MAI–2013-19

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

REPORT OF INVESTIGATION

Surface Nonmetal Mine
(Crushed Limestone)

Fatal Explosives and Breaking Agents Accident
December 4, 2013

Kansas Falls Quarry
Bayer Construction Company, Inc.
Junction City, Dickinson County, Kansas
ID No. 14-01666

Investigators

Lee A. Hughes
Mine Safety and Health Inspector

Thomas Lobb
Senior Physical Scientist

Thomas Turner
Mine Safety and Health Specialist (Training)

Originating Office
Mine Safety and Health Administration
Rocky Mountain District
P.O. Box 25367, DFC
Denver, Colorado 80225
Richard Laufenberg, District Manager

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OVERVIEW

Stephen W. Hetzler, Lead Man, age 63, was killed on December 4, 2013. He initiated a blast and was struck by flyrock. Hetzler was standing 153 feet away from the lead holes of the blast. The largest rock that struck Hetzler weighed approximately 96 pounds.

The accident occurred because management failed to establish safe work procedures for persons to follow during blasting activities at the mine. The victim was using his work cellular phone to video record the blast. Hetzler was positioned too close to the blast and was not provided a blasting shelter to protect him from flyrock.

GENERAL INFORMATION

Kansas Falls Quarry, a crushed limestone operation owned and operated by Bayer Construction Company, Inc., is located at 5372 Old Hwy 40, Junction City, Dickinson County, Kansas. The principal operating official is Leslie K. Briggs, President. The quarry usually operates one 9 hour shift a day, 5 days a week. Total employment is 16 persons.

Material is mined using a single-bench method. The limestone is drilled and blasted. A front-end loader loads the material into haul trucks that transport it to a primary crusher. The material is then transported to the plant by belt conveyor where it is processed and sold for construction aggregate.

The Mine Safety and Health Administration (MSHA) completed the last regular inspection at this operation on September 13, 2013.

DESCRIPTION OF ACCIDENT

On the day of the accident, Stephen W. Hetzler (victim) arrived at the mine around 7:00 a.m. Hetzler and Scott Litke, Supervisor, discussed the day's work schedule. Hetzler was to supervise the crushing plant while Litke operated the river plant.

At approximately 2:00 p.m., Hetzler arrived at the quarry's Poland Pit to load a blast that had been drilled by John Carroll, Truck Driver/Driller. At approximately 2:20 p.m., Hetzler used the CB radio to report that he was preparing to initiate the blast. Witnesses interviewed, reported seeing Hetzler pointing at each individual in the pit to verify their location.

James Potter, Equipment Operator, was sitting in an excavator approximately 25 to 30 feet behind Hetzler, and observed a cell phone in Hetzler's hand. Hetzler appeared to be attempting to take a picture or video of the shot as it detonated. Hetzler was positioned approximately 153 feet away from the southeast blast hole. Several pieces of flyrock traveled toward Hetzler's location. A rock 19 inches long by 14½ inches wide by 7½ inches thick struck Hetzler in the upper torso knocking him to the ground.

Potter called Litke to report the accident and Litke called 911. The Junction City Police Department and Emergency Medical Services (EMS) were dispatched to the mine. EMS arrived and the victim was pronounced dead at 3:15 p.m. The cause of death was determined to be blunt force trauma.

INVESTIGATION OF ACCIDENT

MSHA was notified of the accident at 2:57 p.m., Central Time, on December 4, 2013, by a telephone call from Stan Hambright, Safety Manager, to MSHA's National Call Center. The National Call Center notified Hillary Smith, Assistant District Manager, and an investigation started the same day. An order was issued under the provisions of Section 103(j) of the Mine Act to ensure the safety of the miners. This order was later modified to Section 103(k) of the Mine Act when the first Authorized Representative arrived at the mine.

MSHA's accident investigation team traveled to the mine, conducted a physical inspection of the accident scene, interviewed employees, and reviewed documents and work procedures relevant to the accident. MSHA conducted the investigation with the assistance of mine management, employees, and local law enforcement.

