UNITED STATES
DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION
Metal and Nonmetal Mine Safety and Health

REPORT OF INVESTIGATION

Underground Nonmetal Mine
(Limestone)

Fatal Powered Haulage Accident
January 31, 2005

Underground Black River Operation
Carmeuse Lime and Stone, Incorporated
Butler, Pendleton County, Kentucky
Mine I.D. No. 15-00062

Investigators

Donald B. Craig
Supervisory Mine Safety and Health Inspector

Thomas G. Galbreath
Mine Safety and Health Inspector

F. Terry Marshall
Mechanical Engineer, PE

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Mine Safety and Health Specialist

Originating Office
Mine Safety and Health Administration
Southeast District
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Michael A. Davis, District Manager

OVERVIEW

David W. Wilson, mechanic, age 33, was fatally injured on January 31, 2005, when he failed to maintain control of his tractor in an "S" curve on an underground roadway and the tractor overturned.

The accident occurred because policies, standards, and controls were inadequate and failed to identify excessive free play in the steering wheel and improper air pressure in the tractor tires.

GENERAL INFORMATION

Underground Black River Operation, an underground limestone operation, owned and operated by Carmeuse Lime and Stone, Incorporated was located along Highway 8 in Butler, Pendleton County, Kentucky.

The principal operating official was Carroll Laufmann, site operations manager. The mine operated two 10-hour shifts a day, 4 days a week. Total employment was 87 persons.

A room and pillar mining system was used to mine the limestone in two benches. Limestone was drilled, blasted, and loaded by front-end loaders into haulage trucks. The shot rock was transported to an underground jaw crusher and conveyed to the surface plant where it was further processed. The finished lime products were sold for use in the construction, agriculture, and chemical industries.

The last regular inspection at this operation was completed on January 27, 2005.

DESCRIPTION OF ACCIDENT

On the day of the accident, David Wilson (victim) reported to work one hour prior to his normal starting time of 6:00 p.m. Wilson, along with two co-workers, Michael McKenzie, utility operator, and Gerry Wynn, bolter operator, clocked in and traveled underground to the shop maintenance office. There they met David Tuel, day-shift maintenance foreman, who assigned Wilson to repair the track adjusters on a scaler. About 5:25 p.m., Wilson left the main shop on an industrial tractor and traveled to the North lunch room.

Wilson arrived in the north area of the mine, and met Robert Hord, scaler/bolter, to discuss the repairs needed on the scaler. After a brief discussion, he left as Hord prepared to leave for the shop.

About 6:30 p.m., McKenzie was driving south toward the main shop when he came upon an overturned tractor in the middle of the roadway. He observed an arm sticking out from under the tractor, and called to the victim. When he did not receive a response, McKenzie drove to the shop to summon help. McKenzie reported the accident to Robert Kitchen, maintenance foreman, who called Larry Caswell, 2nd shift hoistman, and asked him to send the slope car

to the bottom. He also notified Jim Markley, kiln operator, to request emergency medical personnel. Kitchen then went to the accident scene with other employees.

A forklift was used to raise the tractor so Wilson could be removed. Cardiopulmonary resuscitation was attempted, but the victim was non-responsive. Wilson was taken by ambulance to the surface where he was pronounced dead at 7:21 p.m. The cause of death was attributed to multiple blunt force injuries.

INVESTIGATION OF THE ACCIDENT

MSHA was notified of the accident at 6:45 p.m. (EST), on January 31, 2005, by a telephone call from Alane K. Preston, loss prevention manager, to Michael A. Davis, district manager. An investigation was started that same evening. An order was issued under the provisions of Section 103(k) of the Mine Act to ensure the safety of the miners. MSHA's accident investigators traveled to the mine, made a physical inspection of the accident scene, interviewed employees, and reviewed conditions and work procedures relevant to the accident. MSHA conducted the investigation with the assistance of mine management, miners' representatives, and employees.

DISCUSSION

TRACTOR

The tractor involved in the accident was a two-wheel drive 1990 Ford, model number 3520. The tractor, equipped with a 3 cylinder 53 hp diesel engine and a manual 8-speed transmission, had a net weight of 5,410 pounds. The tractor wheelbase (axle to axle centers) was approximately 77 inches. A personnel carrier body had been installed on the rear of the tractor to haul personnel, tools, and/or supplies as needed. According to mine personnel, a local shop fabricated the personnel carrier body.

The machine, as evaluated, was not equipped with a roll over protective structure (ROPS). MSHA's mandatory safety and health regulations do not require ROPS and seat belts to be installed on agriculture tractors that are operated underground.

The investigators concluded that the tractor's engine was still running after the accident.

Repairs to the cooling and exhaust systems were made so the tractor could be evaluated. The tractor was operated to conduct functional tests on the brake, steering, clutch, and throttle systems.

DRIVE LIGHTS

The right and left side drive lights on the front of the machine were tested, and both of them illuminated when the dash mounted flip switch was cycled. These lights were reportedly turned off after the accident by mine personnel. An additional light, described as an "area" light by mine personnel, could be rotated for positioning and was mounted on the right side of the tractor body near the operator's seat. This light was also determined to be functional (using a separate flip switch on the light body).

