipment cleaned on weekly preventative maintenance program and as needed.

The plan does not address several significant issues that would be considered as standard inclusions in most clean-up plans, such as clean-up of section roadway spillage, spillage at the feeder, general housekeeping around the section power center, clean-up and dusting along belt conveyer systems and entries, and rib sloughage after initial mining, and trash collection and disposal.

Lung Disease from Coal

Mine ventilation and water sprays are intended both to control explosion potential and to reduce the risk of lung diseases from respirable coal dust, commonly known as Black Lung.

Black lung refers to a number of lung diseases such as coal workers' pneumoconiosis (CWP), emphysema, and chronic bronchitis, caused by inhalation of coal mine dust. The risk of developing the disease depends on the quantity—the intensity and duration—of dust inhaled. When the Mine Act was originally passed in 1969, the U.S. Congress established standards to reduce dust exposure in an effort to eliminate black lung.

The State of West Virginia, Department of Health and Human Services, Office of the Chief Medical Examiner performed autopsies on all 29 victims. The Medical Examiner indicated that most of the victims had evidence of varying degrees of black lung in the form of CWP, emphysema, and fibrosis. A number of these miners had a substantial amount or all of their experience at UBB.

NIOSH research has determined that coal miners continue to be at risk of disease when the current dust limit is followed. Nonetheless, the UBB lung autopsy findings are very troubling. The incidence of disease found in these miners clearly demonstrates that dust control practices at UBB and other mines where these miners worked did not provide adequate protection against black lung.

Roof Control Plan

The roof control plan in effect at the time of the accident was dated October 21, 2009, received by D4 on October 27, 2009, and was approved on December 23, 2009. The portion of the plan outlining the required support for Headgate 1 North and Tailgate 1 North is included in Appendix AH.

The operator failed to design for the extensive occurrence of multiple seam mining conditions, overburden depths exceeding 1,100 feet, and floor heave during development of the 1 North Panel gateroads. The operator did not include pillar design or stability analyses in the roof control plan despite the presence of extensive overlying workings in the reserve area and widespread falls of ground that occurred after mining beneath Powellton seam gateroads. If a stability analysis had been conducted, the Analysis of Multiple Seam Stability (AMSS) program would have indicated that the multiple seam interactions were expected to generate degraded ground conditions and therefore, supplemental support would be required. The operator did not consider the methane outbursts in 2003 and 2004 nor did they implement the precautions discussed with Technical Support at two different meetings in 2004, as described previously in the "Outburst History at UBB" section. These measures, as previously presented, included the construction of a geologic hazard map to predict possible outburst areas, and the related drilling of degasification holes in the identified target areas to release gas prior to mining. During discussion with the mine's senior engineer, Technical Support indicated that a zone of geological weakness appeared to extend southeast through the 2003 and 2004 outburst locations, and that it would be prudent to anticipate encountering a similar event on the next subsequent longwall panel. The mine map indicates that the panel in question was stopped short where it intersected the trend indicated by Technical Support, suggesting that mine management might have been aware of the element of predictability of outbursts in this reserve. However, there appears to have been no attempt to alter the stop position of the 1 North Panel, which mined into the northwestern extension of the projected zone. Technical Support recommended additional precautions in 2004, during a meeting with company officials and CMS&H District 4 personnel, pertaining to the need for increased ventilation on the longwall face and in the longwall bleeder. Those recommendations were not heeded, since the longwall face quantities were actually decreased on the 1 North Panel compared to the previous district where the outbursts occurred.

Pages 2-3 of the approved roof control plan state that tailgate pillars will be designed with 80-foot crosscut centers and that pillars on development and retreat sections will be designed in accordance with the latest edition of Analysis of Retreat Mining Pillar

Stability (ARMPS). The ARMPS program was not an appropriate tool to evaluate the stability of current or future gateroads, which should be evaluated using the Analysis of Longwall Pillar Stability (ALPS) program. In addition, PCC should have used AMSS due to the presence of overlying mine workings and the possibility of multiple seam stress interactions to evaluate gateroad pillar stability. More details with respect to stability analyses are included in Appendix AI.

Roof control issues in Headgate and Tailgate 1 North are listed below.

Headgate 1 North

The headgate was developed as a three-entry gateroad, beginning in November 2008, utilizing 100-foot crosscut centers, with 95-foot centers from the No. 1 to No. 2 Entry, and 105-foot centers from the No. 2 to No. 3 Entry. Prior to this, the development had begun from the North Glory Mains as a 5-entry section in July 2008. The 1 North Panel was the first to be developed beneath Powellton seam longwalls since May 2005, at the end of the previous district when Panel 20 crossed diagonally beneath a 500-foot wide longwall panel. Maximum overburden, based on comparison with structure contours for the Eagle seam provided by the company and a standard USGS topographic map, is 1,290 feet. Headgate 1 North passes beneath several gateroads in the Powellton seam, located 170 feet above. This represents a gob/solid boundary between crosscuts 60-65, with gateroads between mined-out longwall panels, interpreted to represent remnant pillars farther west. For purposes of AMSS analyses, the 4-entry gateroads in the Powellton seam are treated as a single barrier, the width of which is measured to the outside ribs of the outside pillars, a distance of 160 feet. A long barrier between adjacent room-and-pillar workings may represent a remnant pillar configuration near crosscut 45, particularly if the floor has been softened in the Powellton seam or if pillar extraction has been performed.

An AMSS analysis for Headgate 1 North, dated December 14, 2009, was conducted by D4 personnel following deterioration of the headgate. The analysis indicated that the Pillar Stability Factor for tailgate loading essentially met the NIOSH recommended value of 1.13, utilizing a gob/solid boundary beneath the Powellton seam longwall panels and assuming 990 feet of overburden. The MSHA AI Team reviewed the analysis and conducted its own analysis for purposes of comparison. Based on field visits to the Powellton seam and the Eagle seam in this area, the MSHA AI Team analysis used different values for seam height than indicated in the D4 analysis. The D4 analysis appears to address the vicinity of crosscut 60-65, beneath the gob/solid boundary represented by a longwall in the overlying Powellton seam. Based on the D4 analysis seam height of five feet, the design of Headgate 1 North appears to meet the NIOSH recommended value of 1.13. However, field experience indicates that a more realistic value of seam height is seven feet, which substantially reduces the Pillar Stability Factor to 0.82 for tailgate loading conditions and no longer meets the NIOSH recommended value. MSHA's analysis indicates that for the gateroad design to meet the NIOSH recommended Pillar Stability Factor of 1.13, the pillars would have to be increased to

125-foot crosscut and entry centers, compared to the current 100-foot crosscut and 95- to 105-foot entry centers.

