RESPONDING TO AN UNDERGROUND MINE FIRE: A CASE STUDY

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This manuscript presents an overview of emergency response and fire-fighting activities at an underground coal mine in the midwestern United States. Although efforts to contain the fire proved successful, there were lessons learned that may impact future responses. Regarding fires, prior assessment of such elements as water capacity and access to equipment (with correction of inadequate features) are critical. It is also recommended that particular attention be given to potential alternative strategies, e.g., sealing plans, rather than addressing them ad hoc. The authors conclude that it is important for operations to develop and test, under simulated conditions, a comprehensive mine emergency plan.

Fire may be defined as the destructive burning of physical structures or other sites for human activity, with consequent potential for serious harm or loss of life (Vaught and Wiehagen, 1992). When fire occurs in an underground coal mine, the potential loss of jobs and coal (which is a non-renewable energy resource) is extremely likely. Therefore, though any threat to life should be minimized, it is important that an organization make a concerted effort to save the mine. The present paper gives an account of the first 37 hours of such a required response at an operation in the midwestern United States. It is anticipated that experiences related in this case study will offer insights that could prove helpful to those who might be forced to make a similar response sometime in the future.

THE SETTING

The site of this event is located in southern Illinois, with active workings that lie under approximately 1,000 feet of cover. Access to the coal bed, which is some 60 inches thick in the affected area, is by shaft. Opened as a conventional room-and-pillar operation in the Spring of 1983, the mine employs 260 men and women who work two production shifts and a maintenance shift daily. Four sections produce slightly more than 9,000 tons of raw coal per day. The coal is transported from each section, by belt haulage, to a production shaft where skips carry it to the surface. Ventilation is provided by either one of two 84-inch exhausting fans driven by 700-horsepower motors. Each fan rotates at 1,200 rpm's and exhausts more than 300,000 cubic feet of air per minute out the return shaft.

THE EVENT AND SUBSEQUENT STUDY

At noon on November 5, 1991, the lead mechanic was working on a scoop at the underground maintenance shop. This facility is located in the neutral air split, roughly four miles inby the shaft bottom. Upon noticing a faint haze in the air, he reported it to the mine foreman, who then visually inspected the entry. The two men first conjectured that the scoop's brakes had been dragging, creating the haze, and the mechanic went back to what he was doing. Leaving nothing to chance, however, the mine foreman continued his investigation. He checked through a brattice door into an intake entry. Utilizing a carbon monoxide detector, he noted a reading of 38 parts per million. The mine foreman went to a telephone and called the general mine manager, asking him to come to the mechanic's shack. The general mine manager quickly arrived and, after conferring briefly with the mine foreman, determined the unusual haze was apparently light smoke and began an immediate investigation of its source.

This response initiated a week-long effort, first to fight the fire that was soon discovered, then to seal the area and return the mine to normal operations. Three months after this event, Bureau of Mines personnel visited the site to conduct in-depth interviews with five of the key participants. Their interviews, conducted in private at the operation's offices, utilized a structured, open-ended schedule. This instrument was not designed to lead the Bureau team to findings of fact - such conclusions are the province of an official investigation rather than of social science research. Instead, the interviews focused upon self-reported details about the manner in which each individual gathered and processed initial information, how a plan of action was decided upon and carried out, critical decisions that were made (including by whom), and the informant's perceptions of group dynamics during the emergency response.

Audiotapes of these interviews were transcribed and provide a great deal of self-reported information about participants' outlooks on the emergency event. Such subjective data are being analyzed by Bureau researchers in their efforts to gain a better understanding of how large-scale emergencies are managed. The fire presented Bureau researchers with an opportunity to add to their general knowledge base in this area. The purpose of such work is to compile a framework of responders' experiences that can be shared systematically with the industry. This dissemination will be accomplished in two ways. In the long term, computer-based simulations will be constructed and used to help future responders be better prepared. More immediately, however, insights can be passed on through publications and presentations to mining audiences, which is what this manuscript purports to do.

