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UNITED STATES
DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

COAL MINE SAFETY AND HEALTH

REPORT OF INVESTIGATION

Underground Coal Mine

Fatal Injury, Other Accident
November 23, 2009

No. 7 Mine
Jim Walter Resources, Inc.
Brookwood, Tuscaloosa County, Alabama
MSHA I.D. No. 01-01401

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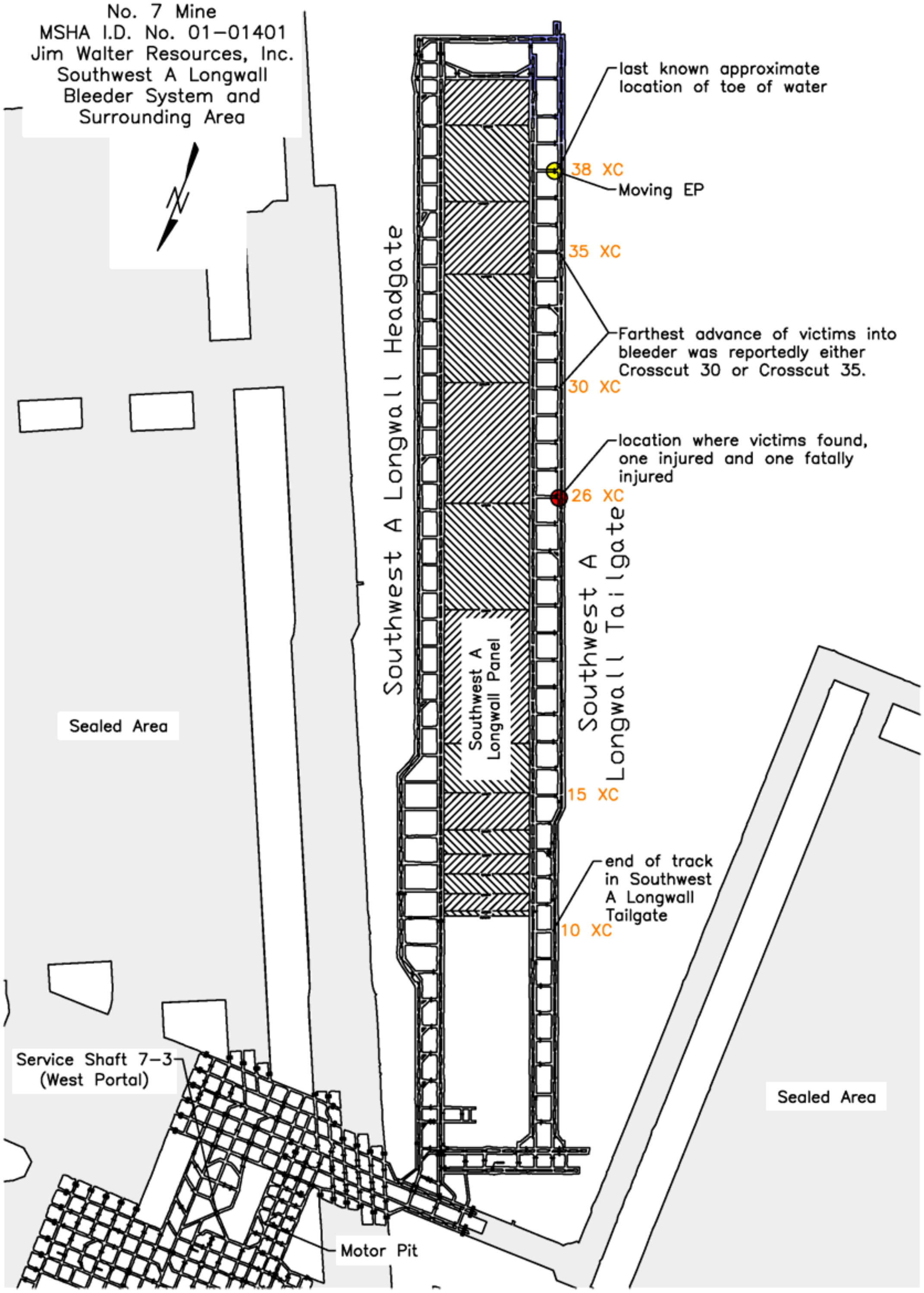
No. 7 Mine
MSHA I.D. No. 01-01401
Jim Walter Resources, Inc.
Southwest A Longwall
Bleeder System and
Surrounding Area
last known approximate location of toe of water
38 XC
Moving EP
35 XC
Farthest advance of victims into bleeder was reportedly either Crosscut 30 or Crosscut 35.
30 XC
location where victims found, one injured and one fatally injured
26 XC
Southwest A Longwall Headgate
Southwest A Longwall Tailgate
Southwest A Longwall Panel
15 XC
end of track in Southwest A Longwall Tailgate
10 XC
Sealed Area
Sealed Area
Service Shaft 7-3 (West Portal)
Motor Pit

OVERVIEW

On Monday, November 23, 2009, a mine foreman, accompanied by another miner, was conducting the weekly examination in the tailgate bleeder entries of the Southwest A Longwall (No. 2 Longwall) bleeder system on the 3:00 p.m. to 11:00 p.m. shift (evening shift) at the Jim Walter Resources, Inc., No. 7 Mine. The two miners encountered a humid and unusually hot atmosphere as they traveled toward the Moving EP examination location at Crosscut 38, near the toe of the accumulated water in the bleeder. Their travel became more arduous as they progressed due to the heat, humidity, and rough terrain. Reportedly, at either Crosscut 30 or Crosscut 35, the mine foreman detected an oxygen deficient atmosphere (19.4 percent oxygen) and decided they would be unable to complete the examination due to the heat, humidity, and oxygen deficiency. Both miners retreated but became incapacitated due to the heat and humidity before exiting the bleeder.

When the miners failed to report near the end of the shift, mine officials initiated a search for both men. At approximately midnight, they were found in the bleeder near Crosscut 26. One miner was injured but responsive. The other miner was non-responsive, not breathing, and had no pulse. Rescue operations were implemented. The injured miner was treated, removed from the area, and transported to a local hospital. The non-responsive miner was brought to the surface where he was pronounced dead (Appendix A contains the victim data sheet).

Rescue and recovery efforts were hampered by high heat, humidity, oxygen deficiency, adverse roof conditions, and rough terrain within the bleeder system. A ventilation change was completed that introduced cooler fresh air into the bleeder entries where rescuers were working. Still, several hours elapsed before the rescuers were able to remove both victims. Many of the rescuers required medical treatment after they became affected by the high heat and humidity. More than 88 persons were directly involved with the rescue and recovery efforts (Appendix B).

GENERAL INFORMATION

The No. 7 Mine, MSHA I.D. No. 01-01401, is an underground coal mine owned and operated by Jim Walter Resources, Inc. The mine is located in Tuscaloosa County, near Brookwood, Alabama.

At the time of the accident, the mine provided employment for 696 persons and operated seven days per week, three 8-hour shifts per day. Coal was produced six days per week on all shifts. The mine produced an average of 9289 clean tons per day during November 2009. The miners are represented by the United Mine Workers of America (UMWA).

The mine operates in the Blue Creek coal seam, with an average mining height of 80 inches. Appendix C depicts the approximate extent of mine workings. Personnel accessed the mine through two service shafts, identified as the East and West Portals. Most mining activities were coordinated at the East Portal. The mine operated seven mechanized mining units (MMUs): five continuous mining machine units and two longwall mining machine units. Coal was transported underground by conveyor belts and hoisted to the surface via two skip shafts. Longwall gateroads were developed using four entries in a yield-stable-yield pillar configuration. Entries were commonly numbered from left to right, as looking inby, with Entry No. 1 being the farthest left entry. The No. 1 Longwall section was mining in the I Panel and mining had been completed in the No. 2 Longwall section in the Southwest A Longwall Panel. Recovery of the Southwest A Longwall equipment was nearly complete.

The principal officials of the mine at the time of the accident were:

Keith Shalvey	Mine Manager
Keith Plylar	Safety Manager

A Mine Safety and Health Administration (MSHA) Safety and Health Inspection was completed on September 30, 2009, and another was ongoing at the time of the accident. The Non-Fatal Days Lost (NFDL) injury incidence rate for the mine for the previous quarter was 5.13 compared to the national NFDL rate of 2.58.

DESCRIPTION OF THE ACCIDENT

The weekly examination of the Southwest A Longwall bleeder system was due to be completed on Monday, November 23, 2009. This examination was normally conducted on the 7:00 a.m. to 3:00 p.m. shift (day shift) by Harold Jones, outby supervisor. Jones was scheduled to be on vacation that day. Therefore, Paul Phillips, general services coordinator, assigned Milton Ethridge, outby supervisor on the evening shift, to conduct the examination in place of Jones. This assignment was made prior to November 22, 2009.

The weekly examination required travel in the downward sloping Southwest A Longwall Tailgate bleeder entries to an examination evaluation point, Moving EP, which was located outby the toe of water that accumulated at the inby end of the bleeder entries. Appendix D depicts the Southwest A Longwall bleeder system and surrounding areas of the mine. The examiner was required to determine if the toe of the water had advanced outby the Moving EP. If the toe of the water was outby the Moving EP, he was to reestablish the Moving EP by knocking a hole in the stopping at the next crosscut outby the toe of the water. Measurement of air quantity and tests for air quality (methane and oxygen) and air direction were required at the Moving EP. Ethridge had previously worked in the bleeder and knew the air temperature in the bleeder was hot. After Ethridge had been assigned to conduct the examination, Jones discussed with him the need to take plenty of sports drinks, water, and ice because the temperature of the air within the bleeder had become hotter than in the past.

Ethridge and James Chaney, general laborer IS (Inside), reported for work prior to their regularly scheduled evening shift on November 23, 2009. Ethridge talked with Ty Olson, outby area manager, and informed him that that he was going to take it slow and would probably be all shift conducting the examination. Chaney, a member of Ethridge's regular crew, was assigned by Ethridge to accompany him while he conducted the weekly examination of the Southwest A Longwall bleeder system. Chaney had also previously worked in the Southwest A Longwall bleeder and knew the area was hotter than other areas of the mine and the ground conditions were difficult.

Prior to entering the mine via the West Portal Service Shaft at the beginning of the shift, Ethridge secured a backpack that he and Chaney filled with water, sports drinks, soft drinks, and ice. Ethridge also reviewed the "Weekly Examinations" mine record book, which contained the results of previous weekly examinations of the Southwest A Longwall bleeder. Ethridge was issued a gas detector identified as MSA#11.

After entering the mine, Ethridge turned on his detector, assigned the remainder of his crew work for the shift, and secured a manbus for transportation. At the motor pit located near the West Portal Service Shaft bottom, Ethridge contacted Dennis Herring, communications supervisor, who was the CO operator (the person assigned to track the locations of miners) stationed on the surface at the East Portal. Ethridge informed Herring that he and Chaney were going to the Southwest A Longwall bleeder and that he expected they would be out of the longwall bleeder around 9:10 p.m. to 10:00 p.m. Herring recorded the information.

Ethridge and Chaney traveled to the end of the track at Crosscut 10 in the Southwest A Longwall Tailgate Entry No. 3. Ethridge discussed switching transportation equipment with the foremen supervising the Southwest A Longwall equipment recovery instead of swapping them around, so they could leave the area before he and Chaney returned. Ethridge and Chaney then removed some of their extra clothing in preparation for the elevated temperatures in the areas that they would be traveling.

Ethridge marked up the regulator located in Entry No. 3 located just inby Crosscut 11 at approximately 4:30 p.m. Then he and Chaney passed through the personnel door in the regulator and entered the bleeder. Chaney walked about 20 feet behind Ethridge, the usual procedure followed when they traveled in bleeders. At the regulator between Entry No. 2 and Entry No. 3 in Crosscut 14, which was one of the daily examination locations for the bleeder, Ethridge checked for dates and initials on the examination dateboard. Chaney asked Ethridge if he was going to mark up the dateboard and Ethridge told him he would on their way back out.

Continuing to travel inby Crosscut 14, Ethridge and Chaney encountered bleeder airflow moving in an outby direction as expected. The air temperature began to increase at approximately Crosscut 15. By 4:41 p.m., Ethridge's detector indicated the methane concentration was 0.55% and the oxygen concentration was 19.9%.

At approximately 5:00 p.m., Herring was relieved as CO operator by John Anderson, communications supervisor. (The CO operators worked 12-hour shifts: 5:00 a.m. to 5:00 p.m. and 5:00 p.m. to 5:00 a.m.) Before Herring left the mine, he transferred miner tracking information and other notes to Anderson. They discussed what was going on both underground and on the surface and the different locations of the miners, including the two who were in the bleeder and when they expected to be out.

Traveling in the bleeder, Ethridge observed the general condition of the ventilation controls in the crosscuts between Entry No. 2 and Entry No. 3. Some were still intact but most had curtain over them to keep the air flowing inby through the worked-out area in Entry No. 2. He also observed danger ribbons, used to mark off the walkway around unsafe roof, moving in the air current and determined the air in the bleeder was traveling in the proper direction.

As Ethridge and Chaney advanced further into the bleeder, walking became increasingly difficult due to numerous supplemental standing roof supports, floor heaving and rock that had fallen to the ground from deteriorated roof. As the terrain in the bleeder entry became more difficult, their pace became slower. They stopped about every three or four crosscuts to rest because they were exhausted and wanted to cool off. They took turns carrying the backpack. Ethridge thought the temperature seemed to be getting hotter than it had when he was previously in the bleeder. Chaney commented about how hot it was and they discussed that it had always been warmer in this bleeder. Ethridge told Chaney that he thought it would get cooler if they went in a little bit further, because in the past the air that came across at the inby end of the bleeder was cooler. They would later discover that this time it did not. A little later, Chaney heard a rock fall some distance off and expressed concern about getting out. Ethridge explained that it sounded like the rock fall was in the adjacent caved area of the longwall panel and it was alright.

The farther Ethridge and Chaney traveled, the hotter it seemed to get. Ethridge recalled his detector alarmed due to an oxygen concentration of 19.5% inby Crosscut 25 or Crosscut 30. Ethridge believed it was somewhere around Crosscut 30 or Crosscut 35 that they encountered an oxygen concentration of 19.4%. At that point, he told Chaney it seemed like it was hotter than it ever had been and that they should turn around and go back out. He would tell Olson they couldn't get back to the toe of the water or the Moving EP. Ethridge noted the air flow was still moving in the proper direction, but not strongly. The time and exact location this occurred could not be determined by MSHA investigators. (After the accident, Ethridge believed the heat and humidity where they turned around was a hazard that he would report if he encountered it again.)

As they traveled outby, walking uphill was more difficult and they stopped to rest about every crosscut. At some point, Ethridge checked the backpack and found that much of the liquids they brought were consumed except for a little water and the ice in the bottom of the backpack.

At about Crosscut 26, Chaney became incapacitated and did not respond to Ethridge’s attempts to communicate with and revive him. Ethridge determined Chaney was not breathing and attempted to move outby. His legs cramping and no longer able to walk, Ethridge attempted to crawl. He traveled about another 15 feet outby. The time this occurred could not be determined by MSHA investigators. Ethridge believed he became unconscious at one time or another. After the accident, Ethridge could not recall or estimate timeframes in which many of the events occurred.

During the 3-minute time period ending at 6:02 p.m., Ethridge's detector recorded the peak methane concentration as 1.30% and the minimum oxygen concentration as 18.60%. During the 3-minute time period ending at 8:47 p.m., the detector recorded the peak methane concentration as 0.60% and the minimum oxygen concentration as 19.30% before the detector’s datalogging session ended. MSHA investigators determined the end of the datalogging session was a result of the instrument being turned off. Ethridge’s detector appears to have been turned on and off two more times before 11:30 p.m. and turned on again at 11:47 p.m. on November 23, 2009.

At 10:30 p.m., Anderson had not heard from Ethridge or Chaney. At 10:40 p.m., he called to speak with Phillips, who was on the surface at the West Portal. Phillips was getting things organized for the 11:00 p.m. to 7:00 a.m. shift (owl shift) and Anderson instead spoke with Timothy Jenkins, an outby supervisor who worked the owl shift at the West Portal, to see if they had heard from Ethridge or Chaney. Jenkins indicated that he would check and call Anderson back.

Anderson also called Gene Condottore, an outby supervisor who worked the owl shift at the East Portal, in an effort to determine if Timothy Tingle, a fireboss who worked the evening shift, had reported the results of his preshift examination for the on-coming owl shift. Until such time as all preshift reports were recorded, mine personnel for the oncoming shift could not enter the mine. Learning that all preshift examination results had not been recorded, Anderson turned on a signal light at both portals that indicated the mine examinations were not finished and notified miners to not enter the mine. It was later learned that Tingle had transportation problems that delayed him in calling out the results of his examinations.

Before 11:00 p.m., Jenkins talked with Phillips. Phillips then contacted Anderson and told him that he had not heard from Ethridge or Chaney. Phillips directed Ricky DeFoor, outby supervisor, and Jarrod "Trent" Creel, general laborer IS, who both worked the owl shift, to go to the Southwest A Longwall bleeder to search for Chaney and Ethridge as soon as all of the preshift examinations were called in.

At approximately 11:05 p.m., DeFoor and Creel entered the mine with the first group of miners working the owl shift at the West Portal Service Shaft. After securing transportation, DeFoor and Creel proceeded to the Southwest A Longwall Tailgate. On the way, they were delayed approximately 15 minutes while motormen moved their car to clear the track for them to pass. The remaining personnel who worked the owl shift were dispatched to their assigned work areas.

The notes maintained by Phillips and Anderson both noted that DeFoor and Creel entered the Southwest A Longwall bleeder at approximately 11:40 p.m. When they encountered the heat just inby Crosscut 15, Creel did not continue. DeFoor sent Creel outby to the end of the track and continued traveling inby.

Meanwhile, at approximately 11:35 p.m., Phillips directed Jenkins to take two subordinates and go to the end of the Southwest A Longwall Tailgate track. Jenkins, James O'Rear, general laborer IS, and Michael Winkleblack, general laborer IS, arrived at the end of the Southwest A Longwall Tailgate track at approximately 12:00 a.m. They waited at the mine phone located one crosscut away in Entry No. 2.

At approximately 12:00 a.m., DeFoor reached Ethridge, who was lying on the mine floor approximately 20 feet outby the edge of Crosscut 26 intersection on the left side of the entry (as looking inby). Ethridge was responsive but not fully coherent. He appeared to DeFoor to go in and out of consciousness. He was not sweating, had leg cramps, and could not stand. DeFoor checked and found Ethridge's pulse to be rapid. DeFoor found Chaney approximately 15 feet inby Ethridge on the right side of the entry. When checked by DeFoor, Chaney was not breathing. DeFoor did not detect a pulse and he believed Chaney was deceased. DeFoor detected 18% oxygen and 0.8% methane at Crosscut 26. DeFoor then returned to Ethridge and told him that he was by himself and needed to leave to get help. DeFoor left and traveled outby to the end of the track.

Shortly after Jenkins, O'Rear, and Winkleblack arrived at the end of the Southwest A Longwall Tailgate track, Creel exited the bleeder. Creel told Jenkins that he had gotten sick and didn't feel safe in the bleeder and that he had left DeFoor at Crosscut 24.

Jenkins called Phillips to report his conversation with Creel. After providing an update to Anderson, Phillips called Jenkins back and told him to take Winkleblack and travel into the Southwest A Longwall bleeder to help DeFoor. At approximately 12:19 a.m., Jenkins and Winkleblack entered the Southwest A Longwall bleeder.

Jenkins and Winkleblack met DeFoor as they passed through the regulator just inby Crosscut 11. DeFoor told Jenkins and Winkleblack that Chaney was deceased and Ethridge needed help. Jenkins told Winkleblack to go out with DeFoor. Jenkins then took all the water they had and started inby to begin treatment of Ethridge. DeFoor and Winkleblack traveled outby to the mine phone near the end of the track to call for help.

RESCUE AND RECOVERY OPERATIONS

Beginning around 11:20 p.m., Anderson notified Dale Byram, Jim Walter Resources, Inc., General Manager of Safety and Training, Shalvey, and Plylar and informed them that two miners were missing in the Southwest A Longwall bleeder and other miners had been sent to search for them. Byram then called John Aldrich, Jim Walter Resources, Inc., Training Instructor, and briefed him on the events at the No. 7 Mine. Both men traveled to the Jim Walter Resources, Inc., Training Center in case a mine rescue team was needed. At approximately 11:45 p.m., Olson was notified about the missing miners and traveled to the mine.

DeFoor contacted Phillips by phone at approximately 12:30 a.m. and reported that he had found the two men; Ethridge was very weak and dehydrated and Chaney was non-responsive. Phillips passed on the information to Anderson. The response transitioned from a search for the missing miners to a rescue and recovery operation. Phillips established his office, on the surface at the West Portal, as the incident command and control center. The remainder of the rescue and recovery operation was coordinated and all involved personnel tracked from this location.

In the Southwest A Longwall bleeder, Jenkins arrived at Crosscut 26 at approximately 12:30 a.m. Jenkins gave Ethridge some water, and then checked Chaney for a pulse and found none. Jenkins then returned to Ethridge and continued first aid treatment (i.e., pouring water on his head and neck, removing clothing, and getting him to drink water).

At about 12:35 a.m., Anderson called Plylar and Byram and reported the information about Ethridge and Chaney. Shortly thereafter, Phillips called Olson, who was en route, and reported that Ethridge and Chaney had been found.

At 12:44 a.m., Plylar called the MSHA toll-free number to report the incident. David Allen, MSHA District 11 Conference and Litigation Resolution Supervisor, was notified of the incidents by the toll-free operator at 12:50 a.m. Allen called Plylar and verbally issued a 103(j) Order. During the phone conversation, Plylar told Allen that two miners were in the Southwest A Longwall bleeder. One miner was responsive but exhausted and the other miner was non-responsive and presumed dead. Plylar told Allen he believed the deceased miner had suffered a heart attack.

Plylar instructed Anderson to withdraw all miners that were not involved with the rescue and recovery efforts from the mine. Among others, Anderson contacted the No. 1 Longwall section and informed Chad Turner, longwall supervisor and Jim Walter Resources, Inc., mine rescue team member, to remove the power and bring his crew outside.

Byram and Aldrich retrieved mine rescue equipment from the Training Center, and proceeded to the No. 7 Mine. Upon arrival at the mine, Byram and Aldrich met Terry Ash and Timothy Dorsett, Jim Walter Resources, Inc., mine rescue team members, and received a situation briefing from Phillips and prepared to go underground. At 1:10 a.m., Team 1, consisting of Byram, Aldrich, Ash, and Dorsett, entered the mine at the West Portal and proceeded to the end of the track in the Southwest A Longwall Tailgate. Phillips called DeFoor and told him to wait at the end of the track for the four mine rescue personnel that were en route to his location and to take them to Ethridge and Chaney.

At 1:20 a.m., Allen called Thomas O'Donnell, MSHA Coal Mine Inspector. Allen told O'Donnell to go to the mine and investigate the possible heart attack.

At approximately 1:30 a.m., Team 1 arrived at the end of the track in Southwest A Longwall Tailgate where they met DeFoor. Byram reminded Team 1 that they would don their Dräger BG-4 self contained breathing apparatuses (SCBAs) when they encountered oxygen concentrations below 19.5%. DeFoor was given an SCBA to carry. Team 1 proceeded into the bleeder without donning their SCBAs (bare faced) with DeFoor in the lead. The others followed with a Stokes basket full of equipment and medical supplies. A Stokes basket is a type of stretcher designed to be used where there are obstacles to movement or other hazards and is widely used in all types of rescue.

At about the same time, Olson, who had previously arrived at the West Portal, entered the mine. He met Ricky Fosse, Brent Allgood, Donald Caldwell, Jamell Treadwell, and Brian Ivey, laborers IS, at the bottom of the West Portal Service Shaft. They traveled by manbus to the end of the track in the Southwest A Longwall Tailgate. Olson instructed the others to bring water and remove any extra clothing so they would not overheat while traveling in the bleeder. At approximately 1:50 a.m., Olson, Fosse, Allgood, Caldwell, Treadwell, and Ivey entered the bleeder. Meanwhile Phillips sent additional men to the Southwest A Longwall Tailgate to aid in the rescue and recovery efforts.

In the Southwest A Longwall bleeder, Team 1 and DeFoor stopped at about Crosscut 22 to rest. Team 1 had been pushing themselves and began to feel the affects of the heat. DeFoor told Byram that Jenkins was still at Crosscut 26 by himself and he was going to keep going inby to assist Jenkins with Ethridge. Shortly after DeFoor left, Olson, Fosse, Allgood, Caldwell, Treadwell, and Ivey caught up with Team 1. Olson left the other five men from his group to help carry the Stokes basket and medical equipment and followed DeFoor inby to Crosscut 26.

At approximately 2:10 a.m., DeFoor reached Jenkins at Crosscut 26 and assisted in treating Ethridge. Olson arrived at approximately 2:15 a.m. and found Ethridge. Ethridge had rapid shallow breathing and was responsive, but did not appear to be fully coherent. Olson also noted that the air was traveling in an outby direction at Crosscut 26. Olson recalled that both his and DeFoor's detectors were in alarm. Olson then retrieved a Stokes basket that was located just inby Ethridge's location. After Olson secured the Stokes basket, he traveled back outby to meet the Team 1 group.

At approximately 2:15 a.m., John Sanders, No. 7 Mine supervisor, along with Theodore Nelson, supply motorman, Chris McGuffie, general labor IS, Steve Smith, rock dust motorman, Randy Gable, general labor IS, Jeremy Hendrix, general labor IS, Dave Thomas, general labor IS, Jeff Beard, bottom man/ dumper, Ross Mize, general labor IS, Brian Miller, CO monitor technician, and Dave Miller, electrician IS, entered the Southwest A Longwall bleeder and started inby to assist in the rescue.

Olson returned to Team 1, Fosse, Allgood, Caldwell, Treadwell, and Ivey and told the group he had found a Stokes basket at Crosscut 26 that could be used to carry Ethridge. At this time, Byram, Ash, and Dorsett started to feel sick from the heat and decided to go back out to the end of the track. Aldrich took an oxygen bottle from the medical supplies and donned his SCBA. Aldrich, Olson, Fosse, Allgood, Caldwell, Treadwell, and Ivey left the Stokes basket they were carrying at Crosscut 22 and continued inby. Along the way, Aldrich checked his detector and noted the oxygen concentration fluctuated, decreasing to as low as 19.1%. On the way inby, Aldrich reached a point where he told Olson that he couldn't go any further. Aldrich's head was hurting, his heart rate had increased, he was nauseous, and his skin was dry. Aldrich recognized that he was in trouble and sat down to rest. Olson took the oxygen bottle from Aldrich and continued inby to Crosscut 26.

At Crosscut 26, Olson attempted to administer oxygen to Ethridge, but the regulator would not properly seal to the bottle. At approximately 3:00 a.m., Ethridge was placed into the Stokes basket and DeFoor, Jenkins, Olson, Fosse, Allgood, Caldwell, Treadwell, and Ivey carried Ethridge outby 20 to 30 feet at a time, going around roof supports and over fallen material, to Aldrich's location near Crosscut 25.

At 3:05 a.m., Phillips called for assistance from the Jim Walter Resources, Inc., No. 4 Mine. Mine rescue team members from the No. 4 Mine were sent to assist.

At Crosscut 25, Aldrich tried to place his SCBA's face piece on Ethridge, but Ethridge kept pulling it off. Aldrich removed the regulator from the oxygen bottle, turned it on, and placed it on Ethridge's chest, hoping the stream of oxygen would provide him some assistance.

After the group rested, Aldrich stood up to move his SCBA out of the way. He felt light headed, and fell to his knees. Treadwell poured water over Aldrich's head in an attempt revive him. Aldrich noted that Treadwell looked bad; his skin appeared dry and dusty. Aldrich's nausea was increasing and he thought three or four of them may be in serious trouble if they did not get water and cool air quickly. Olson sent Treadwell, Caldwell, and DeFoor out to the end of the track to get more people to assist.

A few minutes after DeFoor left, Sanders, Smith, Thomas, Beard, B. Miller, and D. Miller arrived at Crosscut 25. After their arrival, Olson sent Jenkins out to the end of the track. At this time, Olson decided to take Aldrich, Fosse, Allgood, and Ivey outby to the end of the track also. Sanders, Smith, Thomas, Beard, B. Miller, and D. Miller then carried Ethridge to Crosscut 24.

At 3:50 a.m., O'Donnell arrived at No. 7 Mine and modified the 103(j) Order to a 103(k) Order. O'Donnell received a briefing from Shalvey and Plylar and went to the incident command and control center, established in Phillips' office. Jimmy Rivers, State of Alabama Department of Industrial Relations Mining and Reclamation Division, Mine Inspection Supervisor, Tommy McNider, Jim Walter Resources, Inc., General Manager Engineering, and Phillips were already present.

Meanwhile, Team 2, consisting of Jim Walter Resources, Inc., mine rescue team members Vince Nethery, Chad Turner, Anthony Cook, and Matthew Thompson, and Dale Johnson, Mine Inspector State of Alabama Department of Industrial Relations Mining and Reclamation Division and mine rescue team member, entered the mine and traveled to the end of the track in the Southwest A Longwall Tailgate. Byram briefed Johnson and cautioned him to pace himself due to conditions. At 4:21 a.m., Turner marked the time and number of men accompanying him on his wrist when Team 2 entered the bleeder and traveled inby to Crosscut 24.

Team 2 met Aldrich near Crosscut 19. Johnson assisted Aldrich by pouring water on him and Aldrich then continued out to the end of the track. Turner, Thompson, Nethery, and Cook continued inby. Near Crosscut 20 they met Olson. Olson reported Ethridge was at Crosscut 24 and told them to send the bare faced men out when they got there. Near Crosscut 22, Turner, Thompson, Nethery, and Cook encountered oxygen concentrations of less than 19% and donned their SCBAs. Turner, Thompson, Nethery, and Cook arrived at Crosscut 24 and relieved the bare faced men that were with Ethridge. They continued the first aid treatment of Ethridge by giving water, wetting, fanning, removal of clothing, monitoring of vital signs, and administering supplemental oxygen and awaited additional help. Shortly after arriving at Crosscut 24, Nethery got sick from the heat and was taken to the end of the track by Cook. Cook then returned to assist with Ethridge.

At 5:16 a.m., Team 3, consisting of Russell Fox, Joey Hamrick, Keith Burgess, and Buddy Caudill, Jim Walter Resources, Inc., mine rescue team members, Christopher Wilson, No. 7 Mine supervisor, John Dukes, No. 7 Mine supervisor, Kerry Cupp, No. 7 Mine supervisor, and Jason Fox, No. 7 Mine supervisor, entered the mine and traveled to the end of the track in the Southwest A Longwall Tailgate.

Byram was treating Treadwell and Aldrich for heat disorders by administering supplemental oxygen and intravenous (IV) fluids when Team 3 arrived at the end of the track of the Southwest A Longwall Tailgate. Byram told Caudill that there were people being affected by the heat inby the regulator and told them to bring out whoever they found. Byram also told them that there were only four mine rescue team members in the bleeder with SCBAs.

At 5:46 a.m., Team 3 entered the bleeder. Team 3 traveled inby to Crosscut 15 or Crosscut 16 where they encountered an oxygen concentration of 19.5%. R. Fox, Hamrick, Burgess, and Caudill donned their SCBAs and told the four persons without SCBAs to not go inby any further.

Shortly after Team 3 entered the bleeder, Byram transported Aldrich and Treadwell to the surface. Along the way, Aldrich and Treadwell developed leg cramps and Aldrich reported chest pains. Upon reaching the surface at approximately 6:07 a.m., Aldrich and Treadwell were transported to the hospital by ambulance. Byram gathered more medical supplies, reentered the mine and traveled back to the Southwest A Longwall Tailgate.

As day shift personnel reported for work, those not necessary for the rescue and recovery operation were sent home. At approximately 6:30 a.m., day shift personnel were sent underground to the end of the track in the Southwest A Longwall Tailgate.

At approximately 7:00 a.m., Olson called outside to Shalvey. Olson told Shalvey that trying to complete the rescue with bare faced people or mine rescue teams in groups of four was not working. Olson proposed moving the intake air to Ethridge. Shalvey told Olson that he needed to get approval from MSHA to do that and that he would get back to him in a few minutes. While waiting for approval, Olson sent Chris Wilson, No. 7 Mine supervisor, and Gary Allinson, No. 7 Mine longwall manager, into the Southwest A Longwall bleeder to let Turner and Thompson know about the proposed ventilation change in an attempt to bring fresh air to them. Olson also asked Wilson and Allinson to make a list of any open crosscuts between Entry No. 3 and Entry No. 4 that would require a full temporary ventilation control to be built.

Shalvey talked with O'Donnell and requested approval to make the ventilation changes necessary to direct intake air further into the Entry No. 3 of the Southwest A Longwall Tailgate to facilitate the rescue and recovery efforts as Olson had proposed. O'Donnell conferred by telephone with Jacky Shubert, MSHA Supervisory Coal Mine Inspector, and approval was granted. Shalvey called Olson on the phone and told him they could make the ventilation changes. Olson told Shalvey he needed hammers, nails, curtain, bow saws, and a couple packs of VERSI-FOAM. Shalvey told Olson that he would have the materials delivered to him. Olson returned to the end of the track to wait.

Meanwhile in the bleeder, Allinson met Cook, Turner, and Thompson who were at Crosscut 24 with Ethridge. Allinson instructed Wilson to take the notes on the ventilation controls that needed repair outby to Don Fowler, No. 7 Mine supervisor, who was attending the phone at the end of the track. Allinson also instructed Thompson and Turner to leave with Wilson and go back out. The miners traveled slowly, stopping to rest about each crosscut. Cook and Allinson remained at Crosscut 24 with Ethridge.

By 7:50 a.m., the requested supplies had been delivered to the end of the track in the Southwest A Longwall Tailgate and were being carried into the bleeder. Olson directed the men to build a temporary stopping at Crosscut 15 between Entry No. 3 and Entry No. 4 and to cover any holes in the stoppings between Entry No. 3 and Entry No. 4 inby Crosscut 15. Olson helped put up the curtains to Crosscut 15 and then helped build the temporary at Crosscut 15.

Earlier in the morning, Phillips had called the Drummond Co, Inc., Shoal Creek Mine to request assistance from their mine rescue team. At 8:15 a.m., Randy Clements, Shoal Creek Mine safety manager, called back to offer the assistance of the Shoal Creek Mine rescue team. The offer was accepted and the Shoal Creek Mine rescue team was dispatched immediately. Rivers was also asked to dispatch one of the State of Alabama's mine rescue teams to assist.

In the Southwest A Longwall Tailgate, curtains were being installed along Entry No. 3, isolating the entry and directing intake air inby toward Crosscut 24. The repairs continued for approximately 1½ to 2 hours. Between 9:30 a.m. and 10:00 a.m., miners from Team 1, Team 2, Team 3, owl shift, and day shift began to move Ethridge outby from Crosscut 24.

At 10:15 a.m., Ethridge was brought out of the bleeder and was transported to the bottom of the elevator. Team 4 was comprised of Rodney Williams, MSHA District 11 Coal Mine Inspector and Mine Emergency Unit mine rescue team member, Charles Dickey and Pat Pelley, No. 7 Mine supervisors, Tingle, Don Elliott, Eddie Sides, David Keeton, Robert Cagle and Ken Knight, Mine Inspectors State of Alabama Department of Industrial Relations Mining and Reclamation Division and mine rescue team members, entered the mine and were told to keep the track clear and wait near the bottom of the Service Shaft until Ethridge was brought out. At 10:38 a.m., Ethridge exited the mine at the West Portal Service Shaft and was transported to the hospital by life flight helicopter. At the hospital Ethridge was diagnosed and treated for dehydration and heat related illness.

Additional ventilation curtains were sent to the Southwest A Longwall Tailgate. After resting at the end of the track, Allinson, Campbell, J. Hallman, and A. Hallman reentered the bleeder with additional curtain. To establish inby airflow from Crosscut 24 to Crosscut 26, they patched stoppings between Entry No. 3 and Entry No. 4. They reached Crosscut 26 sometime around 11:30 a.m. Allison recalled Campbell's detector indicated the methane and oxygen concentrations at Crosscut 26 were 0.3% and 18.5%, respectively. He noted that there was minimal air movement and that it was hotter there than at Crosscut 24. They prepared Chaney for transport by removing his mine belt, covering him, and securing him in a Stokes basket. Then the group went back to Crosscut 24 to wait for help.

Earlier, Team 4 arrived at the end of the track in the Southwest A Longwall Tailgate. At 11:15 a.m., Team 4 started into the bleeder. Team 4 reached Crosscut 24 about 10 minutes after Allinson returned. Allinson asked the group of miners that came in where the rest of the help was because there was not enough to consider moving Chaney. Although they were eager to get started, Allinson encouraged them to wait for more help. A few more miners arrived and the group of about 12 miners started to move Chaney outby. But they were not able to go very far. Allinson got very hot and told them he couldn't help any longer and that he was going out before he became incapacitated. He told the group he would get more help. The group rested at Crosscut 24.

The Shoal Creek Mine rescue team (Team 5), consisting of Ricky McGuire, Scott Jordan, Tim Cooley, Nathan Diffley, Mike Arkins, Darryl Piper, Mike Schmidt, David Gillespie, David Crowe, and Lee Esch, entered the mine and was taken to the end of the track in the Southwest A Longwall Tailgate. At 12:14 p.m. Team 5 entered the bleeder with Gene Averette, No. 7 Mine supervisor, and traveled inby to Crosscut 24 where they met the other group.

The large group proceeded outby with Chaney, reaching the end of the track at about 2:00 p.m. Chaney was brought out of the mine and pronounced dead at 2:23 p.m. on November 24, 2009. Everyone was out of the mine by 2:55 p.m.

INVESTIGATION OF THE ACCIDENT

The MSHA 1-800 Line operator contacted David Allen, MSHA District 11 Conference and Litigation Resolution Supervisor, and notified him that a fatality had been reported at the No. 7 Mine. Allen then contacted Keith Plylar, Safety Manager, and issued a verbal 103(j) order to assure the safety of all persons at the mine and for the preservation of evidence. Thomas O'Donnell, MSHA District 11 Coal Mine Inspector, was called by Allen at 1:20 a.m. and directed to travel to the mine and initiate an investigation. The 103(j) order was modified to a 103(k) order at 3:50 a.m. At 6:40 a.m. O'Donnell contacted Jacky Shubert, MSHA Supervisory Coal Mine Inspector, and reported the current status of the rescue and recovery efforts. Additional MSHA personnel were dispatched to the mine site. Rescue and recovery efforts were completed at 2:55 p.m. and all persons were removed from the affected area.

The Administrator for Coal Mine Safety and Health (CMS&H) directed that an investigation be conducted of the fatal mine accident that occurred on November 23, 2009. Michael G. Kalich, Senior Mining Engineer, CMS&H, Division of Safety, was assigned as investigation team leader. An investigation team of MSHA personnel was selected from CMS&H District 11, Pittsburgh Safety and Health Technology Center (PS&HTC), and the Office of the Solicitor, Department of Labor (DOL). MSHA conducted the investigation with the cooperation of the State of Alabama Department of Industrial Relations Mining and Reclamation Division, Jim Walter Resources, Inc., and United Mine Workers of America representatives. Appendix E lists the persons who participated in the investigation.

