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

REPORT OF INVESTIGATION

Surface Facility

Fatal Ignition of Gas Accident
April 27, 2003

Rish Equipment Company (CFD)
Bluefield, West Virginia

at

PC WV SYNTHETIC FUEL #1 LLC
COSI SYNFUELS WV#1 INC
Cabin Creek, Kanawha County, West Virginia
I.D. No. 46-08773

Accident Investigator

Sherman L. Slaughter
Mine Safety and Health Specialist/Accident Investigator

Originating Office
Mine Safety and Health Administration
District 4
100 Bluestone Road
Mount Hope, West Virginia 25880
William A. Dupree, Jr., Acting District Manager

Release Date: July 29, 2003

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Figure 1: Photograph of the accident site.

OVERVIEW

On Sunday, April 27, 2003, a 42-year-old contract mechanic, with 19 years mining experience, received fatal burns to the upper part of his body. He was preparing to use starting fluid to clean coal dust and oil from around the top of two motor mount bolts on a front-end loader. During this process, the aerosol can containing the starting fluid contacted an energized battery relay terminal and the frame of the machine, causing an electrical arc that burned a hole through the side of the can. The starting fluid ignited and sprayed through the hole and onto the victim, causing his clothes to catch on fire. He ran around the front of the loader to a nearby service truck where another mechanic laid him on the ground and extinguished the flames. The victim was transported to a burn center where he later died on May 1, 2003, as a result of the injuries.

GENERAL INFORMATION

The PC WV SYNTHETIC FUEL #1 LLC mine is a synthetic fuel plant located near Cabin Creek, Kanawha County, West Virginia. The plant began operations in June of 1998. It is operated by COSI SYNFUELS WV#1 INC whose parent company is COSI SYNFUELS, INC, of Cabin Creek, West Virginia. Coal is belted and trucked to the plant, processed into a specified product, and belted and trucked to nearby facilities for shipment by barges. Raw coal brought in by truck is stored in stockpiles. Two Komatsu WA 500 front-end loaders and one Kawasaki 90 Z-2 front-end loader are used to feed the plant from the raw coal stockpiles and to load trucks from processed coal stockpiles for shipment.

The plant operates two 12-hour shifts per day, seven days per week. Production shifts start at 7:00 a.m. and 7:00 p.m. The plant employs 19 persons.

The last Mine Safety and Health Administration (MSHA) regular safety and health (AAA) inspection was completed January 27, 2003. The Non-Fatal Days Lost (NFDL) incidence rate during the previous quarter was 2.53 for surface facilities nationwide and 0.00 for this operation.

Principal officers of COSI SYNFUELS WV#1 INC at the time of the accident were:

Frank Andracchi .....Vice President
James A. Schad .....Director of Operations
Tom Dimuzio .....Facility Manager

DESCRIPTION OF THE ACCIDENT

On Sunday, April 27, 2003, Billy Thomas, Jr. and Isaac Ward, Jr., mechanics for Rish Equipment Company (maintenance contractor), began their shift at approximately 7:00 a.m. at the company shop in Beckley, West Virginia. They had instructions to travel to the PC WV SYNTHETIC FUEL #1 LLC operation to repair the air conditioning unit of the Komatsu WA 500 front end loader. Garland Ward, front-end loader operator, was using the machine to load coal trucks when Thomas and Ward arrived at the plant at approximately 8:30 a.m. He parked the front-end loader near the stock pile area at approximately 8:45 a.m. for the repairs to be made. He lowered the bucket to the ground, put the transmission in neutral, applied the parking brake, and shut the engine off with the starter switch. Ward then went back to the plant to operate another front-end loader. At approximately 9:00 a.m. Isaac Ward, Jr. connected an air operated vacuum pump to the front-end loader's air conditioning system compressor in preparation for vacuuming the system.

At approximately 10:00 a.m. the lower area of the stockpile area was examined by Richard Williamson, Lead Technician (Shift Foreman). The area where the mechanics were working on the front-end loader was directly adjacent to this stockpile area. Williamson observed the two mechanics standing to the left of the front-end loader, with their service truck parked near the right side of the machine.

Ward and Thomas replaced the receiver dryer located inside the engine compartment and the expansion valve inside the cab behind the seat. While they were working on the machine, they noticed that the two motor mount bolts on the front of the motor (located at the rear of the machine) were loose.

