MAI-2012-06

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

REPORT OF INVESTIGATION

Underground Nonmetal Mine
(Crushed and Broken Limestone)

Fatal Powered Haulage Accident
May 15, 2012

Sterling Materials
Sterling Materials
Verona, Gallatin County, Kentucky
Mine ID No. 15-18068

Investigators

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OVERVIEW

On May 15, 2012, Angela W. Common, age 37, was killed while operating an articulated haul truck down a steep slope. Common returned to work on May 14, 2012, following a voluntary layoff of approximately 2½ years. She was driving down the slope when the truck went out of control and struck a rib, causing the tractor portion of the truck (cab) to overturn.

The accident occurred due to the failure of management to ensure the victim was task trained in the safe operation of the haul truck, that safe operating speeds were maintained, and hazardous conditions on the slope were corrected in a timely manner.

GENERAL INFORMATION

Sterling Materials was a multi-level, underground limestone mine owned and operated by Sterling Materials. The mine was located in Verona, Gallatin County, Kentucky. The principal operating official was Alex Boone, President. The mine normally operated two 12 hour shifts per day, 7 days per week. Total employment was 49 persons.

The mine had three working levels connected by sloped entries. Limestone was blasted from the headings and front-end loaders were used to load the blasted material into haul trucks. The haul trucks carried the material to one of three rock crushers located on each of the three levels. Two parallel slopes connected the second and third levels, referred to as the East Belt Slope and West Slope. The West Slope was the primary travelway used as a haul road when necessary to haul material between these levels.

After the material was crushed and sized, it was transported by belt conveyors to stock piles located underground and/or conveyed directly to the surface. Finished materials were sold for various uses in the construction industry.

The Mine Safety and Health Administration (MSHA) completed the last regular inspection at this operation on March 1, 2012.

DESCRIPTION OF ACCIDENT

On the day of the accident, May 15, 2012, Angela W. Common (victim) reported to work at 7:10 a.m. For the first hour, Common completed "Newly Hired Experienced Miner" training in the mine office. She started this training the day before but needed an additional hour to complete the required training.

At approximately 8:10 a.m., Robert Stanifer, Shift Supervisor, and Common traveled underground in a pickup truck. They traveled to Level 2 at Southwest 5, where a front-end loader was loading haul trucks. Stanifer stopped a haul truck operated by Adam Chapman (Roof Bolter/Truck Driver). Stanifer told Chapman to refresh Common on the operation of the truck while she rode with Chapman. About 8:30 a.m., Chapman resumed operating the truck with Common riding as a passenger. At this time, the truck was being loaded on Level 2 at Southwest 5, hauling down the West Slope to the Level 3 crusher. Chapman hauled approximately 12 loads down the West Slope with Common in the truck. At approximately 11:30 a.m., Chapman asked Common if she wanted to operate the haul truck but she asked to continue observing him operate the truck.

About 12:15 p.m., Stanifer called Chapman on the radio for a progress check. Immediately after this call, Common started operating the haul truck with Chapman riding in the passenger seat. She hauled approximately four loads with Chapman as an observer.

At approximately 12:30 p.m., Stanifer and Chapman left to go to another area of the mine. Common began operating the haul truck alone and resumed hauling down the West Slope to the third level crusher. She hauled approximately 14 loads until 2:30 p.m. About this same time, Stanifer was traveling up the West Slope from Level 3 when he called Common via radio and told her to hold the loaded haul truck at the top of the slope in order to let him pass. Investigators could not determine whether Common was on the slope and had to back up or if she was at the top and backed up to let Stanifer pass.

At 2:40 p.m., Stanifer returned from the Level 3 (east side) of the slope where he discovered Common's haul truck 55 feet up the West Slope. Stanifer called Tammy McIntyre, Level 2 Crusher Operator, and told her to call Chris Pulliam, Superintendent, and tell him to go to the West Slope. McIntyre called Pulliam and he drove down the slope to the truck. Pulliam could not find Common in the truck. He walked up the slope and found her lying on the ground approximately 100 feet from the truck. Pulliam checked Common but she was nonresponsive.

Pulliam told Stanifer to call MSHA personnel, who were in another area of the mine conducting an investigation, and also to call 911. Stanifer called McIntyre, told her the truck was upside down, and to call MSHA and 911. Pulliam instructed Stanifer to evacuate the mine and transport the MSHA personnel from Level 2 to the accident site.

At 2:55 p.m., Scott Johnson, MSHA Lexington Field Office Supervisor, and Donald Gabbard, MSHA Mine Safety and Health Inspector, arrived at the accident scene, walked up the slope, and checked the victim but she was nonresponsive. Johnson promptly issued a verbal 103 (k) Order of the Mine Act to Pulliam. Barry Alexander, Gallatin County EMS, arrived at the accident site at 3:08 p.m. After assessing the victim, Alexander contacted Jacques Hughes, Gallatin County Coroner. At 3:56 p.m., Hughes arrived and pronounced the victim dead. The cause of death was attributed to multiple blunt force injuries.

INVESTIGATION OF THE ACCIDENT

In addition to notifying MSHA personnel underground at the time of the accident, MSHA was notified of the accident at 2:56 p.m. on May 15, 2012, by a telephone call from Katie Hamm, Office Manager, to MSHA's National Call Center. The Call Center notified Doniece Schlick, Assistant District Manager, and an accident investigation was started immediately.

MSHA's accident investigation team traveled to the mine, conducted a physical inspection of the accident scene, the haul truck, interviewed employees, and reviewed documents and work procedures relevant to the accident. Legal counsel for the mine operator was present during a majority of the interviews.

MSHA conducted the physical inspection of the haul truck with the assistance of mine employees, Rudd Equipment representatives, and Volvo representatives.

