

Mine rescue training facility inventory – compendium of ideas to improve US coal mine rescue training

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Abstract

In response to recent mining disasters and new mine rescue team legislation, NIOSH researchers conducted meetings across the United States with mine emergency response experts to investigate current needs and issues. Some of the issues include emergency response preparedness, mine rescue contests, real-life training capabilities and training facilities. Many new teams are being formed that must be trained for mine rescue team competitions as well as be ready to respond to a variety of mine emergencies, including a fire or explosion, a massive roof collapse, mine inundations or vertical shaft rescue situations. Therefore, it is important that these teams are adequately prepared and trained. This paper presents a summary of domestic and international coal mine rescue training facilities and identifies those that provide unique, real-life and/or state-of-the-art training. Research findings from this report will be used in further NIOSH investigations to improve coal mine rescue training.

Key words: Mine rescue, Health and safety, Coal mining

Introduction

When lives are in danger, mine emergency response systems must function rapidly and competently. The hierarchy of response actions begins with self-escape and then first responders and/or fire brigades and finally mine rescue teams. If there is a breakdown in self-escape and first responders are not successful, then the deployment of mine rescue teams, under control of incident command centers, is necessary for a safe rescue to be accomplished.

Emergency situations requiring mine rescue teams are high-consequence, low-probability events. Although the mining industry's goal has always been to reduce this probability with advanced technology, coal mine legislation and proactive injury prevention techniques, the probability may never be reduced to zero at every coal mine in the United States. Mine rescue team members, just like firefighters, accept some personal risk to save the lives of others. "So Others May Live" has become a fairly common motto for coal mine rescue teams across the United States. Therefore, to minimize risk, it is essential that these teams and incident command staff are fully equipped with state-of-the-art technology, are professionally trained at keeping team safety as the number-one priority and receive guidance from only the best available mine emergency response experts.

The Mine Safety and Health Administration (MSHA) developed the Mine Emergency Response Development Drill (MERD) program to improve command center performance during mine emergency situations (Mott and Snyder, 1993). In the 1990s, MERD exercises were conducted frequently at

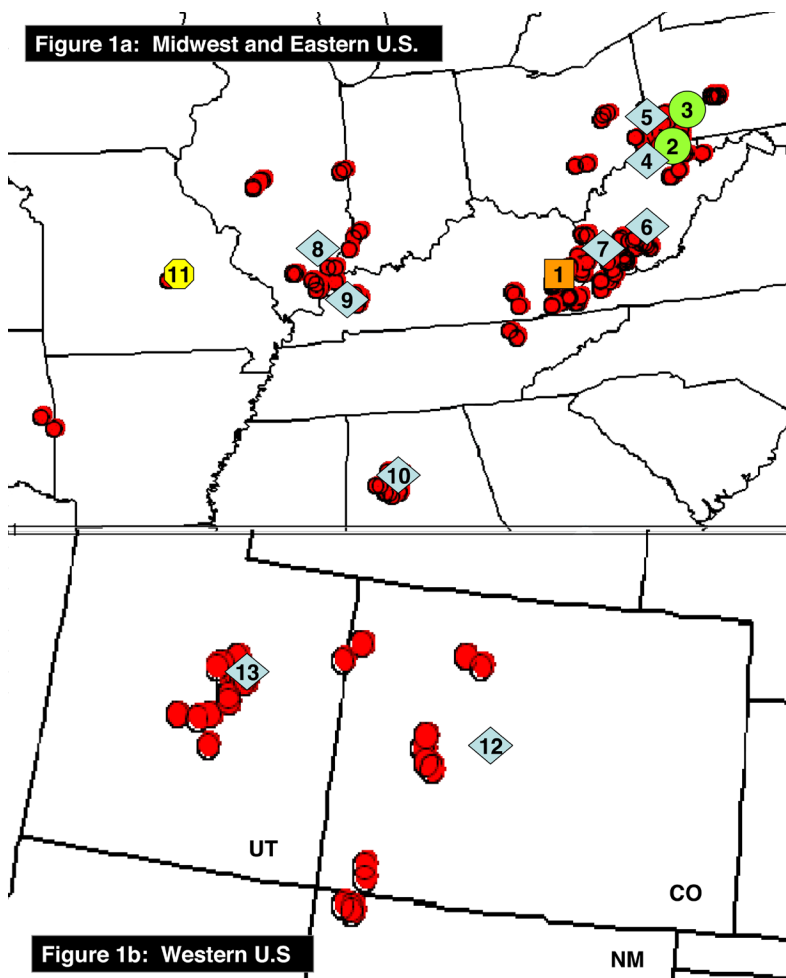
MSHA's Mine Simulation Lab, as well as offered by coal companies and state mining agencies. They most often included the participation of mine rescue team members, but over the years, these MERDs have become less frequent. However, this powerful training tool is starting to gain popularity once again, with more MERDs being scheduled for 2009 and 2010. The National Institute for Occupational Safety and Health (NIOSH) has also developed, over the past 10 years, some effective methods of simulated emergency response training that have received positive responses from mine rescue and fire brigade team members. However, these exercises require mine-like environments to be effective (Conti et al., 1998).

