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DEVELOPMENT AND VALIDATION OF A COMPREHENSIVE MINE RESCUE TEAM TRAINING PROGRAM

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This report discusses the design and development of a comprehensive training program for Mine Rescue (MR) teams and a management tool for mine emergency preparedness. Approved by MSHA in 1984 to meet the requirements for 30 CFR, Part 49, the MR team training materials are user-ready, provide the principles and practices for both initial and advanced training, and supply MR teams with problem-solving activities. The Mine Emergency Preparedness Program (MEPP) is used by management as a tool in the preparation of company personnel for handling mine emergency operations such as mine fires, explosions, inundations, and other hazards that require a total response plan, and encompasses all of the steps from hazard recognition and containment to the involvement of teams in the rescue of survivors and the restoration of mining operations. As a completely new program, MEPP provides means for anticipatory planning of key initial steps in the development of procedures that can lead to swift, orderly, and effective response to a mine emergency. Currently available to the mining industry, these two resources can bolster the efforts of any mine to deal with underground emergencies, to promote planning, and prepare personnel for emergency actions.

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FOREWORD

This report was prepared by the Mining Extension Service, College of Mineral and Energy Resources, West Virginia University, Morgantown, WV, 26505, under USBM contract number J0308002. The contact was initiated under the Coal Mine Health and Safety Program. It was administered under the technical direction of the Pittsburgh Research Center with Mr. James Peay acting as Technical Project Officer. Mr M.L. Nowicki was the contract administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period 1980 to 1986. This report was submitted by the authors in July 1986.

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DEVELOPMENT AND VALIDATION OF A COMPREHENSIVE MINE RESCUE TEAM TRAINING PROGRAM

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ABSTRACT

During the past five years, under contract with the U. S. Bureau of Mines (BOM Contract J0308002), West Virginia University's Mining Extension Service (WVU-MES) has designed, developed, and delivered to the mining industry a comprehensive training program for Mine Rescue (MR) teams and a management planning tool for Mine Emergency Preparedness.

The Mine Rescue team program is systematically built on a set of training objectives, backed up by content, allowing mine operators to conduct team training activities. These materials are user-ready, provide the MR principles and practices for both initial and advanced training, and supply teams with exercises geared to problem-solving activities.

In addition to an instructor's program guide, the eight (8) modules that comprise the initial (20 hour) MR training are: an Introduction to Mine Rescue, an Introduction to Self-Contained Breathing Apparatus (SCBA), a set of modules covering each approved minimum 2-hour SCBA (i.e., the Draeger BG 174-A, the McCaa, the Aerolox, & the Scott Rescue-Pak), and a manual on Auxiliary Apparatus as well as the Chemox Auxiliary SCBA.

Advanced, annual refresher training (40 hour) is covered by seven (7) modules that spell-out the principles and practices needed to establish surface organization, to handle mine gases as well as mine ventilation, to conduct exploration, for fires, firefighting, and explosions, to rescue survivors and recover bodies, and to accomplish a mine recovery.

Approved by MSHA in 1984 to meet requirements for 30 CFR, Part 49, these materials provide a basis for trainers' instruction, for comparison of team capabilities, for modifying programs, resources, and services, and for program planning.

The Mine Emergency Preparedness Program (MEPP) is used by management as a tool in the preparation of company personnel for handling a mine emergency operation. As a wholly new program, MEPP depends upon development of a Mine Emergency Organization and Emergency Operations Procedures. It also requires regular scheduling of drills, periodic mock emergencies, and evaluation of organizational responses and program performance beyond required training of mine rescue teams.

MEPP materials are arranged into three sets of guides: 1) the Preparedness Program System Guides include an Executive Summary, a Program Director's Guide, Mine Emergency Organization, and Emergency Operations Procedures; 2) the Emergency Organization (MEO) User's Guides cover the Rescue and Advisory Division, the Technical/Safeguarding Division, and the Surface Support Division; and 3) the Emergency Procedures (EOPS) User's Guides detail Containment Level Procedures, Notification Level Procedures, Mobilization Level Procedures, and Deployment Level Procedures.

I. THE MINE RESCUE TEAM TRAINING PROGRAM

INTRODUCTION

In cooperation with the U. S. Bureau of Mines under BOM Contract J0308002, the West Virginia University Mining Extension Service (MES) has developed an instructional program that provides trainers with materials for mine rescue (MR) and recovery team training designed to meet requirements established under a new Federal regulation, Title 30 of the Code of Federal Regulations (30 CFR), Part 49 . These materials provide a highly promising core of resources to prepare rescue teams to perform those tasks anticipated during rescue and recovery operations.

The design of these materials was to meet three requirements. First, training materials were to be "user-ready" for both metal/ nonmetal and coal mining operations. Second, it was imperative that the instructional materials deal with the principles and procedures of rescue team performance beyond the initial training traditionally associated with wearing and maintaining some type of self-contained breathing apparatus (SCBA's). Third, team training materials were to integrate content and techniques; they were to offer the opportunity for teams to progress through problem-solving activities during annual refresher cycles of team training.

MINE RESCUE TEAMS

Availability of Rescue Teams

The training focused on here emanates from Federal regulations. The Federal Coal Mine Health and Safety Act of 1969 instituted interim mandatory health and safety standards and an expansion of training programs to prevent accidents and reduce health risks in the coal industry. These standards are described in 30 CFR.

At least as a partial response to developments under the 1969 legislation, Congress passed the Federal Mine Safety and Health Amendments Act of 1977. This Act consolidated coverage of coal and metal/nonmetal mines under a single law and

introduced requirements for training of individuals working in all mining industries.

Section 115 of Title 30, CFR, Part 49 requires that each operator must obtain approval of plans to provide for the ready availability of rescue teams, and assure that appropriate equipment is available; it also sets up provisions for establishing basic skills and training for team members. The Federal Register notes that because of "the inherently hazardous nature of mine rescue and recovery work and the need for professionalism in its performance," minimal criteria must be specified "to ensure that team members who are available in the event of an emergency be physically fit, properly trained, and appropriately equipped." (Federal Register, 45(135), July 11, 1980)

Early estimates indicated that industry investment in all kinds of MR instruction would increase by about 100,000 hours of training per year over the next fifteen years, adding substantially to the cost and manpower already expended on about 3.7 million hours of safety and health training provided miners in 1981. Moreover, for every increase of a million hours of classroom instruction, an additional 1200 to 1500 new full-time trainers would be needed.

Only one-third of the current work force of trainers had taken the Mine Safety and Health Administration (MSHA) trainer's course, and as late as July, 1980, only about 800 persons were listed by MSHA as certified for mine rescue instruction. Some no longer worked in the industry (or never were industry employed, such as fire department, EPA, or manufacturer's personnel), but according to regulations, many of those presently listed would be "grandfathered" as qualified instructors. According to the Federal Register , there was a projected need for about 800 additional teams in the coal industry and 90 additional teams in the metal/nonmetal industry, along with an expected 350 new stations in coal and 50 more stations in the metal nonmetal industry.

Since Part 49 did not require any prior experience in MR work for instructors, one major contingency influencing the construction of training materials was their comprehensibility. Another was scope or coverage sufficient to ensure that instruction could produce the knowledge required to enhance the capabilities of teams to perform in an underground emergency. A third factor was to provide adequate aids and resources to direct instructions toward practice, dealing more with procedures to be used once a team goes underground in an actual emergency.

The Status of Mine Rescue Training.

We observed a wide range of training activities and an equally varied approach to preparation of materials by instructor/trainer personnel. One process that promoted training during several months each year was the annual rescue contests held by rescue associations, States or MSHA. Such training was geared to explicit rules and "contest" procedures. Teams were advised to respond to procedural, "if-then" situations (placards) which promoted appropriate reactions, but did not orient the training toward problem-solving work and related contingencies encountered under emergency conditions. On a somewhat broader scale, the existing emergency preparedness and response capability included the notification of rescue teams, but did not anticipate how such teams were to be mobilized, deployed and managed during emergencies.

The public hearings conducted by MSHA prior to promulgation of Part 49 regulations reflected many areas of misunderstanding as well as points of conflict among interested parties. In general, the final promulgation of Part 49 regulations, and the document rationalizing these regulations, represent the key points of consensus and compromise.

Thus, early in 1981, a common focal point of training was team competition in contests, but there were no established, organized training materials available which could be used to prepare teams for underground emergency and rescue. Information relevant to mine emergencies did exist, yet it was not easily accessible. Although various personnel in industry and in government as well as some consultants had actual experience with underground emergencies and mine disasters, communication was fairly informal, infrequent, and usually crisis-driven. It was also apparent that rescue often was last in line to receive attention and financial support from the industry.

When the 1977 amendments were passed, no systematic, complete body of material covering mine recovery and rescue work was available. Part 49, in addition to physical requirements for members and a required one-year underground experience within the past five years, mandated that (a) before serving on a team, each member would complete an initial, minimal 20-hour course in the use, care, and maintenance of self-contained breathing apparatus (SCBA), and (b) upon completion of the initial training, members would receive at least 40 hours of refresher training annually. Part 49.8 also mandated that advanced training must include mine map training and ventilation procedures, but made no additional provisions for advanced rescue training and procedures . MSHA's Office of Education and Training was to prescribe such training.

IDENTIFICATION OF PROJECT RESOURCES

Under sponsorship of the U.S. Bureau of Mines, WVU's Mining Extension Service was to prepare a set of training modules, using the help of the National Mine Rescue Association (NMRA) which also was under Bureau contract(BOM J0308002) for this service.

A national canvass of MR teams had found a wide range of practices in training teams for underground emergencies. Moreover, the projected need for new teams suggested there would be a demand for training new instructors in the principles and procedures of rescue and recovery work, despite the likelihood that a substantial proportion of those already associated with rescue teams would be "grandfathered" by MSHA under Part 49.8. Finally, the proposed seminars would afford an opportunity to promote common training standards and practices between MSHA and various State training programs and State-designated rescue teams, which also varied widely, depending upon regulations.

The design of training materials for team instructors or trainers would require input from an expert panel of trainers, team performers, and managers enlisted to participate in the identification and elaboration of rescue and recovery tasks. Development of materials also would be facilitated by tapping diverse information pools, as well as by observing training sessions, simulated or mock disasters, and rescue contests.

In addition, MES drew upon its previous experience in the production of MSHA's Health and Safety Training modules for 30 CFR, Part 48. Early in the project, MES acquired a project director. It solicited United Mine Workers of America (UMWA) leadership to participate in an advisory group that was created to assure liaison with the NMRA, MSHA, and the industry as well as to bridge technical and operational differences between coal and metal/nonmetal mines. Arrangements were made with manufacturers of the NIOSH/MSHA approved SCBA for technical review of the training modules associated with their equipment. One consideration in the formation of the advisory committee was to encourage representation from all parties affected by Part 49 and by the materials.

The committee was comprised of the following seven members:

J. D. Pitts, Safety Specialist, Arlington, VA,
MSHA (Metal/nonmetal);
Malcolm Smith, Director-Central Mine Rescue, Wallace, ID,
Industry (Metal/nonmetal);
Walter Magera, Safety Specialist, Pittsburgh, PA,
MSHA (Coal), NMRA;
Joe Martin, Safety Specialist, Denver, CO,
MSHA (Metal/nonmetal);

Robert Barrett, Vice President, Wilmore Coal, Windber, PA, Industry (Coal), NMRA;
Earnest Teaster, MSHA, Arlington, VA, MSHA; and
Rob McGee, Office of Deep Mine Safety, Uniontown, PA, (limited participation) Pennsylvania, NMRA.

Final technical approval was to be made by MSHA. In addition, the training modules were to be forwarded for review by Union representatives and industry associations such as the Bituminuous Coal Operators Association and the American Mining Congress.

The immediate problems facing the group were: (a) the effects of geographical differences in mining on rescue and recovery; (b) the effects of different mining methods; (c) the requirements of coal mining versus metal/nonmetal mining in regard to terminology, systems and procedures, as well as historical differences; and (d) the level of proficiency for instructor certification.

During site visits to several western training operations, competitions, and mines, we discovered that two conditions often facing these mine rescue programs were: (a) remoteness of mine operations and (b) rescue and recovery actions, especially among metal/nonmetal mines, which led to a different training structure.

One practice to accomodate to both remoteness and training needs was to pool teams, resources, and finances to provide coverage to a mining area by operating out of a central location. This meant that a permanent staff maintained the central station, guided training efforts, promoted participation among miners, and reflected management commitments through advisory actions and supervisory investments in training exercises. The overall control of the mine rescue system seemed to work under these conditions. In some areas, we encountered rescue systems which were virtually synonymous with voluntary emergency actions throughout the communities (fire, emergency medical service, and so on).

In addition to literature searches, to on-site observations at mines, and follow-up interviews with MR personnel, further information came from two other sources. First, a letter explaining the project accompanied a nationwide mailed questionnaire to the mining industry. Second, meetings were conducted at several locations across the nation to explain the project, collect information and get input from key figures involved in MR. Based on this information, the committee decided that the materials pertaining to the 40 hour advanced/refresher training would be prepared in two series: one for use in coal mining operations, and the other in metal/nonmetal operations.

TEAM FUNCTIONS, TRAINING OBJECTIVES AND MATERIAL DEVELOPMENT

Rescue Team Functions

What are the functions of a mine rescue team (MRT)? Four major functions are rendered by mine rescue teams. The MRT: 1) keeps the SCBA's and equipment ready for a disaster; 2) is organized to perform the specific tasks necessary to rescue miners, recover victims, or restore the mine; 3) functions as only one organizational subsystem under command of the total emergency organization that must be used during rescue and recovery after a disaster or mine emergency; and 4) has an ongoing training component and can train new recruits as well as upgrade equipment. If these are among the foremost functions of any MRT, how does the development of training materials help teams become prepared to carry out these functions ?