DISCUSSION

Location of the Accident

There were three levels in the mine with each level connected by sloping ramps. With reference to the mine entrance portal elevation, Level 1 was approximately 250 feet deep, Level 2 was approximately 350 feet deep, and Level 3 was approximately 525 feet deep. Each mine level had 40 to 50 foot high ceilings, while the slope ramps had 20 to 25 foot high ceilings. At the time of the accident, the victim was hauling a load of rock down a ramp from Level 2 to the primary crusher located on Level 3. The ramp was referred to as the West Slope. A second, nearly identical ramp referred to as the East Belt Slope, which houses the belt conveyor structure, was adjacent to the West Slope.

Description of the West Slope

The West Slope was approximately 720 feet long, 25 feet wide, and averaged 24.5 percent in overall grade according to the company's survey profile (which was also confirmed by the investigators' measurements). The road was straight, dry, and mainly on the limestone base rock. Poor surface conditions were observed along the road including humps, potholes, and dips, particularly near the bottom of the ramp.

During interviews, haul truck drivers indicated rough conditions could cause the haul trucks to “wheel hop”, resulting in control problems. The miners described the slope as rough and/or “bad” the day of the accident. On May 15, 2012, prior to the accident, Eddie Hearn, Mechanic/ Haul Truck Operator verbally reported to Stanifer that the West Slope roadway was in bad condition and needed scraped. Stanifer told Hearn he would inform the second shift to perform maintenance on the road.

Road maintenance consisted of grading the road surface with a front-end loader bucket, followed by the placement of crushed limestone gravel, a dense grade aggregate. Maintenance was last performed on the West Slope road surface on May 7, 2012.

At the time of the accident, the haul truck had traveled approximately 395 feet down the ramp and struck the left rib, causing the cab of the truck to flip completely upside down. The bed of the truck remained upright and the truck continued to travel approximately 270 feet down slope before coming to rest about 55 feet from the bottom of the slope. The victim was found outside the cab on the haul road and it appeared she had been run over by the trailer wheels.

When the truck hit the left rib, it left a mark on the rib approximately 14 feet, 8 inches long. The mark was made by the truck’s front left tire, since there was no evidence of paint on the rib which would have indicated an impact by the truck’s body. The mark extended from the base of the rib and gradually increased to about 6 feet in height at its final visible location. The mark was approximately 24 inches wide at its widest point. For comparison, the tread width of the truck tire was approximately 29 inches. Considering the articulating nature of the truck’s cab and the size and orientation of the mark, investigators determined that the front left tire of the haul truck rode up onto the rib, causing the cab of the truck to flip over.

There were no major dips or depressions in the road immediately above the location where the truck struck the left rib. The investigators did not observe any skid marks on the road prior to the truck striking the left rib. They did not observe any warning signs or other means for mobile equipment operators to control or restrain their vehicles.

Traffic Rules and Communication

Management did not have any written traffic rules in place at the mine. Management informed the investigators there was an oral policy for a maximum speed limit of 15 miles per hour (mph) and loaded haul trucks typically had the right-of-way. However, the investigators did not observe any traffic control or warning signs posted within the mine indicating the speed limit, stop or yield, percent grade of slope ramps, etc. In addition, the haulage routes were not identified or marked.

Visibility within the mine was typically limited to the distance illuminated by the vehicle's headlights. A few areas of the mine were provided with auxiliary lighting, such as near the crusher stations on Levels 2 and 3. With respect to road dust, witness testimony indicated that it generally did not cause visibility issues within the mine. Visibility was not considered to be a contributing factor to the accident.

The haul trucks and other supporting vehicles were typically equipped with two-way radio communication. The truck drivers were instructed to notify each other when accessing the ramp. However, during interviews, miners stated this was not a common practice. The drivers would often rely on watching for oncoming headlights to determine if another vehicle was coming down (or up) the ramp. During interviews, miners stated that in some cases, the vehicles would turn onto the ramp and then have to immediately back out because another vehicle was heading in their direction.

Management indicated the West Slope was intended to be used as a single lane road. Haul road safety guidelines, such as MSHA's Haul Road Inspection Handbook PH99-I4, recommend that each lane of haulage travel should be provided with clearance on both sides equal to one-half the width of the widest vehicle in use. Using this guidance, the road should be at least 2 times the width of the widest vehicle for single lane traffic, or at least 3.5 times the width of the widest vehicle for two lanes of traffic.

Using the width of the road (25 feet) and the mirror-to-mirror width of the haul truck (11 feet, 9 inches), adequate clearance was provided for single lane traffic use. However, there would not have been enough clearance for a haul truck or other supporting vehicle to safely pass another vehicle on the West Slope.

<u>Truck Involved in the Accident</u>

The mine operator purchased two new Volvo A40F articulated haul trucks, #417 and #418, and put them in service at this mine in December, 2011.

1) TRUCK INFORMATION: The haul truck involved in the accident was a Volvo A40F, six wheel articulated haul truck designated as company truck number "418". It had one drive axle on the tractor (tractor axle) and two

drive axles on the trailer (front and rear bogie axles). The truck was capable of several operating modes to include four wheel drive, six wheel drive, and full six wheel drive. Product information indicated the truck had an outside track width of 11 feet 3 inches, an empty weight of approximately 67,800 pounds, and was rated for a maximum payload of 85,800 pounds. It was equipped with a Volvo D16H diesel engine, an electronically controlled automatic transmission with nine forward speeds, three reverse speeds, and a neutral position. The driver selected transmission control positions in the forward direction included 1, 2, 3, and D.

The rock loaded on the truck at the time of the accident was determined to be 38.7 tons, or 77,400 pounds.