Mine rescue issues and concerns

From December 2007 through March 2008, NIOSH conducted seven stakeholder meetings across the United States to investigate the present issues, concerns, barriers and suggestions for improved mine emergency response. Seventy-one coal mine emergency response expert practitioners and trainers, mostly from industry, participated. Numerous issues emerged, including the current need for more emergency response preparedness training, a disparity in standardization of skills and equipment, incident command shortfalls between teams and the command center, the desire for more realism for mine rescue contests and rules and a shortage of available mine rescue training facilities.

Similar issues were addressed in the December 2006 Mine Safety Technology and Training Commission Report, spon-

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Legend for Figures 1a and 1b:

- Government Research Facility
- Privately-Owned Facility
- ◆ Public Facility
- ⬡ Academic-Only Facility
- UG Coal Mine Rescue Teams

Training facilities and team numbers as of December 2008

Figure 1 — Locations of all the underground coal mine rescue stations and 12 mine rescue training facilities across the United States: a) eastern US and b) western US.

sored by the National Mining Association (NMA), where the following findings and recommendations were made (2006):

- “MSHA should establish criteria for the development and use of contest problems to ensure that time to complete a problem, which is easy to assess during a competition, should not displace other important skill-based performances as primary contest objectives. Likewise, contest problems should emphasize functions that teams will likely be called to perform during an emergency.”
- “MSHA, NIOSH, state agencies, industry and the mine rescue associations should collaborate to conduct a system-wide assessment of teams’ locations, availabilities and capabilities....”
- “Create a federally-sponsored national mine rescue academy for the purpose of building a national community of policy and practice.... Its main role would be to offer resident and distance learning courses and programs that would enhance and standardize the training and capability of mine rescue team members. It could also

help to identify and disseminate lessons learned and best practices, to facilitate promulgation of standards for teams, to develop standard teaching curricula and to collaborate with universities to conduct advanced or specialized training for mine rescue personnel.”

- “Federal and state government agencies and industry should partner to develop more joint training facilities that provide realistic environments.... These should be located to be accessible to teams nationwide.”

This paper provides an inventory of coal mine rescue training capabilities and facilities across the United States and in several other countries. It contains a list of every major coal mine rescue training facility in the United States, as well as most of the smaller training facilities where coal mine rescue training is being planned, enhanced or has major potential to be expanded. The purpose of this research was to identify practices in the United States and around the world that could improve the current underground coal mine rescue system.

United States – coal mine rescue training facilities and practices

The mine rescue stations for the 170 underground coal mine rescue teams registered in the United States are displayed in Figs 1a and 1b as red dots (Mine Safety Technology and Training Commission, 2006). Also shown are thirteen facilities that focus on mine rescue training, offer some real-life training activities or have a unique training feature that could enhance current coal mine rescue training (as of December 2008). Each of the numbered facilities is discussed in more detail below.

This list of training facilities does not include museums, fire departments, mine rescue stations or institutions that predominantly offer new miner and refresher training, and other specialized coal miner training (coal mine rescue training options are either non-existent or minimal). Also not listed are some academic and government facilities

that primarily service metal/nonmetal mine rescue teams, including the New Mexico Tech’s Waldo Mine, University of Arizona’s San Xavier Mine and the Waste Isolation Pilot Plant in Nevada. Finally, a few coal companies have built their own facilities in active or idle mines or buildings. Except for one particular privately-owned facility with a very unique feature, these facilities are not included in this report. No attempt to understand the adequacy of the coal mine rescue training offered or of curricula was attempted in this research. Methods for assessing competencies of individuals, teams and incident-command structures are beyond the scope of this investigation.

