PUBLIC SUBMISSION

As of: 1/15/16 2:57 PM
Received: January 15, 2016
Status: Posted
Posted: January 15, 2016
Tracking No. 1k0-8nef-v6fl
Comments Due: January 15, 2016
Submission Type: Web

Docket: MSHA-2013-0033
Refuge Alternatives for Underground Coal Mines-Request for information

JAN 15 2016

Comment On: MSHA-2013-0033-0038
Refuge Alternatives for Underground Coal Mines

Document: MSHA-2013-0033-0040
Comment from Paul Schulte, National Institute for Occupational Safety and Health (NIOSH)

Submitter Information

Name: Paul Schulte
Address:
1090 Tusculum Avenue
Cincinnati, OH, 45226-1998
Organization: National Institute for Occupational Safety and Health (NIOSH)

General Comment

National Institute for Occupational Safety and Health (NIOSH) comments and letter of submission.

Attachments

MSHA Refuge Alternatives-NIOSH FINAL Cmts_Ltr

AB79-COMM-15

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
1090 Tusculum Avenue
Cincinnati, OH 45226-1998

January 15, 2016

MSHA
Office of Standards, Regulations, and Variances
201 12th Street South
Suite 4E401
Arlington, Virginia 22209-3939

Docket No. MSHA-2013-0033; RIN 1219-AB79

Dear Sir/Madam:

The National Institute for Occupational Safety and Health (NIOSH) has reviewed the Mine Safety and Health (MSHA) Request for Information on *Refuge Alternatives for Underground Coal Mines* published in the *Federal Register* on September 18, 2015 [80 FR 56416]. Our comments are enclosed.

Please do not hesitate to contact me at 513/533-8302 if I can be of further assistance.

Sincerely yours,

Paul A. Schulte, Ph.D.
Director
Education and Information Division

Enclosure

National Institute for Occupational Safety and Health

NIOSH

Comments to MSHA

Comments of the National Institute for Occupational Safety and Health on the Mine Safety and Health Administration Refuge Alternatives for Underground Coal Mines Request for Information

RIN 1219—AB79

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Cincinnati, Ohio

January 15, 2016

In response to the Mine Safety and Health Administration (MSHA) Request for Information (RFI) on *Refuge Alternatives for Underground Coal Mines*, the National Institute for Occupational Safety and Health (NIOSH) offers these comments on questions presented in the reopening of record notice published in the September 18, 2015 *Federal Register* [80 FR 56416]. Text from the notice is in italics.

Page 56417: *III. Questions and Issues for Discussion*

A. Built-In-Place Refuge Alternatives

In its report, "Facilitating the Use of Built-In-Place Refuge Alternatives in Mines," RI 9698, NIOSH makes recommendations on the use of built-in-place shelters, as a type of refuge with a superior environment when compared to tent and steel pre-fabricated structures. The report addresses three issues: (1) Locating built-in-place refuges further from the face than the 1,000-foot limit required under the existing standard; (2) providing a consistent process for the design and approval of refuge stoppings; and (3) delivering a reliable supply of clean, breathable air to a built-in-place refuge. NIOSH recommends allowing operators to locate built-in-place refuges further than 1,000 feet from the face, but only if the refuges:

- *Provide a constant supply of air into the refuge via either a protected compressed air line or a borehole from the surface.*
- *Provide a minimum of 85 cubic feet of space per occupant.*
- *Maintain the interior of the refuge under positive pressure when not in use to ensure that the refuge contains breathable air immediately on entry and to keep contaminated air from entering the refuge when miners enter.*

MSHA invites comments and information on the following issues:

1. How would MSHA's acceptance of built-in-place refuges located further from the face and meeting the above criteria affect your decision on whether or not to install a built-in-place refuge? Discuss the relative merits of location versus design and performance. Please comment on the advantages and disadvantages of NIOSH's recommended approach for built-in-place refuges; the feasibility of installing built-in-place shelters in different mine settings; the risks related to a refuge location that is further away from the working face; and the benefits of a built-in-place refuge's environment and performance characteristics.

Comment: By comparison to portable refuge alternatives, built-in-place (BIP) refuge alternatives (RAs) are more substantial in size and are constructed in place by the mine operator [NIOSH 2015]. In an emergency when immediate escape is not possible due to toxic gases or a blocked escape way, BIP RAs offer the potential to provide miners with an improved psychological and physiological environment, both because the available air makes the space more comfortable and due to the larger amount of space provided per occupant [NIOSH 2015]. Boreholes or protected compressed air line air supply systems also provide a much higher probability of there being communications to the RA [NIOSH 2015].

Despite the advantages of BIP RAs, as currently designed, they cannot be moved frequently. Movement of the RA location is required to keep up with dynamic mining production, and it would be impractical to keep BIP RAs within 1,000 feet (ft) of the nearest working face, as prescribed in <u>30 CFR 75.1506(c)</u>, because of the number of times the RA would have to be rebuilt. Currently, there are approximately 19 BIP RAs in U.S. underground coal mines; however, all of these are located outby the face area and none are designed to be advanced with the working face [Shumaker 2015]. The usage of BIP RAs that can be advanced with the working face will only be practical if three issues can be addressed:

- locating BIP RAs further from the face
- providing a consistent process for the design and approval of RA stoppings
- delivering a reliable supply of clean, breathable air to a BIP RA

To investigate the first issue—the possibility of locating BIP RAs further from the face—NIOSH used three approaches to determine the distance that miners could travel from the face, given the 120 minutes of breathing time afforded by currently available self-contained self-rescuers (SCSRs). The available 120 minutes of breathing time is based on 30 CFR 75.1714-4(a)(1), which requires the mine operator to provide "at least one additional SCSR, which provides protection for a period of one hour or longer, for each person at a fixed underground work location." NIOSH used three approaches to address this issue: examining the current distance criteria for mandated SCSR storage cache locations; performing a timeline study based on worst-case SCSR usage times; and examining established travel times and escape probabilities determined from past NIOSH and U.S. Bureau of Mines research [NIOSH 2015].

To address the second issue—design and approval of RA stoppings—NIOSH analyzed the criteria that engineers must consider when submitting RA stopping designs for approval under the requirements of MSHA's Refuge Alternatives for Underground Coal Mines rule and MSHA guidelines for coal mine seals. Using the MSHA application guidelines as a model, NIOSH developed extensive guidelines for RA stopping design applications as well as specifications for an exemplary RA stopping design. The exemplary stopping design is presented in NIOSH [2015] to illustrate how the proposed design guidelines can be applied in preparing a design submittal to MSHA District Managers for approval [NIOSH 2015].

To explore the third and critical issue—delivering a reliable supply of clean, breathable air to a BIP RA—NIOSH considered the available technologies approved by MSHA for providing breathable air to an RA via a protected compressed air line. NIOSH also analyzed practical and technical considerations for the surface compressor station and the protected compressed air line [NIOSH 2015].

A NIOSH study established conservative maximum distances from the face to RAs for various entry heights based on the assumption that miners have 90 minutes of available travel time in the escape way to reach an RA [NIOSH 2015]. Based on these findings, mines could locate BIP RAs at distances from the working face based on the guidance provided by the table below. This table summarizes the study findings based on entry height with the maximum face-to-RA distance determined by rounding down the shortest distances from the three approaches used in the analysis to the nearest thousand feet [NIOSH 2015]. As noted in the rightmost column, the maximum distance that BIP RAs could be located from the face increases as entry height increases.

Allowing mines to locate BIP RAs at greater distances from the working face, as shown in the table, has several advantages: (1) a higher likelihood of the BIP RA avoiding damage from both primary and secondary explosions that often occur at the face area, which also increases the likelihood that the communication system to the RA survives a disaster; (2) a reduction in the number of BIP RAs required to be constructed; and (3) the introduction of a wider variety of BIP RA designs, which could potentially improve the safety as well as the psychological and physiological comfort and mental well-being of confined miners [NIOSH 2015].

Entry height	Approach 1: Based on mandated SCSR storage cache locations	Approach 2: Based on worst-case SCSR usage times	Approach 3: Based on NIOSH and BOM established travel times and escape probabilities	Maximum BIP RA distance from the face (based on most conservative distances)
<40 in	2,200 ft	2,640 ft	not applicable	2,000 ft
>40–<50 in	3,300 ft	3,960 ft	not applicable	3,000 ft
>50–<65 in	4,400 ft	5,280 ft	6,000 ft	4,000 ft
>65 in	5,700 ft	6,480 ft	6,500 - 7,000 ft	5,000 ft

Despite these advantages, consideration should be given to allowing mines to locate RAs further from the face only if they employ new RA technologies that meet several criteria—specific pressure requirements for the interior atmosphere, the provision of a constant supply of air, and additional RA space per occupant—as detailed in a NIOSH study [NIOSH 2015].

2. Discuss the advantages and disadvantages of the following methods of providing breathable air in refuges: Using supplied air from the surface versus using air from cylinders stored underground; or delivering surface supplied air through a borehole directly into a built-in-place refuge versus compressed air lines run through the mine.

Comment: A borehole from the surface directly into the BIP RA allows a constant supply of fresh air to the BIP resulting in breathable air immediately upon entry and positive pressure to keep contaminated air from entering the RA [NIOSH 2015]. However, using a borehole to deliver air from the surface to the BIP RA may be impractical due surface rights issues, drilling costs, and the need to drill additional boreholes as mining advances. In some cases, using compressed air lines, protected by burial in the mine floor and/or mechanical means, to deliver breathable air to a BIP is more practical [NIOSH 2015]. The use of protected compressed air lines also has limitations and design considerations such as the location of the compressed air source, drainage of condensate, connection of the air line to the BIP RA, and air delivery limits (i.e., how far air can be carried through a compressed air line before pressure losses become too great) that should be considered [NIOSH 2015].

Using compressed air and oxygen cylinders to provide purging and breathable air is less desirable because this results in less occupancy space inside the chamber [NIOSH 2015]. In addition, the chamber would not initially have clean air or positive pressure to keep contaminants out. In this case, additional SCSRs must be available in the RA to sustain miners until the RA can be adequately purged of contaminated air.

3. Discuss options for piping air over several miles through a mine to provide a clean air supply and sufficient air pressure to a built-in-place refuge when a borehole directly into the refuge is unavailable. What issues remain to be addressed for the protection of piping used to provide compressed air to a refuge?

Comment: NIOSH is actively performing research on RAs under the project "Advancement of Refuge Alternatives for Underground Coal Mines." As part of this project, NIOSH is planning to perform research to develop guidelines for RA air supplies. Based on these guidelines, NIOSH plans to evaluate (install) two RA air delivery systems in the Experimental Mine. NIOSH also plans to develop guidelines for the use of boreholes, protected compressed air lines, and cryogenic air supplies for use in mobile and BIP RAs. In addition, NIOSH is currently collaborating with the University of Kentucky to perform research related to protected compressed air lines including piping distances; air line size, durability, and materials; and methods to protect compressed air lines from an explosion.

4. What are the risks and benefits to miners' safety, if any, if a constant air supply from the surface is provided to a refuge and exhausted from the refuge into the mine, as opposed to exhausting to the surface?

Comment: If constant air can be supplied from the surface to an RA, the main benefit is that the miners will have an "endless" duration of available breathable air. This then allows [NIOSH 2015]:

- more time for assessing conditions and planning a safe rescue
- maintaining an adequate positive pressure to keep contaminants out
- more effective CO_2 purge due to adequate ventilation
- accelerated removal of other toxic gases and particles (e.g., smoke)

Some of the risks are [NIOSH 2015]:

- if the air flow rate is too high, some of the occupants might experience a draft or wind effect inside the chamber which may be uncomfortable (feel cold) if in its direct path
- the noise of the constant airflow might be intolerable over time
- the quality of the breathing air may degrade over an extended period of operation if the filtration system is not serviced [ANSI 1997]

Exhausting the air into the mine as opposed to exhausting to the surface may or may not be a problem depending on different situational factors.

- If exhausting into the mine, there is no effect on the miners if the pressure within the mine does not build up to levels to cause decompression sickness or caisson disease (DCS). If the miners are subjected to DCS, then decompression chambers need to be available for use in treatment when they exit the mine.
- If air is exhausted to the surface, there are back-pressure piping issues and additional cost of return air plumbing to consider.

5. What are the advantages and disadvantages of using SCBAs with refill stations as compared to using SCSRs with caches in escapeways?

Comment: Open-circuit self-contained breathing apparatus (SCBAs) used together with refill stations offer an alternative to exchanging SCSRs from a cache during mine escape. There are two systems that could be used. The first, using high pressure compressed air, has been deployed in Australian mines since 1994, such as in Oaky Creek Coal Mine, Tieri, Queensland and a few U.S. mines since 2007, such as in BHP Billiton San Juan Coal mine, Farmington, NM. In this system, the Refill Station stores breathing air in high pressure (6,000 pounds per square inch (psi)) cylinders and fills the high pressure (4,500 psi) bottle on an SCBA directly on demand by the user through a refill line. To make the most efficient use of the stored air, the cylinders in the Refill Station are arranged as banks and deliver air via an auto-cascading pneumatic circuit. The SCBAs are typically one hour duration units.

The second system uses cryogenic (Liquid) air. The Cryogenic Refill Station stores liquid air in a large dewar where it is prevented from evaporating by maintaining the cryogenic temperatures (-318°F) using a Cryocooler. The dewars of the cryogenic SCBAs (CryoBA) are filled directly from the station using filling lines similarly to the air stations. The CryoBA has about twice the duration (two hours) for a similar sized SCBA.

Advantages of using SCBAs with Refill Stations

- The escape breathing apparatus (SCBA or CryoBA) is the same unit and never replaced during escape
- Quick and easy to don apparatus and isolate lungs
- Cooler air and easier to breathe
- Positive pressure in facemask/hood that keeps contaminants out in case of a leak
- User can monitor the available air supply via pressure gauges (SCBA & Refill Station)
- Verbal communication possible through facemask/ hood
- SCBA is refilled while being worn and user is breathing from the apparatus while refilling
- Remaining air in the Refill Station can be used by miners awaiting rescue
- Training is done with actual units that can be restored back to service after use

Disadvantages of using SCBAs with Refill Stations

- Proper fit of facemask on persons with facial hair
- High initial capital cost, then low maintenance cost
- Maintenance on two components of the system – SCBAs and Refill Stations

6. ***Discuss and describe new and improved technology for built-in-place refuges' designs. What is the impact of these designs on the cost of built-in-place refuges? For example, would a moveable wall or other modular design make the use of a built-in-place refuge more feasible and economical?***

Comment: The costs of the existing BIP RAs range from $50,000 to $150,000, depending mainly on stopping and door system costs and borehole costs [NIOSH 2015]. Examples of design considerations for BIP RAs are provided in NIOSH [2015].

B. Miners' Ability to Communicate During Escape

Miners' ability to communicate with each other can be critical during mine emergencies. Under existing rules, miners use self-contained self-rescue (SCSR) escape respirators that have a mouthpiece. A self-contained breathing apparatus (SCBA) has a full-face respirator mask. Miners must remove the mouthpiece of an SCSR to speak, or remove the full-face respirator mask of an SCBA to communicate clearly. These actions expose miners to deadly gases in the mine atmosphere.

7. Discuss the challenges associated with providing two-way communication when using escape SCBAs or SCSRs. What technologies, such as voice amplifiers or wireless communication systems, are available for escape SCBAs or SCSRs that can enhance voice communication among miners?

Comment: Escape SCBAs use a facemask with an integrated speech diaphragm for communication. SCBA manufacturers use this technology as standard in their current products. In the case of the SCSRs, current units use a mouth or bite piece which makes verbal communication difficult. Current NIOSH research is addressing this limitation by developing facepieces that allow the option of breathing from the SCSR without a bite piece while communicating. Two prototypes of hoods with inner half masks have been developed for integration to SCSRs in the past two years. These prototypes are scheduled for further testing and integration into the next generation of SCSR prototypes being developed at NIOSH in conjunction with the U.S. Navy. Some challenges in these hood/mask designs were making them packable (material flexibility) lightweight and incorporating a small but effective speech diaphragm. Small embedded microphones and ear pieces may be explored in these facepieces to test the feasibility of interfacing to mine radios and other mine wide communications networks.

References

CGA [1997]. Compressed Gas Association standard, The quality of the breathing air, CGA G 7.1 Gr.D CGA G-7.1–1997, http://webstore.ansi.org/RecordDetail.aspx?sku=CGA%20G-7-2014&source=google&adgroup=cga&gclid=CJHqhPmlmMoCFUwkgQodbQwA3A.

NIOSH [2015]. Facilitating the use of built-in-place refuge alternatives in mines. By Trackemas J, Thimons E, Bauer E, Sapko M, Zipf K, Schall J, Rubinstein E, Finfinger G, Patts L, LaBranche N. Pittsburgh, PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2015-114, http://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2015-114.pdf.

Shumaker W [2015]. E-mail message from W. Shumaker, Applied Engineering Division Chief, Approval and Certification Center, Mine Safety and Health Administration, United States Department of Labor to D. Yantek, Lead Research Engineer, Electrical and Mechanical Systems Safety Branch, Office of Mine Safety and Health Research, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, April 14, 2015.