THROTTLE CONTROL AND MAXIMUM TRAVEL SPEED

The throttle control was a hand lever located on the right side of the dash board panel below the steering wheel. The control was arranged so the engine speed increased as the control lever was pulled back toward the operator. The throttle control lever was originally designed so the control lever would stay in the position that the operator put it in once hand pressure was released; however, this was not experienced during functional tests. When tested, the control lever sprang back to a low idle position, depending on how the control lever was modulated. If the lever was pulled all the way back and then suddenly released, it would spring back to a low idle position; however, if the control lever was feathered to a partial throttle position, it would stay in a partial throttle position.

When the throttle position was set to a maximum position, in which a "hands free" condition was achievable, the engine speed was estimated to be approximately 1,100 RPM, or approximately ½ throttle.

The speed of the tractor in 8th gear and at an engine speed of 1,100 RPM was calculated to be approximately 8 MPH. At 8 MPH, it was estimated that the engine would need to produce approximately 15-20 horsepower to maintain this speed on the 7.6% grade. A review of the engine's performance characteristics indicated that the engine should have been capable of producing this horsepower at an engine speed of 1,100 RPM. This information indicated that the tractor was capable of pulling the grade in the accident area at a speed of approximately 8 MPH without the operator having to

adjust the throttle control if the throttle was originally positioned as described above. Product literature lists a travel speed of 15.4 MPH in 8th gear with a maximum engine speed of 2,200 RPM.

STEERING SYSTEM

The tractor had power-assisted steering with the engine running and could also be operated in the manual mode with the engine off as needed. Once the tractor was upright, the fluid level in the power steering reservoir was determined to be full. In both the manual and power-assisted modes of operation, the steering wheel was observed to move approximately ¼ of a turn (or 90 degrees) in order to initiate movement of the wheels when changing steering directions.

Visual observations of the steering linkage and connections did not identify any significant wear in the external linkage connections that might produce this effect. The majority of this 'play' in the steering was due to internal problems with the steering gear assembly. For comparison purposes, the Commercial Vehicle Safety Alliance out-of-service criterion for on-highway trucks indicated that any movement exceeding 45 degrees for vehicles equipped with power steering systems would place the vehicle out-of-service.

The steering angles of the right side steering tire were observed to be askew. Physical damage to the right side of the steering axle was observed. Investigators determined that the side of this tire skidded across the mine bottom while the rest of the tractor rotated about the right front wheel as it flipped over during the accident.

SERVICE BRAKE SYSTEM

The tractor had left and right side, enclosed wet disc, brakes on the rear axle. The pedals were arranged so that the left and right side brakes were controlled separately by the operator's right foot through mechanical linkages. The brakes could be applied independently of each other or at the same time by either applying both pedals simultaneously or by locking the pedals together using a pin on the pedal assemblies. The pedals were not pinned together when inspected after the accident.

Pull through tests were conducted on the service brakes. Both the right and left side brakes were functional and returned to the released position after the foot pedals were released. The

tractor was able to pull through in the 6th gear, ½ throttle with both service brakes applied. The service brakes stalled the tractor in both the 7th and 8th gears at ½ throttle.

TRANSMISSION

The tractor had a manual transmission with 8 forward speeds and 2 reverse speeds. The transmission controls were found in the 8th gear position.

TIRE INFORMATION AND PRESSURES

The front tires were Firestone Champion Guide Grip 3 Rib – F2, Tube Type tires, size 6.50-16 with a 6-ply rating. The rear tires were Firestone All Traction Utility – R4, Tube Type tires, size 14.9-28 with an 8-ply rating.

The tire pressures (cold) were measured and are shown in Table #1.

	Left Side (PSI)	Right Side (PSI)
Front Axle	42	22
Rear Axle	7	11

Table #1: Measured cold tire pressures.

The tire pressures measured for the rear tires were low because the tractor was used for transportation rather than pulling implements which required traction. Lowering the rear tire pressures was generally used to increase traction and/or lower ground pressures; however, lowering the rear tire pressures combined with a significant differential between the steering tire pressures adversely affected the handling of the tractor in a turning maneuver.

Inflation charts obtained from the manufacturer[1] indicated that the lowest recommended tire pressure for the rear bias ply tires, while used in transport and traction services, are 18 PSI and 12 PSI respectively. These charts indicated that the lowest recommended tire pressure for the front bias ply tires, while used in field service should be 24 PSI.

HAULAGE WAY INFORMATION

The haulage way immediately before the s-turn required that the victim drive downgrade, through a dip, and then upgrade into the s-turn. The profile of the haulage way leading up to the

[1] Firestone, *Tire Data Book*, http://www.firestoneag.com/databook/, February 2005.

accident area in the direction of travel was provided by mine personnel and is summarized in Table #2.

General Road Geometry	Average Downgrade (%)	Average Upgrade (%)
Straight	6.1	
Straight	0	0
Straight		6.5
Right turn with a 53 feet turn radius		6.7
Left turn with a 40 feet turn radius		7.6

Table #2: Profile of haulage way leading up to the accident area in the direction of travel.