All data presented in this paper are, as was mentioned previously, centered on the recall of personal experience and allow respondents to "... speak for themselves, to tell it as it was for them..." (Taylor et al., 1970:xi). Much of the account given in these pages will be from the Emergency Response Coordinator's (second author) point of view. Even so, some general issues may be raised that are not idiosyncratic to this individual but are based instead upon multiple observations contained in the transcripts. These points, along with discussions pertaining to certain behavioral aspects of the event, are derived from the first author's social science perspective.

INITIAL WARNINGS AND ACTIONS

It is well known that people perceive the environment selectively and tend to

interpret conditions from their usual perspectives until there is sufficient evidence to convince them things are no longer normal (Spitzer and Denzin, 1965; McHugh, 1968). The amount of data needed to prompt this shift in perspective will depend in part upon a person's psychological state and the context within which information is acquired. Additionally, however, the quality of those messages an individual receives will have a bearing on how he or she responds. Mallett et al. (1992) found effective warnings to have certain characteristics: 1) specificity; 2) historical validity; 3) an ability to convey the nature and extent of danger; 4) verifiability; and 5) cues to help people prepare for further action. Hence, that time taken to cease routine activities and begin non-routine ones will be optimized when a message containing these elements is delivered in an unambiguous context and received by a person not so heavily absorbed by other concerns that he or she fails to pay attention.

At the study site, initial warnings received on the surface met at least some of the criteria mentioned above. The second author, upon being informed there was "... a problem underground..." with "... a haze hanging in the neutral entry...", also obtained some specific information about levels of CO that hand-held detectors were registering at various locations. Then, as is generally the case (Flathers, et al., 1982; Baumann and Bourbonnais, 1982), the second author made additional inquiries (by mine telephone) in order to define the situation and reach a diagnosis: He called the security guard as part of his initial inquiry; he called back underground to ask, "... was the haze ... smokey...? - "... what did it smell like...?" and other pertinent questions. While this process was underway, the security guard, whose job includes attending to the mine monitoring system, broke into the conversation with independent verification of rising CO levels. This additional information, coming from a second valid source, was enough to prompt a decision about what initial actions to take. Canter, et al. (1980:117) suggested that human action in a fire emergency can best be analyzed in terms of the extent to which it exhibits: 1) individual cognizance of the situation; 2) a recognition of personal role responsibilities; 3) an understanding of the rules that apply to one's roles; and 4) effective performance based upon these rules. During those first few moments of the event, a proper grasp of the situation was hindered by an oddity: management determined that the haze was coming from an area in which there were no usual sources of combustion (e.g., electric equipment or belt conveyors). Consequently, it was difficult to envision that anything of a serious nature existed. Those in charge thought it best, however, not to delay evacuation of all miners except for those necessary to determine the problem. Understanding their responsibilities vis-à-vis the labor force, management decided to contact all working sections and other work locations in the mine, directing an immediate withdrawal of all personnel. Simultaneously, they began organizing a systematic search for the source of the haze and carbon monoxide gas.

PRELIMINARY EXPLORATION

Social scientists agree there are two components of an initial response to fire. One is recognition and the other is action (Canter, 1980:10). These factors should not, however, be regarded as comprehensive elements. Instead, both recognition and action are more nearly processual in nature. As increasing recognition develops out of ambiguity, it suggests a range of possible actions. At the study site, a systematic search for what was still considered most likely to be a minor problem proceeded as crews were being evacuated. The safety director and a shift foreman went

underground intending to make their way inby from the shaft bottom. Additionally, the lead mechanic who had originally noticed haze at the maintenance shack was directed to travel outby on his swift diesel vehicle and begin explorations in that direction, taking a co-worker with him. While these individuals were beginning their investigations, two additional pairs of workers were directed by the mine foreman to take golf carts and also explore outby, checking periodically through mandoors into the intake air course.