Although the gateroads were subjected only to headgate loading conditions, an AMSS analysis conducted by MSHA indicates that it should have been apparent that the gateroad design was not robust enough to meet the recommended stability factors beneath the deepest overburden in combination with Powellton gateroad crossings. MSHA represented the Powellton gateroad crossings as remnant pillars 160 feet wide, surrounded by adjacent longwall gob 620 feet in width at 1,290 feet of overburden. This resulted in Pillar Stability Factors under headgate loading conditions of only 0.93 (0.52 for tailgate loading conditions). This does not meet the NIOSH recommended value of 1.13, and generates a “condition yellow” warning (A major interaction should be considered likely, unless a pattern of supplemental roof support, such as cable bolts or equivalent is installed; rib instability is also likely) for development, and a “condition red” warning (A major interaction should be considered likely, even if a pattern of supplemental roof support is installed; it may be desirable to avoid the area entirely) for tailgate loading. In the vicinity of crosscut 45, Headgate 1 North passed beneath an 80-foot barrier between two room-and-pillar sections, at 1,260 feet of overburden. The AMSS calculated Pillar Stability Factor for the headgate is only 0.93, following the interpretation that the pillars in the Powellton seam are no longer carrying load, either due to floor softening from water, or undersized pillars that have crushed out, or were retreat mined. The value of 0.93 does not meet the NIOSH recommended value of 1.13.

Inspector notes and witness testimony established that a massive water inundation occurred on the 1 North Panel on November 16, 2009 and forced the panel to be shut down for nearly two weeks while water was pumped out. Based on review of mine maps, the longwall was between Headgate 1 North crosscuts 52-61 during that period, with the face located at crosscut 55 in mid-November. This area is significant in that it occurs beneath the transition in the overlying Powellton seam from a series of longwall panels to room-and-pillar workings, separated by a 220-foot wide barrier. At best, the transition represents a gob/solid boundary and, if the room-and-pillar workings were retreat mined or if mine floor softening prevented pillar remnants from carrying any load, at worst it represents a wide barrier between two gobs. Overburden in this area is up to 1,180 feet. Thus, it is plausible that differential subsidence above the 1 North Panel occurred beneath the barrier, causing joints or fractures to open sufficiently to allow water and air communication between the Eagle and Powellton seams. Notations in the longwall production report indicate that a roof fall, 10 feet high and 16 feet wide, occurred in the headgate entry itself, extending from shield 1 outby to the stage loader, on December 4, 2009, when the face was between crosscuts 51-52 beneath the same gob/solid transition zone. This roof fall was not reported until December 5, 2009 and included inaccurate information. MSHA was unable to evaluate the roof fall because the longwall had advanced and the area was unsafe at the time MSHA was notified. The roof fall was reported to MSHA as falling out between the bolts. Witness testimony also indicated that floor heave had been encountered during development of the Headgate 1 North. Although the ARMPS Pillar Stability Factor exceeded the value recommended by NIOSH for development loading conditions, AMSS predicted a “condition yellow” warning (“A major interaction should be considered likely, unless a pattern of supplemental roof support, such as cable bolts or equivalent, is installed; rib instability is also likely”). Subsequent longwall mining validated the predicted AMSS results when significant floor heave and rib sloughing damaged ventilation controls, and ground conditions became unsuitable for use as a tailgate to the next planned longwall panel. At the time of the underground investigation, the headgate had degraded to the point that it was considered inaccessible.

Tailgate 1 North

Tailgate 1 North was developed using seven entries with 100-foot crosscut and 80-foot entry center spacing, resulting in 80 x 60-foot rectangular pillars. It should be noted that because the 1 North Panel was the first panel in the new longwall district, the tailgate would never be subjected to actual tailgate loading, and instead would be subjected to only headgate loading conditions. However, according to witness testimony and review of the 2008 Annual Ventilation Map, dated January 15, 2009, what became the Tailgate 1 North Panel was developed originally as a 7-entry submains configuration, a non-standard gateroad design. Mine management subsequently elected to use this configuration as a longwall tailgate when the longwall equipment was forced to return earlier than expected from the Castle Mine after encountering adverse geological conditions. The 7-entry submains configuration began development from the North Glory Mains in January 2008 and continued until October 2008 when the two left-hand entries were dropped. The development continued as a 5-entry submains configuration by December 2008. Stability analysis using AMSS indicates that beneath the remnant pillar configuration of overlying Powellton seam gateroads flanked by 620-foot wide longwall gobs and at depths approaching 1,200 feet, such as was encountered during the November 2009 water inundation, the 5-entry Tailgate 1 North is characterized by a Pillar Stability Factor of only 0.95, which does not meet the NIOSH recommended value of 1.13. At the longwall face position at the time of the explosion, the Pillar Stability Factor of 1.11 was slightly less than the recommended value of 1.13 for the tailgate beneath 970 feet of overburden and a remnant pillar configuration in the overlying Powellton seam. If Tailgate 1 North had been used as a submains and not been subjected to longwall abutment stresses, the Pillar Stability Factors would have exceeded the values recommended by NIOSH, even when subjected to the worst combination of overburden depth and multiple seam interaction. However, underground observations by MSHA indicated that extensive floor heave and roof degradation occurred in the 5-entry and 7-entry portions of the Tailgate 1 North, both inby and outby the longwall face. This degradation became progressively worse over time. Floor heave extended from the tailgate entry itself across the section to the No. 1 Entry, the farthest away from longwall side abutment stress.

Emergency Response Plan (ERP)

The MINER Act of 2006 requires all mine operators to develop Emergency Response Plan (ERP)s. The ERP in effect on April 5, 2010 was approved on January 25, 2010. The ERP defines how the company will respond to mine emergencies that occur at the mine.

The approved ERP addressed the following sections:

Training

The ERP required the operator to train miners within 30 days of approval on the provisions of the plan. The approved ERP provided scenarios in which miners on the section and outby areas were to be provide instruction on assembling, evacuation, and donning a SCSR.

Mine Communication and Tracking

Mine operators are required to provide a post-accident communication system between underground personnel and surface personnel, via a wireless two-way medium and an electronic tracking system, which permits surface personnel to determine the location of any persons trapped underground. Operators were required by the Mine Improvement and New Emergency Response (MINER) Act to submit plans by June 15, 2009 to address this requirement. If the fully wireless provisions cannot be adopted, the MINER Act requires that ERP's set forth an alternative means of compliance that approximates, "as closely as possible, the degree of functional utility and safety protection provided by the wireless two-way medium and tracking system." The operator submitted an ERP plan on October 9, 2009. This plan stated that a leaky feeder (radio) system was already installed in the mine to provide a wireless means of communication. It also stated that a tracking system was in the process of being installed. This plan was approved on January 25, 2009.

According to witness testimony, installation of the leaky feeder communication system began on or about October 6, 2009. The system consisted of a coaxial distributed antenna system from which radio frequencies could be transmitted and received. Within range of the coaxial cable, miners could communicate with Ultra-High Frequency (UHF) radios. The tracking system utilized a "tracking tag" transmitter worn by miners, which sent signals to a "tag reader" repeater. When a tracking tag signal was received by the tag reader, it re-transmitted this signal across the leaky feeder system, back to the surface. Miners had to be in range of the tag reader before any signals were transmitted to the surface. The operator had a computer system that recorded when a miner's tracking tag signal was received. When a miner left the tag reader's coverage area, the last known time the miner was located or traveling by the tag reader could be seen in the computers' tag reader database.

As of April 5, 2010, the communication and tracking system was partially completed. The leaky feeder system was approximately 1,250 feet from the face of the HG 22 section, and approximately 750 feet from the TG 22 section. The leaky feeder was installed in the belt entry to the stageloader, and in the track entry to the mule train of the longwall section. The last tag reader for the tracking system was installed at the Mother Drive of the longwall conveyor. This tag reader is approximately 2,700 feet from the longwall face, 3,700 feet from the face of TG 22, and 7,000 feet from the face of HG 22.