MSHA's accident investigation team members met on November 30, 2009, to begin the investigation by reviewing records and receiving a briefing from Richard Gates, CMS&H District 11 Manager, concerning preliminary information obtained by District 11 personnel. The MSHA accident investigation team arrived at the mine on November 30, 2009. They conducted a physical examination of the accessible portion of the accident area. The accident investigation team encountered high heat, humid conditions, and oxygen concentrations of less than 19.5% inby Crosscut 24½ in Entry No. 3 in the Southwest A Longwall Tailgate and were unable to continue. Appendix D depicts information collected in the accident area by the MSHA investigation team during the physical examination. Due to the deteriorated roof conditions, high temperatures, and high humidity encountered, it was deemed unsafe for persons to continue to travel in the bleeder inby Crosscut 15 in the Southwest A Longwall Tailgate.

The MSHA accident investigation team conducted a total of 32 formal voluntary interviews with persons who had relevant knowledge of the circumstances associated with the accident, rescue and recovery operations, and the Southwest A Longwall bleeder system prior to the accident. Appendix F lists persons who provided voluntary statements.

MSHA investigators obtained and reviewed pertinent mine records and collected, examined, and/or tested physical evidence. In addition, information in detector data logs were also obtained and reviewed. A partial mine ventilation air quantity and air pressure survey, air quality survey, and a heat survey were conducted in conjunction with the accident investigation. The information collected was made available to the mine operator. The on-site portion of the investigation was completed on March 10, 2010.

DISCUSSION

Mine Ventilation

The mine was ventilated with an exhausting system. Airflow entered the mine through six intake shafts and exited through five return shafts. The airflow quantities entering and exiting the mine were reported in the November 2009 monthly State of Alabama ventilation report. The intake airflow was 383,822 cubic feet per minute (cfm) through the Service Shaft 7-3 (West Portal), 472,750 cfm through the Production Shaft 7-2, 376,808 cfm through the Production Shaft 7-4, 748,800 cfm through the Service Shaft 7-10 (East Portal), 731,730 cfm through the Intake Shaft 7-11, and 1,101,275 cfm through the Intake Shaft 7-12. The total intake air quantity reported was 3,815,185 cfm. The five return shafts were the Return Shaft 7-1, Return Shaft 7-6, Bleeder Shaft 7-7, Return Shaft 7-8, and Return Shaft 7-9. The Return Shaft 7-1 was equipped with two TLT Babcock, Inc., fans, both Type GAF 31.5/18-1, installed in parallel. One of the fans was idle. The operating pressure of the fan at Return Shaft 7-1 was 15.6 inches of water gauge and it exhausted a reported 875,345 cfm. The Return Shaft 7-6 was also equipped with two TLT Babcock, Inc., fans, both Type GAF 31.5/18-1, installed in parallel. One of the fans was idle. The operating pressure of the fan at Return Shaft 7-6 was 13.4 inches of water gauge and it exhausted a reported 864,150 cfm. The Bleeder Shaft 7-7 was equipped with a Howden, Inc., variable speed centrifugal fan, type MP6 2169.06.90 DBL6T. The fan operated at 20.9 inches of water gauge and exhausted a reported 286,930 cfm. The Return Shaft 7-8 was equipped with a TLT Babcock, Inc., fan, Type GAF 31.5/18-1, which operated at 9.7 inches of water gauge and exhausted a reported 862,250 cfm. The Return Shaft 7-9 was equipped with a TLT Babcock, Inc., fan, Type GAF 31.5/18-1, which operated at 11.7 inches of water gauge and exhausted a reported 927,250 cfm. The total return air quantity reported was 3,816,235 cfm. Subsequent to these measured air quantities and the accident, the fan at Bleeder Shaft 7-13 was activated.

Methane Liberation

The total methane exhausted daily from the mine through the exhaust fans varied due to mining cycles. Air quantity and quality measurements provided as part of monthly State of Alabama ventilation reports revealed that during the three month period of October 2009 through December 2009 the total methane liberation was approximately 16.2 million cubic feet per day in October, 12.6 million cubic feet per day in November and 13.4 million cubic feet per day in December. Additional methane was removed through the horizontal and vertical degasification systems employed at the mine.

Horizontal and Vertical Degasification Program

An extensive methane degasification program was employed at the No. 7 Mine. This degasification program consisted of the use of both in-seam horizontal boreholes drilled from underground and vertical boreholes (gob wells) drilled from the surface. Methane could be removed from mined coal seam(s) in the longwall panels in advance of the face through the in-seam horizontal degasification boreholes. Horizontal degasification boreholes were drilled, connected, and operated in accordance with the approved mine ventilation plan for the No. 7 Mine. The mine operator controlled and operated the in-seam degasification system. Methane from the strata above the mined out seam(s) was removed through the vertical degasification boreholes. The vertical degasification boreholes could continue to be utilized for methane removal after mining in the area ceased. The vertical degasification boreholes were controlled and operated by Black Warrior Methane Corp.

The locations of horizontal and vertical degasification boreholes in Southwest A Longwall Panel are depicted in Appendix G. Horizontal degasification boreholes of varying lengths had been drilled into the Southwest A Longwall Panel from Entry No. 4 in the Southwest A Longwall Headgate. The vertical degasification boreholes were drilled into the strata above the Southwest A Longwall Panel. Longwall mining had progressed outby all horizontal and vertical degasification boreholes by May 31, 2009.

Mine Ventilation Plan

The mine ventilation plan in effect at the time of the accident was approved on September 24, 2008, and included several supplements that were later approved. The plan contained specific requirements for continuous mining machine development sections, longwall mining sections, and longwall bleeder systems.

Continuous Mining Machine Development Sections

Cutting plans for 20-foot, 25-foot, and 30-foot cuts were approved for continuous mining machine development sections. Working places were required to be ventilated using a line curtain installed to a distance no greater than 10 feet from the deepest point of penetration. A minimum of 17,000 cfm of air was required to reach the end of the line curtain where coal was cut, mined, or loaded. When using an extendible line curtain installed by remote means, the minimum quantity of air required to reach the end of the permanent line curtain (measured at the last timber) was increased. When mining a 25-foot cut, the minimum was 18,500 cfm. Minimum air quantity requirements for mining 30-foot cuts were dependent on whether or not the overlying Mary Lee coal seam was extracted in conjunction with the Blue Creek coal seam. Single seam mining was the term used to describe a mining method that extracted only the Blue Creek coal seam. Twin seam mining was the term used to describe a mining method that extracted the Mary Lee coal seam in conjunction with the Blue Creek coal seam. When mining a 30-foot twin seam cut, a minimum of 20,000 cfm of air was required to reach the end of the permanent line curtain (measured at the timber). The minimum air quantity was increased to 21,000 cfm when mining a 30-foot single seam cut. During roof bolting and servicing cycles, a minimum of 7,000 cfm of air, or 10,000 cfm of air when ventilating unsupported 30-foot cuts, was required at the end of the line curtain. In idle working places, a minimum of 3,000 cfm of air was required at the end of the line curtain. A minimum of 30,000 cfm was required to reach the last open crosscut of each split in all working sections.

Longwall Mining Sections

For longwall mining sections, the plan included typical longwall face ventilation drawings for both three and four entry headgate and tailgate developments. The tailgate entry could be ventilated with intake air coursed inby or with return air from the longwall face coursed outby. Air that ventilated the belt entry was approved to be used to ventilate the longwall face or to be directed to the return. Longwall gateroads were typically mined as four entry development in a yield-stable-yield pillar configuration. Variations of the typical face ventilation schemes permitted recovery of the headgate yield pillars located adjacent to the belt entry as the panel was mined.

Specific ventilation parameters were required to be maintained during the set-up of the longwall face equipment, mining, and the recovery of the longwall equipment. Plan requirements were identical for both longwall sections with regard to set-up and recovery of the longwall equipment and mining during the start-up period. The minimum quantity of air required to ventilate the longwall face during set-up and recovery was 18,000 cfm or the quantity of air equal to the sum of the nameplate quantities of all permissible diesel-powered equipment operating on the section, whichever was greater. A minimum of 25,000 cfm of air was required to enter the longwall face. Provisions included in the plan for the start-up of new longwall panels were only applicable until the longwall face retreated a maximum distance of 300 feet or until a main roof fall occurred. During the start-up period, a minimum air quantity of 40,000 cfm or a minimum air velocity of 400 feet per minute (fpm), whichever was greater, was required to be maintained on the longwall face. These minimum airflow requirements were to be maintained at the headgate, midface, and tailgate. In addition, during the start-up period, tests for methane were required at least every ten minutes at the shearer while coal was being mined.

After the longwall face retreated a maximum distance of 300 feet or a main roof fall occurred, minimum ventilation requirements were different for the two longwall sections during mining of the remainder of the panel. A minimum air quantity of 60,000 cfm or a minimum velocity of 600 fpm, whichever was greater, was required to be maintained on the face of the No. 1 Longwall. The minimum air quantity and velocity parameters were required to be maintained at least fifty feet but not more than one hundred feet from the headgate and tailgate, at midface, and inby the yield pillar entry on the headgate. A minimum quantity of 55,000 cfm or a minimum velocity of 600 fpm, whichever was greater, was required to be maintained on the face of the No. 2 Longwall. The minimum air quantity and velocity was required to be maintained at least fifty feet but not more than one hundred feet from the headgate and tailgate, at midface, and inby the yield pillar entry on the headgate.

Longwall Bleeder Systems

Bleeder system requirements were included in the mine ventilation plan. The plan included specific requirements for the maintenance of bleeder systems and also established Measurement Point Locations (MPLs) in accordance with 30 C.F.R. §75.364(a) (2) (iii). The bleeder system was required to be adequately supported and maintained free of water to permit safe travel. Observations and interview statements revealed the typical standing supplemental support utilized in the Southwest A Longwall bleeder system consisted of a single row of propsetters on the headgate side of the bleeder system and a double row of propsetters on the tailgate side of the bleeder system. Water was controlled by installing pumps (air or electric), ditching the bottom (to allow natural drainage), or by building a bridge.

At least once each week, one entry of each set of bleeder entries was to be traveled in order to examine the bleeder system for roof falls, water accumulations, methane and oxygen concentrations, determination of proper airflow direction, and other hazards. The results of these examinations were to be recorded in a book. When bleeder entry travel was considered unsafe, the evaluation of bleeder system performance through a system of check points was to be installed to indicate that the bleeder system was functioning properly. The locations of the check points were to be submitted and approved by the MSHA District Manager prior to implementation. Ventilation devices such as regulators, stoppings, and bleeder connections used to control air movement through "gob bleeder entries" for typical optional bleeder systems were depicted on two sketches contained in the plan. One of the sketches appeared to indicate a multiple longwall panel wrap-around bleeder system configuration. The sketches depicted "typical" MPLs where air exited the mined-out area and entered the bleeder entries at the inby end of each set of gateroads. MPL changes due to design or conditions were to be submitted as a plan supplement. The No.1 Longwall was operated in a longwall district separate from the No. 2 Longwall.

No. 1 Longwall Bleeder System

The I Longwall Panel was the ninth longwall panel mined in the multiple panel longwall district that was ventilated by a bleeder fan system with multiple bleeder entries. The first three longwall panels had been sealed and were isolated from the remaining longwall panels prior to mining of the fourth panel. Two additional longwall panels were projected to be included in the longwall district.

Southwest A Longwall (No. 2 Longwall) Bleeder System

The Southwest A Longwall Panel was the only panel projected to be mined in the active longwall district located south of the West Portal. The width of the longwall face, including the recovered headgate yield pillar, was about 825 feet. Mining commenced in the Southwest A Longwall Panel in September 2008 and had progressed about 7700 feet before mining ceased and recovery of longwall equipment was initiated.

The single longwall panel was ventilated by a multiple entry wrap-around bleeder system. The wrap-around bleeder system was designed, and mining conducted, such that, as the longwall face retreated, two of the four Southwest A Longwall Headgate entries (Entry No. 1 and Entry No. 2) and three of the four Southwest A Longwall Tailgate entries (Entry No. 2, Entry No. 3, and Entry No. 4) inby the longwall face remained intact. The yield pillars between Southwest A Longwall Headgate Entry No. 3 and Entry No. 4 were recovered as the longwall face retreated. The location of ventilation controls made the Southwest A Longwall Headgate Entry No. 2 and Southwest A Longwall Tailgate Entry No. 2 common with the adjacent mined out caved portion of the Southwest A Longwall Panel inby the longwall face.

Airflow through the mined out area was directed in a general pattern from the headgate toward the tailgate and from the face toward the bleeder entries. MPLs had initially been established on the headgate and tailgate sides of the panel where air exited the mined-out area and entered the bleeder entries at the back of the panel in accordance with the approved ventilation plan. Southwest A Longwall Tailgate Entry No. 3 and

Entry No. 4 were designated as bleeder entries and connected to the two bleeder entries that had been developed across the back of the panel between the headgate and tailgate. Permanent ventilation controls separated the Southwest A Longwall Tailgate Entry No. 2 from the tailgate bleeder entries between the longwall face and the bleeder entries across the back of the panel. This line of permanent ventilation controls directed airflow through the mined out area to the inby end of the panel before it exited into the bleeder entries. All of the airflow in the bleeder system exited the area through the two tailgate bleeder entries before joining other splits of air and exiting the mine through Return Shaft 7-1.

Coal elevations in the bleeder system were such that water entering the Southwest A Longwall bleeder system would drain in a general direction from the headgate side of the longwall face to the inby end of the bleeder entries in the tailgate. A vertical dewatering borehole had been drilled and water removed from the tailgate bleeder entries with a progressive cavity pump installed at the bottom of the borehole. However, the pumping capacity was reportedly insufficient to maintain control of the water in the bleeder entries. Water was also removed from the bleeder entries through use of in-mine electrical dewatering pumps and discharge pipe installed in the tailgate bleeder entries.

September 26, 2008, Supplement

On September 26, 2008, a supplement to the mine ventilation plan for the Southwest A Longwall bleeder system was approved. This supplement allowed headgate Entry No. 1, separated by permanent ventilation controls from headgate Entry No. 2, to be converted to a bleeder entry. The supplement indicated the bleeder entry was needed to supplement the ventilation of the longwall face and worked-out area. Implementation of the supplement caused the direction of airflow in the Southwest A Longwall Headgate Entry No. 1 to be reversed to allow airflow to exit from the bleeder entries at the back of the panel on both the headgate and tailgate sides of the panel.

The supplement indicated the location in the headgate bleeder entry outby the longwall face where the methane concentration would be limited to 2% would be where approximately 15% of the airflow in the bleeder entry originated as leakage from the adjacent intake entry. The location in the headgate bleeder entry was required to be monitored to determine the methane concentration once each shift. Notations made and initialed by a representative of the mine operator on the submitted supplement indicated the location of the 2% methane limit in the tailgate bleeder entry (ies) would be established in the same manner. The location in the tailgate was required to be inspected weekly. The locations were required to be marked underground and shown on the map on the surface of the mine. The location of the 2% methane limit was permitted to be adjusted as necessary with notification of MSHA inspectors required. Prior to January 13, 2009, the additional bleeder entry in the Southwest A Headgate was eliminated.

October 15, 2008, Supplement

On October 15, 2008, a supplement to the mine ventilation plan for the Southwest A Longwall Panel was approved. This supplement established an MPL on the tailgate side of the Southwest A Longwall Panel between Entry No. 2 and the bleeder entries at the proposed stopping opened for ventilation. The supplement indicated the MPL would be needed because as the resistance of the mined out area increased from the tailgate corner of the face to the bleeder entries, the pressure differential provided to the tailgate corner of the face could be increased by “relaxing” the stopping. The supplement indicated ”relaxing” the stopping (creating an opening in the stopping or constructing a regulator instead of a solid stopping) at the MPL would “assure an adequate pull off the tailgate of the face and the drive motors”.

The opening in the stopping, or regulator, was intended to “only be opened enough to supplement ventilation on the face and the pull away from the face on the tailgate side”. The supplement indicated the technique had been approved in the past and was “shown to be an effective way to supplement the face ventilation and at the same time having minimal to no impact on the overall bleeder system”. Only a single open stopping, or regulator, and established MPL located inby the longwall face were permitted at a time. The supplement required that when the MPL was established or the opening at the MPL was adjusted, the ventilation between the proposed MPL and the MPLs at the back end of the longwall panel would be evaluated. The quantity of air on the longwall face at the tailgate and the quantity of air entering into the worked-out area was to be evaluated along with the headgate and tailgate MPLs. It was understood that the regulator and associated MPL were permitted to be relocated as the longwall face retreated. The MPL was required to be identified on the mine map and underground at the MPL location.

June 9, 2009, Supplement

On June 9, 2009, a supplement to the mine ventilation plan for the Southwest A Longwall Panel was approved. This supplement allowed for the installation of 120 psi Stratacrete Plug Seals to isolate the Southwest A Longwall Panel from the active areas of the mine. This supplement was intended to be implemented upon completion of mining the longwall panel.

October 1, 2009, Supplement

Adverse mining conditions associated with the fault geology on the longwall face in the outby portion of the panel slowed the rate of retreat and prolonged the life of the bleeder system. While the longwall face was retreated about 6100 feet during the first seven months of operation, the face was retreated less than 1600 feet during the last six and one-half months of operation. The bleeder entries had been supported before the longwall started and support was advanced as the panel was mined. Additional supplemental support had also been installed as needed. However, mine management believed the setting of additional support could not keep up with the deteriorating conditions in the bleeder entries. Further, difficulties were also encountered in removing water from the bleeder entries.

On October 1, 2009, a supplement to the mine ventilation plan for the Southwest A Longwall Panel was approved. This supplement allowed for the establishment of bleeder evaluation points for the final 110 feet of mining, face recovery, and sealing of the Southwest A Longwall Panel. Pumping of water near the inby end of the tailgate bleeder entries was also discontinued at this time. The supplement indicated it was expected that mining and meshing of the longwall face area would be completed around October 10, 2009. Recovery of the longwall equipment was expected to be completed by November 12, 2009, and final sealing was anticipated to be completed by December 15, 2009. Mine examiners conducting required examinations and employees performing work to maintain the bleeders were exposed to deteriorating roof conditions. The deteriorating roof conditions and an increase of the inflow of water from the mined out area were cited in the submitted supplement as justifications for the establishment of the evaluation points (EPs).

Approved EPs in the supplement were to be established on the headgate and tailgate sides of the Southwest A Longwall Panel near the longwall face. In addition to these EPs near the face, an additional evaluation point was to be established near the inby end of the tailgate bleeder entries that moved with the toe of the water (Moving EP). The Moving EP was to be established in the first connecting crosscut between the Southwest A Longwall Tailgate Entry No. 2 and Entry No. 3 outby the toe of the water where the permanent ventilation control would be removed as the water advanced. The bleeder entries in the tailgate were required to be traveled to the toe of the water to complete the examination at the Moving EP. Measurements of methane and oxygen concentrations and air quantity and a test to determine if the air was moving in its proper direction were required at all of the evaluation points. Examinations of the tailgate bleeder entries and at the Moving EP were required to be conducted weekly. The supplement indicated the results of the examinations at the Moving EP were to be recorded weekly in a book on the surface. Examinations at the remaining headgate and tailgate EPs near the longwall face were required to be conducted daily. The supplement indicated the results of the examinations at the EPs "along with the longwall face reading" would provide the information needed to evaluate the bleeder system.

Two mine maps of the Southwest A Longwall bleeder system were contained in the supplement. Map 1 depicted the ventilation on the longwall section and in the Southwest A Longwall bleeder system prior to cutout (completion of longwall mining) and during the start of recovery of equipment. Map 2 depicted the ventilation on the longwall section and in the Southwest A Longwall bleeder system during recovery of the longwall equipment. The ventilation scenario depicted in Map 1 was expected to be changed to the scenario depicted in Map 2 to enable completion of recovery of the longwall face equipment from the tailgate side. A copy of Map 2 is depicted in Appendix H. Differences depicted on the two maps included: the location of the EPs in the Southwest A Longwall Headgate near the longwall face; the direction of airflow across the longwall face; the location of permanent ventilation controls in the headgate and tailgate near the longwall face; and the use of Southwest A Longwall Headgate Entry No. 4 as a return entry to exhaust air from the headgate side of the longwall face once the direction of airflow across the face was reversed (Map 2). Both maps similarly depicted the general airflow patterns through the bleeder system beyond the area closest to the longwall face.

Both maps contained in the supplement showed the projected toe of the water in the bleeder entries would be at the 405-foot elevation. Though not stated in the supplement, coal elevations and estimated mining height in the tailgate bleeder entries indicated water would roof across the bleeder entries in the tailgate. The paths for air flowing from the headgate to the tailgate at the inby end of the longwall panel would have been through the inby setup room and along the edge of the caved material or across the caved material of the mined out longwall panel itself. An airflow direction arrow shown across the caved portion of the panel near the projected toe of the water and the absence of airflow direction arrows in the bleeder entries across the back of the panel suggests similar expectations were depicted on both maps.

The Southwest A Longwall headgate entries inby the longwall face were not able to be traveled, reportedly due to adverse conditions consisting of roof falls and floor heave. Ventilation controls that once separated the Southwest A Longwall Headgate Entry No. 1 and Entry No. 2 were not maintained. Further, the approved supplement maps showed several of the permanent ventilation controls had been removed to effectively make both entries common with the adjacent caved portion of the panel. Regulators located at the inby end of the Southwest A Longwall Headgate entries that had originally controlled airflow distribution within the bleeder system were not accessible and would have been non-functioning after water roofed across the inby end of the bleeder entries in the tailgate.

During the investigation, it was determined that the mine examiner who conducted the weekly examination of the Southwest A Longwall bleeder was not adequately trained on provisions contained in the ventilation plan supplement which was approved on October 1, 2009. Statements provided during the investigation indicated that the mine examiner who was scheduled to conduct the examination of the bleeder on November 23, 2009, was not aware that an air quantity measurement was required at the Moving EP location.

November 1, 2009, Ventilation Change

Interview statements indicated that no ventilation changes were made to the Southwest A Longwall bleeder system following the completion of mining and prior to beginning the recovery of longwall equipment from the headgate side.

A ventilation change was conducted on November 1, 2009, to complete the recovery of the longwall face equipment from the tailgate side that reversed the airflow on the longwall face, and caused it to flow from the tailgate toward the headgate. Such a ventilation change was permitted by and depicted on Map 2 of the supplement approved October 1, 2009. The locations of the EPs were also reestablished underground at that time. Interview statements of the outby manager who participated in and directed miners making the ventilation change revealed the airflow entering the bleeder system from outby the face on the headgate side decreased and airflow entering from the tailgate side increased. Mine management determined the total airflow in the bleeder system remained similar based on the air quantity exiting the bleeder system at the EP location in the Southwest A Longwall Tailgate Entry No. 4 (TG EP 5).

Interview statements indicated no changes in ventilation were made in the Southwest A Longwall bleeder system after November 1, 2009, except for partial removal of the stopping outby the toe of the water at Crosscut 39 in the tailgate bleeder entries. Ventilation controls observed by MSHA personnel following the accident in the headgate were not in the locations depicted on Map 2 of the supplement approved on October 1, 2009. These differences would have affected the resistance of the airflow path from the longwall face to the headgate bleeder entries and did not establish a return entry away from the headgate side of the longwall face.

Investigators determined through interviews and mapping of the ventilation controls in the Southwest A Longwall area of the mine that other discrepancies existed between some of the ventilation controls and airflow directions depicted on the mine map posted at the West Portal mine office and those that existed underground at the time of the accident. Investigators also determined that discrepancies existed between some of the ventilation controls, EP locations, and airflow directions depicted on the supplement Map 2 and those that existed underground at the time of the accident.

Mine Roof Control Plan

The roof control plan in effect at the time of the accident was approved on October 5, 2009. The plan contained specific requirements for continuous mining machine development sections and longwall mining sections. The roof control plan did not contain specific support requirements for bleeder systems.

Examinations and Other Mine Records

The regulations require preshift (§ 75.360), on-shift (§ 75.362), and weekly (§ 75.364) examinations and provide for supplemental examinations (§ 75.361). The bleeder entries in Southwest A Longwall Tailgate were required to be examined weekly. Daily examinations at approved locations in Southwest A Longwall Headgate and Tailgate, exceeding the weekly examination provisions, were required in the mine ventilation plan during final mining of the Southwest A Longwall Panel and recovery of the longwall face equipment and until sealing of the worked-out area was completed.

Section 75.364(a)(2) requires [a]t least every seven days, a certified person shall evaluate the effectiveness of bleeder systems required by § 75.334 as follows: (i) [m]easurements of methane and oxygen concentrations and air quantity and a test to determine if the air is moving in its proper direction shall be made where air enters the worked-out area; (ii) [m]easurements of methane and oxygen concentrations and air quantity and a test to determine if the air is moving in the proper direction shall be made immediately before the air enters a return split of air; and, (iii) [a]t least one entry of each set of bleeder entries used as part of a bleeder system under § 75.334 shall be traveled in its entirety. Measurements of methane and oxygen concentrations and air quantities and a test to determine if the air is moving in the proper direction shall be made at the measurement point locations specified in the mine ventilation plan to determine the effectiveness of the bleeder system. In lieu of the requirements of § 75.364(a)(2)(i) and (iii), an alternative method of evaluation may be specified in the ventilation plan provided the alternative method results in proper evaluation of the effectiveness of the bleeder system (§ 75.364(a)(2)(iv)).

Section 75.360(b) requires the person conducting the preshift examination to examine for hazardous conditions, test for methane and oxygen deficiency, and determine if the air is moving in its proper direction. The locations where preshift examinations are to be conducted are also specified in the regulations and include areas where work or travel during the oncoming shift is scheduled prior to the beginning of the preshift examination.

Section 75.361 requires that, except for certified persons conducting examinations required by this subpart, within 3 hours before anyone enters an area in which a preshift examination has not been made for that shift, a certified person shall examine the area for hazardous conditions, determine whether the air is traveling in its proper direction and at its normal volume, and test for methane and oxygen deficiency.

The applicability of supplemental examinations conducted in accordance with § 75.361 was addressed in "Ventilation Question & Answers" released by MSHA on November 9, 1992. These questions and answers were prepared in response to the promulgation of the Safety Standards for Underground Coal Mine Ventilation Rule that became effective May 15, 1992. Contained within the "Ventilation Question & Answers" were responses to questions submitted to MSHA in order to clarify the rule's intent. In response to the question "Would you elaborate on where supplemental examinations will be required?", the answer provided was "A supplemental examination is required for any area that has not been preshift examined prior to the unscheduled entry of any person other than the certified person performing the examination. It is important to note that a supplemental is not acceptable in lieu of a preshift for areas in which persons were previously scheduled to work or travel; i.e., if work is scheduled in an area prior to the beginning of the shift, the area must be preshift examined. The supplemental examination is required for unscheduled work or travel in areas not preshifted**."**

Additional clarity was provided for supplemental examinations conducted in accordance with § 75.361 by the Federal Mine Safety and Health Review Commission (FMSHRC). In the case of the Secretary of Labor, Mine Safety and Health Administration versus Buck Creek Coal Company, Inc. (Docket No. LAKE 93-241) the FMSHRC ruled that "*We also reject Buck Creek's contention that the operator was required to satisfy only the supplemental examination provisions of section 75.361. That section, which implements section 303(m) of the Mine Act, provides, as relevant here, for a supplemental examination of idle and abandoned areas whenever miners who are underground are dispatched to an area of the mine that was not required to be examined as part of the preshift examination. See 57 Fed Reg. 20,895 (1992). Such an examination is in addition to, not a substitute for, a preshift examination."*

The purpose of examinations is to identify hazardous conditions and make corrections to maintain a safe work environment. The preamble to the final rule for § 75.364 explained that the weekly examination is directed at hazards that develop in the more remote and less frequently visited areas of a mine, including intake and return air courses. Because of the confined nature of the underground mining environment, loss of life can result in other areas of the mine outside the immediate location of the hazard. The weekly examination assures these hazards are located and corrected.

Requirements regarding hazardous conditions are addressed in the regulations in several standards, including in § 75.363. The regulations address posting, correcting, and recording hazardous conditions and recording corrective actions. All hazardous conditions, regardless of when detected or by whom, must be adequately addressed. Proper examinations and records serve as a history of the types of conditions that can be expected in the mine. When properly reviewed, mine management can determine if the same hazardous conditions are of recurring nature and whether or not corrective actions have been effective. The mine foreman or equivalent mine official must be fully aware of the information contained in records of examinations so as to be able to allocate resources to correct safety problems as they develop.

Some examples of hazardous conditions that would be expected to be observed, recorded, and corrected include, but are not limited to: loose roof and ribs; excessive levels of methane; oxygen deficiency; damaged or improperly installed ventilation controls; accumulations of loose coal, coal dust or other combustible materials; inadequate rock dust; and a change in air direction that could materially affect the health and safety of miners.

Hot humid conditions can also pose a hazard to miners working in confined spaces. However, in coal mines, air temperatures do not normally reach that which would be readily recognized as a hazard to miners working in them. In deep mines, elevated air temperatures are more common than in shallow mines. Miners accustomed to traveling or working in many bleeder systems in the deep mines of the Black Warrior Coal Basin in Alabama, including at the No. 7 Mine, experienced and expected air temperatures to be higher than in other active areas of the same mine. However, the normal elevated temperatures were not considered to pose a hazard that could not be addressed adequately through drinking plenty of liquids, walking or working at a slower pace, and wearing fewer layers of clothing. The remoteness of areas such as the Southwest A Longwall bleeder can increase the hazard the elevated temperatures and humidity pose because the inability to quickly remove oneself from the environment can prolong exposure.

MSHA investigators reviewed copies of mine records to determine if required examinations of the Southwest A Longwall bleeder system were conducted, the types of hazards identified during those examinations, and corrective actions taken. The results of the weekly examinations were entered into the Weekly Examinations record books. Records for weekly examinations in the Southwest A Longwall bleeder system conducted from the dates of July 27, 2009, through November 23, 2009, were reviewed. Records indicated weekly examinations of the Southwest A Longwall bleeder system were conducted every seven days, beginning on July 27, 2009, through November 16, 2009, as required. The accident occurred the seventh day after the last completed weekly examination was conducted. No entry was made for the examination being conducted at the time of the accident.

Appendix I depicts results of weekly examinations conducted in the Southwest A Longwall bleeder from October 5, 2009, through November 23, 2009, and results of daily examinations conducted at the EPs located near the longwall face in the Southwest A Longwall Headgate and Tailgate that were conducted on the same dates.

Hazardous conditions and actions taken which were recorded in the Weekly Examinations record books for the Southwest A Longwall bleeder system included:

- September 14, 2009 – "water in back corner too deep"; "pump is pumping" and "set 17 timbers to 20¾ more support at 17 and 18 at 17 to 18 xcut, 9-14-09"
- September 15, 2009 – (no hazard noted); "set timbers between 18-16"

- September 21, 2009 – “water is deep in the back corner”, “can not make HG MPL’s or TG #1 MPL”; “Pumping, Down 11” from highest level”
- September 28, 2009 - “water thigh deep between #1 and #2 TG MPL”; “pump is puming (sic)”

In addition to the examination requirements of § 75.360, § 75.362, and § 75.364, the supplement to the mine ventilation plan approved on October 1, 2009, established evaluation points (EPs) that required daily examinations. As discussed, these EPs were established on the headgate and tailgate sides of the Southwest A Longwall Panel near the longwall face. Measurements of methane and oxygen concentrations and air quantity and a test to determine if the air was moving in its proper direction were required at all of these EPs. The results of the daily examinations were entered into preshift, daily and on-shift report books. Records for daily examinations of these EPs from the dates of October 2, 2009, through November 23, 2009, were reviewed. No record of the examinations for the Southwest A Longwall Headgate EPs was identified for October 23 and October 25, 2009.

Separate notes of work performed by mine personnel and conditions noted during a shift, such as water levels, were recorded by supervisors in No. 7 Mine Outby Report books. Copies of these records made from September 9, 2009, through November 23, 2009, were also reviewed. The information provides some indication as to the type and frequency of work and travel conducted in the Southwest A Longwall bleeder. Notes recorded by supervisors in No. 7 Mine Outby Report book regarding the Southwest A Longwall bleeder system included:

- September 14, 2009 (day shift) – “went to 2 LW done weekly walk + 1 man”, “set 17 props between 17 & 18 xcut”
- September 15, 2009 (owl shift) – “35 Pump to 2 LW Bleeders inby D-Box”
- September 15, 2009 (day shift) – “went to 2 LW to work on pump”, “pulled 100′ 7200 cable down to #16 xcut to be spliced in”, “started splicing cable”, “set 3 timbers between 18-17-16 in 2 LW Bleeder”, “set timber on EOT of 2 LW”
- September 15, 2009 (evening shift) – “got 13 hp pump in carryed (sic) 2 LW Bleeders got it to 18 XC”
- September 16, 2009 (owl shift) – “4 men Pulled 13 hp pump from 18 Crosscut to 26 on 2 LW T/G”
- September 16, 2009 (day shift) – “started pulling pump from 26 inby 30”, “Set 6 timbers”
- September 16, 2009 (evening shift) – “2 LW Bleeders move 13 hp Pump from 29½ xc to 37 xc”
- September 17, 2009 (owl shift) – “Pulled Pump from 36 xcut to water, Put in and Running”
- September 18, 2009 (day shift) – “went to 2 LW Bleeder to check water Hooked up 13 H.p.p. (sic) to pump out side. + 1 man”, “put 7 Joints of 2” vic Together to get to borehole. To pump out side pump is running”

- September 19, 2009 (day shift) – "went to 2 LW Bleeder to check water down 3¾ Height 29¾"
- September 20, 2009 (evening shift) – "2 LW Bleeder water roofed in XC where 30 hp is 24" on corner. Turn valve off going to borehole putting water in PVC pipe"
- September 21, 2009 (evening shift) – worked on pulling cable up T/G #2 LW. Got 1 end of the cable to #18 xcut, the other end at #16 xcut & slack cable is laid out between #18 & #14."
- September 24, 2009 (day shift) – "went to 2 LW Bleeders went all the way to #1", "water from roof 62""
- September 27, 2009 (day shift) – "check pump @ #18 xcut in #2 L/W bleeders – rock fall – remove debris & square pump up. Reset starter box. Rounded up all necessary plumbing & hauled to EOT in #10 "B" track."
- September 28, 2009 (day shift) – "made weekly walk 2 LW Bleeders & 1 man to check water & pumps", "82" from roof to (undecipherable word)"
- October 12, 2009 (day shift) – "went to 2 LW to make weekly walk"
- October 19, 2009 (day shift) – "went to 2 LW Bleeders to make weekly walk + 1 man. Went to toe of water"
- October 26, 2009 (day shift) – "went to 2 LW Bleeders to check water", "knock out brattice outby D Box", "water likes 70′ being to spad 20048 inby D Box)"
- October 26, 2009 (evening shift) – "2 LW stacking out –R- in 1 entry and Brattice in #2 entry H/G"
- October 28, 2009 (owl shift) – "went to 2 L/W #1 Entry to build Reg. complete"
- November 2, 2009 (day shift) – "went to 2 LW Bleeders to check water Likes 20048 10′ + 1 man", "inby D Box", "Hung curtain in #4 Entry"
- November 9, 2009 (day shift) – "went to 2 LW Bleeders water to boot changing Hole + 1 man", "Hung curtain up at 26 & 28 in #4 place"
- November 16, 2009 (day shift) – "went to 2 LW Bleeders to check water. Water is about 10′ out by D Box", "Started Knocking out next brattice knock out about 5 blocks"

Established Procedures, Practices, and Protocol for Working in Remote Areas

A fatal accident that occurred in 2006 at the No. 7 Mine involved a miner working alone in a remote area. Following the accident, the mine operator established a written procedure identified as "Procedures for Working in the Bleeders or Main Return", a copy of which is included in Appendix J.

The procedure indicated that prior to one or more miners entering a bleeder or main return they were to contact the CO operator and give an estimated time they expected to be out of the area. The miners were also to contact the CO operator as soon as they were out of the area. If the miners did not contact the CO operator within one hour of the estimated time, the procedure directed the CO operator to send at least two qualified employees to search for the miners. The procedure also contained directions for notifying the mine manager, safety department, and mine rescue or appropriate personnel.

Investigators believe the mine operator's actions in response to the established "Procedures for Working in Bleeders or Main Return" resulted in the preparedness and timely actions of the miners who participated in the search and rescue operation that likely prevented a second fatality.

An informal practice of using a "buddy system" during weekly examinations had been adopted at the No. 7 Mine. The practice involved the mine examiner being accompanied by another miner for the purpose of providing assistance to the other person should one of them become incapacitated. The origin of the practice was not determined during the investigation, although miners questioned about it consistently stated that the "buddy system" was a common practice after the fatal accident in 2006. The practice was used while conducting the weekly examination of the Southwest A Longwall bleeder system. Investigators learned during interviews that at times the certified person conducting the weekly examination was accompanied by a miner who was not a certified fireboss or mine foreman.

It was determined during the investigation that the weekly examination of November 23, 2009, was scheduled prior to the beginning of the preshift examinations. The normal weekly examiner, Jones, was on vacation November 23, 2009. Jones and Ethridge stated in separate interview statements that they had discussed the examination and bleeder conditions with each other prior to Jones going on vacation. Ethridge also said in an interview statement that Phillips, his immediate supervisor, reminded him prior to November 23, 2009, that he would be conducting the weekly examination of the Southwest A Longwall bleeder during Jones' absence.

Work History and Training of Victims

Chaney had a total of four years and four weeks of mining experience. He worked at the No. 7 Mine as a general laborer IS for one year and two weeks. He also worked at the No. 7 Mine as a contract laborer. He was not a certified mine foreman or fireboss in the State of Alabama. Ethridge had 29 years and 42 weeks of mining experience at the No. 7 Mine: 29 years and 13 weeks were as a foreman. He was certified by the State of Alabama as a mine foreman. A review of Ethridge's and Chaney's training records indicated they had received 30 C.F.R Part 48 training.

Training Plan

30 C.F.R. Part 48 Subpart A sets forth the mandatory requirements for submitting and obtaining approval of programs for training and retraining miners working in underground mines. The No. 7 Mine training plan was approved on April 13, 2006.

While the mine operator's 30 C.F.R. Part 48 training plan addressed many mining related hazards, the plan did not address the potential for heat and heat stress disorders resulting from prolonged exposure to elevated temperatures and humidity that existed at the No. 7 Mine. The mine operator and miners who had worked or traveled in the Southwest A Longwall bleeder were aware the temperatures in the bleeder were higher than other areas of the mine. Miners conducting weekly examinations routinely carried backpacks filled with ice, water, and sports drinks when traveling in the Southwest A Longwall bleeder. On November 16, 2009, the mine examiner conducting the weekly examination encountered unusually high temperatures at the Moving EP that he relocated. The miner accompanying him used measures one would likely consider extreme in an attempt to cool himself. On November 23, 2009, a hazardous condition consisting of high heat and humidity was encountered during the weekly examination of the Southwest A Longwall bleeder. Although the miner conducting the weekly examination decided to exit the bleeder before completing the examination, he did not fully recognize the severity of the hazard in sufficient time to enable successful retreat to a safe environment. The prolonged exposure to the heat and humidity led to the incapacitation of one miner and the death of another. After the accident, the miner who was conducting the weekly examination on November 23, 2009, indicated that if he encountered similar conditions again he would report it as a hazard. The duration of the miner's exposure to the high heat and humidity in the bleeder constituted an immediate hazard. Numerous other persons were adversely affected by the high heat and humidity during the ensuing rescue and recovery operation.

MSHA Partial Mine Ventilation Survey

A partial mine ventilation air quantity and air pressure survey was conducted by personnel from the Ventilation Division, Pittsburgh Safety and Health Technology Center, MSHA, on December 2-3, 2009, in conjunction with the accident investigation. The intent of the survey was to investigate the post-accident ventilation of the bleeder system and develop a simulation from a computerized mine ventilation model that would depict the likely pre-accident ventilation scenario. The area surveyed included the safely accessible portions of the Southwest A Longwall bleeder system and active workings south of Service Shaft 7-3. Results of tests and measurements completed during the survey are shown in Appendix K. Observed ventilation controls and the results of the gas chromatographic analyses of several air samples collected during the survey are also shown. The methane liberation rate of the Southwest A Longwall bleeder system, as determined from analyses of air samples collected and air quantities measured on December 2, 2009, was about 1 million cubic feet per day (mmcfd).