Eleven of these facilities are located in the Midwest and eastern states (Fig. 1a) and two are located in the West (Fig. 1b); they vary in training capacity and capabilities. One of these facilities is privately owned (orange square) and is not available for public use. Two are government research facilities (green circles) that have very limited availability for anything beyond training research. One other facility is an academic institution (purple hexagon) that is rarely available for public use. The other nine facilities (blue diamonds) are available,

schedule permitting, to all mine rescue teams.

The numbers in Fig. 1 correspond to the following list of coal mine rescue training facility names and descriptions.

1. Buchanan Mine Rescue Training Facility, Consol Energy Inc.; Grundy, VA (<http://consolenergy.com>). Formerly the central maintenance shop of Island Creek Coal Company, the Buchanan mine rescue team began converting this building into a one-of-a-kind, all-weather mine rescue training facility in 2007. It is privately owned and not available for public use.

Figure 2 shows the most unique feature in this facility – the indoor mine rescue twin practice fields that are each three entries wide and five entries deep. The practice fields have coal blocks painted on the floor that are 4 × 5 m (14 × 16 ft) wide. This area is large enough to allow two teams to practice for contests simultaneously. Being able to utilize this field all year long and during bad weather creates an efficient training schedule.

This facility also includes a 33.5-m- (110-ft)- long smoke maze, where team members explore and navigate around obstacles in a simulated mine environment in which vision is highly compromised. Other features of this facility include a mine rescue equipment and benching room, first aid station, multiple classrooms (annual eight-hour refresher, electrical, smoke and new miner training, as well as other specialized training) and creative mine rescue artwork. Specialized fire fighting and foam training are not currently conducted at this site. However, plans are being discussed to build an outside fire gallery for first responder training and advanced fire fighting for mine rescue teams.

2. NIOSH Lake Lynn Laboratory, Lake Lynn, PA (<http://www.cdc.gov/niosh/mining/>). This government research laboratory consists of an underground limestone mine, a surface quarry area, fire galleries, offices and laboratory buildings. Because it is primarily used for NIOSH research projects, it is not publicly available for mine rescue training exercises, except for projects where mine rescue teams are used to test new technologies and procedures. The simulated coal mine portion is designed to match the shape of a three-entry, 427-m (1,400-ft) long production section, with entries 2 m (6.5 ft) high by 5.5 m (18 ft) wide. The outdoor fire gallery (Fig. 3) and fire suppression gallery simulates an underground belt entry and is used to teach basic and advanced fire fighting skills in confined spaces. There is also a mine fire preparedness facility in the upper quarry, consisting of concrete burn pads where mine rescue team and fire brigade members can learn how to extinguish gaseous, liquid and solid fuel fires, evaluate firefighting tactics, and handle fire extinguishers and high expansion foam, while researchers study ways to optimize the training methods.

3. NIOSH Bruceton Coal Mine, Pittsburgh Research Lab; Bruceton, PA (<http://www.cdc.gov/niosh/mining/>). There are actually two adjacent mines at this location, the Safety Research Coal Mine (SRCM) and Experimental Mine, which are used to support health and safety research for mine workers. The Experimental Coal Mine, currently not available to the public, consists of two drift entries and multiple rooms with concrete floors driven into the Pittsburgh coal seam. It was created to support full-scale mine ventilation, fire and explosion tests. There are two areas specially designed to handle large fires without risk of the coal seam catching on fire.



Figure 2 — The indoor mine rescue contest practice field at Consol Energy's Buchanan Mine training facility.



Figure 3 — NIOSH LLL outdoor fire gallery (simulated belt entry) showing two teams extinguishing a fire.

The SRCM is a conventional room-and-pillar operation approximately the size of a large working section of a coal mine and is utilized for mine health and safety research in areas such as ground control, ventilation, fires, emergency response, materials handling, communications, remote sensing and drilling and environmental monitoring. This research mine also has a reversible fan, water hydrants, electric power and compressed air. Although it is not publicly available for regular use, the real-life environment makes it an attractive place to conduct mine rescue and fire brigade training research, including a variety of smoke-training exercises and mine emergency response development (MERD) drills. The MERD incident command center, shown in Fig. 4, is located next to the mine and includes communications and mine rescue team staging areas.