The haulage way was dry and in good condition.

TRAINING AND EXPERIANCE

Wilson had 3 years and 30 weeks of experience as a mechanic, and his total mining experience was 4 years, 6 weeks, all at this mine. He had received training in accordance with 30 CFR, Part 48.

ROOT CAUSE ANALYSIS

A root cause analysis was conducted and the following causal factors were identified:

Causal Factor: Management policies, standards, and controls were deficient and did not ensure that the agriculture tractor was

operated safely in the underground environment. The tractor was operated at speeds that were not consistent with conditions of roadway, grades, clearance, visibility, and the type of equipment.

Corrective Action: Establish policies that govern gear selection and operation speed for all mobile equipment and monitor equipment operation.

Causal Factor: Management policies, standards, and controls were inadequate and failed to implement corrective actions in a timely manner. Multiple defects were found on the tractor including the steering system, defective throttle detent, low tire air pressures, and imbalanced air pressures across tire sets. The equipment manufacturer's guidelines were not utilized to evaluate the need for maintenance or repairs.

Corrective Action: Procedures should be established to ensure that all mobile equipment is inspected for defects prior to being placed into service during each shift. Mobile equipment operators should be trained to identify safety defects. Procedures should be implemented to repair any defects that affect safety or remove the equipment from service until the repairs are made. Equipment manufacturer reference manuals should be available and utilized to develop pre-shift inspection procedures to identify defects affecting safety.

Causal Factor: Management's task training failed to utilize the equipment manufacturer's operation procedures for operating the tractor.

Corrective Action: Establish and implement a training program ensuring that all miners assigned to operate mobile equipment are task trained utilizing the manufacturer's Operations Manuals.

CONCLUSION

The accident occurred because policies, standards, and controls were inadequate and failed to ensure that the defective throttle control, steering assembly, and improper tire pressure had been promptly corrected on the tractor. The roadway grade and S turn, in conjunction with the speed, contributed to the operator's failure to maintain control of the tractor.

VIOLATIONS

Order No. 6108510 was issued on January 31, 2005, under the provisions of Section 103(k) of the Mine Act:

> A fatal accident occurred at this operation on January 31, 2005, when a Ford Tractor overturned pinning the operator beneath the vehicle. This order is issued to assure the safety of all persons in the affected area where the accident occurred. It prohibits all work and travel at the 91 North x 95 East cross-cut and includes the Ford Tractor. The mine operator shall obtain prior approval from an MSHA authorized representative for all actions to recover and/or restore operations to the affected area.

This order was terminated on February 22, 2005, when it was determined that the conditions that had contributed to the accident had been eliminated.

Citation No. 6101522 was issued on March 16, 2005, under the provisions of Section 104(a) of the Mine Act for a violation of 30 CFR 57.14100(b):

> A fatal accident occurred at this mine on January 31, 2005, when a tractor overturned, pinning the operator under the tractor. The accident occurred as the operator was negotiating an "S" turn upgrade. Defects affecting safety found on the tractor included free play of one quarter turn in the steering wheel and air pressures in the rear tires below safe levels, and air pressures in the steering tires that differed significantly from left to right. These defects had not been corrected in a timely manner.

This Citation was terminated on April 15, 2005, when the mine operator submitted a letter dated April 14, 2005. The letter stated that the Ford New Holland Tractor, serial number BC5757306, company number 26052, has been permanently removed from service and will be utilized for scrap parts.

Citation No. 6101523 was issued on March 16, 2005, under the provisions of Section 104(a) of the Mine Act for a violation of 30 CFR 57.9101:

> A fatal accident occurred at this mine on January 31, 2005, when a tractor overturned pinning the operator under the tractor. The accident occurred as the operator was negotiating and "S" turn. The operator of this self

propelled equipment failed to maintain control of the equipment while it was in motion.

This Citation was terminated on April 14, 2005. Mine management has reinstructed mobile equipment operators regarding safe operating speeds utilizing their instructor's knowledge, the 30CFR, the mine's training plan, and manufacturer's operations manuals as training materials. Conditions in the mine that can affect safe operation and handling were also included.

Approved by: _____ Date: _____
Michael A. Davis
Southeast District Manager

APPENDIX A

Persons Participating in the Investigation

Carmeuse Lime and Stone, Inc.

Carroll W. Laufmann	site operations manager
John Cairns	area human resources manager
Alane K. Preston	area 2 loss prevention manager
Greg Black	production superintendent
Gary Green	maintenance superintendent
Robert A. Kitchen	night shift underground maintenance supervisor
David Shane Tuel	day shift underground maintenance supervisor

United Steelworkers of America, Local 162

Roger Newman	president
Sammy Linville	vice president
Michael E. Jones	committeeman
John Bravard	committeeman
Bennett C. Thomas	miner’s representative

Liberty Mutual Group Insurance

Ed Macey	Liberty Mutual Group Compensation Agent

Mine Safety and Health Administration

Donald B. Craig	supervisory mine safety and health inspector
Thomas G. Galbreath	mine safety and health inspector
F. Terry Marshall, PE	mechanical engineer
Daniel L. Woods	mine safety and health specialist