Prior to the development of new training materials, on-site observations of team training were conducted to establish baseline descriptions of actual activities performed during training, to identify the nature and types of training resources used by trainers, and to ascertain the manpower and facilities allocated to mine rescue at mine operations. Two different strategies were used to organize these observations. First, five new teams were observed during training for more than six (6) months. Second, a cross- section of teams was selected from among those teams which had placed very high, very low, and average in mine rescue contest competition during the previous year. At least three training sessions were observed for each of the nine teams with contest experience. Collectively, these observations provided information about training practices which could be used in the development of new materials, and suggested ways to approach the development of these materials.

Our observations of MRT training showed that most instructors relied on manufacturer's materials to address how apparatus works. While these materials were high quality, maintaining up-to-date and complete information varied widely from team-to-team setting. Observations suggested that a fully developed set of materials must provide the guidance to allow: repair of equipment, direct the care of those parts subjected to wear, and also encourage the team members to trust their SCBA. Observations also suggested that an apparatus specialist be carefully trained to maintain a high level of reliability for MR apparatus and equipment. This specialist or "benchman" would be available to (a) spot trouble before the malfunction could cause harm to mine rescue team members, (b) replace the deteriorating or faulty parts and (c) release the team members

to concentrate on the routine of wearing, operating, cleaning and caring for SCBA.

Although the level of knowledge about apparatus was not always obvious, mine rescue teams must at least train each member to as high a level of sophistication as that indicated by the most current, correct information associated with each SCBA. From the point of view of stated team functions, it pays to have members thoroughly understand their SCBA and increase their confidence in it.

In addition, useful apparatus modules must be easily tailored by trainers to be employed as a self-taught module for "rookie" members to deal with the problems of replacement as a result of turnover on a MRT. Considering the variability in background among instructors as well as MRT members, the ability to adopt and tailor information usefully was not particularly reliable. Training materials would have to be developed to ensure: a) comprehensive knowledge of the SCBA and b) ease in tailoring to team and individual performance abilities.

The second function, of performing the specific MR tasks needed to operate effectively in a disaster environment, may be created (1) by having teams work in simulations or in recovery operations and 2) by evaluating the common and specific competencies of MRT members, especially by virtue of having the team perform difficult tasks.

Among the tasks to be mastered are those that (1) prevent more explosions or at least predict explosions, (2) extinguish fires or prevent fire from spreading, (3) control falls and mine conditions from injuring or killing personnel, (4) detect and eliminate toxic and explosive gases, (5) reventilate the mine, (6) remove survivors from or through gaseous atmosphere, and (7) collect data to understand the cause of the disaster and to prevent the next disaster. (Mine rescue teams may also need to recover bodies).

Major MRT missions and related tasks are listed below:

COMMAND MISSIONS	TEAM TASKS
Obtain Information On Ventilation	Team measures airflow velocity and direction at designated locations and reports general observations
Obtain Information On Air Quality	Team tests for gases at required and appropriate locations
Obtain Information About Specific Conditions in the Affected Area	Team explores affected area and reports on findings, observations and clues to survivors

Extinguish, or Control Fire in an Affected Area	Team uses direct firefighting methods to put out fire in affected area
Rescue Survivors According to Plan	Team brings out survivors in fresh air route and/or builds airlock before opening a barricade
Restore and/or Alter Ventilation	Team repairs or builds stoppings and other ventilation controls
Isolate or Contain Fire Area by Sealing	Team uses indirect firefighting methods or builds fire seals to cut off oxygen and smother a fire
Restore Affected Area by Unsealing	Team takes air samples of sealed area and if appropriate opens seals
Recover and Rehabilitate Affected Area	Team under oxygen begins rehabilitation of affected area before work crews complete recovery

These may not be the only tasks of a mine rescue team, but if these are not mastered, the training will not be successfully completed.

Some companies have used smoke and pepper gas to simulate a hostile atmosphere for apparatus wearing. One consideration in preparing materials is that trainers cannot subject people to "real danger", but if discomfort results from hard work during activities it is legitimate for training purposes. Teams also used experienced mine rescue team members to assure new members that they will survive. Interviews with veteran mine rescue team members suggested that many were uncertain, even scared at first, but continued to work because of loyalty to their team captain or because their commitment to the team did not permit them to "back-out". Some teams had volunteered to work in disasters at other mines because the experience made their team a better team and more likely to perform under emergency conditions in their own mine.

Observations also indicated that it is useful to spend time telling teams what tasks must be done by someone if the mine is to be recovered. An awareness of the job and a realization that they have a better chance of accomplishing that job, may help a team make the decision to perform. Clearly, a quality mine rescue team training program would have to offer trainers help in creating this fit between skills and the job to be done. Moreover, materials would have to encourage and direct each trainer to train in situations approximating emergency

conditions, and wherever possible, use experienced mine rescue members to assure rookie members of protection as they enter the environment.

The third function is to prepare teams to be ready to function as a subsystem of the larger emergency organization which is responsible for the control of the entire recovery.

Characteristically, an emergency organization is not an established configuration and thus takes time to stabilize and more time to attack the problems at hand. The emergency organization for example, must move men and equipment to the site. If ventilation fans must be repaired or replaced, the organization must accomplish it. If underground transportation must be replaced or hoisting equipment must be rebuilt, or if communications equipment needs to be repaired or replaced, then the emergency organization has these tasks to accomplish.

The training must identify and deal with the surface emergency organizational structure and also prepared mine rescue team members to expect a certain amount of disorder. Training materials must emphasize that safety is the first concern, and make them aware of the dangers from explosions, fires, roof falls, and gases. There was remarkable inconsistency among team training conditions and not much careful planning about duties and tasks a team will be expected to perform.

The other question that must be addressed by the training materials in relating the team to the emergency organization is to show what functions are delegated to the mine rescue teams. For example, the mine rescue teams must communicate the specific physical conditions to the command center. The command center needs reliable data to decide about how to attack and deal with conditions existing in the mine (e.g., about danger of explosions, extent of fires, condition of roof and evidence of gases). The command center also must determine the precise nature of conditions to create a plan of attack that can be used to regain control and successfully recover the operation.

Interviews and team debriefings had repeatedly shown that personnel (management or government) with command responsibilities had entered the mine to inspect the affected site as completely as possible because reports about conditions seemed to be incomplete or were regarded as unreliable. Training programs must not only indicate the importance of communication, but must also lay out the consequences of a poor job of communicating conditions to the command center. The team must understand it does not have all the information that is available to the control center. Likewise, command center personnel must be knowledgeable about MR missions, and capable of anticipating team actions in order to direct a rescue and recovery effort.

The fourth function is training men and providing for the replacement of men and equipment. Team member replacement seems best done by having extra apparatus and allowing extra persons to use the apparatus and stay with the team. At least one extra man should always be part of the training exercises. The individual would learn to use apparatus with self-taught modules as much as possible. (Gas testing skills could be developed in the same manner.) Video-disk, video-recorder tapes, film, or slide-tape presentations would allow demonstration of the preferred level of performance and would simplify the replacement issue for teams.

Trainers may also wish to have a "skull session" about how teams have performed in past disasters and how these actions could have been improved. It is essential that teams have benchmarks and criterion to judge or evaluate themselves. Simply executing a task can easily fall short of preferred procedures; e.g., constructing a stopping is not the same as building a tight seal, taking a gas reading is not the same as knowing what a good test requires. Finally, use of debriefing sessions after an exercise should be encouraged and the trainer should be prepared to relate practices to preferred performances during these sessions.

Identifying Training Objectives

We identified four major goals to guide development of the mine rescue and recovery training materials. First, training materials must ensure that initial training--primarily centered on the use and care of SCBAs--provides at least the minimal critical skills required to function as a team. Second, training on the team must provide the remaining skills and also increase performance to a level of operational effectiveness. Third, team training must maintain performance levels, even though individuals may use some skills infrequently. Fourth, training programs must teach how to deliver mine rescue teams (and replacements) within restricted time limitations of mobilization to deal with underground emergencies.

Based on observations and from interviews with MR team trainers, the following four approaches were included in developing the instructional materials:

1. Training by means of an activity; that is, learning to use SCBA's, learning to test equipment and use gas testing devices.

2. Training by use of adequate informational materials and explanatory devices.

3. "Hands on" training in the check-out and read-out of instrumentation.

4. Training by means of illustration of previous disasters or situations one might expect to encounter during a mine disaster.

Since the training materials would have to reflect specific knowledge and skills required in underground rescue and recovery work, development of the mandated initial and advanced refresher training depended upon a careful specification of objectives and requirements, and their use in a broad range of training activities. Part 49 refers to a "need for professionalism" in dealing with underground emergencies, an achievement that is doubly difficult because of the part-time voluntary basis of team membership and the small amount of time instructors were budgeted for mine rescue training.

In spite of the diversity of objectives dealing with the structure and tasks of rescue and recovery work, we were able to arrange most of the major objectives into a set of twelve training modules. The objectives were a product of a review and feedback process, and constitute a fairly exhaustive list of what mine rescue team members should know or be able to do as a result of participation in an instructional program. The initial and advanced/refresher modules are list in Table 1.

Module Design

Each module is organized in a standard format consistent with current practices in educational materials design. The design principle employed is referred to as the elaboration model (Reigeluth, Bunderson, and Merrill, 1978). Elaboration is like a zoom lens approach to instruction, seeking to present an overview, followed by elaboration of the parts based on the instruction or the principles involved.

Each module opens with a brief description of its contents. Course Objectives are listed; they define the module in terms of the performances which may be expected of trainees upon completion of the module activities. Course Materials are itemized, including materials and equipment required for the activities. There also is a list of Supplementary Resources, such as slide-tape programs and references to publications, available from a variety of agencies. A Course Outline of the content of the modules may aid the instructor in developing presentations and guiding activities.

Table 1. Content of Mine Rescue and Recovery Training Modules

Module Topics	Initial	Advanced/ Refresher [a]
Introduction to Mine Rescue	X	
Introduction to Self-Contained Breathing Apparatus	X	
Draeger BG 174-A Self-Contained Breathing Apparatus [b]	X	
McCaa Self-Contained Breathing Apparatus [b]	X	
Aerorlox Self-Contained Breathing Apparatus [b]	X	
Scott Rescue-Pak Self-Con tained Breathing Apparatus [b]	X	
Auxiliary Apparatus	X	
Chemox Auxiliary Self-Contained Breathing Apparatus	X	
Surface Organization		X
Mine Gases		X
Mine Ventilation		X
Exploration		X
Fires, Firefighting and Explosions		X
Rescue of Survivors and Recovery of Bodies		X
Mine Recovery		X

[a] Separate training modules were prepared for coal and for metal/nonmetal mines for each of the advanced/refresher courses.

[b] Four modules (the Draeger, McCaa, Aerorlox, and Scott) were developed to deal with the NIOSH/MSHA approved minimum 2-hour self-contained breathing apparatus.

The main body of the module consists of (a) Suggested Lectures which an instructor can present as is or may tailor to particular operational goals or team needs, and (b) Instructor's Notes which contain a number of useful suggestions for the instructor. Accompanying the suggested lectures are charts, graphs, and pictures from which overhead transparencies may be made or which can be copied and distributed. These modules contain Self-Checks designed as activities that simulate problems at the mine. Most modules also contain periodically introduced Review Questions, and close with a series of multiple-choice questions, called a Progress-Check, covering the objectives of the modules. Incidentally, the Progress-Check questions cover information similar to the "Statements of Fact" contained in contest rule books, but these Progress-Checks anchor the information in task content, not in memorization.

Two examples illustrate module design features; one is taken from Surface Organization, the other from Mine Ventilation. The Surface Organization begins with notification and mobilization for emergencies, indexing authority and detailing responsibilities. The two taxonomies, of facilities(A) and also of task and duties(B), related to Support Objective 4, spell out the structure and relations for an effective surface operation. While each duty assigned to the Outside Foreman and to the Safety Director(C) may not be reflected in every program plan, the structural relations of command responsibilities is explicitly taught, and team instruction is focused on these structures. (See Illustration 1)

The second example, from Mine Ventilation, depicts how specific procedures are taught. Procedures are a series of events that specify the performances required to accomplish a given objective. Ventilation procedures(A) and mapping skills(B) are mandated topics, and as such, are integrally related to all tasks in rescue work(C). The use of air measurement devices is a Support Objective which represents real-world objects(D). Embedded in a context dealing with the fundamentals of airflow - how air is controlled as well as how to construct controls during an emergency - the capability for assessing the condition of a ventilation system is vitally important in any plan of action during rescue and recovery(E). Measuring airflow is a critical procedure in any assessment of ventilation(F). (See Illustration 2)

Illustration 1 – Surface Organization

Course Objectives

Main objective

The mine rescue team will be able to identify the components of an effective mine rescue and recovery surface organization and the role the team plays in this structure.

Supportive objectives

The team members will:

1. Become familiar with the mine's emergency notification plan.
2. Understand the importance of establishing a chain-of-command and identify the team's place in this chain.
3. Identify the various facilities and arrangements normally recommended for carrying out a rescue and recovery.
4. Identify the various personnel and duties normally involved in surface organization.

