Mine Safety Recommendations

Report to the Director of the Office of Miners' Health, Safety and Training

By the
West Virginia
Mine Safety Technology Task Force

As required by West Virginia Code §56-4-4

May 29, 2006

The views expressed in this document are those of the authors and do not reflect the official policy or position of the Office of Miners' Health Safety and Training or the State of West Virginia. Questions concerning this report can be directed to the Mine Safety Technology Task Force's Technical Advisor, Randall Harris, at 304-558-1425 or randall.j.harris@verizon.net

ABSTRACT

The Sago and Aracoma disasters and their fourteen deaths, highlighted needed improvements in equipment, capabilities and processes for mine emergency response. The resultant worldwide attention has forever shifted the public's view of underground mine safety.

With the resolve of our government leaders, operators and labor representatives, we have embarked on a mission to improve mine health and safety, thus safeguarding the miners that fuel our nation. The Mine Safety Technology Task Force was charged with the duty of investigating and evaluating options and developing guidelines geared toward protecting the lives of our miners. Special emphasis has been placed on the systems and equipment necessary to sustain those threatened by explosion, fire or other catastrophic events while attempting escape or awaiting rescue.

The West Virginia Mine Safety Technology Task Force Report provides a summary of commercial availability and functional and operational capability of SCSR's, emergency shelters, communications, and tracking along with recommendations regarding implementation, compliance and enforcement. The Mine Safety Technology Task Force was established by an Emergency Rule §56-4-4 and consists of six members with more than 200 years collective underground mining experience. They identified critical issues, then queried vendors and subject matter experts for capabilities, limitations and options regarding self-contained self-rescuers, emergency shelters/chambers, communications/tracking and related safety issues during its studies from March 9th to May 25th 2006. The Task Force concluded in each area examined that enhancements of existing health and safety were to be achieved through more widespread

application of existing technologies. However, in each case we also found significant opportunities for further advancements. The report examines each area in detail and outlines recommendations for amending current West Virginia Miner's Health, Safety and Training rules. The Task Force also advances a challenge to West Virginia to maintain and advance the state's current national leadership role in mine health and safety established through the actions of West Virginia Senate Bill 247 through aggressively pursuing the recommendations included in this report.

Mine Safety Recommendations

of the

Mine Safety Technology Task Force

Presented to James Dean, Director

Office of Miners' Health, Safety and Training

May 29, 2006

In Fulfillment of the Requirements of

Emergency Rules Governing Protective Clothing and Equipment §56-4-4

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PREFACE

The Task Force recognizes and appreciates the tremendous amount of hours our Governor spent with the families of the victims at the Sago and Aracoma disasters. This sincerity by the Governor during these onsite visits demonstrates his concern and compassion towards mine health and safety and the effects it has on miners and their families. We applaud the Governor for his swift action in proposing emergency mine safety legislation to enhance mine safety and provide additional protection for miners when events such as this occur.

The Task Force also applauds the Legislature for unanimously passing Senate Bill 247. This swift action by the Governor and the Legislature is indicative of the dedication by our state officials to do whatever is necessary, to provide the best possible protection to the men and women who work in our mines. The Task Force urges the Governor, the Legislature and the Director of the WV Office of Miners Health, Safety and Training to continue that same dedication by implementing these recommendations and providing necessary funding.

The Task Force would like to acknowledge and thank Acting Director, Jim Dean and his staff for their participation and support of the Task Force as we carried out our assignment.

The Task Force would especially like to thank Randall Harris for his assistance in providing technical expertise, making arrangements and scheduling visits of vendors, government and state officials, researching technical issues and assisting our understanding of highly technical issues that was tremendously vital to our work and allowed us to complete our work within the time frame given the Task Force.

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I. EXECUTIVE SUMMARY

The West Virginia Mine Safety Technology Task Force concluded in each of the principal areas upon which it focused: self-contained self-rescuers, emergency shelters/chambers, and communications/tracking that there were significant enhancements in miners health and safety to be achieved through wider application of existing technologies and techniques. However, the Task Force also concluded that there is considerable opportunity for improvements in all areas and in the techniques of integrating technologies and procedures to increase performance and survivability of mine health and safety systems.

This report provides details of the Task Force's findings and resultant recommendations in the areas of SCSR's, emergency shelters/chambers, communication/tracking, and some related areas upon which the group focused. There were many other areas of mine health, safety, and training that are affected by technology that fall within the charge of the Task Force but there was not sufficient time for the group to focus on these prior to the required May 29th date of this report. The Task Force is committed, if called upon, to focus on these areas over the next few months and issue subsequent findings and recommendations.

The Task Force found that technological advances in mine health, safety and training have been stagnant during the last few decades. There were found to be many reasons for this stagnation, but the Task Force believes the primary reason is the relatively small size of the market in relation to the high costs of research and development, and steps required to acquire regulatory certification. In many market segments where market failures inhibit necessary technological advances, government has stimulated the market place by reducing the financial

risk through cost-shared R&D mechanisms such as the federal Small Business Innovative Research program. The Task Force believes West Virginia should support efforts to add such cost-shared R&D programs to the Mine Health and Safety Administration (MSHA) and the National Institute of Occupational Safety and Health (NIOSH) budgets. However, the Task Force believes that West Virginia should go further by establishing a similar program that would further our leadership role. Such a program could provide cost-shared R&D funding that could be leveraged with federal funds by West Virginia small business to focus and advance technology solutions to the mine health, safety and training problems that directly impact our state.

The Task Force has concluded that solutions that focus on 'devices' do not provide the best protection for miners, rather, an approach of looking at devices as part of the system in which they function is appropriate. Therefore, recommendations made require a mine specific evaluation that would determine which of the multiple device options best provide the needed protection and how these additions fit into mine operations, emergency response, and what ongoing training is required by all those likely to use them.

The Task Force has a concern that the devices installed to improve safety, such as battery-powered strobes and radios, may in fact increase the risk of a secondary events caused by damage to the devices in the initial explosion. The Task Force recommends that an independent risk analysis be conducted and therefore does not recommended that battery-powered strobes be installed at this time.

West Virginians owe most of what we have today to our miners and the mines in which they work. They have provided and will continue to provide the core of the State's economic base. Advances in technology to reduce their risk at the Federal level have tended to peak and ebb in direct relations to major mine accidents. The Task Force strongly believes that unless the State takes action to ensure a continual focus on advancing mine health and safety technologies, the current Federal focus will also ebb until the next major accident. We owe it to those whose deaths drove the current focus that the recommendations made here trigger not simply 'a device' but rather 'a process' that will continue to bring the latest advances in technologies to mine health, safety and training.

SELF-CONTAINED SELF-RESCUERS

The key to escape in a toxic atmosphere is the SCSR. In a 2001 study, the National Institute for Occupational Safety and Health (NIOSH) reported that out of 214 miners surveyed 38% had been notified to evacuate a mine because of fire or explosion during their career.[1] US Mine Rescue Association data indicate that the depletion of oxygen and production of carbon monoxide and carbon dioxide cause more fatalities than all other causes combined.[2] Access to and proper operation of SCSR's is a matter of life and death to miners.[3]

[1] Conti, RS [2001] "Responders to Underground Fires", NIOSH, Pittsburgh Research Laboratory
[2] US Mine Rescue Association, http://www.usmra.com/disasters_80on.htm
[3] Immediately following an explosion the typical gas composition is; 6% O_2, 10,000ppm CO, and 11% CO_2 the combination of which is fatal - Foster Miller Associates [1983]: "Recommended Guidelines for Oxygen Self-Rescuers, Volume II", USBM Contract J0199188 p79-80

The Task Force has concluded that options exist to meet SB-247 regarding the sufficient supply of self-contained self-rescuers (SCSR's) to ensure the miners can escape in the event of fire or explosion when mine air has become toxic.

SCSR Recommendations

Under Title 56, Series 4, "Amended Emergency Rules Governing Protective Clothing and Equipment" the Director has required SCSR storage cache plans. The Task Force recommends these rules be amended and SCSR storage cache plans revised to reflect the following:

1. Operators shall revise all SCSR plans and submit those to the Director no later than 60 days after these amendments become final.
2. Operators shall place at least one cache at a readily available location within five hundred (500) feet of the nearest working face in each working section of the mine and each active construction or rehabilitation site. Distances greater than five hundred (500) feet not to exceed one thousand (1,000) feet, are permitted. However, where miners are provided with personal SCSR's rated for less than sixty (60) minutes, travel to these caches are not to exceed five (5) minutes as determined by the height/travel time chart as specified in Section 5.3.2.
3. Each of these caches (nearest working face in each working section of the mine and each active construction or rehabilitation site) shall hold two (2) SCSR's that will provide at least 60 minutes of oxygen per unit for each miner. When each miner carries an SCSR that is rated for less than 60 minutes, in which case the cache shall hold three (3) SCSR's for

each miner. The total number of SCSR's to be cached will be based on the total number of miners reasonably likely to be in that area.