4. West Virginia University (WVU) Mining Extension and Outreach, College of Engineering and Mineral Resources, Morgantown, WV (<http://www.cemr.wvu.edu/eandomining>). WVU maintains two training centers: classrooms and administrative offices are located on the WVU Evansdale campus and hands-on, new-miner and mechanic training facilities located at the Emergency Preparedness Center Doll's Run portal facility located about 10 miles away. Training is also conducted at the MSHA Academy in Beaver, WV. A notable portion of the training is geared towards preparing individual coal miners to handle mine emergency conditions, to protect



Figure 4 — MERD incident command center exercise at the NIOSH Bruceton Coal Mine.

themselves and to take action. WVU believes that every miner, fire brigadesman and mine rescue team member should have, at a minimum, first responder training.

Much of the first responder training is conducted at mine sites, for convenience to the mine operator. Two unique mobile training units are deployed to mines or remote locations. One specially-designed vehicle, named “The Truck” (Fig. 5), is equipped with a changeable three-tiered smoke maze that is used to build confidence among miners while wearing SCSRs or SCBAs in confined-space drills. It consists of a series of movable partitions and swinging doors. The temperature and visibility can be adjusted to simulate the heat and smoke from a fire. Practical hands-on extinguisher and hose experience can be provided by the use of remotely-controlled fire pans in the mine yard. First-responder and firefighting training are also offered at the MSHA Academy.

Major construction of a simulated mine is underway at the Doll’s Run facility. The mine is being built with steel construction, contains three entries, seven crosscuts and an overcast area and is equipped with a mobile mine fan. The mine layout will be adjustable and real-life fire fighting will be conducted within the mine. The facility will be used to accommodate the needs of local mines for new miner training, smoke training, firefighting and specialized mine rescue training and should be available in the fourth quarter of 2009.

5. Mining Technology and Training Center (MTTC), UMW Career Centers, Inc., Ruff Creek, PA (<http://www.umwacc.com>).

The MTTC facility is located north of Waynesburg, PA, in a large building (formerly a mine portal) with classrooms and

a temporary outdoor simulated mine maze built out of brattice curtain walls and tin roof materials. This facility provides opportunities for hands-on and smoke training and room for expansion on the 25-ha (63-acre) property. The majority of training today is designed to meet the needs of inexperienced coal miners and mechanics, and to provide mine examiner/foreman training. Construction of an expansive simulated mine, funded by a Commonwealth of PA grant, with similar capabilities as the Mine Simulation Laboratory at the MSHA Academy, is in progress and will include fire pits and a burn tunnel. The simulated mine will have six entries and seven crosscuts, making it large enough to train multiple teams at once. Some areas in the mine will be hardened, so that team members can experience building ventilation controls and installing roof supports under apparatus; other areas will have the flexibility to simulate a range of coal seam heights and will be equipped with hidden overcasts that can be pulled down from the roof when needed. The current and future facilities are available for public use.

MTTC plans to conduct the following mine rescue training exercises: MERD contests, exploration and navigation techniques in smoke and various classroom courses, including first aid, mine systems and ventilation and basic mine rescue skills. High-expansion firefighting foam, confined space, heavy object removal and incident command center training will also be offered. Future plans may include an indoor mine rescue contest field and a virtual-reality training theatre.

6. The Mine Simulation Laboratory (MSL), National Mine Health and Safety Academy, Beaver, WV (www.msha.gov). The MSL is one of seven complexes at the MSHA Academy that are available for public use. It contains a 4,500-m² (48,000-ft²) building designed to simulate coal and metal/nonmetal mines and has an outside burn area. It is available for public use and in 2008 it began operating on the weekends in order to keep up with the increasing demand for mine rescue training.

The lower floor of the building, shown in Fig. 6, simulates a typical room-and-pillar coal mine, with four entries and nine crosscuts (Dept of Labor, MSHA, Mine Simulation Lab 2008). The burn area, on one end of the building, includes an incombustible burn tunnel and concrete pads. Mine rescue training includes problem solving and first aid classroom courses, numerous outdoor firefighting drills, exploration and navigation in poor visibility and other exercises where team members conduct hands-on mine rescue tasks, including the construction of temporary and permanent ventilation controls while under apparatus. Other noteworthy features of this complex are dormitory space for 320 people, classrooms and laboratories that can accommodate 600 students, a cafeteria,



Figure 5 — WVU Mining E&O’s mobile unit (The Truck) for first responder training in a smoke maze.

library, auditorium and wellness facilities.

