

Underground mine fire preparedness

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Part 3 of 4: underground fire-fighting experiences and workers' perceptions of training and readiness for fire-fighting

This is the third in a series of four articles that discuss underground fire-fighting preparedness. As with the first two articles, it is based on interviews with 214 miners conducted at 7 underground coal mines (referred to as Mines "A" through "G") by researchers of the National Institute for Occupational Safety and Health's (NIOSH) Pittsburgh Research Center [Vaught et al. 1996]. In the first article, the authors presented an overview of the study conducted by NIOSH on mine fire response preparedness and provided a general perspective on underground mine fires. The second article discussed miners' preparedness to evacuate a fire and their experience with incipient fires. In this article, we describe miners' experience in fighting underground mine fires and present their perceptions of training and readiness for fire-fighting.

Miners' experiences in fighting underground mine fires

Figure 1 presents the percentages of workers who reported having direct experience in fighting underground mine fires at some point during their mining careers. The most consistent part of this picture is captured by the finding that, across all seven mines, about 70% of those interviewed had, at some time during their career, fought a fire underground. This suggests that small fires are a constant, i.e., they will always occur. Many miners were involved in more than one firefighting incident; the percentages are reported in Report of Investigations (RI) 9584 [Vaught et al. 1996]. The reader should note that, because of the nature of the questions, summary data for fire response do not distinguish the fire experiences of miners while em-

ployed at a particular mine site from previous experiences working at other sites.

Figure 1 also summarizes the results of follow-up questions concerning these small fires. Note that 19% of the workers were involved in episodes in which apparatus were donned to help fight the fire, and 14% were involved in incidents in which ventilation changes were made (to either clear the smoke or help fight the fire). In terms of their perception of the way in which the fire was handled, 30% of miners reported (in hindsight) being involved in at least one event in which they felt that the fire could have been handled differently (i.e., better), and 45% were involved in fighting a fire (or fires) that they felt could have gotten out of control.

Miners were asked a series of questions about their experiences in

Figure 1.—Percentage of miners with direct experience in underground fire fighting

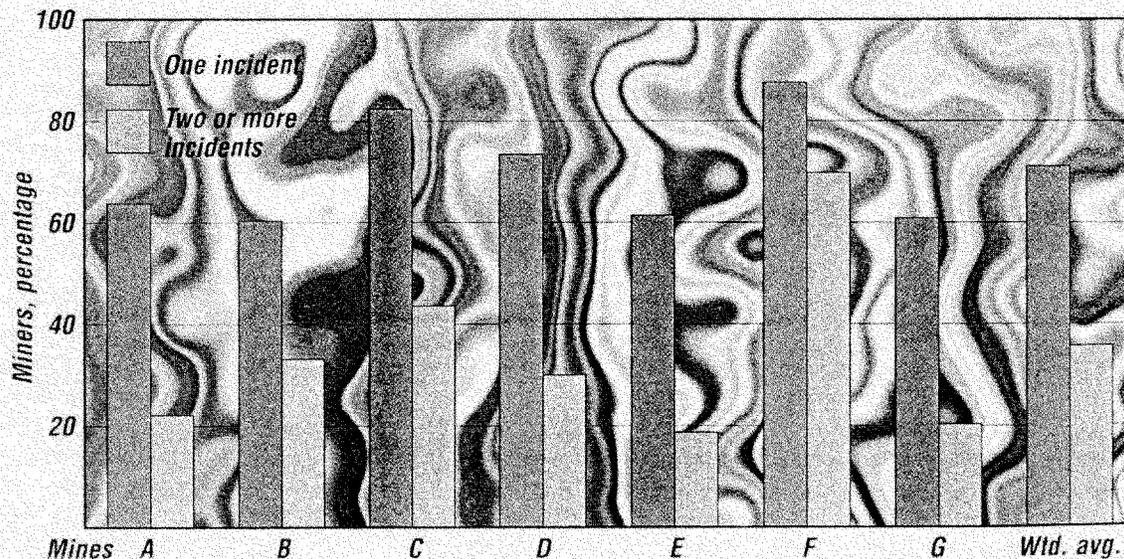
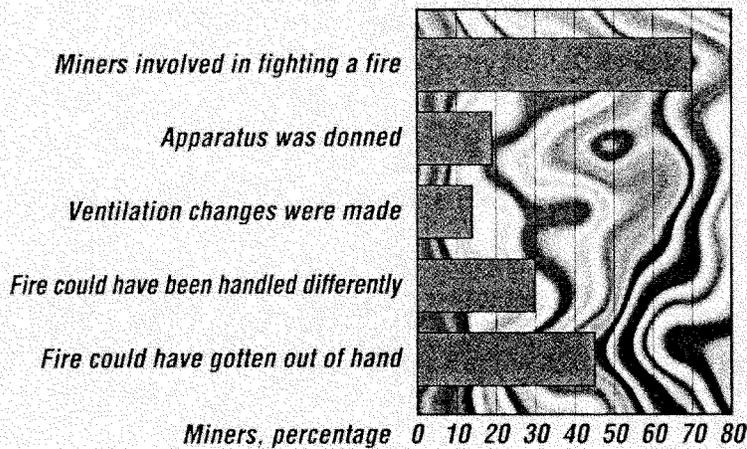