2) GENERAL CONDITION OF THE TRUCK: The tractor portion of the articulated truck came to rest overturned on its top against the right side rib with the loaded trailer portion of the articulated truck still upright and on all four tires. A debris field was observed within the slope which started in the area of initial contact with the left rib, transitioned across the width of the slope, and continued along the right side of the slope down to the final location of the truck.

The tractor portion of the truck sustained significant damage to the cab and engine compartment areas. The tractor's left side tire was deflated, the tractor's left side axle shaft was broken, and both the tractor's left side rim and rubber suspension spring were severely damaged but the tractor axle was still intact to the frame. The tractor frame itself was relatively undamaged. The Rollover Protective Structure (ROPS) was severely damaged and the top of the operator's cab had completely separated from the truck.

The engine could not be operated at the time of the inspection due to accident and truck recovery damage.

All of the brake system's axle and wheel end components were visibly intact. All of the lines for the trailer's hydraulic brake systems (service brake and brake cooling systems) were undamaged on the trailer itself. The service brake foot pedal was intact. Some of the hydraulic lines or couplings for the service brake system were damaged in the rear area of the cab and were repaired to conduct limited service brake tests.

3) SERVICE BRAKE SYSTEM DESIGN: The haul truck was equipped with a fully hydraulic dual circuit service brake system (one circuit for the

tractor service brakes and one circuit for the trailer service brakes) that used enclosed wet disc brakes on all six wheels. Modulation of the hydraulic applied service brakes was primarily controlled by the foot brake pedal control. The service brake system also had electronically controlled features which would apply the service brakes under certain conditions (e.g. the driver applying the load and dump brake, the truck exceeding the maximum ground speed setting, the driver applying the parking brake as an emergency brake) but these features were upstream of the foot valve from a control logic standpoint, i.e., the foot brake pedal control could still be used by the driver to fully apply the service brakes if needed.

The enclosed wet disc service brakes were oil cooled. This cooling circuit used a separate hydraulic pump and reservoir arrangement and a water-cooled brake intercooler.

4) PARKING BRAKE SYSTEM DESIGN: The truck was equipped with a driveline mounted spring applied, air released parking brake system. It was a caliper type disc brake arrangement acting on the rear output side of the drop box that was primarily controlled by a two position toggle switch on the console to the right of the operator's seat. A drop box is generally similar in function to a four wheel drive transfer case used in automotive applications. A spring applied, air released longitudinal differential lock was used in the drop box to transfer parking brake torque to the front wheels when the parking brake was applied. This was done by locking together the front and rear output shafts of the drop box.

5) ENGINE BRAKE SYSTEM DESIGN: The engine brake system, called the Volvo Engine Brake (VEB), consisted of a compression brake in the engine's valve train and an exhaust brake in the engine's variable geometry turbo assembly. It was primarily controlled by the position of the fuel (accelerator) foot pedal and by the service brake foot pedal once a two position toggle switch on the console to the right of the operator's seat was cycled to "arm" (activate) the system. With the engine brake switch in the "arm" position, the engine brake would activate at a low level when the accelerator pedal was fully released to the idle position. The service brake foot pedal was then used to simultaneously modulate the service brakes and increase the engine braking level through the first half of pedal application. Once the service brake foot pedal was pressed past the first half of its range, engine braking level was at its maximum and only the service brakes were applied more aggressively. If the engine brake switch was not cycled to "arm" the engine brake system, the engine brake was not applied at any level regardless of the accelerator or service brake foot pedal positions.

A chart in the cab indicated the maximum permitted speed when operating downhill was 5 miles per hour on a 25 percent grade and 4 miles per hour on a 35 percent grade. These speed ratings were with the truck at its maximum rated gross vehicle weight while using the engine brake system.

6) STEERING SYSTEM DESIGN: The truck had an articulated steering system that used mechanical linkages to actuate a hydraulic steering control valve which then modulated two hydraulic cylinders, one on each side of the truck's articulation joint. A series of engine driven pumps provided hydraulic pressure and flow to the steering valve. In addition to providing approximately 45 degrees of steering in either direction, the articulation joint arrangement had an oscillating hitch. This allowed complete independence of tractor rotation with respect to the trailer on the longitudinal axis, allowing the tractor to rotate 360 degrees with respect to the trailer. Mechanical linkage was used to provide steering inputs from the steering wheel to the hydraulic steering valve mounted beneath the rear portion of the cab. A mechanical linkage was also connected to the steering valve from the trailer to provide position feedback to the steering valve. This allowed the steering valve to automatically adjust to certain operating conditions to minimize driver workload.

The truck also had an auxiliary steering pump to supply adequate pressure and flow in the event the primary steering system's pumps failed. The auxiliary steering pump was ground driven and the truck needed to be moving at least 2 miles per hour in the forward direction for it to operate properly. In general, all other primary steering system components were used to operate the steering when the auxiliary steering pump was needed, i.e., all steering components were shared by both the primary and auxiliary steering systems except for the pumps.

7) ELECTRONIC CONTROL UNIT SYSTEM: The truck had a series of seven electronic control units (modules) that monitored machine functions, stored various machine parameters, stored error codes, and periodically transmitted (uploaded) the logged parameter information to Volvo via a wireless connection module. The modules communicated with each other and subsequently controlled various machine functions through wire harness interconnections.

Whenever an error code was detected, the system would log the occurrence of the fault. The system also stored certain machine parameters but presented this information based on cumulative machine hours. It did not store these machine parameters as real time information. The error code history and parameter settings could be downloaded into what Volvo refers to as a Job Card. The machine parameters history can be downloaded into a Volvo referenced Matris Report. Since the machine parameters were not stored as real time information, the only way that the Matris Report could be used to gain insight into recent operating parameters of the truck was to manually compare a previous Matris Report to the current one. The stored information was accessed on the truck through a service socket in the operator's cab using a computer having the appropriate Volvo software.