After the explosion, mine rescue personnel could not determine the number of miners underground until 1:40 a.m. on April 6, when the correct number of miners underground were reported. The ERP requires PCC to manually track miners in locations where the tracking system is inoperative, but in this case, miners were not tracked properly, a sufficient number of tag readers were not installed, and existing tag readers were not maintained. 27 tag readers were inoperative prior to the explosion and no tag readers were working inby the South Portal area. In addition, not all employees who went into the mine were entered in the computer database, the tracking system did not have an identifiable number entered into the computer that matched the miner's belt tag, and miners were going underground without taking an assigned tracking tag.

Other deficiencies identified regarding the operator's compliance with the communications and tracking requirements of the approved ERP included:

- Leaky feeder amplifiers that were blowing fuses, causing the system to be ineffective for providing adequate post-accident communications; and,
- Several tag readers in the database that were not storing data properly. The readers were displaying data from a previously selected reader; and
- The difficulty of determining the number of miners using only the tracking system's computer screen.

Testimony provided by mine employees indicates that the operator did not utilize sufficient resources on a daily basis to provide an adequate post-accident communication and tracking system. Two mine employees were assigned to install the system, while performing other duties. Appendix AJ describes in greater detail the communication and tracking system.

Mine Emergency Evacuation and Firefighting Program of Instruction (MEEFP)

The Mine Emergency Evacuation and Firefighting Program (MEEFP) is designed to instruct miners in the procedures for mine emergencies that present an imminent danger to miners from fire, explosions, and inundations, and to evacuate all miners not required for a mine emergency response (Appendix AK). 30 CFR §§ 75.1502 and 75.1504 in an operator's program require quarterly drills to be performed. Training drills dealing with emergencies including fires, water inundation, gas inundation, and explosions must be performed on a quarterly basis. The records for the five quarters preceding the explosion on April 5, 2010, show that no explosion drill training was conducted.

MSHA reviewed the operator's approved plans, records, and testimony, and identified deficiencies in the operator's MEEFP. Emergency drill records provided by PCC for the five quarters preceding the explosion revealed that PCC failed to conduct emergency evacuation training in all required topics for all required miners.

Atmospheric Monitoring System (AMS)

The requirements for the AMS are set forth in 30 CFR §§ 75.350, 75.351, and 75.352. The company was required to fulfill these requirements because the mine utilized belt air to ventilate the longwall working section prior to the explosion. The operator's AMS consisted of hardware and software capable of measuring atmospheric parameters, such as CO. Atmospheric measurements were transmitted from the underground mine to two surface computers. The system was primarily comprised of CO sensors along the belt conveyor system. These sensors were programmed to alarm if the CO level reached 10 ppm. An AMS operator was required to be stationed on the surface, where alarms would be registered. The AMS operator should have been trained in accordance with 30 CFR § 75.351(q), to understand the system, and it has the primary responsibility to respond to emergencies. MSHA reviewed the computer system's event log data, mine maps, and CO monitoring devices in the explosion area. Appendix AJ provides details of the system design, layout, and event data.

Damage to several CO sensors was observed along belt entries in the explosion area. The AMS cable was severed at crosscut 89 of the North Glory Mains. According to the computer system's event log, the first occurrence of an alarm on April 5 was for a communication failure that occurred at 3:08:01 p.m. (computer system time). It was determined after the explosion that the computer's clock was fast. Time drift analysis was conducted on the Pyott-Boone system resulting in unexplainable results. Details of these analyses are included in Appendix AJ.

The AMS event log showed no signs of a fire underground prior to the explosion. According to the event log, approximately 26 minutes prior to the explosion, CO sensor 1.51 at Ellis 5 Head Drive alarmed and cleared quickly. This was considered a "nuisance alarm" and occurred commonly at this mine.

All CO sensors, belt monitors, and other system components inby crosscut 81 of the North Glory Mains went into communication failure immediately after the explosion. Several sensors, from crosscut 81 outby, went into alarm, starting at the 6 North belt starter CO sensor 1.95, and progressing outby to the 4 North CO sensor 1.82. These sensors were showing varying concentrations of CO for approximately 15 minutes after the explosion, until all the CO sensors in the North section of the mine stopped communicating. The communication failure was possibly due to either the loss of backup power from the uninterruptible power supplies, or a loss of data signal.

Several deficiencies were discovered with PCC's AMS compliance requirements during the investigation. These deficiencies include:

1. CO sensor spacing was not maintained at 1,000-foot intervals on the HG 22 section, as required. The conveyor belt was approximately 3,750 feet in length. There was only one sensor provided between the HG 22 head drive sensor 1.103 and the section CO sensor 1.53.

2. The CO sensor map was not up-to-date. Sensors were not always shown on the map, and some were shown at incorrect locations. Directions of air flow were shown in the wrong direction compared to other mine maps.

3. AMS operators did not take the correct actions when alarms were received on the surface. Operators failed to have miners removed from underground on three different occasions, when two consecutive alarms occurred.

4. AMS operators did not always record actions taken to correct system malfunctions or failures.

5. Many of the CO sensors were not being calibrated every 31 days. PCC did not indicate that each sensor was being calibrated in the handwritten record book, but instead would indicate that a particular belt's CO sensors were calibrated. The AMS computer's data showed that PCC failed to calibrate some of the CO sensors along belt flights. During the last required 31-day calibration, PCC recorded that the 4 North and 5 North conveyor belts' CO sensors were calibrated. In contrast, the computer log showed that six CO sensors were not calibrated on these two conveyor belts.

6. Not all of the AMS operators at the mine were trained adequately.

7. According to the event log, many nuisance alarms were not being addressed by PCC.

8. CO sensors located at the 6 North drive and the 5 North tailpiece were not positioned correctly.

Refuge Alternatives

Three refuge alternatives were located in the northern portion of the mine (see Appendix H). These three units were Strata Portable Fresh Air Bay units that included inflatable tents. Although the mine rescue efforts after the explosion were, in part, based on the hope that survivors had managed to reach these refuge alternatives and utilize the life-support functions of the units, none of the refuge alternatives were deployed.

Personnel from A&CC, along with representatives from WVOMHST, GIIP and PCC, inspected these refuge chambers on March 31, 2011. All three units were successfully deployed and appeared to be fully functional. Details of this investigation and photos of the refuge alternatives are shown in Appendix AL.

Self Contained Self Rescuers

NIOSH Testing

The Self Contained Self Rescuers (SCSR) used at UBB were manufactured by CSE, Model Number SR-100. NIOSH researchers in Bruceton, Pennsylvania tested a number of SCSRs which MSHA recovered from various underground areas of UBB during the rescue and recovery operations and the accident investigation. The testing included visual inspections, functional tests, and disassembly. Some of the units endured obvious damage from the explosion and, accordingly, were only visually inspected. All of the remaining SCSRs passed the functional tests except for one, PE-39-a, which showed problems with its actuator bottle. Disassembly of this unit revealed a manufacturing defect near the "O" ring seal which allowed air to slip around the seal. NIOSH researchers determined that this condition did not diminish the unit's ability to generate oxygen and that the unit would have functioned as required. Upon disassembly of the rest of the SCSRs, NIOSH researchers determined that the defect was anomalous and had only affected PE-39-a. In sum, all units performed as expected with no problems.