4. Operators shall ensure that caches described above also contain an escape kit containing a hammer, a tagline, a supply of chemical light sticks, and an escape-way map.
5. Beginning at the storage cache located at the working section or active construction or rehabilitation site and beltlines, pumping and bleeder areas, and continuing to the surface or nearest escape facility leading to the surface, the operator shall station additional storage caches containing a number of additional SCSR's equal to or exceeding one each for the total number of persons reasonably likely to be in that area at calculated intervals that a miner may traverse in no more than thirty (30) minutes traveling at a normal pace, taking into consideration the height of the coal seam and utilizing the travel times as specified in Section 5.3.2.
6. The Task Force recommends that SB-247 be modified by removing references to "certified intrinsically safe battery-powered strobe lights" due to the concern that damaged strobe lights would create a potential ignition hazard if damaged in an explosion. The Task Force recommends that each SCSR cache have a reflective sign with the words "SELF-RESCUER" or "SELF-RESCUERS" conspicuously posted at each such cache and that reflective direction signs shall be posted leading to each cache. Cache storage containers shall be of such construction as to protect the SCSR's from normal operational damage, be made of a material that is non-combustible, shall be easy to open during an emergency escape, and shall be noted on the escape-way map.

7. Operators shall provide training in the proper use of SCSR's in simulated emergency situations, which may be on the surface, in all required SCSR training. Training should include but not limited to, manufacturer's required daily inspections, donning and starting the SCSR, ways to maximize duration of the unit, changing between SCSR's, communicating without removing the mouth piece, importance and use of goggles, how to know if the device has failed and what to do if it does, and limitations of the SCSR. Until such time as manufacturers offer an operable training SCSR operators are encouraged to save out-of-service units to activate during training as a supplement to currently available training models. All training shall be recorded and made available upon request.
8. Operators and contractors shall report to the Director all SCSR's in service by manufacturer, model, serial number, mine/contractor ID#, service dates, and results of required inspections. This information shall be submitted electronically as defined by the Director, updated quarterly and will include information on any units removed from service along with reasons. The Director shall compile and analyze the results of this information and distribute a report within 30 days by posting the report on the MHS&T web page, www.wvminesafety.org

EMERGENCY SHELTERS/CHAMBERS

The Task Force has concluded that the first and preferred option for miners in an emergency is to escape. However, it has found that options exist to provide the primary function of an Emergency Shelter/Chamber which is designed to potentially sustain life after a major

underground event such as an explosion and where escape is cut off. The Task Force has developed recommended minimum requirements for the emergency shelter/chamber and its use.

In developing recommendations the Task Force reviewed summaries of mine accidents that resulted in barricading of miners and developed a scenario. The scenario used is of an accident in which miners within 1,000 feet of the working face have survived a methane explosion. The Task Force's scenario does not include secondary explosions or on-going fires in the immediate area. The miners will have made every attempt to exit and found all escape ways impassable. As a last resort, they have been forced to return to the shelter/chamber to await rescue. We have assumed that miners approaching the emergency shelter/chamber will have consumed most of their SCSR time, be exhausted from escape attempts, with some injured and all under great stress. In this condition, the miners will need to be protected by the shelter/chamber within minutes of reaching it and for a period of at least 48 hours.

Emergency Shelter/Chamber Recommendations

1. The Director shall require, in each underground mine, an emergency shelter/chamber, it shall be located in a crosscut no more than 1,000 feet from the nearest working face and shall be accurately located on mine maps.
2. The Director may approve, as an alternative to a shelter/chamber, an additional surface opening located no more than 1,000 feet from the nearest working face and accurately located on mine maps.

3. The Director shall acquire, no later than July 1, 2006, the necessary technical/engineering support needed to evaluate the performance of emergency shelter/chamber components/systems, and to review the effectiveness of emergency shelter/chamber plans.
4. The Director shall, no later than July 10, 2006, issue an open opportunity for emergency shelter/chamber providers to submit products for approval.
5. The applicant is to submit documentation including a certification by an independent licensed professional engineer that its unit meets the requirements.
6. The Director shall maintain a current list of approved emergency shelter/chambers on the West Virginia MHS&T web site www.wvminesafety.org
7. After an emergency shelter/chamber has been approved, any modifications must be submitted for approval by the Director.
8. The Director shall convene the Mine Safety Technology Task Force not less than once per month through June 30, 2007 for the purpose of reviewing progress by manufacturers, regulators, and operators toward achieving the goals set forth in SB-247 and to review the functional and operational capability of necessary mine safety and health technologies. The Task Force shall submit a report to the Director of its findings and recommendations.
9. No later than April 15, 2007 all underground mine operators shall submit an emergency shelter/chamber plan for approval by the Director. The design, development, submission, and implementation of the shelter/chamber plan shall be the responsibility of the operator of each mine.

10. Within thirty (30) calendar days after submission of the emergency shelter/chamber plan, the Director shall either approve the emergency shelter/chamber plan or shall reject and return the plan to the operator for modification and resubmission, stating in detail the reason for such rejection. If the plan is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such plan.
11. Within 15 days of approval by the Director, the underground mine operator shall submit as an addendum to its emergency shelter/chamber plan a copy of any contract, or purchase order, or other proof of purchase of any equipment required to complete the emergency shelter/chamber and for installation and ongoing maintenance.
12. After the Director has approved an operator's emergency shelter/chamber plan, the operator shall submit revisions to the emergency shelter/chamber plan at any time that changes in operational conditions result in a substantive modification. In addition, at any time after approval, the operator may submit proposed modifications or revisions to its plan along with reasons therefore to the Director. Within thirty (30) days after receipt by the Director of any proposed revisions or modifications to the emergency shelter/chamber plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection.
13. If the Director, in his sole discretion, determines that an operator has failed to provide an emergency shelter/chamber plan, has provided an inadequate emergency shelter/chamber plan, has failed to comply with its approved emergency shelter/chamber plan, or has failed

to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

14. In developing the emergency shelter/chamber plan and any revisions, the operator shall take into consideration the physical features of the particular mine, emergency plans, advances in emergency shelter/chamber technologies and any other aspect of the particular mine the operator deems relevant to the development of the emergency shelter/chamber plan.

15. A copy of the approved emergency shelter/chamber plan shall be provided to the mine rescue teams providing coverage for the mine. Copies of the most recent version shall be available at the mine for emergency responders. As changes are made to the system, updated versions shall be submitted to the above parties.

16. The proposed emergency shelter/chamber plan shall:

    - describe the structure and operations of the emergency shelter/chamber and its role in emergency response;
    - ensure that emergency shelters/chambers are included in initial mine hazard training in such a manner that it is in compliance with all manufacturer's requirements and is provided yearly in addition to annual refresher training. All training shall be recorded and made available upon request;

- ensure weekly inspections of emergency shelters/chambers and contents shall be conducted by a certified mine foreman/fireboss and recorded in weekly ventilation examination book;
- ensure that weekly safety meetings review the current location of applicable emergency shelters/chambers and results of the latest inspection;
- ensure that emergency shelters/chambers shall be equipped with easily removable tamper-proof tags such that a visual indication of unauthorized access to the emergency shelter/chamber can be detected; and
- ensure that the mine's communication center shall monitor any communication systems associated with the emergency shelter/chamber at all times that the mine is occupied.

17. The proposed emergency shelter/chamber shall include the ability to:

- provide a minimum of 48 hours life support (air, water, emergency medical supplies, and food) for the maximum number of miners reasonably expected on the working section;
- be capable of surviving an initial event with a peak overpressure of 15 psi and a flash temperature of 300 degrees Fahrenheit;
- be constructed such that it will be protected under normal handling and pre-event mine conditions;
- provide for rapidly establishing an internal shelter atmosphere of O_2 above 19.5%,

CO_2 below 0.5%,

CO below 50 ppm, and

an 'apparent-temperature' of 95 degrees Fahrenheit;

- provide the ability to monitor carbon monoxide and oxygen inside and outside the shelter/chamber;
- provide a means for entry and exit that maintains the integrity of the internal atmosphere;
- provide a means for intrinsically safe power if required;
- provide a minimum eight quarts of water per miner;
- provide a minimum of 4000 calories of food per miner;
- provide a means for disposal of human waste to the outside of the shelter/chamber;
- provide a first aid or EMT kit in addition to a section first aid kit;
- have provisions for inspection of the shelter/chamber and contents;
- contain manufacturer recommended repair materials;
- provide a battery-powered internal strobe light visible from the outside indicating occupancy;
- provide a means of communications to the surface; and
- only contain MSHA approved materials where applicable.

18. The Director may require modifications to an emergency shelter/chamber approval or an emergency shelter/chamber plan at any time following the investigation of a fatal accident

or serious injury, as defined by Title 36, Series 19, Section 3.2, if such modifications are warranted by the findings of the investigation.