Course Outline

I. Introduction

II. Notification plan

III. Establishing a chain-of-command

IV. Making surface arrangements (A)

A. Suggested facilities and arrangements
   1. Command center
   2. Waiting area for teams
   3. Bench area for apparatus
   4. Security
   5. Information center
   6. Waiting area for families and friends
   7. Press room
   8. Food and sleeping quarters
   9. Laboratory
   10. Medical facilities
   11. Temporary morgue

(B)

B. Suggested personnel and their duties
   1. Mine superintendent
   2. Mine clerk
   3. Chief electrician
   4. Chief mechanic or mechanical foreman
   5. Outside foreman
      a. Checkman (C)
   6. Safety director
   7. Chief engineer
   8. Supply clerk
   9. Lampman
   10. Mine foreman
   11. Other company personnel

5. Outside Foreman. The duties of the outside forman are to:

   a. Arrange for guards and state and/or local police to:
      (1) Rope off and guard all mine openings;
      (2) Guard all roads and paths leading to the mine;

   b. Designate a person as a checkman to monitor people entering and leaving the mine. The checkman should:
      (1) Attend to his/her assigned station within the roped off area;
      (2) Allow no one to go underground except persons authorized by the officials in charge;
      (3) Examine each person (entering the mine for matches and smoking materials, making no exceptions;
      (4) Check off each person by name and number and record the time as they go in and come out of the mine;

   c. Set up an eating area and make sure that ample food and drinks are available for the rescue teams and other personnel;

   d. Set up medical facilities (first-aid room, triage center, emergency hospital), restrooms, and a temporary morgue, if necessary, and make arrangements for sleeping quarters.

C. Safety Director. The safety director is usually responsible for the mine rescue teams. The duties that the safety director would normally have are to:

   a. Assemble mine rescue teams and first-aid crews;

   b. Provide facilities and equipment for testing, cleaning, and recharging the breathing apparatus;

   c. Assign personnel to issue, record, and return mine rescue equpment;

   d. Consult with the superintendent regarding plans for the rescue and recovery operation;

   e. Establish a rotation schedule for the rescue teams.

   The rotation schedule should be designed so there is a clear order of team usage and so backup teams are always available. There should be an adequate amount of time allotted for resting teams and for cleaning, testing, and preparing the apparatus.

   Exactly how the schedule is set up depends on how many teams are available to the rescue operation, what the conditions are underground, and what the service time of the apparatus is. It is often recommended that no rescue operation start with less than three teams ready and available on the property.

Illustration 2 – Mine Ventilation

Course Objectives

Main objective

The mine rescue team members will understand how air is coursed through a mine and be able to identify ventilation controls, take air measurements, and build or alter ventilation controls when ordered to do so by the officials in charge.

Supportive objectives

The team members will be able to:

1. Identify the proper chain-of-command for altering ventilation.
2. Identify the major mine ventilation methods.
3. Read a section ventilation map, identify ventilation controls and explain how they affect the movement of air.
4. Use air measurement devices.
5. Construct ventilation controls

Course Outline

I. Introduction

II. Ventilation methods (A)
- A. Natural ventilation
- B. Mechanical ventilation

III. Ventilation maps (B)

IV. Ventilation controls (C)
- A. Mine doors
- B. Stoppings
  - 1. Permanent
  - 2. Seals
  - 3. Temporary
- C. Check curtains or run-through checks
- D. Line brattice
- E. Overcasts and undercasts
- F. Box checks
- G. Regulators
- H. Auxiliary fans and tubing

V. Assessing ventilation (D)
- A. Noting condition of existing ventilation
- B. Measuring airflow (E)
  - 1. Anemometer
  - 2. Smoke tube (F)

VI. Building ventilation controls
- A. Temporary stoppings
- B. Permanent stoppings
- C. Air locks
- D. Line brattice

SMOKE TUBE

The smoke tube is used to show the direction and velocity of slow-moving air.

> Visual: Refer to "Visual 14" for a picture of a smoke tube.

The smoke tube is a device that emits a smoke cloud which floats along with the air current to show the direction of the airflow and the approximate velocity of the airflow.

> Demonstration: If you have a smoke tube, you may wish to demonstrate how to use it as you describe the procedure in the following section.

The smoke tube consists of an aspirator bulb and a glass tube containing a smoke-generating reagent. To operate it, break off both ends of the glass tube and then squeeze the aspirator bulb to force air into the tube. A white cloud of smoke will come out of the tube and travel with the air current in the passage. This will show you the direction in which the air is flowing.

There are two methods of measuring the velocity with a smoke tube. With one method, which is not very accurate, the reading is taken only at the center of the airway. This gives only an approximate reading and a high reading because the center of an airway has the fastest moving air.

The more accuracte method of determining the air velocity is to take four readings at quarter points within the airway. The procedure for doing this is as follows:

> Visual: As you explain the following procedure, refer to "Visual 15" for a drawing showing how to take smoke tube readings at quarter points within the airway.

1. Measure off a distance in an airway that is as straight and uniform as you can find. Twenty-five feet is uaually a suitable distance for this measurement. (This distance should be determined by how well the smoke cloud holds together and how well it can be seen.)

2. Station one person with the smoke tube at the upwind point of the measured distance, and station one person with a stopwatch at the downwind point.

3. The person with the smoke tube then releases a smoke cloud at each quarter point within the airway. The person with the stopwatch times each cloud to determine how long it takes for each cloud to reach the downwind point of the measured distance. The measurements are taken separately, that is, the first smoke cloud is timed, then the second, and so forth.

   Each velocity measurement in a quadrant should be repeated several times to determine an accurate average. Abnormal high and low measurements should be discarded, and the remainder averaged. A correction will then have to be made to the averaged figure because the air travel at the quarter points will average about 10 percent high.

A brief description of the purpose and scope of each module shows how these materials are organized.

INITIAL TRAINING (20 HOURS) - coal and metal/nonmetal:

INSTRUCTORS MANUAL - MSHA 2001

Mine rescue team trainers or instructors use the Instructor's Manual to prepare presentations, demonstrations and activities for training mine rescue teams. The manual covers the materials designed in accordance with the Federal requirements for team training in subjects set forth in Part 49 (30 CFR). It describes the role of the trainer, the subject of the modules, a description of the manual format and a master glossary. The materials focus on the major parts of each module in the series, such as: instructor's notes, visual aids, suggested lecture text, course objectives, course materials and course outline.

INTRODUCTION TO MINE RESCUE - MSHA 2002

The mine rescue tradition developed rescue and recovery operations into highly organized and coordinated missions. Advancements in team training, rescue equipment and organizational efficiency evolved over a long period in the United States. Today, mine rescue teams are trained in subjects set forth in federal regulations. This module is intended to provide mine rescue team members with a background in mine rescue tradition and current mine rescue laws. It covers the history, function and duties of mine rescue teams, plus the eligibility requirements for team membership.

INTRODUCTION TO SELF-CONTAINED BREATHING APPARATUS - MSHA 2003

Mine rescue teams must have a basic background in the principles, purpose and functions of self-contained breathing apparatus (SCBA). Teams also need a basic knowledge of the use, care and maintenance of SCBA. The module is intended to provide team members with an introduction to the SCBAs. It covers general information about the SCBAs and precedes the specific module on the particular apparatus used by the team.

DRAEGER BG 174-A SELF-CONTAINED BREATHING APPARATUS - MSHA 2004

The Draeger BG 174-A is a self-contained breathing apparatus that provides up to four hours breathing protection for mine rescue teams during an emergency operation. The apparatus recycles and replenishes the air in a closed circuit system. The 30-pound unit is equipped with automatic and manually operated safety devices and other features, such as an oxygen pressure gauge. This module provides teams with skills and knowledge in the use, care and maintenance of the Draeger BG 174-A. It includes an appendix that distinguishes between the Draeger BG 174-A and the two hour Draeger BG 174 models.

AEROLOX SELF-CONTAINED BREATHING APPARATUS - MSHA 2005

The Aerolox is a self-contained breathing apparatus that has a three hour service time for mine rescue teams working during a mine emergency operation. The apparatus is a closed circuit system that uses liquid oxygen as the source of oxygen; it weighs 34 pounds when filled with liquid oxygen, 28 pounds when empty. The apparatus is a relatively simple system with no high pressure components and no manually operated valves. This module provides teams with skills and knowledge in the use, care and maintenance of the Aerolox breathing apparatus. The manual includes an appendix that distinguishes the different Aerolox models.

McCAA SELF-CONTAINED BREATHING APPARATUS - MSHA 2006

The McCAA is a two hour, self-contained breathing apparatus that uses compressed oxygen as an oxygen source in a closed circuit system. The manual describes the basic parts and functions of the McCAA. It provides basic skills and knowledge for mine rescue teams in the use, care and maintenance of the McCAA self-contained breathing apparatus. The manual includes an appendix on the McCAA mouthpiece assembly and noseclip for wearing and testing the apparatus.

SCOTT RESCUE-PAC SELF-CONTAINED BREATHING APPARATUS - MSHA 2007

The module describes the Scott Rescue-Pac self-contained breathing apparatus. The Scott Rescue-Pac is a closed circuit system that contains a compressed oxygen supply contained under high pressure in an oxygen cylinder. The apparatus provides up to four hours of fresh oxygen for mine rescue teams during a mine emergency operation. These materials provide mine rescue teams with basic skills and knowledge in the use, care and maintenance of the Scott Rescue-Pac.

INTRODUCTION TO AUXILIARY APPARATUS - MSHA 2008

Mine rescue teams may use Auxiliary Apparatus under special circumstances and conditions of a mine rescue and recovery operation. This module describes the different types of auxiliary self-contained breathing apparatus, and their uses in mine rescue and recovery work. The manual describes several brands, such as: BioPak, Chemox, MSA AirMask, Scott AirPak, SurvivAir, Globe Guardsman, and Seibe Gorman Air Master. It is intended to provide teams with general background information on auxiliary apparatus, such as the types of systems, the functions, the advantages and disadvantages of different apparatus and the federal regulations regarding the use, care and maintenance of auxiliary units.

CHEMOX AUXILIARY SELF-CONTAINED BREATHING APPARATUS - MSHA 2009

This module describes the Chemox auxiliary self-contained breathing apparatus (ASCBA). The Chemox ASCBA is a one hour unit that weighs 13.5 pounds. The apparatus produces oxygen chemically from an attached canister in a closed circuit system. Mine rescue teams may find the Chemox ASCBA particularly well suited for working in low clearance areas during a rescue and recovery operation. The module provides teams with the basic skills and knowledge in the use, care and maintenance of the Chemox ASCBA.

ADVANCED/REFRESHER TRAINING (40 HOURS) - separate series for coal and for metal/nonmetal training :

SURFACE ORGANIZATION - MSHA 2101/2201

Mine rescue teams work with a whole network of people, who make all arrangements for setting up the surface organization. The surface organization consists of authorized personnel, emergency facilities and special services required for an effective rescue and recovery operation. This module is intended to provide mine rescue teams with background information for organizing a mine rescue and recovery operation. The material describes the activities, tasks and procedures normally carried out on the surface during an emergency operation.

MINE GASES - MSHA 2102/2202

Mine rescue teams make tests for gases with permissible gas detectors repeatedly during a rescue and recovery operation. The team's job of gas detection provides information about what happened in the mine and about the potential hazards in the affected area. This training manual provides teams with important information on mine gases, gas detectors and detection methods after a mine disaster. It also describes how to identify mine gases, how to test for gases and how to interpret the findings and readings of gas levels.

MINE VENTILATION - MSHA 2103/2203

Mine rescue teams play a critical role in restoring mine ventilation after a disaster. Teams explore inby specifically to assess damages, measure airflow conditions and check damages to ventilation controls. Teams may be required to alter ventilation according to orders from command officials. This manual provides teams with background in the purpose, principles and methods of mine ventilation. It also covers the mine ventilation map, map symbols and airflow measuring devices.

EXPLORATION - MSHA 2104/2204

Mine rescue teams conduct basic exploration work after a fire, explosion or inundation. Teams explore the affected area to check on damages, report on local conditions inby, and locate missing miners or clues to their whereabouts. Teams follow recommended and acceptable procedures for exploration that developed over the years out of the mine rescue tradition. The module provides teams with a basic understanding of exploration during a rescue and recovery operation. It covers the methods, traveling procedures and the importance of progress reporting and simultaneous mapping during exploration.

FIRES, FIREFIGHTING, & EXPLOSIONS - MSHA 2105/2205

Mine rescue teams frequently fight fires and guard against the propagation of fires or explosions during a rescue and recovery operation. The team's ability to fight fires depends a great deal on hands-on experience with different fire fighting agents and equipment. The team's work includes an assessment of fire conditions, mine fire gases and other potential hazards associated with fire fighting activity. This module covers the underlying principles of the "fire triangle" and the different methods for controlling, containing and extinguishing fires in a mine. It also covers fire-fighting equipment, considerations involved in a sealing operation and the cause-effect of explosions.

RESCUE OF SURVIVORS & RECOVERY OF BODIES - MSHA 2106/2206

Mine rescue teams utilize all of their skills to locate missing miners during a rescue operation. Teams explore inby to search for, and bring out survivors after a mine disaster. The teams attempt to evacuate injured and trapped miners safely according to recommended rescue and recovery methods. This module is intended to provide teams with the proper methods, factors and the numerous considerations involved in locating possible survivors during a mine emergency. The material describes the proper methods for opening a barricade, for administering first aid, for handling injured miners, plus the special requirements for recovery of bodies after a mine disaster.

MINE RECOVERY - MSHA 2107/2207

Mine rescue teams participate directly in the recovery of damaged mine property after a fire, explosion or inundation. The teams use all the skills and knowledge of training in mine recovery work: air sampling, restoring ventilation, unsealing operations and rehabilitation of the affected area. This training module provides mine rescue teams with a background in the specific procedures and methods of mine recovery, plus a basic explanation of the considerations and factors that may affect the recovery job.

MINE RESCUE ACTIVITY BOOK - MSHA 2108/2208

This module contains suggested activities for the instructor or team trainer to use in conjunction with the Advanced/Refresher Mine Rescue Training Modules. Activities supplement classroom lectures or include full scale drills and exercises for mine rescue teams. All activities are identified according to levels of complexity from simple, basic tasks for inexperienced team members, to complex drills for experienced teams. The design of activities focuses on both individual skills performance and on the team's ability to work as a cohesive unit during a rescue and recovery action.