Ventilation changes completed in the Southwest A Longwall bleeder system to facilitate the rescue and recovery operations on November 24, 2009, and during the initial observations of MSHA accident investigators on November 30, 2009, changed the direction and/or distribution of airflow in the bleeder system. The full effect of those changes was not able to be determined by investigators. Due to the inability to safely travel the bleeder system to the toe of the water in the tailgate bleeder entries, the ventilation scenario prior to the accident was not able to be clearly reconstructed. Sufficient information was not able to be collected during the partial mine ventilation survey about critical airflow paths in the bleeder system to develop a reliable computerized mine ventilation model for use in studying a likely pre-accident ventilation scenario.

MSHA Continuous Monitoring Study

Statements of individuals indicated gas concentrations in the Southwest A Longwall bleeder may have changed due to barometric pressure changes. Therefore, a continuous monitoring study of methane and oxygen concentrations in airflow exiting the Southwest A Longwall bleeder system was conducted by personnel from the Ventilation Division, Pittsburgh Safety and Health Technology Center, MSHA, on December 2-3, 2009.

Mine Safety Appliances (MSA) Solaris® Multigas Detectors[1] and Industrial Scientific Corporation iTX Multi-Gas Monitors, both types of instruments equipped with datalogging capabilities, were placed in the airflow exiting the Southwest A Longwall bleeder system inby Crosscut 14 in tailgate Entry No. 4. The study site was at the same approximate location as TG EP 5. Leakage of less contaminated air from Entry No. 3 through ventilation controls in crosscuts inby the monitored location affected the air quality across the entry at the study site, resulting in better air quality on the left side (looking inby) of Entry No. 4. Instruments were hung from the mine roof on both the left side of the entry and on the right side of the entry, one instrument of each type on each side, for more than 24 hours. Two instruments ceased monitoring the gas concentrations after about 12 hours, when their batteries were exhausted. One other instrument failed to record data. Copies of micro-barograph recordings of the barometric pressure were obtained from the mine operator for the time period in which the continuous monitoring study was conducted.

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[1] Reference to specific brand, equipment, or trade name are made to facilitate understanding and do not constitute an endorsement by the Mine Safety and Health Administration.

Figures 1 and 2 depict the recorded oxygen concentrations and methane concentrations, respectively, along with the barometric pressure during the study period. The data suggested increases occurred in the concentrations of oxygen and decreases occurred in the concentrations of methane in the airflow exiting the Southwest A Longwall bleeder system due to an increase in the barometric pressure. The changes observed at the monitoring location would likely have been less pronounced than that which could have occurred in airflow that ventilated the worked-out area of the Southwest A Longwall Panel deeper in the bleeder system.

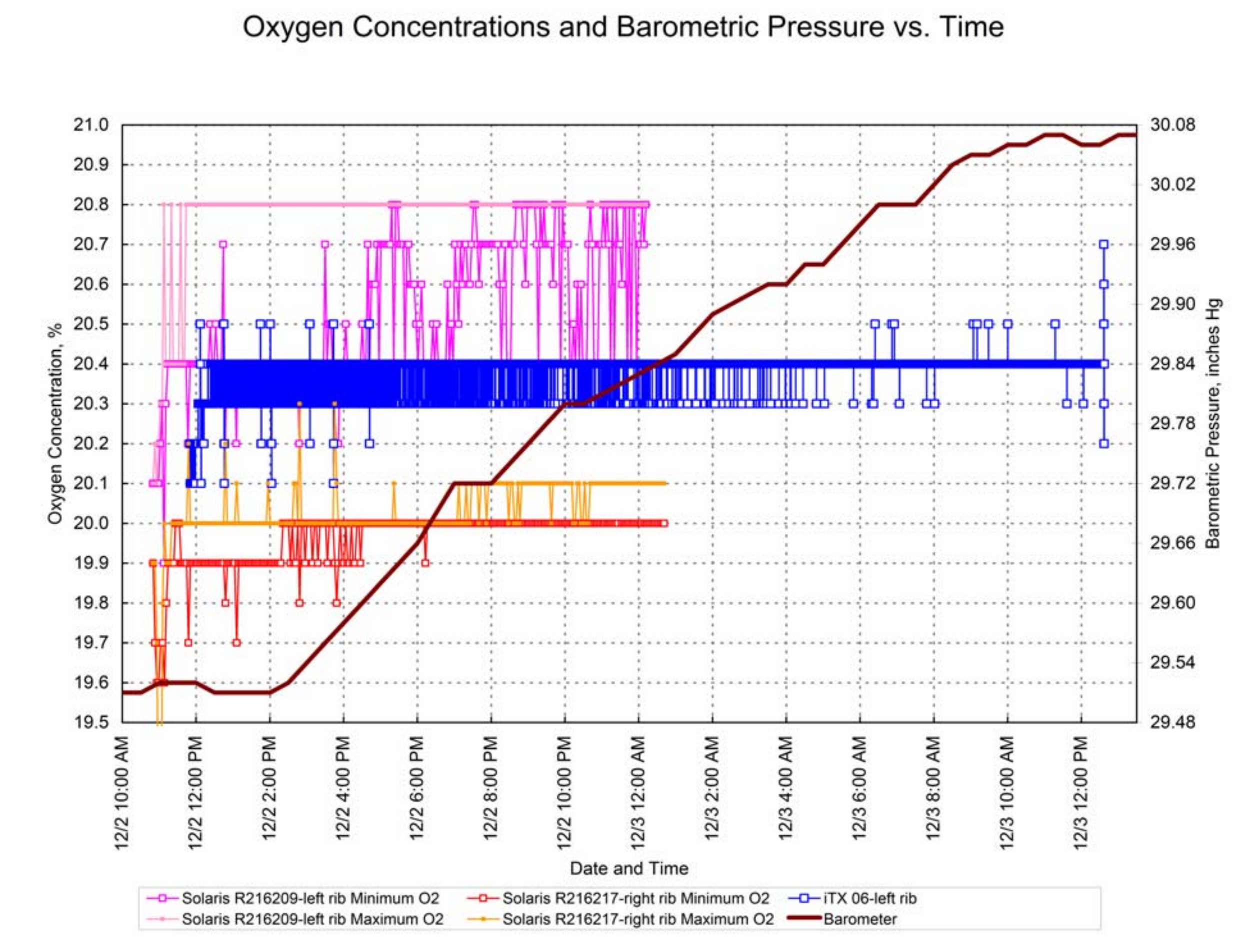

Figure 1. Comparison of Oxygen Concentrations at TG EP 5 and the Barometric Pressure During the MSHA Continuous Monitoring Study on December 2-3, 2009.

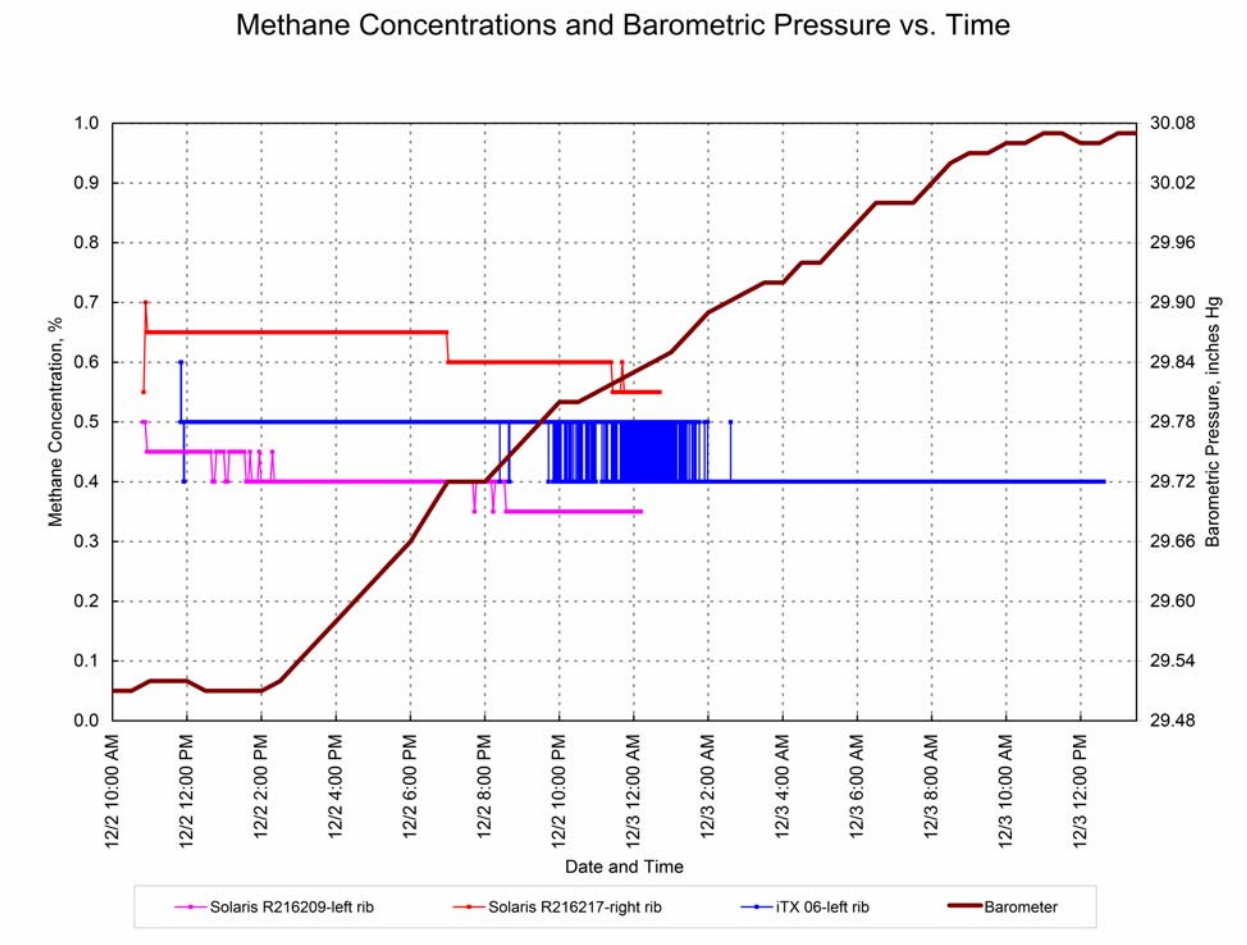

Figure 2. Comparison of Methane Concentrations at TG EP 5 and the Barometric Pressure During the MSHA Continuous Monitoring Study on December 2-3, 2009.

The rate, direction, and duration of barometric pressure change are major factors affecting the expansion or contraction of accumulated gases in sealed areas and poorly ventilated portions of worked-out areas. During the study, a steady rise in barometric pressure occurred over a 19-hour period of time. The total change in barometric pressure during the time period was 0.55 inches of mercury (H_g). The average and median rates of change in barometric pressure during the 19-hour rise were approximately 0.0284 inches of mercury per hour and approximately 0.03 inches of mercury per hour, respectively.

Barometric Pressure Changes on November 23 and 24, 2009

Copies of micro-barograph recordings of the barometric pressure were obtained from the mine operator for the time period including November 23 and 24, 2009. A review of the information revealed the difference between the highest and lowest barometric pressures from November 16, 2009, to November 30, 2009, was about 0.4 inches of mercury.

The barometric pressure from the time just before Ethridge and Chaney entered the bleeder on November 23, 2009, until the ventilation change was completed on November 24, 2009, was relatively steady. The change over the 18-hour period of time, from 4:00 p.m. on November 23, 2009, through 10:00 a.m. on November 24, 2009, was an increase of approximately 0.045 inches of mercury. The largest one-hour change in barometric pressure during the 18-hour period was approximately 0.015 inches of mercury. The average and median rates of change in barometric pressure during the 18-hour time period were both approximately 0.005 inches of mercury per hour.

Figure 3 depicts a comparison between the changes in barometric pressure during the MSHA continuous monitoring study and the changes in barometric pressure on November 23, 2009, and November 24, 2009. For comparative purposes, the barometric pressure during each time period was plotted for 28 consecutive hours. The 28-hour time period plotted for the barometric pressure during the MSHA continuous monitoring study was from 10:00 a.m. on December 2, 2009, through 2:00 p.m. on December 3, 2009. The 28-hour time period plotted for the barometric pressure during the accident was from 1:00 p.m. on November 23, 2009, through 5:00 p.m. on November 24, 2009.

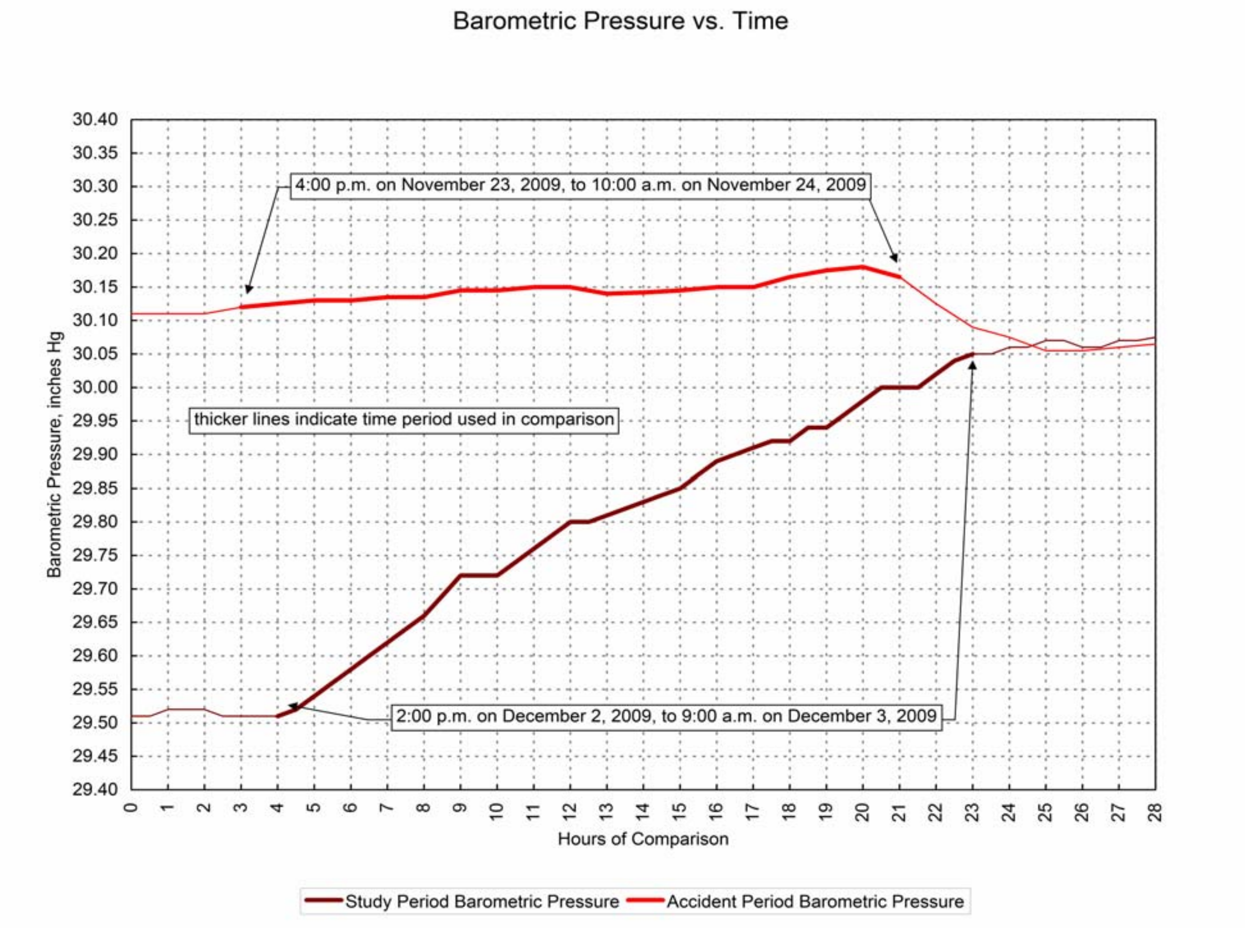

Figure 3. Comparison of Barometric Pressure During the MSHA Continuous Monitoring Study on December 2-3, 2009, and the Barometric Pressure During the Accident on November 23-24, 2009.

The comparison indicates the changes in barometric pressure that occurred during the MSHA continuous monitoring study were much greater than those that occurred during the time just before Ethridge and Chaney entered the bleeder on November 23, 2009, until the ventilation change was completed on November 24, 2009. Further, those barometric changes on November 23-24, 2009, were not severe. Investigators concluded that in a well ventilated bleeder system the barometric pressure changes that occurred on November 23-24, 2009, would not likely have contributed significantly to changes in the air quality.

Handheld Multi-Gas Detectors

Miners were provided several types of handheld multi-gas detectors to test for gases at No. 7 Mine. Each detector was assigned an identification number. A system was developed by the mine operator to track detector usage by miners. A log was maintained at the mine for each shift that indicated which detectors were issued, to whom they were issued, and if they were returned. Investigators obtained copies of, and reviewed, these records to determine which detector was used by an individual miner on the dates pertinent to the accident and during examinations prior to the accident that were conducted in the Southwest A Longwall bleeder. During interviews, some miners indicated the identification number of the detector they used during pertinent time periods.

Mine personnel who conducted examinations in the Southwest A Longwall bleeder system and some of the miners who responded during the rescue and recovery operation on November 23 and 24, 2009, used MSA Solaris® Multigas Detectors. The MSA Solaris® Multigas Detectors were four-gas monitors. At least some of these detectors were equipped with datalogging capabilities. The detectors contained sensors to test for methane, oxygen, and carbon monoxide. Some detectors also contained sensors to test for nitrogen dioxide. The concentration of each gas measured was continuously displayed on the face of the detector. Each detector was equipped with an audible, visual, and vibrating alarm signal that activated at a preset concentration for each gas. The detectors recorded the gas levels detected at preset time intervals in the detector data log. Interview statements indicated most mine personnel were not aware of the datalogging capabilities of the instruments.

Multi-gas detectors exposed to the mine atmosphere in the Southwest A Longwall bleeder were obtained from the mine operator, including the MSA Solaris® Multigas Detector used by Ethridge on November 23, 2009 (detector identified as MSA#11) and the MSA Solaris® Multigas Detector used by Jones on November 16, 2009, when he conducted the weekly examination of the Southwest A Longwall bleeder (detector identified as MSA#20). MSA#20 was not in operating condition when received by investigators. These instruments were subjected to various tests by MSHA Approval and Certification Center personnel to evaluate responses under varying conditions. In addition, repairs were made to MSA#20 in an attempt to recover the datalogged information it contained. Tests indicated MSA#11 responded appropriately when subjected to methane and oxygen concentrations. Tests verified that the MSA#11 audible, visual, and vibrating alarms operated at the expected concentrations for methane and oxygen. A summary of handheld multi-gas detector testing results are contained in Appendix L.

Datalogged Information

The datalogged information from MSA#11 and MSA#4, the MSA Solaris® Multigas Detector used by Olson on November 24, 2009, was downloaded and a printout of each data log obtained from the mine operator. The time indicated by the detector in the data log was compared to the "actual" time and noted when the data log was printed out and obtained for each detector. In the analysis of the information contained in the data logs, adjustments were made to correct for any differences between the time indicated by the detector and the "actual" time, so as to more closely approximate the times at which the data were recorded in the logs. Interview statements indicated

Ethridge and Olson each attached their detectors to their outside garment at about chest height when they traveled into the Southwest A Longwall bleeder.

The detectors provided an exposure warning and exposure alarm, both of which were audible and visual, for each measured gas. The data logs contained a record of the warning and alarm settings for each measured gas. The audible and visual alarms for the MSA#11 detector were set to activate for a methane exposure warning at 2.00% and a methane exposure alarm at 3.00%. The methane exposure warning was non-latching, which indicated the alarm would cease if the methane concentration decreased below 2.00%. The methane exposure alarm was latching, which indicated the alarm would continue even if the methane concentration decreased below 3.00%. The audible and visual alarms for the MSA#11 detector were set to activate for an oxygen exposure alarm at 23.00% and an oxygen deficiency warning at 19.50%. The oxygen exposure alarm and deficiency warning were both non-latching, which indicated the alarm would cease if the oxygen concentration returned to between 19.50% and 23.00%. The audible and visual alarms for the MSA#4 detector were set to activate for methane and oxygen in the same manner as MSA#11 except the exposure warning for methane was set at 2.50%.

The data logs contained session histories. A new session was initiated each time the detector was turned on. Subsequently, turning the detector off ended that particular session. The data log indicated the date and time each session started and ended, along with pertinent information recorded during each session. This information included the date and time of "Events", such as alarms and warnings, and "Gas Readings", such as peak and minimum concentrations detected for each gas. The date the detector was last calibrated was also indicated. MSA#11 was last calibrated on November 10, 2009. MSA#4 was last calibrated on November 23, 2009.

The detectors were preset to record the measured gas concentrations in the data log at approximately 3-minute intervals. Each 3-minute entry indicated the gas concentrations detected since the previous entry was recorded. The information recorded for each 3-minute period included the peak methane concentration (as percent), the peak carbon monoxide concentration (as parts per million [ppm]), and the minimum and maximum oxygen concentrations (as percent). MSA#11 also contained a nitrogen dioxide gas sensor and recorded the peak nitrogen dioxide concentration (as ppm).

Experience has shown and testing verified that oxygen concentrations displayed by the detectors typically vary for a short duration when the sensor is exposed to sudden changes in pressure, such as would be experienced while riding the hoist into or out of the mine or when passing through personnel doors with relatively high ventilating pressure differentials across them. This phenomenon, in conjunction with approximate times indicated in interview statements, was used to estimate the time the miners who carried the detectors passed through the regulator located inby the end of the track in the Southwest A Longwall Tailgate Entry No. 3 and entered the bleeder entries.

MSA#11 Data Log

Information from Ethridge's MSA#11 detector data log is contained in the figures below. The data log indicated there were nine sessions recorded between approximately 4:00 p.m. on November 23, 2009, and 10:07 a.m. on November 24, 2009. Figure 4 depicts methane, oxygen, and carbon monoxide data from these nine sessions as well as the estimated times of pertinent events that occurred while the detector was underground. These sessions are identified as Session 1 through Session 9.

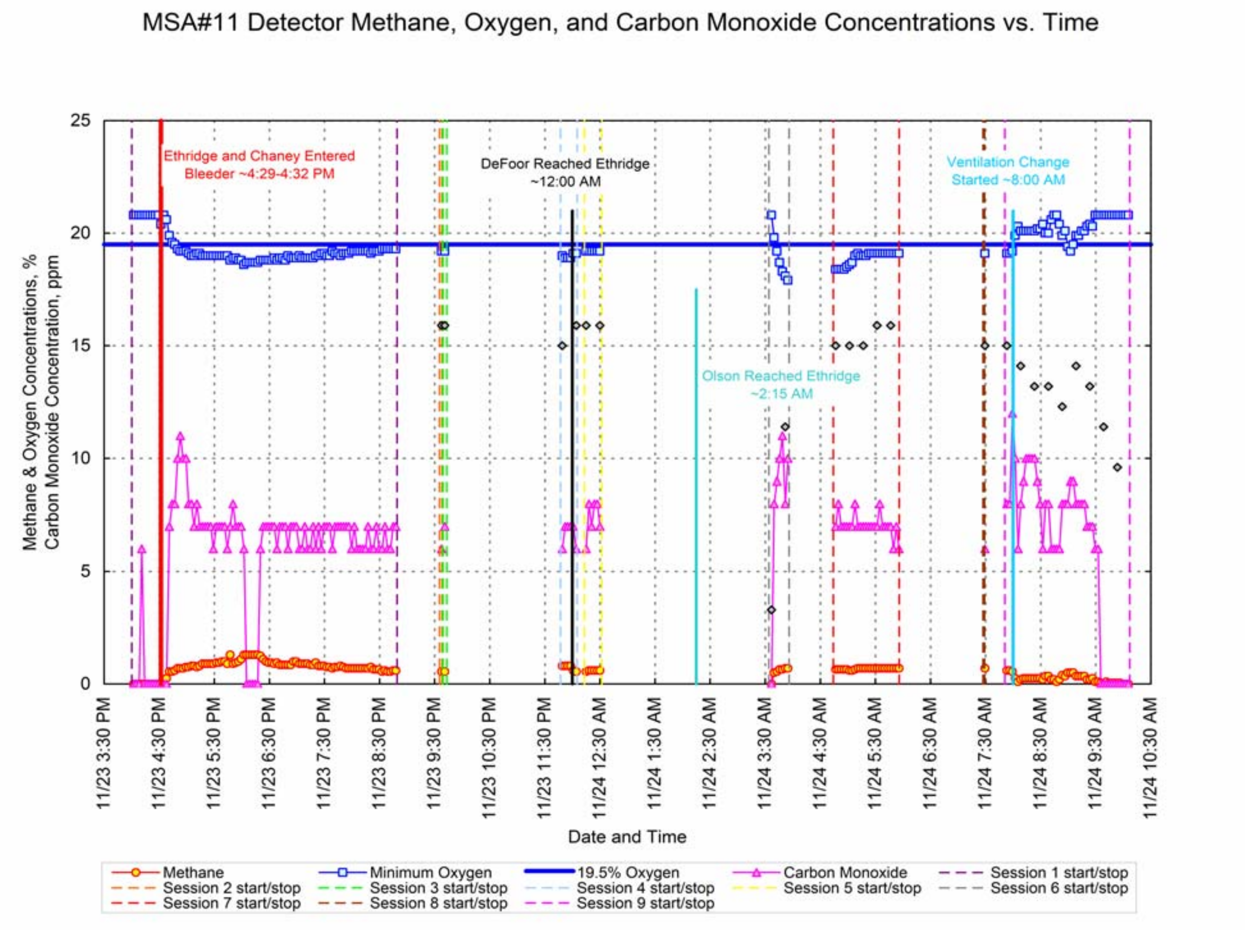

Figure 4. Ethridge's MSA#11 Detector Methane, Oxygen, and Carbon Monoxide Data from November 23-24, 2009.

Session 1 began at approximately 4:00 p.m. and ended at approximately 8:49 p.m. on November 23, 2009. Figure 5 depicts the minimum and maximum oxygen concentrations recorded during Session 1. It was during Session 1 that Ethridge and Chaney entered the Southwest A Longwall bleeder. Estimated times of notable events depicted include: the time Ethridge and Chaney entered the bleeder through the regulator located inby Crosscut 11 (between 4:29 p.m. and 4:32 p.m.); the time the detector first alarmed for oxygen at 19.50% (4:46 p.m.); and the time the detector first recorded an oxygen concentration of less than 19.50% (between 4:47 p.m. and 4:50 p.m.). No oxygen concentration of 19.50% or higher was recorded during the remainder of Session 1. Also, as depicted, the lowest oxygen concentration, 18.60%, was detected between 5:59 p.m. and 6:02 p.m.

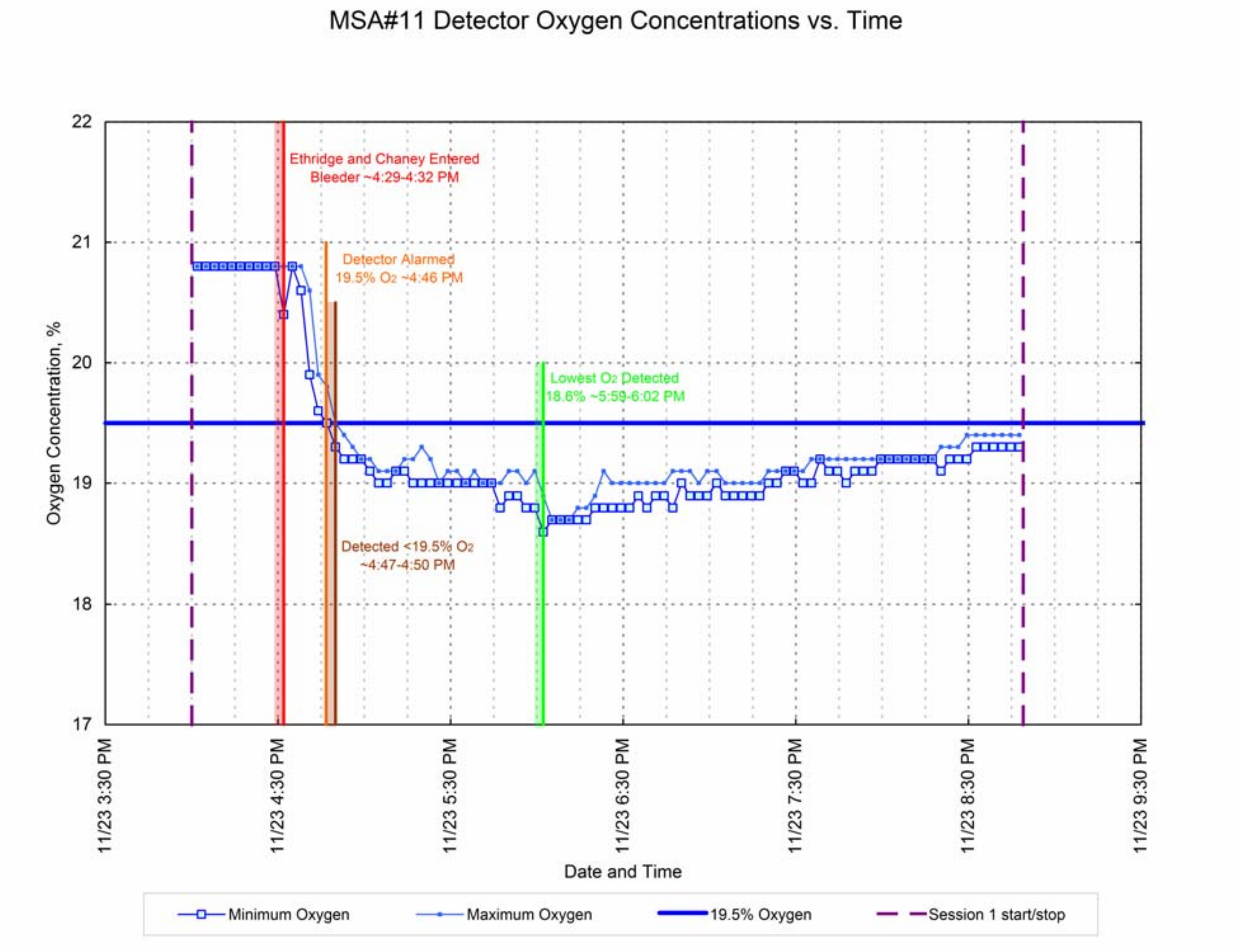

Figure 5. Ethridge's MSA#11 Detector Session 1 Oxygen Data from November 23, 2009.

Figure 6 emphasizes the oxygen concentrations recorded during the first 45 minutes after Ethridge and Chaney entered the Southwest A Longwall bleeder. The minimum and maximum oxygen concentrations recorded are shown. Estimated times of notable events depicted include: the time Ethridge and Chaney entered the bleeder through the regulator located inby Crosscut 11; the time the detector first alarmed for oxygen at 19.50%; and the time the detector first recorded an oxygen concentration of less than 19.50%.

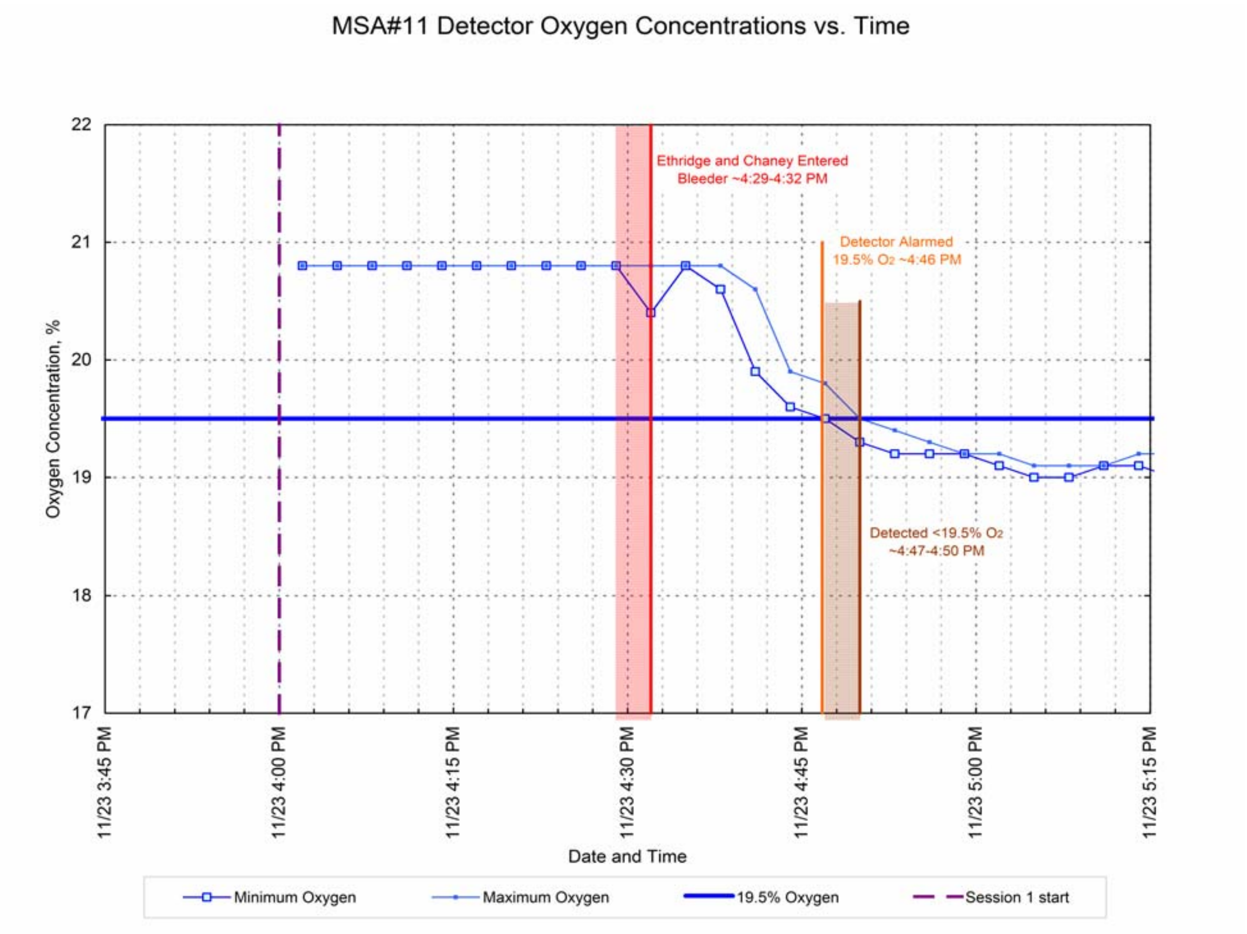

Figure 6. Ethridge's MSA#11 Detector Session 1 Oxygen Data During Initial Travel in Southwest A Longwall Bleeder on November 23, 2009.

Information from Ethridge's MSA#11 detector data log indicated the maximum carbon monoxide concentration recorded was 12 ppm. Information from Ethridge's MSA#11 detector data log indicated the maximum nitrogen dioxide concentration recorded was 1.5 ppm.

MSA#4 Data Log

Information from Olson's MSA#4 detector data log is contained in figures below. The data log indicated there was one session recorded between approximately 1:39 a.m. through approximately 1:05 p.m. on November 24, 2009. Figure 7 depicts methane, oxygen, and carbon monoxide data from the single session as well as the estimated times of pertinent events that occurred while the detector was underground. Estimated times of notable events depicted include: the time Olson entered the bleeder through the regulator located inby Crosscut 11 (between 1:47 a.m. and 1:50 a.m.); the time the detector first alarmed for oxygen at 19.50% (1:57 a.m.); the time the detector first recorded an oxygen concentration of less than 19.50% (between 1:56 a.m. and 1:59 a.m.); and the time Olson reached Ethridge near Crosscut 26 (2:15 a.m.).

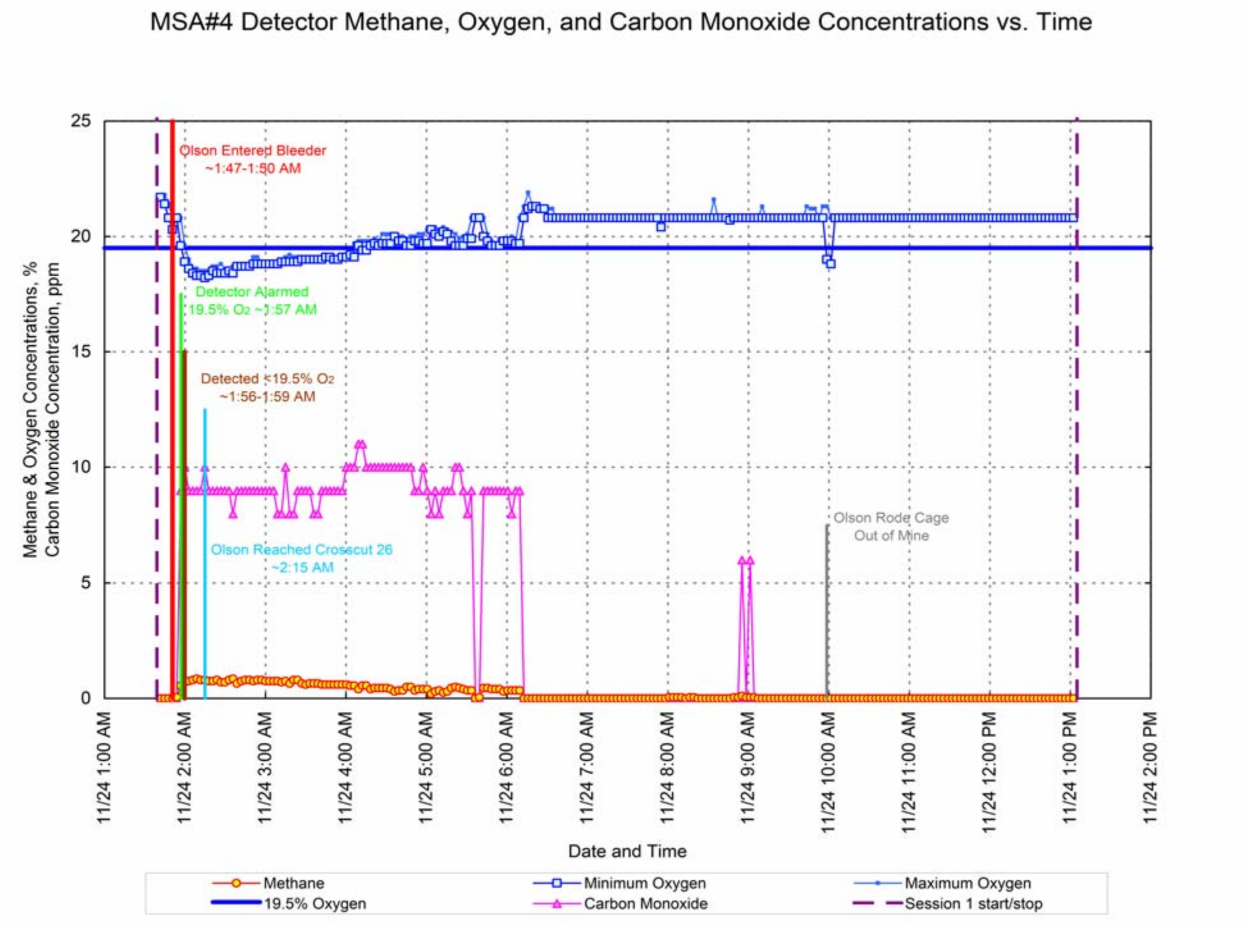

Figure 7. Olson's MSA#4 Detector Methane, Oxygen, and Carbon Monoxide Data from November 24, 2009.