Disassembly of the units also involved visual examinations of the units' chemical beds. Based on these examinations, NIOSH researchers were able to determine which units had been used (i.e., whether oxygen had been consumed) as well as the extent to which the units had been used (i.e., how much oxygen had been consumed. (Appendix AM)

SCSRs apparently used by Blanchard and another top company official

During its investigation, MSHA found six deployed SCSRs in various locations in the area affected by the explosion. MSHA later determined that Blanchard and another top company official most likely deployed and used these SCSRs during their exploration activities following the explosion. The investigation team was unable to determine the purpose or extent of their travels as both individuals exercised their rights under the Fifth Amendment and declined to be interviewed by MSHA.

ROOT CAUSE ANALYSIS

The Accident Investigation Team performed an analysis to determine the root cause and other significant factors that contributed to the accident. Eliminating these causes would have prevented the loss of 29 lives and the two significant injuries resulting from the explosion at UBB.

Root Cause: Performance Coal Company (PCC) and Massey management engaged in practices and procedures that resulted in non-compliance with the Mine Act and regulations. PCC/Massey engaged in intimidation of miners; had a policy of illegal advance notice of MSHA inspections; did not comply with their own training plan; and intentionally failed to maintain required books recording hazards known to the company. PCC and Massey's actions reflected a pervasive culture that valued production over safety creating a significant threat to the safety and health of UBB miners and contractors. Specifically:

- Miners were routinely intimidated by PCC and Massey managers. They did not report safety problems at the mine because of fear of retaliation. They were also discouraged from listing hazards in the required examination records and correcting them. MSHA cannot be in every mine every day, and it relies on miners to report hazardous conditions in the mine. PCC and Massey's actions deprived miners of the right to participate in their own safety.

- PCC and Massey established a practice of providing advance notice to those on the surface and underground when enforcement personnel were at the mine. Mine security personnel were instructed to notify the mine personnel when inspectors arrived on mine property. Mine personnel then informed persons underground that an inspector was present at the mine. This advance notice gave those underground the opportunity to alter conditions and fix hazards prior to the inspector's arrival on the section. Advance notice resulted in limited rock dusting and ventilation changes in areas where inspectors were expected to travel. At time foremen shut down the working section before the inspector arrived.

- PCC and Massey kept two sets of books. They were aware of hazards and noted them in a production or maintenance record but in many instances failed to record them as required in the official examination book. Had these hazards been recorded as required in the official book, inspectors and miners would have had the opportunity to understand and assess the hazards and ensure they were corrected.

The investigation team also recognizes that other contributory factors, detailed below, played a significant role in the accident at UBB. These factors further reflect the disregard for miners' safety and for the obligation to comply with the Mine Act and regulations. Had these resulting contributory factors not existed, the explosion would have been averted. The new mine operator will need to develop and implement a comprehensive corrective action plan to address all of these issues.

Contributory Factor: PCC and Massey did not comply with the approved training plan; many miners did not receive training in hazard recognition, prevention of accidents, roof control, ventilation and other mining plans, and the training required in new work tasks. The lack of training was corroborated by the conditions in the mine, which led to the explosion.

Contributory Factor: PCC and Massey did not perform adequate pre-shift, on-shift, and weekly examinations. Mine examiners did not identify numerous existing hazardous conditions throughout the mine. Several air courses had not been examined in the proper time frame or were not being examined at all. Examiners and section foremen did not energize their multi-gas detectors when required and the detectors often remained de-energized for extended periods of time. As a result, examiners could not and did not take adequate air quality measurements and often recorded false measurements in the examination records. In addition, examinations were not being consistently performed in the tailgate entry near the longwall face. Finally, on-shift respirable dust parameter checks were not being performed as required on the longwall section, and tests for methane were not consistently being made at 20 minute intervals on the longwall when the shearer was operating.

Contributory Factor: PCC and Massey did not correct or post hazardous conditions immediately. Numerous reported hazardous conditions remained uncorrected. For example, belt examination records regularly indicated the need for cleaning and/or rock dusting on several consecutive shifts without any corrective actions being taken.

Contributory Factor: PCC and Massey did not maintain the longwall shearer in safe operating condition. At least two worn bits were present on the face ring of the tail drum of the shearer. Both of these bits were clearly missing their carbide tips.

Contributory Factor: PCC and Massey did not comply with the approved ventilation plan. The tailgate end drum of the longwall shearer was being operated with missing and clogged water sprays. Seven sprays were missing. As a result of the missing sprays, no pressure could be measured on the shearer tailgate drum.

Contributory Factor: PCC and Massey did not maintain the volume and velocity of the air current at a sufficient volume and velocity to dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, dusts, smoke, and fumes, in the areas where persons worked or traveled.

<u>Contributory Factor</u>: PCC and Massey did not comply with the approved roof control plan. The required supplemental roof support in the tailgate entry of the longwall was not installed. The failure to maintain the required tailgate support contributed to the inability to properly ventilate the explosive mixture of gas that accumulated in the tailgate.

<u>Contributory Factor:</u> PCC and Massey did not rock dust the mine adequately. A mine dust survey was performed in the area affected by the explosion. Of the 1353 samples collected in the flame zone, 90.5 percent were non-compliant.

<u>Contributory Factor:</u> PCC and Massey failed to ensure that accumulations of loose coal, coal dust, and float coal dust were cleaned up and removed from the mine.

<u>Corrective Actions:</u> This mine has been under a Section 103(k) order since April 5, 2010, and has been the subject of an ongoing investigation. Massey Energy no longer owns and operates the mine at UBB. The new corporate owner must take the actions necessary to prevent unsafe and unhealthful conditions in its mines. MSHA will require the operator to take appropriate actions to address the root cause and each of the contributory factors. A commitment to health and safety must extend to all management members and corporate officials and be monitored and enforced at the highest levels. Those that instill and condone a dangerous culture must be held accountable for their actions or inactions.

CONCLUSION

The tragic deaths of 29 miners and serious injuries to two others at Upper Big Branch were entirely preventable. PCC and Massey routinely ignored obvious safety hazards and let conditions develop that allowed a small methane ignition to propagate into a massive coal dust explosion. MSHA's investigation revealed that the dangerous conditions existing at UBB were the result of PCC and Massey's practices and procedures that resulted in non-compliance with the Mine Act and regulations. This included intimidating miners to discourage them from reporting hazards or stopping production to make needed corrections; routinely giving advance notice of inspections; failing to train miners adequately; and not recording hazards in required examination books.

Along with these practices, PCC and Massey failed to take other safety precautions that would have prevented the explosion from occurring. They did not conduct examinations properly, did not correct hazards, and did not maintain the longwall shearer in the correct working condition. In addition, PCC and Massey failed to comply with the approved ventilation and roof control plans, inadequately applied rock dust and did not clean up extensive amounts of loose coal, coal dust and float coal dust accumulations.

MSHA concluded that the explosion at UBB originated as a methane ignition that led to a methane explosion and then transitioned into a massive coal dust explosion. It most likely started with an initial methane ignition caused by the cutting bits on the tail drum of the longwall shearer, which likely generated hot streaks on the sandstone roof or floor. The flame from the initial ignition then ignited an accumulation of methane. It encountered this methane because of PCC's poor roof control practices, which restricted the airway through the next inby crosscut, thereby allowing methane to accumulate.