COMMUNICATIONS/TRACKING

In completing its charge to evaluate availability, functional and operational capacity of required communication and tracking devices, the Task Force reviewed multiple products, designs, and approaches and has determined that while no single product exists to meet all the requirements, the intent of SB-247 can be met in most if not all mines by employing separate systems, possibly requiring one for communications and one for tracking.

Further, the Task Force has determined that through utilizing multiple products and procedures an integrated communication/tracking system can be installed that would meet the intent of the law … "to protect miners in an emergency".

Communications/Tracking Recommendations

1. The Director shall require, in each underground mine, an integrated communication/ tracking system, a component of which shall be a communication center monitored at all times during which one or more miners are underground.
2. The Director shall acquire, no later than July 1, 2006, the necessary technical/engineering support to evaluate the performance of individual communication/tracking systems and review the effectiveness of communication/tracking plans.
3. The Director shall convene the Mine Safety Technology Task Force not less than once per month through June 30, 2007 for the purpose of reviewing progress by manufacturers, regulators, and operators toward achieving the goals set forth in SB-247 and other mine

health and safety technology to promote the availability, functional and operational capability of necessary mine safety and health technologies. The Task Force shall submit a report to the Director of its finding and recommendations.

4. No later than August 31, 2007 all underground mine operators shall submit a communication/tracking plan for approval by the Director. The design, development, submission, and implementation of the communication/tracking plan shall be the responsibility of the operator of each mine.

5. Within thirty (30) calendar days after submission of the communication/tracking plan, the Director shall either approve the communication/tracking plan, or shall reject and return the plan to the operator for modification and resubmission, stating in detail the reason for such rejection. If the plan is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such plan.

6. Within 15 days of approval by the Director, the underground mine operator shall submit as an addendum to its plan, a copy of any contract, or purchase order, or other proof of purchase of any equipment required to complete the communication/tracking system and for installation and ongoing maintenance.

7. After the Director has approved an operator's communication/tracking plan, the operator shall submit revisions to the communications plan at any time that changes in operational conditions result in a substantive modification in the communication/tracking system. In addition, at any time after approval, the operator may submit proposed modifications or revisions to its plan along with reasons therefore to the Director. Within thirty (30) days

after receipt by the Director of any proposed revisions or modifications to the communications/tracking plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection.

8. If the Director, in his sole discretion, determines that an operator has failed to provide a communications/tracking plan, has provided an inadequate communications/tracking plan, has failed to comply with its approved communications/tracking plan, or has failed to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

9. In developing the communication/tracking plan and any revisions, the operator shall take into consideration the physical features of the particular mine, emergency plans, existing communication infrastructure, advances in communication/tracking technologies and any other aspect of the particular mine the operator deems relevant to the development of the communication/tracking plan.

10. The proposed communication/tracking plan shall describe the structure and operations of the separate or integrated communication/tracking system(s) and its role in emergency response specific to the mine shall be detailed and submitted to the Director and, once approved, to the mine rescue teams providing coverage for the mine. Copies of the most recent version shall be available at the mine for emergency responders. As changes are made to the system, updated versions shall be submitted to the above.

11. The proposed communication/tracking system shall include the ability for:

- a communication center monitored at all times during which one or more miners are underground. This center shall be staffed by persons holding a valid underground miners certificate, and trained and knowledgeable of the installed communications/ tracking systems, monitoring and warning devices, travel ways, and mine layout. Individuals not possessing a valid underground miner's certificate but working full-time as a communication center operator on or before May 25, 2006 shall be allowed to continue as communications center operators at that mine provided they will have successfully completed no later than December 31, 2006 a certified 80 hour underground miners apprentice training program and documentation is available for inspection;
- knowing the location of all miners immediately prior to an event by tracking/locating in the escape-ways, normal work assignments, or notification of the communication center;
- knowing the location of miners in the escape-ways after an event providing the tracking system is still functional;
- check-in and check-out with the communication center by persons prior to entrance and exit from bleeders and remote or seldom used areas of the mine (all times shall be logged);
- allowing two way communications coverage in at least two separate air courses and at least one of which shall be an intake;

- maintaining communication/tracking after loss of outside power and maintain function both inby and outby of the event site with suitable supply of equipment for rapid reconnection;
- maintain a surface supply of communication/ tracking devices for use by emergency rescue personnel;
- allow for communication to surface at all required shelters/chambers;
- all miners and likely emergency responders shall be trained in the use, limitations and inter-operability of all components of the communication and tracking/locating system. This shall be incorporated into required training. All training shall be recorded and made available upon request;

12. The operator shall provide a schedule of compliance for the communication/tracking plan, which shall include:
    - a narrative description of how the operator will achieve compliance with above requirements;
    - a schedule of measures, including an enforceable sequence of actions with milestones, leading to compliance; and
    - a statement indicating when the implementation of the proposed plan will be complete.
13. The operator shall provide as attachments to its communication/tracking plan:
    - a statement of the analysis and evaluation required in developing its plan;

- a statement indicating the initial training dates for implementation of the communication/ tracking system and how the communication/tracking system will be incorporated in other required training;
- a statement regarding how the communications/tracking system will be tested and maintained; and
- the name of the person or persons representing the operator, including his or her title, mailing address, email address and telephone number, who can be contacted by the Director for all matters relating to the communication/tracking plan and weekly testing of the system.

14. The Director may require modifications to a communication/tracking plan at any time following the investigation of a fatal accident or serious injury, as defined by Title 36, Series 19, Section 3.2, if such modifications are warranted by the findings of the investigation.

RELATED SAFETY ISSUES

The Task Force found many related safety and health issues important to miners but was unable to dedicate significant time to any. It provides the following recommendations and will work with the Director and the Board of Coal Mine Health and Safety to better explore these related issues.

LIFELINES

In lieu of installed lifelines in track or belt entries, markers such as floor mats with arrows, fish plate reflectors, red/green lasers shall be installed at distances not to exceed 1,000 feet or line of sight, or other equivalent devices may be used if approved by the Director.

SEALS

'Omega" type blocks shall not be used in future seal construction. They may, however, be used for other type ventilation controls. The Task Force applauds the Director's May 12, 2006 action imposing a moratorium on "Omega" type block installations and MHS&T's ongoing review of all existing installations. It is recommended that immediate corrective action be taken where warranted.

SEISMIC LOCATING DEVICES

The Director shall provide portable seismic locating systems at each regional office for use in locating trapped miners. Each office will maintain a trained staff that shall upon notification from Homeland Security Office, be capable of delivering the system to the mine site and to deploy the system immediately and without delay. These persons shall practice with the said systems at least annually at different mine sites.

MINE RESCUE TEAMS

The Task Force supports and applauds the actions taken by the Board of Coal Mine Health and Safety and the Director of the Office of MHS&T for their efforts to address mine rescue capabilities and other mine rescue concerns in the State of West Virginia. The Task Force

recommends these efforts be expanded to reflect currently available technology for mine rescue and fire fighting.

RECOMMENDED IMPLEMENTATION TIMELINE

		SCSR	Shelters	Comm/Track
2006	June	Amended rules issued based upon recommendations		
	July	Proposed Final Rules submitted to Legislature Submit Revised SCSR Plan		
	August	Director Approves/Rejects Revised SCSR Plans	July 1 - MHS&T Acquire Technical Support July 10 – MHS&T Issue Opportunity for approvals	
	September		Vendors working with operators, MSHA, and MHS&T to test, refine and get approvals	
	October		Task Force monitors and issues monthly reports	
	November		MHS&T announces approvals as done	
	December		Operators and vendors develop and test proposed plans	
2007	January			
	February			
	March			
	April		April 15 - Submit Shelter/Chamber Plan	
	May		Director Approves/Rejects Submit PO's with approval	
	June			
	July			July 31 – Submit Comm/Trac Plan
	August			Director Approves/Rejects Submit PO's with approval

Installation will progress according to schedules included in approved plans.

II. SELF-CONTAINED SELF-RESCUERS

SUMMARY

The Task Force has concluded that options exist to meet SB-247 regarding the sufficient supply of self-contained self-rescuers (SCSR's) to ensure the miners can escape in the event of fire or explosion and mine air has become toxic.

In developing recommendations the Task Force reviewed summaries of mine evacuations, operation of SCSR's, capabilities and limitations of SCSR's, metabolic parameters of miners during escapes, cache storage options, and aids to escape.

The Task Force concluded that caches should be provided near the most likely locations of miners at the time of an event and every 30 minutes of travel time through designated escape ways to the nearest surface opening or shaft. The Task Force also concluded that SCSR's certified by MSHA/NIOSH for at least 60 minutes shall be cached at quantities outlined in a plan approved by the Director.

The Task Force concluded that SCSR caches should be protected from normal mining operational hazards, be constructed of a non-combustible material, will be easy to locate during an emergency, be noted on escape-way maps, and easy to open. We also find that strategic caches should contain basic aids for escape.