Figure 8 depicts the minimum and maximum oxygen concentrations recorded during the entire session. Figure 9 emphasizes the oxygen concentrations recorded during Olson's initial travel to Crosscut 26. Estimated times of notable events are also depicted on these figures.

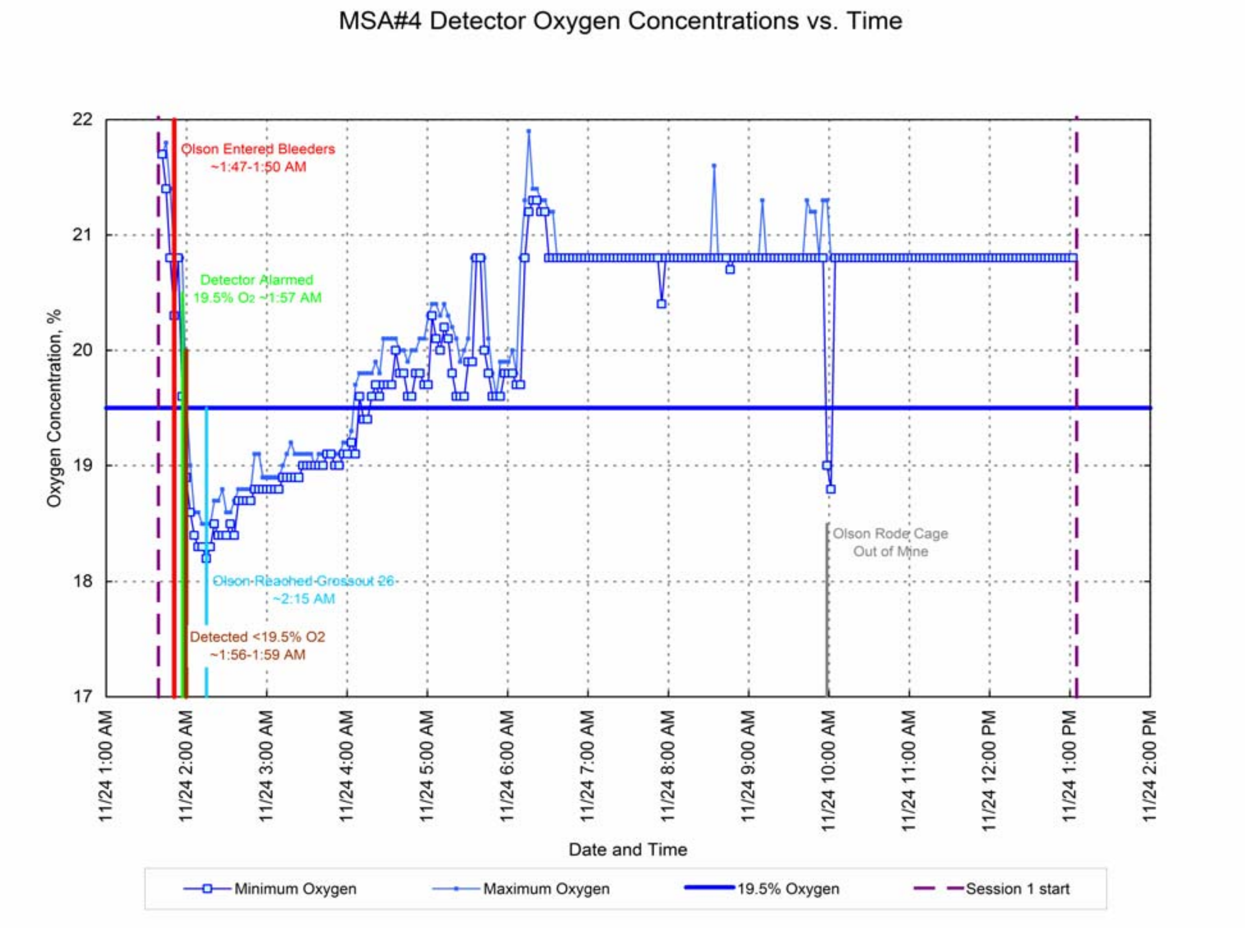

Figure 8. Olson's MSA#4 Detector Oxygen Data on November 24, 2009.

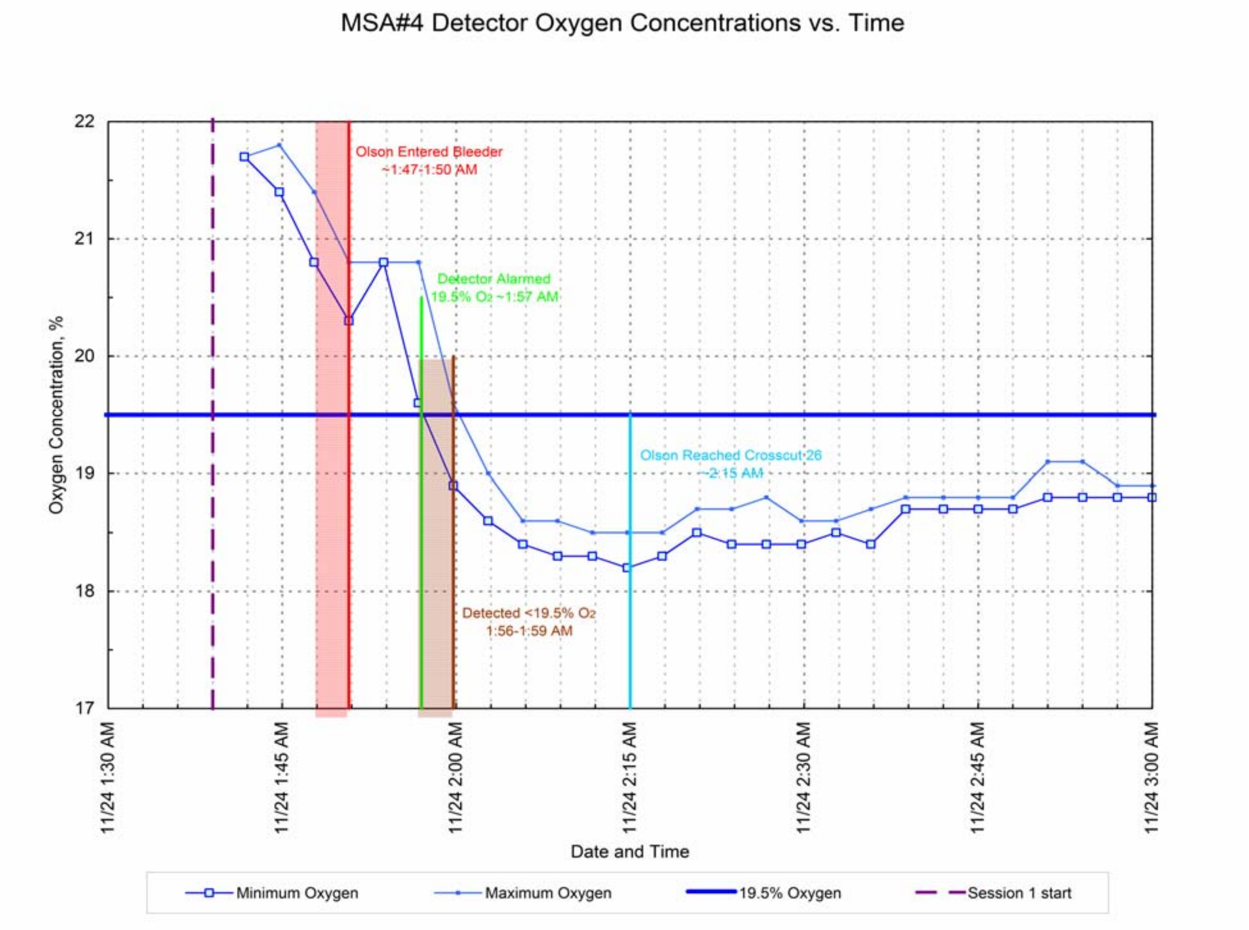

Figure 9. Olson's MSA#4 Detector Oxygen Data During Initial Travel in Southwest A Longwall Bleeder to Crosscut 26 on November 24, 2009.

Information from Olson's MSA#4 detector data log indicated the maximum carbon monoxide concentration recorded was 11 ppm. Olson's MSA#4 detector was not equipped with the sensor to measure nitrogen dioxide concentrations.

MSA#20 Data Log

Information from Jones' detector used while he conducted the weekly examination of the Southwest A Longwall bleeder on November 16, 2009, was recovered with assistance provided by the detector's manufacturer. There was a loss of session information and there appeared to be gaps in the logged data. Investigators concluded the information obtained from the data log could not be adequately correlated. Therefore, no conclusions were able to be derived from the information, nor was the information used in the formulation of findings and/or conclusions contained in this report.

Conditions in the Southwest A Longwall Bleeder

MSHA investigators considered information from numerous sources in an attempt to determine the conditions that existed, and to which miners were exposed, in the Southwest A Longwall bleeder system on the evening shift of November 23, 2009. In addition to subjects normally considered, information led investigators to pursue some which were atypical.

The changes in ventilation made on November 24 and 30, 2009, and the inability to safely access the entire portion of the Southwest A Longwall bleeder in which the accident occurred significantly impacted the ability to fully determine the conditions encountered by Ethridge and Chaney in the bleeder, and their actions in response to those conditions. However, investigators were able to develop limited resolution regarding Southwest A Longwall bleeder system airflow patterns, airflow distribution, air temperatures, gas concentrations, and effectiveness, and the extent of travel by Ethridge and Chaney on November 23, 2009.

Conditions in the Southwest A Longwall Bleeder Encountered During Weekly Examinations Prior to November 23, 2009

Conditions in the Southwest A Longwall bleeder deteriorated over time. Control of water at the lowest elevation in the bleeder, the inby end of the tailgate entries, was hampered by ground conditions, the remote location of the area, and pumping capacity issues. The mine operator attempted to control the water by using submersible permissible electric pumps and a progressive cavity pump, but neither pumping system sufficiently maintained control of the water. The operator also applied for a 101(c) petition for modification to install deep well pumps, including in the Southwest A Longwall bleeder. Due to the timing issues relative to the processing of the petition and completion of mining in the Southwest A Longwall, the petition was subsequently withdrawn and resubmitted without including the Southwest A Longwall area.

On September 21, 2009, Stephen Harrison, MSHA District 11 Mining Engineer, conducted an inspection in the Southwest A Longwall bleeder system. He was accompanied by Olson, who simultaneously conducted the weekly examination of the Southwest A Longwall Tailgate bleeder entries. Notes made during this inspection provided detailed information about the conditions at that time. Harrison's notes indicated the longwall reportedly had only 110 feet to complete mining of the panel. A citation was issued for failing to travel at least one entry of the Southwest A Longwall bleeder in its entirety on September 14, 2009, and September 21, 2009. Harrison learned the mine examiner discovered deep water, close to being roofed, at the intersection of Entry No. 3 and Crosscut 42 that blocked his travel and prevented the completion of the weekly examination. Mine management investigated the hazard to determine its cause and found the power cable for an electric water pump was struck by fallen roof rock and had become inoperable. The damaged section of cable was replaced and another electric water pump was installed to increase pumping capacity. During the weekly examination on September 21, 2009, the depth of the water was found to have decreased, but still blocked travel and prevented the completion of the weekly examination. The citation noted the hazard and corrective action taken had been recorded in the Weekly Examinations mine record book as required.

Harrison noted high heat and high humidity was encountered in Entry No. 3 inby Crosscut 15. He noted severe heaving of the mine floor in Entry No. 4 and the roof was more deteriorated in Entry No. 3 inby Crosscut 20. The methane, oxygen, and carbon monoxide concentrations at Crosscut 28½ were 0.9%, 19.5%, and 7 ppm, respectively. Conditions required zigzag travel. At Crosscut 35, he traveled into Entry No. 4 for one crosscut distance and returned to Entry No. 3. The methane, oxygen, and carbon monoxide concentrations were 0.5%, 20.8%, and 0 ppm, respectively. The methane, oxygen, and carbon monoxide concentrations at Crosscut 39 were 0.5%, 20.3%, and 0 ppm, respectively. At the MPL regulator located in Crosscut 41 between Entry No. 2 and Entry No. 3, the methane, oxygen, and carbon monoxide concentrations were 0.4%, 20.8%, and 0 ppm, respectively. Although the water was nearly roofed in the flooded area, Harrison noted that there appeared to be plenty of airflow around the back of the bleeder from the headgate. He also noted the air temperature and humidity was much lower in that area. The methane, oxygen, and carbon monoxide concentrations were 0.4%, 20.8%, and 0 ppm, respectively.

The notes in the No. 7 Mine Outby Report books reflect the type of work conducted in the bleeder during this time as well. Interview statements of miners who completed much of the work were also revealing. Miners dragged lengthy power cables and heavy water pumps from the end of the track in the Southwest A Longwall Tailgate to the back of the bleeder entries. A Stokes basket was used by the miners to assist in the strenuous process of pulling the water pumps. Standing supplemental roof supports were installed. These tasks required multiple miners to work several shifts under difficult conditions in the bleeder.

Appendix M is a series of maps that depict the estimated extent of the water in the bleeder entries at the time weekly examinations were conducted during the month prior to the accident. The depicted information was based on interview statements, Outby Daily Report notes, coal elevations, and approximate mining heights in the tailgate bleeder entries. Records indicated that during the weekly examination conducted on October 26, 2009, the toe of the water in the bleeder was 70 feet inby survey station (spad) 20048, which was located at Crosscut 39. This would indicate the water was likely roofed below the 390-foot elevation. On November 2, 2009, the toe of the water was reported to be 10 feet inby spad 20048. This would indicate the water was likely roofed below the 392-foot elevation.

Based on mine examination record books, other mine records, and interview statements, investigators determined the following was pertinent information regarding the Southwest A Longwall bleeder on November 16, 2009:

- Jones completed all the daily and weekly examinations of the Southwest A Longwall bleeder system on November 16, 2009. He was accompanied in the bleeder by Romie Pendleton, No. 7 Mine supervisor and new miner.
    - Changes in methane and oxygen concentrations recorded for each examination location near the longwall face, in both the headgate and tailgate entries, were within what appeared to be the usual fluctuations in the measurements.
    - When Jones measured the air quantity at TG EP 1 and TG EP 2, on November 16, 2009, the curtains across Entry No. 1 and Entry No. 2 in the tailgate at the face were down. He believed this permitted more air to go past the face in Entry No. 1 and Entry No. 2.
    - Two lines were marked in the weekly examination record book in place of text or numerical entries for the direction and measured air quantity at the Moving EP on November 16, 2009. The record indicated 1.0% methane and 19.6% oxygen at the Moving EP.
    - As previously noted, the entry in the weekly examination record book indicated 1.4% methane and 19.6% oxygen were the highest methane and lowest oxygen concentrations encountered during the examination of the bleeder.
    - No hazardous conditions were noted in the weekly examination record book.
- Jones carried his detector as usual in the bleeder, clipped to the outside of his shirt about chest high, with the display pointed away from him, so he could see the alarm lights and gas concentrations.
- The air was moving in the proper direction in the bleeder.
    - The air in Entry No. 3 was moving inby to Crosscut 15. Inby Crosscut 15 the air was flowing outby.
    - At Crosscut 35, Pendleton could feel a little bit of air movement and saw the ends of the hanging danger flagging moving a little.
    - When Jones knocked the hole in the stopping at Crosscut 38, the hot air that exited the worked-out area through the hole barely moved toward the bleeder entry. Jones recalled that when he put his anemometer up to measure the velocity of the air moving through the hole the anemometer vanes barely moved.
    - There was some air movement outby over the water in Entry No. 3, but most of the air was coming out Crosscut 38 after the hole was knocked in the Crosscut 38 stopping. Jones did not measure the air quantity coming over the water in Entry No. 3. Jones thought the amount of air coming over the water, in general, had decreased over time.

    - The methane concentration initially increased slightly at Crosscut 38 after the hole was knocked in the stopping. Jones recalled that he detected 19.5% to 19.6% oxygen and 0.9% methane after he knocked a hole in the stopping.
- Ventilation controls were observed.
    - The ventilation controls between Entry No. 2 and Entry No. 3 in the bleeder on November 16, 2009, were intact. There were no holes observed in the stoppings. Curtains had previously been installed over some of the stoppings because they were leaking.
    - The stoppings between Entry No. 2 and Entry No. 3 between TG EP 2 and TG EP 3 were intact.
- The water at the inby end of the bleeder had risen since the previous examination conducted on November 9, 2009, moving the toe of the water further outby. (Appendix M contains maps that depict the estimated extent of the accumulated water on October 26, November 2, and November 16, 2009.)
    - The depth of the water was about half the height of the stopping at the Moving EP location in Crosscut 39.
    - Jones estimated the toe of the water in Entry No. 3 was about 15 to 20 feet inby Crosscut 38.
- Jones knocked a hole in the next stopping located outby the toe of the water in compliance with the approved mine ventilation plan supplement. This stopping was located in Crosscut 38 between Entry No. 2 and Entry No. 3. Information differed regarding the size of the opening he made.
    - Jones recalled the size of the whole he knocked in the stopping at Crosscut 38 was about 5 feet by 20 feet, or just about the entire stopping.
    - Notes made in the Outby Daily Report book on November 16, 2009, for the day shift and signed by Jones indicated he started knocking out the next stopping and that five blocks were knocked out.
    - Jones also indicated the size of the hole he knocked in a stopping when relocating the Moving EP generally depended on how many blocks could be knocked out before the heat of the air coming through the hole became too great to endure. He recalled that he generally removed about half of the stopping.
- The temperature of the air moving outby in the bleeder was elevated.
    - Jones thought the air temperature in the bleeder had increased over the previous three months.
    - Jones recalled that the air did not get cooler at the inby end, at the toe of the water, as it had during previous examinations in the bleeder. The temperature seemed to be hot throughout the area.
    - The air that exited from the gob through the hole Jones knocked in the stopping at Crosscut 38 was hot. He described the way it felt was "like when you open your oven on the stove".

    - After Jones knocked the hole in the stopping, the temperature remained about the same: it was hotter than previous times when he had relocated the Moving EP. He did not stay there long because it was hot.
    - The air temperature was hotter at the hole in the stopping at Crosscut 38 than at the toe of the water.
    - Although it seemed to Pendleton that the air temperature increased all the way in to Crosscut 35, he couldn't be certain because the length of time he was exposed to the heat and the arduous travel he endured in the bleeder may have affected his perception.
- The time required to conduct the examination in the bleeder was similar to that for previous examinations.
    - Jones estimated that it took him about 50 minutes to walk to the back of the bleeder, noting it was downhill. That time included stopping to rest once or twice for just a few minutes along the way. It took about one and one half to two hours to come back out because it was uphill. He recalled it took about the normal time to conduct the examination in the bleeder on November 16, 2009.
    - Pendleton estimated it took about 50 minutes to travel from the end of the track to Crosscut 35 in the Southwest A Longwall bleeder. He recalled they stopped and rested on the way in. As far as Pendleton went was Crosscut 35. He waited there, because he knew he had to get back out and he knew that it was uphill on the way out.
- The ground conditions made travel arduous.
    - The air was reportedly better in Entry No. 4 than in Entry No. 3. However, the miners traveled in Entry No. 3 because the bottom in Entry No. 4 was heaved and there were few supplemental supports installed.
    - There were adverse roof conditions in Entry No. 3. Supplemental roof supports were set about every 5 to 6 feet. Travel required miners to zigzag around the supports.
    - Some areas of the travelway were low, which required crawling on hands and knees. In other areas, the miners had to zigzag their way around supplemental roof supports and other obstructions.
    - The ground conditions in the crosscuts between Entry No. 2 and Entry No. 3 were considered unsafe.
    - Jones used the conditions they encountered in the bleeder as a means of providing instruction to Pendleton about what were safe and unsafe conditions. Jones pointed out poor roof, roof bolts that needed replaced, timbers exposed to floor heave, slipping and tripping hazards, and unsafe ribs. He pointed out some poor roof that had been made safe.
    - Areas of dangerous roof along the travelway in the bleeder were marked with danger flagging.
- Jones and Pendleton had prepared in advance for travel in the Southwest A Longwall bleeder.

  - Each carried a backpack with several bottles of water and sports drinks, some which were frozen, light snacks, and ice. Jones carried about the same amount of liquids as when he made the examination previously, about 4-5 bottles of sports drink and 3-4 bottles of water.
  - Jones looked over what Pendleton had packed to take with him into the bleeder. Pendleton had 2 quart size canteens, 2 more bottles of water, and one or two bottles of sports drink. Jones told him to take more water and gave him a big bottle of sports drink that Jones had frozen.
- Jones and Pendleton anticipated the conditions would be difficult and travel would be strenuous. They acted in a manner they believed appropriate.
  - They stopped to rest a couple times on the way in.
  - They paced their consumption of fluids so they wouldn't get sick.
  - Pendleton was instructed that if something happened to one of them, the other should go get help.
  - They left their coats in the bleeder entry before they encountered the hot temperatures. Somewhere between Crosscut 18 and Crosscut 20, Pendleton removed his outer shirt, which left him with a T-shirt, uniform pants (light cotton ones), mine boots, hard hat, backpack, cap lamp, and self contained self rescuer (SCSR).
  - They stopped to rest about every crosscut on the way out, drinking fluids each time. When they stopped, Pendleton laid on the mine floor on his back. He even rubbed some of the mud that was on the mine floor on his arms in an attempt to cool off.
  - At about Crosscut 18, Pendleton laid on the ground with his face in an opening at the bottom of a stopping in a crosscut that had cooler air flowing into the bleeder entry through the hole. Upon reaching Crosscut 14 and the cooler air entering the bleeder from the end of the track, Pendleton recalled it felt like the best experience of his life.
  - Pendleton recalled that the heat in the bleeder was similar to what he experienced working in a steel mill.
- Except for apparent fatigue, neither Jones nor Pendleton appeared to have experienced any ill effects from the heat.

Conditions in the Southwest A Longwall Bleeder Encountered by Ethridge and Chaney on November 23, 2009

Investigators concluded the air in the bleeder was oxygen deficient. Deteriorated roof and the presence of numerous standing supplemental supports made travel arduous. Traveling uphill toward the end of the track would have been more strenuous than traveling downhill toward Crosscut 38. Crawling over material in some locations was necessary. Air with decreased oxygen would most likely have been encountered after reaching the point where they encountered air flowing outby from deeper in the bleeder, which would most likely have been at Crosscut 15 in Entry No. 3. The temperature was notably higher inby Crosscut 15. The bleeder entries were blocked by water at the inby end of the tailgate entries. Accumulated water likely increased the resistance of other parallel airflow paths around the inby side of the caved portion of the longwall panel. The amount of airflow ventilating the bleeder entries from the toe of the water outby had decreased over time.

Investigators considered several pieces of information in assessing the extent to which Ethridge and Chaney advanced into the Southwest A Longwall bleeder on the evening shift of November 23, 2009, before deciding to retreat, including:

- The estimated walking paces of persons who responded on the night of the accident and the mine examiner who normally conducted the weekly examination of the Southwest A Longwall bleeder were calculated. Investigators extrapolated the information to estimate travel times at each pace from Crosscut 11 to Crosscut 26, Crosscut 30, and Crosscut 35.
    - Figure 10 depicts a comparison of the time approximate distances could be traveled in the Southwest A Longwall bleeder at the various paces indicated by Ethridge, Olson, DeFoor, and Jones. The oxygen information from a portion of Session 1 from Ethridge's detector data log is also depicted.
    - The pace of travel for Ethridge was based upon his estimate of three to four minutes per crosscut as he and Chaney traveled in the Southwest A Longwall bleeder on November 23, 2009. He also recalled stopping at Crosscut 14 TG EP 3, and a couple of additional times to rest on the way in. No additional time for these stops was included in the travel times depicted in Figure 10.
    - The pace of travel for Jones was based on his estimate of 50 minutes to travel from Crosscut 10 to Crosscut 38 and included his stopping to rest a couple of times. His average pace for the 28 crosscut distance was approximately 1.8 minutes per crosscut.
    - The pace of travel for DeFoor was based on his interview statement and incident mine records that indicated he travel from Crosscut 10 to Crosscut 26 in approximately 20 minutes. There was no indication he stopped to rest. His average pace for the 16 crosscut distance was approximately 1.3 minutes per crosscut.
    - The pace of travel for Olson was based on his interview statement and information from his detector's data log. He traveled from Crosscut 11 to Crosscut 26 in approximately 25 minutes. This timeframe included two stops for discussions with other personnel in the bleeder. His average pace for the 15 crosscut distance was approximately 1.7 minutes per crosscut.
- Mine records.
- Other records compiled during the response to the accident.
- Barometric pressure recordings.

- Recorded data logs from handheld multi-gas detectors carried by individuals who traveled in the Southwest A Longwall bleeder at the time of the accident and during rescue and recovery operations.
- Analysis of heat stress conditions.
- Medical examiner's report.
- MSHA investigation surveys and study.
- Interview statements.

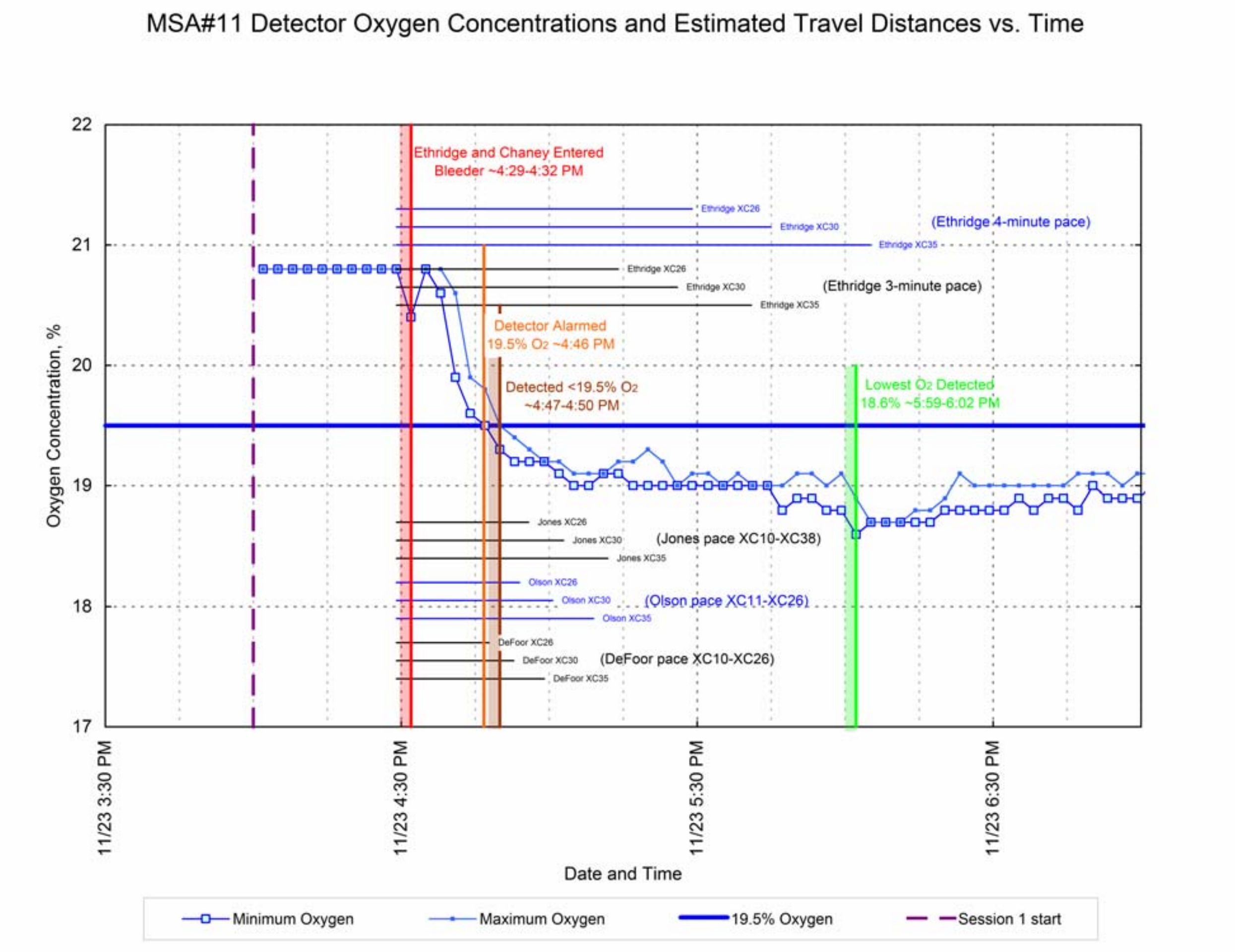

Figure 10. Comparison of Estimated Travel Times in the Southwest A Longwall Bleeder and Ethridge's MSA#11 Detector Oxygen Data on November 23, 2009.

Ethridge indicated during interview statements that he and Chaney traveled to Crosscut 30 or to Crosscut 35 before deciding to turn around and exit the bleeder. His recollections of all the events were not clear. While they were moving Ethridge out of the bleeder, somewhere between Crosscut 25 and Crosscut 26, Olson asked him how far he and Chaney had gone and Ethridge reportedly told Olson, "This is as far as we got." Ethridge later told Olson that they had gotten further in, possibly Crosscut 30 or

Crosscut 35. Olson thought Ethridge was not fully coherent that morning. Olson indicated that since the first time he asked, Ethridge consistently indicated that he was on his way out. It is certain Ethridge and Chaney advanced to at least Crosscut 26.

Investigators were unable to definitively determine the extent to which Ethridge and Chaney advanced into the Southwest A Longwall bleeder on the evening shift of November 23, 2009, before deciding to retreat. Ethridge's detector recorded less than 19.5% oxygen within a maximum of 21 minutes from the time he and Chaney entered the bleeder. Investigators determined it was physically possible for a person to travel from Crosscut 11 to Crosscut 26, the location where the victims were found, within 21 minutes, but not at the pace Ethridge estimated they walked. Investigators determined that it is not plausible that Ethridge and Chaney traveled to either Crosscut 30 or Crosscut 35 in a 21-minute time period.

Conditions in the Southwest A Longwall Bleeder Encountered During the Search, Rescue, and Recovery Operations on November 23-24, 2009

Based on interview statements of persons with pertinent information, and the data logged information from Olson's detector, investigators determined the following conditions existed in the Southwest A Longwall Entry No. 3 during the search, rescue, and recovery operations prior to the November 24, 2009, ventilation change:

- Entry No. 3 was the entry traveled by miners participating in the search, rescue, and recovery.
- Intake air entered the bleeder in Entry No. 3 after passing through the regulator located just inby Crosscut 11.
- Air in Entry No. 3 flowed inby from Crosscut 11 to Crosscut 15.
- At Crosscut 15, the air in Entry No. 3 flowed through the open crosscut to Entry No. 4.
- Inby Crosscut 15, the direction of airflow in Entry No. 3 was outby to Crosscut 15.
- Air movement, in an outby direction, was perceptible at Crosscut 26 (several miners indicated the movement was slight). Crosscut 26 reportedly was the farthest inby location of any of the persons responding to the incident.
- Oxygen deficient air that contained less than 19.5% oxygen was encountered in Entry No. 3, the bleeder entry in the Southwest A Longwall Tailgate where miners normally traveled and worked, including at the location where Ethridge and Chaney were found. Many of the miners responding to the incident were exposed to the oxygen deficient atmosphere. The oxygen and methane concentrations were different at various locations in Entry No. 3 and the concentrations may also have changed over time at a specific location.
    - DeFoor recalled detecting 18% oxygen at Crosscut 26 at about 12:00 a.m.
    - DeFoor recalled detecting 18.3% oxygen at the location he found Ethridge, just outby Crosscut 26, at about 2:10 a.m.

  - Jenkins recalled detecting 18.3% oxygen at Crosscut 26 between 12:30 a.m. and 3:00 a.m.
  - Byram recalled the oxygen concentration at Crosscut 22 was 19.6% oxygen when he was there at about 2 a.m.
  - An oxygen deficient atmosphere was first encountered by Aldrich inby Crosscut 22.
  - Olson recalled detecting 18% to 18.3% oxygen at Crosscut 26 at about 2:15 a.m. Olson's detector recorded an oxygen concentration of 18.2% just before 2:15 a.m.
  - Olson recalled the oxygen concentration at Crosscut 24 when he was there was 18.8%.
  - Hours later, Thompson recalled encountering oxygen concentrations of 18.2% to 18.3% between Crosscut 20 and Crosscut 24.
  - Thompson recalled encountering less than 19% oxygen at Crosscut 18 some time after 4:21 a.m.
  - Turner recalled encountering less than 19% oxygen between about Crosscut 20 and Crosscut 22, where he went under oxygen using a SCBA some time after 4:21 a.m.
  - Turner recalled never detecting an oxygen concentration below 19.0% at Crosscut 24. He also recalled the methane concentrations at Crosscut 24 while he was there fluctuated between 0.8% and 1.2%. Thompson recalled the oxygen concentrations increased to greater than 19.5% soon after he and Turner arrived there.
  - Allinson recalled 19.2% oxygen and 0.3% methane at Crosscut 24 at about 7:00 a.m.
  - Burgess recalled encountering an oxygen concentration of 19.5% at Crosscut 15 or Crosscut 16 and 18.5% oxygen before reaching Nethery at about Crosscut 21 sometime around 6:00 a.m.
- The temperatures of the outby moving bleeder airflow were elevated.
  - Some responders reportedly suffered symptoms consistent with those of heat stress before reaching Crosscut 26.
  - One responder apparently became so severely affected by the conditions during the rescue and recovery operation that his recollection and/or perception of the facts after he became affected were impaired.
  - Some responders reportedly felt sick and were removed from the area before encountering oxygen concentrations of less than 19.5%, possibly only three to four crosscuts into the bleeder.
- The ground conditions were difficult. Numerous supplemental standing roof supports and rock that had fallen to the ground from deteriorated roof made traveling and carrying the victims and medical supplies in Entry No. 3 bleeder arduous.

Conditions in the Southwest A Longwall Bleeder Encountered During the MSHA Post-accident Physical Examination on November 30, 2009

MSHA investigators traveled to just inby Crosscut 24½ in the Southwest A Longwall bleeder on November 30, 2009. Appendix D notes many of the observations of the investigation team. The following conditions were encountered:

- Air flowed inby in Entry No. 3 from the end of the track to Crosscut 15.
- At Crosscut 15, the two curtains that had been installed as a temporary stopping between Entry No. 3 and Entry No. 4 during the rescue and recovery operation were found damaged, permitting airflow to short circuit directly into Entry No. 4 from Entry No. 3.
- The airflow in Entry No. 3 inby Crosscut 15 was found moving outby.
    - The methane and oxygen concentrations detected just inby Crosscut 15 in the airflow moving outby were 0.60% and 19.9% respectively.
    - The temperature of the air moving outby was noticeably higher than the air outby Crosscut 15.
- Before the investigation team advanced beyond Crosscut 15, the curtains were repaired and the airflow direction inby Crosscut 15 reversed (caused to move inby).
- The curtains that covered the stoppings in the crosscuts between Entry No. 2 and Entry No. 3 did not appear to be as effective as well maintained stoppings in preventing leakage from the gob into the bleeder entry.
- Some stoppings appeared to be damaged.
- A roof fall in Crosscut 21 between Entry No. 2 and Entry No. 3 had crushed out the stopping. Air was leaking through the curtain that was hanging in the crosscut.
- The temperature of the air entering the bleeder entry as leakage from Entry No. 2 increased from 84 °F in Crosscut 18 to 95 °F in Crosscut 23.
- Personnel accompanying the investigation team increased the opening in the regulator located in Entry No. 3 to direct additional airflow toward Crosscut 24.
- Airflow was found to be moving inby slightly at the point of farthest advance of the investigation team, just inby Crosscut 24½. Several investigation team members and some of those accompanying them stopped before reaching that location.
- The temperature of the air in the bleeder entry about one half crosscut distance inby Crosscut 24 was 95 °F.
- The mine floor was obstructed with fallen roof material, pipe, and remaining track rails and ties. Obstructions required investigators to crawl through some areas inby Crosscut 23.
- Roof in Entry No. 3 was deteriorated and marked with danger flagging.
- Several supplemental standing roof supports were no longer effective. Some were broken and the roof had fallen away from others.

- It was determined by MSHA accident investigators that travel in the Southwest A Longwall Tailgate bleeder entries inby Crosscut 15 was no longer safe due to adverse and hazardous conditions, including elevated air temperatures, apparent high humidity, and deteriorated roof. During the subsequent sealing of the area, roof conditions continued to deteriorate, extending the area unsafe for travel to outby Crosscut 15.
- Most of the persons in the investigation party became fatigued and some suffered ill effects from the activity.

Investigation of Air Quality and Heat Sources in the Southwest A Longwall Bleeder

As previously discussed, information obtained by investigators revealed miners in the Southwest A Longwall bleeder were exposed to oxygen concentrations of less than 19.5% and unusually elevated air temperatures on November 23 and 24, 2009. Miners who previously travel in the bleeder reported the heat was most pronounced in areas of the bleeder where the poorest air quality was typically found, in the entry adjacent to the worked-out area of the Southwest A Longwall Panel approximately between Crosscut 22 and Crosscut 27, and at the Moving EP locations. Additional information obtained during voluntary interviews suggested the need to explore the possibility that miners in the bleeder on November 23 and 24, 2009, were exposed to other potential hazards in the form of toxic gases and/or vapors.

Naturally Occurring Sources

Naturally occurring conditions and events such as oxidation of coal and wood in the worked-out area of the longwall panel, spontaneous combustion, geothermal activity, and in-situ rock temperatures were considered as potential sources of the heat and hazardous gases and/or vapors.

Oxidation, Spontaneous Combustion, and Fires

Coal exposed to oxygen will oxidize and release heat. Oxygen can also react with wood, rags, and pyrites to produce heat. This process occurs naturally. Temperatures can increase if the ventilation is not sufficient to remove the heat. However, ventilation also brings additional oxygen to the fuel. The additional oxygen increases the rate of oxidation and thus the released heat. As the temperature increases, the rate of oxidation increases.

In a coal seam that is susceptible to spontaneous combustion, under ideal conditions, the increase in temperature due to oxidation may eventually cause a fire to develop. At least 2% oxygen in the atmosphere is needed[2] for oxidation or smoldering combustion of coal to occur. At least 12% oxygen is required for flaming combustion (rapid

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[2] Mackenzie-Wood and J. Strang, Fire Gases and their Interpretation, The Mining Engineer, 470-478 June 1990.

oxidation) of coal to occur. Experiments by the Bureau of Mines have shown that neither the Blue Creek nor the Mary Lee coal seams are prone to spontaneous combustion.[3] In fact, both seams were the least prone of the bituminous coal samples tested to undergo spontaneous combustion.

Gases are emitted in a specific order as coal oxidizes.[4] For bituminous coal, hydrogen is emitted around 45 ˚C (113 ˚F). Around 100 °C (212 °F) carbon monoxide is emitted. Then ethylene is emitted around 110 to 120 °C (230 to 248 °F). Propylene is emitted around 120 to 130 °C (248 to 266 °F). Finally, acetylene is emitted around 815 °C (1499 °F). If acetylene is present, flaming combustion is occurring. The ignition temperatures of coal and wood are about 400 to 500 °C (752 to 932 °F) and 190 to 260 °C (374 to 500 °F), respectively.