A search pattern had emerged. The shift foreman was walking one set of main intake entries (2nd Southeast) from the shaft bottom (see Figure 1). The safety director, after taking a CO reading at the upcast and finding nothing abnormal, traveled on a golf cart to an area in the main intake (3rd Southeast) where some de-watering pumps were located. finding no problem at this location, he continued traveling inby in the intake air course. The shift foreman and safety director rendezvoused at the mouth of the intake Southwest Main Entries (see

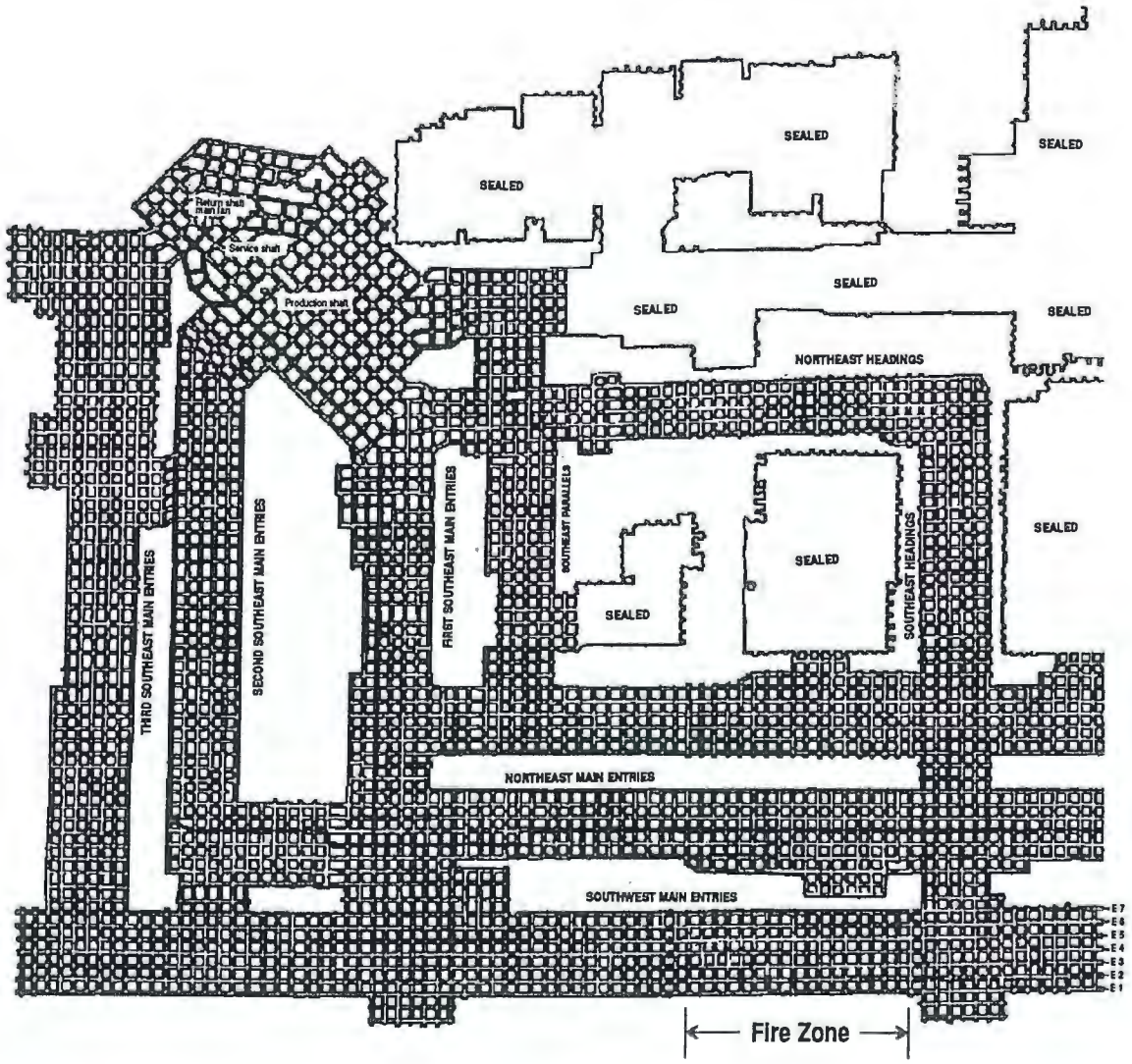

Figure 1: Map of the Affected Area. For Detail of the Fire Zone, See Figure 2.