The Task Force recommends that SCSR training be increased with the inclusion of realistic simulations.

The Task Force recommends that a statewide SCSR reliability tracking system be initiated to enhance the understanding of SCSR performance and to allow recall of units if required.

BACKGROUND

The key to escape in a toxic atmosphere is the SCSR. In a 2001 study the National Institute for Occupational Safety and Health (NIOSH) reported that out of 214 miners surveyed 38% had been notified to evacuate a mine because of fire or explosion during their careers.[4] US Mine Rescue Association data indicate that the depletion of oxygen and production of carbon monoxide and carbon dioxide cause more fatalities than all other causes combined.[5] Access to and proper operation of SCSR's is a matter of life and death to miners.[6]

The Task Force SCSR recommendations address:

- Mine-wide emergency strategies that take into account the capabilities and limitations of the SCSR's
- Impacts of traveling long distances in adverse conditions, high heat and humidity
- Realistic training
- Aids to escape

[4] Conti, RS [2001] "Responders to Underground Fires", NIOSH, Pittsburgh Research Laboratory
[5] US Mine Rescue Association, http://www.usmra.com/disasters_80on.htm
[6] Immediately following an explosion the typical gas composition is; 6% O_2, 10,000ppm CO, and 11% CO_2 the combination of which is fatal - Foster Miller Associates [1983]: "Recommended Guidelines for Oxygen Self-Rescuers, Volume II", USBM Contract J0199188 p79-80

In addressing SCSR's the Task Force reviewed published studies on mine fires and explosions with special attention to the behavior of miners while using SCSR's.[7] The Task Force determined that due to reports of miners having difficulty using or being recovered with unused SCSR's that it needed a better understanding of the capabilities and limitation of the devices and most likely requirements of the escaping miner.[8]

The Task Force began with researching how the various devices work. It found there are presently two basic SCSR designs. One provides oxygen from compressed gas and the other through a chemical reaction. Both designs utilize a means of removing exhaled carbon dioxide and protect from inhaling carbon monoxide and smoke. All units provide a mouth piece that fits behind the lips and is clasped with the teeth along with a clip that restricts air through the nostrils and a bag to hold reserves of oxygen-rich air. The carbon dioxide is removed through a chemical reaction; the ability to remove sufficient carbon dioxide is a critical factor determining the unit's physical size and duration.

Currently there are only three manufacturers of MSHA/NIOSH certified SCSR's.[9] Two produce oxygen using chemicals and one provides compressed oxygen. The certification process involves a manufacturer's unit being tested by a human subject in a defined series of exercises with the goal being to maintain the subject's metabolic indicators within specified ranges. The units are rated on the time segments of these exercises it successfully passed i.e., 10, 30, or 60

[7] Vaught C, et al [2000]: "Behavioral and Organizational Dimensions of Underground Mine Fires", NIOSH also Kavitz, J [1977]: "An Examination of Major Mine Disasters", NIOSH also DeRosa, MI [2004]: "An Analysis of Mine Fires 1990-1999", NIOSH IC9470 also US Mine Rescue Association [2006]: "Mine Accidents 1980-2006", http://www.usmra.com/disasters_80on.htm
[8] Mine accident reports can be found on the MSHA web site at http://www.msha.gov/fatals/fab.htm
[9] Interview with John Kovac, NIOSH Pittsburgh Research Laboratory

minutes. There is no attempt to test beyond the manufacturer's requested duration target. As a result MSHA/NIOSH cannot endorse manufacturer claims that their units will go beyond the rated durations or time a unit will provide breathable air under exertion rates other than those of the MSHA/NIOSH test.[10]

MSHA/NIOSH also conducts periodic evaluations of selected SCSR's removed from active mines. These evaluations are conducted using a testing machine verses human subjects and are designed to identify potential problems, **not as a quality control of certified performance.** These tests have identified some problems in design, materials, and maintenance over the years which manufacturers have corrected. MSHA/NIOSH also accepts volunteered information on failed units along with descriptions of the causes of failure and uses this information to work with manufacturers on improvements.[11]

Several studies were reviewed by the Task Force that looked at performance in simulated underground mine escapes. These studies provided the Task Force with insights into the metabolic requirements of an escaping miner. Since every mine is different and every miner unique, it is not surprising that there are deviations from the certified durations of SCSR's when tested in the real-world verses the laboratory.[12] MSHA/NIOSH claims that miners' lack of familiarity with using SCSR's in the stress of an escape situation accounts for some of the

[10] Interview with John Kovac, NIOSH Pittsburgh Research Laboratory
[11] Kyriazi N and Shubilla JP [2002]: "Self-Contained Self-Rescuer Field Evaluation: Seventh-Phase Results", RI9656 - also see RI9401, RI9635, and RI9451
[12] Foster Miller Associates [1983]: "Recommended Guidelines for Oxygen Self-Rescuers, Volume II, Escape Time Studies", USBM Contract J0199118

variance. While this explains most of the findings, it adds to the task of determining adequate spacing for SCSR storage caches.

After consulting with manufacturers and experts from MSHA/NIOSH and drawing upon its own experience, the Task Force concluded that a safety margin regarding the typical distance traveled needed to be applied by discounting existing SCSR's model's certified duration by 50%. This was derived by looking at escape simulations studies from the US Bureau of Mines[13], United Kingdom[14], and South Africa[15]. Collectively these studies found that actual useful life varied from 26% to 125% of the MSHA/NIOSH certified durations. The Task Force also took into consideration reports indicating miner difficulties in donning the SCSR's in real and simulated emergencies[16], and the findings of the MSHA/NIOSH field evaluations[17]. The recommended approach provides a 100% safety margin against the unexpected in both travel time and SCSR operation.

The Task Force is troubled that there has been little change in the underlying technology and the design of these units in the last 30 years. The original SCSR design criteria were defined by the National Academy of Engineering in a 1970 study[18].

[13] Foster Miller Associates [1983]: "Recommended Guidelines for Oxygen Self-Rescuers, Volume II, Escape Time Studies", USBM Contract J0199118
[14] Jones, BJ et al [2003]: "Use of self-rescuers in hot and humid mines", Research Report #180
[15] Schreiber, WL [2004]: "Annual Report on SCSR Monitoring in the South African mining industry for the period January – December 2003", Department of Minerals and Energy, # 2004-0153
[16] Vaught C, et al [2000]: "Behavioral and Organizational Dimensions of Underground Mine Fires", NIOSH
[17] Kyriazi N and Shubilla JP [2002]: "Self-Contained Self-Rescuer Field Evaluation: Seventh-Phase Results", RI9656 - also see RI9401, RI9635, and RI9451 – also presentation by John Kovac, NIOSH to the Colorado School of Mines in April 2003, "Analysis of SCSR Problems"
[18] National Academy of Engineering [1970]: "Mine Rescue and Survival", Washington DC

Recent workshops sponsored by MSHA and NIOSH to explore SCSR options are encouraging; however, the identified potential changes appear to be only in design rather than in the underlying technology.[19] Indicative of the stagnation in the mine health and safety technology market place, many of the design changes at the workshop were rediscoveries of those proposed in the late 1970's by the US Bureau of Mines but never brought through certification by manufacturers.[20]

After discussions with MSHA, NIOSH, and current and potential manufacturers, the Task Force believes this situation is due to the limited size of the mine safety market (estimated 80,000 units are deployed in the US[21]) and relatively slow turnover of this installed base (about 15% per year[22]). These facts, taken with the relatively low gross margin to the manufacturers[23], relatively high costs of R&D and a lengthy certification process,[24] act as barriers for innovation in SCSR technologies. Based upon the Task Force's review, at a minimum, there is a need for innovation in indicators for SCSR condition before and during use, longer duration smaller sized SCSR's, improved CO_2 scrubbers, lowered breathing resistance, realistic training systems, and easier inventorying means such as RFID tags or bar codes. The Task Force recommends that the state not only support efforts in Congress to increase development funding for NIOSH but also

[19] Kovac J [2006] "Self-Contained Self-Rescuer (SCSR) Technology: Capabilities/Challenges", NIOSH presentation at Beckley Mine Academy March 30, 2006
[20] Chironis, NP [1977] "Operating Handbook of Underground Mining", Coal Age Mining Informational Services ISBN: 0070114579
[21] Discussions with NIOSH and manufacturers allowed for a rough estimate by the Task Force that was affirmatively vetted with these same groups
[22] Based on confidential discussions with manufacturers regarding their expected production levels for 2006 prior to changes in the law and the estimate of in service SCSR's
[23] Confidential interviews with manufacturers
[24] Perception of the manufacturers – NIOSH believes the process is efficient

initiate a program of its own to focus on issues specific to West Virginia mine health and safety problems and encourage local small businesses to bring innovations forward.