The Mine Emergency Operations (MEO) Building and Mine Rescue Station is located next to the Mine Simulation Laboratory. The mine emergency command vehicles, office trailer, rescue capsule, ATV, emergency generators, and water pumps are housed in this building. Also, the mine rescue station for MSHA's Mine Emergency Unit (MEU) is located inside and contains a full complement of equipment for mine rescue/recovery. The MSHA's MEU has mutual aid agreements with the Federal Emergency Management Agency (FEMA), Occupational Safety and Health Administration (OSHA) and the U.S. military. They also utilize a neighboring facility where they partner with The International Union of Operating Engineers (IUOE) to provide HAZMAT and Disaster Site Worker Training. MSHA's mine rescue resources could be used to respond to local and nationwide disasters.

7. Academy for Mine Training and Energy Technologies, Southern West Virginia Community and Technical College (SWVCTC), Logan, WV (<http://southernwv.edu/mining>). The Academy at SWVCTC offers academic and certification programs to the public, along with specialized coal mine rescue training conducted on campus, at a local underground coal mine, at a firefighting area, in a trailer equipped with virtual-reality computer-based simulations and in a simulated coal mine. The downtown facility is designed to simulate underground coal mines, with low-, mid- and high-seam heights. It provides trainees the opportunity for hands-on training in a realistic environment. There is even a hoist elevator that is used for transportation and mine shaft evacuation training.

Mine rescue training exercises include navigation in smoke and water hazards, confined space rescue, advanced medical training, rapid transportation of injured miners and the use of new mine rescue technology, including exploration in poor visibility with thermal imaging cameras. Outdoor burn pads and a fire gallery are used for specialized firefighting training. This facility also utilizes state-of-the-art 3D computer simulations, where trainees can be immersed in real-life situations, without exposure to hazardous conditions.

SWVCTC places a heavy emphasis on incident command and mobilization of emergency assets and integrates this expertise into mine rescue training in the form of MERDs. This facility operates an on-call 24/7 fleet of five mine emergency response and support vehicles that is partly funded by the state of WV. Given the name Task Force 1, they are specially designed to provide communications, rescue and fire service to mines in very remote locations. Rescue equipment includes light towers, rescue jaws and cutters, 816-t (900-st) airlift bags, technical rope equipment for vertical rescue, self-contained breathing apparatus (SCBA), portable power systems and medical equipment. The Mobile Communications Unit (Command 1), shown in Fig. 7, is equipped with 12 computer workstations with fax/copy/scanner capabilities, a GPS and three satellite communication systems, MSHA-approved radio systems, a portable weather station and helicopter landing-zone equipment. It can be used as an incident command center at any location that is accessible by a bus.

8. RLC Coal Mining Training Center, Rend Lake Community College, Ina, IL (<http://www.rlc.edu/>). Rend Lake Community College, in partnership with the state of Illinois and the federal government, has been awarded funding to design, engineer, equip and construct a coal-mining training facility to revitalize its mining technology program. This program will



Figure 6 — Mine rescue team fighting a fire at the MSHA MSL fire gallery.

be able to offer a wide range of coal-mining technology and training opportunities, including some specialized training for mine rescue teams. The facility is expected to be available for public use in mid-2009.

The Rend Lake College (RLC) Coal Mining Training Center will be a 30-by-61 m (100-by-200 ft) steel building and will include classroom and office space, coal mining equipment and a small simulated mine. The north half of this facility is designed to resemble an underground coal mine for a variety of training purposes. It will have removable walls, a black colored interior and a smoke machine to simulate limited visibility. The Illinois Department of Mines and Minerals has expressed interest in using this facility to train mine rescue teams. There will also be an outside area where fire safety training will be performed.

9. Kentucky Coal Academy, Madisonville Community College, Madisonville, KY (<http://coalacademy.kctcs.edu/contact.cfm>). The Kentucky Coal Academy is comprised of four community and technical colleges, located in the eastern and western Kentucky coalfields, where mining technology programs are offered. The mission is to educate and train the coal workforce of the future, create and sustain jobs in the coal industry and provide career pathways for miners from high schools. Mine rescue training is an increasing component of the training offered by the Kentucky Coal Academy, especially at the Madisonville Community College. This institute utilizes a simulated mine with four entries and four crosscuts to conduct smoke training. This mine also contains equipment and a refuge chamber. Plans are being made to attach a burn tunnel at the end of the simulated mine to facilitate specialized firefighting training.