8) TRUCK DIFFERENTIAL LOCKING SYSTEM: The truck had a series of differentials and locking clutches to provide operating modes of up to full six wheel drive capability. A longitudinal differential in the drop box provided four wheel drive (driven by both the tractor axle & the front bogie axle) and a dog-clutch assembly between the front and rear bogie axles provided six wheel drive (driven by the tractor axle, the front bogie axle and the rear bogie axle). Each of the three axles normally operated in an open differential type mode but had transverse (cross axle) locking differentials which could lock each side of the respective axle together. During operation, all three axle (cross axle) differentials were controlled at the same time, i.e. all three drive axles operated in the same cross axle mode as each other, either all three open or all three locked. The truck differential locking system had two operating modes to include an automatic traction control (ATC) mode and a manual mode. The truck normally operated in the ATC mode in which the truck differential locking system was electronically controlled depending on operating conditions and required no driver interaction. The truck automatically switched between four wheel drive, six wheel drive, and full six wheel drive. In full six wheel drive, all six wheels rotate at the same speed. A foot button switch allowed the driver to operate in the manual mode as needed. When the foot button was depressed, all the differential locks and the interaxle dog-clutch between the front and rear bogie axles would lock if operating conditions permitted, providing full six wheel drive.

9) SERVICE BRAKE TESTING: The service brake system could not be tested in its entirety due to accident and recovery damage. The inability to run the truck engine prohibited the use of the truck's hydraulic system to supply and maintain hydraulic pressure to the brake charging system. As such, a remote hydraulic power source was used to supply hydraulic pressure to the service brake system upstream of the foot brake valve and the accumulator systems for both the front and rear service brake circuits. After some minor repairs of damage to the service brake system caused by the

accident and truck recovery, tests were conducted using the foot brake valve to cycle the service brakes. Both the front and rear service brakes cycled using the foot brake valve. Application pressures of approximately 2,000 PSI were achieved in both the front and rear service brakes with a brake system charge pressure of approximately 3,600 PSI. This is within Volvo service manual specifications [(1)]. In addition, the accumulators for both the front and rear service brake circuits were determined to be fully functional in that both systems maintained the minimum specified pressure after two full application cycles of the service brakes as specified within Volvo service manual specifications [(1)].

Due to damage incurred during the accident and truck recovery, the brake charging pump could not be tested on the truck for adequate pressure and flow. However, the lack of an error code related to the supply pressure of this pump system indicated the brake charging pump functioned normally throughout the shift and up to a time shortly before the accident.

The wear indicator pins and disassembly of select wheel ends indicated the wet disc brake pack wear for the enclosed wet disc brake assemblies on all six wheel ends were within the manufacturer's recommendations.

Maintenance documents for another Volvo A40F articulated truck operated at this mine indicated this truck (Product Identification Number VCEOA40FL00011386, designated as company truck number "417") had recently been experiencing brake cooling oil overheating problems with the service brake system. Investigators determined the brake cooling oil overheating issue was caused by a degradation of a 'cork' backing material used on the brake stator (metal disc) between the stator and brake piston in the wet disc brake packs. Portions of this backing material had broken free of the stator and contaminated the cooling system for the enclosed wet disc brakes, adversely affecting the cooling capacity of the brake cooling circuit. The dislodged backing material had clogged both the hydraulic filter and intercooler for the brake cooling circuit.

Portions of the brake cooling circuit for the truck involved in the accident were disassembled and visually inspected for similar problems. It was determined that although the underlying problem also existed on this truck (degradation of the 'cork' backing material), the backing material had not yet dislodged from the stators and caused any visible restrictions in the filter or intercooler for the brake cooling circuit.

10) PARKING BRAKE CONDITION AND TESTING: The parking brake disc had bluish-black patches of discoloration on the brake disc's contact surfaces around the entire circumference of the disc. This was indicative of the parking brake having been dynamically applied and experiencing high brake temperatures during the dynamic application.

It was demonstrated during recovery of the truck that when applied, the parking brake (in an ambient temperature condition) was capable of skidding both wheels on the front bogie axle in the slope area with the truck bed loaded.

The parking brake control system could not be tested due to extensive damage to the control system from the accident and truck recovery.

11) ENGINE BRAKE SYSTEM TESTING: The engine brake system could not be tested due to extensive damage to both the control system and the engine from the accident and truck recovery.

All of the drive-train components from the transmission output shaft to the wheel ends were determined to be intact except for the left side axle shaft of the tractor. However, failure of this axle shaft was consistent with damage expected from the left side tractor tire contacting and climbing the left rib.

12) ELECTRONIC CONTROL UNIT SYSTEM TESTING: During the field investigation, all seven of the electronic control units were determined to be visibly intact. Several of the wiring harnesses required for system communications were damaged as a result of the accident and truck recovery. As such, all seven of the electronic control units (modules) were removed from the accident truck and installed into a similar Volvo A40F truck (Product Identification Number VCEOA40FL00011386, company truck number "417") that was present on the mine site during the field investigation.

While connected to the "donor" truck, the system recognized and communicated with all seven of the accident truck's electronic control modules. This allowed the stored error code history, parameter settings, and a history of the machine parameters to be examined and downloaded, thus producing a Matris Report for the current machine hours and a Job Card showing the current error code history and current parameter settings. The error code history indicated there were no relevant error codes stored in the system.