Once a localized methane explosion occurred, it encountered fuel in the form of coal dust and float coal dust beginning in the tailgate entries that were inadequately rock dusted. Examiners had allowed these and other accumulations at other locations in the mine to build up over days, weeks, and months. If float coal dust had not accumulated and the mine dust had contained sufficient quantities of incombustible content, the localized methane explosion would not have propagated any further. PCC did not apply adequate quantities of rock dust in the affected area; as a result, the coal dust and float coal dust allowed the localized methane explosion to propagate into a massive coal dust explosion that quickly spread throughout the northern section of the mine. The explosion resulted in the worst mining disaster in the United States in the last 40 years.

12/6/11

Kevin G. Stricklin
Administrator for Coal
Mine Safety and Health

Date

ENFORCEMENT ACTIONS

A 103(k) order was issued to ensure the safety of all persons until an investigation was completed and the area and equipment deemed safe. Twelve violations that were deemed to have contributed to the accident were issued to PCC. Of this number, nine were designated as flagrant violations. Two additional contributory citations were issued to DSC. Other violations deemed not to have contributed to the cause or severity of the accident were cited separately and are not addressed in this report.

Control Order No. 4642503 under Section 103(k) of the Mine Act

An accident occurred at this operation on 4/5/2010 at approximately 3:27 p.m. This order is being issued, under the Federal Mine Safety and Health Act of 1977 Section 103(j), to prevent destruction of any evidence which would assist in investigating the cause or causes of the accident. It prohibits all activity in the underground areas of the mine except to rescue and recover miners.

The initial order is modified to reflect that MSHA is now proceeding under the authority of Section 103(k) of the Federal Mine Safety and Health Act of 1977. This Section 103(k) Order is intended to protect the safety of all persons on-site, including those involved in rescue and recovery operations or investigation of the accident. The mine operator shall obtain prior approval from an Authorized Representative of the Secretary for all action to recover and/or restore operations in the affected area. Additionally, the mine operator is reminded of its existing obligations to prevent the destruction of evidence that would aid in investigating the cause or causes of the accident.

104(a) Citation No. 8431853, Section 103(a) of the Mine Act, S&S, Reckless Disregard

Section 103(a) of the Mine Act states that: "Authorized representatives of the Secretary… shall make frequent inspections and investigations in coal or other mines each year…" and that "In carrying out the requirements of this subsection, no advance notice of an inspection shall be provided to any person…". The mine operator has failed to comply with this section of the Mine Act. Testimony given by both management and hourly employees during the accident investigation indicates that the mine had a regular practice of notifying persons underground that an inspector was present on the surface. Underground employees would regularly cease production to correct hazards prior to the possible arrival of the inspectors. This advance notice prevented MSHA inspectors from observing the actual conditions to which miners were being exposed.

Unannounced inspections are a key part of MSHA's effort to identify unsafe and unhealthy conditions in mines. By providing advance notice of inspections, the mine operator has interfered with inspectors in their attempts to inspect the mine and has shown a reckless disregard for the health and safety of their miners.

This violation of the Mine Act contributed to the death of 29 miners in that MSHA was denied the opportunity to develop additional guidelines, discover hazards, and make inspections of the actual conditions at the mine.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8250014, 30 CFR §75.220(a)(1), S&S, High Negligence

The operator failed to comply with the approved roof control plan, in the 1 North Panel tailgate entry. Page 19 of the plan stipulates that in longwall development entries of initial longwall panels, "the Tailgate Entry will have supplemental support in the form of two rows of 8' (foot) cable bolts or posts installed between primary support. This supplemental support shall be maintained 1000 feet outby the longwall face at all times." The operator failed to install the required supplemental supports in the tailgate entry adjacent to the 1 North longwall panel. The operator failed to install cable bolts and only installed one row of posts in the tailgate entry.

Required tailgate support is significant because observations indicate that crosscut 49, (the first crosscut inby the face) had already caved prior to the face reaching crosscut 48, (the crosscut outby the face) as evidenced by observations of soot, coal dust and debris on the fall rubble. Roof failure in crosscut 49 restricted airflow from traveling inby from the face. The failure to maintain the required tailgate support contributed to the inability to properly ventilate the explosive mixture of gas accumulation in the tailgate and contributed to the explosion that occurred on 4-5-2010 that resulted in the deaths of 29 miners.

The failure to maintain the required supports in the tailgate entry also prevented safe access for mine examiners from conducting required examinations in those entries.

The failure to maintain the required supports in the tailgate entry also prevented examiners from conducting required examinations in those entries.

The installation of one row of posts rather than the required two rows would have been very evident to weekly examiners, Longwall preshift and on-shift examiners and the Longwall Coordinator. Testimony revealed that examiners were instructed that one row of supports was sufficient in the tailgate entry.

The operator has engaged in aggravated conduct constituting more than ordinary negligence. This is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc. and Massey Energy Company.

104(a) Citation No. 8227560, 30 CFR §75.321(a)(1), S&S, Moderate Negligence

The operator has failed to maintain the volume and velocity of the air current in the areas where persons work or travel to dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, dusts, smoke, and fumes.

The air current at the Longwall tail (Tailgate 1 North, crosscut 48) was not sufficient to dilute, and render harmless, and carry away flammable, explosive, noxious and harmful gases, dusts, smoke, and fumes. An explosive mixture of gases was allowed to accumulate in the vicinity of the shearer which was located at the tailgate end of the longwall. An ignition of this mixture resulted in a mine explosion on 4/5/2010 and propagated throughout areas of the mine including the longwall, HG 22, and TG 22 sections. This explosion resulted in the deaths of 29 miners, disabling injuries to one miner, and serious injuries to another miner.

In addition to the occurrence of the explosion, the following facts establish that the air current at the tailgate end of the longwall was inadequate:

The mine has a history of methane incidents on prior longwall panels. These incidents put the operator on notice for methane hazards on the longwall face. These incidents include:

- A methane ignition / explosion that occurred on 1/4/1997 at No. 2 West Longwall.
- A methane outburst that occurred on 16 Longwall panel in July of 2003.
- Another methane outburst occurred on 17 Longwall panel on 2/18/2004.

These incidents all occurred in a fault zone and while mining with an overburden in the excess of 1,000 feet. The accident on 4/5/2010 occurred in this same fault zone.

This mine was on a 103 (i) spot inspection due to the methane liberation.

The operator failed to implement / follow the recommendations of MSHA's geologist and Ventilation technical support group following the 2004 outburst. These recommendations included:

- Increasing airflow along the longwall face (the plan at the time required a minimum of 60,000 cfm).
- Degasification wells for the subsequent longwall panels in an effort to bleed of gas prior to encroachment of the longwall face.
- Construct a hazard map that showed areas with 1,100 feet of overburden and less than 13 feet of interburden between the eagle and lover eagle seams. Additionally this map should show the projected structural zone identified in headgate 18, and overmined areas.

The operator's failure to maintain a sufficient volume and velocity to dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, dusts, smoke, and fumes contributed to the deaths of 29 miners.

- This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

<u>104(d)(2) Order No. 8431838, 30 CFR §75.360, S&S, Reckless Disregard</u>

The operator has engaged in a practice of failing to conduct adequate preshift examinations in the north area of the mine where an explosion occurred on April 5, 2010 which resulted in 29 fatalities and serious injuries to two miners. The inadequate examinations occurred from 1.1.2010 up to the date of the explosion.