Figure 2). These two individuals then began traveling inby in the Southwest mains, separated by double stopping lines. The lead mechanic, who had been driving outby in the Northeast Main Entries and pausing at each set of cut-throughs to check the Southwest mains, was now approaching the Southeast Headings. At this point he traveled into the cut-through entries.

Approximately half-way to those cut-through entries of Southeast Headings, the safety director, who was in Number 2 Entry, encountered smoke. The lead mechanic, who had gotten into smoke at Southeast Headings, had driven outby and entered Number 1 Entry of Southwest mains through the 1st Southeast cut-through entries. At roughly the same time that the safety director found smoke in the entry he was traveling, the mechanic drove up Number 1 entry and "... stopped within 50 feet of the wall of smoke there...", a few crosscuts inby the safety director's position. Posting a man to keep watch, the mechanic was in the process of leaving to report his findings when he encountered the safety director. After conversing briefly, the safety director sent the mechanic to phone the information outside while he further explored the area.

The safety director was soon joined by the mine foreman and a section foreman from one of the evacuated sections. These three decided to don self-contained self-rescuers (SCSRs) and attempt to determine the fire's precise location and approximate size. Finding Number 2 Entry impassable because of heat and smoke, the men traveled across the stopping line into Number 3 entry, which was still clear of smoke. The safety director and his companions explored along this entry past the point where he had initially encountered smoke in Number 2 entry (at survey station 8678). Coming to a man door some four crosscuts further inby, the three individuals opened it and encountered heavy smoke. They immediately retreated outby to fresh air in the Number 1 and Number 2 entries to prepare for a fire fighting attempt.

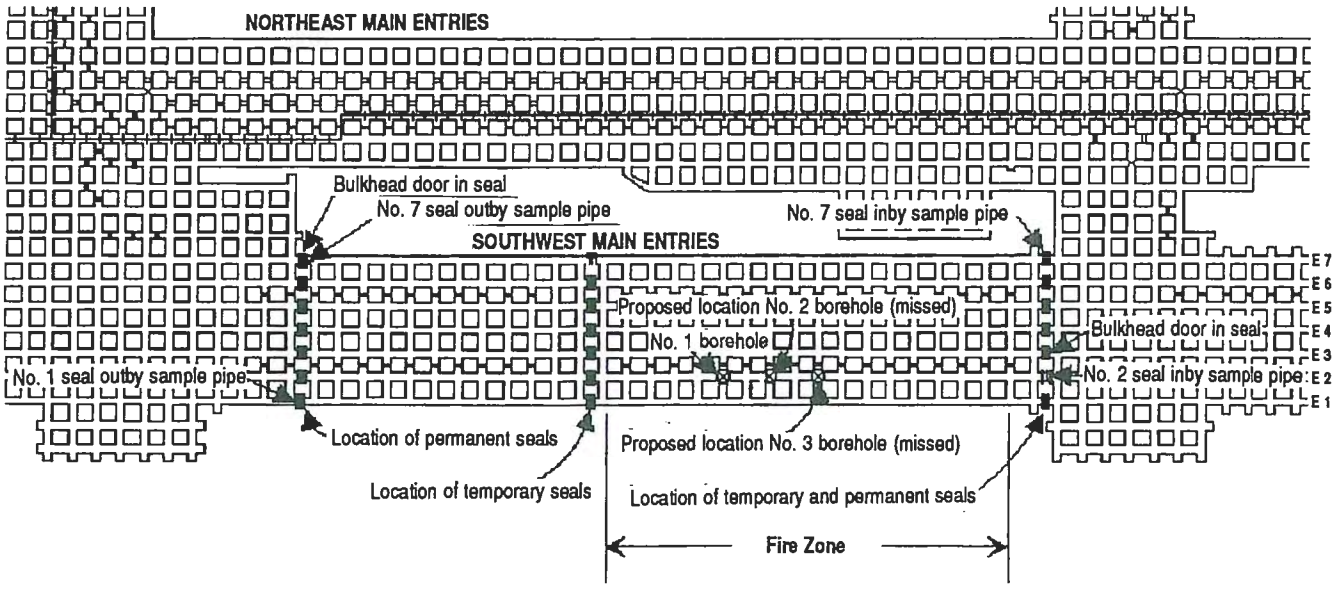

Figure 2. Map of the immediate fire area.