The Madisonville training offers a unique exercise, where a 9.3-ha (23-acre) outside field is designed to simulate six entries and the length of the field is 366 m (1,200 ft). This field is used to teach rapid techniques for underground exploration. Trainers strive to teach both mine rescue national contest exploration rules, as well as protocols and practices that would be employed during a real mine emergency response.

10. Alabama Mine Training Consortium (AMTC), Beville State Community College, Sumiton, AL (<http://www.bscc.edu/mining/>). The AMTC, located on the Beville State's



Figure 7 — SWVCTC Mobile Communications Unit (Command 1) equipped with a multiple-satellite communication system.



Figure 8 — Edgar Mine MERD exercise showing teams building a ventilation control.

Sumiton Campus, was established to meet the immediate needs of Alabama coal companies for mine workers and to create a pipeline of future skilled workers. It offers short-term academic certificate programs and other training, including a new underground miner, refresher, mine electrician, first aid/CPR and mine rescue. This facility is available for public use.

A simulated mine consisting of four entries, four crosscuts, an overcast, beltline, power center and fan is used to conduct smoke training and foam training for mine rescue teams. Burn galleries and outdoor fire pads are not available, but first-responder training using hand-held fire extinguishers is offered. AMTC recently received funding to build a command center and control room that will include computers, communication systems and the latest technology in fan and CO sensor alarms. Construction has already begun and command-center training should be offered during the first half of 2009.

11. Missouri University of Science and Technology (MS&T) Research Mine, Rolla, MO (<http://mining.mst.edu>). Under the direction of the mining engineering department, this underground limestone mine has the unique feature of being utilized to train college students in mine rescue. The MS&T student mine rescue teams compete against professional teams and host a metal/nonmetal mine rescue contest every year. Another unique feature is that this contest (using MSHA-modified rules) is held in an underground mine and not on an indoor floor or outdoor open field.

The main function of the Research Mine is for academic purposes and to train the mine rescue students in a real-life

environment. Hence, it is not available to mine rescue teams for training. The facility includes a classroom area, an outdoor contest field and a benching room, containing both Dräger and Biomarine breathing apparatus. Firefighting training is limited to the use of hand-held extinguishers. Navigation training in limited visibility using artificial smoke is being considered.

12. Edgar Mine Rescue Training Center, Colorado School of Mines (CSM), Idaho Springs, CO (http://mining.mines.edu/edgar_mine.htm). The Edgar Mine is one level of an old hardrock vein gold mine with multiple, small-cross section entries and large rooms that the Colorado Division of Reclamation, Mining and Safety leases from CSM to train mine rescue teams. It is available for public use, student training, faculty research projects and U.S. Army exercises. Because it is an authentic mine, very little simulation is needed to create realistic mine emergency training conditions. Instructors strive to prepare teams for a wide range of mine emergency events. Training exercises can be developed and tailored to the specific needs of any mine rescue team.

Facilities and equipment available at the mine include an underground 30-person classroom with audio/visual equipment, vertical-rope rescue equipment, a confined-space training maze, artificial smoke (non-toxic) generating equipment, live fires, gas-testing equipment, breathing apparatus bench facilities and other specialized mine rescue equipment. Onsite firefighting training is limited to fire extinguisher instruction. However, the Colorado Mine Safety and Training Program has a partnership with several local fire departments to conduct specialized firefighting training at their facilities.

MERD exercises, using modified MSHA-approved rules, are offered that engage team members in realistic and hands-on training. In one example, participating teams rotate through three different situations: incident command center, underground mine rescue team, and back-up mine rescue team. Mine rescue teams work a realistic problem using both contest rules and procedures for a real-life emergency by navigating in smoke, building ventilation controls (Fig. 8), simulating fire fighting and hose management, performing first-aid procedures on real persons, solving problems and making decisions, utilizing back-up teams, and performing command-center duties. Incident command training gives team members a better understanding of the skills and knowledge needed for decision-making, the use of mine rescue team information, ventilation issues, and delays that take place during an underground mine rescue. Teams are also given a written test (one per team) to assess their skills and knowledge and then participate in a debriefing discussion at the end of the exercise.