MATERIALS EVALUATION AND PROGRAM DEVELOPMENT

Materials Evaluation

One of our objectives was to obtain an index of the user-ready nature of these training materials. In our estimate, if the materials were comprehensive and a range of applications could be identified, the goal of user-ready training resources would be fairly well attained. Nearly 200 trainers who had received complete sets of materials were asked to evaluate each module with regard to (a) completeness (coverage of concept, procedure and tasks), (b) scope (range/ extent of content, topics, actions), (c) adaptability (continuity of content and actions consistently from one module to another), and (d) practicality (usefulness of materials in determining application and effort). These evaluations were combined, and each module was given an overall rating, ranging from 0 (low) to 5 (high). Table 2 reports the "comprehensiveness" scores for each module.

The most consistent, systematic activity engaging team members throughout repeated training sessions is related to the operation and uses of the SCBAs. Clearly, the most highly rated module dealt with the Draeger BG 174-A. Next, high rating was given to those modules dealing with "rescue of survivors and recovery of victims," and "surface organization". In some measure, the "heroic" quality of teams' actions is expressed by rescue and victim recovery. The high rating given this module showed that procedures and tactics were handled by the materials in a really practical way. In addition, this module filled a gap in training.

This also applied to the "surface organization" materials. Information related to surface functions and activities had seldom received specific attention except to exhort team members to remain disciplined under chaotic conditions and to appreciate that the mammoth efforts expended during a disaster required an absolute authority. The module not only depicted the notification processes, along with some key determinants for command actions, but reviewed team schedules and identified the range of functions the surface organization performed in response to underground emergencies. At a mimimum, any team could begin its indoctrination into coping with and responding to chaotic conditions in terms of the structure described by surface command operations and procedures.

The "introduction to mine rescue" received good ratings mainly because of the systematic presentation of information, much of which was available, but piecemeal. The "heroics" and "pathos" of disasters were tied to legal, medical, and training requirements, and to the structure and role of the mine rescue

Table 2 . User-Ready Rating of MR Training Modules

Modules Topics	Comprehensiveness [1] (User-ready rating)
Draeger BG 174-A SCBA [2]	4.75
Rescue of Survivors	4.73
Surface Organization	4.63
Introduction to Mine Rescue	4.56
Mine Recovery	4.33
Exploration	4.31
Introduction to SCBAs	4.31
Fires, Firefighting & Explosions	4.27
Mine Gases	4.25
Chemox Auxiliary Apparatus	4.14
Auxiliary Apparatus	4.10
Mine Ventilation	3.94

[1] An average ranking of each module, based on a 0 (low) to 5 (high) score combining completeness, scope, adaptability, and practicality scores.

[2] The BG 174-A is the most widely used self-contained breathing apparatus in the United States; we addressed the assessment to this apparatus.

team. Accompanied by a slide-tape, these materials enhance virtually any initial team training sessions.

The core of advanced/refresher team training materials, dealing with "mine recovery," "mine exploration," "fires and firefighting," and "mine gases," received good ratings from instructors. These modules also received attention in the Activities Book assuring greater user-ready practices.

All these materials received high ratings for completeness and content. There was a deliberate decision to exclude step-by-step operating instructions of testing devices because many such measuring devices are available to the industry, and each mine, in any case, selects the instruments fitting its requirement. Also, instruction pertaining to procedural standards which show how these instruments apply to activities during rescue and restoration missions was deemed more appropriate than describing how to operate the measuring instrument itself.

Of the seven modules dealing with features of advanced/ refresher team training, the one that received only an average rating was about "mine ventilation". The module received either a very good or below average rating from trainers. Experienced instructors felt the module adequately covered the basic principles and procedures about ventilation, including use of basic instruments (i.e., use of the anemometer and smoke tube). Newer instructors, on the other hand, were more interested in obtaining answers to problems dealing with changes in ventilation, strategies for containing and controlling conditions, and so on. Inexperienced instructors were more often less satisfied with the module, largely because it dealt with specific tasks rather than the control of mine ventilation. Yet, as one veteran noted, the team needs to know the safest procedure for carrying out its tasks, not what needs to be accomplished, since these decisions are made by the command group directing the entire emergency operation. In essence, rescue teams are expected to conduct the missions assigned to them, but presumably the command group in charge of the emergency operation provides the expertise involved in planning and directing actions.

Uses of Rescue Team Training Materials

Training personnel familiar with the MES-developed mine rescue modules identified various ways to use these materials. Virtually every instructor, for example, felt that the materials dealing with SCBAs as well as other initial training modules should be employed in developing new teams. Not only would each new member be exposed to a common standard, but each could be trained to a high performance level in the uses of the apparatus, based on component-by-component description of the inhalation and exhalation system of the SCBA, on established

step-by-step testing procedures, and on systematic trouble-shooting practices.

On the other hand, instructors regarded the set of advanced materials as especially useful for most of the experienced trainers and veteran teams. While some information in the training modules might have been available to exerienced trainers, it was the systematic arrangement into specific modules that was most useful. For the first time, an organized set of materials was available as an entire program for advanced MR training.

Training uses most often cited by instructors are listed below (the percentage approving usage is in parenthesis) :

TRAINING USES

Initial Training (20 hrs) -for a new MR team (93%);

Initial Training (20 hrs) -defines standards and common practices for each team member (87%);

Initial & Advanced Training (20 + 40 hr) - use materials for training new "replacement" members (turnover) (82%);

"Surface Organization" module - to foster an integrated company operating plan (69%);

Initial & Advanced Training - informing mine management about the content & needs of mine rescue team training (52%);

Initial & Advanced Training - for guidance in securing approval of operators program (48%).

As noted, another suggested way to use the set of materials was to provide guidance to mine management for the development of mine rescue programs and to generate a commitment among management to upgrade their investment in program approval. Overall, instructors viewed the surface organization module as fairly important for establishing explicit training objectives leading toward integration between underground tasks and surface arrangements during a disaster. This training module afforded a fairly concise understanding of the structure and functioning of surface operations. At least every team had an opportunity to learn about the basic features of surface organization during an underground emergency.

Trainers felt that a strong feature of the modules was the use of visuals and handouts. Trainers often had some visuals of apparatus (e.g., from manufacturers), but seldom had visuals on advanced training activities. Noted features were:

BEST FEATURES OF THE MATERIALS

Visuals and Handouts (88%)
Activities and Exercises (81%)
References (71%)
Trouble-shooting and error guides (67%)
Descriptions of disasters
and of disaster conditions (60%)

Likewise, the practical exercises and training activities guides were viewed favorably, although some instructors felt not enough activities were provided to annually retrain their teams year after year.

This apparent shortcoming was interesting in relation to the support that normally was provided for rescue training and instructor preparation. On the average, less than five percent of the entire instructional time was allocated to mine rescue preparation and training. This is equivalent only to about eight hours per month for their total active rescue commitment dealing with preparation, training, review, and so on.

In industry, the majority of instructors had some team background, but few had much more than one or two years of training experience in mine rescue, and most had only team experience confined to contest-related training. Consequently, many were unable to construct or tailor training activities for teams if these activities were not spelled out step-by-step. It is one thing, for instance, to tell team members about extinguishing a fire, but quite another to teach the team how to actually extinguish a fire. An instructor would need to know the correct size and depth of the fire pit, the proper mixture of fuel, and the rate of application of an extinguishing or wetting agent to be able to conduct the training activity.

Almost by definition, initial training was far easier for trainers than advanced training; apparatus skills and related activities were more specific, more controlled, and relatively redundant. In a fashion, the differences in the response given by industry and by government training personnel pivoted around this division. Traditionally, the latter did the initial apparatus training, and subsequently might monitor and check out advanced rescue training. There was less opportunity to refine advanced skills and procedures among many of the state or federal trainers. Beyond these initial instructional efforts, agency-based trainers usually acted as advisors to industry trainers. Thus, the devotion to apparatus training probably persisted because it legitimized effort and required little or no organizational change.

There are indications, of course, that the activities guides were useful and did encourage some imaginative new departures among industry instructors when effort and support

were provided. Developing mock-ups of simulated underground emergency conditions, using local or regional fire training facilities, examining access or egress from various specific sectors of the mine, improving communications skills, and attaining proficiency in monitoring or testing tasks have been stimulated by employing and tailoring suggested activities.

Upgrading Team Performance

No matter how much effort goes into the design of instructional materials, into training goals, or into an instructional model, how well these instructional resources are performing in terms of trainer and trainee behavior lies beyond the control of course material. Whenever rescue training is conducted, even if geared for contest competition or as "token" compliance to those regulations that spawned these training materials, there still is feedback from the team about the relevance of outcomes for their safety and their work. Trainers do recognize this, and many seek ways to improve their training and facilitate the performance of their teams.

A viable mine rescue training program requires support from operational as well as senior mine management. It needs strong state or Federal endorsements that reach beyond a stated agency policy and the approval of company programs that seem to coincide with such policy. Beyond mandated equipment, other requirements are: time to prepare training plans and to customize materials, time to interact with other trainers and identify resource personnel, as well as control over schedules, determination of selection and team replacement options, and the participation of supervisory personnel whose involvement is required when underground emergencies occur. Furthermore, requirements dealing with instructional arrangements, and with facilities and equipment as well as networks of resource personnel, would not automatically be satisfied even if training were conducted only by Federal or state agencies.

Trainers were requested to indicate the amount of effort they invested in instructional activities and administrative duties: to report about the planning, coordinating, and programming functions related to their mine rescue and recovery training activities. Having trainers judge their needs and investments in regards to an array of responsibilities and duties provided both a framework of common functions, and a chance to rank these functions. Table 3 presents these duties and functions.

Although instructional activities usually received the highest priority, administrative duties nonetheless were perceived to require significant effort. Materials "tailoring" and activities development, designing mock-ups, demonstrating procedures and motivating performance required a good deal of attention. On the other hand, updating members, training

Table 3 . MR Trainer Functions- Reported Instructional and Administrative Duties

Instructional Duties	Administrative Responsibilities
rank	rank
1. Design materials & tailor content	2. Back-up MRT captain's authority
3. Demonstrate preferred performance for each procedure	6. Arrange for transport equipment/supplies (van or mine rescue vehicle)
4. Use periodic mock/simulated mine emergency to learn how to plan and cooperate	7. Identify teams and other personnel who will be deployed in an emergency
5. Design exercises/activities which allow trail-and-error practice	9. Inform mine management of MR training goals and team needs
8. Debrief training sessions to evaluate tasks and explain events	10. Coordinate selection and training of FAB (fresh air base) personnel
13. Use reports/information about mine disasters to examine fit between the demands and expectations of MR work	11. Maintain liaison with mine foreman/shift boss about MR training objectives
14. Update MRT members about hazards,fires and other conditions at their mine(s)	12. Coordinate MRT training programs
16. Tailor instructional materials for use in training new (rookie) MRT members	15. Implement liaison with educational/agency groups
18. Develop a program of instruction(e.g., 3-5 years) to maintain & upgrade team performance and cross-train members	17. Develop personnel selection and MRT replacement plans
19. Establish "performance standards" for SCBA testing,monitoring and for communication activities	21. Work with assigned state/federal mine inspectors
20. Develop MRT proficiency in contest rules and contest procedures	22. Train with MRTs at mines likely to request services or assistance
	23. Promote distinct identification for team members (logos,jackets,etc)
	24. Join regional or national Mine Rescue association(s)

Note: The assigned ranking was derived from the average rank for each function; instructors ranked all functions.

"rookie" replacements and devising proficiency measures for various skills and procedures were only occasionally performed or perhaps intermittent functions. Among admininstrative duties, arranging transportation, coordinating, reporting, and maintaining team manpower took a fair effort from trainers most often. For the most part, however, follow up observations had shown that MR training was tied to separate mine operations with one, sometimes two teams whose support and vigor depended on immediate, local management.

Broadly speaking, federal and state trainers more often instructed a collection of trainees (usually rookies) drawn from a range of operations, whereas industry trainers encountered team-by-team replacement. Likewise, industry's trainers were more likely to need to deal with maintenance, supplies, and transportation as part of their normally expected responsibilities. Surprisingly, there was no strong concern among trainers, generally, to secure coordinated training with other teams that might be called to their operation in an emergency, nor to promote efforts to standardize resources, equipment, and practices among likely back-up teams. For all practical purposes, the functions of MR training still seem to preclude most activities beyond the immediate instructional needs associated with classroom demonstration and team practices.

By and large, trainers were expected to fit in such programs without loss of time on other duties. Futhermore, there was little chance for career or company advancement by training part-time volunteers to deal with underground emergencies. Coincidentally, little effort was made to evaluate the effectiveness of recovery and rescue training, or to assess an organization's mobilization capability for an underground emergency.

Ordinarily, mine management regarded mine disaster and rescue as an improbable event. Management endorsed these MR training activities when they were at no cost or very inexpensive, provided step-by-step procedures, and required limited additional preparation or managment commitment. The experience of one trainer pretty much summed up the pattern we found often among companies. He noted that "for six months after we had the water inundation (at a limestone operation), we got anything we needed and asked for, and then everyone forgot, and nothing any longer went to training." Often managers did not know what to do with their MR capabilities, and as a result, did not know how to support training activities.

Mine Rescue Skills and Member Specialization

What are the priorities for the skills and knowledge involved in MR training? Are some skills more specialized than

others? Do instructional materials sufficiently cover all the basic ingredients for an effective team operation?

Our work with trainers showed that there were priorities and there was a limited, but definite tendency toward specialization of activities on teams. See Table 4.

Practically every trainer indicated that each rescue team member needs to perform all rescue and recovery procedures, but rated as top priority those skills relevant to the safety of all members and their ability to effectively use and control their apparatus. Most trainers agreed that proficiency in testing and wearing an SCBA, plus good care and maintenance of SCBAs are premium skills for every team member. Next, training must ensure that each member understands signals, and knows how to travel and how to "tie in" safely while carrying out assigned tasks. On the other hand, trainers regarded gas testing and other monitoring skills, as well as responsibility for communications as fairly specialized actions for a few members or a single team member. As shown in Table 4, this arrangement of skills is nearly paralleled by how instructors ranked the knowledge/understanding competencies for MR teams.