COMMUNICATIONS

While preliminary explorations were underway the lead mechanic had driven outby approximately 1,200 feet to the nearest mine phone. From there he called the second author, who was outside, to report that they "... definitely have some type of mine fire..." and related what had been observed. As he was talking to the second author, the mechanic noted man trips loaded with evacuating miners traveling by his location. After concluding his conversation, the mechanic next set about establishing communications to the area that would be situated as the initial fresh air base.

On the surface, the second author, in his emerging role as the response coordinator, was attempting to contact MSHA, notify state officials, and alert those mine rescue team members who were off shift. The first significant problem occurred when he sought to place a telephone call to the MSHA subdistrict office. Because of a malfunction in the receiving phone system, he was not able to make contact. After several tries, which entailed some period of time and were interspersed with other more compelling actions, such as the notification of a backup mine rescue team at another operation, the second author phoned MSHA's district office and requested a telefax be sent to the subdistrict people asking them to call immediately. Within a few moments, he was contacted by the subdistrict manager.

While the response was commencing above-ground, the lead mechanic and several fellow workers were marking a route into the fire area and preparing to install a phone line as close to the scene as possible. In fairly short order, therefore, communications had been established with those exploring this area and the second author was soon in a position to talk directly with someone at the actual location. At this point, he encountered a second problem, which research has shown to be all too common for those who must make decisions based upon information gathered by telephone: miscommunication.

Nigg (1987:111) identified two factors that influence how much weight is given to second-hand intelligence: source credibility and message content. The section foreman who drew initial communications duty at the fire site possessed complete source credibility, as he had a significant amount of mine rescue experience. This person's role was to pass on information from those who were attempting to explore the area so that the situation could be depicted accurately for management, as well as MSHA and state officials upon their arrival at the mine. As details were relayed to the second author outside, he noted them on a marker board in the command center. The content of some early messages, unfortunately, was faulty. The second author, in his role as response coordinator, was led to believe the inby side of the fire had been explored thoroughly, its boundary was known, and that the site had been curtained off. Subsequently, during the next several hours he interacted with officials and made logistical decisions based upon an erroneous notion that later proved to be unfounded. No one had actually curtained around the fire, so the ventilation had not been controlled in the fire area. Additionally, nobody really knew the inby extent of the blaze they would be fighting.

AVAILABILITY AND FUNCTIONING OF EQUIPMENT

In mounting an effective response, the single biggest drawback became a lack of water. Because there were no conveyor belts or equipment in those entries affected, all water lines had been reclaimed. The lead mechanic, after laying phone wire to the site, was assigned the role of "dispatcher

supply man" and set up a "depot" by the mine telephone he had used originally to call outside. The first item requested was water line: "... we were lucky in that this mined out unit still had a lot of belt line and stuff in there that we had been reclaiming, so we had a large pile of two-inch plastic water line right there available. [W]e started laying one two-inch water line to the fire scene from our four-inch fresh water line [which connected] within fifty or eighty feet of where I was..."

Even with the availability of the plastic pipe underground, however, it still took a while to get the line laid and connections made. A very significant hindrance stemmed from the fact that workers had been evacuated and management ordered power to areas inby the fire shut off without bringing any supplies or equipment outby. Thus, crews trying to distribute the water line, assemble it, transport men, materials and equipment to the site had only one battery-powered scoop with which to work. There was also a short delay in getting the final fittings to both ends and installed. Regardless, the second author felt, because of his original misconception about the fire's size, that this effort would in all likelihood suffice.

