Virginia Department of Mines, Minerals & Energy
Division of Mines

Accident Investigation Report
Surface Coal Mine

Exploding Vessel Fatality Investigation Report
September 5, 2003

Twin Star Mining, Inc.
Lower Elk Creek Strip

Mine Index No. 14562AA
Buchanan County, Virginia

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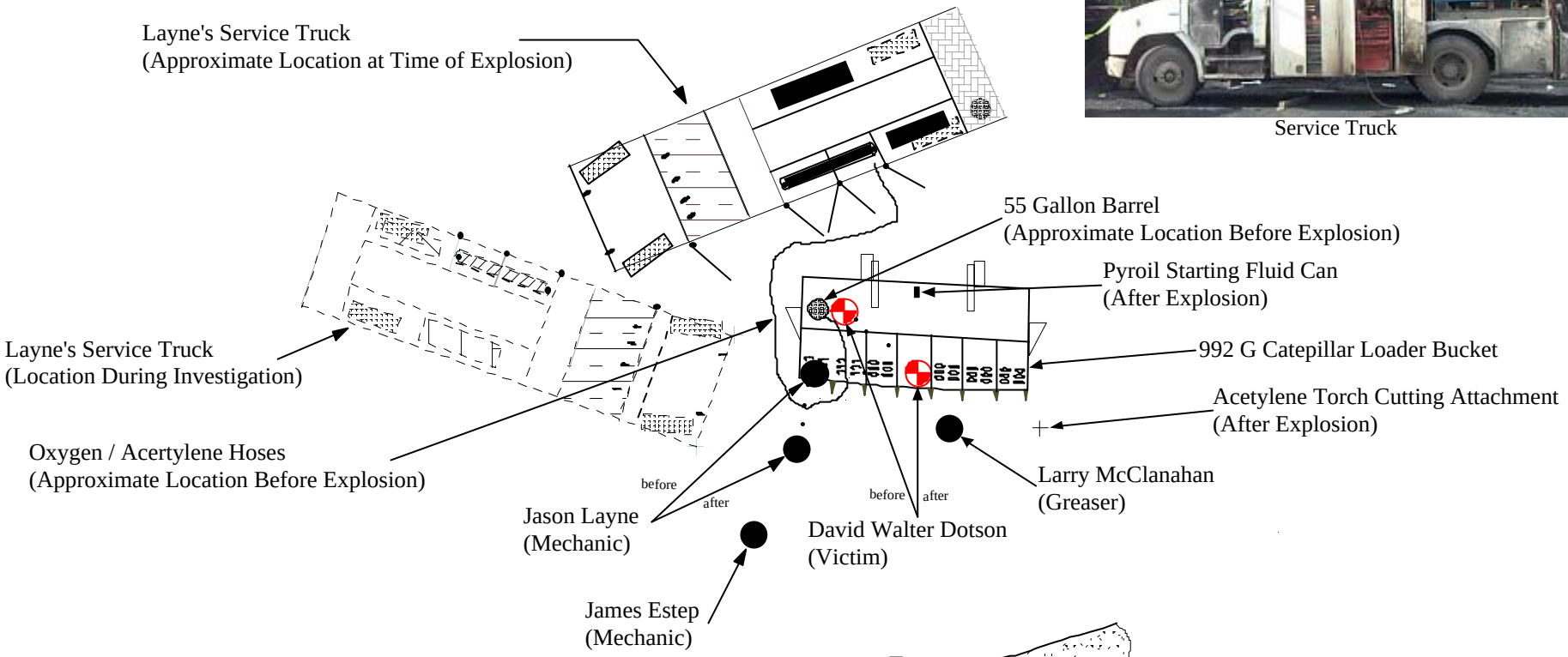
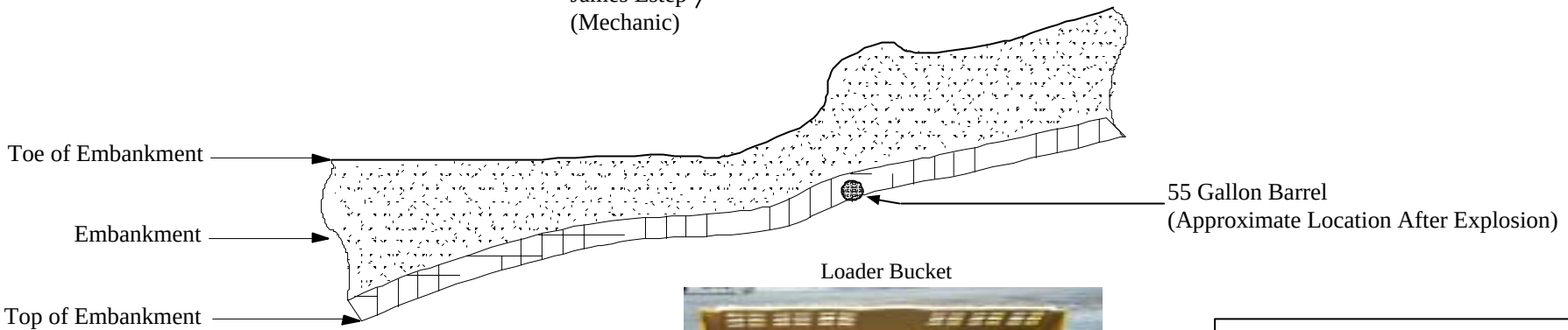
Service Truck

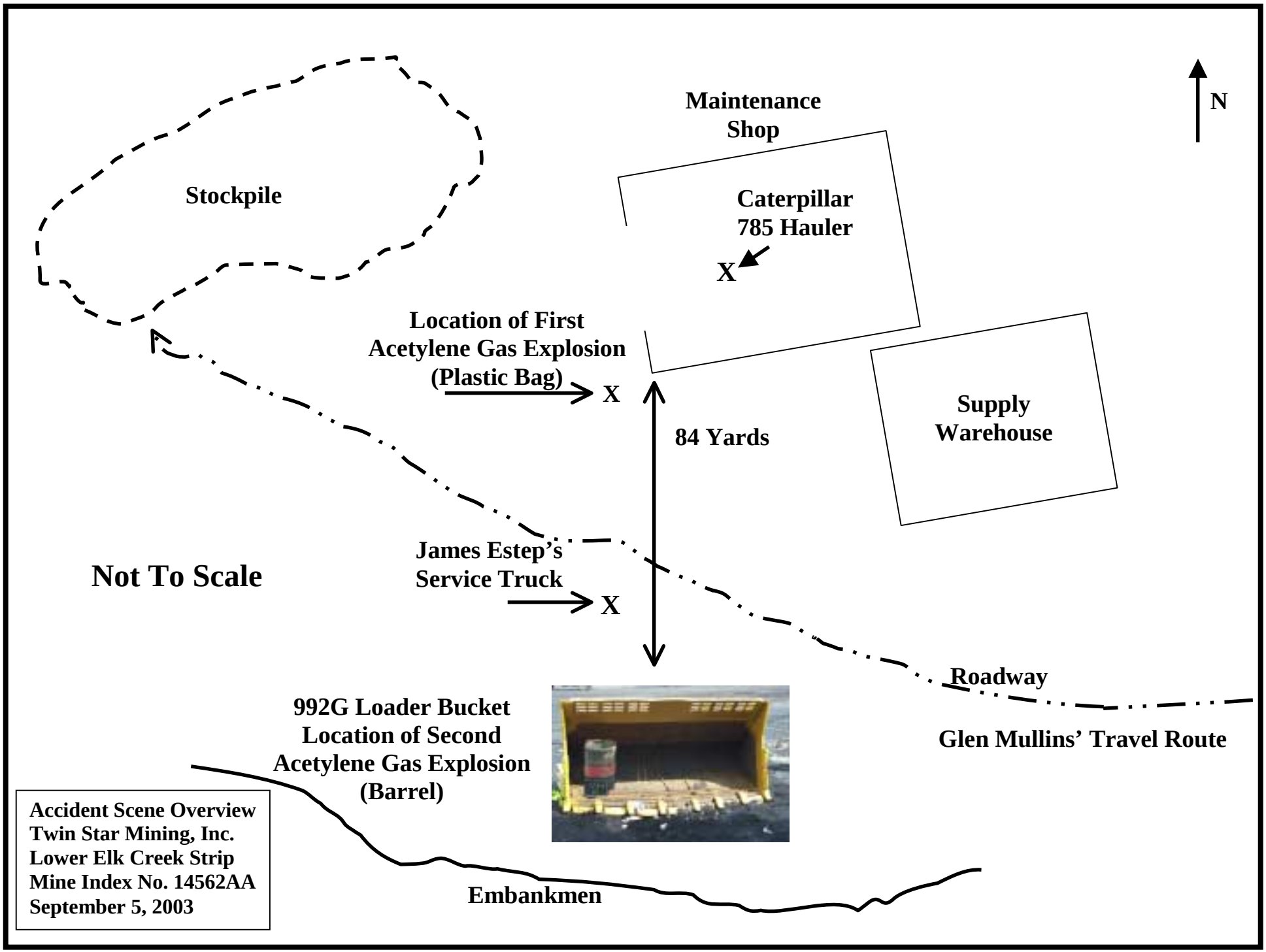




Loader Bucket

Scale 1" = 10'

