

UNITED STATES
DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

COAL MINE SAFETY AND HEALTH

REPORT OF INVESTIGATION

Underground Coal Mine

Fatal Machinery Accident
December 2, 2016

Zhengzhou Coal Mining Machinery (Group) Co. Ltd America (B5251)
Pittsburgh, PA

at

Oak Grove Mine
Oak Grove Resources LLC
Hueytown, Jefferson County, Alabama
I.D. No. 01-00851

Accident Investigators

Timothy R. Stockman
Mine Safety and Health Inspector

Ronald D. Caudill
Mine Safety and Health Specialist

Ronald Medina
Mechanical Engineer

Originating Office
Mine Safety and Health Administration
District 11
1030 London Drive, Suite 400
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Richard A. Gates, District Manager

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OVERVIEW

On Friday, December 2, 2016, at approximately 11:00 a.m., a 36-year-old shield designer and engineer was fatally injured when the longwall shield he was working on collapsed and fell on him. The victim was in the process of installing hydraulic components on the tilt cylinder. His co-worker, who was working with the victim, removed plugs from both support cylinders which depressurized the hydraulic system and caused the shield to collapse. The victim was asphyxiated by the weight of the shield.

GENERAL INFORMATION

The Oak Grove Mine, owned and operated by Oak Grove Resources LLC., was controlled by ERP Compliant Fuels, LLC at the time of the accident. The mine is located near Hueytown, Jefferson County, Alabama. This is an underground bituminous coal mine, which uses both longwall and continuous mining methods. Coal is mined and

placed on a conveyor belt and transported to the preparation plant for processing and shipment. The primary coal seam mined is the Blue Creek seam which is approximately seven feet thick. The mine currently has 377 underground miners and 44 surface miners. Coal is mined three shifts per day, Monday through Saturday, with maintenance work performed on Sunday.

The mine produces approximately 824 tons of coal daily and liberates 3,774,681 cubic feet of methane in a 24 hour period.

The principal officials of the mine at the time of the accident were:

Larry Millburg.....General Mine Manager
Larry McCarty.....Mine Superintendent
James D. Morris.....Safety Manager

The last quarterly safety and health inspection was completed by the Mine Safety and Health Administration (MSHA) on September 29, 2016. A quarterly inspection was ongoing at the time of the accident. The mine operator’s Non-Fatal Days Lost (NFDL) incidence rate for 2015 was 1.84. The national incidence rate for underground coal mines of this type in 2015 was 3.13.

DESCRIPTION OF THE ACCIDENT

On Friday, December 2, 2016, at approximately 6:15 a.m., Qian Yujun (victim), Shield Designer and Engineer, and Liang Shengping, Sales Manager and Translator for Zhengzhou Coal Mining Machinery (Group) Co. Ltd (ZMJ), arrived at the mine’s North Portal to prepare for their first day underground. Oak Grove is the first mine in the United States to purchase longwall shields from the People’s Republic of China. Around 7:00 a.m., Qian and Liang joined the mine’s longwall set-up crew and entered the mine using the service hoist. At approximately 7:15 a.m., the crew boarded a rail mounted mantrip and traveled to the 17 East Longwall Panel.

William Bonner, Longwall Foreman, held a safety meeting with the longwall set-up crew. Donnie Tisdale, General Inside Laborer, and Brandon Wright, Longwall Mechanic, were assigned to work with Qian and Liang. While Tisdale and Wright gathered hand tools, Qian and Liang walked to the set-up face with Jack Rexrode, Maintenance Foreman. Rexrode asked Qian to inspect the hydraulic components on

longwall shields 186 through 172 that had been previously installed by Oak Grove employees.

Tisdale and Wright arrived at the tailgate side of the set-up face and met with Qian and Liang. The four men then walked to the headgate side of the set-up face and loaded hydraulic components on a battery-powered longwall shield hauler. Rexrode left to check on miners working at another location. Qian and Liang returned to the tailgate side of the set-up face. Tisdale and Wright took the longwall shield hauler around the back entry to the tailgate side of the set up face. The four men unloaded the hydraulic components and placed them by the shields where they would be installed. Tisdale and Wright took the shield hauler back to the headgate. Qian and Liang walked to shield 171 (serial number 075) to begin installing hydraulic components.