As the water line was being laid, the mine's trained rescue teams arrived at the scene and began establishing a fresh air base and installing check curtains in the Number 2 and Number 3 entries. As soon as the final connections were completed, a team started applying water to the fire area. It quickly became apparent that there was insufficient water volume with a single two-inch line. The decision was made to lay a second two-inch line. Since little initial progress was being made in attempts to extinguish the fire, additional mine rescue teams were notified and requested to respond. Well into evening, as more and more personnel became involved, the second author was approached by his counterpart, the general superintendent at that mine which had originally furnished a back-up rescue team. This individual pointed out their need for more resources, underscoring the fact they were facing a situation they had neither the equipment nor supply trailers to handle. He then offered to have battery powered scoops and trailers brought in from his operation. The added support, along with the second water line, which was completed around midnight, would enhance the fire fighting efforts.

The most successful advance into the immediate fire area was made by a responding mine rescue team that also arrived in late evening. These people were equipped with turn-out gear (regular fire fighters' insulated flame retardant clothing and personal protective equipment), which provided protection against the intense heat and steam. Whereas other crews had been driven back by the heat and smoke coming out of the oily shale roof, this team was able to penetrate to the third crosscut in the Number 2 entry. At the intersection, they made initial contact with the actual flames. The team would advance, then find it necessary to retreat and apply water and foam to the ribs in the pillar line as they would heat up. After cooling down the ribs, they would advance once more, only to be forced to retreat again. While this rescue team's turnout gear allowed them to proceed further, they experienced difficulty keeping their helmets on and their shields cleared as they tried to direct water at the blaze.

Several attempts were made during the night to apply foam to the fire. The first foam generator a team tried to use was water-powered. The connection did not take standard threads, so an adaptor was required. One was available, because this particular machine belonged at the mine. Somewhere in transportation, however, or while personnel were endeavoring to make the connection, the adaptor was lost. A

significant amount of time was spent trying to procure a suitable fitting. The team with turn-out gear desired to set the generator as close to the fire as possible. As they were attempting to make their set-up just inby the A intersection, a fall of roof forced them back and the machine was lost, never having applied any foam.

A diesel foam generator was brought in from another operation in the very early morning. When the apparatus was connected, there was inadequate water pressure to operate it properly. At that time there were four inch-and-a-half fire hoses or hand foam applicators feeding off the two water lines. The safety director made a decision to suspend use of these hoses and divert all water through the diesel foam generator. They were still not able to amass 80 psi of pressure, which this device needed in order to function properly. As a result, the generator sent large volumes of air down the entry, adding more oxygen to the fire. At this point, flames became visible to the workers and were rolling back toward the fresh air base. After several attempts, the rescue teams reverted to using the four hoses.

At that time, there were four rescue teams underground and numerous other support workers. The second author, after discussions with an MSHA official who had been working beside him, decided to consider sealing. The response now began to move into a new phase, with an emphasis on simple containment of the fire and most effort directed toward construction of temporary seals to accomplish this containment. As personnel began retreating to establish seal building sites, conditions became worse and logistics more difficult. This was especially true of ventilation arrangements, because a set of check curtains had been installed across the left side (entries 4, 5, 6 and 7) to evacuate smoke in Numbers 1 and 2 entries. Since the inby end of the fire area had not been isolated, these curtains had the effect of diverting even greater quantities of air over the combustion source.

LOGISTICS AND SUPPORT FUNCTIONS

Teams shifted to fire containment as preparations were made to construct the temporary seals. In addition to the numerous personnel underground, there were approximately 50 people on the surface. It was necessary to keep everyone fed, in addition to fire fighting and support. The mine's purchasing agent was assigned this support role in the mine emergency plan and responded early in the event. Due to the cooperation of local establishments, he was able to furnish those on the surface with continental breakfasts, a hot lunch of fried chicken, spaghetti or other substantial fare, and a nourishing evening meal. For crews underground, the purchasing agent obtained and sent in cases of distilled water, coolers of soda, sports drinks, hamburgers, cold cuts, fruit, candy, quick energy snacks and chewing tobacco.

It soon appeared that some foods were more suitable than others for the fire fighters. Hamburgers and french fries, among the first meals to arrive underground, became cold and unappetizing before rescue team members could find time to eat. Soft drinks, with their sweetness and high carbonation, caused discomfort. Early on, the workers showed a preference for lunch meats and fruit. Additionally, because of the high temperatures, fire fighters were hot and perspiring heavily. This was especially true for those wearing turn-out gear. Consequently, they consumed large quantities of sports drinks, which not only slaked their thirst but replaced electrolytes as well.