Seam or strata gas is a source of air contaminants. As coal is mined, gases are liberated from the coal and surrounding strata. Some mines liberate more gas than others. The Southwest A Longwall Panel liberated approximately one million cubic feet of methane per day. Common components of seam gas include methane, ethane, and carbon dioxide. Methane is generally the predominate component. Adequate ventilation renders these gases harmless. In addition to the above mentioned gases, the gases of some seams contain hydrogen, propane, butane, etc. The gases of a few seams contain hydrogen sulfide and/or carbon monoxide. Some of the material in the gob was likely from the Mary Lee coal seam. Table 1 presents the composition of the Mary Lee seam gas.

Table 1. Seam Gas from the Mary Lee Seam[5].

Gas	Gas Concentration (%)
Methane	97.171
Nitrogen	2.58
Oxygen + argon	0.102
Carbon dioxide	0.10
Hydrogen	0.044
Ethane	0.006

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[3] Smith, A.C. and C.P. Lazzara, Spontaneous Combustion Studies of U. S. Coals, BOM RI 9079, 1987.

[4] Chamberlain, E.A.C. and D.A. Hall, The Ambient Temperature Oxidation of Coal in Relation to the Early Detection of Spontaneous Heating: Part 2, The Mining Engineer, 132:387-399, 1973.

[5] Trevits, M.A. and G.L. Finfinger, Coalbed Gas: An Analysis of the Relationship Between Gas Content, Gas Composition and Mine Emissions, Proceedings of the 4th Mine Ventilation Symposium, 519-514 Berkeley, California, June 5-7 1989.

The analyses of air samples, which are discussed in a later section of this report, reveal the presence of carbon monoxide and hydrogen. Hydrogen may have been a constituent of the seam gas and may not be indicative of oxidation. However, the presence of carbon monoxide is indicative of oxidation. Oxidation may have contributed to the elevated temperatures in the bleeder.

Geothermal Activity and In-situ Rock Temperature

Appendix N contains a technical analysis of the geothermal and core rock temperatures. The types of geologic structure observed in the Southwest A Longwall Panel, namely faults, joints, drag folds and angled fractures, are common features in many coal mines, especially those in proximity to zones of tectonic deformation. Observation of these structures in the gateroad development indicated that these features are unlikely to have facilitated geothermal heat transfer into the mine.

In the vicinity of the No. 7 Mine, temperatures from gas well data range from approximately 82°F to 104°F for depths roughly equivalent to the mine horizon. The actual in-situ rock temperatures tend to be slightly higher than those recorded in the boreholes. The reasons for the variance in temperature data could not be determined. The in-situ rock temperatures of the surrounding strata may have contributed to the elevated temperatures in the bleeder.

Unnaturally Occurring Sources

Investigators also explored potential unnatural sources. Large volumes of roof consolidation material and void filling material, both of which had potential to generate heat and produce toxic gases and vapors, were used to control deteriorated ground conditions on the longwall face. Multiple ignitions occurred and a fire reportedly occurred on the longwall face. The longwall manager indicated the fire involved roof consolidation material that leaked onto the mine floor.

Discussion of Foams and Roof Consolidation Materials

Because of adverse roof conditions and faults, large amounts of resins were injected into the mine roof and foams were used to fill voids. These materials were used to control the ground conditions on the Southwest A Longwall face. Purchase orders, obtained from the mine operator, indicated the following: 960 45-pound bags of cementitious foam (Minova USA Inc. Tekfoam) were purchased in August 2009; 816 280- kilogram containers of component A and 840 250-kilogram containers of component B for urea silicate foam (BASF MEYCO® MP 367) were purchased from September 2009 through November 2009; and 719 55-gallon barrels and 716 55-gallon barrels of the Bevedan® and Bevedol® components, respectively, for polyurethane resin (Carpenter Co. – Chemical Systems Division) from April to October 2009.

Polyurethane resin was injected into the roof to consolidate fractured strata. Polyurethane was delivered in two components. These two components were mixed together in the application nozzle for activation as the material was injected under pressure into the roof. Typically, the two components are an isocyanate and a polyol.

Isocyanates are hazardous compounds and special precautions need to be employed for safe use of these compounds. Isocyanates are powerful irritants to the mucous membranes of the eyes, gastrointestinal tract, and the respiratory system. The major health issue concerning isocynates is the sensitization of a person exposed to the compound. Sensitized individuals experience asthmatic type reaction upon subsequent exposure. A severe reaction can lead to death. Methylene bisphenyl isocyanate (MDI) and toluene diisocyanate (TDI) are both common isocyanates used in the production of polyurethane. According to the Carpenter Co. – Chemical Systems Division's Material Safety Data Sheet (MSDS), the isocyanate component of the polyurethane used at the No. 7 Mine was MDI.

The chemical analysis of the other component of the polyurethane used at the No. 7 Mine is regarded as proprietary (trade secret) and is not defined in the accompanying MSDS. However, the MSDS indicated the proprietary compound was not hazardous. The MSDS further asserts that there are no regulatory exposure limits for this component. Although not specifically identified as such, it was assumed the other component contained polyol because polyurethanes are made by mixing an isocyanate with a polyol.

Polyurethane resin generates heat during the curing process. Several factors influence the amount of heat generated, including contamination of the uncured mixture by water, thickness of the applied uncured material, and mixture of the components. Cornely conducted experiments with Bevedol® and Bevedan®. During curing, the mixture reached 135 °C (275 °F) and, when contaminated with 2% water, the temperature reached 167 °C (333 °F).

According to manufacturer literature (BASF) and studies reported by the Australian Queensland Directorate of Mining, a polyurethane foam, when mixed, was found to have reached approximately 133 °C (271 °F) while curing. When the uncured mixture came in contact with moisture or water, the temperature reached 170 °C (338 °F). By changing the mixture from the recommended 1 to 1 ratio to a 1 to 4 ratio, the maximum temperature increased to 198 °C (388 °F).

As the thickness of the polyurethane foam increases, the curing temperatures increase. Polyurethane foam is a good thermal insulator. Heat flux has been documented to linearly decrease with an increase in thickness. This can be attributed to two primary causes; (1) a decrease in the efficiency of radiative transfer due to an increase in solid composition (2) an increased internal volume of gases in ratio to exposed surface area for conduction to occur. Therefore, the internal temperature of a thick layer of polyurethane foam would reach a higher temperature than a thin layer. The generated heat dissipates through conduction and convection upon completion of curing. The rate of heat dissipation is dependent upon the heat transfer potential.

Studies showed that polyurethane decomposition initiating around 170 °C (330 °F) can give rise to its original compounds (diisocyanates and polyols) or to amines, olefins (double bonded hydrocarbons), and carbon dioxide due to the breakage of polymeric chains and secondary reactions. Diisocyanates may react to form a carboiimide, which at 320 °C (608 °F) will degrade to isocyanate. Above 300 °C (572 °F) the degradation of polyols was also observed. Furthermore, the decomposition was influenced by the presence of oxygen, affecting the breakage of polymeric chains and altering the temperature at which some compounds will be produced. Although the testing and studies involved polyurethane foams, it would be expected that polyurethane resins would produce similar gaseous and vapor contaminants.

Roof cavities above the longwall face were filled with either cementitious foam or urea silicate foam. Cementitious foam is made by combining cement with the proper amount of air to form foam.

Cementitious foams produce heat as they cure. Data for Tekfoam could not be found. However, Tekseal® and Tekfoam are similar products. The MSDS sheets show that both products contain 60% to 100% hydraulic cement with similar additives. Data for Tekseal® was located. Tekseal® has a density of 35 pounds per cubic foot and Tekfoam has a density of 20 pounds per cubic foot. Therefore, the curing temperature of Tekfoam would be lower than Tekseal®. The temperature increase of Tekseal® reached 90 °F after seven days under semi-adiabatic conditions.

Urea silicate foam is also made by mixing two components. One component is an isocyanate and the other is sodium silicate. According to the manufacturer (BASF), the urea silicate foam reaches a temperature of about 95 °C (203 °F) while curing. In the product information materials, the manufacturer provided a chart comparing the curing temperature of polyurethane and urea silicate foam. The chart indicated curing temperatures of urea silicate are less than that of polyurethane. No information regarding application factors was provided.

The analyses of air samples, which are discussed in a later section of this report, did not reveal the presence of any decomposition constituents or free isocyanates. This indicated that the roof consolidation material had cured and there was no additional heat contributed due to decomposition of the material. Because the rate of heat dissipation after curing in the Southwest A Longwall could not be determined, no conclusion could be drawn as to the affect of curing temperatures on the temperatures in the bleeder.

The Effects of Air Quality on Miners

Physiologic Effects of Oxygen Deficiency

Title 30 C.F.R. § 75.321(a)(2) requires [t]he air in areas of bleeder entries and worked-out areas where persons work or travel to contain at least 19.5% oxygen. According to National Institute for Occupational Safety and Health (NIOSH), 19.5% oxygen includes a safety factor because oxygen deficient atmospheres offer little warning of danger. NIOSH also indicated that exposure to an oxygen concentration of 16%, impairs judgment and breathing. The American National Standards Institute (ANSI) in ANSI Z88.2-1992, "American National Standards For Respiratory Protection" recognized that 16% oxygen impairs one's ability to think and pay attention, and one's coordination. Furthermore, ANSI recognized that at 19% oxygen there are adverse physiological effects. Table 2 details the effects of oxygen deficiency on a person. The information was adapted from Bureau of Mines Miner's Circular No. 33.

Table 2. Effects of Oxygen Deficiency.

Oxygen Concentration in percent	Effect on Humans
20.95	None – normal air concentration
17	Faster deeper breathing
15	Dizziness, buzzing in ears, rapid heart beat
13	May lose conscious if exposure prolonged
9	Fainting, unconsciousness
7	Life endangered (equivalent to 5 ½ miles elevation)
6	Convulsive movements, death

In order for the body to function, cells need oxygen. Oxygen is absorbed by the hemoglobin in the red blood cells as the blood flows through the lungs. Red blood cells then deliver oxygen to the body. When the oxygen concentration is low, the body constricts the arteries in the extremities to send the oxygenated blood to the brain and heart. As the oxygen level in the blood decreases, the heart rate increases so the cells receive the required oxygen. The brain is the organ most susceptible to oxygen deficiency because of its high metabolic rate and its lack of reserve oxygen, and it is incapable of anaerobic metabolism.

Other Factors Affecting the Oxygen Content of the Blood

The concentration of oxygen, carbon dioxide, carbon monoxide, pH of the blood, body temperature, and water vapor in the air affects the amount of oxygen in the blood. Water vapor reduces the available oxygen in the air. Typically, gas chromatography analysis only determines the gaseous components of air and does not measure water vapor. The presence of water vapor reduces the volume of the gaseous components of air. Although the oxygen concentration in dry air could be the same as the oxygen concentration of humid air, the amount of oxygen would be greater in dry air.

As the concentration of carbon monoxide and carbon dioxide increases in the air that is breathed, the amount of oxygen that can be carried by the hemoglobin is reduced. Hemoglobin binds with carbon monoxide 240 times more readily than it binds with oxygen. In effect, the binding of carbon monoxide in hemoglobin reduces the available space for oxygen in the blood. When the concentration of carbon dioxide in the blood becomes elevated, the blood becomes acidic. Acidic blood cannot absorb as much oxygen from the lungs.

In a mixture of ideal gases, each gas has a “partial pressure”, which is the pressure the gas would have if it alone occupied the volume. The total pressure of a gas mixture is the sum of the partial pressures of each individual gas in the mixture. To calculate the partial pressure, the percent of the gas is multiplied by the total pressure. As the percentage of a gas in air decreases, the partial pressure of that gas decreases. Gases dissolve, diffuse, and react according to their partial pressures, and not necessarily according to their concentrations in a gas mixture. The partial pressure of oxygen in air with 20% oxygen is greater than the partial pressure of oxygen in air with 18% oxygen, given that all other factors remain constant. As the altitude increases, the air pressure decreases. The converse also occurs. Any chemical vapor or water vapor in the air reduces the partial pressure of oxygen from dry uncontaminated air because it displaces the volume available for the gases to occupy.

Barometric pressure also affects the air pressure. For calculating the actual air pressure, the station pressure must be used to correct the barometric pressure. To demonstrate the effect of elevation and barometric pressure an example is provided assuming that the air in the Southwest A Longwall bleeder contained 3% water vapor (fully saturated at 100% relative humidity). At 1500 feet below sea level (the approximate depth of the Southwest A Longwall) and considering the fan pressure, the estimated partial pressure of oxygen within the Southwest A Longwall bleeder with concentrations of 19.5% and 18.0% oxygen would be approximately 149.7 and 138.2 Torr, respectively. Torr is the unit of measure for partial pressures of gases in air. In comparison, the partial pressure of oxygen at sea level in uncontaminated air with oxygen concentrations of 19.5% and 18.0% oxygen would be 143.8 and 132.7 Torr, respectively.

The difference between the partial pressure of oxygen in the air and the partial pressure of oxygen in the blood determines the amount of oxygen absorbed by the blood. Gases will always flow from a region of higher partial pressure to one of lower pressure; the larger this difference, the faster the flow. Any gas or vapor that displaces oxygen in the air will decrease the partial pressure of oxygen, thus making it more difficult for the person to function. Therefore, an oxygen deficiency of 19.5% oxygen can have a greater effect on a person at 5000 feet elevation than at sea level. People who work at high altitudes where the partial pressure of oxygen is lower become acclimatized. Their body adapts to the condition by producing more hemoglobin in their blood to enable better absorption of the limited oxygen. Table 3 shows the effect of partial pressure on the body's ability to function. The information was adapted from Patty's Industrial Hygiene and Toxicology[6] and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values[7] (TLV®).

Table 3. Effect of Oxygen Partial Pressure.

Partial Pressure in Torr	Effect
131	None in healthy adults
126	Loss of dark adaptation (loss of ability to see in the dark)
121	Increased pulmonary ventilation, increased cardiac output, incoordination, and impaired attention and thinking
117	Rapid exposure can cause headache, nausea, vomiting, and respiratory alkalosis for unacclimatized individuals
104	Abnormal fatigue upon exertion, faulty coordination, impaired judgment, emotional upset
93	Impaired respiration, very poor judgment and coordination, and tunnel vision
67	Minimum tolerated by an unacclimatized person

Another factor that decreases the ability of hemoglobin to transport oxygen is the core body temperature. While this factor is not as dramatic as the concentration of carbon monoxide and carbon dioxide, it is important. As the body's temperature increases, the ability of hemoglobin to carry oxygen to the cells decreases.

Physiologic Effects of Carbon Dioxide

Title 30 C.F.R. § 75.321(a)(2) requires [t]he air in areas of bleeder entries and worked-out areas where persons work or travel shall contain carbon dioxide levels that do not exceed 0.5% time weighted average (TWA) and 3.0% short term exposure limit (STEL). The TWA is for an 8-hour exposure and the STEL is for a 15-minute exposure. Table 4, taken from a publication[8] released by the United States Environmental Protection Agency shows the effect of carbon dioxide on people.

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[6] Clayton G.D. and F.E. Clayton (editors), Patty's Industrial Hygiene and Toxicology, Volume IIC , John Wiley and Sons, 3rd revised edition pp.4054-4056. 1979.

[7] American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, 2010.

[8] US EPA, Carbon Dioxide as a Fire Suppressant: Examining the Risks, EPA43000-002-R-, 2000.

Table 4. Acute Effects of Carbon Dioxide Exposure.

Carbon Dioxide Concentration in percent	Exposure Time	Effect
2	Several hours	Headache, dyspnea (shortness of breath) upon exertion
3	1 hour	Mild headache, sweating, and dyspnea at rest
4-5	Within a few minutes	Headache, dizziness, increased blood pressure, uncomfortable dyspnea
6	1-2 minutes	Hearing and visual disturbances
	≤16 minutes	Headache, dyspnea
	Several hours	Tremors
7-10	Few minutes	Unconsciousness, near unconsciousness
	1.5 minutes to 1 hour	Headache, increased heart rate, shortness of breath, dizziness, sweating, rapid breathing
>10-15	1 minute to several minutes	Dizziness, drowsiness, severe muscle twitching, unconsciousness
17-30	Within 1 minute	Loss of controlled and purposeful activity, unconsciousness, convulsions, coma, death

As depicted in Appendix D, the carbon dioxide concentration in the bag sample collected by investigators at Crosscut 24½ was 0.54%. However, investigators were unable to determine the carbon dioxide concentration in the bleeder airflow to which Ethridge, Chaney, and miners who participated in the search, rescue, and recovery operation were exposed. The autopsy report for Chaney did not indicate the carbon dioxide or oxygen levels or the pH of the blood. The investigators were unable to arrive at a determination as whether miners were overexposed to elevated carbon dioxide levels or whether any experienced adverse physiological effects due to carbon dioxide.

Air Sampling and Analysis

MSHA personnel collected air samples to determine whether hazardous gases and/or vapors existed in the mine atmosphere of the bleeder that could have adversely impacted the conditions to which Ethridge and Chaney were exposed. Samples were collected in gas bags, thermal desorption tubes, and coconut shell charcoal tubes. Thermal desorption tubes were used to detect substances in the air. Coconut shell charcoal tubes were used to measure the concentration of substances. An analysis of the air samples was conducted to determine the existence of coal oxidation and thermal decomposition of foams. In addition, air samples were collected for the same purpose from vertical degasification boreholes located above the Southwest A Longwall Panel. It is not uncommon for vertical degasification boreholes to communicate with the mine atmosphere in the worked-out areas of a longwall panel when methane exhausters are used to remove methane from the overlying strata. Appendix K depicts the locations of the underground samples and Appendix G shows the locations of the sampled vertical degasification boreholes fitted with a methane exhauster. Partial results of the bag sample analyses are listed on the appendix maps.

Gas Chromatographic Analyses

On November 30, 2009, air samples were collected in foil grab bags inby Crosscut 24 in Entry No. 3 of the Southwest A Longwall Tailgate bleeder. These samples were analyzed using gas chromatography to determine the concentrations of the following gases: oxygen, nitrogen, carbon dioxide, carbon monoxide, methane, ethane, ethylene, acetylene, hydrogen, and argon. MSHA's gas analysis of the sample collected on November 30, 2009, revealed 11 ppm of carbon monoxide in the Southwest A Longwall bleeder. The regulatory limit for carbon monoxide is an 8-hour time weighted average (TWA_8) of 50 ppm. The hydrogen, ethylene, and acetylene concentrations were each less than 5 ppm. In the gas chromatographic analyses conducted, the lowest quantifiable concentration of these gases was 5 ppm. The measured gas concentrations of nitrogen, carbon monoxide, methane, ethane, ethylene, acetylene, hydrogen, and argon did not pose a hazard to miners. The results did not indicate an abnormal rate of oxidation of coal or the thermal decomposition of foams and resins.

In addition, one gas sample was analyzed for hydrogen sulfide and sulfur dioxide by an outside laboratory. These hazardous gases were selected because they can be generated by heating pyrite in the presence of water or by burning coal. Neither compound was detected above 1 ppm. These gases have a TWA_8 of 10 ppm and 5 ppm, respectively.[9] The results indicated that these gases did not pose a hazard to miners and offered no indication of burning coal.

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[9] American Conference of Governmental Industrial Hygienists, Threshold Limit Values of Airborne Contaminants, 1972.

Air samples were collected in Tedlar gas sample bags on December 10 and 11, 2009, in the Southwest A Longwall bleeder airflow and in the exhaust of vertical degasification boreholes located above the mined out portion of the Southwest A Longwall Panel, respectively. The Tedlar bags were analyzed using the same methodology as those collected on November 30, 2009. The samples collected underground did not show any significant deviations from normal mine air. The results of the analyses of the air samples collected in the exhaust of the vertical degasification boreholes revealed no unusual results. The methane exhausters, intended to exhaust the maximum amount of methane possible from each operational borehole, were vented to the atmosphere. Gas concentrations of individual vertical degasification boreholes vented to the atmosphere typically vary. Elevated methane and ethane concentrations with oxygen and nitrogen concentrations less than found in normal air indicated the methane exhausters pulled some air from the mine atmosphere through the overlying strata and out the boreholes. No unusual gases or unusual concentration of normal gases were detected.

The gas chromatographic analysis conducted by MSHA did not detect quantifiable levels of hydrogen. Therefore, the oxidation temperature was probably less than 45 °C (113 °F). The heat generated from the oxidation of coal within the bleeder system was not abnormal and likely contributed to the heat in the bleeder.

No toxic levels of other measured gases, such as carbon monoxide, nitrogen dioxide, sulfur dioxide, and hydrogen sulfide, were found. Furthermore, in combination, the measured gases were found to pose no hazard to the miners in the bleeders.

Thermal Desorption Tube and Coconut Shell Charcoal Tube Analyses

Air samples were collected in thermal desorption tubes and on coconut shell charcoal tubes on December 10 and 11, 2009, in the Southwest A Longwall bleeder airflow and in the exhaust of vertical degasification boreholes located above the mined out portion of the Southwest A Longwall panel, respectively. The thermal desorption tubes and coconut shell charcoal tubes were analyzed to detect the presence of volatile organic compounds that would have indicated thermal decomposition of roof consolidation material or foams. Permissible sampling pumps pulled air through the thermal desorption tubes and coconut shell charcoal tubes. NIOSH analyzed the thermal desorption tubes and no organic compounds generated by the thermal degradation of foams were detected on any of the thermal desorption tubes. There was no indication of thermal degradation products of foams or polyurethane roof consolidation resins. Also, there was no indication of thermal degradation products of foams or polyurethane roof consolidation resins in the analysis of the coconut shell charcoal tubes.

The results of sampling for vapors were compared to thermal decomposition vapor products of polyurethane and foams identified in the manufacturer’s literature and on the MSDS sheets for the substances. When polyurethane and foams undergo thermal decomposition, products such as hydrogen cyanide, chlorinated or brominated hydrocarbons, and phosgene are produced. Analysis of the thermal desorption tubes did not find any of these compounds.

MSHA tested the air for the presence of isocyanates. Isocyanates could be from unreacted material or from the thermal decomposition of polyurethanes. The isocyanate would react with water vapor to produce an amine. Amines are detectable on thermal desorption tubes. No amine was detected during the analysis of the thermal desorption tubes.

No compounds contained in polyurethane resins and foams or thermal decomposition products were found in any of the samples collected. There was no indication that products of decomposition of the roof consolidation material contributed to the miner's incapacitation or posed a hazard to the miners in the bleeders.

Effects of Heat on Miners

Heat Stress and Physiologic Effects

Heat stress is the combination of environmental and metabolic heat that causes the body to store excess heat. The stored heat places a strain on the body and can cause heat disorders. Metabolic heat is heat generated by the body doing work. A heavy workload generates more metabolic heat than resting. The amount of metabolic heat generated from work is also related to body mass. A large person, doing the same work as a small person, would generate more metabolic heat.

To remove excess heat from the body, the blood vessels under the skin dilate, diverting blood to the skin. The amount of blood circulated per heart beat increases. The heart beats faster to send more blood to the skin where most of the excessive heat is removed by the evaporation of sweat. This process also removes heat by convection. Environmental factors such as airflow velocity, partial pressure of water vapor in the air, and air temperature all affect the evaporation process. A very humid atmosphere (one in which the partial pressure of water vapor is high) inhibits sweating. A humid atmosphere has a high relative humidity. Likewise, wearing impervious or heavy clothing inhibits the evaporation of sweat.

Heat exposure can produce health disorders, including heat syncope, heat cramps, heat exhaustion, heat stroke, and heat rash.

Heat rash is a condition that mainly occurs when the skin stays continually moist from sweat. Profuse tiny raised red blisters on the affected area and a pricking sensation during heat exposure are signs of heat rash. Plugged sweat gland ducts develop an inflammatory reaction. The condition is less severe than the other heat disorders.

Heat syncope occurs when a person faints while standing. This is caused by the blood pooling in the dilated blood vessels in the skin and in the lower body. Consequently, the brain does not receive adequate oxygen.

Heat cramps occur when the body sweats profusely and the person drinks copious volumes of water without appropriate replacement of electrolytes (salt). The person experiences painful spasms of the muscles used during work. The spasms may occur long after work has ceased.

Heat exhaustion occurs if the person fails to replace water lost to sweating. Signs of heat exhaustion include fatigue, nausea, thirst, headache, and giddiness. The person's skin is clammy and moist and the complexion is pale, muddy, or hectic flush. Upon standing the person may faint and has a rapid thready pulse and low blood pressure.

Heat stroke, hyperthermia, is the most serious heat disorder and is a true medical emergency. Prompt appropriate emergency aid needs to be administered to the victim prior to transportation to a hospital for additional medical treatment. If appropriate medical treatment is not received, the victim could incur permanent disability (e.g., kidney failure or brain damage) or die. Typically, the heat stroke victim ceases sweating, has a rapid pulse, is fatigued, experiences nausea or vomiting, has a headache, and has reddish or mottled skin, loses conscious, or, if conscious, exhibits confusion. The core body temperature (temperature of the internal organs) exceeds 105.8 °F.

Heat Stress Factors

Physical and medical factors involving the individual impact the susceptibility of an individual to heat disorders. Obesity, age (persons over 50), poor physical condition, and lack of acclimatization subject individuals to a greater risk of incurring a heat disorder. Breathing, circulatory, kidney, or skin (e.g., heavy scarring from burns or scleroderma) problems are medical issues that make an individual more susceptible to adverse health effects due to heat. Some medicines, such as water pills and hay fever pills, tend to dehydrate the body. Lack of drinking sufficient amounts of water, juice, or sports drinks or drinking caffeinated (coffee, tea or cola) or alcoholic beverages leads to dehydration. Dehydration makes a person more susceptible to heat stroke.

Even among individuals with identical physical and medical risk factors, there is great variability as to their ability to withstand heat. Some individuals will become incapacitated because of high heat and humidity while others can function normally in the same environment.

High humidity makes it difficult for sweat to evaporate. Any sweat, which drips from the body, loses its ability to cool the body. The normal temperature of the skin is 95 °F.

Because of this, air temperatures exceeding 95 ˚F stop the body from losing heat to the environment via convection. In the interviews the rescuers described the sweat as dripping off their bodies while they were in the bleeder. NIOSH estimates that sweat begins to drip off the body when the relative humidity exceeds 70%. Under conditions where the air temperature exceeds 95 ˚F and the humidity exceeds 70%, the body would be unable to lose excess heat to the environment, raising the core temperature of the body.

Acclimatization is the physiologic adaptation of the body enhancing its ability to cope with abnormal environments. The physiologic adaptations for acclimatization to heat include: beginning to sweat at a lower body temperature; increased sweat production; and lower electrolyte concentration in the sweat with a simultaneous stabilization of the circulation. One becomes acclimatized by being gradually exposed to increasing heat and humidity. Typically, the acclimatization process occurs over five to ten days. However, once the exposure to heat ceases, the body quickly loses its acclimatization. Noticeable loss in acclimatization occurs after four days without exposure to heat. A complete loss of acclimatization occurs after three to four weeks with absence of work in heat. Exposure to summer temperatures in Alabama can also result in miners becoming more acclimatized to the heat and humidity. However, the accident occurred during the winter months and Ethridge and Chaney were not likely to be routinely exposed at work to temperatures that they encountered in the bleeder. If Ethridge and Chaney were not acclimatized, they would have been more susceptible to the heat that they encountered in the bleeder.

Heat Stress Survey

Heat stress measurements were conducted where air entered and exited the Southwest A Longwall bleeder system by the MSHA Physical and Toxic Agents Division (PTAD) on December 2, 2009. Appendix K details the data collection locations and the information collected. Because of hazardous conditions, the heat stress survey could not be conducted inby Crosscut 15 in the Southwest A Longwall Tailgate. Heat information about the air exiting the Southwest A Longwall bleeder system was obtained at heat information location 1, just inby Crosscut 14 in Entry No. 4 of the Southwest A Longwall Tailgate.

The heat was measured using the typical three thermometer setup. All the thermometers were mercury in glass type that met NIOSH's recommended accuracy requirements. They were held on a tripod at approximately chest height. The tripod was positioned in the center of the entry or crosscut. After the thermometers reached thermal equilibrium with the mine atmosphere, the measurements were recorded.

A total immersion thermometer measured the ambient air temperature (t_a). A partial immersion thermometer inserted into a 6-inch copper globe painted flat black measured the radiant heat and convective heat. The natural wet bulb temperature (t_{nwb}) was measured using a partial immersion thermometer whose bulb was covered by a wetted cotton sleeve. The sleeve was wetted with distilled water. The t_{nwb} takes into account the humidity and the air velocity. Moving air removes the sweat from the body more efficiently than still air.

In addition, psychometric wet and dry bulb temperatures were measured with a sling psychrometer to determine the relative humidity. The cotton sleeve of the wet bulb thermometer was wetted with distilled water. Psychometric temperatures were obtained at the same locations as the heat temperatures.

While the heat data were being collected, MSHA PS&HTC Ventilation Division personnel measured the air velocity with a vane anemometer. The ventilation engineer traversed the vane anemometer across the entry to obtain the average air velocity. The air measurements were conducted within 10 to 15 feet of the heat measurements.

The heat stress survey was conducted after the ventilation was changed to recover the victims. When the heat stress survey was conducted, the t_{nwb}, t_a, and globe temperatures (t_g) were 76, 81, and 81.5 °F, respectively, at heat information location 1. The globe temperature was approximately the same as the air temperature at heat information location 1, which indicated radiant heat was not a significant factor at that location. In addition, the measured relative humidity at heat information location 1 was approximately 79%. Although the survey measurements were not taken where the victims were recovered, the results support the assumption that the relative humidity at the victims' location was at least 70%. The air quantity measured at heat information location 1 diluted the heat.

Heat Stress Analysis of the Accident

No heat stress criterion exists in Title 30 Code of Federal Regulations. However, MSHA has issued guidance documents addressing heat exposure and best practices to mitigate the hazards associated with exposure to excessive heat. MSHA has five publications posted on the agency's website concerning heat stress in the mining industry. In addition, the MSHA website has links to three articles on heat stress published in the Holmes Safety Association Bulletin. These publications and articles describe heat disorders and their symptoms. Furthermore, suggested remedial actions which mine operators can implement to reduce the occurrence of a heat disorder are presented.

The heat estimated exposure of Ethridge and Chaney was compared to several widely accepted guidelines. NIOSH issued a heat stress criteria document in 1986.[10] This document provided guidance as to what are considered acceptable occupational heat

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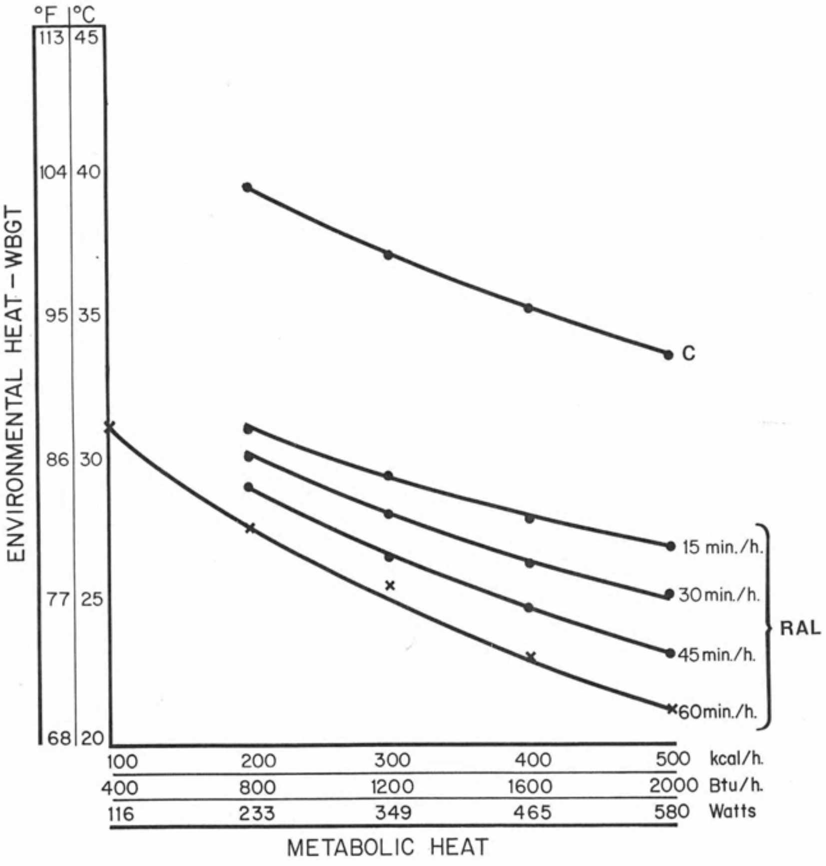
[10] NIOSH, Criteria for a Recommended Standard Occupational Exposure to Hot Environments Revised Criteria 1986, DHHS(NIOSH) Publication 86-113, April 1986.

levels. The guidance involved measuring the t_{nwb}, t_a, and the t_g and estimating the work load. Heat stress is evaluated based upon the hottest one hour exposure.

Heat is evaluated using the Wet Bulb Globe Temperature (WBGT). The WBGT takes into account the humidity, air temperature, radiant heat, and air velocity on the affected person. When radiant heat is not a major factor, the formula is:

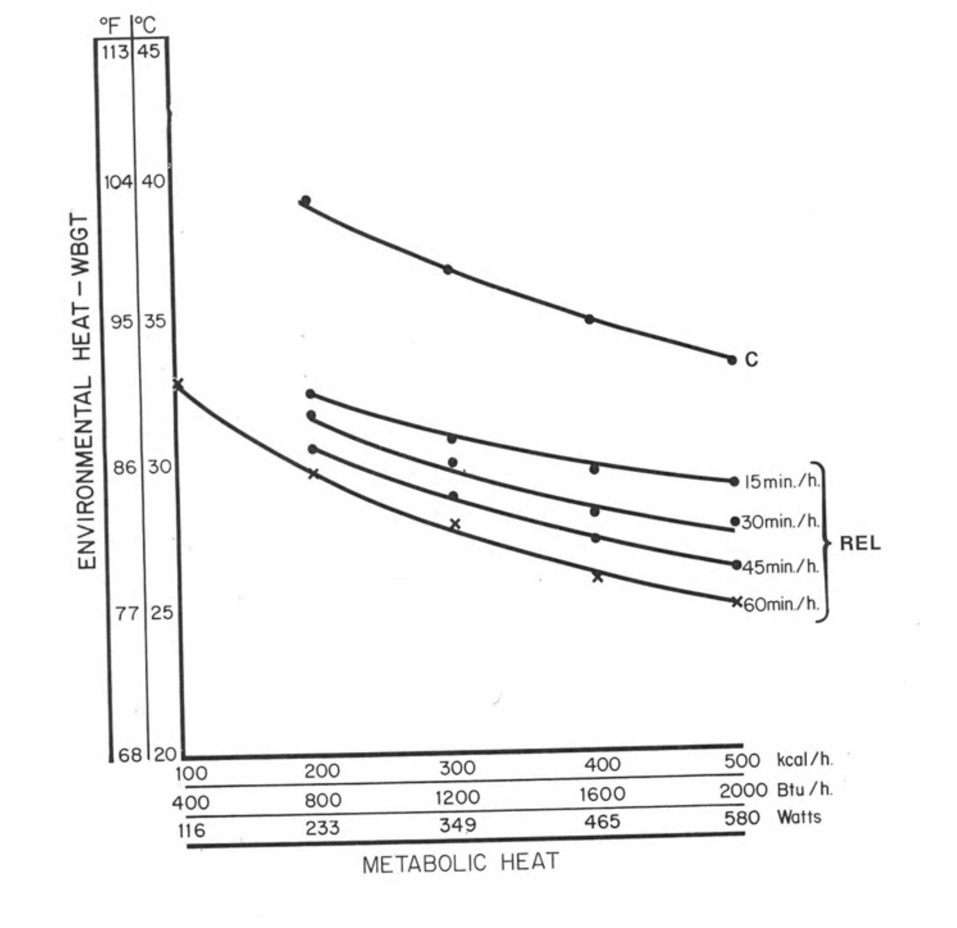
$$WBGT = 0.7\ t_{nwb} + 0.3t_g$$

Figure 11 and Figure 12 show the NIOSH criteria for unacclimatized and acclimatized workers, respectively. The plotted criteria need to be adjusted for the type of clothing worn. These figures also show the ceiling limit for heat exposure.



C = Ceiling Limit
RAL = Recommended Alert Limit
* For "standard worker" of 70 kg (154 lbs.) body weight and 1.8 m^2 (19.4 ft.^{2}) body surface.

Figure 11. Recommended Heat-Stress Alert Limits (RAL) – Heat-Unacclimatized Workers.



C = Ceiling Limit
RAL = Recommended Alert Limit
* For "standard worker" of 70 kg (154 lbs.) body weight and 1.8 m^2 (19.4 ft.^{2}) body surface.

Figure 12. Recommended Heat-Stress Alert Limits (REL) – Heat-Acclimatized Workers.

Another widely accepted heat stress criteria are those of the ACGIH.[11] Like the NIOSH criteria, the ACGIH criteria take into account work load, t_{nwb}, t_a, and t_g. The ACGIH preferred method for heat stress analysis is the WBGT. In addition, the criteria are separated into unacclimatized and acclimatized workers. Figure 13 shows the ACGIH criteria.

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[11] American Conference of Governmental Industrial Hygienists, Documentation for Heat Stress and Strain, 2009

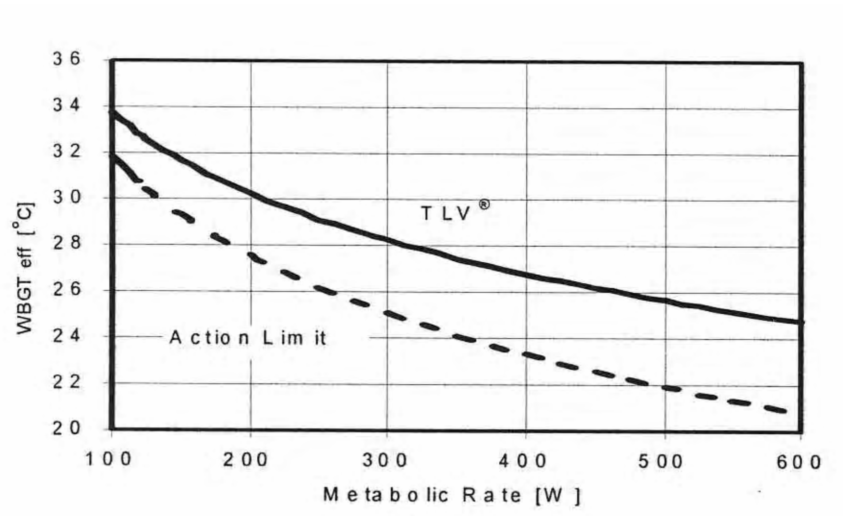


Figure 13. TLV® (solid line) and Action Limit (broken line) for Heat Stress. WBTG$_{eff}$ is the measured WBGT plus the clothing adjustment factor.

The Action Limit levels apply to unacclimatized workers and the TLV® levels apply to acclimatized workers. ACGIH also published a table (see Table 5) showing criteria they suggest to be used as a screening tool. These values are more protective than those in Figure 13. When the values in Table 5 are exceeded, ACGIH recommends a more extensive heat stress survey should be conducted.

Table 5. ACGIH screening criteria for heat exposure from the ACGIH documentation for heat stress.