The strongest endorsement for specialized task work came most often from governmental or educational training specialists, where roles as "map man," "gas man," "number 3", or "number 4" man were regarded as specific assignments in a definite division of labor. Perhaps this inclination to focus more on "position", less on "mission", derives from long-time attention to successive training of batches of new MR recruits. Perhaps it follows from rescue contest procedures; but the mission versus position issue frequently arose in field training observations and during interviews. Generally, industry trainers were more apt to rotate team members among positions, selecting the more proficient ones for specialized work as the tasks or team mission warranted.

As a whole, team performance goes beyond hands-on demonstrations with apparatus, bringing teams into situations that depend upon opportunities for "trial and error" practices, and team debriefing. Successful teams require situations which present "mock" or "simulated" conditions--problem solving work. Clearly, some skills tended toward specialization, and these were the tasks that required most attention during training.

Table 4. Skills and Information Required by Members of Mine Rescue Teams: An Empirical Ranking.

MINE RESCUE SKILLS

	No.	
INDIVIDUAL ABILITY	1.	Willing and able to do MR work
	2.	Test and wear apparatus (SCBA)
	19.	Cope with stress
	4.	Care and maintenance of SCBA
TEAM EFFECTIVENESS	3.	Work and travel in smoke
	11.	Use lifeline & signals correctly
	12.	Tie-in & travel properly
	13.	Fight large fires directly(water/foam/agents)
	7.	Control and extinguish small fires (incipient/early stages)
	14.	Control fires indirectly (erect temporary/permanent seals)
	9.	Construct "section" ventilation controls
	18.	Perform first-aid
SUPERIOR COMPETENCE	6.	Perform gas tests
	5.	Take air samples correctly
	15.	Attend to victims & survivors
	8.	Measure airflow
	10.	Mapping correctly
	17.	Obtain breifing information appropriately
	16.	Report conditions & status of team members
	20.	Equip team for a task/mission

MINE RESCUE INFORMATION

	No.	
PERSONAL/ TEAM SAFETY	22.	Understanding importance of facepiece seal
	24.	Knowing equipment malfunctions & corrective actions
	21.	Knowing why each SCBA test & check is made
	27.	Knowing the effects of different gases on humans
	23.	Understanding advantages & limitd of different SCBAs
WORK PROCEDURES	34.	Knowing procedures for opening barricades
	37.	Knowing the fundamentals of unsealing during recovery
	39.	Understanding reasons for standby & backup teams
	30.	Understanding the fundamentals of Fresh Air Base(FAB)
	23.	Understanding the fundamentals of airflow/ventilation
	32.	Knowing the whens & wheres of barefaced explorations
	28.	Knowing explosive concentrations of gases
	31.	Understanding team's relation to FAB & command center
	29.	Know how mine fires are controlled
	40.	Understanding the "cycling" of teams
TASK/MISSION KNOWLEDGE	44.	Knowing MR laws and regulations
	35.	Understanding survivor "triage"
	43.	Knowing how other teams have performed
	36.	Understanding the functions of noting evidence
	33.	Knowing the purpose & processes of briefings
	41.	Understanding the functions of security
	26.	Understand how air is controlled
	42.	Understanding functions of air sampling
	38.	Know how to arrange for transportation,supplies

*Note: Each item above is a shorthand of the original item (e.g., "No.10 Mapping correctly" was initially stated as "Mapping correctly with proper symbols"). During interviews each item was assessed by a trainer to determine whether the skill or information was to be learner by every member, at least one team member, or none of the MR team members, and similarly, how did the trainer evaluate the learning (pencil tests, demonstrations, walk-through), as well as what kinds of activities or exercises were to be observed to evaluate the skill or competency.

TRAINING MINE RESCUE TEAM INSTRUCTORS

Located at sites throughout the nation, the eleven instructor training seminars, in cooperation with the U. S. Bureau of Mines and the Mine Safety and Health Admininstration, were supposed to stimulate the diffusion of materials, train the trainers, and set down guidelines for the certification of trainer's qualifications. (See Appendix A.)

The operational effectiveness of mine rescue teams in an actual underground emergency is the combination of all of the training goals, including the initial selection of volunteers, members' commitment to the team effort and MR tasks, the integration of teams into a coherent tactical plan to regain control of the underground environment, and the continuous training for effective performance by both teams and surface organization. Without good methods in designing and assessing training, trainers have little chance to improve team capabilities or themselves.

In preparing rescue team members to perform effectively during an underground emergency, there are two fundamental ways to provide instructional assistance to the learner: a) improve the instructional materials, and b) direct the learners attention and assure feedback on performances. Many instructors attending these training sessions had only limited experience with instructing rescue teams; however, the seminars did address two of their major problems. First, the materials both focused and organized the content of Mine Rescue and Mine Recovery training. Second, the seminars provided an opportunity for instructors to compare notes, to review their concerns and collectively review their responsibilities. For nearly 300 industry, federal and state trainers who participated, the seminars provided a way of defining mine rescue and assured them the essential content of what they would teach. The organized contents of the materials provided a basis for trainers' instruction, for comparison of team capabilities, for modifying programs, resources, and services, and for program planning.

II. THE MINE EMERGENCY PREPAREDNESS PROGRAM

INTRODUCTION

A number of unanswered questions dealing with emergency preparedness and management's functions and responsibilities arose during the development of the mine rescue team training materials. Information received from a cross-section of individuals involved in actual mine rescue attempts and in extended mine recovery work indicated a concern about problems associated with rescue and recovery operations that were beyond the scope of MR team training. Specifically, what is the role of mine management in organizing a rescue and recovery operation? For example,

1. Is mine management experienced in rescue procedures?
2. Does mine management participate in rescue training?
3. Does (Do) the rescue team(s) rely on management's decisions and actions dealing with mine rescue procedures?
4. Are "mock emergencies" conducted to prepare individuals, other than the team members, who would be involved in an actual emergency?
5. How often is mine rescue training conducted for State, Union, and Federal officials who would be providing the direction and ancillary support for the functioning mine emergency organization and the restoration of the mine?
6. Has the mine's emergency plan of action ever been tested for efficiency, accuracy, or coordination?

The Mining Extension Service, thus, requested the Bureau of Mines to allow MES to explore the nature of management's role in mine emergency preparedness in the mining industry . MES also proposed to develop materials that could be employed by the mining industry to design and implement emergency preparedness.

Behavior in Complex Organizations: Learning from Experience with Disasters and Mine Emergencies.

In an emergency, an organization cannot and does not automatically react to the increased demands for information, or to logistical demands for personnel and resources created by the situation since it has little accurate knowledge about the event. Moreover, recognition and identification of an

emergency or a disaster initially provides only a tentative suggestion as to the scope of impact. The organization does not know the magnitude of future tasks. Consequently, a considerable amount of uncertainty is encountered within any organization reacting to an emergency.

In responding to emergencies or disasters, a mine organization: 1) operates under very uncertain conditions; 2) operates under conditions of urgency; 3) operates in the context of emergency consensus; 4) loses its autonomy; and 5) transforms the basis for its members' participation.

Typically, during any mine emergency (or mine disaster) certain aspects of an organization's previous activities become less important, and traditional lines of communication and authority may even collapse. Commonly, decision-making will involve different processes and persons. Decision-making is altered, first because of a significant increase in those activities related to communication and coordination; and second, because of a heightened concern for defining the boundaries of the organization.

Uncertainty arises in those situations in which an organization is not sure of the consequences of its actions once these actions and alternative courses of behavior have been mapped out. Uncertainty tends to work in two directions: 1) it provides conditions whereby organizations get involved, and 2) it provides impetus for a shift in patterns of activities. During an emergency, goals are apt to become vague, either because these goals are implied and seldom actualized or are difficult to ascertain as a result of the conditions. Organizations, however, are expected to act. If the organization waits for a clarification of the situation so that its role and tasks can be defined, it runs the risk of having its actions defined by others, or being seen as unwilling to help in an emergency.

On the other hand, immediate reaction can and does lead to a commitment of personnel and resources that may exceed the scope of an organization's experience or its anticipated role. Likewise, members may commit themselves to activities which have little to do with emergency organization positions, or to actions that will not mesh with the role to which it is committed during an emergency. Therefore, in addition to the uncertainty of demands, organizations experience uncertainty as to the status of their own personnel and material resources, as well as the status of other organizations on which they may need to depend.

The uncertainty accompanying an underground mine emergency means that an organizational commitment initially has to be given to anticipatory planning and to gathering information. Anticipating emergency conditions and planning responses to them warrants a significant effort on the part of an organization to identify, evaluate, and reduce its vulnerability.

At least some features of the organization's emergency structure and protective processes are amenable to planned actions. Programs for the mobilization and deployment of personnel and resources may be designed and executed as tactics of preparedness. However, preparedness planning must be focused selectively: some segments of the organization become more important than others. Emergency preparedness plans must show how personnel and resources are notified and mobilized during emergencies. It must specifically determine which personnel are tied to particular activities, and especially establish procedures for gathering information about the predictable environmental changes as well as the operational capabilities of the organization during deployment.

Emergency Organization: Notification, Mobilization and Deployment

Early in the emergency, the "need for knowing" means that previous, well established lines of communication may no longer be followed and new lines, emergent in terms of specific tasks accepted by the organization, may be developed. Normal patterns of authority and routine decision-making processes tend to be replaced by new ones. A mine disaster disrupts virtually all routine operation and production. These altered, ambigious conditions may also require specific types of expertise and consultation. Furthermore, there is tremendous pressure among all levels of the organization toward overmobilization, calling in all shifts and stockpiling volunteers. Characteristically, after impact, there are usually too many people, and at the same time, there never is quite enough manpower ("seasoned" or appropriate personnel to to direct the effort and conduct the work).

Organizations usually have a schematic plan which includes notification of off-shift personnel and identifies basic services, depending upon the extent of impact and the scope of actions initiated. However, notification and mobilization rarely run smoothly at first, in part because the scope of the emergency is unknown and partly because personnel may be confronted with conflicting role obligations. Efforts to reduce deterioration of an organization's readiness during the transition from normal to emergency operation, and to foster the notification and mobilization of the emergency subsystem requires that personnel are where they need to be, not where

they think they should be. Thus, emergency program planning not only must attempt to secure strong commitment, but must also train to ensure that members stay in their assigned roles.

An emergency preparedness program depends upon a sensible policy charter, backed up by authority and the ability of its designated personnel to execute the functions of the emergency organization. An assessment of "vulnerabilities" in a mine, a vigilant monitoring of them, and sound training to swiftly execute the procedures designed to control conditions provide the underpinning for an ongoing preparedness program.

During any large, sustained response to an emergency, initial on-site efforts may be overwhelmed and become ineffective. This necessitates mobilization of external services and resources, and an expansion of the admininstrative apparatus. People who have skills relevant to the control and restoration effort at the mine may be recruited from outside.

Accounts of emergency situations as well as official reports after actual mine emergencies showed many people other than mine rescue teams are involved in a mine emergency. These individuals would have immediate and/or delegated responsibilities which cover a broad array of activities, and directly affect the actual performance of the organization and mine rescue team(s).

The effectiveness of rescue and restoration operations is determined to a great extent by the response of the individuals who will be directing team activities and related operations. The problems associated with managing a mine emergency are apt to include the following:

1. Knowledge of emergency plans of action
2. Experience in command center functions
3. Experience in fresh air base activities
4. Knowledge of mine rescue team procedures
5. Coordination required for decision-making
6. Experience in briefing and debriefing procedures
7. Assurance of team confidence and trust
8. Guaranteed control of the rescue operation

The proficiency with which these problems are handled affects not only the efficiency of emergency rescue and restoration operations, but directly bears on the lives of possible survivors, the safety of team members, and the extent of damage to mine property.

DEVELOPMENT OF MINE EMERGENCY PREPAREDNESS PROGRAM (MEPP) MATERIALS

Three steps in the development of the MEPP materials were: 1) research, 2) organization, and 3) review and reformatting of the final MEPP guidebooks.

The initial step laid the groundwork for the content of the MEPP materials. Research into the nature of mine emergencies and mine emergency operations focused on major concerns, a range of rescue and recovery activities, and organizatonal responsibilities. For example, what are the salient objectives of an emergency preparedness program? How can the program attain an evaluation of the performances required by specific procedures to achieve those objectives? How does a mine emergency organization integrate multiple "unit" operations? Or, how can an emergency organization develop capabilities to forecast the consequences of deployment at different "stages" of emergency (i.e., incipient/early, collapsed/fullblown, and post-emergency/restorative stages)?

Mainly, the first step produced a series of outlines which determined the placement of information under various topics. These materials were arranged around two focal points: 1) the Mine Emergency Organization (MEO) and 2) the Emergency Operations Procedures (EOPS). This led to two separate modules and generated the tools for the Evaluation of Capability and an Assessment of Reliability.

The second step required terminological consistency and targeted certain gaps in the materials. Four levels of emergency response were determined: containment, notification, mobilization, and deployment. Information was organized to deal with specific actions and procedures required under each level.

With the basic structure established, a second draft of the materials was produced by March 1985. These materials, however, were contained in one volume which was bulky and not practically useful. This volume was distributed to a panel of reviewers who were veterans of numerous mine emergency operations.

During the third step, the reviews of the MEPP program were used to refine the material. Two criticisms had been that: the material was cumbersome, and the content was not concisely arranged for easy use in the mining industry.

The reformatting of the material eliminated repetitions contained in the single volume and broke the program into a set of eleven (11) modules.