Fatal Accident Scene
Twin Star Mining, Inc.
Lower Elk Creek Strip
Mine Index No. 14562 AA
September 5, 2003


Maintenance
Shop
N
Stockpile
Caterpillar
785 Hauler
X
Location of First
Acetylene Gas Explosion
(Plastic Bag)
X
84 Yards
Supply
Warehouse
Not To Scale
James Estep's
Service Truck
X
Roadway
992G Loader Bucket
Location of Second
Acetylene Gas Explosion
(Barrel)
Glen Mullins' Travel Route
Embankmen
Accident Scene Overview
Twin Star Mining, Inc.
Lower Elk Creek Strip
Mine Index No. 14562AA
September 5, 2003

Fatal Accident Scene
Twin Star Mining, Inc.
Lower Elk Creek Strip
M.I. No. 14562AA
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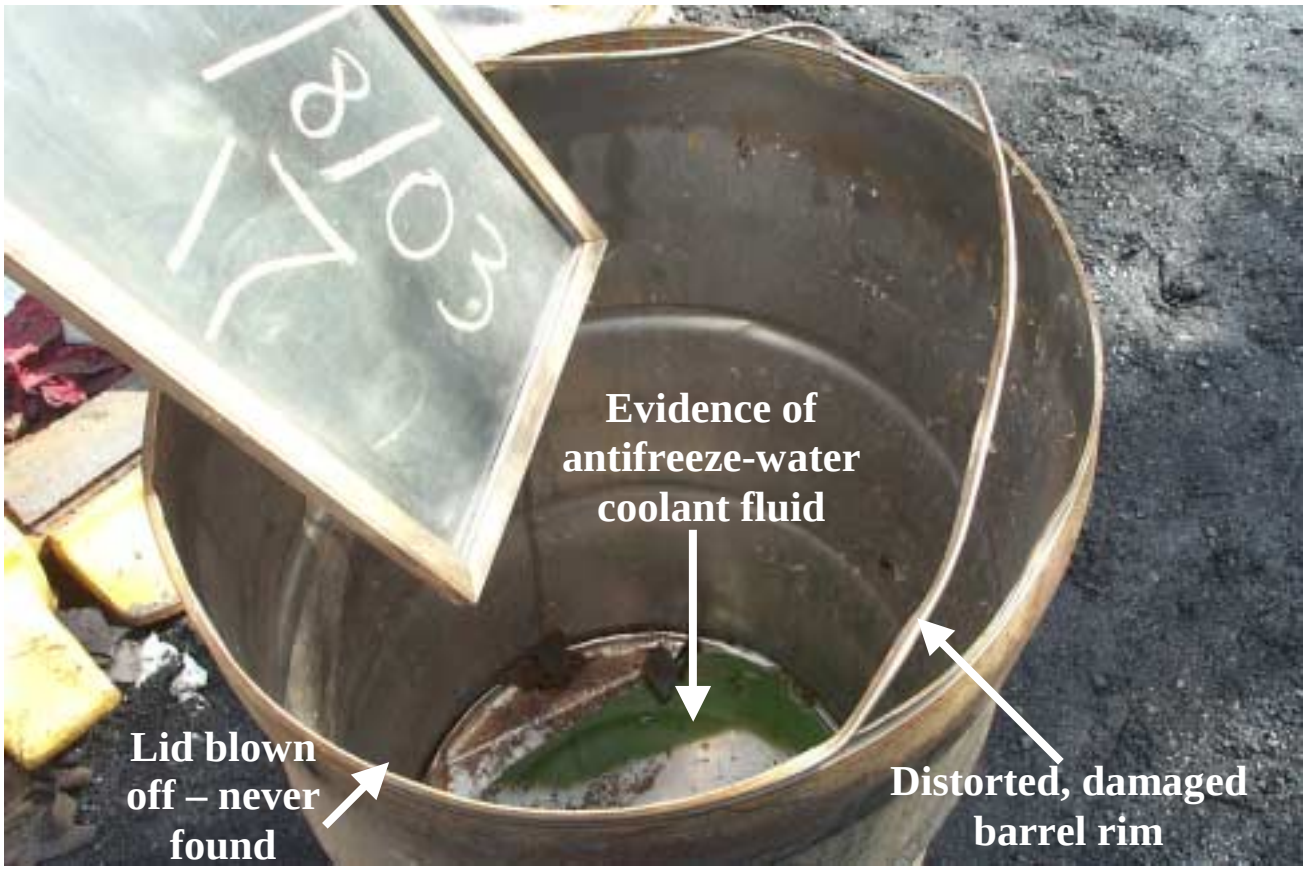