At approximately 11:00 a.m., Ward went to the service truck to get replacement bolts and nuts. Thomas (victim) had a scraper and an aerosol spray can of starting fluid to clean the coal dust and oil from around the bolts. Thomas was standing on the left side of the machine gaining access to the bolts through the rear engine compartment door. During this process, the aerosol can containing the starting fluid contacted an energized battery relay terminal and the frame of the machine, causing an electrical arc that burned a hole through the side of the can. The starting fluid ignited and sprayed through the hole and onto Thomas, causing his cloths to catch on fire.

A nearby truck driver, who was at the stockpile having his truck loaded, went to the office to call for emergency assistance when he saw Thomas step away from the end loader as he was slapping at the flames trying to put them out. Thomas ran around the front of the loader to the service truck. The other mechanic, Ward, heard Thomas say "Junior" and looked up to see Thomas engulfed in flames from his belt to the top of his head. Ward grabbed Thomas and put him on the ground, rolling over with him until the flames were extinguished. A second truck driver helped Ward get Thomas up and walk him to the nearby office where they sat the victim down and gave him water to drink. Thomas had severe burns on the upper part of his body from the waist up.
Systems Technician, Phala Shafer had called for an ambulance when the first truck driver notified her that they needed emergency help. The Kanawha Ambulance Authority

arrived at approximately 11:10 a.m. and transported Thomas to the nearby Riverside High school where a helicopter (Health Net) transported him to the burn center at Cabell Memorial Hospital, located in Huntington, WV, where he was treated for 3rd degree burns to the upper part of his body.

Ward received severe burns to both of his hands when he extinguished the flames on Thomas. He completed the work of charging the air conditioner and installing the bolts on the front-end loader with the help of James Wayne, Foreman for the production operator, and drove himself to Raleigh General Hospital in Beckley, WV, where the burns to his hands were treated.

Thomas died in the hospital as a result of his injuries on May 1, 2003.

INVESTIGATION OF THE ACCIDENT

The Mine Safety and Health Administration was notified at 1:00 p.m. on Sunday, April 27, 2003, that a serious accident had occurred and accident investigators were immediately dispatched to the plant. A section 103 (k) order was issued to insure the safety of all persons at the plant. The investigation was conducted with the assistance of the operator, the contractor, and the employees. A list of those persons who participated, were interviewed, and/or were present during the investigation can be found in Appendix A of this report.

Representatives of MSHA traveled to the accident scene to conduct an investigation of physical conditions. Photographs and relevant measurements were taken. A sketch of the accident scene was made. Interviews were conducted at the plant and at the contractor's shop with persons who had knowledge relevant to the accident. The physical portion of the investigation was completed on May 13, 2003.

DISCUSSION

Training

Records of training were reviewed. Mine and contractor personnel were interviewed regarding training provided to the victim and other employees. Evidence indicated that the victim had received the required training.

Examinations

The records of mandatory examinations indicated that the examinations required by 30 CFR 77.1713 were being conducted. However, the person who examined the active working areas of the mine on the day shift (7:00 a.m. to 7:00 p.m.) on April 27, 2003 was not certified. A citation was issued for this violation of 30 CFR Part 77.1713(a), but the violation did not contribute to the accident. In this instance, the examiner's lack of certification did not reduce the effectiveness of the examination.

Physical Factors

1. The mechanics' service truck that was parked beside the front-end loader when the accident occurred was removed from the accident scene and was not available at the plant for examination at the time of the investigation.

2. A pump was being used to vacuum the air conditioning system of the Komatsu WA 500 front-end loader (Co. No. 2 and PIN A70287) when the accident occurred. The air supply for the pump was provided from a compressor mounted on the mechanic service truck. While the pump was running it was positioned on the battery box of the end loader on the right side of the machine. Two flexible hoses were hooked to the high and low quick connectors of the front-end loader air conditioning system compressor. The pump was hooked up at approximately 9:00 a.m., but was not started until shortly before the accident. The front-end loader engine was not running.

3. The Komatsu WA 500 front-end loader (No. 2) was parked where the accident occurred at approximately 8:40 a.m. on April 27, 2003. The bucket was lowered to the ground, the transmission was put in neutral, the park brake was set, and the engine was shut off with the starter switch in the cab. The machine remained in this condition and was not restarted before the accident occurred.

4. The front-end loader was being used to load coal trucks at the stockpile immediately before it was parked for Thomas and Ward to work on the air conditioner.

5. Ward and Thomas noticed that the nuts were missing on the two front engine mounting bolts of the front-end loader when they started working on the machine. Oil and coal dust had accumulated around the bolt heads and would need to be cleaned off before they could replace the bolts.