The practice includes violations of the following subsections of 75.360:

(a)(1) Miner testimony obtained during the accident investigation indicates that miners entered the mine prior to the completion of the preshift examinations.
An agent of the operator, Jeremy Burghduff, failed to conduct a preshift examination prior to two miners on the pumping crew entering the work area for at least 19 shifts from 03.18.2010 through 04.05.2010. Testimony indicates that the two miners traveled with Mr. Burghduff while he conducted the preshift examination. In addition, data downloaded from Burghduff's Solaris multi-gas detector reveals that the detector had not been turned on from 03.18.2010 until after the mine explosion on 04.05.2010. With his detector turned off, Burghduff was unable to test for methane or oxygen deficiency as required.
Another agent of the operator, John Skaggs, performed an inadequate preshift examination of the longwall on 4.4.2010 for the oncoming midnight maintenance shift. According to testimony, the examination consisted of examining the stage loader area. The examiner failed to examine the entire length of the longwall face, where miners were scheduled to and did work during the oncoming shift, and did not include the required air measurements.
Testimony indicates that examiners routinely failed to examine the tailgate entry of the longwall section.

(b) Over many shifts, several different examiners failed to adequately examine the areas along the travelways from the North Portal to/and including the three working sections: headgate 22, tailgate 22 and the longwall. The examiners failed to identify very obvious hazardous conditions throughout the examined areas. For example, accumulations of loose coal, coal dust, and float coal dust are present in the entries and crosscuts throughout these areas. Additionally, entry widths exceeded the required widths of the approved roof control plan in 16 locations.

(c)(2) The operator regularly failed to accurately measure the air quantity in the intake entries at the intake end of the longwall immediately outby the face.

(g) Preshift exam records for headgate 22 (03.25.2010), tailgate 22 (03.22.2010) and the longwall (03.10.2010) were not verified by the person conducting the examinations. The operator recorded hazardous conditions in its internal production and maintenance reports while failing to record the same hazards in its preshift examination records. This practice prevented MSHA, WVMSH&T, miners, and oncoming foremen from knowing of hazardous conditions and taking preventative measures. In the alternative, the operator failed to comply with 30 C.F.R. 75.363(b).

The failure to identify, record and correct hazards in one area of the mine can result in injury or loss of life in another part of the mine, due to the confined nature of the underground mining environment. The operator's practice of failing to conduct adequate preshift examinations, as well as the operator's practice of failing to conduct adequate weekly and on-shift examinations (as cited in 8431855 and 8227550), exposed miners to ongoing hazards. This practice of failing to conduct adequate preshift examinations and to identify and correct obvious hazardous conditions contributed to the explosion on April 5, 2010 and the resulting 29 deaths, disabling injuries to one miner, and serious injuries to another miner.

The operator engaged in aggravated conduct constituting more than ordinary negligence. This violation is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc. and Massey Energy Company.

104(d)(2) Order No. 8227550, 30 CFR §75.362, S&S, Reckless Disregard

The operator has engaged in a practice of failing to conduct adequate onshift examinations in the north area of the mine where an explosion occurred on April 5, 2010 which resulted in 29 fatalities and serious injuries to two miners. The inadequate examinations occurred from October, 2009 up to the date of the explosion.

The practice includes violations of the following subsections of 75.362:

(a)(1) The operator failed to identify obvious accumulations of loose coal, coal dust, and float coal dust that were present in various locations in the entries and crosscuts of the travelways for HG 22, TG 22, and Longwall sections and on the sections. These hazardous conditions existed over several shifts and should have been observed, recorded and corrected by examiners.

(a)(2) The operator engaged in a practice of failing to conduct adequate onshift examinations of the longwall equipment within one hour of the shift change or before production began to ensure compliance with the respirable dust control parameters.

Numerous deficiencies on the longwall equipment existed as cited in Order No. 8227558 and Citation No. 8227552.

(d) The operator had a practice of failing to test for methane at 20 minute intervals during the operation of the shearer. On the day of the explosion six (6) 20 minute tests for methane were not conducted.

The failure to identify and correct hazards in one area of the mine can result in injury or loss of life in another part of the mine, due to the confined nature of the underground mining environment. The operator's practice of failing to conduct adequate onshift examinations, as well as the operator's practice of failing to conduct adequate preshift and weekly examinations, exposed miners to ongoing hazards. This practice of failing to conduct adequate onshift examinations and to identify and correct obvious hazardous conditions contributed to the explosion on April 5, 2010 and the resulting 29 deaths, disabling injuries to one miner, and serious injuries to another miner.

The operator has engaged in aggravated conduct constituting more than ordinary negligence. This is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 4900578, 30 CFR §75.363(a), S&S, Reckless Disregard

The operator failed to immediately correct or post with conspicuous "Danger" signs hazardous conditions observed and recorded during the on-shift examinations of the belt conveyor systems in the north area of the mine (the area affected by the explosion on 4.5.2010). From 03.01.2010 through 04.05.2010, the operator's on-shift examination records identified approximately 982 hazardous conditions. Of these hazardous conditions, approximately 937 were listed as accumulations of coal and/or lack of rock dusting.

The preshift and onshift records do not indicate that the corrective actions required to address the listed accumulations were taken. Although some corrective actions were listed, most instances where cleaning and dusting was listed as being needed do not indicate that the required corrective actions were adequately performed.

The operator’s failure to immediately correct these hazardous conditions contributed to the death of 29 miners, disabling injuries to one miner, and serious injuries to another miner. Witness statements indicated that the belts were in need of cleaning and additional rock dusting. Investigators observed accumulations of combustible materials in the form of loose and compacted coal throughout the area affected by the explosion. Laboratory Analysis of the rock dust spot survey conducted by MSHA in the affected area after the April 5, 2010 explosion indicated significant non-compliance. The explosion propagated throughout this area where records show cleaning and rock dusting was needed but was not performed.

The operator engaged in aggravated conduct constituting more than ordinary negligence. This violation is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8431855, 30 CFR §75.364, S&S, Reckless Disregard

The operator has engaged in a practice of failing to conduct adequate weekly examinations in the north area of the mine where an explosion occurred on April 5, 2010 which resulted in 29 fatalities. The inadequate weekly examinations occurred from January 1, 2010 up to the date of the explosion. Weekly examinations of this area conducted during this period failed to identify and correct obvious hazardous conditions, including accumulations of combustible materials, and failed to effectively evaluate the performance of the mine's ventilation system.

The practice includes violations of the following subsections of 75.364 that occurred between 01.01.2010 and 04.05.2010:

Subsection 75.364(a) has been violated as follows:
1. Between 01.01.2010 through 04.05.2010, records show that the required weekly examinations of worked-out locations exceeded the required 7 days;
2. Evaluation Point (EP)-LW 1 (air entering Headgate 1 North to assure the headgate of the Longwall is ventilated) was last examined on 03.10.2010. An entry in the record for 03.16.2010 reflects that this EP is blocked with water and records do not indicate it was examined/or could be examined since that date;
3. Data downloaded from one examiner's multi-gas detector indicates that the detector had not been turned on since 03.18.2010. Records indicate this examiner conducted numerous examinations at Bandytown fan, EP-LW 3 (where air exits Headgate 1 North), and EP-TG 1 (where air exits Tailgate 1 North) with his detector turned off;
4. There is no record of EP 65 (return of TG 22 entering Headgate 1 North) ever having been examined;
5. One of the five required air readings (#3 entry) for the EP-LW 2 (Tailgate 1 North) was never taken;
6. No air quality measurements were taken at MP A (intake side of Longwall at Headgate 1 North) and MP B (Longwall tail side of Tailgate 1 North);
7. Air Quantity measurements were not taken at Monitoring Point (MP) B since 03.20.2010.