MSHA/NIOSH acknowledges a need to better understand the status of SCSR's actually in the possession of miners. MSHA/NIOSH have worked with manufacturers to develop workable testing and mines are supplied the equipment from their vendors. However, there is no standard means of determining if these mine-level testing programs ensure the viability of the SCSR's in the mine. Also beneficial would be a statistically based means of identifying problems of in-service units by determining reasons for destruction or out-of-service events. This data would provide critical information on the performance of deployed SCSR's, early warning of problems, and the ability to recall specific units for service if required. The Task Force agrees and recommends that West Virginia initiate such a program.

The Task Force believes that training is a critical issue for miners in all areas, but particularly regarding SCSR's. Most miners go through their entire careers and never have the experience of donning an SCSR. When a miner finds the first time he actually uses an SCSR is in the midst of an emergency, he needs to be confident he can do everything right the first time. The Task Force believes the best way to accomplish this is through realistic SCSR simulation during training. Many of the reports of SCSR failure investigated by MSHA/NIOSH concluded that the miners had misinterpreted typical SCSR operation as a malfunction.[25] Breathing oxygen, from a cylinder or from a chemical in a can, while in a smoke-filled mine is not the same as using a non-working training unit in a classroom. Training shall include manufacturers'

[25] Vaught, CJ et al [1999]: "Worker Responses to Realistic Evaluation Training", NIOSH Pittsburgh Research Laboratory

required daily inspection of each unit, donning and starting the SCSR, ways to maximize duration of the unit, changing between SCSR's, communicating without removing the mouth piece, importance and use of goggles, how to know if the device has failed and what to do if it does, and limitations of the SCSR. All training shall be recorded and made available upon request. While no manufacturer currently offers such a training device, the Task Force strongly encourages the development and incorporation into training of a simulation device that would allow miners to experience the realistic or simulated sensations of breathing through an active unit. Until such time, operators are encouraged to save out-of-service units to be activated during training as a supplement to currently available training models.

When smoke is encountered underground, visibility is reduced, anxiety levels increase and decision-making skills become clouded[26]. To aid in a smoke-filled escape, the Task Force recommends that caches at the working section, active construction or rehabilitation sites contain a tagline to allow members of groups escaping to stay together in zero visibility by each holding the line, a supply of chemical light sticks that can be started and dropped periodically as they escape to warn the miners if they have accidentally doubled back, a hammer to bang on roof bolts and an escape-way map.

DEFINITIONS

Self-Contained Self-Rescuer (SCSR) means a type of closed circuit self-contained breathing apparatus approved by MSHA and NIOSH under 42 CFR part 84 for escape only in underground mines. SCSR's are not to be confused with Filter Self-Rescuer (FSR) that does not

[26] Vaught, CJ et al [1995]: "Decision Making During a Simulated Mine Fire Escape", NIOSH

supply or generate oxygen. The Task Force recommends that FSR's not be allowed in West Virginia mines.

SCSR Storage Cache means a non-combustible container constructed to withstand normal mine conditions and protect a number of SCSR's. The cache shall allow easy access for inspection of the SCSR's and easy access for miners who are escaping.

REQUIREMENTS

Operators shall place at least one cache at a readily available location within five hundred (500) feet of the nearest working face in each working section of the mine and each active construction or rehabilitation site. Distances greater than five hundred (500) feet, not to exceed one thousand (1,000) feet, are permitted. However, where miners are provided with personal SCSR's rated for less than sixty (60) minutes, travel to these caches are not to exceed five (5) minutes as determined by the height/travel time chart specified in Section 5.3.2.

Each of these caches (nearest working face in each working section of the mine and each active construction or rehabilitation site) shall hold two (2) SCSR's that will provide at least 60 minutes of oxygen per unit for each miner. When each miner carries an SCSR that is rated for less than 60 minutes, in which case the cache shall hold three (3) SCSR's for each miner. The total number of SCSR's to be cached will be based on the total number of miners reasonably likely to be in that area.

Operators shall ensure that caches described above also contain an escape kit containing a hammer, a tagline, a supply of chemical light sticks, and an escape-way map.

Beginning at the storage cache located at the working section or active construction or rehabilitation site and beltlines, pumping and bleeder areas, and continuing to the surface or nearest escape facility leading to the surface, the operator shall station additional storage caches containing a number of additional SCSR's equal to or exceeding one each for the total number of persons reasonably likely to be in that area at calculated intervals so that a miner may traverse in no more than thirty (30) minutes traveling at a normal pace, taking into consideration the height of the coal seam and utilizing the travel times specified in Section 5.3.2.

The Task Force recommends that SB-247 be modified by removing references to "certified intrinsically safe battery-powered strobe lights" due to the concern that damaged strobe lights would create a potential ignition hazard if damaged in an explosion. The Task Force recommends that each SCSR cache have a reflective sign with the words "SELF-RESCUER" or "SELF-RESCUERS" conspicuously posted at each such cache and that reflective directional signs shall be posted leading to each cache. Cache storage containers shall be of such construction as to protect the SCSR's from normal operational damage, be made of a material that is non-combustible, shall be easy to open during an emergency escape, and shall be noted on the escape-way map.

Operators shall provide training in the proper use of SCSR's in simulated emergency situations, which may be on the surface, in all required SCSR training. Training shall include, but not be limited to, manufacturer's required daily inspection of unit, donning and starting the SCSR, ways to maximize duration of the unit, changing between SCSR's, communicating without removing the mouth piece, importance and use of goggles, how to know if the device has

failed and what to do if it does, and limitations of the SCSR. Until such time as manufacturers offer an operable training SCSR, operators are encouraged to save out-of-service units to activate during training as a supplement to currently available training models. All training shall be recorded and made available upon request.

Operators and contractors shall report to the Director all SCSR's in service by manufacturer, model, serial number, mine/contractor ID#, service dates, and results of required inspections. This information shall be submitted electronically as defined by the Director, updated quarterly and will include information on any units removed from service along with reasons. The Director shall compile and analyze the results of this information and distribute the report within 30 days by posting a report on the MHS&T web page.

COMMERCIAL AVAILABILITY

The Task Force reviewed SCSR's from CSE, Drager and Ocenco. All units are MSHA/NIOSH approved and commercially available although manufacturers report shipping delays exceeding 6 months due to manufacturing capability limitations.

OPTIONS REVIEWED

Chemical generated oxygen

Units that generate oxygen in the SCSR are based upon a chemical reaction of water vapor for exhaled breath and a potassium oxide. The reaction releases oxygen as byproduct while capturing a small amount of carbon dioxide. The carbon dioxide is captured in a separate chemical reaction that converts it into a solid. The amount of oxygen the units can generate and carbon dioxide they can capture is a function of the volume of chemicals. Exhaled air is

'scrubbed' of carbon dioxide and mixed with oxygen in a breathing bag from which miners take breaths. Oxygen levels vary with the breathing rate of the miner, i.e. amount of water vapor they exhale. There is a delay in oxygen production rates as demand increases and decreases with exertion rate.

Cylinder stored oxygen

Units that use oxygen in cylinders also use a chemical for carbon dioxide removal. The amount of oxygen the units can supply is a function of the pressure rating for the cylinder. Exhaled air is 'scrubbed' of carbon dioxide and mixed with oxygen in a breathing bag from which miners take breaths. Oxygen levels can be adjusted through a regulator on the unit.

IMPLEMENTATION, COMPLIANCE AND ENFORCEMENT

Under Title 56, Series 4, "Amended Emergency Rules Governing Protective Clothing and Equipment" the Director has required SCSR storage cache plans. The Task Force recommends these rules be amended and SCSR storage cache plans revised to reflect the following:

1. Operators shall revise all SCSR plans and submit those to the Director no later than 60 days after these amendments become final.
2. Operators shall place at least one cache at a readily available location within five hundred (500) feet of the nearest working face in each working section of the mine and each active construction or rehabilitation site. Distances greater than five hundred (500) feet not to exceed one thousand (1,000) feet, are permitted. However, where miners are provided with personal SCSR's rated for less than sixty (60) minutes, travel to these

caches is not to exceed five (5) minutes as determined by the height/travel time chart specified in Section 5.3.2.

3. Each of these caches (nearest working face in each working section of the mine and each active construction or rehabilitation site) shall hold two (2) SCSR's that will provide at least 60 minutes of oxygen per unit for each miner. When each miner carries an SCSR that is rated for less than 60 minutes, in which case the cache shall hold three (3) SCSR's for each miner. The total number of SCSR's to be cached will be based on the total number of miners reasonably likely to be in that area.
4. Operators shall ensure that caches described above also contain an escape kit containing a hammer, a tagline, a supply of chemical light sticks, and an escape-way map.
5. Beginning at the storage cache located at the working section or active construction or rehabilitation site and beltlines, pumping and bleeder areas, and continuing to the surface or nearest escape facility leading to the surface, the operator shall station additional storage caches containing a number of additional SCSR's equal to or exceeding one each for the total number of persons reasonably likely to be in that area at calculated intervals that a miner may traverse in no more than thirty (30) minutes traveling at a normal pace, taking into consideration the height of the coal seam and utilizing the travel times as specified in Section 5.3.2.
6. The Task Force recommends that SB-247 be modified by removing references to "certified intrinsically safe battery-powered strobe lights" due to the concern that damaged strobe lights would create a potential ignition hazard if damaged in an

explosion. The Task Force recommends that each SCSR cache shall have a reflective sign with the words "SELF-RESCUER" or "SELF-RESCUERS" conspicuously posted at each such cache and that reflective directional signs be posted leading to each cache. Cache storage containers shall be of such construction as to protect the SCSR's from normal operational damage, be made of a material that is non-combustible, shall be easy to open during an emergency escape, and shall be noted on the escape-way map.