Figure 2.—Miners involved in fighting fires



the use of fire-fighting equipment and materials (such as rock dust). The four bar charts in figure 2 summarize for each mine visited ("A" through "G") the percentage of miners who reported having hands-on experience in the use of rock dust, fire extinguishers, fire hoses, and fire suppression systems on equipment. The extent of these workers' experience was differentiated as to whether they had used the equipment underground to fight fires, used them underground for some other purpose, and/or used them at all. In the case of rock dust use, however, it appeared relevant to ask miners only whether they had ever employed it to put out a fire underground. Looking across the four bar charts and across mines, with regard to fighting fires underground, over one-half of the miners interviewed had hands-on experience using rock dust to put out a fire. Although rock dust served as a successful extinguisher for many miners, there were some instances where it was not. As one miner noted:

"I was on third shift rock dusting, and we was coming back up the track, and we hit smoke. When we hit that smoke, we put our self-rescuers on to go through the smoke. [The motorman] just put the motor in low tram, and we rode the motor

and rock duster through it. And when we got through it, we got to the fire up there. We found it, located it, and we got on the good side; we had good air. We took our self-rescuers off then, and we had about half a tank of rock dust left. . . I went in there and started shooting rock dust on the fire, you know, trying to contain it, and it was done too far gone."

When fire extinguishers had been employed inside the mine, it was almost always to fight a fire. Forty percent of the respondents had used fire extinguishers to perform this task. About 30% of the workers had used water hoses, and less than 10% had activated a fire suppression system. As a group, workers were most likely to report having hands-on experience in the use of water hoses in general (over 80%). Individuals were also most likely to have used hoses underground (about 75%). Because water hoses are utilized in the mine for such tasks as washing down equipment and wetting roadways, this is not an unexpected finding. About 75% of all respondents had hands-on experience in the use of fire extinguishers, although only about one-half of these miners had used extinguishers underground to fight a fire. As mentioned above, most

of the extinguishers discharged inside the mine were used on a fire:

"I guess the [shuttle car] cable caught on fire. So, anyway, the cable was burning. All the cable on the roll, probably about four blocks of cable on the roll, was burning, and the shuttle car tire was on fire, too. Now, like I said, I went back in for the fire extinguisher. I shoot the fire extinguisher off, but it never helped."

In general, machine-mounted fire suppression systems had the lowest percentage (less than 30% overall) of use, both in fire response and general use (e.g., in training). The only exceptions were for miners at Mine G, where more than 69% of the workers had activated a fire suppression system. In terms of the differences among mines with regard to workers' use of fire-fighting equipment, note that for Mine A 100% of the miners had used a fire extinguisher and almost 100% of them had used a water hose. These individuals were also most likely to describe their fire-fighting training as a hands-on approach.

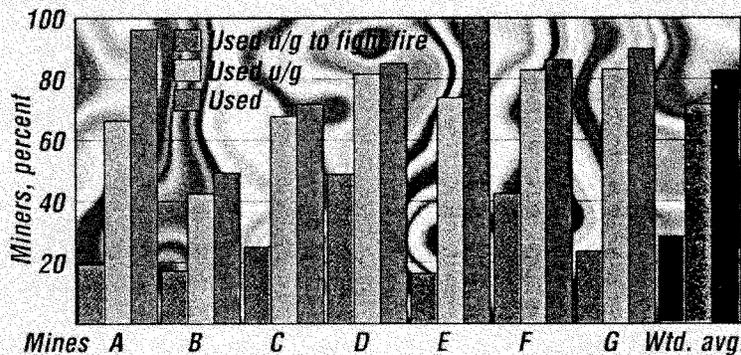
Workers' perceptions of training and readiness for fire-fighting

Miners were asked to describe their training to fight underground mine fires in terms of whether this instruction was conducted primarily through the use of lectures (being told what to do), discussion (talking about it), or a hands-on approach (practicing with fire-fighting equipment). Many miners reported that their training consisted of a combination of two of the three approaches (e.g., discussion and lecture). The percentages of miners reporting each of the three types of training are depicted for each mine in figure 3. Workers from Mines B, C, D, and F described their training as consisting primarily of lecture and discussion. Conversely, more miners at Mines A