MINE EMERGENCY PREPAREDNESS PROGRAM (MEPP) GUIDEBOOKS

I. PREPAREDNESS PROGRAM SYSTEM GUIDES	1. Executive Summary 2. Program Director Guide 3. Mine Emergency Organization 4. Emergency Operations Procedures
II. EMERGENCY ORGANIZATION USER'S GUIDES (MEO)	5. Rescue and Advisory Division 6. Technical/Safeguarding Division 7. Surface Support Division
III. EMERGENCY PROCEDURES USER'S GUIDES (EOPS)	8. Containment Level Procedures 9. Notification Level Procedures 10. Mobilization Level Procedures 11. Deployment Level Procedures

The program director's guidebook encompassed most of the material initially included in the introduction to the MEPP.

The workbooks (MEO and EOPS) were restructured to fit the six steps required for developing the emergency preparedness program. Also provided was a basic structure (i.e., curriculum design) for management in terms of "how to develop" a program. Thus, six logical steps were established for implementing the program, plus suggestions about how management could "tailor" the material to meet specific needs of a company, a mine or a set of mines.

The process of reformatting the material combined two divisions (e.g., Rescue Action/Advisory Divisions) into one manual and developed segments for the Technical/Safeguarding Division and the Surface Support Division. Manuals on the levels of response covered Containment, Notification, Mobilization and Deployment. Some of the organizational planning tools were contained in these separate manuals so that the user would have access to the same visual and planning guides as the program director.

Lastly, development of the Executive Summary focused on the overall contents of the MEPP materials. This manual provided a framework for organizing the complete program.

THE STRUCTURE OF THE MINE EMERGENCY PREPAREDNESS PROGRAM

The Mine Emergency Preparedness Program (MEPP) is a management tool for preparing company personnel to handle the jobs, tasks and duties required of a mine emergency operation.

The program depends on the development of a Mine Emergency Organization, and the development of Emergency Operations Procedures. It requires the regular scheduling of mocks and drills and the evaluation of response and performance.

The program can be applied to a single mine or a group of mines. The adoption of the program does not mean that management has to set up a Mine Emergency Organization separate from the company's normal operations. This program is intended as one way to organize and prepare existing mining personnel to function and respond more effectively in emergency situations. The program can help improve a company's emergency response efforts only if management supports it with a firm commitment.

Features of the Program

The preparedness program includes suggested approaches for preparing, training and organizing the personnel to be used for a mine emergency operation.

Management can use these materials to develop plans of action for security, communications and transporting equipment, supplies and personnel. MEPP contains substantial information about who and what is needed for a mine emergency operation, how and where to mobilize personnel and supplies, and what actions must be taken to secure the mine site, safeguard the operation and protect personnel. Moreover, management can use the MEPP materials to assess the company's current level of readiness. Afterwards, management can determine the scope and goals of the company's preparedness effort.

Components of Preparedness

Mine emergency preparedness consists of three components. The components of preparedness are:

1. ORGANIZATION of qualified personnel who hold responsibility for all human and technical resources needed for a mine emergency operation.

2. PLANS OF ACTION that outline the procedures for personnel to follow to control a mine emergency situation.

3. MOCKS & DRILLS involving supervisory and other mine personnel in the activities and actions of a mine emergency operation.

These components form the basis of a company's program. They serve as the focal points to organize and prepare all personnel for handling an emergency condition at a mine site.

Context for Preparedness

Mine crises provide the context for a preparedness program. The actual conditions of an emergency establish the boundaries of what a company faces at the mine site. Each emergency requires proper, immediate and correct actions to contain the problem before it gets out of hand.

Emergency actions may range from early on-site efforts, such as a section crew extinguishing a small fire, to exploration by Mine Rescue Teams in the affected area of the mine.

A mine emergency condition also forces management to halt normal production activities. This condition means that:

a. Mining personnel at the site must respond quickly as well as correctly within a matter of minutes to contain and control the emergency condition.

b. The mine's Emergency Notification and Evacuation plans must be activated to mobilize authorized personnel needed to support and sustain the mine emergency operation.

c. Management must ensure a sufficient call-up of personnel and an effective mobilization without creating confusion, disorder and congestion at the mine site.

An emergency calls for a company plan of action that lays out duties, tasks and procedures. This effort must specifically detail initial and additional actions that must be accomplished soon after discovery and reporting of the problem. To support a mine emergency operation, management may use this program to plan for other human and technical support services. These support groups, such as police and hospital units, or vendors of apparatus parts, can mean the difference between a coordinated rescue effort and confusion at the mine site.

Purpose of Preparedness

Mine fires and explosions or entrapments and inundations create a need for prompt action. Few mines have had access to an organized emergency response system -- outside of teams -- that could be activated quickly.

Mine emergency plans usually focus on the notification of personnel. Or, plans may only involve the training of Mine Rescue Teams in compliance with Federal and state regulations. However, Mine Rescue Teams alone can not control a mine emergency situation. The preparedness program provides guidance that allows for the assessment of an emergency situation before it occurs. This program helps to determine:

1. What actions mining personnel must take immediately to contain a problem at the mine site?

2. Do mine employees have the preferred skills to perform the necessary tasks properly and reliably?

3. Who should assume temporary command of the emergency effort?

4. Who is in charge of other parts of the operation?

5. What other special services does management have to call on to support and sustain rescue actions?

6. How do mining personnel obtain information and assess reports to make critical decisions?

Maintaining a preparedness program provides a measured investment in personnel who are prepared for a mine emergency operation. In this way management can depend on a smooth, professional effort, in case of an emergency situation, instead of relying on an untested Notification Plan or a series of off-the-cuff decisions. Management commitment to MEPP marks the first step toward the effective control of a mine emergency.

Goals of Preparedness

The MEPP goals address the need for management to continuously assess the readiness of a company's emergency response system.

These goals should help to ensure :

AVAILABILITY of an organized chain of command consisting of qualified persons in charge of technical, safeguarding and support units.

ACCESSIBILITY to well-trained and prepared persons who know their roles, and the company's emergency operations plans.

ABILITY of emergency personnel who participate regularly in mocks, drills and simulations that test their skills for handling a mine emergency.

Management may use the MEPP Goals as a set of guidelines to develop company goals. Management goals must be tailored to fit the special concerns of the company and its mining operations.

Company's Preparedness Policy

Management's policy directive should underscore the company's commitment and support of MEPP. The directive should define the company's purpose and reasons for the program, and should address at least the following points:

a. Long-range, intermediate, and immediate goals as well as the purpose of the program.

b. Management commitment and support for the program.

c. Appointment of a MEPP Program Director and a company planning committee.

d. Budget outlay and incentives for the program.

e. Involvement of employees in training programs.

The goals should be feasible and within the range of the organization's human and technical resources. These goals serve as benchmarks for a mine or a department to improve emergency skills steadily over a period of years.

Naming A Program Director

The MEPP Program Director holds the responsibility for the company's program. This role requires a person with managerial, operations and other skills. The program director must have the experience, the position and the authority to cut across levels of the company. The director may come from engineering, safety, training or operations.

Specifically, the program director should be a person who has:

a. A well-rounded knowledge of each department or unit within the company.

b. Enough authority to ensure cooperation and participation at all levels in the organization.

c. Earned respect of management, employees and others in mining, safety and training.

d. Good skills in management, human relations and communications.

Management must give the director full support to put the program in motion. To assist the director, management has to engage in the selection of a company planning group or committee. This effort helps to divide the workload needed to plan, organize and implement the company's program.

MINE EMERGENCY ORGANIZATION (MEO)

The Mine Emergency Organization includes qualified and skilled persons who are in charge of the resources and services needed to conduct a mine emergency operation. These persons are in charge of the "areas of responsibility" within the organization.

The Mine Emergency Organization can be described in the following ways:

a. It is a collective and orderly arrangement of authorized personnel, resources and services needed to conduct an emergency operation at a mine site.

b. It provides a structured framework for conducting all activities and controlling all actions in an emergency situation.

c. It helps coordinate surface and underground communications, including all reports, orders, information and instructions.

d. It is a well-managed and organized effort that facilitates the flow of command actions and decisions.

e. It provides management with a group of professionally skilled personnel needed to support command decisions.

f. It also depends on the availability of personnel, supplies and special services.

The establishment of a Mine Emergency Organization ensures a solid, complete and cooperative arrangement of personnel, resources and services. This effort helps to identify, organize and prepare personnel to conduct a mine emergency operation.

Emergency personnel have to be called early if a problem is not contained soon after its discovery. Without an available organized group of "emergency operations" personnel, management faces the immediate problems of disorder and confusion at a mine site.

Developing the Organization

Development of the Mine Emergency Organization is the first part of the program, and is fundamental to the company's emergency response system. Management can establish a Mine Emergency Organization in three basic steps. Each step consists of three tasks to be completed by the program director and the planning group. These steps are:

1. Develop the Mine Emergency Organization by 1) identifying areas of responsibility, 2) deciding on positions needed and assigning personnel, and 3) organizing the chain of command structure.

2. Establish the Criteria for Training and Planning by 1) planning and organizing each division of operations, 2) designing position descriptions, and 3) developing and scheduling mine emergency activities.

3. Evaluate the Capability of Performance by 1) examining organizational needs, 2) assessing individual staffing needs, and 3) revising and up-dating the chain of command.

Each step requires the use of the Director's and the Individual User's guides.

Areas of Responsibility

The MEPP User's Guides contain a complete description of the areas of responsibility in the Mine Emergency Organization. These guides describe and address the four divisions of the Mine Emergency Organization, including:

1. RESCUE ACTION DIVISION: This division includes all of the personnel who direct, assist or accomplish the actual rescue and recovery operation.

2. ADVISORY DIVISION: This division includes all personnel who help guide and assist persons-in-charge of the rescue and recovery operation.

3. TECHNICAL/SAFEGUARDING DIVISION: This division includes personnel who oversee and provide technical support and safeguarding services during the mine emergency operation.

4. SURFACE SUPPORT DIVISION: This division includes persons who help maintain and provide administrative and supportive services required on the surface during a mine emergency.

The guides can help management and other personnel to examine the needs of each division.

Each User's Guide includes planning and organizing checklists, exhibits and descriptive information organized in the following manner: 1) broad level functions, 2) typical duties and 3) personnel assessment for the position.

The materials provide information for developing position descriptions, and for establishing criteria for training. These guides help to determine qualifications for personnel who must be assigned to the Mine's Emergency Organization.

Broad Level Functions

More specifically, the MEPP User's Guides contain information on the following positions in the Mine Emergency Organization:

Rescue Action Division:	Rescue Action Director(s) Fresh Air Base Coordinator Mine Rescue Teams Additional Services Personnel
Advisory Division:	MSHA Representative(s) State Dept. of Mines Rep(s). Labor Rep(s). (if appro.) Company Representative(s) Outside/Other Specialists
Technical/Safeguarding Division:	Communications Services Health and Safety Services Mining Engineering Services (Ventilation) (Mine Maps) Electrical/Mechanical Maintenance Services
Surface Support Division:	Activity Log/Secretary Operations Security Materials Handling Food/Facility Arrangements Transportation Services Family Welfare and Accommodations Public and News Media Relations Medical Services Documentation Services Legal Counsel

In assigning personnel to positions, preparation must be made to identify and assign "back-up" or "relief" personnel. In addition, replacement forces must be anticipated so that changes in shifts go smoothly during a mock or real emergency operation. This group also provides alternative support in the event frontline personnel are unavailable or are located far from the site of the emergency.

MINE EMERGENCY OPERATIONS PROCEDURES (EOPS)

Mine Emergency Operations Procedures are the plans of action to be followed in an emergency situation. These plans apply to the "levels of response" within a mine emergency operation. The Mine's Emergency Operations Procedures can be described in the following ways:

a. They are the guidelines and plans that personnel must follow to respond quickly and properly to an emergency condition.

b. They provide a common set of practices that govern the diverse and varied activities needed for an orderly operation.

c. They are applicable to all actions taken at each level of emergency response.

d. They help mining officials implement strategies for early containment and control of an underground problem.

e. They also establish a common set of rules for training all emergency operations personnel.

f. They set the criteria for the company's emergency response planning.

An emergency condition at a mine can have a traumatic effect on a company. The establishment of concise operational procedures helps to ensure that supervisory and other personnel know exactly how to perform tasks needed to control an emergency situation.

Management must recognize the wide range of actions that must occur if an underground problem escalates rapidly. Without concise emergency operations procedures, it cannot be sure that company personnel take adequate measures to cope with a problem early and immediately.

Management also can test the procedures and evaluate the performance of personnel in a mock or drill. This effort can help management build and develop a reliable response system. The system can cover all actions ranging from the moment of discovery to the staging and deployment of Mine Rescue Teams.

Developing Plans of Action

Development of the Mine Emergency Operations Procedures is the second part of the program. This part is critical to a company's effort to contain an emergency condition before the problem turns into an out-of-control situation.

Management can establish the company's Emergency Operations Procedures in three basic steps. Each step contains a set of three tasks to be completed by the program Director and planning group. These steps are:

1. Develop Emergency Operations Procedures by 1) identifying the levels of response, 2) deciding on plans of action, and 3) organizing an Emergency Operations Procedures manual.

2. Establish the Criteria for Training and Planning by 1) planning and organizing each level of response, 2) designing emergency plans of action, and 3) developing and scheduling practical exercises, drills and mocks.

3. Assess the Reliability of Response by 1) examining the plans of action developed, 2) assessing specific needs for emergency procedures, and 3) revising and up-dating the company's Emergency Operations Procedures manual.

Each step requires the use of the MEPP Program Director's guide and the individual User's guides to each level of response.

Levels of Response

To address response levels, the MEPP Planning group uses the Program Director's Guide and the User's Guides. These guides describe and address the four levels of response in a mine emergency operation, including:

1. CONTAINMENT LEVEL: This response level encompasses all actions taken immediately after discovery of a problem from initial detection and reporting to containment.