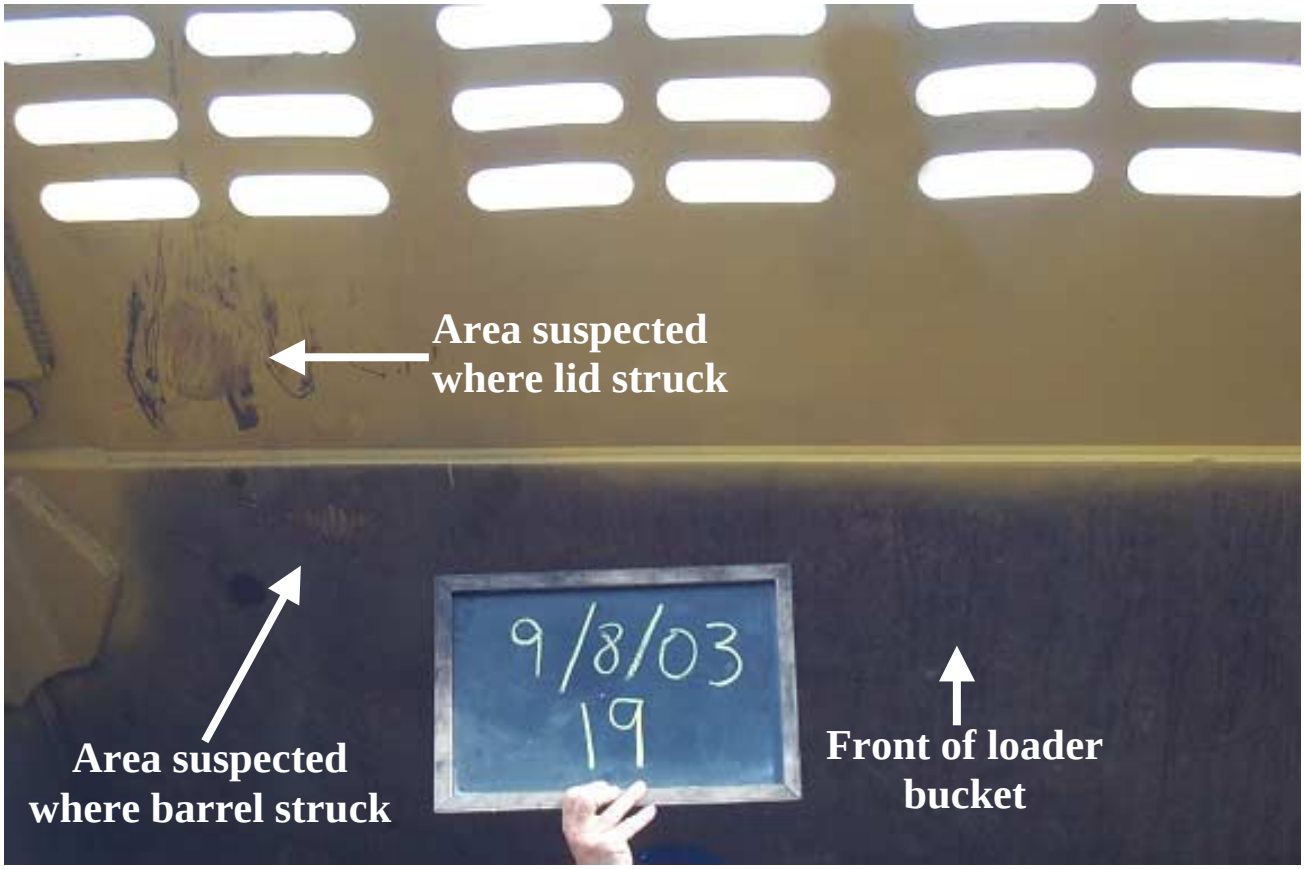

Fatal Accident Scene
Twin Star Mining, Inc.
Lower Elk Creek Strip
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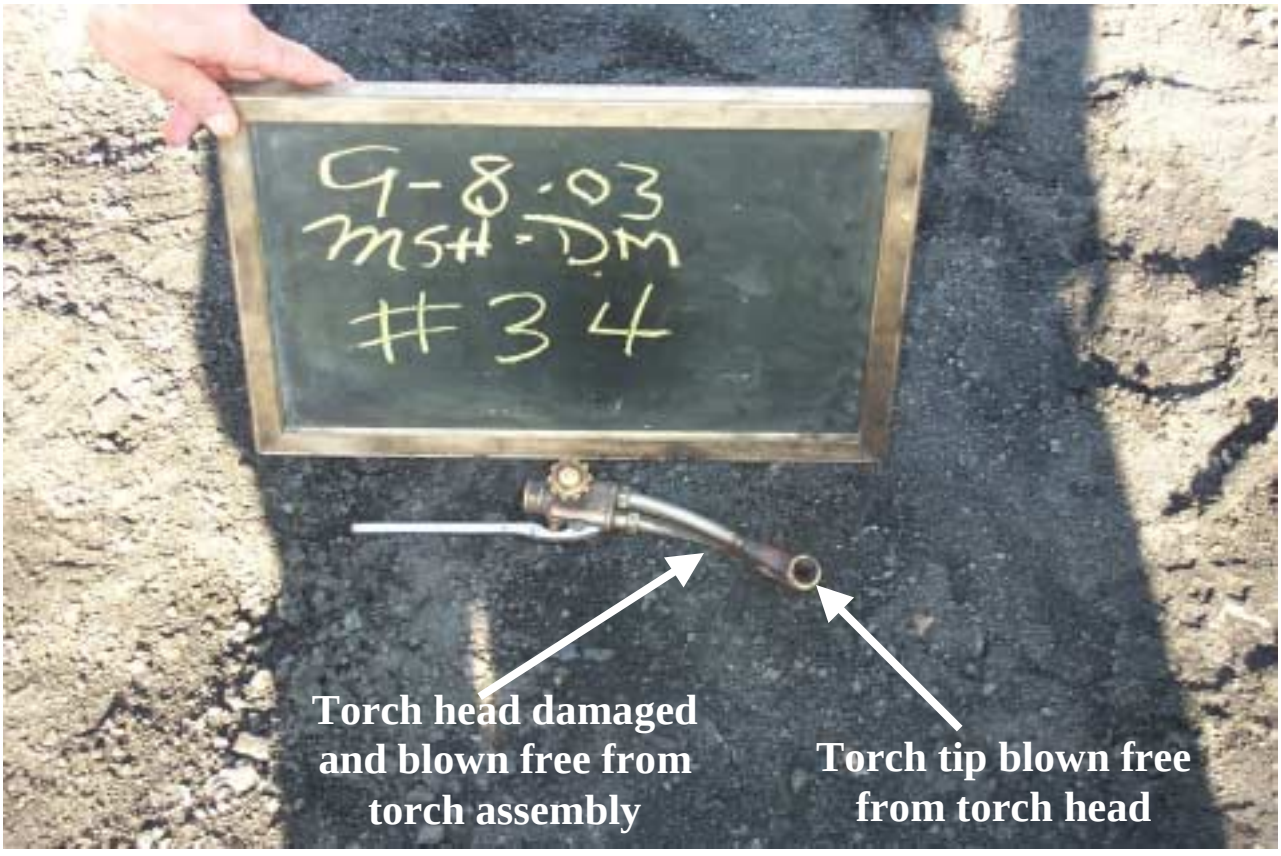
September 5, 2003



EXPLODING VESSEL FATALITY INVESTIGATION REPORT
TWIN STAR MINING, INC.
LOWER ELK CREEK STRIP
MINE INDEX 14562AA

On Friday, September 5, 2003, at approximately 8:45 p.m., a surface accident involving the explosion of an empty 55-gallon metal barrel occurred at the Twin Star Mining, Inc., Lower Elk Creek Strip, Mine Index No. 14562AA. David Walter Dotson, a utility man, was fatally injured when struck by flying debris and the force of a violent explosion of acetylene gas that was intentionally released inside an empty 55-gallon antifreeze barrel to demonstrate an acetylene gas explosion. Mr. Dotson was holding an oxyacetylene torch in his hand with the torch tip inserted in the barrel when it exploded prematurely from an undetermined ignition source. Three other coworkers, located in close proximity to the barrel, also received injuries from the explosion. Mr. Dotson, age 28, had 10 years total mining experience, seven years and six months employment with Twin Star Mining, Inc., as a utility man. At approximately 11:00 p.m., on September 5, 2003, the Department of Mines, Minerals and Energy's Division of Mines was notified of the accident and a joint investigation with the Federal Mine Safety and Health Administration was initiated the same day. This mine is scheduled to receive one regular inspection and one spot inspection every 12 months. A spot inspection was completed on May 22, 2003.

COMMENTARY

Twin Star Mining, Inc., Lower Elk Creek Strip, is located on State Route 711 near Hurley, in Buchanan County, Virginia. This surface mine operation has 53 miners employed on two production shifts per day and operates five days per week. The surface mine permit boundaries include mining areas located in Virginia, Kentucky and West Virginia. Approximately 1,500 raw tons of coal are produced daily using two active units of surface equipment to mine the Eagle, Clintwood, Alma, and Pond Creek coal seams.

On Friday, September 5, 2003, at approximately 5:00 p.m., the evening shift crew assembled at the maintenance shop area at the start of the shift, to receive work instructions from Mr. Glen Mullins, surface foreman. The evening shift maintenance crew consisted of four employees, Mr. Dotson, Mr. Larry McClanahan, greaser, Mr. Jason Layne, mechanic, and Mr. James Estep, contract mechanic, and owner of James Equipment Co., independent contractor identification No. C655. Coal production and equipment maintenance work progressed as normal during the shift until the time of the accident.

Mr. Mullins coordinated production activities at the start of the shift and monitored production operations during the first part of the shift. A Caterpillar 785 hauler was scheduled for mechanical repairs on the evening shift. The hauler was originally parked near a detached Caterpillar 992G front-end loader bucket, located approximately 84 yards south of the maintenance shop. Mr. Layne assisted Mr. Estep in removing the rock guard from the hauler using the boom lift device provided on Mr. Estep's service truck. After completing this work, Mr. Layne and Mr. Estep returned to the maintenance shop.

Mr. Dotson and Mr. McClanahan had completed service work on various equipment and had returned to the maintenance shop area to lubricate and refuel the coal loaders, located in the stockpile area adjacent to the maintenance shop. The coal loaders were refueled by Mr. Dotson and greased by Mr. McClanahan. Mr. McClanahan was younger than the other maintenance coworkers and had only been employed at the mine for approximately two weeks.

Later, Mr. Dotson and Mr. McClanahan joined Mr. Layne and Mr. Estep, who were located inside the maintenance shop. The mechanical repair work scheduled for the Caterpillar 785 hauler was discussed at this time. The cooler system on the hauler was leaking antifreeze into the hydraulic oil and the mechanical repairs would require an empty barrel, with the top cut out, to drain the oil from the hauler. Mr. Estep departed the shop area and traveled to the location of the hauler and drove it back to the maintenance shop.