7. Operators shall provide training in the proper use of SCSR's in simulated emergency situations, which may be on the surface, in all required SCSR training. Training should include but not be limited to, manufacturer's required daily inspections, donning and starting the SCSR, ways to maximize duration of the unit, changing between SCSR's, communicating without removing the mouth piece, importance and use of goggles, how to know if the device has failed and what to do if it does, and limitations of the SCSR. Until such time as manufacturers offer an operable training SCSR, operators are encouraged to save out-of-service units to activate during training as a supplement to currently available training models. All training shall be recorded and made available upon request.
8. Operators and contractors shall report to the Director all SCSR's in service by manufacturer, model, serial number, mine/contractor ID#, service dates, and results of required inspections. This information shall be submitted electronically as defined by the Director, updated quarterly and will include information on any units removed from service along with reasons. The Director shall compile and analyze the results of this

information and distribute a report within 30 days by posting the report on the MHS&T web page.

III. EMERGENCY SHELTERS/CHAMBERS

SUMMARY

The Task Force has concluded that the first and preferred option for miners in an emergency is to escape. However, it has found that options exist to provide the primary function of an Emergency Shelter/Chamber which is designed to potentially sustain life after a major underground event such as an explosion and where escape is cut off. The Task Force has developed recommended minimum requirements for the emergency shelter/chamber and its use.

In developing recommendations, the Task Force reviewed summaries of mine accidents that resulted in barricading of miners and developed a scenario. The scenario used is of an accident in which miners within 1,000 feet of the working face have survived a methane explosion. The Task Force's scenario does not included secondary explosions or on-going fires in the immediate area. The miners will have made every attempt to exit and found all escape ways impassable. As a last resort, they have been forced to return to the shelter/chamber to await rescue. We have assumed that miners approaching the emergency shelter/chamber will have consumed most of their SCSR time, be exhausted from escape attempts, with some injured miners and all under great stress. In this condition, the miners will need to be protected by the shelter/chamber within minutes of reaching it and for a period of at least 48 hours.

The Task Force has determined that there are commercially available manufactured emergency shelters/chambers that meet and/or exceed the minimum requirements necessary to provide a "last resort" atmosphere when escape is cut-off. It is also evident that there will be

evolution of the designs and that continued support of these innovations by the State and industry will benefit mine safety.

The Task Force concluded that an emergency shelter/chamber or equivalent protection, in the form of additional surface openings, shall be located within 1,000 feet of the nearest working face.

The Task Force reviewed several documents produced during the 1970's and 1980's by the US Bureau of Mines regarding the use of built-in-place shelters using areas, i.e. crosscuts in a mine.

Some Task Force members wanted to prohibit the use of built-in-place shelter in the State of West Virginia, while other Task Force members wanted to allow the use of built-in-place shelters as an option to provide equivalent protection to a shelter/chamber. The Task Force discussed this issue many times throughout our deliberations and could not reach a consenus.

BACKGROUND

An explosion is such a complex phenomenon that no one can explain all of the reasons for its path, fluctuating violence, changing shape, and other characteristics. History proves that most miners survive the initial explosion and flames, however, too many fall victims to toxic air[27].

After a mine explosion, the desire of all miners is to immediately escape. While the provisions of SB-247 enhance their ability to escape, experience has demonstrated that in some instances, a small number of miners may have no alternative but to barricade. Providing a ready

[27] McCoy JF et al [1983]: "Development of Guidelines for Rescue Chambers, Volume II, Appendices", USBM Contract J0387210, page 13

'barricade' equivalent, in the form of an emergency shelter/chamber, should enhance their chances for survival. The record clearly demonstrates that regardless of the quality of the barricade, the lives of miners who have been forced to barricade depend on well-trained mine rescue teams and mine rescue operations[28].

For that reason, the Task Force supports the comprehensive review of West Virginia's mine rescue infrastructure and rules with the intent of enhancing rescue capability.

Since there are no nationally recognized performance standards for emergency shelters/chambers the Task Force spent considerable time determining what minimum standards should apply. It is the Task Force's intent that these recommendations serve truly as minimum standards and that manufacturers strive to exceed these thresholds.

The first step taken was to develop a scenario. In doing this the Task Force looked at studies of mine explosions and fires where barricading was utilized[29]. This was done through review of the professional experience of Task Force members, interviews with mine safety vendors, review of the recent accidents in West Virginia, and documents from MSHA, NIOSH, and other countries.

The Task Force concluded that the function of an emergency shelter/chamber must be ensuring a safe atmosphere for survivors. Documents reviewed indicated that carbon dioxide and carbon monoxide poisoning was by far the cause of most fatalities among those that survived the initial explosion. As methane and liberated coal dust are combusted they first create carbon

[28] McCoy JF et al [1983]: "Development of Guidelines for Rescue Chambers, Volume II, Appendices", USBM Contract J0387210
[29] McCoy JF et al [1983]: "Development of Guidelines for Rescue Chambers, Volume II, Appendices", USBM Contract J0387210

dioxide, then as the oxygen decreases, carbon monoxide. Carbon dioxide increases the breathing rate which pulls more air into the lungs and the air increasingly becomes concentrated with carbon monoxide, this compound binds to the hemoglobin in the blood blocking oxygen. The reduction in oxygen carrying capacity of the blood results in acute hypoxia (oxygen starvation)[30] which results in unconsciousness and eventual death if the concentration exceed 15% for high-risk miners[31].

The next performance criterion the Task Force set was duration. The times from event to either rescue or estimated time of death in mine accidents that resulted in barricading were reviewed. From 1940 to 1980 US Bureau of Mines reported that 127 miners survived behind barricades while 40 died[32]. Each accident was unique and the reporting was not consistent making it difficult to draw statistical conclusions. However, of those that discussed duration the maximum was 54 hours at the Belva No. 1 mine in 1954 and the least was 4 hours at the Pocahontas 31 mine in 1957. The majority were in the 20-30 hour range[33]. Based on its findings, the Task Force set a minimum duration of 48 hours.

The next criterion deals with the physical environment in which the emergency shelter/chamber must survive in order to be useful to those who can not immediately escape. Looking again at reports and drawing upon its own experience, the Task Force found few cases

[30] http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning
[31] Peterson, JE [1975]: "predicting carbonhemoglobin levels resulting from carbon monoxide exposure", J. Appl. Physiol., 39, 633-638 and Davidson, T [2002], Gale Encyclopedia of Medicine
[32] Foster Miller Associates [1975]: "Design of Reusable Explosion-Proof Bulkheads for a Crosscut Refuge Chamber", National Technical Information Service, PB251714
[33] McCoy JF et al [1983]: "Development of Guidelines for Rescue Chambers, Volume II, Appendices", USBM Contract J0387210 and Kravitz JH [1981] "An examination of Major Mine Disasters in the United States", MSHA and US Mine Rescue Association [2006]: "Mine Disasters Since 1980", www.usnra.com and CDC [2004]: "Analysis of Mine Fires for all Underground and Surface Coal Mining Categories: 1990-1999", IC 9470

where miners who had barricaded were affected by secondary explosions or fires. The instances where secondary explosions had cost lives predominately have been the lives of fellow miners or rescue team members who entered areas where methane levels were building without adequate ventilation. Additionally, the Task Force did not conclude that barricading in emergency shelters/chambers would allow survival from a major mine fire in the immediate area. Experience demonstrated that if a coal mine fire cannot be contained within a few hours after discovery, the chances of successfully extinguishing the fire without sealing part of the mine or the entire mine are greatly diminished[34]. Given these realities, the Task Force recommends that the shelter/chamber be designed to survive an initial event.

The Task Force concluded that the shelter/chamber needs to be sized to support a number equal to or exceeding the total number of miners reasonably likely to be in that area.

Based upon this scenario it was necessary to define the pressure threshold for survival of the emergency shelter/chamber during the initial event. Pressures referred to in regulations and rules for mine stoppings and seals are for static pressure. Static pressure is the force per unit area exerted across a surface parallel to the direction of the flow.[35] In an explosion, static pressure increases rapidly then returns to normal. This sudden increase in pressure is referred to as peak overpressure. The overpressurization wave from a methane explosion in a mine is a function of the concentration of the methane and the length of the area in which the reaction occurs. As the flame front moves through the gas, it increases the temperature of the reaction products it leaves behind. The hot gases expand pushing the flame-front much like a piston in a cylinder.