6. Oxygen and acetylene torches or other flame producing tools were not used while the repairs were made. No welding was done.

7. With the engine starting switch off, one terminal located on the battery relay was energized and one terminal on the engine starting switch was energized. No other parts were energized on the machine when the starter switch was off except for the battery, which was located outside the engine compartment on the right rear of the end loader frame. The battery was enclosed inside its own compartment. The engine starting switch was located inside the operator's cab and the battery relay was located on the frame immediately inside the left, rear engine compartment access door of the front-end loader. When the engine starting switch was off, the only energized electrical terminal inside the engine compartment was located on this battery relay. The energized terminal of the battery relay was provided with a cap (rubber insulating boot) to prevent contact and accidental shorting of the terminal to ground. This cap had been slid back onto the wire lead attached to the terminal exposing the energized terminal to possible inadvertent contact. When tested with the starter switch off, there was 26 volts dc measured from the energized battery relay terminal to ground.

8. The purpose of the cap provided for the energized battery relay terminal was to prevent contact and accidental shorting of the terminal to ground. This cap was swollen and would slide easily off the terminal and onto the attached electric wire. Age, oil contamination, and heat had damaged the cap.

9. The mechanics, Ward and Thomas, did not smoke and there were no flame producing items present at the accident scene. None were used while the repair work was being done. No other persons were near the front-end loader when the accident occurred.

10. When the accident occurred, Ward was at the service truck on the right side of the end loader and did not see any flames at the engine compartment where the vacuum pump was located.

11. A truck driver was parked approximately 150 ft. from the front-end loader when the accident occurred. The driver was looking at the victim and only saw flames on the victim when he stepped away from the front-end loader. There were no flames coming from the engine compartment.

12. After the accident Ward and Wayne completed installing the engine mounting bolts and servicing the air conditioning system. Ward cleaned up around the front-end loader and left the mine. He took the aerosol spray can of starting fluid with him. He also took the victim's burned shirt with him. During the accident investigation, on April 28, 2003, he returned these items to recreate the accident scene. He placed the can of starting fluid on the ground near the front of the left rear wheel of the front-end loader. He placed the victim's shirt on the ground to the right of the end loader, near where he indicated that the mechanics' service truck was located at the time of the accident. Pictures were taken of those items at that time.

13. A hole was burned through the side of the aerosol spray can of starting fluid, located approximately 2 inches from the bottom of the can and measuring approximately 1/8 inch by 1/4 inch. The paint on the side of the can around this hole was burnt showing that the area around the hole had been subjected to more intense heat than the other portions of the can. When one held the can in their right hand with forefinger on the spray nozzle, the hole was directed toward the user's right arm and elbow. Witnesses stated that the victim's right elbow was burnt more than the other parts of his body.

14. The victim had the aerosol spray can of Hot Shot Starting Fluid in his hand at the time of the accident. He was working inside the left rear access opening to the engine compartment of the end loader when the can ignited. The top of the mounting bracket for the battery relay was approximately 2 inches from the top of the exposed energized terminal of the relay. The mounting bracket was common to the grounding system of the front-end loader.

15. The MSDS sheet for the Hot Shot Starting Fluid, manufactured by Spray Products Corporation, shows that the fluid is composed of 32.5 percent Diethyl Ether, 60.5 percent Heptane, 6 percent Carbon Dioxide, and 1 percent Upper Cylinder Lubricant with

a flash point of -49°F. It has a lower explosive limit of 1.85 percent and an upper explosive limit of 48 percent. The sheet does not give the auto ignition temperature.

16. The MSDS sheet from Mallinckrodt Baker, Inc. for Ethyl Ether (one synonym being Diethyl ether) indicates that this chemical is an extremely flammable liquid, with a vapor flash point of -45°F and an auto ignition temperature of 320°F.

17. The MSDS sheet from Mallinckrodt Baker, Inc. for Heptane indicates that this chemical is a flammable liquid, with a vapor flash point of 25°F and an auto ignition temperature of 399°F.