Work cycle[1]	TLV® in WBGT in °C (°F)				Action Limit in WBGT in °C (°F)			
	Light[2]	Moderate[3]	Heavy[4]	Very Heavy[5]	Light	Moderate	Heavy	Very Heavy
75 to 100%	30.8 (87.4 °F)	28.2 (82.8 °F)	26.6 (79.9 °F)	25.5 (77.8 °F)	28.1 (82.6 °F)	25.0 (77.0 °F)	23.0 (73.4 °F)	21.6 (70.9 °F)
50 to 75%	31.2 (88.2 °F)	29.0 (84.3 °F)	27.6 (81.7 °F)	26.5 (79.8 °F)	28.7 (83.6 °F)	26.0 (78.8 °F)	24.2 (75.6 °F)	22.9 (73.3 °F)
25 to 50%	31.8 (89.2 °F)	30.1 (86.1 °F)	28.8 (83.9 °F)	27.9 (82.3 °F)	29.3 (84.8 °F)	27.2 (81.0 °F)	25.7 (78.3 °F)	24.6 (76.3 °F)
0 to 25%	32.3 (90.2 °F)	31.3 (88.4 °F)	30.5 (86.9 °F)	29.8 (85.7 °F)	30.0 (86.1 °F)	28.8 (83.8 °F)	27.8 (82.0 °F)	27.0 (80.6 °F)

[1] Work cycle is the allocation of work in a cycle of work and recovery. This is for a one hour exposure. If the person rested in a cooler area, a time weighted average of the heat exposures would need to be computed.

[2] Light work is considered light hand or arm work while sitting or standing.

[3] Moderate work is considered normal walking.

[4] Heavy work is considered pushing or pulling a heavy load.

[5] Very heavy work is considered working nearly at the maximum pace.

Both the NIOSH and ACGIH criteria assume the worker is wearing long pants and long sleeve shirt. Additional clothing, such as insulated coveralls and long underwear, would further impede heat loss from the worker. The methodology incorporates a correction factor to account for this additional clothing which reduces the WBGT for which concern begins. Ethridge and Chaney were wearing additional clothes compared to typical work clothes of long pants and long sleeve shirt. While information on the exact correction factor for the clothing worn and the backpack carried by the miners is lacking, an estimate using similar clothing can be made. Wearing long underwear bottoms, coveralls, and boots, while carrying a backpack, would lower the criteria by approximately 2 °C. Table 6 shows the screening criteria corrected for mining clothes worn by Ethridge and Chaney.

Table 6. ACGIH screening criteria for heat exposure while wearing mining clothes from the ACGIH documentation for heat stress.

	TLV® in WBGT in °C (°F)				Action Limit in WBGT in °C (°F)			
Work cycle	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 to 100%	28.8 (83.8 °F)	26.2 (79.2 °F)	24.6 (76.3 °F)	23.5 (74.3 °F)	26.1 (79.0 °F)	23.0 (73.4 °F)	21.0 (69.8 °F)	19.6 (67.3 °F)
50 to 75%	29.2 (84.6 °F)	27.0 (80.6 °F)	25.6 (78.1 °F)	24.5 (76.1 °F)	26.7 (80.1 °F)	24.0 (75.2 °F)	22.2 (72.0 °F)	20.9 (69.6 °F)
25 to 50%	29.8 (85.6 °F)	28.1 (84.4 °F)	26.8 (80,2 °F)	25.9 (78.6 °F)	27.3 (81.4 °F)	25.2 (77.4 °F)	23.7 (74.7 °F)	22.6 (72.7 °F)
0 to 25%	30.3 (86.5 °F)	29.3 (84.7 °F)	28.5 (83.3 °F)	27.8 (82.0 °F)	28.0 (82.4 °F)	26.8 (80.2 °F)	25.8 (78.4 °F)	25.0 (77.0 °F)

The NIOSH criteria document and the ACGIH TLV® Booklet also present controls for heat stress. While controlling heat in mines can be difficult, many controls can be implemented in underground coal mines. Examples of reducing heat exposure would include, improving ventilation, using more workers to complete arduous tasks, providing cool, potable drinking water, and using Personal Protective Equipment (PPE).

Based upon the heat measurements conducted by the investigation team in the Southwest A Longwall on November 30, 2009, the t_a and the t_{nwb} were 95 °F at Crosscut 24½. These temperatures were measured using a sling psychrometer that was held steady (not slung). The wetted bulb corresponds to the t_{nwb} and the other thermometer to t_a. The temperatures were measured after ventilation changes were implemented for the rescue and recovery. The ventilation changes introduced cooler fresh air into the bleeder entries and likely reduced the heat in the affected area. Additionally, the investigation team could not reach Crosscut 26 where Ethridge and Chaney were found due to the high heat and humidity. Investigators concluded that the humidity in the bleeder exceeded 70%. Walking in the Southwest A Longwall bleeders was estimated to present a moderate work load. Moreover, carrying a loaded backpack filled with drinks would result in an increase in the work load. Investigators were unable to definitively determine the exact temperature, humidity, and length of exposure that Ethridge and Chaney experienced prior to becoming incapacitated.

Ethridge exhibited many of the symptoms of heat stroke based upon the testimony of miners who first reached him and a State Medical Examiner from the Alabama Department of Forensic Sciences ruled that Chaney died from hyperthermia due to exposure to heat and humidity in a coal mine. After reviewing the autopsy report, a medical doctor from the Federal Occupational Health Service concurred with this determination. Further, at least nine persons participating in the rescue and recovery operation experienced heat related issues in the bleeder and were transported to the hospital: two were admitted. Investigators concluded that high heat and humidity in the Southwest A Longwall bleeder to which Ethridge and Chaney were exposed presented an immediate hazard to miners.

Summary of Air Quality and Heat Considerations

Investigators concluded the most likely source of heat was natural causes, including normal oxidation within the worked-out area and the in-situ temperature of the surrounding strata of the Southwest A Longwall Panel. Although Ethridge and Chaney were exposed to oxygen concentrations of less than 19.5%, the exposure most likely did not directly contribute to their incapacitation or injuries. Also, no toxic gases or vapors were found that contributed to their incapacitation or injuries.

The air temperature and humidity to which Ethridge and Chaney were exposed combined to create an immediate hazard. Although Ethridge determined the conditions were a hazard and decided to exit the bleeder, the miners did not fully recognize the severity of the hazard in sufficient time to enable successful retreat to a safe environment. Both miners became incapacitated. One miner died and the other was revived by rescuers.

The heat could be reduced or exposure to the heat could be mitigated in various ways. The air quantity measured in the Southwest A Longwall Tailgate Entry No. 4 at TG EP 5 (heat information location 1) diluted the heat. Sufficient airflow and proper distribution within the bleeder system could have reduced the heat to which miners were exposed. Alternate design of the bleeder system to prevent prolonged exposure and the use of PPE such as cooling vests could have mitigated the effects of the heat.

MSHA encourages mine operators to provide training to miners on heat stress and to evaluate heat exposures. If the heat exposure exceeds a reputable guideline, the mine operator should investigate methods of reducing the exposure such as assigning more miners to accomplish the task, provide better ventilation, provide PPE, etc.

ROOT CAUSE ANALYSIS

An analysis was conducted to identify the underlying causes of the accident that were correctable through reasonable management controls. Listed below are root causes identified during the analysis and the corresponding corrective actions implemented to prevent a recurrence of the accident:

1. Root Cause: The mine operator permitted non-certified persons to accompany mine examiners on scheduled weekly examinations and the Southwest A Longwall bleeder had not received the required preshift examination.

Corrective Action: Citation No. 7699097 was issued which required the mine operator to prohibit non-certified persons from entering areas of the mine where a preshift examination has not been performed.

2. Root Cause: Beginning Outby Crosscut 26, the heat and humidity presented a condition in which prolonged exposure resulted in an immediate hazard. Although Ethridge determined the conditions were a hazard and decided to exit the bleeder, the miners did not fully recognize the severity of the hazard in sufficient time to enable successful retreat to a safe environment.

Corrective Action: The operator's approved Part 48 training plans will be updated to provide training to recognize the hazard associated with heat exposure and ways to mitigate the effects of heat exposure.

CONCLUSION

Chaney was not a certified mine examiner and was permitted to enter into an area of the mine that was not examined as required. Deteriorating roof conditions and water accumulations within the bleeder likely altered the airflow patterns within the bleeder system, resulting in increased air temperatures. The air temperature and humidity which Ethridge and Chaney encountered, and the duration of their exposure, combined to create an immediate hazard. Although Ethridge determined the conditions were a hazard and decided to exit the bleeder, the miners did not fully recognize the severity of the hazard in sufficient time to enable successful retreat to a safe environment. Both miners became incapacitated. One miner died and the other was revived by rescuers.

ENFORCEMENT ACTIONS

A 103(j) order No. 7699074 was issued and subsequently modified to a 103(k) order to ensure the safety of all persons and prevent the destruction of any evidence until an investigation was completed. The following violation was deemed to have contributed to the accident. Other violations identified during the fatal accident investigation deemed not to have directly contributed to the cause of the accident were cited separately under an E16 spot inspection, event number 4491484.

Contributory

104(a) Citation No. 7699097 75.360(a)(1) S&S Moderate

The operator permitted a non-certified person to enter the Southwest A Longwall bleeder prior to completing a preshift examination of the area. On November 23, 2009, a non-certified person accompanied the certified person conducting the weekly examination. During the course of the investigation, testimony revealed that the weekly examination had been scheduled prior to November 23, 2009. Both persons were overcome by a combination of high heat and humidity while walking in the bleeder. The certified examiner required medical treatment and the non-certified person suffered fatal injuries from the effects of heat stress and high humidity. Failure to prohibit non-certified persons from entering an area where a required preshift examination was not conducted resulted in the exposure of personnel to the hazardous conditions which ultimately led to the death of a person who was not permitted to be in an area.

NON-CONTRIBUTORY ENFORCEMENT ACTIONS

The following violations were deemed to not have directly contributed to the cause of the accident were cited separately under an E16 spot inspection, event number 4491464.

104(a) Citation No. 7699098 75.159 Non-S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, it was determined that the mine operator did not maintain a complete list of certified and qualified persons. Harold Jones and Milton Ethridge were not included on the list of qualified persons provided to the investigation team.

104(a) Citation No. 7699099 75.321(a)(2) Non-S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, in the Southwest A Longwall bleeder system it was determined that the air in the bleeder entries where persons work or travel contained less than 19.5 percent oxygen. This determination was based on statements provided during the investigation and information from multi-gas detectors that were used during the weekly examination and the rescue and recovery. Detector MSA #11, which was used during the weekly examination conducted on November 23, 2009, recorded oxygen levels as low as 18.6 percent. Testing by MSHA Technical Support personnel indicated that the detector accurately recorded oxygen levels to within manufacturer's specifications. Statements provided during the investigation indicated that miners were exposed to oxygen levels as low as 18 percent during the rescue and recovery.

104(a) Citation No. 7699100 75.333(h) S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, in the Southwest A Longwall bleeder system it was determined that permanent ventilation controls on the tailgate side between Entry No. 2 and Entry No. 3 were not maintained to serve the purpose for which they were built. The permanent ventilation control at Crosscut 21 had crushed out due to a roof fall; another control at Crosscut 16 was damaged. There were holes in the permanent ventilation controls between Entry No. 3 and Entry No. 4 at Crosscut 14 ½ and Crosscut 13 ½. In lieu of repairing or replacing damaged ventilation controls, curtains were installed by the operator to reduce leakage. The permanent ventilation controls were essential to properly control and direct airflow through the worked-out area and to the back of the bleeder in this wrap-around bleeder system. The damaged and leaking ventilation controls reduced the amount of airflow directed through the worked-out area to the Moving EP.

104(a) Citation No. 8519001 75.334(d) S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, it was determined that the required examination and evaluation to determine that the Southwest A Longwall bleeder system was working effectively could not be completed on the day of the accident. The mine examiner determined that he could not complete the weekly examination due to high heat and humidity and attempted to retreat from the area. In addition, the bleeder system was ineffective in that it failed to provide sufficient ventilation to maintain an oxygen concentration of at least 19.5 percent within areas of the bleeder where miners were required to travel. The oxygen deficient atmosphere encountered by the mine examiner was also a factor considered in his determination to exit the bleeder before completing the weekly examination.

104(a) Citation No. 8519002 75.360(a)(1) S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, it was determined that the operator permitted non-certified persons to enter the Southwest A Longwall bleeder prior to completing a preshift examination of the area. On two previous occasions November 9, and November 16, 2009, non-certified persons accompanied the certified person conducting the weekly examination. Interview statements revealed that the weekly examination had been scheduled prior to the day the examinations were conducted.

104(a) Citation No. 8519003 75.370(a)(1) S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, in the Southwest A Longwall it was determined that the approved ventilation plan was not being complied with in that the following deficiencies existed:

- Ventilation controls were not constructed in all locations as approved.
- All evaluation points were not located in the approved locations.
- A return air course was not established in the Southwest A Longwall headgate Entry No. 4, outby the longwall face, as approved.
- Air was not coursed in the proper direction in the tailgate entry outby the face. The air was traveling in an outby direction. The approved plan required the air to travel in an inby direction.
- The airflow direction between Southwest A Longwall Headgate Entry No. 2 and Entry No. 3 was opposite the direction shown in the approved plan.
- No record of the examination for the Southwest A Longwall Headgate EPs could be found for October 23rd and October 25th.

104(a) Citation No. 8519004 75.370(e) Non-S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, it was determined that the mine examiner who conducted the weekly examination of the Southwest A Longwall bleeder was not adequately trained on provisions contained in the ventilation plan supplement which was approved on October 1, 2009. Statements provided during the investigation indicated that the mine examiner who was scheduled to conduct the examination of the bleeder on November 23, 2009, was not aware that an air quantity measurement was required at the Moving EP location.

104(a) Citation No. 8519005 75.1200 S&S Moderate

During the investigation of a fatal accident which occurred on November 23, 2009, it was determined that the mine map was not being kept up-to-date. The direction of airflow in the Southwest A Longwall tailgate entry outby the face was not accurately indicated. The air was found to be flowing in the opposite direction as indicated on the mine map. Also, in the Southwest A Longwall it was determined that the temporary notations, revisions and supplements on the mine map were not being kept up-to-date. The permanent ventilation controls depicted on the mine map posted on the surface did not accurately show all ventilation controls that existed underground.

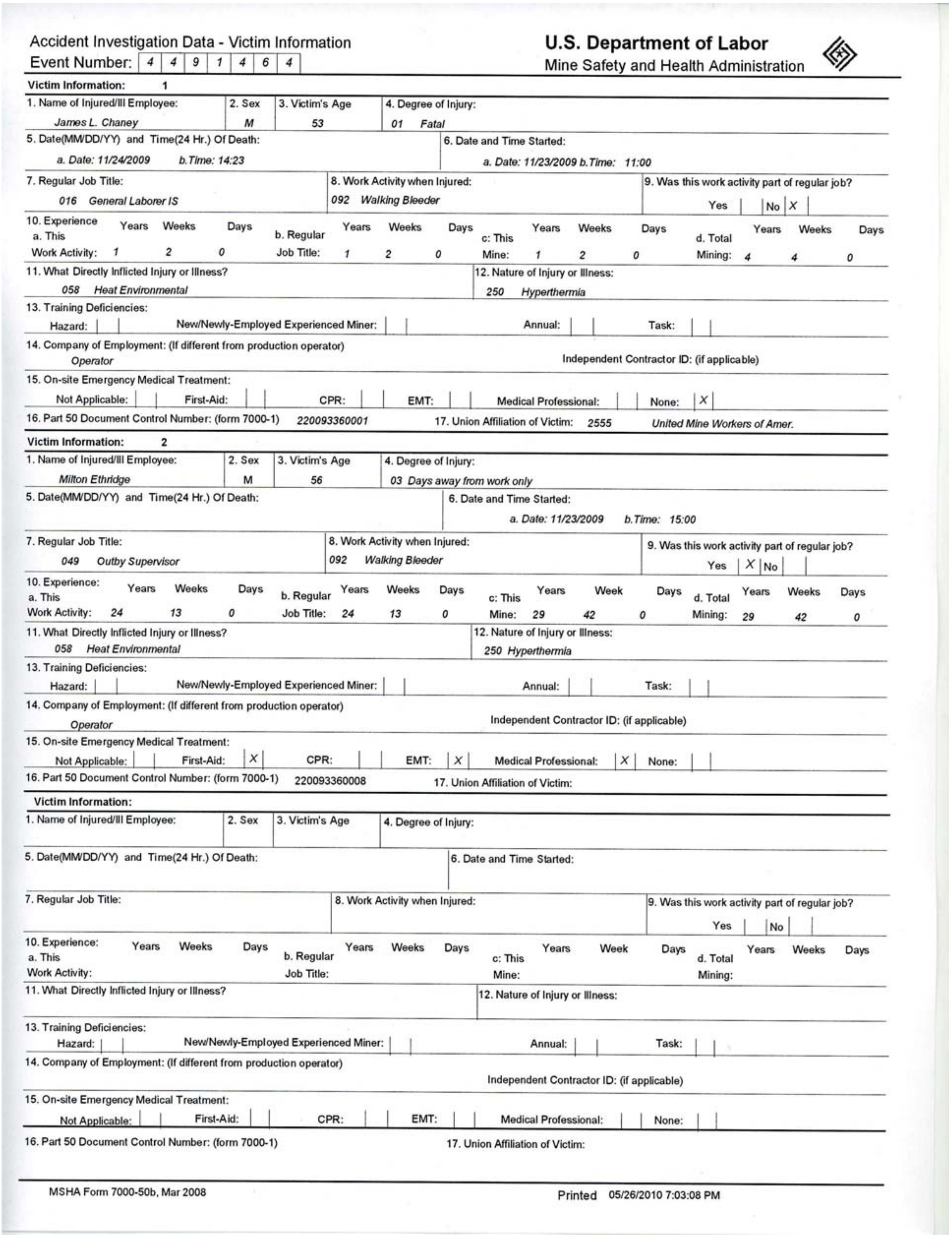
Signature Page

Approved: ____________________________________

Kevin G. Stricklin, Administrator

Date: 08/13/10

Appendix A – Victim Data Sheet



Accident Investigation Data - Victim Information
Event Number: 4 4 9 1 4 6 4

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

Victim Information: 1

1. Name of Injured/Ill Employee: *James L. Chaney*
2. Sex: *M*
3. Victim's Age: *53*
4. Degree of Injury: *01 Fatal*
5. Date(MM/DD/YY) and Time(24 Hr.) Of Death: *a. Date: 11/24/2009 b.Time: 14:23*
6. Date and Time Started: *a. Date: 11/23/2009 b.Time: 11:00*
7. Regular Job Title: *016 General Laborer IS*
8. Work Activity when Injured: *092 Walking Bleeder*
9. Was this work activity part of regular job? Yes ☐ No ☒

10. Experience	Years	Weeks	Days
a. This Work Activity:	1	2	0
b. Regular Job Title:	1	2	0
c: This Mine:	1	2	0
d. Total Mining:	4	4	0

11. What Directly Inflicted Injury or Illness? *058 Heat Environmental*
12. Nature of Injury or Illness: *250 Hyperthermia*
13. Training Deficiencies: Hazard: ☐ New/Newly-Employed Experienced Miner: ☐ Annual: ☐ Task: ☐
14. Company of Employment: (If different from production operator) *Operator*
Independent Contractor ID: (if applicable)
15. On-site Emergency Medical Treatment: Not Applicable: ☐ First-Aid: ☐ CPR: ☐ EMT: ☐ Medical Professional: ☐ None: ☒
16. Part 50 Document Control Number: (form 7000-1) *220093360001*
17. Union Affiliation of Victim: *2555 United Mine Workers of Amer.*

Victim Information: 2

1. Name of Injured/Ill Employee: *Milton Ethridge*
2. Sex: M
3. Victim's Age: *56*
4. Degree of Injury: *03 Days away from work only*
5. Date(MM/DD/YY) and Time(24 Hr.) Of Death:
6. Date and Time Started: *a. Date: 11/23/2009 b.Time: 15:00*
7. Regular Job Title: *049 Outby Supervisor*
8. Work Activity when Injured: *092 Walking Bleeder*
9. Was this work activity part of regular job? Yes ☒ No ☐

10. Experience:	Years	Weeks	Days
a. This Work Activity:	24	13	0
b. Regular Job Title:	24	13	0
c: This Mine:	29	42	0
d. Total Mining:	29	42	0

11. What Directly Inflicted Injury or Illness? *058 Heat Environmental*
12. Nature of Injury or Illness: *250 Hyperthermia*
13. Training Deficiencies: Hazard: ☐ New/Newly-Employed Experienced Miner: ☐ Annual: ☐ Task: ☐
14. Company of Employment: (If different from production operator) *Operator*
Independent Contractor ID: (if applicable)
15. On-site Emergency Medical Treatment: Not Applicable: ☐ First-Aid: ☒ CPR: ☐ EMT: ☒ Medical Professional: ☒ None: ☐
16. Part 50 Document Control Number: (form 7000-1) 220093360008
17. Union Affiliation of Victim:

Victim Information:

1. Name of Injured/Ill Employee:
2. Sex:
3. Victim's Age:
4. Degree of Injury:
5. Date(MM/DD/YY) and Time(24 Hr.) Of Death:
6. Date and Time Started:
7. Regular Job Title:
8. Work Activity when Injured:
9. Was this work activity part of regular job? Yes ☐ No ☐

10. Experience:	Years	Weeks	Days
a. This Work Activity:			
b. Regular Job Title:			
c: This Mine:			
d. Total Mining:			

11. What Directly Inflicted Injury or Illness?
12. Nature of Injury or Illness:
13. Training Deficiencies: Hazard: ☐ New/Newly-Employed Experienced Miner: ☐ Annual: ☐ Task: ☐
14. Company of Employment: (If different from production operator)
Independent Contractor ID: (if applicable)
15. On-site Emergency Medical Treatment: Not Applicable: ☐ First-Aid: ☐ CPR: ☐ EMT: ☐ Medical Professional: ☐ None: ☐
16. Part 50 Document Control Number: (form 7000-1)
17. Union Affiliation of Victim:

MSHA Form 7000-50b, Mar 2008

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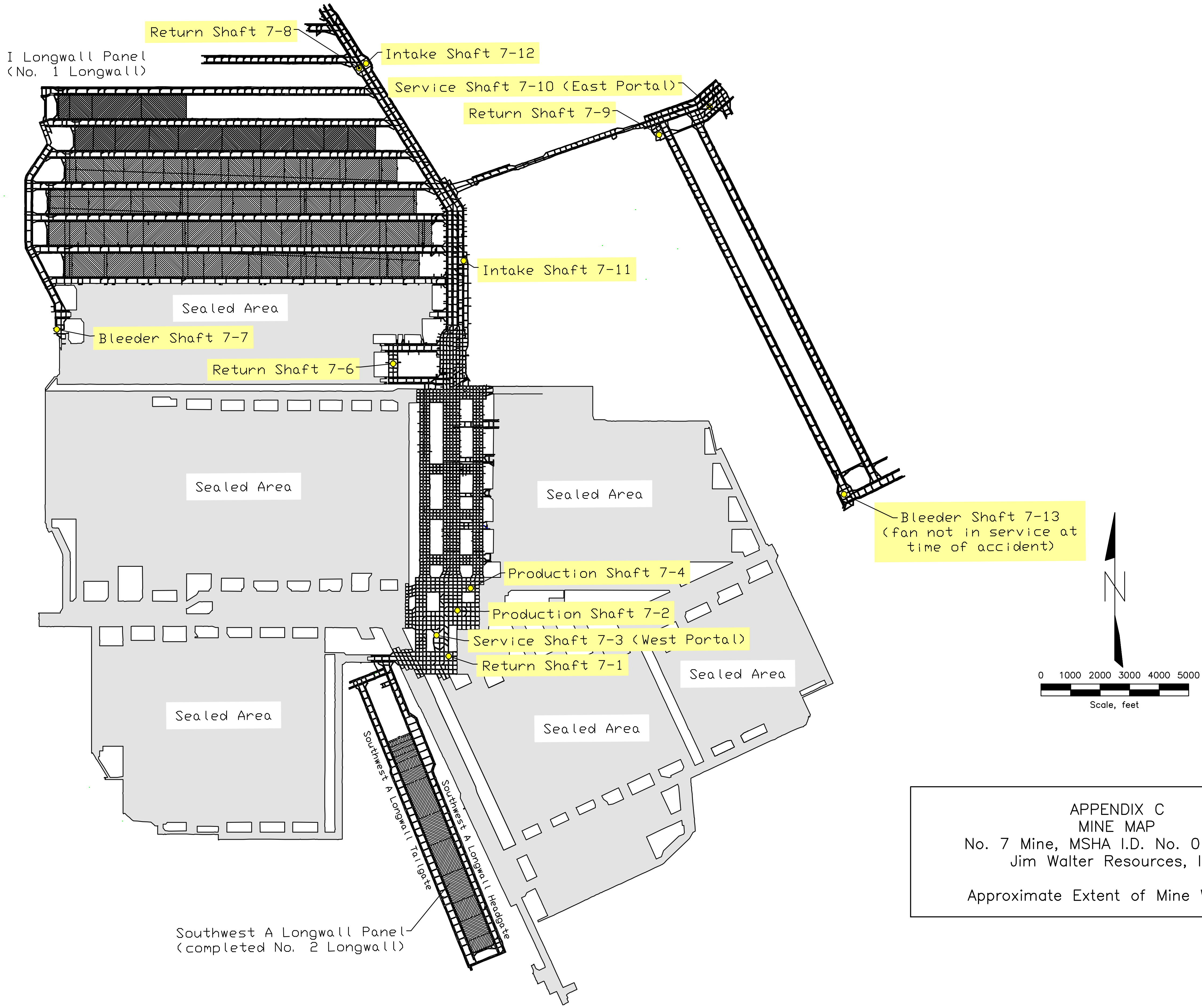
Appendix B – Personnel Involved Underground in the Rescue and Recovery Operation

Johnny Aldrich	Jim Walter Resources, Inc.
Brent Allgood	Jim Walter Resources, Inc.
Gary Allinson	Jim Walter Resources, Inc.
Terry Ash	Jim Walter Resources, Inc.
Mike Atkins	Shoal Creek
Gene Averette	Jim Walter Resources, Inc.
Jeff Beard	Jim Walter Resources, Inc.
J. Beatie	Jim Walter Resources, Inc.
M. Bell	Jim Walter Resources, Inc.
S. Bernes	Jim Walter Resources, Inc.
Keith Burgess	Jim Walter Resources, Inc.
Dale Byram	Jim Walter Resources, Inc.
Robert Cagle	State of Alabama
John Caldwell	Jim Walter Resources, Inc.
Sonny Campbell	Jim Walter Resources, Inc.
Mike Campbell	Jim Walter Resources, Inc.
Buddy Caudill	Jim Walter Resources, Inc.
Stanley Chandler	Jim Walter Resources, Inc.
Eugene Condottore	Jim Walter Resources, Inc.
Anthony Cook	Jim Walter Resources, Inc.
Tim Cooley	Shoal Creek
Trent Creel	Jim Walter Resources, Inc.
David Crowe	Shoal Creek
Kerry Cupp	Jim Walter Resources, Inc.
Ricky DeFoor	Jim Walter Resources, Inc.
Charles Dickey	Jim Walter Resources, Inc.
Nathan Diffley	Shoal Creek
Tim Dorsett	Jim Walter Resources, Inc.
John Dukes	Jim Walter Resources, Inc.
Don Elliott	State of Alabama
Robbie Epperson	Jim Walter Resources, Inc.
Lee Esch	Shoal Creek
Ricky Fosse	Jim Walter Resources, Inc.
Donald Fowler	Jim Walter Resources, Inc.
Russell Fox	Jim Walter Resources, Inc.
Jason Fox	Jim Walter Resources, Inc.
Benny Franklin	Jim Walter Resources, Inc.
Randy Gable	Jim Walter Resources, Inc.
Dave Gardiner	Jim Walter Resources, Inc.

David Gillespie	Shoal Creek
Butch Gladson	Jim Walter Resources, Inc.
Joshua Hallman	Jim Walter Resources, Inc.
A. Hallman	Jim Walter Resources, Inc.
John Hamilton	Jim Walter Resources, Inc.
Joey Hamrick	Jim Walter Resources, Inc.
Dexter Harris	Jim Walter Resources, Inc.
Jeremy Hendrix	Jim Walter Resources, Inc.
S. Hill	Jim Walter Resources, Inc.
Brian Ivey	Jim Walter Resources, Inc.
Tim Jenkins	Jim Walter Resources, Inc.
Dale Johnson	State of Alabama
Scott Jordan	Shoal Creek
David Keeton	State of Alabama
Darrel Key	Jim Walter Resources, Inc.
Ken Knight	State of Alabama
Jason Lee	Jim Walter Resources, Inc.
Larry McGiboney	Jim Walter Resources, Inc.
Chris McGuffie	Jim Walter Resources, Inc.
Ricky McGuire	Shoal Creek
Brian Miller	Jim Walter Resources, Inc.
David Miller	Jim Walter Resources, Inc.
Ross Mize	Jim Walter Resources, Inc.
Larry Morgan	Jim Walter Resources, Inc.
R. Morgenthaler	Jim Walter Resources, Inc.
J. Morris	Jim Walter Resources, Inc.
Theodore Nelson	Jim Walter Resources, Inc.
Vince Nethery	Jim Walter Resources, Inc.
James O'Rear	Jim Walter Resources, Inc.
Ty Olson	Jim Walter Resources, Inc.
Pat Pelley	Jim Walter Resources, Inc.
Darryl Piper	Shoal Creek
Jarred Prestridge	Jim Walter Resources, Inc.
John Sanders	Jim Walter Resources, Inc.
Ed Scalla	Jim Walter Resources, Inc.
Mike Schmidt	Shoal Creek
Eddie Sides	State of Alabama
Steve Smith	Jim Walter Resources, Inc.
Terry Tavel	Jim Walter Resources, Inc.
David Thomas	Jim Walter Resources, Inc.
Matt Thompson	Jim Walter Resources, Inc.
Tim Tingle	Jim Walter Resources, Inc.
Marion Towle	Jim Walter Resources, Inc.

Gene Trammel	Jim Walter Resources, Inc.
Jamal Treadwell	Jim Walter Resources, Inc.
Chad Turner	Jim Walter Resources, Inc.
Rodney Williams	MSHA
Christopher Wilson	Jim Walter Resources, Inc.
Michael Winkleblack	Jim Walter Resources, Inc. Inc.



APPENDIX C
MINE MAP
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Approximate Extent of Mine Workings

APPENDIX D
MINE MAP
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Southwest A Longwall Bleeder System and Surrounding Area
Observations of MSHA Accident Investigation Team During Physical
Examination of Accident Area on November 30, 2009

LEGEND

CH4–0.60% O2–19.9%	handheld multi–gas detector methane (CH_4) and oxygen (O_2) concentrations
Bag Sample CH4–0.60% O2–19.90% CO2–0.60% CO–10 ppm	gas chromatographic analysis results [methane, oxygen, carbon dioxide (CO_2), and carbon monoxide (CO) concentrations]
tnwb–82°F ta–84°F	air temperature, natural wet bulb temperature (t_{nwb}), dry bulb temperature (t_a)
24 XC	crosscut number
▬	seal
—400—	estimated bottom elevation contour line
←	intake airflow
←	return airflow
↜	perceptible movement
═	stopping
═	stopping with personnel door
≠	stopping with hole(s)
R	regulator
ʃ	curtain

Notes: Ventilation controls observed and noted by MSHA investigation team are depicted in orange color. Ventilation controls observed and noted during MSHA ventilation survey are depicted in magenta color. Ventilation controls not observed and noted by MSHA accident investigation personnel and shown on the posted mine map of the Southwest A Longwall Panel area are depicted in black color. Other ventilation controls are depicted in brown color.

Bottom elevation contours are offset by 2000 feet. (i.e. actual bottom contour elevation of 1600 feet below sea level [–1600] depicted as 400 feet above sea level [400].)

Appendix E – Persons Participating in Investigation

Jim Walter Resources, Inc.

Keith Shalvey	Mine Manager
Keith Plylar	Safety Manager
Tommy McNider	General Manager Mining Engineer
Ty Olson	Outby Area Manager
Johnny Humphreys	Mining Engineer
Butch Gladson	Safety Supervisor
Jeff Strickland	Mining Engineer
Randall Long	Mining Engineer
Alan Ferguson	Mining Engineer

Black Warrior Methane Corp.

Charles Willis	President & General Manager
Joe Steele	Supervisor

UMWA

Thomas Wilson	International Representative
Edgar Oldham	International Representative
Dwight Cagle	Mine Safety Committee
Jarred Prestridge	Mine Safety Committee
John Connellan	Mine Safety Committee
Renea Aldrich	Miners Representative

Mine Safety Appliance Co.

Brian Sutterlin	Engineering Manager

State of Alabama

James Rivers	Mine Inspection Supervisor
Dale Johnson	Mine Inspector

MSHA

Richard Gates	District Manager
Joseph O'Donnell	Assistant Manager
Mike Kalich	Senior Mining Engineer

Dennis Beiter	Supervisory Mining Engineer
Johnny Calhoun	Mining Engineer
Michael Valoski	Supervisory Industrial Hygienist
Mark Pompei	Mining Engineer
George Aul	Geologist
Thomas Morley	Mining Engineer
Richard Stoltz	Chief Ventilation Division
Christina Stalnaker	Industrial Hygienist
George Durkt, Jr.	Industrial Hygienist
Tim Foster	Roof Control Specialist
Alveriado Getter	Ventilation Specialist
Sheila Dawkins	Health Specialist
David Allen	CLR Supervisor
Steven Harrison	Mining Engineer
Thomas O'Donnell, Jr.	Safety and Health Inspector

Appendix F – List of Persons Who Provided Voluntary Statements*

Name	**Title**
Johnny Aldrich	Training Instructor
Gary Allinson	Longwall Manager
John Anderson	Communication Supervisor
Bobby Brucke	General Laborer IS
William Burgess	Safety Supervisor
Dale Byram	General Manager of Safety and Training
Rocky Davis	Pre Mason Construction
Ricky DeFoor	Outby Supervisor
Milton Ethridge	Outby Supervisor
Dennis Herring	Communication Supervisor
Timothy Jenkins	Outby Supervisor
Howard Jones	Outby Supervisor
Charles Ledlow	General Laborer IS
Ty Olson	Outby Area Manager
Romie Pendleton	Monitoring Systems Manager
Rodney Pendley	General Laborer IS
Paul Phillips	General Services Coordinator
Charles Reed	Pre Mason Construction
Anthony Ross	General Laborer IS
Ronald Soneff	Electrician OS/ Hoistman
Al Sterling	General Laborer IS
Matthew Thompson	Outby Supervisor
Chad Turner	Longwall Supervisor
Stuart Walton	Utility Man IS

*Confidential statements were also given.

Notes: Ventilation controls observed and noted by MSHA investigation team are depicted in orange color. Ventilation controls observed and noted during MSHA ventilation survey are depicted in magenta color. Ventilation controls not observed and noted by MSHA accident investigation personnel and shown on the posted mine map of the Southwest A Longwall Panel area are depicted in black color. Other ventilation controls are depicted in brown color.

Bottom elevation contours are offset by 2000 feet. (i.e. actual bottom contour elevation of 1600 feet below sea level [−1600] depicted as 400 feet above sea level [400].)

14-10-05	14-10-08	14-03-12	11-14-14
Bag Sample 1	Bag Sample 1	Bag Sample 1	Bag Sample 1
CH_4—59.52%	CH_4—51.21%	CH_4—46.55%	CH_4—42.77%
O_2—3.47%	O_2—4.57%	O_2—3.40%	O_2—8.26%
CO_2—1.07%	CO_2—1.11%	CO_2—2.40%	CO_2—0.64%
H_2—9 ppm	H_2—21 ppm	H_2—36 ppm	H_2—10 ppm
CO—NDA	CO—NDA	CO—14 ppm	CO—NDA
N_2—35.06%	N_2—42.12%	N_2—46.20%	N_2—47.53%
C_2H_6—4600 ppm	C_2H_6—4900 ppm	C_2H_6—9000 ppm	C_2H_6—2200 ppm (suspected dilution)
Bag Sample 2	Bag Sample 2	Bag Sample 2	Bag Sample 2
CH_4—38.22%	CH_4—51.93%	CH_4—47.12%	CH_4—55.15%
O_2—9.73%	O_2—4.34%	O_2—3.18%	O_2—4.59%
CO_2—0.69%	CO_2—1.11%	CO_2—2.46%	CO_2—0.84%
H_2—6 ppm	H_2—22 ppm	H_2—37 ppm	H_2—13 ppm
CO—NDA	CO—NDA	CO—14 ppm	CO—NDA
N_2—50.47%	N_2—41.62%	N_2—45.78%	N_2—38.67%
C_2H_6—2900 ppm (suspected dilution)	C_2H_6—4900 ppm	C_2H_6—9100 ppm	C_2H_6—2900 ppm

TG EP 3	TG EP 5
Bag Sample 1	Bag Sample 1
CH_4—0.07%	CH_4—0.40%
O_2—20.87%	O_2—20.34%
CO_2—0.06%	CO_2—0.26%
H_2—NDA	H_2—NDA
CO—NDA	CO—NDA
N_2—78.08%	N_2—78.07%
C_2H_6—NDA	C_2H_6—15 ppm
Bag Sample 2	Bag Sample 2
CH_4—NDA	CH_4—0.39%
O_2—20.91%	O_2—20.35%
CO_2—0.05%	CO_2—0.26%
H_2—NDA	H_2—NDA
CO—NDA	CO—NDA
N_2—78.11%	N_2—78.06%
C_2H_6—NDA	C_2H_6—15 ppm

APPENDIX G
MINE MAP
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Southwest A Longwall Bleeder System and Surrounding Area
Faults, Degasification Boreholes, Bottom Contours, and Additional Gas Sampling Results

LEGEND

╲	horizontal degasification boreholes
● 14-06-01	vertical degasification boreholes (gob wells)
● 14-10-05	producing vertical degasification boreholes on December 11, 2009
←	return airflow where sampled in mine
15'	fault with distance of vertical displacement
400	bottom elevation contour line from mine map
Bag Sample 1 CH_4—59.52% O_2—3.47% CO_2—1.07% H_2—9 ppm CO—NDA N_2—35.06% C_2H_6—4600 ppm	gas chromatographic analysis results [methane (CH_4), oxygen (O_2), carbon dioxide (CO_2), hydrogen (H_2), carbon monoxide (CO), and ethane (C_2H_6) concentrations; NDA is no detectable amount]
24 XC	crosscut number

Jim Walter resources, inc.
BLUE CREEK COAL - BROOKWOOD, ALABAMA

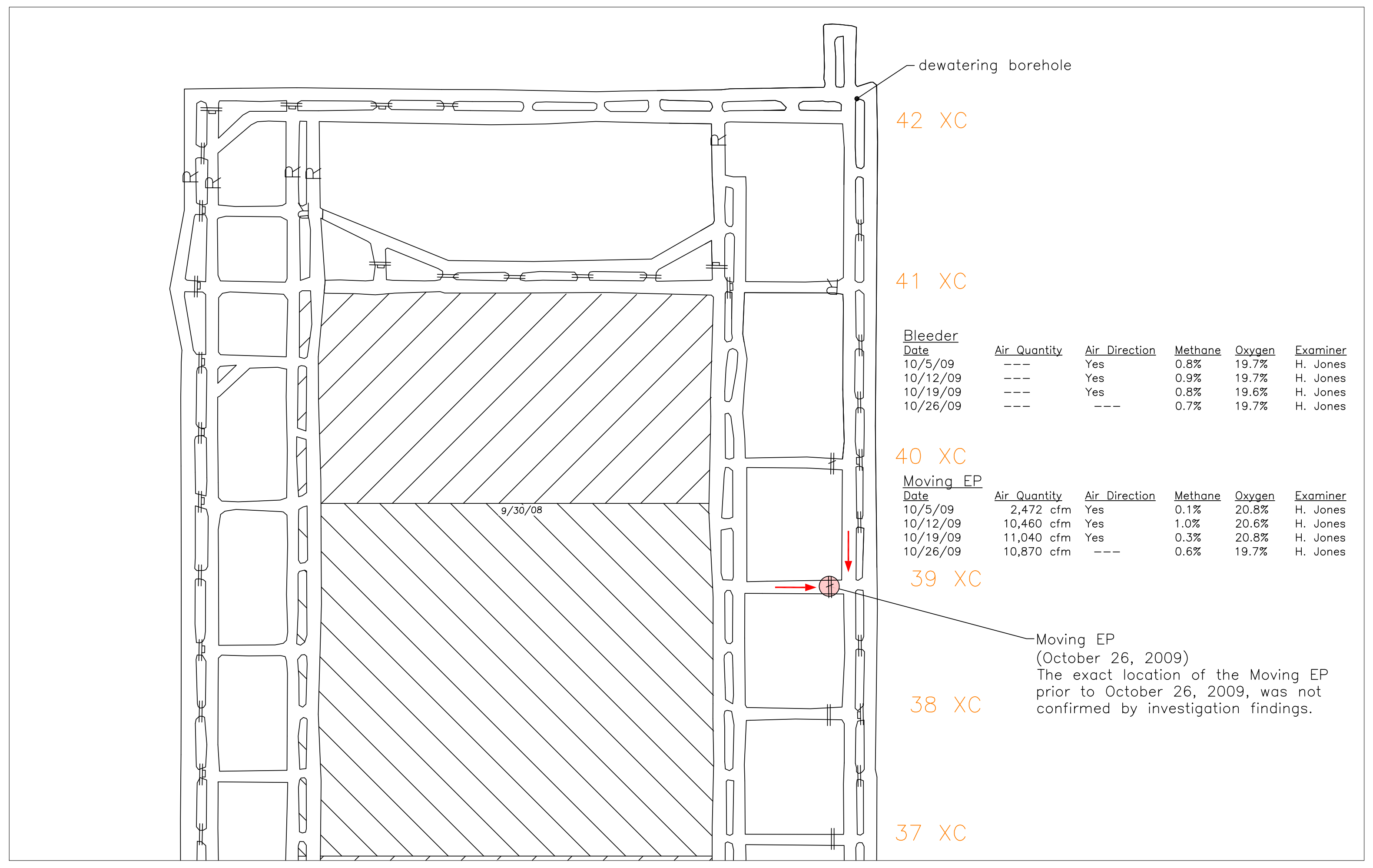
MAP 2
SOUTHWEST A VENTILATION DURING RECOVERY

Drawing Source:		
Plot Tab Name: VENT	Revision Date: 9/21/09	Checked By: J. HUMPHREYS
Scale: 1" = 400'	Plot Date: 9/21/09	Drawn By: J HUMPHREYS

APPENDIX H
MINE MAP
No. 7 Mine, MSHA I.D. No. 01-01401
Jim Walter Resources, Inc.