2. NOTIFICATION LEVEL: This response level includes actions needed to identify, locate and contact emergency operations personnel after declaration of an emergency.

3. MOBILIZATION LEVEL: This response level involves actions necessary to activate the Mine Emergency Organization and to safeguard personnel and property in accordance with Federal, state and other agreements.

4. DEPLOYMENT LEVEL: This response level consists of actions necessary to conduct and support missions underground and to ensure effective control of the emergency operation.

These guides help management examine the needs of each response level separately. Each User's Guide includes planning and organizing checklists, exhibits and descriptive information. The guides are organized in the following manner: 1) broad level actions, 2) typical procedures, and 3) personnel normally involved.

The materials also provide information for developing plans of action, for establishing criteria for planning and for determining who or what is needed at each response level.

Broad Level Actions

A mine emergency situation requires different but identifiable actions to contain or control an emergency condition. The actions range from immediate detection of a problem to deployment of Mine Rescue Teams.

The MEPP guides contain information that can be useful for the development of plans of actions. They can be used for a single mine or a group of mines. The guides describe the fundamental concerns and considerations of an emergency operation.

The guides address a wide range of actions that must be taken at each level of response, including:

Containment Level:	Discovery and Reporting Early On-Site Efforts Monitoring the Situation
Notification Level:	Assessment of Situation Early Warning and Alert Declaration of Emergency

Mobilization Level:	Staging and Arrangements Rotation and Transition Immediate Actions Required
Deployment Level:	Briefing and Debriefing Decisions and Strategy Control of Operations

In developing plans of actions, management must recognize the critical decision-making points at each response level. This effort also affects plans for different shifts or for particular locations in a mine. Shift-specific and location-specific procedures can further assure the safety of mine personnel. These shift-specific plans have to address the availability of personnel and resources at different times of the day.

BUREAU OF MINES TECHNOLOGY TRANSFER SEMINARS ON MINE EMERGENCY PREPAREDNESS

The Bureau of Mines provided the support to permit the Mining Extension Service of West Virigina University to develop materials explicitly focusing on management's role in emergency preparedness. Ten workshop-style seminars were held at five (5) different locations throughout the United States to provide the mining industry with the guidelines and training materials needed to formulate and establish a comprehensive mine emergency preparedness program.

The seminar presentations covered areas such as developing emergency operations procedures, establishing criteria for training and planning, and developing programs that test a company's ability to perform in emergency situations. Eleven seminars were conducted, providing these resources to management representing coal, metal and nonmetal mining, as well as officials from state and federal agencies and representatives of insurance, legal, educational and labor organizations. (See Appendix B for participating organizations.)

Given the high marks from participants in these seminars, and the generally strong attendance by the mining industry and other officials and representatives, the new resources for dealing with emergency preparedness in the mining industry must be considered a very highly successful accomplishment.

III. SUMMARY AND RECOMMENDATIONS

The design and development of a comprehensive training program for Mine Rescue (MR) teams and a management planning tool for Mine Emergency Preparedness (MEPP) are two significant resources currently available to the mining industry to bolster its capacity to deal with underground emergencies, to promote planning and prepare personnel for emergency actions.

These rescue and preparedness programs depend on sensible plans of action, backed up by authority and the ability of qualified personnel to execute the functions of the emergency organization. An assessment of the "vulnerabilities" in a mine (potential hazards or failures in the program), a vigilant monitoring of them, and sound training to quickly execute the procedures designed to control conditions provide the underpinning for an ongoing preparedness program.

Such means for anticipatory planning are key initial steps in the development of procedures that will lead to the swift, orderly, and effective response to a mine emergency. While the first minutes after the discovery of fire, explosion, massive roof fall or any other hazard are crucial, a total emergency plan for responding to a hazard must be broader in scope, encompassing all of the steps from hazard recognition and containment to the involvement of teams in the rescue of survivors and restoration of mining operations.

Other steps, however, remain to be taken in order to support these resources as well as to meet prevailing needs in the mining industry. Our recommendations fall into two main areas: 1) immediate extensions of existing resources and 2) intermediate research and development of new resources. The following listing constitutes a checklist for further work in emrgency response planning and training.

1. EXTENDING EXISTING RESOURCES (IMMEDIATE)

Mine Rescue Team Members' Guides:

Individual guides should be prepared specifically for members of mine rescue teams. These guides should correspond to the instructional materials dealing with 30 CFR, Part 49, and must be geared to procedures, techniques, and standards required from every member to achieve effective team performance during emergency operations. These guides should be practical and useful for individuals to review mine rescue standards on their own. The format can be pocket-size or workbook size and may be accompanied by slide-tape or video supportive resources.

Surface Mining Emergency Preparedness:

Emergency preparedness in surface mining operations has been overshadowed by the attention to underground mine disasters. However, contacts made during the development of existing emergency resources confirm a vital need in this area.

This approach to surface operations can consist of some current entrapment techniques for bins, silos and hoppers and extend to an overall emergency planning system for surface mining operations. Such materials can focus on adequate plans, an appropriate emergency organization, continual assessment of procedures, and training through drills and simulations. These would be essential elements of this type of preparedness program.

Small Mines Emergency Planning:

Small mining operations have some unique concerns that require attention. With the use of existing resources, a program of preparedness should be tailored for use by small mine operators. This approach may involve scaling down the MEPP so that small mine operators, given their limited resources, can target emergency response plans at their level. Roundtable seminars and technology transfer conferences would be an extension of this approach.

Technology Transfer Seminars:

Continuation of on-going efforts by the Mining Extension Service and Federal or state agencies can serve as a bridge between some of the immediate needs for information on emergency planning and future developments. Seminars, workshops and assessment planning sessions, at this time, represent one of the most feasible ways to address emergency planning in the mining industry.

2. DEVELOPMENT OF NEW RESOURCES (INTERMEDIATE)

Training and Evaluation Methods:

Use of mocks, drills, simulations and training exercises are put forth as practical extensions of current programs to test personnel and evaluate plans of action. These demonstrations can be used to prepare mine managers, rescue teams, and government personnel for emergency operations.

However, the precise methods for evaluating such activities requires further attention. This prospect may be viewed as a "systems planning approach" to emergency operations. It may draw on existing research and developments from various disciplines modified for the mining industry.

The development of accurate evaluation and testing materials would draw on areas such as behavioral psychology, sociology, management sciences and other approaches (e.g., risk theory, control theory, systems engineering and statistics). This approach should include modifications of current efforts such as mine rescue team competitions and the MSHA-developed MERD (Mine Emergency Response Development) system, which uses role playing and video replay of decisions.

A systematic method for evaluation would allow participants to determine the effectiveness of plans, their consequences and alternative measures. By using results of comparison, mine management and other personnel can determine the capacity of a mine or a set of mines to coordinate an emergency operation, to identify accurate actions required, and to allocate human and technical resources appropriately to achieve the objectives of an emergency plan.

The value of this approach can focus on coordination of emergency operations. Coordination, in this case implies that management personnel, in charge of the operation, should know how an emergency plan develops in a step-by-step process and whether the plan is progressing successfully to complete the operation. In testing plans, participants can determine the transition in authority and responsibility, the knowledge required for the planned response, other available options, and precisely what steps must be taken to assure successful execution. The intention of this approach is not to anticipate every contingency, but to allow room for improvement in the recognition of errors or problems in emergency planning and training, especially when actions deviate from plans.

Integrated Emergency Information Systems:

A computerized system should be developed for administration of Part 49 regulations. In cooperation with MSHA (and participating states), a data system should be developed which contains information for each mine about: (1) mine rescue plans filed and approved; (2) nature and number of

formal legal agreements incorporating Federal, state and volunteer organizations (especially in regard to small mines and remote capabilities); (3) state or MSHA approved modifications to mine rescue plans; (4) certified instructors (records, skills, competencies, and participation data); and (5) description of procedures for obtaining coverage and agreements of responsibility.

In the past, MSHA has contracted to inventory team strength and hardware, and has maintained a list of "qualified" instructors, but together these listings have had limited usefulness. Any anticipated support to develop and approve rescue plans, to approve modifications, sustain up-to-date instructor qualifications, inventory capacity, allocate resources, and provide incentive for policy requires an information system available to personnel throughout MSHA districts, and between coal and metal/nonmetal administration.

In light of the present MSHA mine emergency response development (MERD), an information system could provide regional profiles about MR team strength and qualification, permit articulation of sponsoring and developmental efforts, and forecast mobilization and deployment patterns for existing and identified resources. Since informal arrangements normally adjust to or react to demands in unanticipated ways, a fundamentally sound planning effort for response to underground emergencies must be pinned to a firm data and information system.

Continuing support of research, development, and adaptation of innovative rescue techniques, practices and equipment could be extended to include emergency communications networks and innovative transportation systems which may be incorporated into regional responses and deployment. One feasibility study in cooperation with the West Virignia Department of Mines has suggested that the location of teams and stations may be allocated (statewide) to facilitate coverage using sector mapping- by employing State Travel Area Maps (STAMs)- which identify "travel time" between all extremely small geographical units.

Computer-assisted mapping and allocation of MR stations also is feasible. Furthermore, there is a need to develop communication systems, especially opportunities for long-distance, direct visual or graphic, computer-assisted analysis of mine gases, ventilation, or even recovery plans. These represent potential options or strategies not previously available during actual emergency operations. Such new departures will require a vigorous commitment, and steady design to determine reliable procedures and tactics.

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APPENDIX A. Instructor Qualification and Program Evaluation: MSHA Responsibility for Part 49 Implementation.

Adoption of the new instructional materials by MSHA meant that this program would be the core of team training work. Elsewhere in MSHA a program was underway to improve its Mine Emergency Response Training (MERD). However, MSHA also had to develop a cadre of personnel to certify team instructors, review programs and prepare for formal, cooperative relations with the mining industry that were related to Part 49.

In late 1982, after "realignment" of Education and Training (MSHA), John English requested (supported by Joseph Lamonica, Administrator for Coal Mine Safety and Health) that West Virginia University's Mining Extension Service (WVU -MES) cooperatively establish a seminar focused on preparing MSHA personnel to deal with agency responsibility pertaining to 30 CFR, Part 49 regulations. Considerable effort was invested into the program. Working with MSHA, five specific objectives were established for a 3-day workshop to be conducted by MES personnel. The workshop was conducted in April, 1983, and was to prepare each participant:

1) to conduct 20 hour initial MR Training,
2) to conduct 40 hour Advanced/Refresher MR Training,
3) to qualify mine rescue instructors,
4) to review Mine Rescue Training plans and and materials for approval, and
5) to provide interpretation of Part 49 implementation.

The Mining Extension Service also recommended that each coal district manager should clarify the responsibilities for each participant sent to the workshop. A total of 22 persons attended. The mine rescue background of the participants varied greatly: some had actual mine rescue experience, others' mine rescue involvement was purely contest related, and a few had no mine rescue background at all.

All of the participants volunteered to become involved in each phase of the workshop, and the interaction that was achieved enhanced the program goals. In order for the established objectives to be achieved, the participants felt that continuing support would be needed from senior MSHA administration. This would be necessary to achieve the objectives of the seminar as well as the mine rescue duties and responsibilities that they would be expected to perform in their respective districts.

The initial activity focused on the functions and duties that participants anticipated they would perform in regards to Part 49 regulations. Table A.1 shows the duties these participants expected to perform, from primary duties (those judged as essential) to nominal (token) activities. Although none expected to perform all these duties, the frame of reference was fairly consistent among participants, and only eroded for various nominal level responsibilities, in which case actual experience played an important part (e.g., those in the group with the widest experiences had occasionally performed these activities). Results were fed back to participants, and were also reported to district and other key MSHA administrators in order to encourage a common definition of functions for the agency.

Instructor Qualification.

The seminar was composed of two workshop sessions. Two "nominalizing" tasks were incorporated into the workshops in order to expedite participation, and elicit personal experience and knowledge.

The first session was designed to examine instructor qualifications and to determine criteria for assessing mine rescue capabilities of instructors. The initial task statement used to direct participant efforts during the workshop session was stated as follows:

> " List the skills, abilities, qualities and traits that you consider important for qualification as a mine rescue instructor. "

Following the nominalizing format, the "round robin" generated 48 statements, and the clarification process provided a final battery of 14 skills and abilities statements. Each workshop participant then evaluated these 14 statements (selecting the top five statements) and a priority list was produced. The final eight items which were retained are the following (in rank order):

1. Principles and procedures of rescue and recovery;
2. Teaching and evaluation skills;
3. Leadership;
4. Mine Rescue Experience;
5. Knowledge of and experience in the use of SCBA's;
6. Mining Experience;
7. Knowledge of mining methods; and
8. Knowledge of mine rescue contests and contest rules.

Table A.1. Part 49 Functions and Responsibilities of MSHA Personnel.

Primary Functions: Review & Evaluate	Mean Value [a]
Qualify mine rescue (MR) instructors	5.32
Train industry MRT instructors	5.27
Interpret Part 49 for mine operators	4.91
Review MRT training plans	4.61
Monitor MRT training	4.60
Participate in MSHA's MRT training	4.60
Secondary Assignments: Train & Assist	
Conduct inspections of MRT stations	4.45
Instruct MR contest judges training	4.36
Judge MR contests	4.36
Conduct MR team training (on request)	4.23
Conduct simulated MR training for MSHA inspectors	4.20
Coordinate with state MR teams (were organized)	4.18
Assist industry in developing training programs	4.08
Tertiary Activities: Direct & Maintain	
Direct MR contests	3.91
Plan MR contests	3.73
Instruct industry in contest rules	3.73
Maintain apparatus & equipment for MSHA district MRT	3.42
Train MSHA district MR teams	3.00
Team captain district MR team	2.50

[a] Each participant was asked to score each function on a scale from 6 (essential) through 3 (important) to 0 (never perform); the reported values represent the average ranking for each function.