DISCUSSION

Location of the Accident

The accident took place at the mine's Poland Pit. The area was flat with freshly dug overburden. Ground conditions were dry. The blast pattern was situated on a narrow deposit of limestone that had dirt and clay mixed with the rock.

Weather

The weather conditions on the day of the accident were overcast with temperatures below freezing. Weather was not considered to be a factor in the accident.

Description of the Blast

The blast associated with the accident was designed and directed by the victim, who was the blaster in charge of the detonation. The blast was laid out, the rock was drilled, and the blast was loaded by mine employees.

The blast consisted of 66 holes, 3½-inches in diameter to a full depth of 8 feet, laid out in 6 rows on a 9-foot by 9-foot burden and spacing. The bench height was 8 feet with no drill log. One lead-in line was observed during the investigation. The amount of explosive product, ANFO, loaded in the 66 holes was 716 pounds. The holes were stemmed with 5 feet of drill cuttings.

Blast Design

Blasters use several basic rules of thumb to determine blast design. Each pound of explosives is equivalent to ~76,000,000 horsepower[1]. Blast holes are designed to balance this amount of energy. Large diameter blast holes require thicker amounts of burden than small diameter blast holes do. Uniform geologic materials can evenly distribute the energies while broken areas (fractures) leak energy; i.e., powder has to be more evenly distributed in faulty areas than it does in uniform structured areas. Large diameter blast holes require more stemming and burden than small diameter blast holes do as shown on the following chart:

Blast Parameters 12 – 04 - 2013	**Blast (3 1/2 " hole) 9 X 9 pattern**	**Blast (ideal with high risk blast)**	**Design Parameters**
Hole Depth / Burden	0.89	**Min 1.5**	**1.5 – 4.0**
Collar Depth (Stemming)	5 feet	**6.3 feet**	**70 % Burden**
Stemming Vs. Hole Diameter	5/(3.5/12) = 17.14	**6.3/(3.5/12) =21.6**	**14.1 – 28.1 times hole diameter**
Burden to Charge Ratio	30.85	**~30**	**20 – 40**
Spacing / Burden (Ms delay)	1	**1.5**	**~ 1.2 – 1.8**
Delay between holes in same row (mS)	25	**16 - 80 mS**	**~1 – 5 mS per foot burden**
Delay between rows (mS)	17	15 – 75 mS	**~2 – 3 mS/ft bur**
Powder Factor	Not reported	Calculated 0.44	**Use 0.50 for a high risk area!**

[1]1 17th Edition ISEE Blasters' Handbook

When using the chart, an analysis of the blast design parameters on the day of the accident shows: The stemming appears adequate for this blast.

- The blast hole timing structure for this blast was not reported, but magazine records indicate row timings of 25 mS and between row timings of 17 mS. These timings would be marginal for this blast to achieve maximum efficiency.
- Back break is fracturing of the area adjacent to the previous blast site. Back break is typically noticed by the driller during drilling as loss of air pressure, jumping of the drill stem and otherwise difficult drill penetration. Back break and/or loose burdens are responsible for many occurrences of flyrock since they do not provide the required confinement typical to consolidated burden.
    - Drillers note this condition in their drill log.
    - Drillers should note other conditions in the drill log as well. No drill records were produced by the operator.

Flyrock

Title 30 Code of Federal Regulations (CFR) Part 56/57 Subpart A.2 defines the blast area as: 'the area near blasting operations in which concussion or flying material can reasonably be expected to cause injury.' Flyrock is rock that travels outside of the blast area defined by the blaster.

Flyrock is generated in two ways; (1) by an insufficient burden (blow-out, over break, blast hole too close to free face, geology), or by (2) cratering (insufficient stemming, unconsolidated cover, too high of a powder factor, too large of a blast pattern or similar). Insufficient burden type flyrock usually has a lower trajectory angle than does the cratering type of flyrock. The investigators reviewed the basic blast design and determined the flyrock that resulted in this accident was a blow-out type of flyrock due to the straight path that directly impacted the victim. Investigators determined the flyrock was travelling approximately 400 miles per hour**.**

Blast Design Spreadsheet

The following table is a spreadsheet calculation of the blast as reconstructed from the magazine records. This spreadsheet indicates a powder factor (pf) of 0.44 pounds per cubic yard of material. Typically, a powder factor of 1.0 for quarries is common.

Hole Diameter	d	3 1/2
Hole Area per Foot of Depth (ft2)		0.07
Hole Depth	H	8
Burden	B	9
Spacing	S	9
Stemming (Collaring)	C	5
Subdrill	J	0
Number of Holes		66
Distance to the Blast (feet)		160
Scaled Distance Weight		
W= (0 - 300 feet)	50	10.24
W= (301 - 5000 feet)	55	8.46
W= (over 5000 feet)	60	7.11
Height Powder Column (feet)		3.00
Powder Factor (one hole basis)		0.44
Powder Density (g/cc)	0.85	0.85
Cubic yardage (Drill Pattern)		648.00
Weight of 1 ft^3 of water (pounds)	62.4	62.4
s.g. of rock	2.1	2.1
Tons of Rock per Cubic Yard		1.77
Pattern (yds^3 per hole blasted)		24.00
Tons of Rock per Hole		42.46
Pounds of Explosives/Hole (Calc)	W	10.64
(Reported)		
(Lbs/ft of column)		3.55
Total Explosives (Holes X P) Lbs.		702

Note: there is a difference in the amount of explosives reported and this spreadsheet. This is normal because the spreadsheet is an ideal calculation while the reported explosives are the actual amount used. When the spreadsheet and the actual usage are approximately the same, the results of the blast occur as expected.

Video Recording

The investigators found the cellular (cell) phone, issued to Hetzler by management, near him. Statements made during interviews indicate the victim was observed either taking pictures or video recording the blast with the cell phone. The cell phone was examined at the Federal Bureau of Investigation's laboratory in Pittsburgh, Pennsylvania on January 31, 2014. A video clip showing approximately 11 seconds of a blast was retrieved from the cell phone. No audio was recorded. The video recording had a time stamp of December 4, 2013, at 8:44 p.m. Although the time stamp of the video recording was approximately six hours after the accident, the content of the video indicates this is footage of the fatal accident and corroborates the witness statements.

TRAINING AND EXPERIENCE

Steve Hetzler (victim) had approximately 16 years of mining experience and worked at this mine for 11 years, 48 weeks, and 4 days. A representative of MSHA's Educational Field Services staff conducted an in-depth review of the mine operator's training records. The training records for Hetzler were reviewed. All of his required MSHA Part 46 training, including annual refresher training and task training, was found to be up-to-date and in compliance with MSHA requirements.

ROOT CAUSE ANALYSIS

The investigators conducted a root cause analysis of this accident and the following root causes were identified and the corresponding corrective actions implemented to prevent a recurrence of the accident:

Root Cause: Management did not ensure the driller and blaster communicated to construct the blast as it was designed. Since explosives generate such a large amount of energy (76 million horsepower per pound), the blast construction needed to be accurate and in solid burden. The driller did not report to the blaster the noted poor geology and back break.

Corrective Action: Management developed and implemented a Blasting Standard Operating Procedures (SOP) that includes requirements for a driller's log. The procedures outline responsibilities for safe blasting procedures including explosives handling and blasting security. The driller's log will be used when the driller and blaster communicate regarding any irregularities the driller finds that the blaster may encounter while loading and stemming blast holes. All persons involved in blasting were trained regarding the SOP.

Root Cause: Management did not ensure persons were protected from flyrock from the blast. The victim was recording the blast, standing 153 feet away from it and was not provided a blasting shelter.

Corrective Action: Management developed and implemented a Blasting SOP, addressing the positioning of miners during blasting procedures. Miners will be located at least 1,000 feet from the blast area. The blaster will always be located inside a blasting shelter. The SOP also addresses communications of the blaster with the other miners to clear the blast area before the blast is initiated. All persons involved in blasting were trained regarding the SOP.

CONCLUSION

The accident occurred because management failed to establish safe work procedures for persons to follow during blasting activities at the mine. The victim was using his work cell phone to video record the blast. Hetzler was positioned too close to the blast and was not provided a blasting shelter to protect him from flyrock.

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ENFORCEMENT ACTIONS

Order No. 8595397- issued under the provisions of Section 103(j) of the Mine Act:

> *An accident occurred at this operation on December 4, 2013, at approximately 14:44. As rescue and recovery work is necessary, this order is being issued under section 103(j) of the Federal Mine Safety and Health Act of 1977, to ensure the safety of all persons at this operation. This order is also being issued to prevent the destruction of any evidence which would assist in investigating the cause, or causes of the accident. It prohibits all activity at the Pit area north of the Poland Road, until MSHA has determined it is safe to resume normal mining operations in this area. This order applies to all persons engaged in the rescue and recovery operation and any other persons onsite. This order was initially issued orally to the mine operator on December 4, 2013, at 15:21 and has now been reduced to writing.*

Order No. 8754923 – issued under provisions of Section 104(d)(2) of the Mine Act for a violation of 30 CFR 56.6306(e):

> *A fatal accident occurred at this operation on December 4, 2013, when a lead man was struck by broken rock from a planned blast. The lead man was initiating the blast from 153 feet away from the closest blast hole. There was no blasting shelter in this pit. The lead man initiated the blast within the blasting area without the use of a blasting shelter. The mine operator engaged in aggravated conduct constituting more than ordinary negligence in that the lead man was an agent of the operator and failed to take the necessary safety precautions while initiating a blast.*

Approved By: Date: March 3, 2014

Richard Laufenberg
District Manager

List of Appendices

Appendix A

Persons Participating in the Investigation

Bayer Construction Company, Inc.

Stan Hambright	HR and Safety Manager
Scott Litke	Mine Supervisor
Michael Mayer	Grading Foreman
James Potter	Equipment Operator
John Carroll	Haul Truck Driver/Driller

Mine Safety and Health Administration

Lee A. Hughes	Mine Safety and Health Inspector
Thomas Turner	Mine Safety and Health Specialist (Training)
Thomas Lobb	Senior Physical Scientist

Appendix B

Victim Data Information

Accident Investigation Data - Victim Information
Event Number: 6 6 1 5 5 5 4

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

Victim Information: 1

1. Name of Injured/Ill Employee:	2. Sex	3. Victim's Age	4. Degree of Injury:
Stephen W. Hetzler	*M*	*63*	*01 Fatal*

5. Date(MM/DD/YY) and Time(24 Hr.) Of Death:	6. Date and Time Started:
a. Date: 12/04/2013 b.Time: 15:15	*a. Date: 12/04/2013 b.Time: 7:00*

7. Regular Job Title:	8. Work Activity when Injured:	9. Was this work activity part of regular job?
107 Blaster/Leadman	*003 Blasting*	Yes X No

10. Experience	Years	Weeks	Days		Years	Weeks	Days		Years	Weeks	Days		Years	Weeks	Days
a. This Work Activity:	*5*	*0*	*0*	b. Regular Job Title:	*5*	*0*	*0*	c: This Mine:	*11*	*48*	*4*	d. Total Mining:	*15*	*48*	*4*

11. What Directly Inflicted Injury or Illness?	12. Nature of Injury or Illness:
044 Explosives	*170 Impact from flyrocks*

13. Training Deficiencies:
Hazard: | New/Newly-Employed Experienced Miner: | Annual: | Task:

14. Company of Employment: (If different from production operator)
Operator
Independent Contractor ID: (if applicable)

15. On-site Emergency Medical Treatment:
Not Applicable: | First-Aid: | CPR: | EMT: | Medical Professional: | None: X

16. Part 50 Document Control Number: (form 7000-1) *220133440012*
17. Union Affiliation of Victim: *9999* *None (No Union Affiliation)*