Subsection 75.364(b) has been violated as follows:

1. The intake split from the West Jarrells Mains to the return off HG 22, and the intake split traveling through old #2 section and crossover, located outby the Longwall, was not traveled;
2. The return split in the crossover between HG 22 and TG 22 was not traveled since 03.13.2010;
3. The intake split, #7 entry of Tailgate 1 North was not traveled since its plan approval on 03.11.2010.

Subsection 75.364(c) has been violated as follows:
1. Air quantity measurements were not taken for 13 intake air splits;
2. Air quality and quantity measurements were not taken for five return air splits.

Subsection 75.364(d) has been violated as follows:
1. The Operator has failed to immediately correct very obvious hazardous conditions that are present throughout ten air courses and two bleeders in the North area of the mine that existed prior to the mine explosion on 04.05.2010. Very obvious hazards of loose coal, coal dust, and float coal dust are present in numerous locations throughout the entries and crosscuts of the air courses that are required to be examined weekly. The explosion which occurred on 04.05.2010 propagated throughout these ten air courses and two bleeders. These areas that the explosion propagated through include intake and return air courses required to be traveled by the weekly examiner. This fire and explosion hazard was obvious to the most casual observer.
2. The Operator has failed to immediately correct areas where entry widths exceeded 21 feet for a distance of more than 5 feet, in 17 locations throughout various areas traveled by the weekly examiner.
3. Since 01.01.2010, hazardous conditions were listed in the weekly examination reports with no corrective action listed. Some of these same hazards were recorded for several consecutive weeks with no corrective action shown. For example, water accumulations in the longwall bleeders were recorded for eight consecutive weeks with no correction action noted.

Subsection 75.364(f) has been violated as follows:
The entry in the weekly examination record book on 03.16.2010 reflects that EP-LW1 was blocked by water and could not be examined. Although the entire mine could not be examined, persons continued to enter the mine and produce coal until the explosion on 04.05.2010.

Subsection 75.364(h) has been violated as follows:
The Operator failed to record hazardous conditions, their locations, corrective action taken, results and locations of air quality and quantity measurements at various times and various locations.

The failure to identify and correct hazards in one area of the mine can result in injury or loss of life in another part of the mine, due to the confined nature of the underground mining environment. The operator's practice of failing to conduct adequate weekly examinations, as well as the operator's practice of failing to conduct adequate preshift and on-shift examinations (as cited in 8431838 and 8227550), exposed miners to ongoing hazards. This practice of failing to conduct adequate weekly examinations and to identify and correct obvious hazardous conditions contributed to the explosion on April 5, 2010 and the resulting 29 deaths, disabling injuries to one miner, and serious injuries to another miner.

The operator has engaged in aggravated conduct, constituting more than ordinary negligence. This is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A. T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8226115, 30 CFR §75.400, S&S, Reckless Disregard

Loose coal, coal dust and float coal dust, was allowed to accumulate in active workings and on rock dusted surfaces. These accumulations of combustible materials existed throughout the following active workings inby survey spad station 19430: Old North Mains, Tailgate 1 North, Headgate 1 North, North Glory Mains, the Long Wall Face, Tail Gate 22 development section, Head Gate 22 development section, Jarrells Mains and the areas known as the Longwall cross over's.

Accumulations ranged from a thin observable layer of float coal dust on belt structures, cribs and various other types of stationary equipment to as much as four feet deep in travelways. The accumulations extended up to the entire entry width and extended as much as 120 feet in length. Many of these accumulations were created during the initial development stages of the mining process. Observations of the cited accumulations are consistent with belt examination records and testimony provided by several miners.

A mine explosion occurred on April 5, 2010 originating on the tailgate of the Longwall and propagating through these areas of the mine inby survey spad 19430. These accumulations of combustible material contributed to the deaths of 29 miners and the disabling injuries of one miner and the serious injuries to another.

The cited accumulations were obvious, extensive and existed for an extended period of time. The conditions were evident to mine management due to the hundreds of weekly, preshift and onshift examinations that had been conducted by examiners and countersigned by upper management during the time the area was developed from March of 2005 to April 5, 2010. These conditions would be obvious to the most casual observer and would have been recorded by any prudent and diligent examiner.

Based on the history of 75.400 violations and this mine being previously placed on a potential pattern of violations, the operator had been placed on notice that greater attention to compliance with 75.400 was needed. The lack of appropriate action to address this ongoing problem establishes that the operator has engaged in a practice of violating 75.400. This is an unwarrantable failure to comply with a mandatory standard.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8226116, 30 CFR §75.403, S&S, Reckless Disregard

The operator has failed to adequately apply and maintain rock dust in such quantities that the incombustible content of the combined coal dust, rock dust, and other dust are not less than 65 per centum in intake air courses or 80 per centum in return air courses. Following a mine explosion on 04.05.2010 a mine dust survey was conducted by MSHA to determine the incombustible content of the combined coal dust, rock dust, and other dust in the mine. These survey samples provided a depiction of the pre-explosion incombustible content in the affected areas of the mine.

MSHA divided the underground workings into 22 separate sampling areas beginning at survey spad 22382 along the Ellis Track entry and survey spad 7301 along the North Mains and extending inby to the deepest accessible portions of the mine affected by the explosion. Areas 18, 20, 21 and 22 inby the Longwall face were not accessible due to adverse roof conditions. Sampling locations were designated on a mine map for each area. Those locations were spaced every 500 feet in areas outby crosscut 67 of Old North Mains and approximately every 100 feet in areas inby crosscut 67. Sampling on 100-foot centers has been shown to offset any dust transport that may have occurred during an explosion. MSHA identified 2,207 locations for band sampling. If an area was too wet or inaccessible due to hazardous conditions, MSHA did not take a sample. Of the 2,207 intended sampling locations, MSHA took samples at 1,803 locations because actual mine conditions dictated that 404 locations were either too wet or otherwise inaccessible for sampling. MSHA sent all 1,803 samples for analysis to determine their incombustible content. Of the 1803 samples collected 1412 of the samples were non-compliant (78.31 percent). Of the 22 sampling areas designated by MSHA, flame propagated through 12 of these areas (area 5 at crosscut 67 and extending inby, and areas 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 19). Flame propagation could not be determined in areas 18, 20, 21 and 22 due to inability to collect samples. The flame propagation through these areas directly contributed to the deaths of 29 miners.

The results of the 1353 mine dust samples collected by MSHA within the area encompassed by flame propagation (determined by the extent of coking found in the dust samples collected) show that the operator failed to adequately apply and maintain rock dust on the top, floor, and ribs of this underground coal mine. Of the 1353 total samples collected from the flame propagation area, 1225 were non-compliant (90.5 percent). The failure by the operator to adequately rock dust these areas of the mine allowed a coal dust explosion to propagate, resulting in the deaths of 29 miners and injuries to others. The operator has engaged in aggravated conduct and more than ordinary negligence by failing to adequately rock dust and maintain the incombustible content in these areas of the underground coal mine to control dangerously volatile accumulations of combustible material. This is an unwarrantable failure to comply with a mandatory standard.