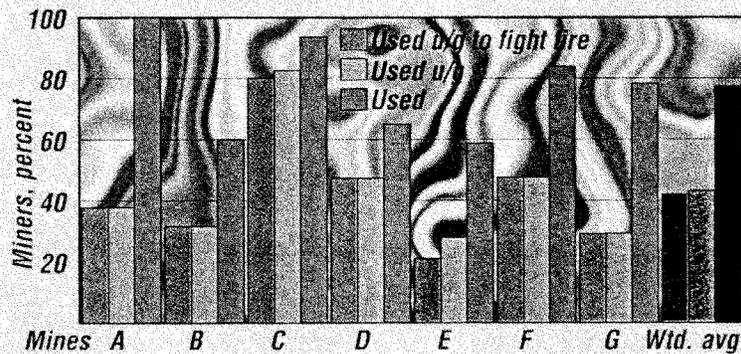
Figure 3.—Percentage of miners reporting hands-on experience with various means of fire suppression
ROCK DUST



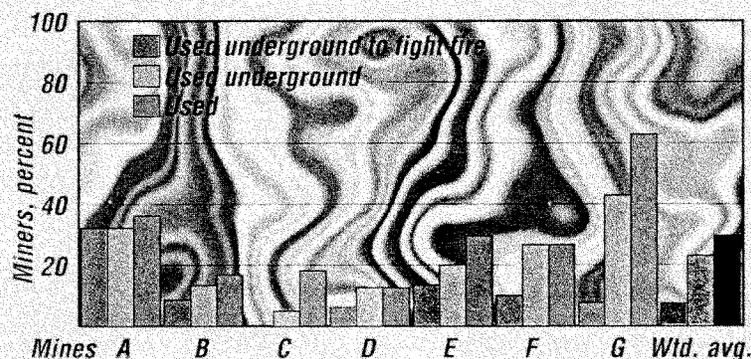
FIRE HOSE



FIRE EXTINGUISHER



FIRE SUPPRESSION SYSTEM

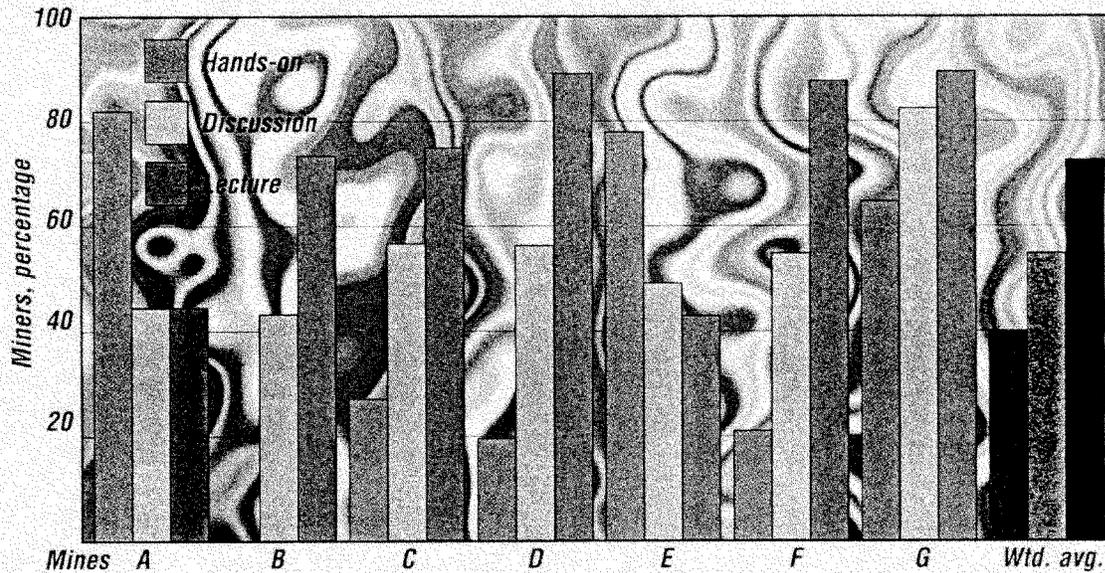


and E described their training as a hands-on approach. At Mine G, this approach was often in combination with lecture and/or discussion. Miners were asked if they felt that they had an acceptable level of fire-fighting skills. Figure 4 indicates the percentage of miners at each mine who believed that they possessed an acceptable level of such skills. At four of the mines—C, D, E, and F—about 70% of the workers felt that they had an acceptable level of skills. The highest percentages were found at Mines A and G, two operations where fairly high percentages of miners reported a hands-on approach to training. Conversely, only 57% of miners from Mine B felt that they had an acceptable level of fire-fighting skills; this was also the only mine where none of the miners described their firefighting training as a hands-on approach. In describing his level of fire-fighting skill, one miner commented:

"I think I know when to fight a fire, and I believe I know how big a fire I can put out just by looking at it, and if I can't put it out, then we're gonna get people down here to do it... If it's bad enough [that] I can't put it out, management will be immediately made aware that we have a problem with this area."