[34] Conti RS [2006]: "Responders to Underground Mine Fires", NIOSH Pittsburgh Research Laboratory
[35] http://en.wikipedia.org/wiki/Pressure

Turbulence is created by imperfections in the ribs, roof and floor and varying methane concentration between floor and roof. Studies by the US Bureau of Mines found that a typical 25 foot flame-front generates a 15 psi overpressurization wave with one second duration[36]. As the flame-front passes a crosscut, a portion of its energy is transferred along these paths reducing the pressure in the forward direction. In addition, as the pressure front moves it loses pressure as a result of friction with ribs, floor and ceiling.

The Task Force's scenario assumes that miners are within 1,000 feet of a methane explosion. Each crosscut that the blast passes reduces its pressure by 1/3, therefore, if it were 15 psi before a cross-cut it would be 10 psi afterward[37]. The additional loss from surface friction is 33% per 100 feet traveled[38]. We also found that Department of Defense weapon designers use a 13 psi peak overpressure as the 100% lethality threshold[39]. Blast injury occurs from an interaction of the overpressurization wave and the body with differences occurring from one organ system to another. Air-filled organs such as the ear, lung, gastrointestinal tract and organs surrounded by fluid-filled cavities such as the brain and spinal cord are especially susceptible to overpressure blast injury[40]. The overpressurization wave dissipates quickly, causing the greatest risk of injury to those closest to the explosion[41]. It is thus possible that because of the turbulent nature of the pressure, some survivors could benefit from emergency shelter/chamber

[36] Mitchell, DW and Nagy J [1963]: "Experimental Coal Dust and Gas Explosions", US Bureau of Mines, RI 6344
37 GexCon AS: "Gas Explosion Handbook", http://www.gexcon.com/index.php?src=handbook/GEXHBchap1.htm
[38] Mainiero, RJ and Weiss ES [1983]: "Blast Wave Propagation in Underground Mines", USBM Pittsburgh Research Laboratory
[39] US Naval graduate school [2006]: "Introduction to Naval Weapons", http://www.fas.org/man/Department of Defense-101/navy/docs/es310/syllabus.htm
[40] Elsayed, N. M. (1997). Toxicology of blast overpressure. *Toxicology, 121*, 1-15.
[41] Mayorga, M. A. (1997). The pathology of primary blast overpressure injury. *Toxicology, 121*, 17-28.

installations. The Task Force thus determined that a 15 psi overpressurization wave for a shelter/chamber located in a crosscut 500 feet but no more than 1,000 feet from a working face explosion would likely survive for use by miners who find they could not escape.

The Task Force also considered dynamic pressure. Dynamic pressure is the pressure increase that a moving fluid imparts upon an object in its path and is expressed as the velocity of that object. A 1/16 inch square rock particle would be accelerated by the explosion of 1,000 cubic feet of 10% methane to 1,500 feet per second.[42] It is unlikely that even the most robust shelter/chamber could survive such conditions. Using the same logic as MSHA uses for seal limits the Task Force recommends that shelter/chambers be positioned in crosscuts in order to avoid much of the dynamic pressure.

Temperature thresholds were predominately developed based upon the discussions with SCSR manufacturers and NIOSH that revealed the maximum temperature at which catastrophic failures were observed were in the 150 ºF to 300ºF range[43]. Most emergency shelter/chamber manufacturers appear to be offering oxygen supply in the form of compressed gas or chemical generation processes similar to those used by SCSR manufacturers. It was also learned that the irreversible damage threshold for human skin is 170ºF for 1 second[44]. Methane combustion generates temperatures at the flame front exceeding 2,500ºF with the front moving at

[42] $v(\text{at } 100 \text{ m}) = (2150 \text{ m/s})\, e^{-(1.2 \times 0.5 \times 0.0001 \times 100)/(2 \times 0.002)} = 480$ m/s - Fragment velocity at 100 m from the detonation given: A = 1 cm^2 $C_d = 0.5$ m = 2 g with the default value for the density of air.
[43] Interviews with NIOSH scientists and CSE, Drager, and Ocenco technical personnel [April 2006]
[44] Clarke J [1999]: "Burns" Brit Med Bull 1999; 55: 885-894 and Koumbourlis A C [2003]: "Electric injuries" Crit Care Med; 30 (Suppl 11): S424-430.

approximately 100 feet per second[45]. While the flame would quickly pass, the resultant convective and irradiative heat would likely exceed the skin damage thresholds by at least a factor of two resulting in deep 2nd and 3rd degree burns[46]. The Task Force concluded that a flash temperature of 300 ºF would ensure that the shelter would survive an initial event.

It does little good if the shelter survives the initial event but the environment inside will not support the lives of any miners who may not be able to escape. In considering interior environmental criteria, the Task Force adopted existing NIOSH, MSHA, and WV MHS&T guidelines of oxygen, carbon dioxide, and carbon monoxide. For temperature we found general consensus among Department of Defense, NATIONAL AVIATION AND SPACE ADMINISTRATION, Canadian, Australian, and United Kingdom guidance for an 'apparent-temperature' of 95ºF [47]. The largest technical challenge in maintaining this temperature is the approximately 400 BTU per hour per miner that will be generated while the shelter/chamber is occupied[48]. Each BTU per hour represents the energy required to raise the temperature of one pound of water by one degree Fahrenheit. Potentially high temperatures are compounded by high humidity in a sealed environment. High humidity reduces the ability of the body to regulate

[45] University of South Australia, School of Engineering [2003]: "Gas, dust, spontaneous combustion & outbursts"
[46] Wilcox R [1996]: "The realities of explosive thermal radiation", http://www.explosafety.homecall.co.uk/art1pt3.htm and Burnsurgery.org [2006]: "Section II: Pathogenesis of burn injury (initial and delayed)",
[47] Apparent temperature is an adjustment to the dry bulb temperature based on the level of humidity. It is computed using AT = Ta + 0.33×e − 4.00 where Ta = Dry bulb temperature (°C) and e = Water vapor pressure with the water vapor pressure calculated from the dry bulb temperature and relative humidity using the equation: e = rh / 100 × 6.105 × exp (17.27 × Ta / (237.7 + Ta)) with rh being the relative humidity in percent
[48] NATIONAL AVIATION AND SPACE ADMINISTRATION [2004]: "Manned Systems Integration Standards" http://msis.jsc.National Aviation and Space Administration.gov/Volume1.htm

temperature by sweating thus raising the internal body temperature to the danger range[49]. Several studies report deaths as the result of elevated temperatures in enclosed spaces.[50]

The Task Force set criteria in others areas it concluded appropriate. The Task Force recommends that the emergency shelter/chamber be able to maintain its acceptable environment while allowing miners to enter and exit as needed. The Task Force recommends that the shelter/chamber provide a means to readily identify where it is and if it is occupied. The Task Force concludes it should provide a means of monitoring both the inside and outside air quality and provide a means of signaling the surface. Regarding food and water, the Task Force looked to various Department of Defense, NATIONAL AVIATION AND SPACE ADMINISTRATION, and other sources for minimum sustainable levels. Regarding sanitation the Task Force recommends removal verses chemical treatment. In maintainability, the Task Force recommends that the shelter/chamber be transportable, readily inspected, and contain supplies for its repair while occupied. The Task Force concluded it should be provided with appropriate first aid supplies. And lastly, because it will only be used in the case of an emergency, where applicable, anything in or associated with the shelter/chamber be MSHA certified intrinsically safe or explosion proof.

The Task Force views emergency shelters/chambers as a system. The system includes the materials that physically are in the shelter/chamber, the emergency rescue plan that includes the shelter, and the training for miners and rescue teams in the use of the shelter as a 'last resort'.

[49] Brenkley BJ et al [2003]: "Use of Self-Rescuers in Hot and Humid Mines", UK Mines Rescue Service; Research Report 180
[50] Brake, DJ and Bates, GP [1999]: "Criteria for the Design of Emergency Refuge Stations for Underground Metal mines", AusIMM Proceedings, No. 2 1999

For that reason, the Task Force also recommends that shelters be incorporated in all aspects of safety, prevention, response planning, and training. All training shall be recorded and made available upon request.

DEFINITIONS

- **Emergency Shelter/Chamber** – An enclosed space located within 1,000 feet of the nearest working face with all sides made from man-made materials whose function is to protect the occupants from hazardous gases.