Copy of Map 2 from Mine Ventilation Plan
Supplement Approved October 1, 2009

Note: Scale indicated on copy of map not correct in presented format.



Bleeder

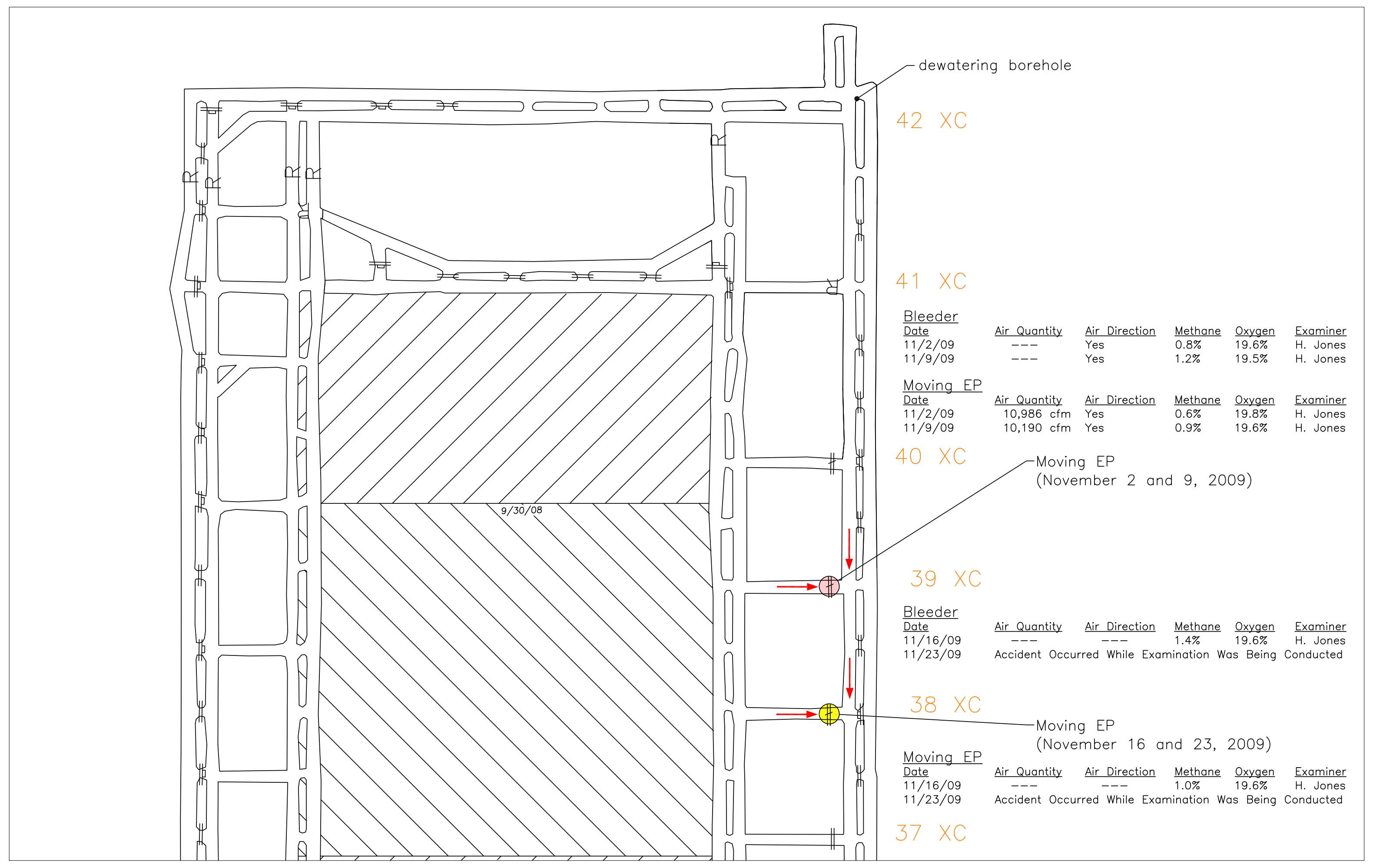
Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
10/5/09	---	Yes	0.8%	19.7%	H. Jones
10/12/09	---	Yes	0.9%	19.7%	H. Jones
10/19/09	---	Yes	0.8%	19.6%	H. Jones
10/26/09	---	---	0.7%	19.7%	H. Jones

Moving EP

Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
10/5/09	2,472 cfm	Yes	0.1%	20.8%	H. Jones
10/12/09	10,460 cfm	Yes	1.0%	20.6%	H. Jones
10/19/09	11,040 cfm	Yes	0.3%	20.8%	H. Jones
10/26/09	10,870 cfm	---	0.6%	19.7%	H. Jones

Moving EP
(October 26, 2009)
The exact location of the Moving EP prior to October 26, 2009, was not confirmed by investigation findings.

Detail 1A – Results of recorded weekly examinations performed at the Southwest A Longwall Tailgate Moving EP and the "poorest" air quality detected in the bleeder entries while the longwall face was ventilated from Headgate to Tailgate.



Bleeder

Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
11/2/09	---	Yes	0.8%	19.6%	H. Jones
11/9/09	---	Yes	1.2%	19.5%	H. Jones

Moving EP

Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
11/2/09	10,986 cfm	Yes	0.6%	19.8%	H. Jones
11/9/09	10,190 cfm	Yes	0.9%	19.6%	H. Jones

Moving EP
(November 2 and 9, 2009)

Bleeder

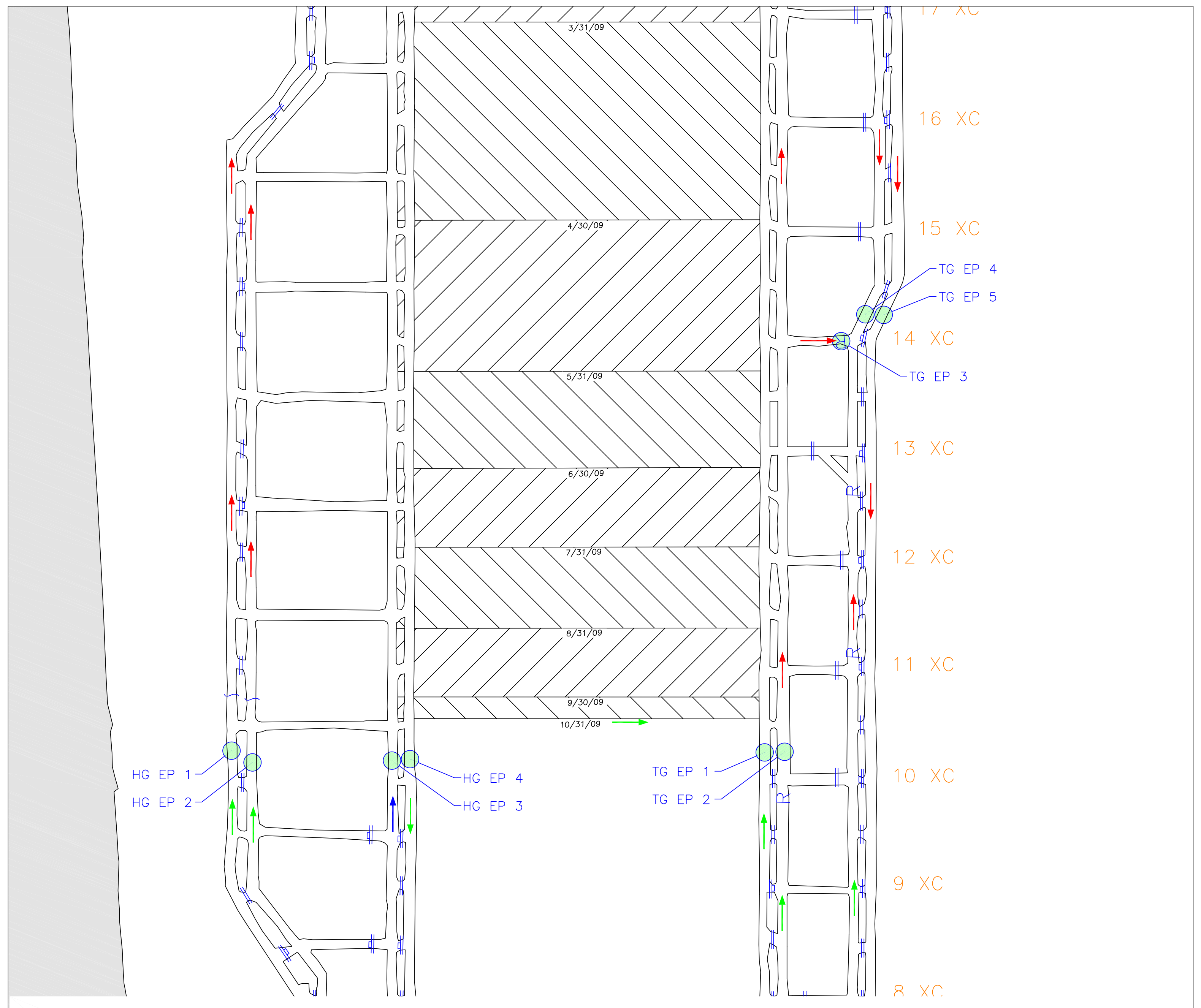
Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
11/16/09	---	---	1.4%	19.6%	H. Jones
11/23/09	Accident Occurred While Examination Was Being Conducted				

Moving EP
(November 16 and 23, 2009)

Moving EP

Date	Air Quantity	Air Direction	Methane	Oxygen	Examiner
11/16/09	---	---	1.0%	19.6%	H. Jones
11/23/09	Accident Occurred While Examination Was Being Conducted				

Detail 1B – Results of recorded weekly examinations performed at the Southwest A Longwall Tailgate Moving EP and the "poorest" air quality detected in the bleeder entries while the longwall face was ventilated from Tailgate to Headgate.



HG EP 1

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	62,400 cfm	0.0%		T. Penfield
10/12/09	52,200 cfm	0.0%	20.8%	T. Penfield
10/19/09	54,300 cfm	0.0%	20.8%	T. Penfield
10/26/09	51,750 cfm	0.0%		T. Penfield

HG EP 2

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	75,320 cfm	0.0%		T. Penfield
10/11/09	61,740 cfm	0.0%	20.8%	T. Penfield
10/19/09	54,320 cfm	0.0%	20.8%	T. Penfield
10/26/09	50,680 cfm	0.0%		T. Penfield

HG EP 3

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	87,230 cfm	0.0%		T. Penfield
10/12/09	87,100 cfm	0.0%	20.8%	T. Penfield
10/19/09	98,150 cfm	0.0%	20.8%	T. Penfield
10/26/09	92,170 cfm	0.0%		T. Penfield

HG EP 4

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	49,650 cfm	0.0%		T. Penfield
10/12/09	39,300 cfm	0.0%	20.8%	T. Penfield
10/19/09	33,180 cfm	0.0%	20.8%	T. Penfield
10/26/09	32,480 cfm	0.0%		T. Penfield

TG EP 1

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	8,700 cfm	0.5%	20.8%	H. Jones
10/12/09	8,850 cfm	0.0%	20.8%	H. Jones
10/19/09	12,300 cfm	0.3%	20.8%	H. Jones
10/26/09	9,600 cfm	0.3%	20.8%	H. Jones

TG EP 2

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	6,508 cfm	0.0%	20.8%	H. Jones
10/12/09	7,938 cfm	0.0%	20.8%	H. Jones
10/19/09	5,916 cfm	0.0%	20.8%	H. Jones
10/26/09	4,586 cfm	0.1%	20.8%	H. Jones

TG EP 3

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	66,960 cfm	0.5%	20.8%	H. Jones
10/12/09	64,865 cfm	0.0%	20.8%	H. Jones
10/19/09	63,840 cfm	0.5%	20.8%	H. Jones
10/26/09	68,351 cfm	0.4%	20.8%	H. Jones

TG EP 4

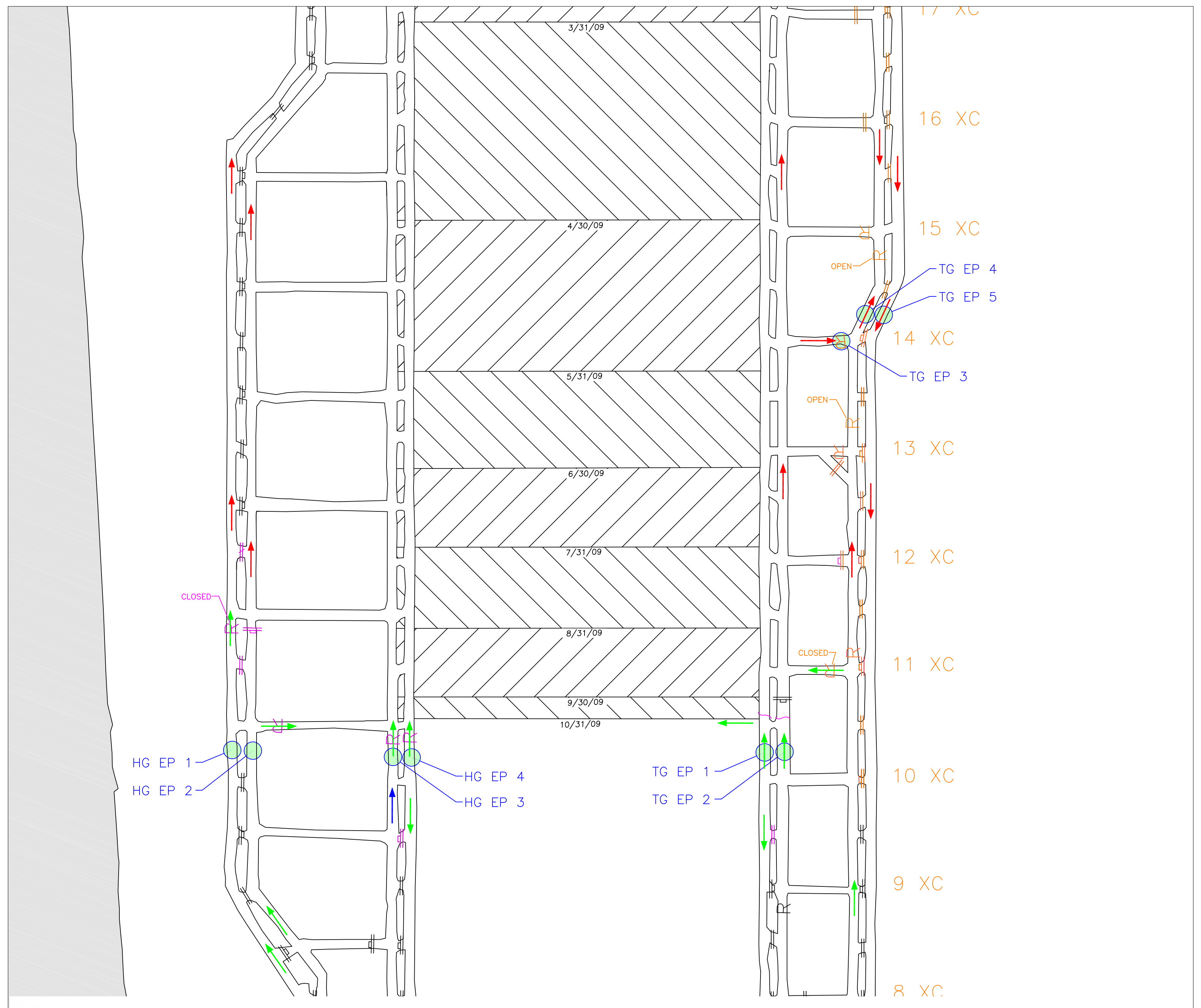
Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	87,720 cfm	0.2%	20.8%	H. Jones
10/12/09	96,140 cfm	0.0%	20.8%	H. Jones
10/19/09	91,800 cfm	0.4%	20.8%	H. Jones
10/26/09	97,290 cfm	0.6%	20.8%	H. Jones

TG EP 5

Date	Air Quantity	Methane	Oxygen	Examiner
10/5/09	111,820 cfm	0.4%	20.8%	H. Jones
10/12/09	116,360 cfm	0.0%	20.8%	H. Jones
10/19/09	112,400 cfm	0.6%	20.7%	H. Jones
10/26/09	112,380 cfm	0.6%	20.8%	H. Jones

Ventilation controls and airflow directions depicted as shown on Map 1 – Southwest A Ventilation Prior to Cutout And Start Of Recovery, most recent submitted and approved ventilation plan supplement.

Detail 2A – Results of recorded daily examinations performed at the Southwest A Longwall Headgate and Tailgate EPs located near the longwall face while the longwall face was ventilated from Headgate to Tailgate.



HG EP 1

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	7,950 cfm	0.0%	20.8%	H. Jones
11/9/09	7,800 cfm	0.0%	20.8%	H. Jones
11/16/09	7,160 cfm	0.0%	20.8%	H. Jones
11/23/09	7,540 cfm	0.0%	20.8%	M. McNeil

HG EP 2

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	26,600 cfm	0.0%	20.8%	H. Jones
11/9/09	15,120 cfm	0.0%	20.8%	H. Jones
11/16/09	12,420 cfm	0.0%	20.8%	H. Jones
11/23/09	64,950 cfm	0.0%	20.8%	M. McNeil

HG EP 3

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	9,360 cfm	0.0%	20.8%	H. Jones
11/9/09	18,450 cfm	0.0%	20.8%	H. Jones
11/16/09	8,460 cfm	0.0%	20.8%	H. Jones
11/23/09	22,400 cfm	0.0%	20.8%	M. McNeil

HG EP 4

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	26,700 cfm	0.0%	20.8%	H. Jones
11/9/09	24,900 cfm	0.0%	20.8%	H. Jones
11/16/09	22,160 cfm	0.0%	20.8%	H. Jones
11/23/09	25,100 cfm	0.0%	20.8%	M. McNeil

TG EP 1

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	98,000 cfm	0.1%	20.8%	H. Jones
11/9/09	104,000 cfm	0.1%	20.8%	H. Jones
11/16/09	98,700 cfm	0.0%	20.8%	H. Jones
11/23/09	85,100 cfm	0.0%	20.8%	M. McNeil

TG EP 2

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	97,225 cfm	0.0%	20.8%	H. Jones
11/9/09	98,000 cfm	0.0%	20.8%	H. Jones
11/16/09	99,866 cfm	0.0%	20.8%	H. Jones
11/23/09	90,000 cfm	0.0%	20.8%	M. McNeil

TG EP 3

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	69,895 cfm	0.1%	20.8%	H. Jones
11/9/09	68,700 cfm	0.2%	20.8%	H. Jones
11/16/09	69,398 cfm	0.2%	20.8%	H. Jones
11/23/09	73,220 cfm	0.2%	20.8%	M. McNeil

TG EP 4

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	92,400 cfm	0.2%	20.8%	H. Jones
11/9/09	73,900 cfm	0.2%	20.6%	H. Jones
11/16/09	89,500 cfm	0.2%	20.8%	H. Jones
11/23/09	91,000 cfm	0.3%	20.8%	M. McNeil

TG EP 5

Date	Air Quantity	Methane	Oxygen	Examiner
11/2/09	116,650 cfm	0.5%	20.6%	H. Jones
11/9/09	114,840 cfm	0.5%	20.7%	H. Jones
11/16/09	116,140 cfm	0.5%	20.7%	H. Jones
11/23/09	115,950 cfm	0.5%	20.8%	M. McNeil

Evaluation Points (EPs), ventilation controls, and airflow directions indicated in interview statements and as observed by MSHA investigators after the accident conflicted with some of those shown on Map 2 – Southwest A Ventilation During Recovery, the most recent submitted and approved ventilation plan supplement.

The depicted ventilation controls and airflow directions were based on those observed and interview statements of mine personnel, including one of the mine examiners who conducted the examinations at the EPs.

Detail 2B – Results of recorded daily examinations performed at the Southwest A Longwall Headgate and Tailgate EPs located near the longwall face while the longwall face was ventilated from Tailgate to Headgate.

Overview Not to Scale

0 100 200 300 400 500
Scale, feet
(Detail Maps Only)

Notes: Stoppings at Crosscuts 38, 39, and 40 in the Southwest A Longwall Tailgate were depicted with holes based on statements of interviewed mine personnel.

Interview statements indicated curtains had been placed over permanent ventilation controls located between Entry No. 2 and Entry No. 3 of the Southwest A Longwall Tailgate bleeder prior to the date of the accident as a means to reduce leakage. On November 23, 2009, it was observed that some stoppings were intact, but that most of the stoppings had curtains over them. Although numerous curtains were observed on November 30, 2009, by MSHA investigators, it could not be determined which, if any, of those observed had been installed during the rescue and recovery operations. Further, miners who had worked and traveled in the bleeder were not able to identify specific locations where they had been installed. Because the exact locations of these curtains was not able to be determined, they were not depicted in this appendix as being in place before the time of the accident.

Additional curtains, hung across the No. 4 Entry in Southwest A Longwall Tailgate to direct more airflow into the No. 3 Entry, were reportedly installed at locations including near Crosscut 26 and Crosscut 28. Because the exact location of these controls was not able to be determined, they were not depicted in this appendix as being in place before the time of the accident.

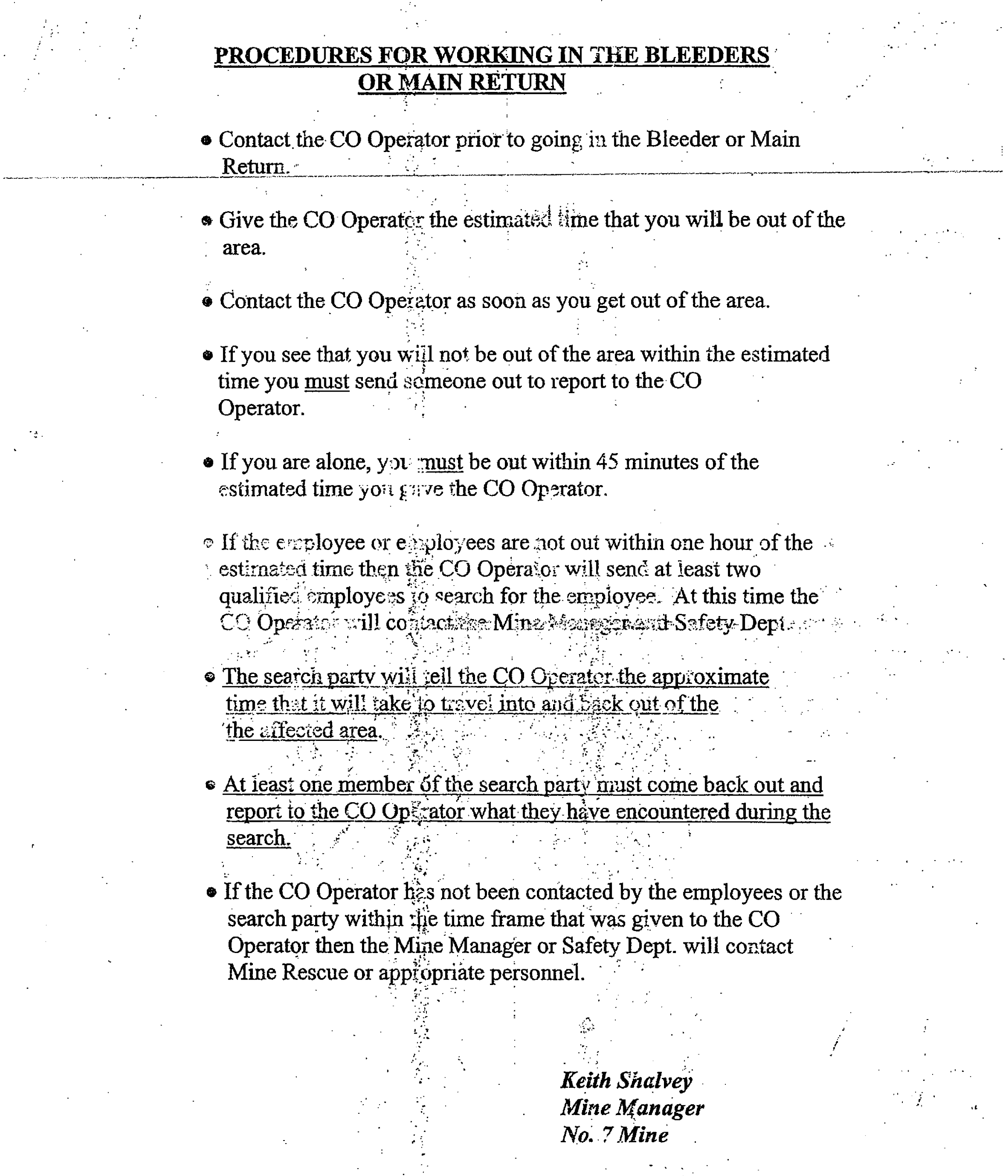
APPENDIX I
MINE MAPS
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Southwest A Longwall Bleeder System and Surrounding Area
Detail Maps Highlighting Bleeder System Examination Records

LEGEND

🟡 Moving EP	Moving EP (weekly examination location established November 16, 2009)	←	intake airflow
● Moving EP	Moving EP (weekly examination location prior to being moved on November 16, 2009)	←	return airflow
○ HG EP 1	Headgate and Tailgate (TG) daily examination locations	←	belt airflow
15 XC	crosscut number	═	stopping
▬	seal	═	stopping with personnel door
		R	regulator
		∫	curtain

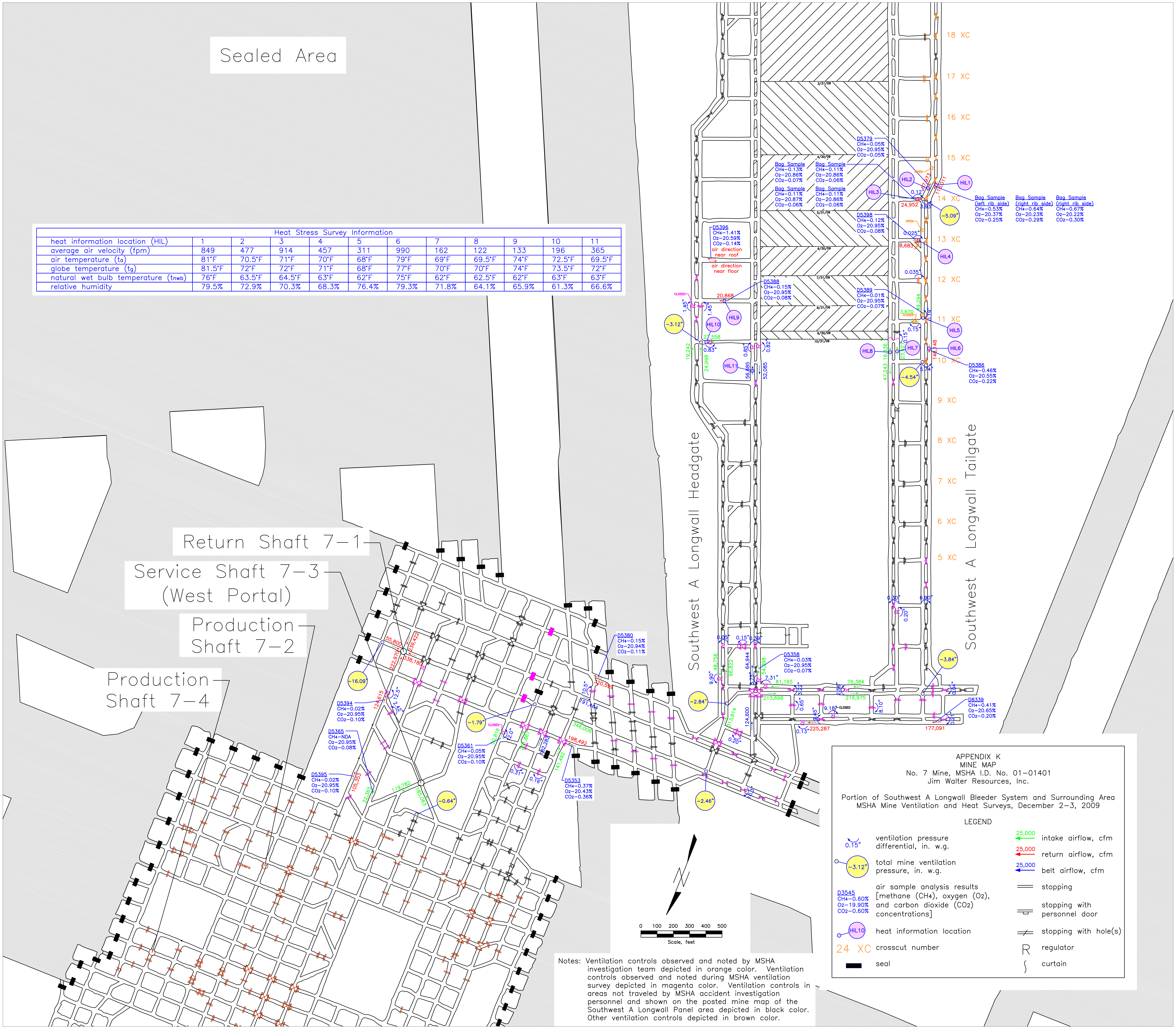
Appendix J – Procedures for Working in the Bleeders or Main Return



PROCEDURES FOR WORKING IN THE BLEEDERS OR MAIN RETURN

- Contact the CO Operator prior to going in the Bleeder or Main Return.
- Give the CO Operator the estimated time that you will be out of the area.
- Contact the CO Operator as soon as you get out of the area.
- If you see that you will not be out of the area within the estimated time you <u>must</u> send someone out to report to the CO Operator.
- If you are alone, you <u>must</u> be out within 45 minutes of the estimated time you gave the CO Operator.
- If the employee or employees are not out within one hour of the estimated time then the CO Operator will send at least two qualified employees to search for the employee. At this time the CO Operator will contact the Mine Manager and Safety Dept.
- <u>The search party will tell the CO Operator the approximate time that it will take to travel into and back out of the the affected area.</u>
- <u>At least one member of the search party must come back out and report to the CO Operator what they have encountered during the search.</u>
- If the CO Operator has not been contacted by the employees or the search party within the time frame that was given to the CO Operator then the Mine Manager or Safety Dept. will contact Mine Rescue or appropriate personnel.

Keith Shalvey
Mine Manager
No. 7 Mine



Heat Stress Survey Information											
heat information location (HIL)	1	2	3	4	5	6	7	8	9	10	11
average air velocity (fpm)	849	477	914	457	311	990	162	122	133	196	365
air temperature (t_a)	81°F	70.5°F	71°F	70°F	68°F	79°F	69°F	69.5°F	74°F	72.5°F	69.5°F
globe temperature (t_g)	81.5°F	72°F	72°F	71°F	68°F	77°F	70°F	70°F	74°F	73.5°F	72°F
natural wet bulb temperature (t_{nwb})	76°F	63.5°F	64.5°F	63°F	62°F	75°F	62°F	62.5°F	62°F	63°F	63°F
relative humidity	79.5%	72.9%	70.3%	68.3%	76.4%	79.3%	71.8%	64.1%	65.9%	61.3%	66.6%

APPENDIX K
MINE MAP
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Portion of Southwest A Longwall Bleeder System and Surrounding Area
MSHA Mine Ventilation and Heat Surveys, December 2–3, 2009

LEGEND

0.15"	ventilation pressure differential, in. w.g.	25,000	intake airflow, cfm
-3.12"	total mine ventilation pressure, in. w.g.	25,000	return airflow, cfm
D3545 CH4–0.60% O2–19.90% CO2–0.60%	air sample analysis results [methane (CH4), oxygen (O2), and carbon dioxide (CO2) concentrations]	25,000	belt airflow, cfm
HIL10	heat information location	═	stopping
24 XC	crosscut number	╤	stopping with personnel door
▬	seal	≠	stopping with hole(s)
		R	regulator
		∫	curtain

Notes: Ventilation controls observed and noted by MSHA investigation team depicted in orange color. Ventilation controls observed and noted during MSHA ventilation survey depicted in magenta color. Ventilation controls in areas not traveled by MSHA accident investigation personnel and shown on the posted mine map of the Southwest A Longwall Panel area depicted in black color. Other ventilation controls depicted in brown color.

Appendix L – Summary of Handheld Multi-gas Detector Testing Results

The Mine Safety and Health Administration, Technical Support, Approval and Certification Center (A&CC) conducted a laboratory investigation associated with three Mine Safety Appliances Company (MSA) Model Solaris Multi-Gas Detectors recovered from a fatal mine accident at the Jim Walter Resources Inc No. 7 Mine on November 23, 2009.

The investigation began with a preliminary inspection of all the evidence received. The preliminary inspection included documenting visual observations, and photographing.

The data stored in the MSA Solaris detectors identified as MSA#11, MSA#20 and MSA#64 was extracted. The MSA Solaris detectors with identified as MSA#11 and MSA#64 were subjected to methane, oxygen, and carbon monoxide accuracy testing in various temperature and humidity conditions.

The last phase of the investigation included a detailed inspection of the gas detectors.

It was concluded that:

1. In general, the MSA#11 Solaris responded to methane and oxygen within the allowable limits of error specified in 30 CFR.
2. The MSA#11 did not respond with MSA's specifications for accuracy for carbon monoxide.
3. No conclusion can be made regarding the oxygen performance of the MSA#64 Solaris.
4. The methane performance of the MSA#64 Solaris was significantly affected by humidity when tested. In low humidity, it gave low methane readings; in high humidity, it gave slightly high readings.
5. The MSA#64 Solaris met MSA's specification for carbon monoxide accuracy.
6. Neither MSA#11 nor MSA#64 Solaris seemed to be affected by changes in ambient temperature between 23 and 35 °C.

7. The temperature recorded by the MSA#11 and MSA#64 Solaris units was consistent with their measured internal temperature. However, the internal temperature did not stabilize for 2 hours, regardless of ambient temperature. There appeared to be no effects on the recorded temperature due to human body temperature.

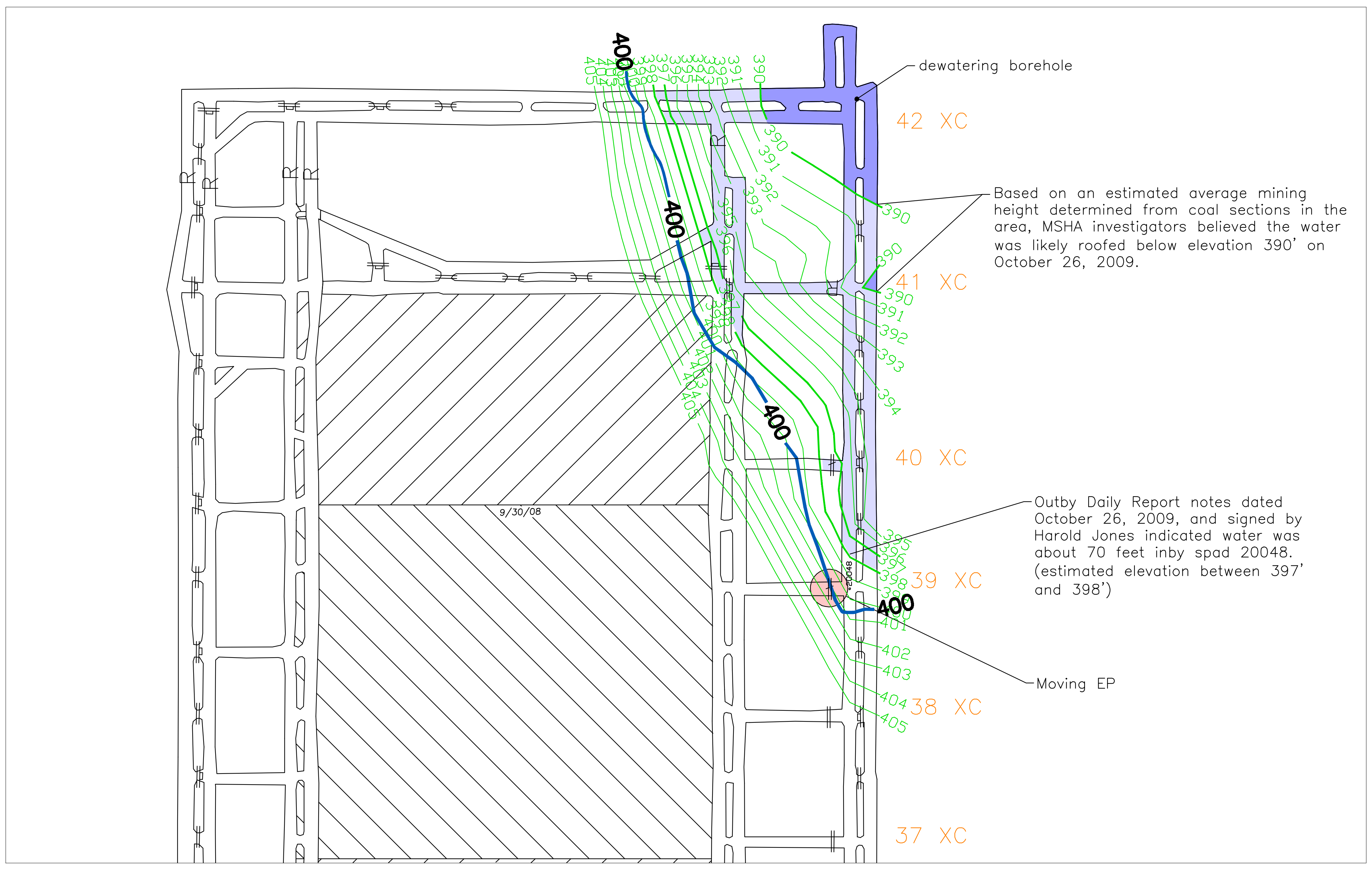
8. There were no unexpected effects on the performance of either MSA#11 or MSA#64 due to changes in barometric pressure.