The last identified routine Matris Report according to the information provided to date by Volvo personnel was from May 11, 2012. A comparison of selected machine parameters of this Matris Report with those obtained during the field investigation was manually performed and the results shown in Figure 1. The results of the comparisons show three distinct trends, of note, within this time frame:

- the time the truck traveled uphill and downhill was very similar;
- the time the truck operated on what would be considered severe grades was a very high percentage of the time the truck was moving;
- the distribution of time the truck traveled in fourth gear through ninth gear forward could be considered very high for the apparent operating conditions. This could be indicative of the drivers not using the transmission and brake controls to manually select and hold the transmission in forward gears that were more appropriate for the loaded downhill hauls on severe grades. A chart in the cab indicated the maximum permitted speed when operating downhill was 5 miles per hour on a 25 percent grade and 4 miles per hour on a 35 percent grade. The maximum speed for the A40F at an engine speed of 2,000 RPM was 5.3 miles per hour in second gear forward (F2) and 3.6 miles per hour in first gear forward (F1). The operating percentages for F2 and F1 could be expected to be higher than that which is shown in the appendix chart when considering the amount of time the truck appeared to be operating downhill on severe grades in a loaded condition. It should also be noted that the electronically controlled transmission was set to always start in F2 when the truck was operated forward whenever the transmission selector was not put in the F1 position. This was a parameter that could be changed using the Volvo software and the service socket interface. As such, the F1 position had to be manually selected by the driver in order for the truck to start in F1 from a standstill. However, this setting (F2 start) did not prohibit the transmission from downshifting into F1 during automatic downshifting once the truck was moving if operating conditions permitted.

Installation of the electronic control modules into the “donor” truck also allowed access to the system using the instrument cluster display and features which indicated:

- The display’s hour meter reading was 1,221 hours;
- The load counting system had logged 34 completed cycles since the last reset;

- The load counting system had an operating time of 5 hours, 29 minutes and 1 second since the last reset.

The current Matris Report for the truck involved in the accident downloaded during the field investigation also verified this truck was not experiencing abnormal service brake temperatures on any of the three axles. This further supported that the degradation of the ‘cork’ backing material on the brake stators had not yet fostered itself to a condition that adversely affected the operation of the service brakes on the accident truck.

13) STEERING SYSTEM TESTING: All of the mechanical steering linkages and the hydraulic lines from the steering valve to the steering cylinders were visibly intact but the steering valve had been pulled from its mounting area during the accident and truck recovery.

Due to damage incurred from the accident and truck recovery, neither the primary or auxiliary steering pumps could be tested on the truck for adequate pressure and flow. However, the lack of any error codes related to the supply pressures of both the primary and auxiliary steering pump systems indicated the steering pumps were functioning normally throughout the shift and up to a time shortly before the accident.

An attempt was made to remotely supply the steering valve with hydraulic pressure and check the output pressure responses of the steering valve when cycling the steering wheel; however, the hydraulic pressure internally bypassed to the steering valve’s tank passage regardless of the steering valve’s hydraulic spool position. The damage sustained to the exterior portions of the valve housing during the accident and truck recovery made it highly likely that the valve also sustained internal damage during these events which caused it to internally bypass.

14) DRIVER’S SEAT ASSEMBLY: The driver’s seat assembly had a retractable lap type seat belt with a webbing width of approximately 3 inches. The firewall of the cab had been pushed downward during the accident and the steering wheel was contacting the bottom seat cushion. The seat back had been pushed rearward and rotated approximately 90 degrees relative to the bottom seat cushion (i.e., the seat assembly was flattened out). The seat belt was found in a latched condition with the webbing stretched across the top of the bottom seat cushion. The buckle latched and unlatched when tested after cleaning out some loose debris of dirt and small rock that had worked its way into the buckle assembly during the accident or truck recovery. The mounting areas of the retractable portion of the seat belt

assembly were damaged and adjustment features of the seat belt were not assessed. Due to the condition of the seat and the injuries to the victim, investigators could not determine whether she was wearing the seat belt at the time of the accident.

<u>TRUCK EVALUATION SUMMARY</u>:

1) No problems were identified with the service brake system that would have prohibited the driver from maintaining control of the truck. Electronic data recovered from the control modules indicated there were no stored error codes relating to the service brake system prior to the accident which monitored machine parameters such as service brake charge pressure and service brake cooling oil temperatures in each of the three axles.

   The current Matris Report and physical inspections of the service brake cooling components indicated the degradation of the 'cork' backing material used on the brake stator (metal disc) between the stator and the brake piston of the wet disc brake packs had not yet fostered itself to a condition that adversely affected the operation of the service brakes on the truck.

2) No problems were identified with the steering system that would have prohibited the driver from maintaining control of the truck. Electronic data recovered from the control modules indicated there were no stored error codes relating to the primary and auxiliary steering systems prior to the accident which monitored machine parameters such as the supply pressures for both steering systems. All of the mechanical steering linkages were intact and the hydraulic steering lines and cylinders downstream of the steering valve were intact.

3) The parking brake was able to skid the front bogie axle (front trailer axle) tires of the loaded truck on ground conditions found in the accident slope. Although the parking brake appeared to have dynamically applied during the accident, the ability of the parking brake to transfer maximum braking capacity to the ground was compromised after the tractor struck the left rib due to the abnormal operating conditions encountered to include the broken left side tractor axle shaft and/or the tractor itself being overturned. In these cases, the parking brake would have only been capable of transferring brake torque to the ground through the front bogie axle unless the transverse (cross axle) differential lock of the tractor axle was

engaged with the right tractor tire contacting the ground or the inter axle dog-clutch between the bogie axles (trailer axles) was locked.