Throughout the response, according to all informants, workers had whatever items they

needed in short order. The lead mechanic, in his role as inside supply coordinator, requisitioned towels, oxygen bottles, replacement face masks, fittings and other materials. These were sent underground and transported from the bottom to his depot by diesel locomotive. From there they were dispatched to the fire site on battery powered three-wheelers and golf carts. Later, when battery powered scoops arrived from the other operation, they were put into service. As sealing activities got underway, the other mine's diesel scoop was brought underground and utilized to haul solid concrete blocks that were needed to build the fire seals.

About eight hours into the event, management had made preparations for drilling a borehole to be drilled from the surface to just above the actual fire location. Then, as soon as all temporary seals had been completed, this borehole was to be punched through into the fire site and liquid carbon dioxide pumped in. This plan required that a drill rig be set up and several tanker loads of carbon dioxide procured. Since the operation had no established account with the CO_2 supplier and they required a $5,000 advance deposit, it proved necessary for the purchasing agent to deal through company headquarters in order to obtain this shipment. In spite of this difficulty, there was an adequate supply of carbon dioxide on hand when workers had finished building the temporary seals.

SURFACE DIRECTION AND ORGANIZATION

The second author continued in a decision making capacity on-site for 37 hours - from the initial warning until temporary seals had been completed and all personnel evacuated from the mine. Except for the first few hours of this event, as mentioned previously, he remained in almost constant telephone contact with his safety director, who had assumed the role of underground coordinator. On the surface, the second author solicited and received advice from MSHA officials, representatives of the Illinois Department of Mines and Minerals, company executives, and incidental experts which included a private consultant. Amazingly, a noticeable characteristic of group dynamics in the mine office was an atmosphere of consensus and cooperation. In his role as response coordinator, the second author was able to share information generally, consult persons he felt would offer especially helpful advice at any given point, make decisions based upon this guidance and reach swift concurrence with a majority of those present.

Research has shown that an individual making decisions is actively involved in a process that possesses certain elements: 1) problem detection; 2) diagnosis; 3) consideration of possible options; 4) a choice of what is perceived to be the best option; and 5) execution of this choice based on what has transpired to that moment (Vaught et al., 1992). Judgment theorists have identified several factors which seem to have a significant impact upon how well this process works. Among them are: uncertainty, caused by faulty, incomplete, or conflicting information; stress, generated not only by a problem at hand but the necessity of dealing with any circumstantial difficulties that arise; and complexity, which refers to the amount of differing information that must be attended to (Biggs, 1968; Jensen and Benel, 1977; Brecke, 1982). All these influences may act as impediments to quick decisions.

The second author experienced several impairments to effective decision making: fatigue engendered during his 37 hour stint in the command center; stress generated by concerns about how his decisions would affect the safety of those underground; and

communications required to gather information and discuss it with the advisors. At the mine site, however, dissension was minimized, thereby allowing response coordination to proceed fairly smoothly.

As containment activities proceeded and the sealing process was underway, good decision making became even more critical. Fire gases accumulate behind the seals and the atmosphere may grow volatile. Everything at this stage must be done with care. It was decided to construct concrete block seals across all seven entries just outby the fire and inby near those cut-throughs at Southeast Headings. While construction started on the outby seals, a team explored the inby extent of the fire. They telephoned outside and reported that construction could be done at their chosen location but entries 1 and 2 had high concentrations of smoke and CO. Brattice curtains were hung to divert air from the intake of Northeast Main Entries across the Southwest mains. This allowed much of the work to be performed bare faced (without the BG-174 apparatus).