This order is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(a) Citation No. 8227549, 30 CFR §75.1725(a), S&S, Moderate Negligence

The operator has failed to maintain the JOY 7LS Longwall Shearer in safe operating condition.

At least two worn bits were found on the outby bit ring on the drum. Both bits were clearly missing the carbide tip. These bits had noticeably large wear flats on them.

An explosion occurred at this mine on 4/5/2010 that resulted in 29 fatalities.

The most likely ignition source was the longwall shearer bits striking rock. Studies have shown that worn bits pose a significant ignition potential. This can occur when the steel shank of the bit strikes sandstone with a high quartz content and produces a hot molten streak. Studies have also shown that a well maintained tungsten carbide tip, when used with the proper attack and tip angles to prevent the steel shank from coming into contact with the sandstone, will greatly reduce the odds of a frictional ignition. Frictional heat from the worn bits striking rock is the most likely source of the ignition for the April 5, 2010 explosion. The failure to maintain the shearer in safe operating condition contributed to the deaths of 29 miners.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8256726, 30 CFR §48.3, S&S, Reckless Disregard

The mine operator failed to comply with the approved training plan in effect at the mine prior to April 5, 2010. The approved training plan, dated March 29, 2007, required training to be provided in several training programs, including experienced miner training, task training, and annual refresher training. The operator's failures included:

1). Approximately 112 miners either did not receive experienced miner training or received incomplete experienced miner training.

2). Approximately 42 miners did not receive task training before performing the task as mobile equipment operators or performing other new job tasks.

3). Approximately 21 miners did not receive annual refresher training.

4). Approximately 22 miners received experienced miner training from individuals who were not MSHA-approved instructors. Nine different individuals certified these miners' training records despite not being MSHA-approved instructors.

Company audits conducted in September 2009 and October 2009 identified many of these failures, which put the operator on notice of its compliance problems. As of April 5, 2010, the operator had failed to correct or address most of these failures.

Due to the operator's failure to comply with the mine's approved training plan, many miners did not receive training in hazard recognition, prevention of accidents, and the mine's roof control and ventilation plans (including the mine's methane and dust control plan for the longwall water spray system). The operator also failed to provide task training to many of its examiners, its rock dusting crew, and several miners who operated and maintained the longwall shearer. The underground conditions at the mine, including the extensive accumulations of loose coal, coal dust, and float coal dust, the lack of adequate rock dusting, and the poor condition of the longwall shearer, were present in part because of the operator's failure to provide adequate training on identifying and correcting these hazardous conditions. These conditions contributed to the deaths of 29 miners on April 5, 2010.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

104(d)(2) Order No. 8227558, 30 CFR §75.370(a)(1), S&S, Reckless Disregard

The mine operator failed to follow the approved ventilation plan in effect at the mine on April 5, 2010.

The operator failed to comply with the methane and dust control plan portion of the approved ventilation plan approved on June 15, 2009 for the 050-0 MMU. The approved methane and dust control portion of the ventilation plan requires that the JOY 7LS Longwall shearer be equipped with 109 water sprays, with 43 water sprays on each drum. The plan further specified that these sprays operate at a minimum of 90 psi at each spray block.

Evidence obtained during the investigation of an explosion accident revealed that the shearer was being operated with missing and clogged water sprays. Seven sprays on the tailgate drum were missing. As a result of the missing sprays, the pressure at the remaining sprays was significantly reduced below the 90 psi requirement. One function of the water sprays is to prevent a potential ignition source from frictional heat generated by the shearer bits striking rock. Such frictional heat from bits striking rock is the most likely source of the ignition for the April 5, 2010 explosion. The failure to comply with this plan requirement contributed to the deaths of 29 miners.

Operating the shearer with the missing sprays would have been obvious to casual observation. Testimony and company records indicate that operating the shearer with missing sprays was a practice at the mine. The operator has engaged in aggravated conduct constituting more than ordinary negligence. This is an unwarrantable failure to comply with a mandatory standard.

Standard 75.370(a) (1) was cited 33 times in two years at mine 4608436 (33 to the operator, 0 to a contractor).

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

<u>104(a) Citation No. 4900615, 30 CFR, §75.363(a), S&S, Moderate Negligence</u>

An employee of David Stanley Consultants LLC has failed to immediately correct or post with conspicuous "Danger" signs hazardous conditions observed and recorded during the examinations of the belt conveyor systems in the North area of the mine (the area of the mine affected by an explosion on 04.05.2010). From 03.05.2010 through 04.05.2010, David Stanley Consultants (YBV) employee William Campbell conducted 83 examinations along the conveyor belts affected by explosion. The record reflects that these conveyor belts needed rock dusting and/or cleaning. These hazardous conditions were almost never shown to be fully corrected or posted with conspicuous danger signs.

David Stanley Consultants LCC's failure to immediately correct these hazardous conditions contributed to the death of 29 miners, disabling injuries to one miner, and serious injuries to another miner. Witness statements indicated that the belts were in need of cleaning and additional rock dusting. Investigators observed accumulations of combustible materials in the form of loose coal and compacted coal throughout the areas affected by the explosion. Laboratory Analysis of the rock dust spot survey conducted by MSHA in the affected areas after the April 5, 2010 explosion indicate significant non-compliance. The explosion propagated throughout areas where records show cleaning and rock dusting was needed but was not performed.

This citation is being issued to the following entities as a unitary operator: Performance Coal Company, Massey Coal Services, Inc., A.T. Massey Coal Company, Inc., and Massey Energy Company.

<u>104(d)(1) Citation No. 8431839, 30 CFR, §75.360, S&S, High Negligence</u>

An employee of David Stanley Consultants LLC has failed to conduct adequate preshift examinations in the North area of the mine where an explosion occurred on April 5, 2010 which resulted in 29 fatalities and serious injuries to two miners. This employee of David Stanley Consultants performed inadequate preshift examinations for several months prior to the explosion.

The inadequate examinations include violations of the following subsections of 75.360:

(b) Over many shifts, the employee of David Stanley Consultants failed to adequately examine the areas along the travelways from the Ellis Portal to the three working sections: headgate 22, tailgate 22, and the longwall. The examiner failed to identify very obvious hazardous conditions throughout the examined areas. For example, accumulation of loose coal, coal dust, and float coal dust were present in the entries and crosscuts throughout these areas. Additionally, entry widths exceeded the required widths of the approved roof control plan in at least 16 locations.

(g) The examiner conducted preshift examinations on the tailgate 22 section, headgate 22 section, intake rooms off the North Mains and Glory Hole Mains, and travelways/track entries. For these locations, the examiner repeatedly failed to record the results of the required air quality checks.

The failure to identify, record and correct hazards in one area of the mine can result in injury or loss of life in another part of the mine, due to the confined nature of the underground mining environment. The contractor's failure to conduct adequate preshift examinations exposed miners to ongoing hazards. This failure to conduct adequate preshift examinations and to identify and correct obvious hazardous conditions contributed to the explosion on April 5, 2010 and the resulting 29 deaths, disabling injuries to one miner, and serious injuries to another miner.

The contractor engaged in aggravated conduct constituting more than ordinary negligence. This violation is an unwarrantable failure to comply with a mandatory standard.