An assessment of these eight characteristics conducted during the workshop showed that leadership qualities as well as one's mine rescue background and mining experience may and can be evaluated directly from a personal resume and other requested career background information which should be submitted to MSHA by the person requesting instructor qualification. Any MSHA reviewer who is assigned the responsibility to qualify instructors should be prepared to recognize those relevant personal and career development patterns, as well as any other activities related to the applicant's management and teaching experience that would support the qualifications of the applicant. Thus, 3,4,6 and 7 can be evaluated from application information submitted for review to district or sub-district offices.

With regard to knowledge of Mine Rescue principles and procedures (#1) and apparatus experience (#5), explicit standards and performances were specified, and workshop participants recommended that such standards should be employed systematically throughout MSHA districts in order to assure nationally comparable instructor qualification in mine rescue. Logistically and technically, MSHA will need to establish the appropriate resources and provide an adequate evaluation facility in its various districts to permit the testing and hands-on activities in an equitable way. Its instructional staff at the Academy should provide the resources for updating and distributing both materials and MSHA personnel assigned to Part 49 enforcement, perhaps in fashion similar to the agency's current investment in rescue contest preparation and participation.

The following outline is a summary of the workshop session on instructor qualifications in relation to MR principles, SCBA's, and evaluation criteria. The first column, in Table A.2, identifies the key principles, column two addresses information that is minimally required for qualification, and the third column deals with performance skills basic to instructor qualifications. For example, "knowledge of gases and use of detection equipment" are recognized competencies that must be exhibited by every instructor. Each instructor would be required to correctly address questions/problems dealing with effects on humans and the explosive consequences of gases. Demonstrated performance is displayed by producing a "good" test of a gas(es) and through the ability to communicate it correctly.

The question of disqualifying a candidate as a mine rescue instructor received considerable attention from workshop participants. Instructor status should not be awarded simply on the basis of underground mining experience and claimed MR background. Workshop participants strongly recommended that certification of mining industry candidates should be based on a case-by-case investigation so that at least, minimally, the

Table A.2. TASK 1 RESULTS- Criteria for Certifying MR Instructor Qualification.

PRINCIPLE OR PROCEDURE	CRITERION OR STANDARD	PERFORMANCE OR SKILL
Uses and Care of Self-Contained Breathing Apparatus		
• knowledge of SCBA's (those appropriate to MR team)	know how come each test must be made for appropriate SCBA know equipment malfunctions/ failures & solutions for them	correctly test & wear SCBA demonstrate correct procedures for maintaining SCBA
MR Principles and Procedures		
• knowledge of gases and uses of detection devices	knowing the effects of different gas concentrations on humans knowing the explosive concentrations of gases	performing gas tests - (CH_4, O_2, CO)
• knowledge of ventilation and ventilation systems	understanding the fundamentals of airflow knowing how air is controlled (pressure losses, splitting air, leakage losses) knowing how mine drainage is controlled	controlling ventilation within a mine section (pencil & paper)
• knowledge of sealing and of unsealing affected areas	understanding the functions of air sampling knowing the fundamentals of unsealing during recovery	taking air samples correctly
• knowledge of mapping	understanding the functions of recording evidence and of noting victim locations	correctly marking and reading map of affected mine area

PRINCIPLES OR PROCEDURES	CRITERION OR STANDARD	PERFORMANCE OR SKILL
• knowledge of firefighting procedures & equipment	knowing how to fight fires directly	erect temporary/permanent seals correctly
• knowledge of mine exploration	knowing how mine fires are controlled (sealing, wetting agents, loading out)	work in smoke
		correctly control fires involving obstacles
		select correct equipment to fight different kinds of fires
	understanding the fundamentals for locating & establishing the FAB (fresh air base)	use signals and lifeline correctly
		tie-in & travel properly
	understanding the reasons for MR backup and standby teams	report conditions, locations, & activities of MRT accurately
• knowledge of surface emergency organization	knowing how a command center and FAB functions to direct MR team missions	obtain appropriate information by conducting a debriefing
	knowing the purpose and process of briefings and debriefings	
	understanding team schedules & rotation cycles	correctly select and equip a MR team for an assigned task or mission
	knowing procedures for securing transportation, communications equipment, and supplies	
• knowledge of survivor rescue	knowing correct procedures for opening barricades	correctly attend to survivors and to victims
	understanding the "triage" system	correctly perform first-aid

purported experience could be verified by MSHA. Coupled with qualification tests addressing apparatus skills(#5) and rescue procedures(#1), participants felt that a far greater reliability would be introduced into the emergency and protective capacity of the mining industry.

Finally, workshop members proposed a "two-step" instructor qualification: a) provisional- which would permit an individual to assist in training, based on demonstrated knowledge of MR principles and a thorough knowledge and satisfactory performance on the SCBA, and b) fully qualified- which would permit a person to develop and direct a mine rescue program, based on one's background experiences as well as required on-site evaluation of the program by MSHA.

Provisional and full qualification recognized what in fact does occur in MR team training; namely, activities are executed by team "captains-trainers" with occasional direction from the designated MR instructor in the organization. Although two-step qualification is not current policy, workshop participants believed that team performance and company support for emergency organization and rescue training could be enhanced both through the promotion of a strong program review and a two-step qualification which would permit instructor development to be undertaken with MSHA guidance.

Elements of Training Programs.

The second task follows the presumption that candidate credentials and MR skills and knowledge will be evaluated to obtain qualification for instructors. The task was initiated with the following statement:

> " List the important elements that need to be included in training programs to ensure sound mine rescue team preparation. "

The "round robin" produced 47 items, which were reduced to eight general statements about training programs, and were grouped into 3 components requiring reviewer evaluation. These are:

1. Instructional and evaluation skills ;

2. Comprehensive coverage of material providing information on: a) initial training (20 hours); and b) advanced/refresher training (40 hours annually); and

3. Management emergency preparedness planning.

Qualification of instructors follows from TASK 1, but the materials coverage and management commitment depend to some extent on the knowledge and experience of both instructors (developing the program) and reviewers (responsible for recommending and approving the program). Results of TASK 2 are specified through content objectives as well as by how management budgets support and participation .

Instructional and evaluation skills may be indicated by how the instructional program is designed to incorporate discussion, demonstration, exercises, and skills performance into consistent lessons. For example, How are the concepts and ideas taught? How is equipment selected and used to bolster preferred performances for individuals as well as teams? How well do handouts and visuals incorporate training objectives?

Specifically, the competencies of a "quality" instructor would be:

1. demonstrating procedures to show team members how to perform prior to attempting a task or an activity;

2. specifing standards of performance (strong verses token effort), and appropriately rewarding individual and/or team effort (use of inducements and application of penalties);

3. establishing an appropriate pace of work for the tasks and activities assigned to teams and individual members (ties pace and effectiveness together);

4. developing explicit task and skill rating procedures for individual and team exercises; and

5. identifing how immediate objectives and activities are related to a schedule of intermediate team goals (e.g., annually) and longer-range programs (mine emergency response programs).

The next component dealt with management investments. Management commitment to emergency preparedness and to mine rescue training may be spelled out through provisions indicating:

1. management participation, including review of:
   a) emergency organization planning with instructors;
   b) training standards for team performance objectives, and
   c) an established schedule of management's participation in activities and practical exercises.

2. quality control for MR personnel by a) supporting recruitment programs, and b) physical fitness standards.

3. budgeting dependable financial support for:
   a) suitable training facilities, on-site (classroom, storage, cleaning and maintenance), and off-site (e.g. fire training);
   b) maintaining, upgrading, replacing equipment and supplies ;
   c) equitable compensation and incentives for MRT members and trainers; and
   d) contest preparation and participation.

Finally, the evaluation of a mine rescue training program must key on up-to-date material, including visual (video, slide-tape) and bibliographic resources, and correctly designed, step-by-step procedures.

Initial training (20 hour) materials must provide information that:

1. promotes the history, functions, and duties of mine rescue ;

2. identifies the laws and regulations governing mine rescue teams;

3. defines the objectives of mine rescue work;

4. establishes the mine rescue team concept and associated tasks ;

5. identifies the team composition and member's roles;

6. specifies the qualifications for team membership;

7. defines the basic types of SCBA's, their use and maintenance ;

8. specifies the proper use and maintenance of Draeger BG174-A (or appropriate apparatus);

9. identifies the basic characteristics, components, applications, and regulations of auxiliary SCBA's.

The advanced/refresher (40 hour) materials need to provide information that:

1) identifies the components of an effective mine rescue and recovery surface organization;

2) specifies the facilities, personnel and duties involved in surface organization;

3) identifies the properties and characteristics of gases encountered during rescue and recovery work;

4) establishes the tests and the uses of gas detection devices;

5) specifies basic mine ventilation methods and control procedures;

6) establishes the uses of air measurement devices;

7) establishes the procedures for mapping and the functions of mapping;

8) defines the fundamentals of explorations and identifies related communicating, traveling, and testing procedures;

9) identifies the procedures for assessing underground fire conditions and techniques for controlling fires;

10) identifies the causes and effects of explosions;

11) specifies the procedures for rescuing survivors and recovering victims;

12) defines the procedures for opening barricades; and

13) establishes the procedures for recovering and restoring disaster areas.

The workshop produced a set of standards which could be a basis for the qualification of instructors and review of any program dealing with Part 49. Strong administrative support is imperative to legitimize these standards and to improve the practice and preparation of mine rescue teams.

Recommendations for MSHA Mine Rescue Training Assistance

The Mining Extension Service made three recommendations to to deal with underground mine rescue instruction and to aid in the development of the program. These recommendations were as follows:

First, MSHA personnel who are responsible for training, qualifying, and certifying the mine industry's rescue team instructors should receive at a minimum the NMS "benchman's" training program on the Draeger BG 174-A SCBA. As a rule, the "benchman" role and practices should be encouraged throughout the coal industry as a feature of Mine Rescue team readiness. This recommendation is based on results from the "hands-on" experience with the BG 174-A among MSHA personnel participating in the workshop.

Second, the basic qualification of mine rescue instructors must provide evidence of: a) thorough knowledge and use of the appropriate SCBA, and b) knowledge of the fundamentals of mine rescue and recovery principles and procedures.

Workshop participants considered these to be the minimal requirements for any instructor qualification. Specific minimum standards and related performances were spelled out in relation to TASK 1 of the workshop.

Finally, third, a policy memorandum addressing MR training program requirements should specify that the material used for any training program must include the currently approved MSHA materials (WVU-USBM modules and materials).

A definite standard for training material contents must be established for program review, especially for the review of alternative training materials. Workshop action on Task 2 indicated key elements which need evaluation during program assessment and monitoring.

APPENDIX B. Mine Emergency Preparedness Technology Transfer Seminar Participants.

Organizations with representatives participating in the Mine Emergency Preparedness Program (MEPP) Bureau of Mines Seminars conducted at five sites (Beckley, West Virginia; Denver, Colorado; Pittsburgh, Pennsylvania; St. Louis, Missouri; and Tucson, Azizona) are identified according to a) mining industry, b) private industry, c) state or federal government, and d) educational institutions. More than one hundred organizations were represented at these seminars.

MINING INDUSTRY FIRMS:

Allied Chemical
Alabama By-Products Company
American Electrical Power
Arch Minerals
Asarco
Belfry Coal Company
Beth Energy Mines, Inc.
Boeing Petroleum Services
Chevron Resources Company
Climax Molybdenum Company
Consolidation Coal Company
Cotter Corporation
Drummond Corporation
Cyprus Industries Minerals
Duquesne Light Company
Eastern Associated Coal
Emerald Mine Company
Emery Mining Company
Empire Energy Corporation
Exxon Mineral Corporation
Freeman United Coal Mining
Gateway Coal Company
Harrison Western Corporation
Homestake Mining Company
Inland Steel Coal Company
International Salt Company
Interstate Coal Corporation
Island Creek Coal Corporation
Marrowbone Development Company
Mathies Coal Company
Martin County Coal Company
Mississippi Lime Company
North American Coal Company
Pammlid Coal Company
Paramont Coal Corporation
Peabody Coal Company
Pea Ridge Iron Ore Company
Penn Allegheny Coal Company
Pennsylvania Mines Corporation
Pittston Coal Group, Inc.
Plateau Mining Company
Pratt Mining Company
Pyro Mining Company
Quarto Mining Company
Ranger Fuel Group, Inc.
Richland Construction, Inc.
Rochester and Pittsburgh Coal
Saskatchewan Mining, Ltd. (Canada)
Shannopin Mining Company
Southern Ohio Coal Company
Stillwater Mining Company
St. Joe Minerals
Western Fuels Associates, Inc.
Texasgulf Mineral and Metals
Tuscaloosa Energy Corporation
USG Industries

Jersey Miniere Zinc
Kaiser Coal Corporation
Kerr McGee Coal Company
Kitt Energy Corporation
Lion Coal Company
Mapco Coal Corporation
Magma Copper, Inc.
U.S. Gypsum Corporation
United Coal Company
Valley Camp Coal Company
Westmoreland Coal Corporation
Wilberg Mining Company
Windsor Power House Coal
Wolf Creek Collieries

PRIVATE FIRMS:

American Mine Services, Inc.
Carson Consultants
GREFCO, Inc.
J.M. Huber Corporation
Ketron, Inc.
Mine Safety Appliances, Inc.
National Mine Service Company
Tech Enterprises, Inc.
Central Mine Rescue Association
Azizona Small Mines Association

GOVERNMENTAL AGENCIES:

Mine Safety and Health Administration - MSHA
State of Arizona
Colorado Division of Mines
State of Illinois
Louisiana Department of Energy
Montana Bureau of Mines
Pennslyvania Deep Mine Safety
West Virginia Department of Mines

COLLEGES:

Colorado School of Mines
Lawrence Livermore Laboratories
University of Missouri
Eastern Oregon State College
Penn State University
College of Eastern Utah