The second author, using a map and listening to phone conversations at each site, monitored the ventilation and construction activities closely. An additional concern to arise during this time dealt with installation of sampling tubes. In order to make appropriate decisions long after a fire is isolated, it is necessary to sample the atmosphere behind the seals. To obtain a valid sample, the tube should be installed far enough into an area that there is no contamination caused by air pressure on the seals. Finally, since gases have different densities, the tube ought to be placed in such a manner that samples are not all drawn from one elevation (Mitchell, 1990:101). To accommodate this, management intended to insert long metal piping through the seals. Because construction was progressing so rapidly, however, there was not enough time to procure it and transport it underground. Thus, those at the fire scene were instructed to take a two-inch water line that was no longer in use and extend these tubes 150 feet into two different entries at both the inby and outby seals. These pipes were to be suspended off roof bolt plates approximately midway between the top and mine floor. Underground, the supervisors overseeing seal construction could not comprehend why it was so important to perform this task. Reasoning that the intense heat would merely burn off the ends of these plastic lines anyway, they decided to install regular sampling pipes through the seals. The consultant, who was on hand, did unroll about 100 feet of three-quarter inch rubber hose into the area. This later proved to be one of the more valid sampling points.

The primary concern during the last several hours of the situation was that those working outby would finish their seals before the inby ones were completed. This was not according to plan. Gases and pressure build-up can become unpredictable and hard to control in such a circumstance. For that reason, management had intended to seal off both ends simultaneously. The second author understood, from auditing a mine phone conversation, that the individual leading the two teams working on the inby seals had directed the outby seals completed. The second author was unable to get a clear explanation of what was happening and therefore experienced a high degree of anxiety. Nevertheless, the second author chose to trust that person's judgment because the team leader possessed superior expertise in that situation. In actuality, this individual knew that too much smoke was coming through onto the inby workers and decided to do something about it. He was, in fact, manipulating a temporary curtain-material seal. Each time the team leader felt pressure building up behind this seal, he would relieve it by raising the curtain cloth. Those inby were able to complete their

work and the last seal outby was closed. All workers immediately evacuated and liquid carbon dioxide was pumped down the borehole, onto the fire.

During the next few days permanent seals were built and the miners returned to work. Three weeks after the fire another load of CO_2 was introduced in order to ensure that oxygen levels would be held down behind the seals. By late Spring, 1992, gas analyses revealed no further evidence of active combustion at the fire site.

DISCUSSION

At the time this event occurred, mine personnel had attended several mock mine disasters and had their own mine emergency plan under continual development. According to all respondents, this plan, though untested, proved to be instrumental in saving the mine. The lesson learned is that an operation ought to prepare a well thought out response strategy and validate it under conditions as close to real world circumstances as possible. The fire provided other points for consideration: First, it is imperative to insure that a coal mine's water supply system is adequate to address a situation like the one described here. In other words, plan for the worst. Second, when evacuating a mine, personnel should attempt to bring all the mobile equipment it is possible to transport without delaying evacuation or endangering anyone. Third, someone not directly engaged in response activities should be assigned to initiate development of a sealing plan well before it is needed. At the study site, this was not done. The preparations to seal the fire scene were, in effect, made ad hoc rather than according to a sealing plan. Fourth, the capability to feed people and providing a place to sleep is essential. Finally, mine management should plan provisions for rotation of decision-makers during an emergency response. The second author, safety director and several others stayed at their posts throughout the crisis. Loss of sleep affects judgment and hence has an impact upon the quality of one's decisions.

As a result of the fire at this operation, management has taken various steps to strengthen their emergency response and fire fighting capabilities. A fire brigade response team is being assembled and trained. Necessary equipment for this team has been procured. The upgrading of fire fighting cababilities include procurement of additional foam generating equipment and establishment of a water supply system capable of sustaining extensive fire fighting activity. Deployment of the response equipment is strategically located to preclude the possibility of an event occurring outby, thus rendering the equipment inaccessible. The outstanding response of the mine rescue team has placed greater emphasis on the commitment to mine rescue and training. The Mine Emergency Response Plan (MERP) has been altered to facilitate the outby movement of essential equipment in the event of a mine evacuation. The MERP was also modified to staff the response team in a manner that minimizes fatigue, while maximizing communications. In sum, the entire experience has been taken as an opportunity to learn and improve the response in such a situation. It is hoped that others will benefit vicarously as well.

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