Qian crawled behind the two support leg cylinders of shield 171 to install low flow yield valves on the tilt cylinder. While Qian was located in the pinch point, behind the support cylinders, he instructed Liang to remove the $\frac{3}{8}$ inch pipe plug from the tailgate side support cylinder, in preparation for the installation of a pressure gauge. This action depressurized the tailgate side support leg cylinder and placed all of the weight of the shield canopy on the headgate side support leg cylinder.

Qian, still working on the tilt cylinder, instructed Liang to remove a $\frac{1}{2}$ inch pipe plug without specifying from which support cylinder. Liang removed the $\frac{1}{2}$ inch plug from the headgate side support leg cylinder, which depressurized the cylinder, causing the shield to collapse.

Liang immediately called for help. Wayne Ingle, Longwall Electrician, and Grady Robinson, Longwall Shearer Operator, were working approximately 75 feet away and heard Liang. They could see that shield 171 had collapsed behind Liang. Ingle, Wright, and Tisdale ran toward the tailgate while Robinson ran to the headgate to get the hydraulic pump started to pressurize the shield.

Ingle attempted to communicate with the victim when he arrived at shield 171, but there was no response.

Robinson notified Rexrode and the rest of the crew that a shield had collapsed. He started the hydraulic pump which sent hydraulic fluid to the shield line. Bonner

notified persons on the surface of the accident and Rexrode and Bonner went to the accident scene.

Upon arrival at the scene, Rexrode manually activated the valve control, in an attempt to raise the collapsed shield. Oil flowed freely from the unplugged port on the tailgate support cylinder, preventing activation of the cylinder. Rexrode plugged this open port and again attempted to raise the shield. This attempt also failed, as oil also flowed freely from the open port on the headgate side support cylinder. Rexrode then plugged the headgate side cylinder and the shield was successfully raised. Two wooden crib blocks were placed on the pan line to securely block the shield in position.

Matt Miller, Longwall Stage Loader Operator and Mine Rescue/First Aid Team Member, arrived at the scene. Miller checked the victim's vital signs and found none. The victim was placed on a stretcher and transported to the surface area of the mine.

Phillip Russell, Jefferson County Deputy Coroner, arrived at the mine site and pronounced the victim dead at 12:02 p.m. An autopsy was performed by the Jefferson County Coroner/Medical Examiner Office. The cause of death was listed as mechanical asphyxia.

INVESTIGATION OF THE ACCIDENT

Ronald Caudill, MSHA Health Specialist, was at the mine performing inspection work. At approximately 11:00 a.m., Benny Long, Oak Grove Mine Employee, notified Caudill that an accident had occurred. Caudill issued a 103(k) order to Michael Richardson, Safety Supervisor, to ensure the safety of all persons and to prevent the destruction of evidence. Caudill traveled to the accident scene and conducted a preliminary examination of the area.

Caudill informed Danny Crumpton, MSHA Assistant District Manager (Enforcement), of the accident. Timothy Stockman, MSHA Coal Mine Inspector; Ed Boylen, MSHA Field Office Supervisor; and Steve Womack, MSHA Assistant District Manager (Technical), were sent to the mine.

At 11:05 a.m., James Morris, Safety Manager, notified the Department of Labor National Contact Center of the accident.

After the accident investigation team arrived at the mine, they informally interviewed 20 people. After the interviews were completed, Caudill and Stockman traveled underground to the accident scene and began their investigation.

On Sunday, December 4, 2016, Ron Medina, MSHA Technical Support Mechanical Division; Leon Ko, MSHA Technical Support Electrical Division; and Richard A. Gates, MSHA District Manager, along with Caudill and Stockman, traveled to the mine to continue the accident investigation.

Persons participating in the investigation are listed in Appendix A. The report prepared by MSHA Technical Support is in Appendix B.

DISCUSSION

Equipment

The primary purpose of the longwall shields is to provide temporary roof support during longwall mining operations. The Oak Grove Mine recently purchased 188 longwall face shields and 8 gate shields from ZMJ. Each face shield weighs 28.6 U.S. tons and each gate shield weighs 32 U.S. tons. Each face shield and each gate shield is equipped with two double acting leg cylinders. Each cylinder has a working load rating of 595 U.S. tons at 6,110 psi. The canopy of each shield weighs 9.6 U.S. tons and each caving shield weighs 5 U.S. tons. ZMJ was also contracted to provide on-site technical service for 60 days to aid in the installation of the longwall shields. The shields were to be installed on the 17 East Longwall set-up face.

The longwall shields were shipped to the Oak Grove Mine in October 2016 without yield valves and pressure gauges. Those devices were to be installed once the shields were in place underground. Each longwall shield is equipped with a pilot-operated check valve. The purpose of the check valve is to allow the support cylinder to yield at a set pressure to prevent damage.

Each leg support cylinder is equipped with a valve block containing protected ports and unprotected ports. The protected ports have a pilot check valve. This check valve prevents hydraulic oil from leaving the leg support cylinder, which would cause sudden decompression of the leg cylinder, in the event of a component failure such as a broken hydraulic hose. The unprotected ports do not have a pilot check valve. If they are opened to the atmosphere, hydraulic oil will leave the leg support cylinder, and the

leg support cylinder will decompress. During normal operation, a yield valve and a pressure gauge are installed in the unprotected ports. This allows some, but not all, hydraulic oil to escape in the event that the weight on the shield gets near the weight capacity limit, in order to prevent equipment failure of the shield. The port plugs removed by Liang were on unprotected ports. With plugs removed from unprotected ports on each leg support cylinder, the hydraulic system depressurized, causing the shield's canopy to collapse (see the drawing in Appendix B). MSHA Technical Support determined there were no defects in the design or function of longwall shield 171.

Accident Site Observations

The accident occurred on the 17 East Longwall Panel set-up face. The mine was in the process of installing longwall shields, starting from the tailgate side. The longwall face was 1,000 feet wide, requiring a total of 186 shields. Shields 186 through 95 had been positioned and the canopy (see the drawing in Appendix B) pressurized to allow the valves and gauges to be installed, but not placed against the roof. The plugs, valves, and gauges lock into place by the insertion of a "U" shaped piece of metal that has two "legs," commonly referred to as a staple.

Prior to the accident, the mine personnel had installed yield valves and pressure gauges on shields 186 through 172 without incident. Shield 171, involved in the accident, was found in the following configuration:

- A $\frac{3}{8}$ inch plug was found with one leg of the staple installed on the tailgate support cylinder.
- A $\frac{1}{2}$ inch plug was found missing from the tailgate support cylinder.
- A $\frac{1}{2}$ inch plug was found with one leg of the staple installed on the headgate support cylinder.

The plugs that were locked with one staple leg were the plugs quickly installed by the first responders to lift the shield off of the victim. This is consistent with witness statements.

Work Experience and Training

Qian had 13 years of experience as a shield designer and engineer with ZMJ. During an interview, Liang stated he (Liang) was the Sales Manager of the International Department of ZMJ. He received a university degree in English and was the only person at the mine who could speak both English and Mandarin. All miners

interviewed believed that his primary role was to translate for the victim. The investigation team acquired a copy of Liang's resume from the ZMJ U.S. distributor and it did not list any experience assembling longwall shields.

The victim was the shield designer and technical expert sent by ZMJ to aid the mine in the installation of the new longwall shields, therefore, no 30 CFR § Part 48.7 task training was required for him. However, Liang should have been tasked trained in the installation of the new longwall shields. According to Liang, the victim directed him verbally to remove plugs from the support cylinders.

MSHA 30 CFR § Part 48 requires all new miners to receive at least 40 hours of training prior to being assigned work duties in an underground coal mine. Mine management provided MSHA with MSHA 5000-23 forms showing that the victim and Liang were given 32 hours of new miner training at the Oak Grove mine site from November 28, 2016 through December 1, 2016. This training was provided by Beville State Community College. The additional eight hours of on-site training required by Part 48, prior to performing work duties, was not completed at the time of the accident on December 2, 2016. Therefore, MSHA issued a noncontributory citation for a violation of 30 CFR § Part 48.5.

Accident Events Analysis

Based on the interview with Liang and the investigation of the accident scene, the following events occurred. Liang was told by Qian to remove a $\frac{3}{8}$ inch pipe plug from the tailgate side support leg cylinder in preparation for the installation of a pressure gauge. When he removed this plug, it depressurized the tailgate side support leg cylinder. The tailgate side support leg cylinder was also found to have a $\frac{1}{2}$ inch pipe plug removed where a yield valve was going to be installed. Liang was then told by Qian to remove a $\frac{1}{2}$ inch plug in preparation for the installation of a yield valve. The $\frac{1}{2}$ inch pipe plug on the tailgate side cylinder had already been removed, so Liang removed the $\frac{1}{2}$ inch plug from the headgate side support cylinder. This caused the shield's canopy to collapse. Therefore, Liang's lack of practical knowledge of longwall shields is a root cause of the accident. At least one plug removed from each cylinder will cause the shield to collapse.

Work Practices

The mine operator began placing shields underground and installing yield valves and gauges while the victim and Liang were going through the training class. During the investigation, the mine operator produced an email that explained the process that should be followed when installing yield valves and gauges on the longwall shields. The process is as follows:

- Install tilt yield valves
- Install support cylinder yield valves
- Install yield valves on ram and base lift cylinders

The mine operator followed these procedures while installing the hydraulic components on shields 186 through 172 without any problem. The ZMJ employees did not follow this procedure or follow standard maintenance practices. If the ZMJ employees had installed the valves and gauges according to the procedure above, there would not have been a plug removed from two cylinders at the same time. Each cylinder would have had the valves and gauges installed before moving onto the next cylinder, as outlined by the procedure.

The standard maintenance practice is only one support cylinder should be depressurized at a time when performing maintenance or installing hydraulic components. Additionally, no one is allowed past the support cylinders while maintenance is performed on either cylinder. In extreme cases, should it be necessary to depressurize both support cylinders at the same time, the shield canopy would be blocked against motion, for example, with a four-point crib or a set of timbers. These standard practices were not followed during installation of hydraulic components on longwall shield 171.

ROOT CAUSE ANALYSIS

An analysis was conducted to identify the basic causes of the accident, which could have been corrected through reasonable management controls. Root causes were identified that, if eliminated, would have prevented the accident.

1. Root Cause: The contractor did not have an effective procedure to ensure persons working on longwall shields were properly task trained. The contractor used the sales manager/translator as a maintenance assistant, but the translator was not trained in the task of installing the longwall shield. He did not have practical knowledge of safe work procedures for the task and did not recognize the hazard created by depressurizing both support cylinders at the same time.

Corrective Action: The contractor will ensure that all its personnel performing work in the mine are properly trained.

2. Root Cause: The mine operator and contractor did not have an effective procedure to ensure the longwall shield was blocked against motion at all times while work was performed in an area where the shield could collapse onto a miner. Both of the support cylinders of the shield were depressurized while the victim was in the pinch point performing maintenance on the tilt cylinder.

Corrective Action: The mine operator submitted a revision to the roof control plan that requires a 4-point wood crib to be installed to block the shield against motion while work of this type is performed. MSHA approved this plan revision. The operator and the contractor have retrained all longwall installation personnel on the proper procedure to block the longwall shield canopy when repair, maintenance, or installation of the longwall shield would cause both support cylinders to depressurize.

CONCLUSION

An engineer employed by a longwall shield manufacturer was fatally injured when a longwall shield collapsed onto him. The victim was installing hydraulic components on the tilt cylinder of longwall shield 171, while his coworker, whose primary job was as a translator, removed hydraulic components on both support cylinders without blocking the longwall shield canopy against motion.

Approved by:

Richard A. Gates
District Manager

Date

ENFORCEMENT ACTIONS

1. A 103(k) Order, No. 8534206, was issued to Oak Grove Mine on December 2, 2016, to prevent the destruction of any evidence that would assist in investigating the cause or causes of the accident, and to ensure the health and safety of person who are employed at this mine until an investigation of the accident can be completed.
2. A 104(a) Citation, No. 8534212, was issued to Zhengzhou Coal Mining Machinery (Group) Co. Ltd for a violation of § 75.1725(c).

An employee of Zhengzhou Coal Mining Machinery Group Co., LTD (ZMJ) was fatally injured while performing work at Oak Grove Mine. Two ZMJ employees were installing hydraulic components on a shield recently purchased by the mine, when the shield collapsed, fatally injuring one of the employees. The shield was not blocked against motion prior to work being conducted on both supporting leg cylinders of the shield.

3. A 104(a) Citation, No. 8534213, was issued to Oak Grove Resources LLC for a violation of § 75.1725(c).

An employee of Zhengzhou Coal Mining Machinery Group Co. LTD (ZMJ) was fatally injured while performing work at Oak Grove Mine. Two ZMJ employees were installing hydraulic components on a shield recently purchased by the mine, when the shield collapsed, fatally injuring one of the employees. The shield was not blocked against motion prior to work being conducted on both supporting leg cylinders of the shield.

4. A 104(a) Citation, No. 8534227, Zhengzhou Coal Mining Machinery (Group) Co. Ltd for a violation of § 48.7(c).

A fatal accident occurred at Oak Grove Resources, LLC, Oak Grove Mine on 12/02/2016 while two employees of Zhengzhou Coal Mining Machinery Group Co. LTD (ZMJ) longwall shield manufacturer were installing components on new shields purchased by the mine operator. One of these contractor employees received fatal injuries when the second contractor employee removed plugs from the hydraulic system on the leg support cylinders of the shield, causing the canopy to collapse. The employee who removed the plugs was present primarily as a

translator for the victim, who could not speak English. He was not properly trained in the safety and health aspects and safe work procedures of this task. He did not recognize the hazard of removing plugs from both hydraulic leg support cylinders, which caused the canopy to collapse on the victim.

APPENDIX A

Persons Participating in the Investigation (Persons interviewed are indicated by a * next to their name)

Oak Grove Resources LLC

Ken McCoy Chief Executive Officer
Mike Zervos President
Robert McAtee Executive Vice President
Mark Nelson Vice President of Operations
Dan Curry Director of Corporate Safety
Larry Millburg General Mine Manager
Larry McCarty..... Mine Superintendent
Gary L. Short Engineer
James D. Morris Safety Manager
Randy McWilliams Longwall Maintenance Planner
David Ingle Longwall Manager
Scotty Cagle Longwall Maintenance Supervisor
Mike Gregory Attorney
Mike Carroll Safety Supervisor
*Michael Richardson Safety Supervisor
*Nathan Diffley Safety Supervisor
*Jack Rexrode Maintenance Foreman
Daniel Hundley Safety Committee, Chairman
Garey Vincent Safety Committee
*Brandon Wright Longwall Mechanic
*Donnie Tisdale General Inside Laborer
*Grady Robinson Longwall Shearer Operator
*Wayne Ingle Longwall Electrician
*Von Solowese General Inside Laborer
*Jesse Mixon Longwall Utility
*Shane Goggins Roof Bolter Operator
*Justin Ingle Longwall Shearer Operator
*Dustin Hewlett Continuous Mining Machine Operator
*John Earnest Underground Electrician and UMWA
President, Local 2133
*Matt Miller Longwall Stage Loader Operator
*Tom Bunn Longwall Utility

*Tim Bailey Underground Electrician
*Jeremy Vining Longwall Shield Puller
*William Bonner Longwall Foreman

Zhengzhou Coal Mining Machinery (Group) Co. Ltd

*Liang Shengping Sales Manager/Translator
Don Sims..... President of ZMJ America

United Mine Workers of America

James Blankenship International Safety Representative

Mine Safety and Health Administration

Richard A. Gates District Manager
Steven D. Womack Asst. District Manager, Technical Div.
Edward M. Boylen Field Office Supervisor
Timothy R. Stockman Inspector / Investigator
Ronald D. Caudill Specialist / Investigator
Ronald Medina Mechanical Engineer, Technical Support
Leon Ko Electrical Engineer, Technical Support

Alabama Department of Industrial Relations

Buddy Herren State Supervisor
Ronnie West Inspector

Appendix B

MSHA Technical Support Equipment Related Physical Factors

PAR NUMBER: 110728

LOCATION: Oak Grove Mine; Mine ID 01-00851; Hueytown, Jefferson County, Alabama. This is an underground coal mine.

EMPLOYER OF ACCIDENT VICTIM: Zhengzhou Coal Mining Machinery Group Co., Ltd. (ZMJ)

EQUIPMENT: Longwall Face Shield Serial #075 at the Oak Grove Mine, manufactured by the Zhengzhou Coal Mining Machinery Group Co., Ltd. (ZMJ)

DATE OF ACCIDENT: December 2, 2016 at approximately 11:00 AM

DATE OF EQUIPMENT EVALUATION: December 4-5, 2016

EQUIPMENT INVESTIGATOR: Ronald Medina, Mechanical Engineer, Mechanical and Engineering Safety Division, Approval and Certification Center; and Leon Ko, Electrical Engineer, Electrical Safety Division, Approval and Certification Center

ACCIDENT SUMMARY: Yujun Qian, a representative of a longwall shield manufacturer, was killed during the installation of a new longwall system at the Oak Grove Mine. Yujun Qian was working behind the leg cylinders and in front of the caving shield of Face Shield Serial #075 at the Oak Grove Mine. The shield collapsed when pipe plugs plumbed to the pilot-operated check valve block attached to each of the two leg cylinders on Face Shield Serial #075 were removed. This allowed hydraulic fluid to suddenly escape from both leg cylinders, causing the leg cylinders to retract, and the canopy and caving shield to move downward and pin the victim. The hydraulic system was in a de-energized state and the hydraulic pumps were not running. The shield was in a raised position, but was not contacting the roof, and was not bearing any weight from the roof strata.

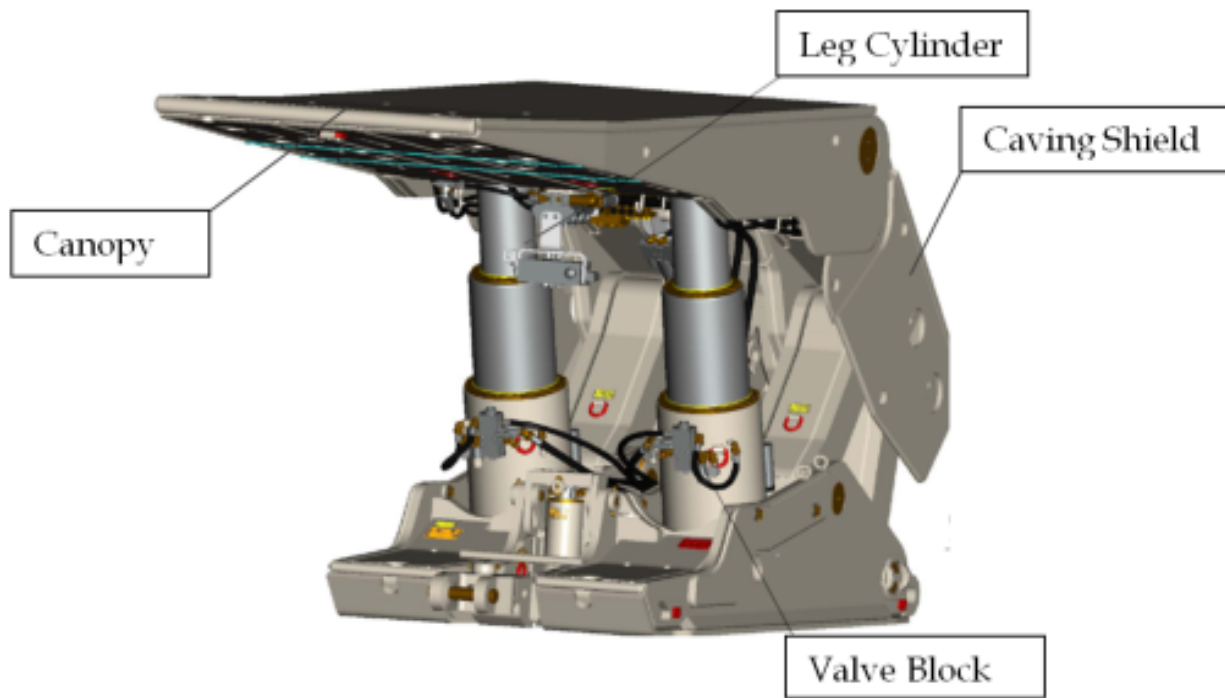
PHYSICAL FACTORS:

1) LONGWALL SUPPORTS GENERAL DESIGN:

- Manufacturer: Zhengzhou Coal Mining Machinery Group Co., Ltd. (ZMJ)

- Shipped to the Oak Grove Mine in October 2016
- Quantity of shields supplied: 194 face shields and 10 gate shields
- Center line distance between all shields: 1.75 m (68.9 inches)
- Face shield weight: 28.6 US tons
- Gate shield weight: 32 US tons
- Maximum face shield height: 96 inches
- Maximum gate shield height: 120 inches
- Two double acting leg cylinders on all shields, each with a working load rating of 595 US tons @ 6110 psi
- Leg yield pressure for all shields: 6,110 psi
- Leg set pressure for all shields: 4,400 psi

2) LEG CYLINDERS DESIGN FEATURES:



The figure above depicts a ZMJ face shield. The canopy is supported by two hydraulic leg cylinders. A valve block is attached directly to the “cylinder-extend” port of each leg cylinder. Each valve block was etched, indicating it was an FDY400/50 Pilot-Operated Check Valve manufactured by the Zhengzhou Coal Mining Machinery (Group). Co., Ltd. This valve block also has seven other ports where hoses or fittings could be attached to it. There are two “PA” ports and two “A” ports. If hydraulic flow and pressure enters any of the “A” or “PA” ports, the leg cylinder will extend. In addition, there are three “PB” ports. One “PB” port is designed to be connected to the leg “cylinder-retract” port, a second “PB” port is designed to be connected to a return line to the electrohydraulic control valve, and the third “PB” port is an unused

port that is plugged with a staple-lock plug. An electrohydraulic control valve is provided on each shield, and can be used to operate all the functions of the shield.

As long as the longwall pumps are de-energized and no pilot pressure is available, the two pressure ports marked "PA" are protected by the pilot check valve feature. If a hose or plug is removed from a "PA" port, hydraulic fluid will not escape from the hydraulic cylinder, and the cylinder will not retract. When the electrohydraulic control valve is activated to raise the shield, hydraulic fluid under pressure enters the pilot-operated check valve block through a "PA" port, and the leg cylinder extends. The pilot check valve feature allows free flow into the "cylinder-extend" port, but prevents reverse flow unless pilot pressure is applied to unseat the pilot check valve, as would occur when the cylinder is intentionally powered down using the electrohydraulic control valve. When the longwall pumps are shut down, no pilot pressure is available, so the hydraulic fluid inside the cylinder cannot escape through a "PA" port.

Although the pilot check valve will keep the cylinder locked in position if a "PA" port is opened to atmosphere; if either of the two "A" pressure ports is opened to atmosphere, hydraulic fluid can freely escape from the cylinder and allow it to retract. As designed, a low flow yield valve and a pressure gauge were connected with a tee fitting to one of the "A" ports of the pilot-operated check valve block.

The low flow yield valve protects the shield by letting fluid out of the leg cylinders in response to large downward forces on the shield canopy, such as from strata deformation. Yielding prevents excessive hydraulic pressure from developing in the leg cylinders that could result in leg or shield damage.

If the low flow yield valve or the pressure gauge (or the plugs capping the ports where these devices are intended to be attached) is removed, oil can freely escape and the leg cylinder can retract. Removing a low flow yield valve or pressure gauge from an "A" port of only one leg cylinder would not cause the shield to collapse, since the other leg would continue to support the weight of the canopy. However, the moment a low flow yield valve or pressure gauge (or the plugs capping the ports where these devices are intended to be attached) is subsequently removed from an "A" port on the second leg cylinder of the same shield, both leg cylinders would retract, and this would cause the shield to collapse. This did occur at the time of the accident based on the missing plugs found by miners during the rescue immediately after the accident. The DN-10 staple-lock plug where the pressure gauge was to be installed had been removed from the right-side (tailgate-side) leg cylinder, while the DN-12 staple-lock plug where the yield valve was to be installed had been removed from the other leg of the same shield. These plugs were reinstalled during the rescue attempt to allow the shield to be elevated hydraulically.

3) **ADDITIONAL YIELD VALVES:** In addition to the leg cylinder low flow yield valves, a high flow yield valve was directly attached to each leg cylinder and could also relieve pressure from the “cylinder-extend” side of these cylinders.

Each leg cylinder was further equipped with a separate yield valve to protect the “cylinder-retract” side of each leg cylinder, and additional yield valves protected other shield cylinders.

4) **ELECTRICAL CONSIDERATIONS:** At the time of the accident, no part of the electrohydraulic shield control system was energized, as that was to be done later in the installation process. The only energized circuitry was a separate lighting system, which provided illumination to the area.

CONCLUSION:

The shield collapsed when pipe plugs plumbed to the pilot-operated check valve block attached to each of the two leg cylinders on Face Shield Serial #075 at the Oak Grove Mine, were removed. This allowed hydraulic fluid to suddenly escape from both leg cylinders, causing the leg cylinders to retract, and the canopy and caving shield to move downward and pin the victim. The pipe plugs that were removed were capping the ports where a pressure gauge and a low flow yield valve were intended to be attached during the longwall installation process.

Appendix C

Victim Information

Accident Investigation Data - Victim Information

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



Event Number: 6 4 9 2 5 2 8

Victim Information: 1															
1. Name of Injured/III Employee: <i>Qian Yujun</i>				2. Sex: <i>M</i>		3. Victim's Age: <i>36</i>			4. Degree of Injury: <i>01 Fatal</i>						
5. Date(MM/DD/YY) and Time(24 Hr.) Of Death: <i>a. Date: 12/02/2016 b. Time: 11:00</i>								6. Date and Time Started: <i>a. Date: 12/02/2016 b. Time: 7:00</i>							
7. Regular Job Title: <i>099 Contractor- Technical Advisor (Engineer)</i>						8. Work Activity when Injured: <i>039 Longwall Shield component installation</i>						9. Was this work activity part of regular job? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>			
10. Experience															
a. This				b. Regular				c. This				d. Total			
Years	Weeks	Days	Job Title:	Years	Weeks	Days	Years	Weeks	Days	Years	Weeks	Days	Years	Weeks	Days
<i>13</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>13</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>13</i>	<i>0</i>	<i>0</i>	<i>13</i>	<i>0</i>	<i>0</i>
11. What Directly Inflicted Injury or Illness? <i>067 Shield leg jacks de-pressurized</i>								12. Nature of Injury or Illness: <i>110 Asphyxiation</i>							
13. Training Deficiencies:															
Hazard: <input type="checkbox"/> New/Newly-Employed Experienced Miner: <input checked="" type="checkbox"/> Annual: <input type="checkbox"/> Task: <input type="checkbox"/>															
14. Company of Employment: (If different from production operator) <i>Zhengzhou Coal Mining Machinery Group Co., LTD</i> Independent Contractor ID: (if applicable)															
15. On-site Emergency Medical Treatment:															
Not Applicable: <input type="checkbox"/> First-Aid: <input type="checkbox"/> CPR: <input type="checkbox"/> EMT: <input type="checkbox"/> Medical Professional: <input type="checkbox"/> None: <input checked="" type="checkbox"/>															
16. Part 50 Document Control Number: (form 7000-1) <i>220163470018</i> 17. Union Affiliation of Victim: <i>9999</i> None (No Union Affiliation)															