9. The data extracted from the memory of the MSA#11 and MSA#64 Solaris units was undamaged. However, the data extracted from the MSA#20 Solaris was incomplete; therefore an accurate determination concerning actual time and date could not be adequately correlated with recorded data.

10. The user cannot start or stop datalogging in the MSA Solaris during normal use conditions .

11. After comparing the detectors to documentation on file at the A&CC, some discrepancies between the detectors and approval documentation were found. None of the discrepancies were considered significant. These discrepancies would not have affected the performance or permissibility of the detectors.

Comprehensive test results are contained in the U.S. Department of Labor Mine Safety and Health Administration Technical Support Investigative Report PAR 97674

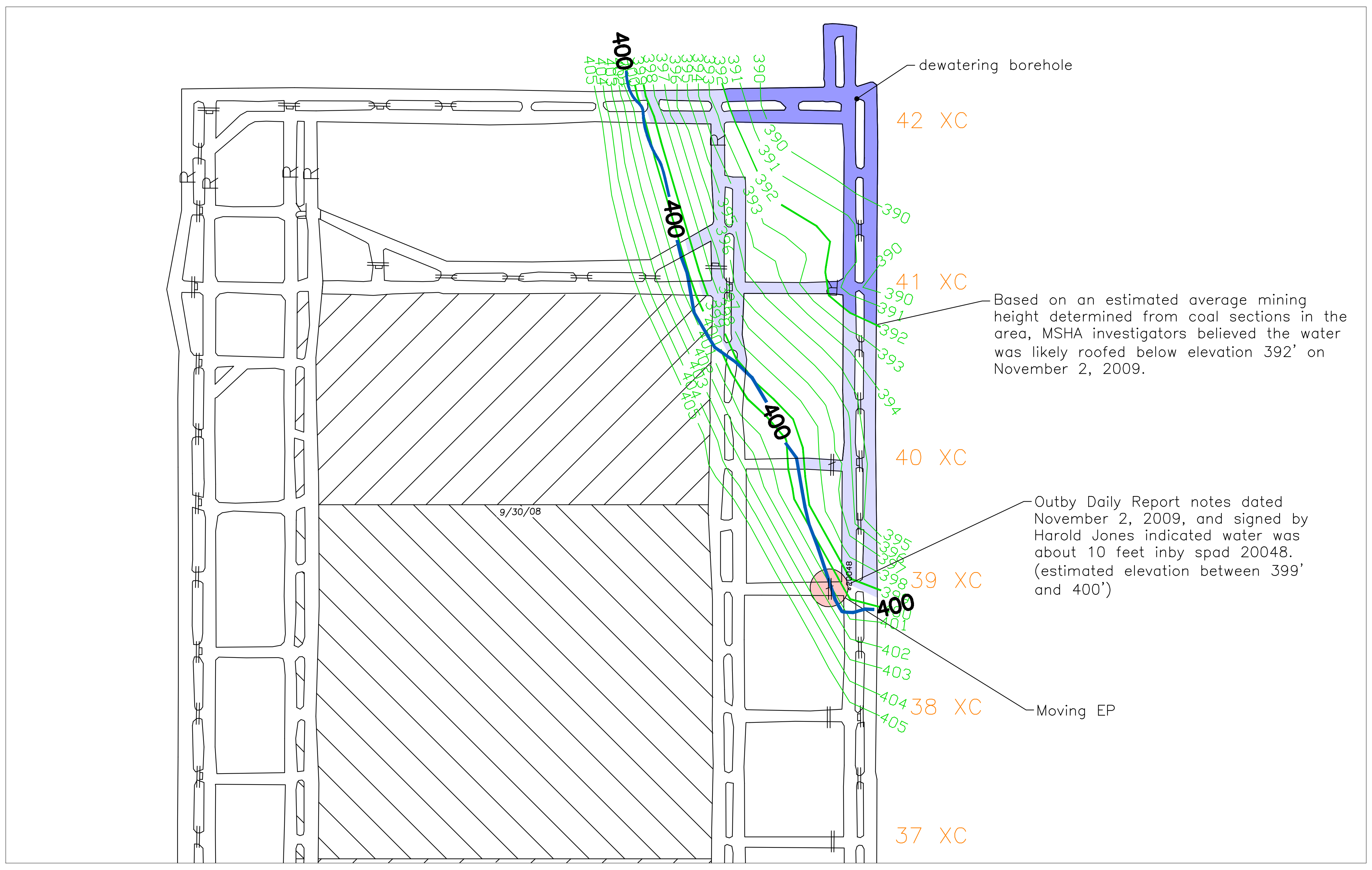


Based on an estimated average mining height determined from coal sections in the area, MSHA investigators believed the water was likely roofed below elevation 390' on October 26, 2009.

Outby Daily Report notes dated October 26, 2009, and signed by Harold Jones indicated water was about 70 feet inby spad 20048. (estimated elevation between 397' and 398')

Moving EP

Detail Map 1 – October 26, 2009

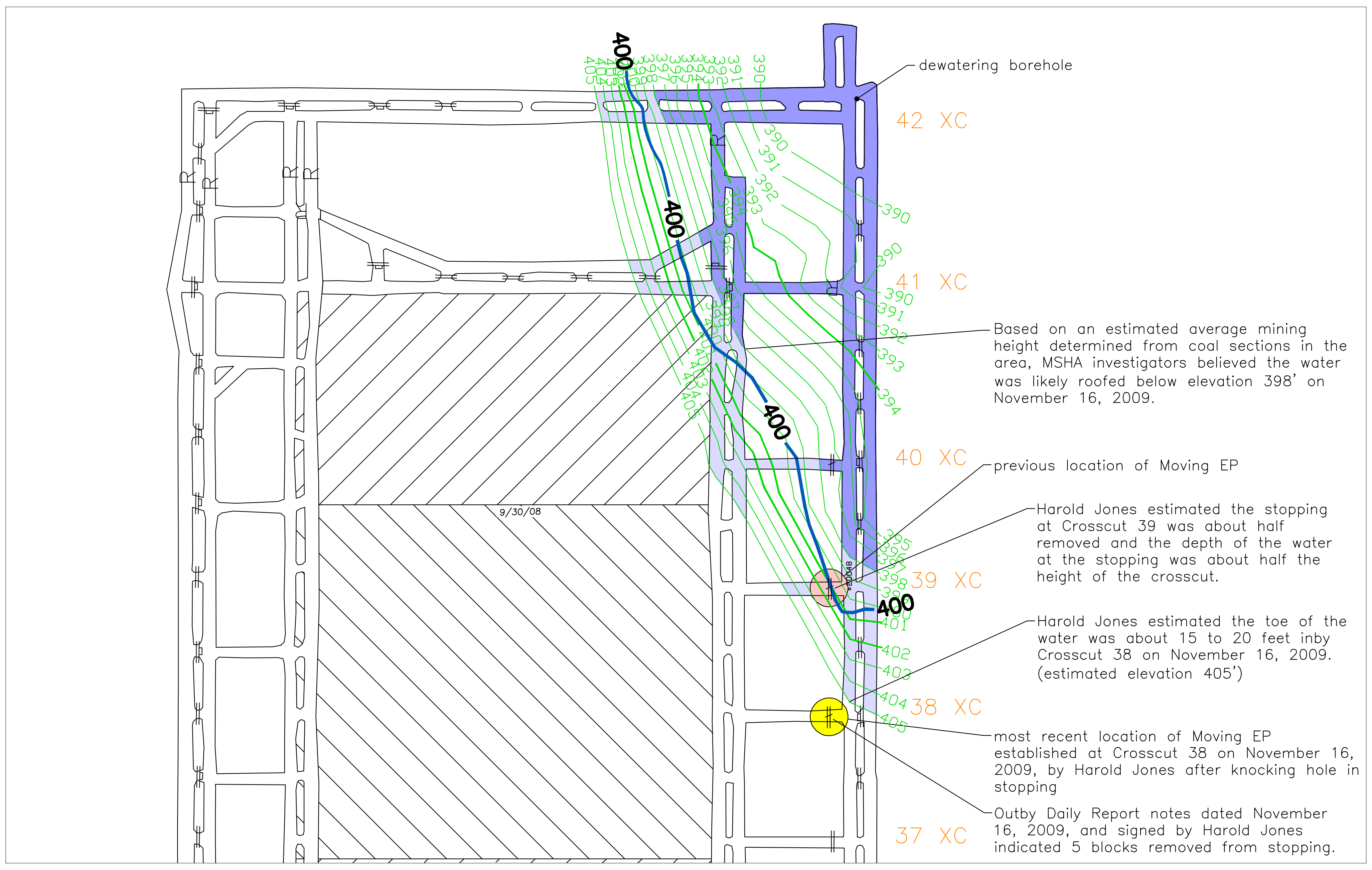


Based on an estimated average mining height determined from coal sections in the area, MSHA investigators believed the water was likely roofed below elevation 392' on November 2, 2009.

Outby Daily Report notes dated November 2, 2009, and signed by Harold Jones indicated water was about 10 feet inby spad 20048. (estimated elevation between 399' and 400')

Moving EP

Detail Map 2 – November 2, 2009



Based on an estimated average mining height determined from coal sections in the area, MSHA investigators believed the water was likely roofed below elevation 398' on November 16, 2009.

previous location of Moving EP

Harold Jones estimated the stopping at Crosscut 39 was about half removed and the depth of the water at the stopping was about half the height of the crosscut.

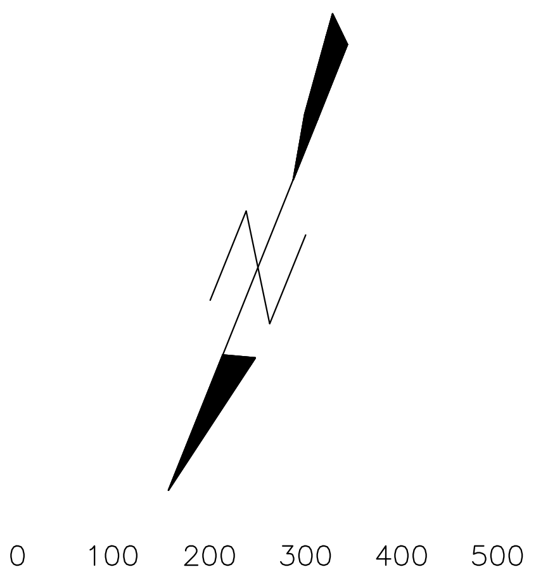
Harold Jones estimated the toe of the water was about 15 to 20 feet inby Crosscut 38 on November 16, 2009. (estimated elevation 405')

most recent location of Moving EP established at Crosscut 38 on November 16, 2009, by Harold Jones after knocking hole in stopping

Outby Daily Report notes dated November 16, 2009, and signed by Harold Jones indicated 5 blocks removed from stopping.

Detail Map 3 – November 16, 2009

Overview Not to Scale



Scale, feet
(Detail Maps Only)

Notes: Ventilation controls as shown on the posted mine map of the Southwest A Longwall Panel area with holes in stoppings at Crosscuts 38, 39, and 40 based on statements of interviewed mine personnel.

Estimated one foot coal bottom contour lines were derived from elevations depicted on mine maps in the Southwest A Longwall Panel headgate, tailgate and connecting bleeder entries.

Location of toe of water was last observed by Harold Jones on November 16, 2009.

Bottom elevation contours are offset by 2000 feet. (i.e. actual bottom contour elevation of 1600 feet below sea level [–1600] depicted as 400 feet above sea level [400].)

APPENDIX M
MINE MAPS
No. 7 Mine, MSHA I.D. No. 01–01401
Jim Walter Resources, Inc.

Inby End of Southwest A Longwall Bleeder System
Detail Maps Highlighting Estimated Water Levels in Bleeder

LEGEND

—400—	bottom elevation contour line from mine map
—400—	estimated bottom elevation contour line
═	stopping
╤	stopping with personnel door
≠	stopping with hole(s)
R	regulator
37 XC	crosscut number
+20048	spad number
▬	estimated area where water roofed
▭	estimated area of additional accumulated water

Appendix N – Geothermal and Core Rock Temperature Analysis

Jim Walter Resources, Inc., No. 7 Mine Geological Evaluation

The following discussion is offered in response to the possibility that geologic factors or in-situ rock temperature could have contributed to high heat conditions reported for the Southwest A Longwall Panel bleeder system, inby the longwall face. The discussion focuses primarily on two issues:

1. Geologic structure as a potential for heat transfer.
2. An estimation of in-situ rock temperatures.

Geologic structure was evaluated during a traverse of the Southwest A Longwall Panel gateroad development and information pertaining to in-situ rock temperature was derived from Black Warrior Basin energy literature and discussions with Geologic Survey of Alabama personnel.

Geologic Structure

The Southwest A Longwall Panel extends southeastward to within 1.7 miles of the point where the seam outcrops on the northwest limb of the Blue Creek anticline. Although strata in the reserves generally have a shallow dip, the seam gains approximately 1700 feet in elevation over the 1.7 mile interval. The compressional tectonic forces that produced this regional-scale fold at the basin margin have also produced structural features in the mine. The structural features observed during the traverse of Southwest A Longwall Panel gateroads included normal faults, joints, drag folds, and angled fractures.

<u>Normal faults</u>

Southwest A Longwall Panel is oriented northwest-southeast and is bounded and bisected longitudinally by faults oriented parallel with the panel. These structures are common in the southeast portion of the Black Warrior Basin, are interpreted as normal faults, and tend to be roughly perpendicular to thrust direction. Four faults are identified on mine maps. The location of the Warrior Basin is depicted in Figure 1. The fault that bounds the tailgate development on the southwest side of the panel has as much as 210 feet of displacement towards the inby portion of the panel. Displacement decreases to less than 30 feet outby. This fault was not accessible. Displacement for the fault (also not accessible) that bounds the headgate development on the northeast side ranges from 0 to at least 100 feet. Two faults, 130 feet apart cut the panel on the northeast side; however, only one of them extends outby the panel. Exposure of this fault occurred in the entries that connect the headgate and tailgate of the Southwest A Longwall Panel. At this location, the fault was vertical, planer, one to five inches wide and showed approximately four feet of displacement, southwest side down. Thin, less distinct parallel structures were visible on either side of the main fault in a zone 8 to 10 feet wide. There was no groundwater inflow or significant ground control problems associated with the fault zone where it is exposed in the submains. The characteristics of the fault inby the longwall face could not be determined. Nearly all faults have the potential to act as conduits for fluids and gases but the fault characteristics observed in the submains do not suggest that this particular fault could serve as a source of geothermal heat transfer into the mine. Furthermore, the orientation of this fault system is roughly perpendicular to the local direction of maximum horizontal stress, a factor that may inhibit fluid or gas migration.

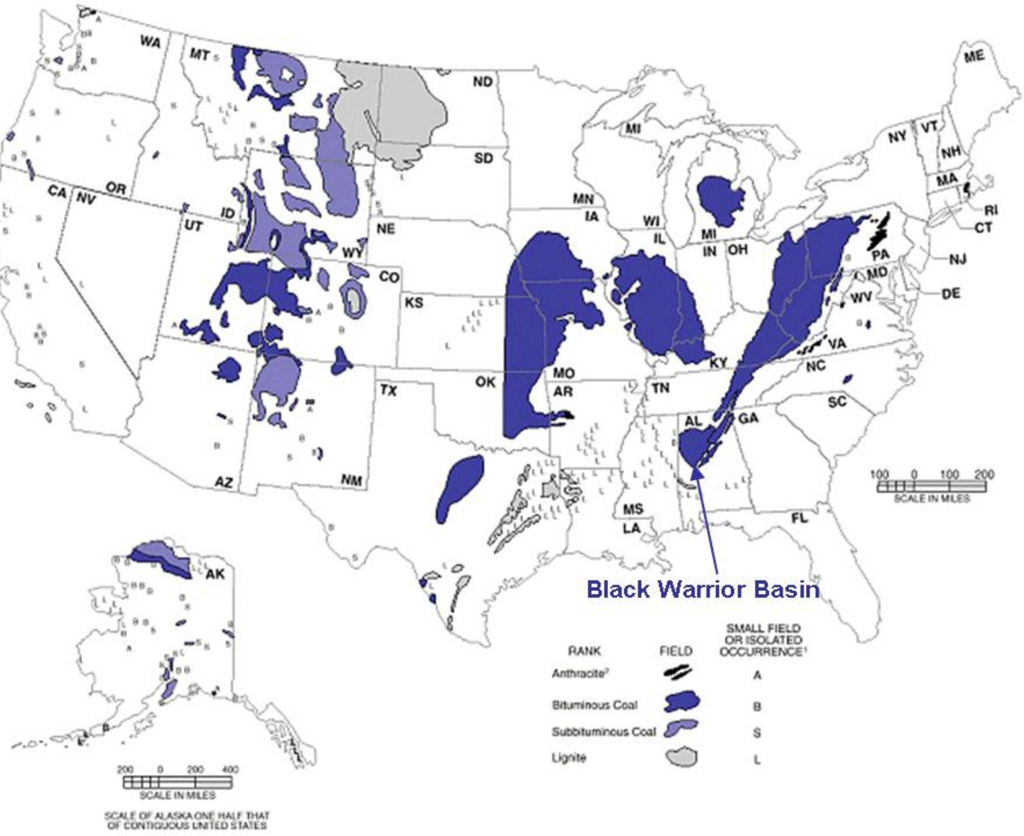


Figure 1. Map of United States coal basins with the Black Warrior basin in northern Alabama labeled.

Drag folds

Systematically occurring drag folds with amplitudes of less than two feet were common in development entries and crosscuts. Orientation of the fold axes ranged from N20°E to N60°E, roughly parallel with the thrust front and the basin margin. The upper boundary of the folds, which were typically exposed by wedge failures, was smooth to moderately slickensided. These features are common throughout U.S. coal basins and are particularly common near zones of tectonic deformation such as thrust fronts. The low amplitude of the drag folds observed in the Southwest A Longwall Panel gateroads indicates that these features extend only a few feet beyond the mine horizon.

Joints

The dominant joint set observed in the Southwest A Longwall Panel gateroads ranged in orientation from N50°W to east-west but more commonly from N60°W to N70°W. This orientation is typical in the eastern portion of the Black Warrior Basin (Figure 2). Jointing was typically tight, planer and vertical. Joints were most easily observed in the roof where minor raveling or slaking exposed the joint plane. Because of the tightness of the joints and heavy coatings of rock dust on the roof, an accurate assessment of joint spacing was not possible. While it appears that spacing is on the order of several feet, localized areas exhibited tighter spacing. In an exposure of the immediate roof in a shallow failure between Crosscut 12 and Crosscut 13 in the tailgate Entry No. 2, joint spacing was less than one foot. Although areas of increased joint density may induce localized ground failures, there does not appear to be any correlation between jointing and heat flow.

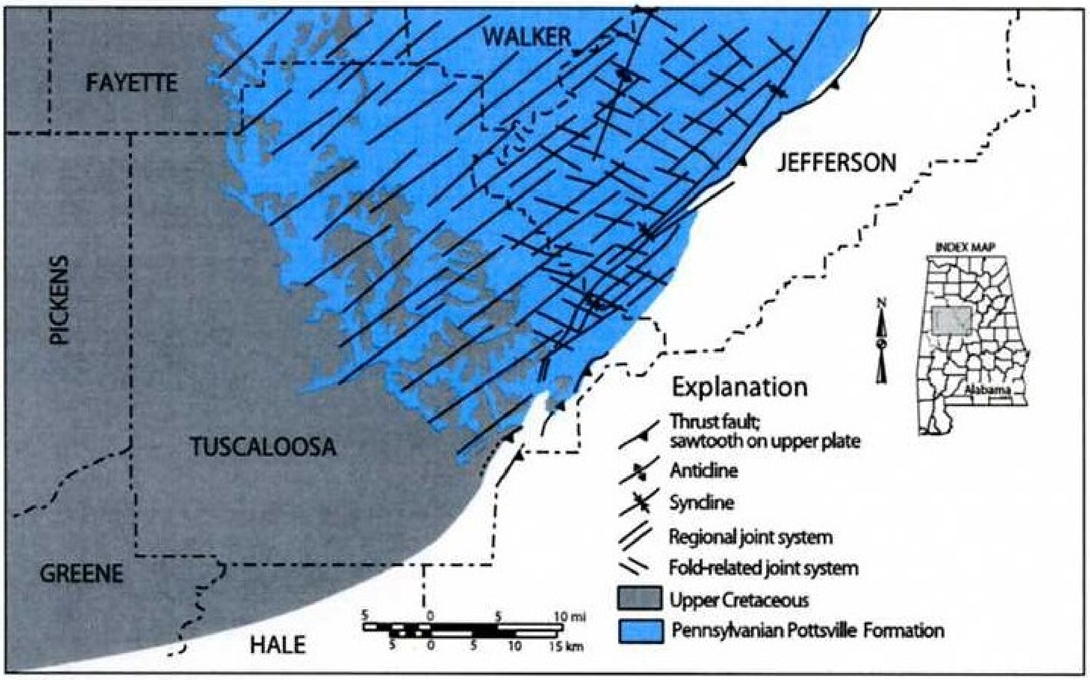


Figure 2. Generalized map of joint systems in the southeastern Black Warrior Basin. (Hatch and Pawlewcz, 2007)

Angled fractures

Angled fractures were common in the roof throughout the Southwest A Longwall Panel gateroads. These structures tend to be prevalent on the limbs of synclines/anticlines and result from compressional tectonic forces. The fractures intersected the mine horizon on roughly 45° angles and were most easily observed where wedge shaped slabs beneath the fractures became detached from the roof, causing the fractures to dilate. Angled fractures tended to be truncated by prominent bedding planes, especially at transitions in rock type. Individual fractures tended not to extend beyond the mining horizon for any appreciable distance. It is likely that fracturing also occurs in the floor, but was masked by muck and rock dust.

In-situ Rock Temperatures

Mine management and technical personnel at the Jim Walter Resources, Inc., No. 7 Mine have reported that ambient mine temperatures typically range from the low to mid 70s (° F). Ambient temperature, however, typically refers to the rock-air interface and is affected by the temperature and flux of intake air. An approximation of in-situ rock temperatures in the vicinity of the mining horizon can be determined by several methods that utilize data from gas wells and geothermal gradient maps.

The first method simply consists of a direct examination of general temperature-depth data. Figure 3 plots temperatures recorded in the bottom of gas wells with respect to depth within the Pottsville formation throughout the Black Warrior Basin. Temperatures range from 80° to over 140°F for depths of 1000 to 6000 feet.

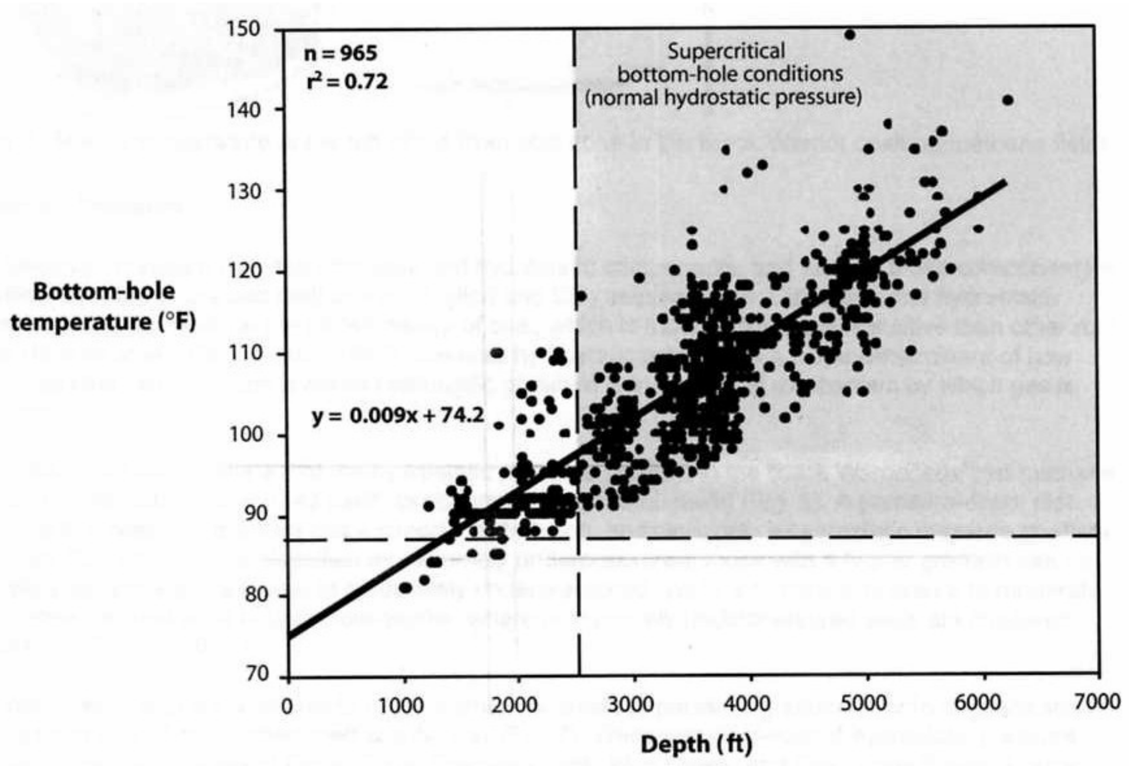


Figure 3. Temperature-depth plot for coalbed methane wells in the Black Warrior Basin (Pashin and McIntyre, 2003).

Although there is a significant degree of variation in the data (r^2=0.72), the temperature range for the approximate depth of the mining horizon (1700 ft) in the Jim Walter

Resources, Inc., No. 7 Mine is roughly 85°F to 95°F. The regression line intercept for a depth of 1700 feet indicates a temperature of 90°F. It should be noted that temperatures recorded in gas wells are typically considered minimum estimates: corrected borehole temperatures tend to be slightly higher than recorded temperatures (Jack Pashin, pers. comm.).

Another way to assess rock temperature in the Mary Lee coal zone is to consider the local geothermal gradient and temperature data from the Pratt coal zone, which is located roughly 900 feet above the Mary Lee zone. A temperature map of the Pratt coal zone (Figure 4), based on extensive gas exploration indicates that in the vicinity of the No. 7 Mine, estimated borehole temperatures at the top of the zone range from 80°F to 85°F. Corrected bore temperatures would be higher.

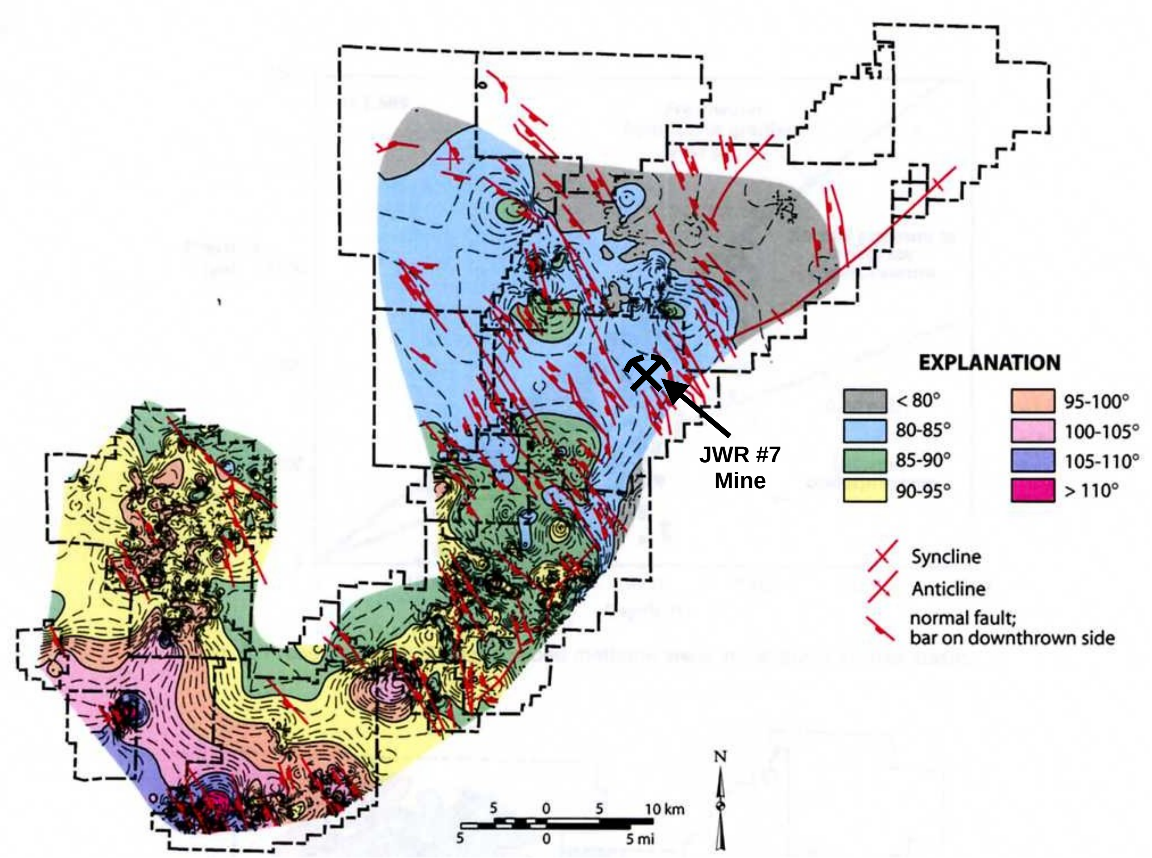


Figure 4. Temperature contour map for the top of the Pratt coal zone based on temperatures measured at the bottom of gas wells. Modified from Pashin and McIntyre (2003).

The geothermal gradient (Figure 5) in the area of the mine is 6-9°F/1000 feet. Using the geothermal gradient to extrapolate Pratt coal zone temperatures to the No. 7 Mine, 900 feet below, yields a temperature range of 85.4°F to 94.1°F. Again, temperatures would be expected to be higher after correction of the estimated borehole temperatures used.

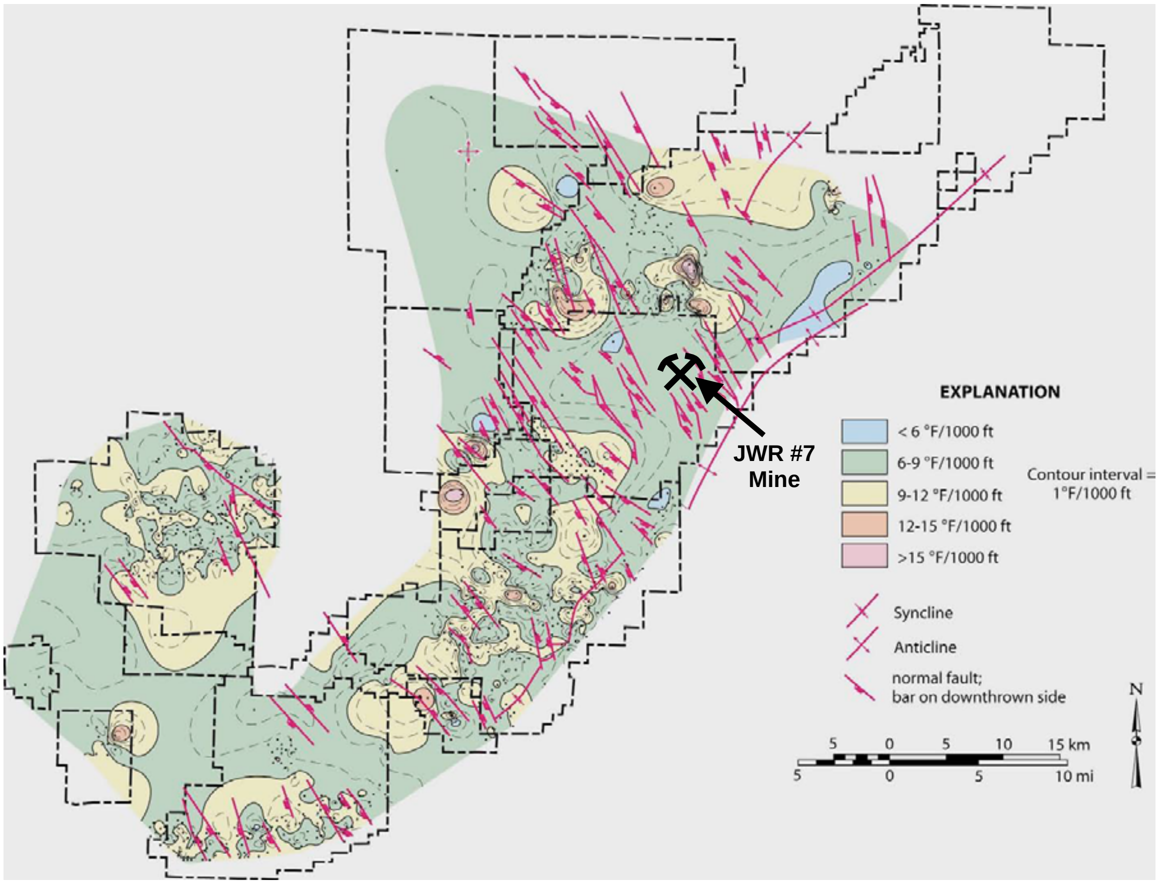


Figure 5. Geothermal gradient map for the southeast portion of the Black Warrior basin. Modified from Pashin and McIntyre, 2003.

A third method involves the examination of a few specific bore hole temperature measurements from gas wells in the vicinity, and at similar elevations, of the Southwest A Longwall Panel. Figure 6 shows the location of 57 boreholes, their bottom elevation, and estimated bottom temperature, derived form the Brookwood Borehole Temperature database maintained by the Geological survey of Alabama. The large cluster of gas wells located southwest of the mine was drilled significantly deeper than the mine horizon. However, five of the holes north and east of the No. 7 Mine (Shown in red on Figure 6.) were drilled to elevations between -1200 and –1700 feet, roughly equivalent to the Southwest A Longwall Panel (-1300 to -1600 ft). The temperature range for these holes is 82°F to 104°F with a mean of 91.4°F. Again, these temperatures would be minimum estimates. In-situ rock temperatures could be a few degrees higher. The range in temperatures is reflective of temperature variation in the rest of the wells, regardless of depth. There do not appear to be any discernible factors that control the variation of temperature in holes drilled in close proximity to each other. They often show a significant temperature difference. It is possible that some of the variance is due to differences in drilling fluid temperatures or the amount of time elapsed between drilling a hole and recording the temperature.

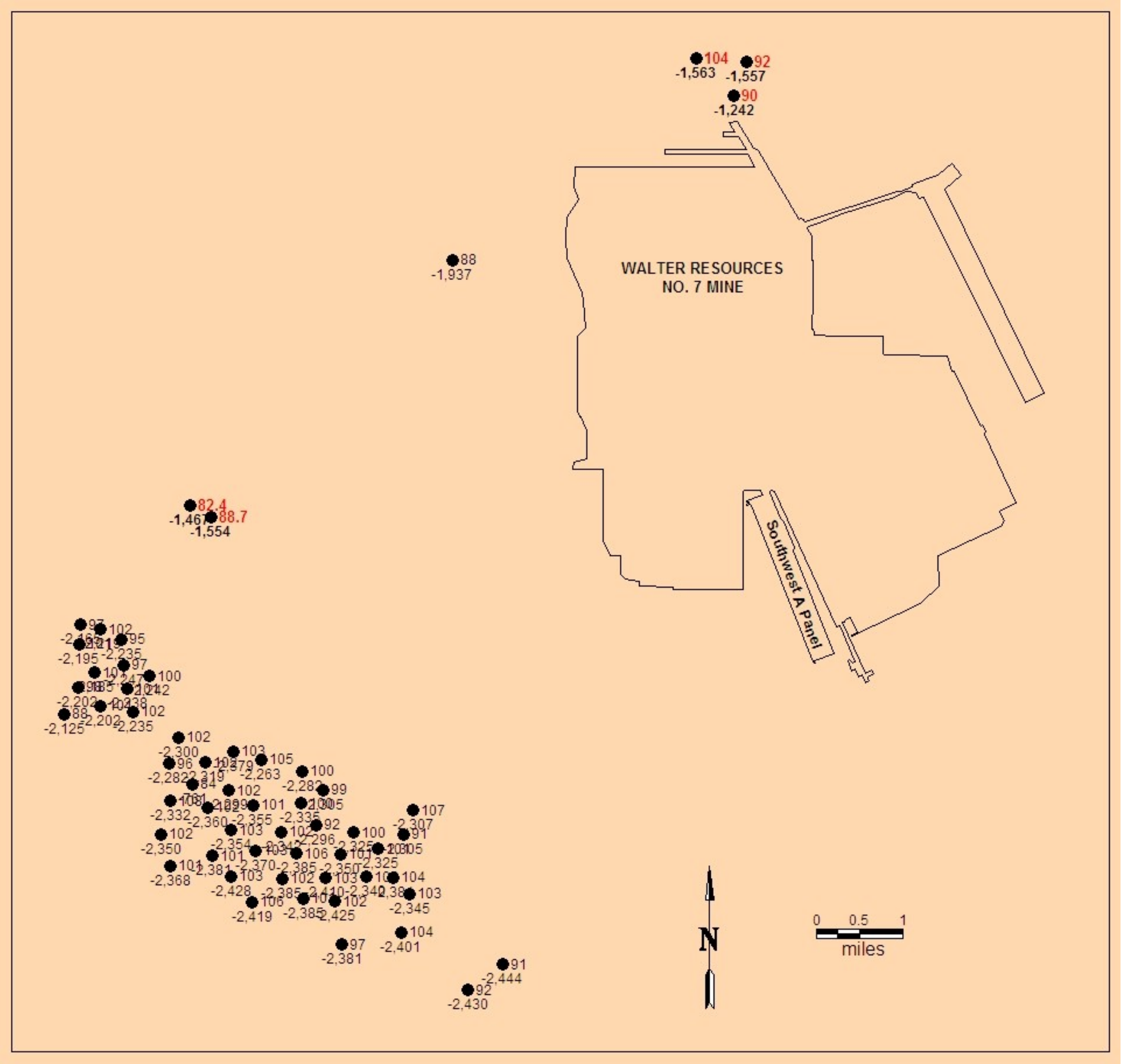


Figure 6. Gas well data from holes drilled near the Jim Walter Resources, Inc., No. 7 Mine. Black dots are hole locations. Temperatures (°F) are shown to the right of the hole location, and elevation (MSL) is shown below. Temperatures shown in red were recorded in holes drilled to approximately the same elevation as the Southwest A Longwall Panel.

Summary

The types of geologic structure observed in the Southwest A Longwall Panel, namely faults, joints, drag folds and angled fractures, are common features in many coal mines, especially those in proximity to zones of tectonic deformation. Observation of these structures in the gateroad development indicated that these features are unlikely to have facilitated geothermal heat transfer into the mine.

In the vicinity of the No. 7 Mine, temperatures from gas well data range from approximately 82°F to 104°F for depths roughly equivalent to the mine horizon. The actual in-situ rock temperatures tend to be slightly higher than those recorded in the boreholes. The reasons for the variance in temperature data could not be determined.

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