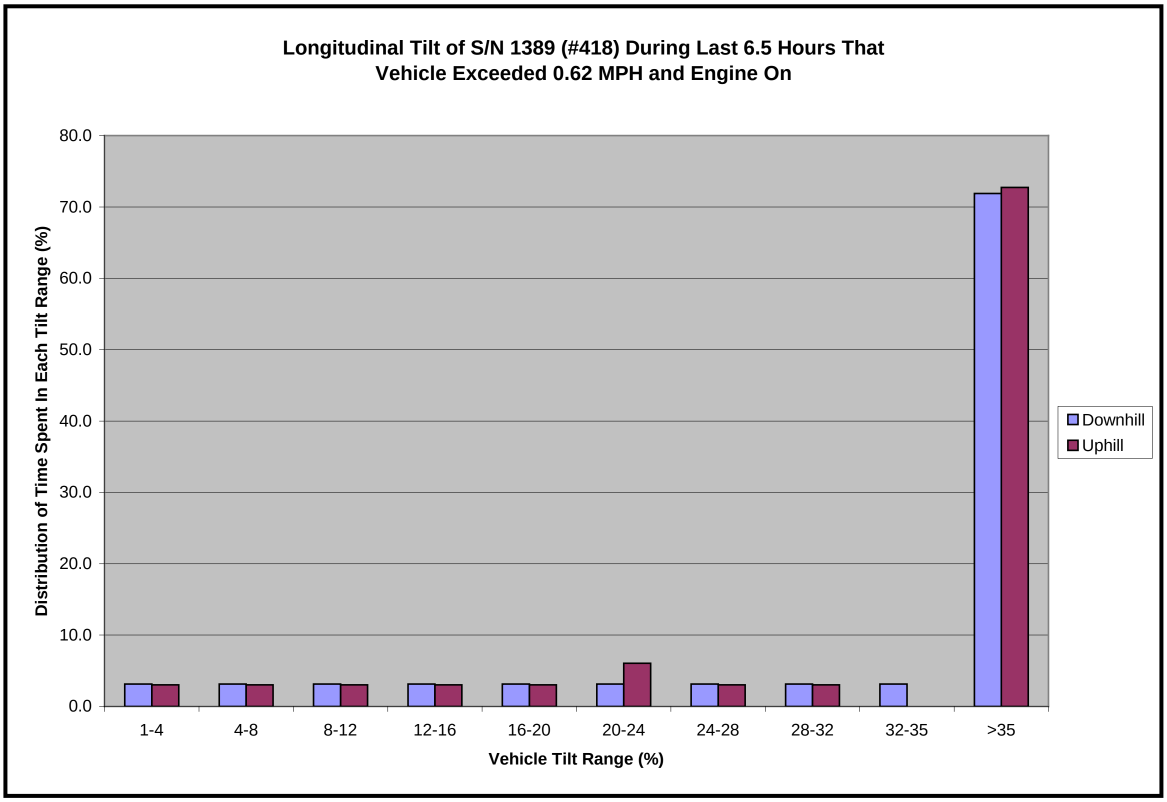
4) The emergency brake features of the truck would have been compromised due to the tractor overturning after contacting the rib and damage subsequently incurred. The signal line for the hydraulic rear service brake relay valve was found to be damaged in the rear cab area. This would have prohibited the service brakes on the trailer from applying correctly when the parking brake was applied with the truck moving, i.e., when the emergency brake feature was activated.

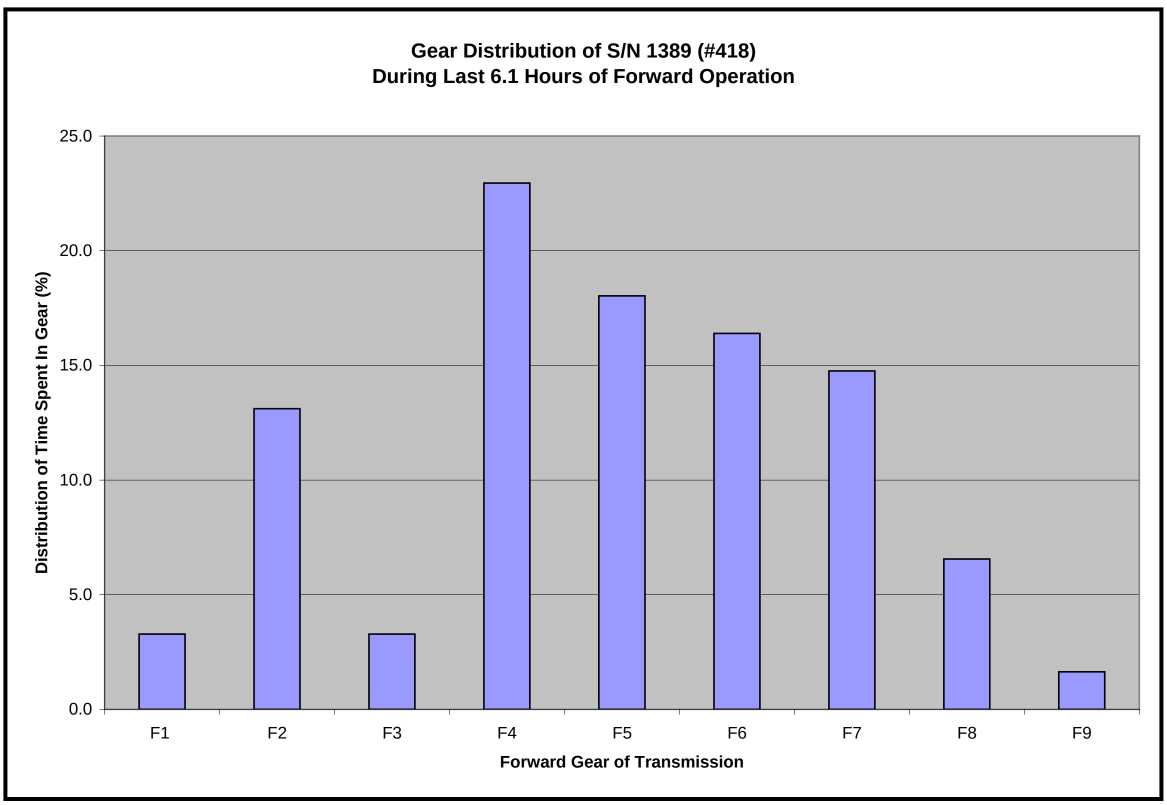
5) The engine brake system could not be tested due to the extensive damage to both the engine brake control system and the engine caused by the accident and truck recovery.