18. On April 29, 2003, the Komatsu WA 500 front-end loader (Co. No. 2 and PIN A70287) was operated at the stockpile area loading trucks and then parked for 2-1/4 hours, which duplicated the use of the machine immediately prior to the accident. Thermal readings were taken of the components inside the engine compartment to determine if they would have been hot enough to ignite the starting fluid. The following readings were taken with a Thermal Infra Red Gun manufactured by Raytek:

	Immediately After Shutting Off Engine	2-1/4 Hours After Shutting Off Engine
Engine Exhaust Manifold	356°F	122°F
Exhaust side of turbocharger	440°F	114°F
Engine Block	204°F	131°F
Engine Oil Pan	195°F	127°F

After being parked for 2-1/4 hours one could touch the engine block with the hand but could not leave the hand there for an extended period.

18. The only ignition source determined to exist inside the engine compartment or near the victim where he was located at the time of the accident was the exposed, energized battery relay terminal.

ROOT CAUSE ANALYSIS

A root cause analysis was conducted. The following causal factors were identified:

1. Causal factor: The victim was using a highly flammable fluid near potential ignition sources.

Corrective Action: The contractor provided instruction to their field mechanics and managers, making them aware of the factors involved with this accident and directing them not to use flammable cleaning fluids or materials to clean equipment and parts. Workers were also retrained in their Haz-com program (including the identification of chemicals, hazards presented by their use, and safe work procedures). Several different brands of nonflammable cleaning fluids were provided for the mechanics to use. Their purchasing agent was also instructed to purchase more effective and nonflammable cleaning fluids to lessen the likelihood that the mechanics would want to use starting fluid as a cleaner.

2. Causal factor: The cap (rubber insulating boot) provided to cover the energized battery relay terminal located inside the engine compartment of the Komatsu WA 500 front-end loader (Co. No. 2 and PIN A70287) was deteriorated (swollen from age and exposure to heat and oils) and was not covering the terminal. This condition failed to prevent contact between the exposed, energized, electrical terminal and the base of the can of starting fluid. When the side of the can touched the grounded mounting bracket of the relay, a high amperage arc occurred burning the hole into the side of the can and igniting the starter fluid.

Corrective Action: A new cap was installed on the energized, electrical terminal of the battery relay preventing accidental contact with the bare terminal. All personnel were made aware of the hazards associated with the energized battery relay terminal on the Komatsu WA 500 front-end loader. They were also informed of the importance of maintaining the cap on the terminal. Examinations of front-end loaders now include a weekly examination conducted by a qualified electrician.

CONCLUSION

The accident occurred because a flammable fluid was being used near potential ignition sources. The ignition source, an energized battery relay terminal, was exposed because its insulating cap had deteriorated over time. When the side of the pressurized can containing the flammable liquid contacted both the energized terminal and the grounded mounting bracket, a high amperage electrical arc occurred that melted a hole through the side of the can. The starting fluid ignited and sprayed through the hole onto the victim, causing fatal burn injuries to his upper body.

ENFORCEMENT ACTION

A 103 (k) Order, No. 7185876, was issued to Cosi Synfuels WV#1 Inc, to ensure the safety of all persons at the facility until all areas and equipment were deemed safe.

A 104 (a) citation, No. 7213900 was issued to Cosi Synfuels WV#1 Inc, for a violation of 30 CFR, 77.1606(c), stating in part that the accident occurred as a result of a defect that was present on the Komatsu WA 500 front-end loader (Co. No. 2 and PIN A70287). The defect was a deteriorated (swollen) cap (rubber boot) provided by the manufacturer to cover an energized, 24-volt dc, terminal where a wire connected the batteries to the battery relay of the machine. The cap had slid along the wire, exposing the energized terminal. Contact with the exposed conductor terminal caused an arc that ignited and ruptured a can of pressurized starting fluid, resulting in fatal burn injuries to a mechanic.

Approved by:

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William A. Dupree, Jr.
Acting District Manager

APPENDIX A

The following persons were interviewed during this investigation:

COSI SYNFUELS WV#1 INC

James A. Schad .....Director of Operations
Richard Williamson .....Lead Technician
James C. Wayne.....Chief Electrician
Phala Shafer .....Assistant Technician
Garland Ward .....Front-End Loader Operator

Big E Trucking

William Scott .....Truck Driver

Rish Equipment Company

Rod Mills .....Manager
Isaac Ward, Jr.....Mechanic
Tom Foley.....Mechanic
Steve Archie.....Mechanic
Tim Bandy .....Mechanic
Mark Pack.....Mechanic
Randy Jennings.....Mechanic
Bruce Tyren .....Warehouse Manager

Mine Safety and Health Administration

Sherman L. Slaughter..... Surface Coal Mine Safety and Health Specialist/Accident Investigator
Mike Hess .....Coal Mine Safety and Health Inspector