13. Western Energy Training Center (WETC), College of Eastern Utah, Helper, UT (<http://www.westernenergy-training.org/>). The WETC training center is located in the former surface portal facilities of the Willow Creek Mine and has been converted into a training facility for all energy industries in the western United States, including underground coal. Training instructors strive to offer practical and hands-on training for new miners, annual retraining, virtual-reality simulation, first aid, electrical safety, etc., and prepare coal miners for emergency response. The outside grounds offer only limited firefighting capabilities. This facility is available for public use and provides training across a variety of energy industries for maintenance, power-plant operations, oil and gas production and construction.

Table 1 — List of the 13 mine rescue training facility capabilities and features.

Facility name	Available to public	UG Mine (real or simulated)	Classroom exercises	Specialized firefighting	Navigation in smoke
1. Buchanan	no	no	yes	proposed	yes
2. Lake Lynn	research only	real	no	yes	yes
3. Bruceton	research only	real	no	no	yes
4. WVU E&O	yes	sim.offsite MSL	yes	yes, offsite MSL	yes, mobile unit & MSL
5. MTTC	yes	sim.3rd Qtr 2009	yes	yes, 3rd Qtr 2009	yes
6. MSHA MSL	yes	sim.	yes	yes	yes
7. SWVCTC	yes	sim.	yes	yes	yes
8. RLC	yes	sim. 3rd Qtr 2009	yes	yes, 3rd Qtr 2009	yes 3rd Qtr 2009
9. KY Coal Academy	yes	sim.	yes	yes, 2010	yes
10. AMTC	yes	sim.	yes	no	yes
11. MS&T	no	real	yes	no	proposed
12. Edgar Mine	yes	real	yes	yes, offsite	yes
13. WETC	yes	sim. 2nd Qtr 2009	yes	yes, 2010	yes, 2nd Qtr 2009

Limited mine rescue training is currently being conducted; however, several new additions to enhance training capabilities are being proposed as funding becomes available. A simulated underground mine is planned, along with re-opening an underground tunnel (formerly a concrete-lined belt entry) to provide more realistic and confined-space firefighting exercises. Dormitory space is currently being proposed for long-term training needs.

Summary of US coal mine rescue training facilities

A visual inspection of Fig. 1 suggests a deficiency in the number and capacity of coal mine rescue training facilities. Only eight of twelve (67%) training facilities discussed above are readily-available public facilities; the others are either exclusively for government or academic research or are privately-owned resources. This shortage of local facilities

causes many teams to travel long distances, which consumes valuable training time and resources. Furthermore, teams might not even be able to receive training at the closer facilities, because of limited availability in the facility schedule.

Tables 1 and 2 show whether or not eleven selected features and training capabilities are provided at each investigated facility. For training centers that are in a planning or construction phase, expected start dates are given.

Tables 1 and 2 show that out of the eight public facilities, four of them are currently under construction and should be in full operation by late 2009 or 2010. MSHA's Mine Simulation Lab is the oldest and most heavily utilized facility. A new facility that provides real-life and wider-ranging training opportunities is the SWVCTC Academy for Mine Training and Energy Technologies in Logan, WV. All of the available centers provide training in a real or simulated underground mine and offer a range of classroom and first-aid teaching

Table 2 — List of the 13 mine rescue training facility capabilities and features.

Facility name	Incident command or MERD exercises	Heavy object lifting	Vertical or shaft rescue	Water rescue	Indoor contest practice fields	On-site lodging
1. Buchanan	no	no	no	no	yes	no
2. Lake Lynn	yes	no	no	no	no	no
3. Bruceton	yes	no	no	no	no	no
4. WVU E&O	yes	no	no	no	no	no
5. MTTC	yes	yes	no	yes	proposed	no
6. MSHA MSL	yes	no	no	no	no	yes
7. SWVCTC	yes	yes	yes	yes	proposed	no
8. RLC	no	no	no	no	no	no
9. KY Coal Academy	yes	no	no	no	no	no
10. AMTC	yes, 2nd Qtr 2009	no	no	no	no	no
11. MS&T	no	no	no	no	no	no
12. Edgar Mine	yes	proposed	yes	no	no	no
13. WETC	yes	no	no	no	yes	proposed

exercises. Most of them offer specialized firefighting and smoke-training exercises, but some must go offsite or utilize a mobile unit. Incident command or MERD training is provided by most facilities, except for the ones located in the Midwest United States (MS&T and RLC). Heavy-object removal and vertical-rope rescue is offered at two training centers and water rescue is only offered at one. Teams at only two facilities can practice on indoor mine rescue contest fields, but two more are being proposed at two different facility locations. Finally, only one facility can provide lodging, the MSHA Academy.