TRUCK EVALUATION REFERENCES:

(1) Volvo Ref. no. VOE21A1006582, January 2011, A40F Service Manual, pages 109 & 110.

Figure 1


Longitudinal Tilt of S/N 1389 (#418) During Last 6.5 Hours That
Vehicle Exceeded 0.62 MPH and Engine On
Distribution of Time Spent In Each Tilt Range (%)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1-4
4-8
8-12
12-16
16-20
20-24
24-28
28-32
32-35
>35
Vehicle Tilt Range (%)
Downhill
Uphill


Gear Distribution of S/N 1389 (#418)
During Last 6.1 Hours of Forward Operation
Distribution of Time Spent In Gear (%)
25.0
20.0
15.0
10.0
5.0
0.0
F1
F2
F3
F4
F5
F6
F7
F8
F9
Forward Gear of Transmission

Training and Experience

Angela Common (victim) had 2 years and 20 weeks of mining experience, all at this mine. Investigators reviewed the training material used and training records for the victim and found deficiencies in Task Training and Experienced Mining Training as well as documentation of training. They found the task trainer lacked a full understanding of the safe operating procedures of the Volvo A40F haul truck involved in the accident. The trainer was never trained using the operator's manual, did not use the manual while task training the victim, and could not provide any task training documentation or verification of task training for the haul truck. The mine operator was aware additional task training was needed for all the haul truck drivers for the new haul trucks, yet postponed the training several times.

On May 14, 2012, Common was provided Annual Refresher Training. However, Common was an experienced miner and upon returning to work after an extended period should have received Experienced Miner Training in accordance with the mine operator's approved training plan. Common received an additional hour of Annual Refresher Training on the morning of May 15, 2012. The trainer did not accompany the victim underground or provide the mine tour as required by the approved plan for Experienced Miner Training.

MSHA investigators conducted interviews with the miners and found the mine operator did not provide the minimum training requirements as required by the mine's approved Part 48 training plan.

- The mine operator was task training new employees on various types of equipment at the same time and/or before these employees had completed the required New Miner Training.
- The mine operator hired five new miners and put them on jobs underground their first day of employment without any training.
- An approved trainer was not completing the training documents.
- Annual Refresher training was provided to an experienced miner rather than the required Experienced Miner Training.

The mine operator could not provide any task training documents, 5000-23 forms, for the victim or other haul truck drivers operating the Volvo trucks although based on interviews, Volvo provided some training to five haul truck operators on December 29, 2011.

As a result of the review of training documentation, the District Manager disapproved the mine operator's training plan on May 30, 2012. A new plan was approved on June 5, 2012. On July 2, 2012, the District Manager proposed to revoke the instructor's approval for the trainer. The revocation became final on August 24, 2012.

Following the accident, management established procedures and policies to ensure that mobile equipment operators were trained in accordance with the manufacturer's recommendations. All persons that operate mobile equipment were trained, using experienced and certified trainers, regarding these new policies and procedures.

Root Cause Analysis

A root cause analysis was performed and the following root cause was identified:

Root Cause: Management's policies and procedures failed to ensure equipment operators were trained in the safe operation of Volvo haul trucks. The victim did not maintain control of the haul truck she was operating. Poor surface conditions of the West Slope including humps, potholes, and dips, were not corrected in a timely manner. No traffic warning signs or signals were provided to ensure safe travel in the mine.

Corrective Action: Management established a written plan for New Miner and Task Training. This training included procedures ensuring persons can safely operate the haul trucks. The proper documentation of the training will be provided. Management established policies and procedures to ensure that equipment operators operate mobile equipment safely. The new policies and procedures require in part that:

1. Mobile equipment operators were task trained and certified by a trainer that has extensive knowledge of hazards associated with the work to be performed.
2. Signs were posted limiting speed while traveling steep slopes.
3. Loaded haul trucks will not travel between levels using the slopes.
4. Mobile equipment will be operated at reduced speeds in all haulage ways with reduced clearance, corners, curves, or damp conditions.
5. Only one piece of mobile equipment will be allowed on a slope at a time.

6. When traveling around blind corners or entering ramps or slope crosscuts, radio contact will be made to warn other persons before entering.
7. All persons that operate mobile equipment were trained regarding these new policies and procedures.
8. All haul truck operators were task trained as to the safe operation of the specific truck being operated.

CONCLUSION

The accident occurred due to the failure of management to ensure the victim was task trained in the safe operation of the haul truck, that safe operating speeds were maintained, and hazardous conditions on the slope were corrected in a timely manner.