Mr. McClanahan observed Mr. Dotson exit the maintenance shop carrying an empty plastic bag and return shortly with the plastic bag pressurized, apparently with acetylene gas. At this time, Mr. Dotson took the plastic bag outside the shop. Mr. Layne and Mr. McClanahan were located inside the shop when Mr. Estep arrived with the Caterpillar 785 hauler. Mr. Layne and Mr. McClanahan guided Mr. Estep as he drove the hauler inside the maintenance shop. At this time, Mr. Dotson ignited the bag of acetylene gas at a location outside of the shop using aerosol engine starting fluid sprayed on the ground to act as a fuse to detonate the bag of acetylene gas. Mr. Dotson stood approximately 20 feet away from the bag of acetylene gas when he ignited the starting fluid. Mr. Layne was startled when he heard the explosion and thought that a tire had burst on the hauler when he heard the explosion. Mr. Estep also heard the explosion but did not question the source. At this time, Mr. Dotson returned to the shop.

Mr. McClanahan and Mr. Estep attached the safety cord to secure the Caterpillar 785 hauler dump bed. Mr. Estep stated that he planned to drain the oil from the hauler. Mr. Dotson and Mr. Layne stated that they would get the barrel to catch the oil. Mr. Dotson removed an empty 55-gallon antifreeze barrel from the maintenance shop and carried it over placing it in the loader bucket. Mr. Layne was located at the loader bucket with his assigned service truck when Mr. Dotson arrived with the barrel. Mr. Layne understood that the top of the antifreeze barrel was going to be cut off using the oxyacetylene equipment provided on the service truck.

Mr. McClanahan and Mr. Dotson departed the maintenance shop and traveled to the 992G front-end loader bucket. Mr. Dotson informed Mr. McClanahan of his intentions to demonstrate an explosion of acetylene gas using the empty barrel. After arriving at the loader bucket, Mr. McClanahan became apprehensive about Mr. Dotson's intentions and departed to join Mr. Estep at his service truck, located between the loader bucket and the shop. Mr. McClanahan informed Mr. Estep of Mr. Dotson's intentions.

At this time, Mr. Mullins drove by the maintenance shop and loader bucket while enroute to direct an equipment move. Mr. Mullins observed Mr. Estep and Mr. McClanahan standing next to Mr. Estep's service truck. Mr. Mullins continued traveling by their location to the lower end of the stockpile area and did not observe anyone at the loader bucket at this time. Mr. Mullins stated that it was approximately 8:30 p.m. when he drove by and observed Mr. Estep and Mr. McClanahan at this location.

Mr. Dotson arrived at the 992G front-end loader bucket with the empty antifreeze barrel, where Mr. Layne was located. After Mr. Dotson positioned the empty antifreeze barrel in the loader bucket, he got the oxyacetylene torch from the side compartment of the service truck, operated by Mr. Layne. Mr. Dotson placed the torch assembly on the top lid of the barrel with the torch tip positioned at an angle inside the large cap-lid opening located in the top cover of the barrel. The loader bucket was positioned such that only the back of the bucket was visible from the maintenance shop area. The front of the bucket was positioned near the embankment at the outer edge of the stockpile area.

When Mr. Layne had arrived at the location of the 992G front-end loader bucket, he became curious about the machine work of the mounting assembly that had been completed during a recent rebuild of the bucket. As Mr. Layne was examining the quality of the machine work on the back of the bucket, Mr. Dotson walked from the front to the back of the bucket to join him. After a short discussion concerning the machine work, Mr. Dotson returned to the front of the bucket. Approximately five minutes later, Mr. Layne walked from the back of the loader bucket around to the front of the bucket. Mr. Layne smelled acetylene when he arrived at the front of the bucket. Mr. Layne observed Mr. Dotson standing near the empty 55-gallon antifreeze barrel while holding the torch assembly with the torch tip inserted in a perpendicular position inside the large cap opening of the barrel. Mr. Layne asked Mr. Dotson what he was doing and Mr. Dotson replied that he planned to demonstrate an acetylene gas explosion to Mr. McClanahan.

At this time, Mr. Estep and Mr. McClanahan were traveling toward the loader bucket from Mr. Estep's service truck. Mr. Estep intended to check on Mr. Dotson and Mr. Layne and to investigate why it was taking so long to cut the top out of the barrel.

Approximately one minute after Mr. Layne observed Mr. Dotson holding the tip of the torch assembly inside the large cap opening in the top of the antifreeze barrel, a violent explosion occurred. At this time, Mr. Estep and Mr. McClanahan had arrived and were located in front of the loader bucket when they observed a flash of bright light and heard a loud explosion. Mr. Dotson sustained serious head, right arm and left hand injuries, was knocked unconscious and was thrown approximately six feet from the barrel, landing in the loader bucket. The explosion force knocked Mr. McClanahan to the ground. Mr. Estep was struck by flying debris that temporarily impaired his vision. The explosion force and the torch assembly that had blown apart struck Mr. Layne in the face and neck while knocking him down to the ground and burning his face and eyes. After Mr. Layne regained his vision and realized what had happened, he observed the torch assembly on fire near his side. He immediately attempted to extinguish the fire by crimping the oxygen and acetylene hoses together and eventually extinguished the fire. Mr. McClanahan jumped up and ran to Mr. Layne's service truck where he called other shift personnel for medical assistance and first aid supplies using the truck radio. Mr. McClanahan then moved Mr. Layne's service truck from behind the bucket around to the side of the bucket to provide better lighting for mine personnel to administer first aid to Mr. Dotson.

Mr. Shawn Cline, hauler operator - emergency medical technician, heard the radio call for medical assistance and responded to the accident scene. Mr. Bruce Mounts, hauler operator – emergency medical technician, was traveling toward the Virginia side of the mine when he heard Mr. McClanahan's radio call requesting medical assistance and also responded to the accident scene. Mr. Mounts was the second emergency medical technician to arrive at the accident scene and assisted Mr. Cline in administering first aid and cardiopulmonary resuscitation (CPR) to Mr. Dotson. Mr. Mullins

arrived shortly thereafter and summonsed additional medical assistance and later notified state and federal mine officials. Mr. Mullins departed the accident scene and drove to the mine entrance where he waited to escort the rescue service to the accident scene. Representatives of the Knox Creek Fire and Rescue, Inc. responded and administered first aid treatment to Mr. Dotson. Med Flight medical personnel were also notified and responded to the scene to administer first aid. The Knox Creek Fire and Rescue, Inc. personnel transported Mr. Dotson to the Buchanan General Hospital, located in Grundy, Virginia, where he was pronounced dead by Dr. Joseph Segen, Buchanan County Coroner. Mr. Layne, Mr. Estep and Mr. McClanahan were also transported to Buchanan General Hospital where they were treated and later released from the hospital.

STATEMENTS FROM MINE PERSONNEL AND OTHER FACTORS

Statements from mine personnel and other factors determined during the investigation revealed the following:

1. The initial interviews of mine personnel were conducted on September 8, 2003. Due to discrepancies in statements made by mine personnel and physical evidence observed at the accident scene, second interviews were conducted on September 17, 2003, in which mine personnel were placed under oath. Final interviews were conducted on October 14, 2003, to complete the investigation.
2. The exploding vessel accident occurred on September 5, 2003, at approximately 8:45 p.m. The exploding vessel involved an empty 55-gallon antifreeze – water, engine coolant barrel.
3. Mr. Layne, mechanic, stated that he witnessed the accident and that he was standing near Mr. Dotson and the barrel immediately before the explosion occurred. He stated that Mr. Dotson was holding the oxyacetylene torch assembly in his hand with the torch tip inserted in a perpendicular position inside the large cap - lid opening in the top of the barrel when the explosion occurred. He stated that the torch was not ignited and that he did not observe any type of illumination being emitted from an external ignition source before the explosion occurred.