Mitchell [1990] indicates that many miners may not be as knowledgeable in fighting fires as they think they are. For example, handheld or portable fire extinguishers are often the most common equipment used to fight a fire. However, these contain only a small amount of the fire suppression agent; a lack of knowledge in their use makes them of little utility and even dangerous, because misuse on oil and other fluid fires can spread the fire. In fact, as common as they are, few miners have learned how to activate and apply the agent onto a fire. Dry-powder chemical and foam generator systems are used, but fires can reignite on

Figure 4.—Mine-specific training in underground fire-fighting



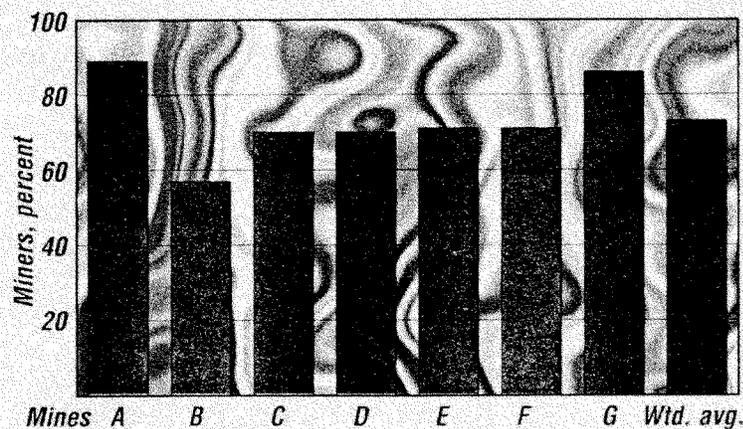
belting when these extinguishing agents have been applied. Mitchell also points out that "the best facilities and equipment can never compensate for poor preparation." Thus, training is needed and "the most important facts to teach and learn are how to lead and how to follow. Too often the Section Foreman is not the only one telling the crew what is best to do, what route to take." According to Mitchell, fire drills should be unannounced. They should involve a simulated fire or explosion specific to conditions in the section and should reinforce the training and identify any weaknesses in the emergency plan. The principal obstacle to overcome when this training is given is that the miners do not experience smoke (because the chance for injury is too great if smoke is added). He also notes that there are logistical problems if, for example, 7 miners had the opportunity to don their self-contained self-rescuers (SCSR's) during these drills; in that case, replacement miners would be needed if production is not to be interrupted. Another topic discussed by Mitchell concerning fire response is the use of check curtains (when,

where, how, and why) to control smoke. Mitchell also advises that when miners are well trained, are equipped with SCSR's, and have access to escapeways that are adequately identified and maintained, barricading will not be necessary. However, he advises that miners should still have some training in barricading techniques.

Miners' perceptions of their work crew as a fire-fighting unit

Miners were questioned as to whether they had specific duties in case a fire occurred on their section. The percentages of miners who responded affirmatively varied from lows of 31% to 33% for Mines G and C to highs of 80% to 94% for Mines B and D, respectively. Traditionally, many miners have been instructed (via lecture and discussion) in the performance of specific roles if a fire occurs. There appears to be a slight movement from these cultural traditions, typified by the responses of

Figure 5.—Percentage of miners who feel they have an acceptable level of fire-fighting skills



miners from Mines G and C, to a more practical, problem-based solution that relies heavily on the leadership, skills, and experience of the supervisor and veteran crew members. Obviously, there are both advantages and disadvantages to preassigning specific duties in case of an incipient fire. An important question might be whether or not miners actually put these preset protocols into place when fire does occur. Complicating this further, the frequency of job changes, shift, and crew scheduling, as well as multiple skills and duties, can result in miners performing many tasks over a short period. This could result in confusion and difficulties if miners were preassigned specific duties based on traditional occupational classifications.

Miners were asked to rate, on a scale of 1 to 5, their confidence in

their crew's ability to extinguish fires on their section:

"I think if it's extinguishable, we can put it out. [We could not handle] a fire that had been burning long enough that the ribs and stuff had also caught fire..."

A mean confidence rating was computed for each mine by averaging the ratings of individual respondents. The resultant means range from a low of 3.9 for Mine F to a high of 4.6 for Mine A (the operation at which most miners had hands-on training).

Perspective

There is perhaps little difference during the incipient phase between a fire that goes unreported and one that results in a mine being sealed. It is simply that the latter either was not detected quickly enough or was not

responded to properly. To achieve enhanced mine fire preparedness, mining companies will need to sharpen their strategy with regard to available technology and equipment while investing increased time and effort in their human resources. If this is done, the number of reportable incidents will likely decline even further and there should be even less chance of another disaster or permanent mine sealing.

The final article of this four-part series offers suggestions to improve mine fire-fighting preparedness.

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