ENFORCEMENT ACTIONS

Issued to Sterling Material

Order No. 8640969 - issued on May 15, 2012, under the provisions of Section 103(k) of the Mine Act:

> *A fatal accident occurred at this operation at this operation on May 15, 2012, at approximately 2:20 p.m. A miner was involved in a wreck with Volvo A40F co #418 haulage truck resulting in a cab roll-over. This order is issued to assure the safety of all persons at this operation. Road conditions appear to be a factor in this accident. This order prohibits all activity in the mine until MSHA has determined that is is safe to resume normal mining operations. Therefore, the mine operator is to obtain prior approval from an authorized representative for all actions to recover and restore operations to the mine.*

This order has not been terminated. Termination is pending the mine operator's submission and subsequent approval from the District of a long term plan, standard operational procedures, that will address additional precautionary measures and restrictions on traffic control through out the mine and when traveling the steep slopes at this mine.

<u>Citation No. 8641284</u> - issued on August 6, 2012, under the provisions of Section 104 (d) (1) of the Mine Act for a violation of 30 CFR 57.9101:

> *On May 15, 2012, a fatal accident occurred at this operation when a fully loaded haul truck, traveling down the West Slope, went out of control and overturned. The operator of the haul truck failed to maintain control of the mobile equipment while traveling down the West Slope. The speed of the haul truck was not consistent with the conditions of the roadway. The slope was steep and the entire roadway was uneven with potholes. The hazardous roadway condition of the West Slope was reported to the shift supervisor before the accident occurred. The shift supervisor engaged in aggravated conduct constituting more than ordinary negligence in that he was aware of the hazardous conditions and did not take action to correct the hazards or warn persons operating the haul trucks to reduce speed while traveling the steeply sloped roadway. This violation is an unwarrantable failure to comply with a mandatory standard.*

<u>Order No. 8641285</u> - issued on August 6, 2012, under the provisions of Section 104 (d) (1) of the Mine Act for a violation of 30 CFR 57.9100 (b):

> *On May 15, 2012, a fatal accident occurred at this operation when a fully loaded haul truck, traveling down the West Slope went out of control and overturned. The West Slope was steep and approximately 720 feet long and 25 feet wide. The mine operator did not provide any signs or signals to warn persons traveling the West Slope of the hazardous conditions. The superintendent engaged in aggravated conduct constituting more than ordinary negligence in that he was aware of the lack of signs or signals yet took no action to provide them for persons operating mobile equipment on the West Slope. This violation is an unwarrantable failure to comply with a mandatory standard.*

<u>Order No. 6098283</u> - issued on August 6, 2012, under the provisions of Section 104 (d) (1) of the Mine Act for a violation of 30 CFR 48.7 (a) (3):

> *On May 15, 2012, a fatal accident occurred at this operation when a fully loaded haul truck, traveling down the West Slope went out of control and overturned. The victim was operating a new haul truck but was not instructed in safe operating procedures applicable to the new equipment. The mine operator did not provide adequate task*

operator's manual, did not use the manual during the training, and had no task training or verification of task training for this unit. The mine operator engaged in aggravated conduct constituting more than ordinary negligence. This violation is an unwarrantable failure to comply with a mandatory standard.

Approved:____________________ Date: 12/11/12____

Michael A. Davis
District Manager

APPENDICES

APPENDIX A: Persons Participating in the Investigation

APPENDIX B: Victim Information

APPENDIX A

Persons Participating in the Investigation

Sterling Material

Tina Stanczewski	Esq. Counsel for Sterling Materials
John W. Walters	General Counsel, CFO
Timothy E. Stout	Chief Operating Officer
Sam Van	General Manager
Chris Pulliam	Mine Superintendent
R. L. Maxwell	Plant Superintendent

Volvo Equipment/ITC

John C. Bartz	Director, Product Assurance & Regulation
Michael Rogers	Sr. VP Transportation

Rudd Equipment

Darren Cobbum	Northern Regional Service Manager

Gallatin County Coroner

Jacques Hughes	Gallatin County Coroner

Mine Safety and Health Administration

Stanley K. Stevenson	Mine Safety and Health Supervisory Inspector
Michael A. Evans	Mine Safety and Health Inspector
F. Terry Marshall	Mechanical Engineer
Steven J. Vamossy	Civil Engineer, P.E.
Debra Combs	Mine Safety and Health Specialist

APPENDIX B

Accident Investigation Data - Victim Information

Event Number: 6 5 8 5 6 1 5

U.S. Department of Labor

Mine Safety and Health Administration

Victim Information: 1

1. Name of Injured/Ill Employee: Angela W. Common	2. Sex F	3. Victim's Age 37	4. Degree of Injury: 01 Fatal
5. Date(MM/DD/YY) and Time(24 Hr.) Of Death: a. Date: 05/15/2012 b.Time: 14:40		6. Date and Time Started: a. Date: 05/15/2012 b.Time: 7:10	
7. Regular Job Title: 076 Haul Truck Driver	8. Work Activity when Injured: 055 Operate Haul truck underground		9. Was this work activity part of regular job? Yes X No

10. Experience

	Years	Weeks	Days
a. This Work Activity:	2	20	0
b. Regular Job Title:	2	20	0
c: This Mine:	2	20	0
d. Total Mining:	2	20	0

11. What Directly Inflicted Injury or Illness? 110 Haul Truck

12. Nature of Injury or Illness: 170 Blunt force trama

13. Training Deficiencies

Hazard: [ ] New/Newly-Employed Experienced Miner: [ ] Annual: [ ] Task: [X]

14. Company of Employment: (If different from production operator) Operator

Independent Contractor ID: (if applicable)

15. On-site Emergency Medical Treatment

Not Applicable: [ ] First-Aid: [ ] CPR: [ ] EMT: [ ] Medical Professional: [ ] None: [X]

16. Part 50 Document Control Number: (form 7000-1)

17. Union Affiliation of Victim: 9999 None (No Union Affiliation)

Victim Information: