

# USING PERFORMANCE MANAGEMENT STRATEGIES TO IMPROVE MINE EMERGENCY TRAINING AND PREPAREDNESS

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The MINER Act of 2006 called for significant improvements to emergency response training and preparedness at U.S. underground coal mines. Yet, results from a recent survey on self-escape competency by the National Institute for Occupational Safety and Health (NIOSH) suggest that underground coal miners may still be underprepared for self-escape. These findings can motivate safety trainers to identify strategies for improving the workforce's self-escape preparedness for every worker during every shift in the event of an underground mine emergency.

While the MINER Act requires assessment of self-escape competency, it provides no standardized definition of the specific self-escape competencies that all miners must have, no standardized competency-based training methods or tools, nor any guidelines on how to assess them. In the 2013 report, "Improving Self-Escape From Underground Coal Mines," the National Academy of Sciences urges the industry to adopt a "train-to-mastery" system with competency-based standards instead of focusing on fulfilling time-based training requirements. To that end, competency-based self-escape training and assessment focuses on outcomes, such as the mastery of critical self-escape knowledge, skills, and abilities (KSAs), thus placing the emphasis on task performance and individual proficiency instead of training duration. The National Academy of Sciences report noted that this shift toward a train-to-mastery system would help improve self-escape training and, in turn, improve self-escape preparedness.

In response to the report recommendations, NIOSH identified the critical self-escape competencies and administered the Self-Escape Competency Survey under a research protocol approved by the NIOSH Institutional Review Board (IRB) and Office of Management and Budget

(OMB), which assessed coal miners' self-escape confidence in 28 identified critical self-escape KSAs. The results from this effort appeared in the 2018 January-February *Coal Age* article, "The ABCs of KSAs: Assessing the self-escape knowledge, skills and abilities of coal miners." The next step is to determine how mine companies can use the identified critical self-escape KSAs to adopt and implement competency-based training and assessment strategies to improve miners' self-escape preparedness, thus allowing the shift from a time-based to a train-to-mastery system.

In this article, the authors report on one company's efforts to improve its miners' self-escape competencies after participating in the NIOSH survey. The company has implemented competency-based performance management strategies, including assessment and remediation processes, which it incorporates into its mandated training to monitor and improve self-escape competence throughout the year.

## Survey Results and Industry Feedback

In 2016-2017, eight underground coal mines in the eastern United States participated in NIOSH's Self-Escape Competency Survey. The survey assessed miners' self-reported confidence on 28 critical self-escape competencies identified through a preliminary task analysis. Researchers collected surveys from 895 workers, including miners, supervisors and safety personnel.

After completing data collection at each mine, researchers compiled a comprehensive mine-specific feedback report of findings for the operations to review, including workers' responses to the 28 self-escape competency items. Because mine safety personnel generally considered their workers to be well prepared for self-escape, many were surprised when

miners' self-reported confidence suggested otherwise. When describing their reaction to their survey results, mine safety personnel used terms such as "eye-opening," "surprising," "shocking" and "frustrating."

Consol Energy (Consol), one of the mine operators that participated in the survey, operates three mine sites in western Pennsylvania that collectively employ more than 1,600 workers. Consol prepares its miners to self-escape from a mine emergency through delivering training and holding exercises that include smoke expectations and fire-fighting training.

Jason Diamond coordinates all of the training for all three mine sites with the help of two to three individuals from Consol's mine rescue teams. Consol utilizes these individuals as key resources during training development and delivery, where they can draw upon lessons learned through their own experiences in emergencies to develop content.

The mine's safety personnel readily agreed to participate in the current study, interested in learning what their workforce had to say. Like safety personnel at the other participating mine sites, Consol's safety manager described their survey results as surprising when it became apparent that gaps in critical self-escape KSA knowledge remained, despite the company's past training efforts.

## First Steps: Addressing Identified Gaps in Self-escape KSAs

In order to improve self-escape performance in the areas where gaps were identified from their survey results, safety personnel and mine trainers from Consol came together to brainstorm next steps. The company's training coordinator, corporate's general manager of safety, and two members of Consol's mine res-

cue teams met to develop and implement a competency-based assessment tool for the company's upcoming annual refresher training.

The company's first step was to implement a pen-and-paper knowledge check during its 2018 annual refresher training. This knowledge check included detailed questions about items from the Self-Escape Competency Survey, along with additional questions that safety personnel believed were important for self-escape. For example, "where your SCSR caches are located" was a competency survey question; therefore, Consol included "name the specific locations where SCSRs are kept at your mine" on its knowledge check. The training coordinator also incorporated mine-specific questions (e.g., where fire extinguishers are kept at the mine site, how many gallons of water the mine site's diesel fire cars hold and their locations, etc.). Trainers also asked questions about what types of topics and exercises the workforce would like to see added to future training sessions.

The training coordinator administered the knowledge check at the beginning of each annual refresher training session, after giving a brief overview of the general results of the Self-Escape Competency Survey as detailed in the January-February *Coal Age* article, "The ABCs of KSAs." The trainer indicated that he presented this information before administering the knowledge check in order to help mineworkers understand that they aren't alone if they are less than fully confident in any of the self-escape competencies and to encourage honesty in their responses.

After reviewing each mineworker's annual refresher knowledge check, the training coordinator found that about 10% of the workforce needed remediation in one or more critical self-escape KSAs. At the individual level, safety trainers identified specific workers in need of KSA improvement and developed individualized remediation approaches to improve the mineworkers' self-escape competencies. At the mine-wide level, the training coordinator worked to incorporate KSAs that were in need of improvement into future training and assessment procedures and materials.

The training coordinator followed up with those mineworkers who responded

incorrectly to key self-escape KSA items during their next shift. The safety trainer worked one-on-one with individuals on the KSAs that they struggled with in an attempt to improve their knowledge and confidence. Mineworkers were encouraged to ask questions and to give their candid feedback to the trainer, to help him understand why they were still struggling on the identified item or items, and what types of training or exercises might help them improve. This feedback, paired with the general results across all of the mineworkers, helped safety trainers identify key areas to focus on when developing their future training.

### Next Steps: Incorporating Results Into Subsequent Trainings

Some key areas in need of improvement among Consol's workforce were mine map symbol and lifeline symbol knowledge, what to expect when wearing an SCSR, how to enter the mine's refuge alternative, and how to fight fires. Thus, Consol built training and assessment elements on these topics into the annual smoke/SCSR expectations training and developed a supplemental firefighting refresher training to deliver on the same day.

Consol held this training in a three-entry simulated mine, a portion of the



Figure 1—Workers entering a simulated mine as part of a training exercise for navigating through smoke.

locker room that was renovated to serve as the location of this smoke exercise (Figure 1). Each year, the layout of the simulated mine is different from the year before and trainers incorporate new scenarios, obstacles, and challenges into the training exercise. Firefighting training is held in the fire gallery after the expectations exercise is completed.

To challenge mineworkers on their mine map symbol knowledge and map reading abilities, trainees were required to walk through the simulated mine beforehand, mapping out the "mine" layout, (e.g., location of escape routes, primary and secondary escapeways, lifelines, SCSR caches, telephones, power center), and noting other simulated "mine-specific" characteristics (e.g., man doors and cross-check curtains).

Groups of four to six trainees then were required to use this map to simulate escape when navigating through smoke during the expectations exercise. After the exercise, trainers met with each group to review their performance and the maps they had drawn prior to completing the exercise, and to offer feedback and answer questions when necessary.

When mineworkers were asked to report any requests and/or recommendations for future trainings during their annual refresher quiz, a large number requested more opportunities to use actual live SCSR units instead of expectations units during expectations training. In response to this feedback, Consol trainers collected the about-to-expire Ocenco M20 and EBA 6.5 SCSR units that were in need of refurbishment and offered mineworkers the opportunity to don them during the smoke training (Figure 2). Prior to sending the units for servicing, trainers were able to use them to allow mineworkers a more realistic experience on what to expect when opening, donning and wearing a real SCSR.

Finally, to improve mineworkers' confidence in firefighting, Consol trainers also incorporated 1.5 hours of firefighting training into annual refresher training. The firefighting training included a review of the operation and setup of diesel-powered fire cars, location and use of fire extinguishers, setup and use of the company's foam packs and lightweight portable foam generators, and firefighting practice



Figure 2—Worker donning an SCSR unit to prepare for smoke training.

using fire hoses in the company's fire gallery. To improve mineworkers' procedural knowledge and understanding of refuge alternative setup and operation, company trainers revised this training by grouping related activation and setup steps into logical step clusters. Trainers used specific feedback from the survey and from trainees' recommendations to develop this training, with the intent of making the process more intuitive.

### Early Results: Increased Engagement and Personal Accountability

When NIOSH researchers spoke with the company's training coordinator about the results of these competency-based training, assessment, and remediation efforts, the coordinator mentioned that he had seen improvement in his workforce's self-escape KSAs as well as their attitude about health and safety training at the mine site. He reported that, in his opinion, the workforce was more engaged in their training, more willing to ask for specific trainings that they were interested in or felt were necessary (e.g., more realistic and hands-on escape training, including using live one-hour SCSR units as well as live 10-minute units, etc.). The trainer also reported that mineworkers were more eager to ask questions when they needed more information or help on a subject and were open to admitting when they were strug-

gling on a training topic, demonstrating increased personal accountability for their self-escape preparedness.

Mine rescue team members, who assisted in carrying out the expectations and fire prevention training, similarly reported having seen marked improvement and increased engagement among the workforce, noting that mineworkers seemed to be asking more questions and participating more enthusiastically compared to prior years.

To reinforce the year-round retention of self-escape KSAs and to continue to develop trainings that are tailored to specific competency gaps among the workforce, the training coordinator plans to incorporate additional assessment and remediation strategies into the mine sites' quarterly escapeway drills. This will enable consistent and targeted self-escape KSA monitoring and improvement.

### Incorporating Competency-based Assessment Into Self-Escape Training

Mine safety professionals who participated in NIOSH's Self-Escape Competency Survey were surprised when results showed that their mineworkers were not as prepared for self-escape as they had believed. Unfortunately, many times the true self-escape preparedness of a mine's workforce is only determined after an actual mine emergency occurs, when it is too late to intervene. Regular competency-based assessment and remediation would help mines to make informed decisions about where to direct their resources and efforts to best maximize the benefit of the already-required self-escape trainings (e.g., the annual refresher training, annual smoke expectations training, quarterly response drills, etc.).

By employing simple, cost-effective assessment methods such as pen-and-paper quizzes (like the ones developed by Consol), mine companies can identify weaknesses in self-escape competency and tailor training content to "fill in the gaps." These methods allow for the assessment of a large number of mineworkers at once, making it easier and more time-effective than trying to gauge competency through performance, also allowing safety trainers to identify mineworkers who are struggling so that they may provide more individualized remediation where neces-

sary. This enables mine companies and safety trainers to respond to KSA gaps at both the mine-wide and individual level.

Self-Escape Competency Survey results also indicated that mineworkers were more confident in their self-escape KSAs when they felt that health and safety training was a priority at their mine and that their escape training was realistic and hands-on. Simply making the effort to assess and improve preparedness gaps and asking mineworkers what they want or need is a great place to start. These efforts can demonstrate the mine company's commitment to the health and safety of its mineworkers, creating more opportunity for open communication about areas where improvement is necessary and what efforts might help achieve that improvement.

Recent NIOSH self-escape research has produced materials that can aid mine companies in developing competency-based training and assessment practices to implement during already-required trainings. The aforementioned critical self-escape items included on the competency survey, detailed in the prior *Coal Age* article, "The ABCs of KSAs," can help mine companies to prioritize key competencies to focus on during training. Additionally, a detailed table listing training resources and assessment opportunities for each of the self-escape competencies listed on the Self-Escape Competency Survey was included in that article and is available by request from NIOSH.

### Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of any company or product does not constitute endorsement by NIOSH.

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