- Mr. Layne stated that Mr. Dotson removed the empty 55-gallon antifreeze barrel from the maintenance shop and carried it over placing it in the loader bucket where the accident occurred. He stated that he thought that they were planning to cut the top out of the barrel. He stated that Mr. Dotson got the torch assembly from the side compartment of the service truck and brought the torch assembly to the barrel.
- Mr. Layne stated that he was located at the back of the loader bucket when Mr. Dotson placed the barrel in the loader bucket. He stated that Mr. Dotson laid the torch assembly on top of the barrel with the torch tip inserted at an angle in the large cap-lid opening in the top of the barrel. He stated that he was located at the back of the bucket approximately four to five minutes, while observing the recent rebuild machine work that had been performed on the mounting frame of the bucket. He stated that he smelled acetylene as he walked around to the front of the bucket where Mr. Dotson was located. He stated that when he asked Mr. Dotson what he was doing, Mr. Dotson replied that he planned to demonstrate an acetylene gas explosion to Mr. McClanahan. Mr. Layne observed Mr. Dotson standing near the empty 55-gallon antifreeze barrel while holding the torch assembly with the torch tip inserted in a

perpendicular position inside the large cap opening of the barrel. He stated that he stood near Mr. Dotson and the barrel for approximately one minute before the explosion occurred.

- Mr. Layne stated that the explosion force and the torch assembly that blew apart striking him in the face and neck, knocked him down to the ground while causing injuries. After he realized what had happened, he observed the torch assembly on fire near his side. He immediately attempted to extinguish the fire by crimping the oxygen and acetylene hoses together and eventually extinguished the fire.
- Mr. Layne stated that on previous occasions, he had observed Mr. Dotson place acetylene gas in plastic bags and ignite the bags using aerosol engine starting fluid sprayed on the ground to act as a fuse. He stated that before the accident occurred, Mr. Dotson ignited a plastic bag containing acetylene gas outside the maintenance shop while he was guiding Mr. Estep into the shop with the hauler. He stated that when the explosion occurred, he thought a tire had burst on the 785 hauler as Mr. Estep was driving the hauler into the shop.

4. Mr. Estep, independent contractor mechanic, stated that he assisted Mr. Layne in removing the rock guard from the 785 hauler using the boom lift device provided on his personal service truck. He stated that he and Mr. Layne walked to the maintenance shop after completing this work. He stated that he walked from the maintenance shop back to the hauler and drove the hauler to the shop. He stated that Mr. Dotson, Mr. Layne, and Mr. McClanahan were located in the shop when he departed to bring the hauler to the maintenance shop. He stated that he thought Mr. Layne and Mr. Dotson were taking the barrel to the loader bucket to cut the top out of the barrel.

- Mr. Estep stated that he thought he heard an explosion, coming from a location outside the maintenance shop, while he was operating the hauler. He stated that approximately 10 minutes elapsed after he brought the hauler to the shop before the second explosion occurred at the loader bucket. He stated that Mr. McClanahan traveled with him to the bucket and that he was traveling to this location to investigate why it was taking so long for Mr. Dotson and Mr. Layne to cut the top out of the barrel. He stated that the explosion occurred just as they arrived at the front of the bucket. He stated that he did not observe any type of illumination being emitted from the bucket prior to the explosion. He stated that when the explosion occurred, he was struck by particles of flying debris that temporarily impaired his vision.
- Mr. Estep stated that he had previously observed Mr. Dotson ignite plastic bags containing acetylene gas and that he was aware of Mr. Dotson playing practical jokes on coworkers at this mine. He stated that he had observed Mr. Dotson ignite plastic bags containing acetylene three or four times prior to the accident. Mr. Estep also stated that before the accident occurred, he recalled Mr. McClanahan telling him something about Mr. Dotson planning to put acetylene gas in the barrel to demonstrate an explosion.

5. Mr. McClanahan, greaser, stated that he came to the maintenance shop area initially to assist Mr. Dotson as he performed service work on the coal loaders. He stated that he completed lubrication maintenance work while Mr. Dotson refueled the coal loaders, located near the shop area. He stated that he was located inside the shop with Mr. Layne when Mr. Estep arrived with the hauler. He stated that he assisted Mr. Layne with guiding Mr. Estep into the shop with the hauler. He stated that he observed Mr. Dotson exit the shop carrying an empty plastic bag and that he returned shortly with the plastic bag apparently pressurized with acetylene gas. He stated that Mr. Dotson then took the plastic bag containing acetylene gas outside the shop and ignited it using aerosol engine starting fluid sprayed on the ground to act

as a fuse to detonate the bag. He stated that Mr. Dotson stood approximately 20 feet away from the bag of acetylene gas when he ignited the starting fluid.

- Mr. McClanahan stated that he walked with Mr. Dotson from the maintenance shop to the loader bucket when Mr. Dotson informed him that he planned to demonstrate an acetylene gas explosion. He stated that he traveled to and walked around the bucket with Mr. Dotson, but became apprehensive about Mr. Dotson's intentions, and then returned to join Mr. Estep who was located at his service truck.
- Mr. McClanahan stated that when Mr. Estep traveled with him to the loader bucket, the explosion occurred just as they arrived at the front of the bucket. He stated that as he and Mr. Estep arrived at the front of the bucket, he observed a flash of bright light and heard a loud explosion. He stated that he did not observe any type of illumination being emitted from the bucket prior to the explosion. He stated that the force of the explosion knocked him to the ground. He stated that when he got up, he ran to Mr. Layne's service truck and called other mine personnel requesting medical assistance, using the truck radio. Mr. McClanahan stated that he moved Mr. Layne's service truck from behind the bucket around to the side of the bucket to provide better lighting for mine personnel to administer first aid to Mr. Dotson.

6. Mr. Cline, hauler operator - emergency medical technician, stated that he heard the call for medical assistance and responded to the accident scene. He stated that he administered first aid treatment to Mr. Dotson and that during this time he observed and removed a can of aerosol engine starting fluid from Mr. Dotson's right front pants pocket.
7. Mr. Mounts, hauler operator - emergency medical technician, stated that as he was traveling from the Kentucky side of the mine to the Virginia side, he heard a radio call for medical assistance. He stated that he also responded to the accident scene and assisted Mr. Cline in administering first aid treatment to Mr. Dotson. Mr. Mounts stated that upon arrival at the accident scene, he observed a cellular phone lying on the ground near Mr. Dotson's location.
8. Mrs. Debbie Blankenship, a customer at Bertha's Diner, Stopover Kentucky, verified receiving a call-in food order from Mr. Dotson on September 5, 2003. Mrs. Blankenship verified receiving the call at approximately 7:40 p.m. Mrs. Blankenship stated that she had no other contact with Mr. Dotson after receiving the call-in order.
9. Mr. Mullins, second shift surface foreman, stated that on September 5, 2003, at approximately 8:30 p.m., he observed Mr. Estep and Mr. McClanahan standing near Mr. Estep's service truck that was parked between the maintenance shop and the loader bucket. He stated that he observed a large piece of metal on the back of Mr. Estep's service truck. He stated that he observed Mr. Estep and Mr. McClanahan as he drove by their location while enroute to the lower end of the stockpile area to direct an equipment move. He stated that as he drove by Mr. Estep's service truck, he did not observe anyone located at the loader bucket where the explosion occurred.
   - Mr. Mullins stated that he was aware of Mr. Dotson playing practical jokes on coworkers at this mine but had no knowledge of Mr. Dotson detonating plastic bags containing acetylene gas prior to the accident. He stated that he had never heard any explosions associated with detonating bags containing acetylene gas.
   - Mr. Mullins stated that he found the oxyacetylene torch cutting attachment approximately four feet from the right front corner of the loader bucket after the explosion. This cutting attachment was blown approximately fifteen feet from Mr. Dotson's location near the barrel when the explosion occurred. He stated that neither the torch tip nor the torch tip nut were in the cutting attachment when it was found after the accident.

10. Mine personnel stated that aerosol engine starting fluid was commonly used for a number of purposes other than that recommended by the product manufacturer. Mine personnel stated that they used starting fluid to clean grease off their hands, clothing, equipment, and tools.
11. Mine personnel stated that the barrel containing the acetylene was blown from the loader bucket by the force of the explosion to the top of the embankment located directly in front of the loader bucket. Mine personnel stated that the barrel was moved from the top of the embankment following the explosion to examine the contents of the barrel.

PHYSICAL FACTORS

The investigation of physical factors at the scene of the accident revealed the following:

1. The exploding vessel accident occurred on Friday, September 5, 2003, at approximately 8:45 p.m., at a detached Caterpillar 992G front-end loader bucket, located near the maintenance shop.
2. The exploding vessel involved an empty 55-gallon metal barrel that originally contained a premixed 50% antifreeze – 50% water, engine coolant fluid manufactured by Texaco. Pressurized acetylene gas was apparently released into the barrel using an oxyacetylene torch assembly to demonstrate an acetylene gas explosion.
3. The explosion blew off the top end of the 55-gallon metal barrel and the top of the barrel could not be found during the investigation. The barrel was identified as a Texaco antifreeze product according to statements of mine personnel, and similar empty barrels of this type were located at the maintenance shop. A small amount of fluorescent green fluid, identified as 50% antifreeze - 50% water, engine coolant fluid, was observed in the bottom of the barrel. The exact amount of antifreeze-water fluid contained in the barrel when the explosion occurred could not be verified. Testimony from mine employees suggests that only a very small amount of fluid could have been present because the barrel was described as being “empty”. The bottom of the barrel was distorted from the force of the explosion and conformed to a physical impression observed in the bottom of the loader bucket.
4. The barrel was blown from the loader bucket approximately 30 feet onto the top of the embankment, located directly in front of the bucket. An impression was observed in the material on top of the embankment that appeared similar to the shape of the barrel.
5. The following physical evidence was observed in the loader bucket:
   - An impression was observed on the left side, bottom of the bucket that appeared similar to the bottom rim of a 55-gallon barrel;
   - Physical marks were observed on the concave metal surface inside the bucket that appeared to have been caused by the barrel striking this area;
   - Physical marks were observed on the top metal portion of the bucket (expansion guard) that appeared to have been caused by top of the barrel striking this area.
6. The antifreeze barrel was placed in a detached Caterpillar 992G front-end loader bucket that had been recently rebuilt. The loader bucket was located approximately 84 yards south of the maintenance shop.

7. A can of aerosol engine starting fluid was observed in the loader bucket and was verified by Mr. Cline as being removed from Mr. Dotson's right front pants pocket. The Material Safety Data Sheet (MSDS) No. 503.0340954-001.004 for the starting fluid identified this product as "Pyroil Regular Starting Fluid" distributed by "The Valvoline Company, Lexington, Kentucky". The can of starting fluid was sent to the Mine Safety and Health Administration's Approval and Certification Center, located in Triadelphia, West Virginia for examination and testing.
8. The rear bumper of the Freightliner service truck appeared to have an impression of the bottom rim of a 55-gallon barrel in the dust collected on the bumper of the truck.
9. The oxygen and acetylene cylinders (tanks) were supplied on a model 2001 FL70 Freightliner service truck. Valley National Gases, Inc., located in Logan, West Virginia, supplied the oxygen and acetylene cylinders. Mountain State Air Gas, located in Charleston, West Virginia, is the acetylene distributor. The acetylene was manufactured by Airgas, Inc., located in Radnor, Pennsylvania. The acetylene regulator gauge was set on 11 pounds per square inch (PSI) and the oxygen regulator gauge was set on 139 PSI.
10. Mine personnel identified the Motorola Timport 270C cellular phone, found near Mr. Dotson's location, as his personal property. The top portion of the cellular phone antenna was apparently damaged by heat from the explosion. The cellular phone was sent to the Mine Safety and Health Administration's Approval and Certification Center, for examination and testing. The cellular phone display revealed that the last call transmitted from the phone on September 5, 2003, occurred at 7:40 p.m. The phone display indicated this call was sent to the telephone number of Bertha's Diner. No in-coming calls were listed on the telephone display for September 5, 2003. The user's manual, provided for this model cellular phone, contains the following warnings:

    Potentially Explosive Atmospheres:

    - Turn off your phone prior to entering any area with a potentially explosive atmosphere, unless the phone is a model specifically identified as being "Intrinsically Safe" for use in such areas (for example, Factory Mutual, CSA, or UL Approved);
    - Do not remove, install, or charge batteries in such areas. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death;
    - Areas with potentially explosive atmospheres referred to above include: fueling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust, or metal powders, and any other area where you would normally be advised to turn off your vehicle engine.
    - Areas with potentially explosive atmospheres are often but not always posted.
11. The interior of the loader bucket measured fourteen feet and six inches in width and six feet and three inches in height. The bucket was positioned such that only the back was visible from the shop area. The front of the bucket was positioned near the embankment surrounding the stockpile area.
12. The oxyacetylene torch assembly was a combination-cutting torch manufactured by Victor Equipment Company, Denton, Texas. The cutting torch assembly was blown apart at the cutting attachment fitting on the torch body. The torch tip and torch tip nut were blown off the cutting attachment and were never found. The force of the explosion twisted the cutting attachment approximately 90 degrees. The cutting attachment was found approximately 15 feet from where Mr. Dotson was standing near the barrel when the explosion occurred. The two components of the torch assembly were sent to the Mine Safety and Health Administration's Approval and Certification Center, for examination.

13. A 100% antifreeze solution is shipped to Poskas Oil and Supply Company in bulk shipments. The Poskas Oil and Supply Company is located in North Tazewell, Virginia. The Poskas Oil and Supply Company dilutes the 100% antifreeze solution to a 50% antifreeze - 50% distilled water mixture. The Poskas Oil and Supply Company re-packages the antifreeze-distilled water mixture in 55-gallon reconditioned drums at the North Tazewell complex and distributes this product to mining customers. The premixed antifreeze-distilled water mixture was delivered to this mine in 55-gallon drums (barrels).
14. Material Safety Data Sheets (MSDS) for the Airgas acetylene, Texaco (Shellzone) antifreeze, and the Pyroil starting fluid were maintained at the mine.
15. The United States Naval Observatory Astronomical Applications Department listed the sunset time on September 5, 2003, at 7:52 p.m. and the end of civil twilight at 8:18 p.m. (http://aa.usno.navy.mil/). The accident occurred at approximately 8:45 p.m. Mr. Layne stated that during the time he was standing next to Mr. Dotson and the antifreeze barrel, immediately prior to the explosion, he did not observe any type of illumination being emitted from an external ignition source and that the torch, held by Mr. Dotson, was not ignited. McClanahan and Estep also stated that they did not observe any type of illumination being emitted from the loader bucket, prior to the explosion.
16. The Mine Safety and Health Administration's Approval and Certification Center staff conducted the following examinations and tests and provided the following results:
    - Empty 55 gallon antifreeze barrel involved in the explosion – laboratory tests of this barrel revealed ethylene glycol and matched a sample of full barrels containing this antifreeze product located at the mine site.
    - Fluorescent green fluid observed in the bottom of the barrel – laboratory tests identified this fluid as an antifreeze water mixture containing ethylene glycol.
    - Oxyacetylene torch assembly – visual observations revealed extensive damage to the cutting torch assembly. Nondestructive physical and microscopic examinations revealed strong visual evidence that the torch assembly was intact and that the torch tip was in place when the explosion occurred.
    - Pyroil engine starting fluid aerosol can and contents – laboratory tests revealed the contents of the can matched the labeling on the can for ether and heptane. Cyclohexane and toluene, two closely-related hydrocarbons, were detected, with the cyclohexane probably accounting for the hexane on the label. No detectable concentrations of engine starting fluid were detected in content samples taken from inside the barrel involved in the explosion.
    - Cellular phone identified as Mr. Dotson's personal property – test results pending.
17. Oxygen and acetylene equipment, normally referred to as "oxyacetylene", is commonly used in the mining industry to heat and cut various types of metals. The oxyacetylene torch provides a thermal cutting technique. This system consists of oxygen and acetylene cylinders, regulators, hoses, torch body, cutting attachment, and torch tip. This equipment consists of separate oxygen and acetylene steel cylinders, regulators that attach to each cylinder, and attaching rubber hoses used to transfer the oxygen and acetylene from the cylinders to the torch assembly. Oxygen and acetylene flow separately under pressure from the cylinders and regulators to the torch assembly. Depending upon the type and function of the torch assembly, the oxygen and acetylene are mixed in a mixing chamber or a torch tip. The torch assembly is equipped with a separate oxygen-jet lever that provides approximately 40 to 60 pounds per square inch (PSI) oxygen pressure, which does the cutting after the metal has been preheated by the oxyacetylene flame.

DISCUSSION

I. Fuel Sources:

1. **Acetylene gas:** This highly flammable, explosive gas intentionally released into the barrel was the most likely fuel source based on mine personnel testimony, events that occurred on the day of the accident, and the victim's history of igniting acetylene gas placed in plastic bags on previous occasions. The victim ignited a small plastic bag containing acetylene gas on the day of the accident and had informed coworkers, before the explosion occurred, that he intended to place acetylene gas in the barrel to demonstrate an explosion. Coworkers stated that they had observed the victim ignite plastic bags containing acetylene gas on previous occasions.
    a) Acetylene, (C_2H_2), a compound of carbon and hydrogen, is a colorless, highly flammable gas. It is slightly lighter than air and has a garlic-like odor. Acetylene is a very unstable gas and is stored in high pressure cylinders filled with porous material containing acetone into which the acetylene is dissolved. (http://www.welding supply.net/acetylene.htm)
    b) Acetylene is a compressed gas that is used as a fuel and is stored in a liquid state. It is marketed compressed in a cylinder and dissolved in acetone to make it non-explosive. When a cylinder valve is opened and acetylene pressure is released, a portion of the liquid turns to gas. The device that the cylinder is connected to releases this gas when activated.
    c) The minimum energy required to ignite acetylene ranges from approximately seventeen micro joules in air, down to two-tenths micro joules in pure oxygen. This is an extremely low ignition energy when compared to common gases such as methane that has a range from approximately three-hundred micro joules down to three micro joules. The human body can accumulate a static electrical charge that is 70 times greater than the energy required to ignite methane. The energy required to ignite methane is 15 times greater than the energy required to ignite acetylene. A very black smoke and soot are produced when pure acetylene is ignited. No soot or blackened areas were observed inside the barrel or on the loader bucket following the explosion. Spontaneous combustion can occur when acetylene and oxygen are mixed in proper proportions. This proportion would exist at the point where the most complete combustion would occur. The production of soot would depend on the degree of complete combustion of acetylene as more complete combustion decreases the amount of soot production.
    d) Acetylene, the simplest and best known member of the hydrocarbon series, contains one or more pairs of carbon atoms linked by triple bonds, called the acetylenic series, or alkynes. Mixtures of air and acetylene are explosive over a wide range, from 2.4 percent to 83 percent acetylene in air. When burned with the correct amount of air, acetylene gives a pure, white light, and for this reason it was at one time used for illumination. The burning of acetylene produces a large amount of heat, and, in a properly designed torch, the oxyacetylene flame attains the highest flame temperature (about 6,000°F, or 3,300°C) of any known mixture of combustible gases. Acetylene is produced by three methods: by the reaction of water mixed with calcium carbide;

by the passage of hydrocarbons through an electric arc; by partial combustion of methane with air or oxygen. (http://www.britannica.com/seo/a/acetylene)

e) The Material Safety Data Sheet (MSDS) number 001001, provided for the acetylene product being used at this mine, contained the following information:

- Explosive Range: 2.4% to 83%
- Specific Gravity: .906 (lighter than air)
- Source: Methane heated in low oxygen atmosphere
  Dissolved in acetone
- Flash Point: 32°F (Fahrenheit)
- Autoignition Temperature: 581°F (Fahrenheit)

Safety Keypoints:

- Extremely flammable gas;
- Explosion hazard exists in confined spaces when the gas is released;
- Explosion sensitive to static electrical discharge;
- All hoses, fittings and torches for use in oxyacetylene cutting shall be inspected prior to each use and replaced as necessary. Only hoses and connections designed for oxyacetylene cutting shall be used;
- All oxyacetylene cutting equipment shall be equipped with check valves and or combination check valve – flashback arrestors to prevent reverse gas flow. These safety devices shall be installed on both hoses at either the torch or regulator connections.

f) Compressed Gas Association, Inc., (CGA) Chantilly, Virginia, published an Acetylene Safety Alert bulletin, in January 1996, to communicate the dangers of using acetylene for anything other than its intended purpose. The bulletin states that any effort to transfer acetylene into a foreign container, such as a balloon or plastic bag, is highly dangerous. Even under circumstances where a "knowledgeable" person thinks he or she can do it safely, "playing" with acetylene is a very high risk activity. Acetylene can easily be ignited by static electricity.

2. Antifreeze coolant and or vapors: The empty 55-gallon barrel previously contained a premixed 50% antifreeze – 50% water, engine coolant fluid. It could not be determined how long the barrel had been empty nor could it be determined if the two cap-lids provided in the top of the barrel were in place prior to the barrel being moved from the shop to the loader bucket. The time period that the barrel may have been empty and whether or not the cap-lids were in place may have contributed to explosive vapors accumulating inside the empty barrel. Mine personnel testified that an oxyacetylene torch had been used at this mine to cut the top off these type barrels and/or cut the barrels in half on many occasions and that they had never experienced any type of combustion or explosive results. It could not be determined if and to what extent the antifreeze coolant or vapors may have contributed to the violence of the explosion. Based on the fact that mine personnel testified that they had cut on many of these empty antifreeze barrels using an oxyacetylene torch and had never experienced any type of combustion or explosive results, a fuel source other than the antifreeze coolant fluid apparently was responsible for the barrel explosion. A physical examination of the inside of the barrel revealed a very small amount of fluorescent green fluid that was similar in appearance to antifreeze coolant and did not reveal the physical presence of other petroleum or flammable/explosive products. A sample of the fluid in the barrel was sent for analysis to the Mine Safety and Health Administration's Approval and Certification Center.

The Material Safety Data Sheet (MSDS) number 80070E–14 provided for the Shellzone Antifreeze Coolant, being used at this mine, contained the following information:

- Containers, even those that have been emptied, can contain explosive vapors;
- This coolant fluid will not burn unless preheated;
- Avoid heat, open flames, including pilot lights, and strong oxidizing agents near this coolant fluid;
- Use explosion proof ventilation to prevent vapor accumulations;
- Keep containers closed when not in use;
- Do not cut, drill, grind, weld or perform similar operations on or near containers;
- Misuse of empty containers can be hazardous as cutting and welding of empty containers might cause a fire or explosion, or cause formation of toxic fumes from residues;
- Do not pressurize or expose open flames or heat to empty containers.

3. **Pyroil engine starting fluid:** A partial can of aerosol Pyroil engine starting fluid was removed from the victim's right front pants pocket immediately following the explosion. It could not be determined if starting fluid had been sprayed into the barrel prior to the explosion. Coworkers, located at the scene where the explosion occurred, testified that they did not observe or have any knowledge that starting fluid had been placed in the barrel prior to the explosion. Ethyl ether, a major ingredient in starting fluid, emits a bluish - orange colored flame when ignited.

   The Material Safety Data Sheet (MSDS) number 503.0340954-001.004, provided for the Pyroil engine starting fluid, being used at this mine, contained the following information:

   - Specific Gravity: .773
   - Flame Propagation: >18.000 In/S (Inches per Second)
   - Composition of ingredients:

	%	(by weight)
Heptane	69.0	79.0
Ethyl Ether	11.0	21.0
Carbon Dioxide	1.0	11.0
Hexane	2.8	2.8

   - Highly volatile and readily gives off vapors which may travel along the ground or be moved by ventilation;
   - Can be ignited by flames, sparks, heaters, smoking, electric motor or static discharge;
   - Can ignite explosively;

II. IGNITION SOURCES:

An exact ignition source could not be determined. Since neither the eyewitness nor the other two coworkers located at the accident scene observed any intentional application of an ignition source in the immediate vicinity of the barrel immediately prior to the explosion, some type of spontaneous autoignition or static electricity apparently ignited the contents of the barrel. One, or a combination of the following three situations, apparently provided an autoignition source:

1. **Spontaneous autoignition – acetylene gas molecules:** Since acetylene gas was the most likely fuel source of the explosion based on mine personnel testimony, an acetylene molecule autoignition could have resulted in a premature detonation of the acetylene gas when it was released into the empty 55-gallon antifreeze barrel. Acetylene gas has an autoignition temperature of 581°F and presents an explosion hazard in confined spaces when the gas is released. An autoignition could have occurred as the acetylene gas was being released into the confined space of the barrel. The acetylene gas molecules could have spontaneously ignited caused by static friction of the molecules being compressed and rubbing against each other. This static friction created by the gas molecules could have generated sufficient frictional heat to result in an autoignition of the acetylene gas.
2. **Spontaneous autoignition by contact with pressurized oxygen released into the barrel containing acetylene gas:** Pressurized oxygen released into the barrel containing acetylene gas, whether intentional or unintentional, would affect acetylene in the following three ways: (1) lower the threshold potential of acetylene autoignition; (2) expedite autoignition of the acetylene gas; (3) contribute to the violence of the explosion. If oxygen had been released into the barrel containing acetylene, friction created between the pressurized oxygen molecules and the acetylene molecules could have generated sufficient frictional heat to cause a spontaneous autoignition of the acetylene gas.
3. **Static electricity:** A static electrical charge stored on or transferred to the victim's person could have discharged onto the surface of the barrel in the vicinity of the acetylene gas and provided a potential autoignition source. The creation of a static electrical charge could also have been generated as the victim was releasing acetylene gas into the barrel due to the acetylene molecules rubbing and contacting each other causing friction, thus creating a static electrical charge because acetylene can be a static generator when discharging out of a torch tip. The generation of this static electrical charge is created as the acetylene gas vaporizes from the acetone in the cylinder and microscopic droplets of acetone are suspended in the acetylene resulting in electron stripping, thus creating a static charge build up at the torch tip. A static electrical arc, of sufficient strength to ignite the acetylene gas, could have been discharged from the victim to the top of the barrel in close proximity to the gas **or** a static electrical arc could have discharged from the torch tip to the barrel resulting in an autoignition. An acetylene gas safety alert bulletin published by the Compressed Gas Association, Inc., states that "any transfer of acetylene into a foreign container is highly dangerous and that acetylene gas is easily ignited by static electricity." The victim was wearing rubber-soled shoes, which would have increased the potential of a static electrical charge being stored on or transferred to his person and discharged onto the barrel igniting the highly explosive, acetylene gas.

CONCLUSION

On Friday, September 5, 2003, at approximately 8:45 p.m., a surface accident involving the explosion of an empty 55-gallon metal barrel occurred at the Twin Star Mining, Inc., Lower Elk Creek Strip. David Walter Dotson, a utility man, was fatally injured when struck by flying debris and the force of a violent explosion of acetylene gas that was intentionally released inside an empty 55-gallon antifreeze barrel to demonstrate an acetylene gas explosion. Mr. Dotson was holding an oxyacetylene torch in his hand with the torch tip inserted in the barrel when it exploded prematurely from an undetermined ignition source. Three other coworkers, located in close proximity to the barrel, also received injuries from the explosion.

ENFORCEMENT ACTION

The following enforcement action was taken as a result of the investigation:

1. An order of closure, No. DWA0004004, was issued under Section 45.1-161.91.A. (ii) of the Coal Mine Safety Laws of Virginia to control and preserve the scene of the accident pending an investigation. The order of closure was modified to allow implementation of an accident action plan.

RECOMMENDATIONS

1. Mine operators should establish a policy prohibiting the cutting or application of heat to empty barrels. The safest procedure is to provide special containers for draining or "catching" fluids when servicing and repairing equipment.
2. Any enclosed container to be cut, welded, brazed, soldered, drilled or grinded should be cleaned out with detergent and water and filled with inert material prior to applying any form of heat or cutting with oxyacetylene torches. Under no condition should cleaning agents that contain flammable or combustible ingredients be used on containers or other metals to be cut or welded.
3. All current and newly hired employees should be trained on the Material Safety Data Sheets pertaining to all flammable and combustible materials located on mine property. All employees assigned to work with newly purchased flammable or combustible material(s) shall be trained on the Material Safety Data Sheet(s) prior to employees being assigned to work with such material(s). Training on flammable and combustible product(s) Material Safety Data Sheet(s) information should be reviewed at least annually with all personnel.
4. Training should be conducted and regularly reviewed on general cutting/welding procedures with all employees who are assigned or may be assigned to perform this work activity. This training should be conducted by experienced individuals and should include the following:
   a) A review of the manufacturer's recommendations, instructions and guidelines for cleaning oxyacetylene torches and other torch assembly components;
   b) A review of the manufacturer's instructions and guidelines pertaining to the inspection and maintenance of oxyacetylene gauges, regulators, hoses and torches;

c) A review of manufacturer recommended guidelines provided for troubleshooting and repairing all oxyacetylene torch assembly components including: gauges, regulators, hoses, and torches;
d) A review of the potential hazards associated with the transportation, storage, handling and use of compressed oxygen and acetylene gases.

5. All containers should be marked to identify their contents and empty containers that previously contained petroleum products, cleaning solvents, and antifreeze should be stored separate of other containers.
6. Starting fluid should never be used to clean employee's hands, tools, clothing, or any metals that are to be cut or welded. Starting fluid shall only be used as recommended by the manufacturer, i.e. to start engines.
7. The mine operator should develop and inform all personnel of policies prohibiting "horseplay" and practical jokes. Such policies should be strictly enforced.

SIGNATURE SHEET

This report is hereby submitted by Terry Ratliff and approved by Frank A. Linkous.

TERRY A. RATLIFF, COAL MINE INSPECTOR DATE

FRANK A. LINKOUS, CHIEF DATE

APPENDIX

VICTIM DATA SHEET

PERSONS PRESENT DURING THE INVESTIGATION

MINE LICENSE INFORMATION

VICTIM DATA SHEET

Name:	David Walter Dotson
Occupation:	Utility man
Mailing Address:	HC 60 Box 219A Hurley, Virginia 24260
Date of Birth:	February 19, 1975
Total Mining Experience:	Ten years
Experience with Present Company:	Seven years and six months
Experience in Present Occupation:	Seven years and six months

PERSONNEL

The following personnel provided information and/or were present during the investigation:

TWIN STAR MINING, INC.

Kenneth R. Nicewonder	Mine Operator	
Timothy Gresham, Esq.	Attorney at Law, Pennstuart	
Charles Justice	Safety Consultant	
Samuel Casey	Superintendent	Dayshift
Danny Rife	Mechanic	Dayshift
Glen Mullins	Surface Foreman	Evening Shift
James Estep	Contract Mechanic	Evening Shift
Jason Layne	Mechanic	Evening Shift
Larry McClanahan	Greaser	Evening Shift
Bruce Mounts	Hauler Operator, Emergency Medical Technician	Evening Shift
Shawn Cline	Hauler Operator, Emergency Medical Technician	Evening Shift

MINE SAFETY AND HEALTH ADMINISTRATION

Edward Morgan	District Manager
Norman Page	Assistant District Manager
Derrick Tjernlund	Fire Protection Engineer, Approval and Certification Center
James Poynter	Conference and Litigation Representative
James R. Baker	Educational Field Services Specialist
Russell Dresch	Electrical Engineer
Jesse Persianni	Supervisor, Coal Mine Safety and Health Inspector
Harold Musick	Roof Control Specialist
Wade Gardner	Coal Mine Safety and Health Inspector
David Woodward	Mining Engineer, Ventilation

VIRGINIA DIVISION OF MINES

Frank Linkous	Chief, Division of Mines
Opie McKinney	Mine Inspector Supervisor
Carroll Green	Mine Inspector Supervisor
Danny Altizer	Coal Mine Inspector
Joseph Altizer	Coal Mine Inspector
Bill Messick	Coal Mine Inspector
Terry Ratliff	Coal Mine Inspector

MINE LICENSE INFORMATION

Official Corporation:	Twin Star Mining, Inc.
Official Business Name of Operator:	Virginia Energy Company
Person with Overall Responsibility:	Kenneth R. Nicewonder
Person in Charge of Health and Safety:	Kenneth R. Nicewonder

LIST OF PERSONS INTERVIEWED

Samuel Casey	Superintendent	Dayshift
Danny Rife	Mechanic	Dayshift
Glen Mullins	Surface Foreman	Evening Shift
James Estep	Contract Mechanic	Evening Shift
Jason Layne	Mechanic	Evening Shift
Larry McClanahan	Greaser	Evening Shift
Bruce Mounts	Hauler Operator, Emergency Medical technician	Evening Shift
Shawn Cline	Hauler Operator, Emergency Medical Technician	Evening Shift