A review of Tables 1 and 2 and Fig. 1 suggests that training capabilities and facilities are not universally available to all teams. Some regions require teams to travel long distances, especially in western Colorado/New Mexico, Ohio, Kentucky, Tennessee, Virginia and Oklahoma/Arkansas. However, NIOSH is currently investigating this issue further and will provide more detailed information in future reports.

International mine rescue training facilities

Although funded, staffed and legislated in diverse ways, it is typical for international coal-producing countries to operate regional mine rescue training facilities. They are centrally located in the middle of coal fields or between groups of mines to keep travel time from each mine to a minimum. These facilities also have the capacity to train all of the local mine rescue teams.

Highly specialized and all-inclusive training centers exist in South Africa, Australia, China, India, United Kingdom, Germany and Eastern Europe (Russia, Poland and the Ukraine). They provide physical, and sometimes rigorous, hands-on training in mines or simulated real-life environments. The full-time staff at these facilities are highly experienced mine emergency response specialists and provide expertise and leadership during mine emergencies. It is common in some countries to utilize specialized medical personnel as full-time staff and trained members of the mine rescue teams.

These centers offer the basic mine rescue training similar to those listed in Table 1. Some facilities offer other specialized training, including multiple-casualty extrication, life-support mine medics, rescue through boreholes, location of trapped miners and control-room and incident-command-center procedures. Australian training facilities utilize state-of-the-art virtual-reality theaters to simulate a wide range of mine hazards and mine rescue training exercises. Medical testing (heat tolerance and fitness for duty), first-responder training, standards evaluation and auditing, coordination of mine rescue teams, the housing of specialized mine-emergency equipment and technical expertise training are other uses of these facilities. Finally, these centers are utilized for mine rescue contests. The contests are designed to have multiple real-life or simulated exercises that assess individual team member competencies.

Conclusion and recommendations

Training in a real-life environment with opportunities for hands-on experience has been established as beneficial to coal mine rescue teams. Most international mine rescue teams receive standardized skills training for a wide range of mine emergency responses. Right now there is a training disparity among teams for both skill competencies and opportunities to learn. Throughout this training facility and practices investigation, NIOSH researchers created a list of skills and knowledge for mine emergency response. This comprehensive list is provided below. Competencies in these skills are suggested for all teams to be better prepared for a mine emergency and

to help standardize mine rescue skills across the United States.

Primary skills

- Basic mine rescue skills and practices (contest and real-life rules, first aid, map reading, mine gases, dust and ventilation, communications, breathing apparatus, rescue and firefighting equipment, atmospheric gas collection, ventilation control construction, etc.)
- Basic mining skills and knowledge (roof and rib control, shoring and cribbing standing support, sources of ignition, the importance of adequate rock dusting, equipment safety, personal protective equipment, capabilities and limitations of hand-held gas detectors, electrical do's and don'ts, history of mine disasters and outcomes, etc.)
- Basic knowledge of incident command, surface support and the use of back-up mine rescue teams.
- Advanced first aid and life support systems (e.g., a paramedic on each team).
- Specialized firefighting; ventilation effects of fires
- Navigation and working under apparatus and in reduced visibility (smoke or dust)
- Multiple team rotation procedures.
- Incident-command training.
- Problem-solving and decision-making.

Non-typical skills

- Heavy-object lifting or removal.
- Vertical-rope rescue or repelling from structures or shafts and raises.
- Still and swift water rescue.

Preliminary findings suggest that increasing the current number of training facilities and/or capacities may help coal mine rescue teams be better prepared for mine emergencies. Numerous countries utilize regional or centralized mine rescue training facilities to provide the above skills training. These facilities are structured to be systematic, efficient, self-contained and designed to provide realistic training. This report shows that comprehensive regional facilities do not exist in the United States. However, there are existing facilities that provide varying amounts and kinds of realistic and hands-on coal mine rescue training. This paper provides numerous examples of good and unique features that could enhance each facility in one area or another.

The research findings in this report will be used in further NIOSH investigations to improve coal mine rescue training and to consider the applicability of international practices. Further studies are needed to more clearly define coal mine rescue training needs and develop recommendations for improvement. The ultimate goal is to ensure that the coaching, mentoring, and training of mine rescue personnel is adequate to protect teams and prepare them for a mine emergency response to the fullest extent possible.

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