REQUIREMENTS

Based upon the Task Force's scenario it is recommended that in order to be approved the Director determine that each proposed emergency shelter/chamber:

- provide a minimum of 48 hours life support (air, water, emergency medical supplies, and food) for the maximum number of miners reasonably expected on the working section;
- be capable of surviving an initial event with a peak overpressure of 15 psi and a flash temperature of 300 degrees Fahrenheit;
- be constructed such that it will withstand normal handling and pre-event mine conditions;
- provide for rapidly establishing an internal shelter atmosphere of

  O_2 above 19.5%,

  CO_2 below 0.5%,

  CO below 50 ppm, and

  an apparent-temperature not exceeding 95 degrees Fahrenheit;

- provide the ability to monitor carbon monoxide and oxygen inside and outside the shelter/chamber;
- provide a means for entry and exit that maintains the integrity of the internal atmosphere;
- provide a means for intrinsically safe power if required;
- provide a minimum of eight quarts of water per miner;
- provide a minimum of 4000 calories of food per miner;
- provide a means for disposal of human waste to the outside of the shelter/chamber;
- provide a first aid or EMT kit in addition to a section first aid kit;
- have provisions for inspection of the chamber/shelter and contents;
- contain manufacturer recommended repair materials;
- provide a battery-powered internal strobe light visible from the outside indicating occupancy;
- provide a means of communications to the surface; and
- only contain MSHA approved materials where applicable.

COMMERCIAL AVAILABILITY

The Task Force has reviewed multiple shelter/chamber designs and has determined that products able to meet these standards are currently available for the Director's evaluation.

OPTIONS REVIEWED

Built-in-Place

A built-in-place shelter is a barricade that utilizes the mine as part of its construction (for example enclosing a crosscut). The Task Force reviewed several documents produced during the 1970's and 1980's by the US Bureau of Mines regarding the use of built-in-place shelters using areas, i.e. crosscuts in a mine.

Some Task Force members wanted to prohibit the use of built-in-place shelters in the State of West Virginia, while other Task Force members wanted to allow the use of built-in-place shelters as an option to provide equivalent protection to a shelter/chamber.

The Task Force discussed this issue many times throughout its deliberations and could not reach a consensus.

Hard-Walled

The Task Force reviewed many designs including some prototypes for chambers constructed with hard walls. Most were made of steel, however, some innovative designs included composites and other materials. They are either ready to enter or require minimal assembly if miners find they can not escape.

Soft-Walled

The Task Force reviewed a lesser number of soft-walled chambers. These would be stored in some manner for protection prior to an event and would only be deployed if the miners were unsuccessful in escaping.

Internal Subsystems

Manufacturers differed in their approaches to provide an acceptable atmosphere inside their chambers. Many utilized compressed air or oxygen with some using chemical oxygen production. They all utilized some form of chemical carbon dioxide removal and carbon monoxide removal. Several have attempted to address the temperature control issue without using battery power and the Task Force has confidence they will succeed. The Task Force has encouraged manufacturers to find as many ways as possible to eliminate dependence on electricity from batteries as they introduce the chance of failure in a chamber that may sit for years without use. Several have made significant strides toward this as their designs evolve.

IMPLEMENTATION, COMPLIANCE AND ENFORCEMENT

1. The Director shall require, in each underground mine, an emergency shelter/chamber, it shall be located in a crosscut no more than 1,000 feet from the nearest working face and shall be accurately located on mine maps.
2. The Director may approve, as an alternative to a shelter/chamber, an additional surface opening located no more than 1,000 feet from the nearest working face and accurately located on mine maps.
3. The Director shall acquire, no later than July 1, 2006, the necessary technical/engineering support needed to evaluate the performance of emergency shelter/chamber components/systems, and to review the effectiveness of emergency shelter/chamber plans.

4. The Director shall, no later than July 10, 2006, issue an open opportunity for emergency shelter/chamber providers to submit products for approval.
5. The applicant is to submit documentation including a certification by an independent licensed professional engineer that its unit meets the requirements.
6. The Director shall maintain a current list of approved emergency shelter/chambers on the West Virginia MHS&T web site.
7. After an emergency shelter/chamber has been approved, any modifications must be submitted for approval by the Director.
8. The Director shall convene the Mine Safety Technology Task Force not less than once per month through June 30, 2007 for the purpose of reviewing progress by manufacturers, regulators, and operators toward achieving the goals set forth in SB-247 and to review the functional and operational capability of necessary mine safety and health technologies. The Task Force shall submit a report to the Director of its findings and recommendations.
9. No later than April 15, 2007 all underground mine operators shall submit an emergency shelter/chamber plan for approval by the Director. The design, development, submission, and implementation of the shelter/chamber plan shall be the responsibility of the operator of each mine.
10. Within thirty (30) calendar days after submission of the emergency shelter/chamber plan, the Director shall either approve the emergency shelter/chamber plan or shall reject and return the plan to the operator for modification and resubmission, stating in detail the

reason for such rejection. If the plan is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such plan.

11. Within 15 days of approval by the Director, the underground mine operator shall submit as an addendum to its emergency shelter/chamber plan a copy of any contract, or purchase order, or other proof of purchase of any equipment required to complete the emergency shelter/chamber and for installation and ongoing maintenance.
12. After the Director has approved an operator's emergency shelter/chamber plan, the operator shall submit revisions to the emergency shelter/chamber plan at any time that changes in operational conditions result in a substantive modification. In addition, at any time after approval, the operator may submit proposed modifications or revisions to its plan along with reasons therefore to the Director. Within thirty (30) days after receipt by the Director of any proposed revisions or modifications to the emergency shelter/chamber plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection.
13. If the Director, in his sole discretion, determines that an operator has failed to provide an emergency shelter/chamber plan, has provided an inadequate emergency shelter/chamber plan, has failed to comply with its approved emergency shelter/chamber plan, or has failed to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the

Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

14. In developing the emergency shelter/chamber plan and any revisions, the operator shall take into consideration the physical features of the particular mine, emergency plans, advances in emergency shelter/chamber technologies and any other aspect of the particular mine the operator deems relevant to the development of the emergency shelter/chamber plan.
15. A copy of the approved emergency shelter/chamber plan shall be provided to the mine rescue teams providing coverage for the mine. Copies of the most recent version shall be available at the mine for emergency responders. As changes are made to the system, updated versions shall be submitted to the above parties.
16. The proposed emergency shelter/chamber plan shall:
    - describe the structure and operations of the emergency shelter/chamber and its role in emergency response;
    - ensure that emergency shelters/chambers are included in initial mine hazard training in such a manner that it is in compliance with all manufacturer's requirements and is provided yearly in addition to annual refresher training. All training shall be recorded and made available upon request;
    - ensure weekly inspections of emergency shelters/chambers and contents shall be conducted by a certified mine foreman/fireboss and recorded in weekly ventilation examination book;

- ensure that weekly safety meetings review the current location of applicable emergency shelters/chambers and results of the latest inspection;
- ensure that emergency shelters/chambers shall be equipped with easily removable tamper-proof tags such that a visual indication of unauthorized access to the emergency shelter/chamber can be detected; and
- ensure that the mine's communication center shall monitor any communication systems associated with the emergency shelter/chamber at all times that the mine is occupied.

17. The proposed emergency shelter/chamber shall include the ability to:

- provide a minimum of 48 hours life support (air, water, emergency medical supplies, and food) for the maximum number of miners reasonably expected on the working section;
- be capable of surviving an initial event with a peak overpressure of 15 psi and a flash temperature of 300 degrees Fahrenheit;
- be constructed such that it will be protected under normal handling and pre-event mine conditions;
- provide for rapidly establishing an internal shelter atmosphere of

  O_2 above 19.5%,

  CO_2 below 0.5%,

  CO below 50 ppm, and

  an 'apparent-temperature' of 95 degrees Fahrenheit;

- provide the ability to monitor carbon monoxide and oxygen inside and outside the shelter/chamber;
- provide a means for entry and exit that maintains the integrity of the internal atmosphere;
- provide a means for intrinsically safe power if required;
- provide a minimum eight quarts of water per miner;
- provide a minimum of 4000 calories of food per miner;
- provide a means for disposal of human waste to the outside of the shelter/chamber;
- provide a first aid or EMT kit in addition to a section first aid kit;
- have provisions for inspection of the shelter/chamber and contents;
- contain manufacturer recommended repair materials;
- provide a battery-powered internal strobe light visible from the outside indicating occupancy;
- provide a means of communications to the surface; and
- only contain MSHA approved materials where applicable.

18. The Director may require modifications to an emergency shelter/chamber approval or an emergency shelter/chamber plan at any time following the investigation of a fatal accident or serious injury, as defined by Title 36, Series 19, Section 3.2, if such modifications are warranted by the findings of the investigation.

IV. COMMUNICATIONS AND TRACKING

SUMMARY

In completing its charge to evaluate availability, functional and operational capacity of required communication and tracking devices, the Task Force reviewed multiple products, designs, and approaches and has determined that while no single product exists to meet all the requirements, the intent of SB-247 can be met in most if not all mines by employing separate systems, possibly requiring one for communications and one for tracking.

Further, the Task Force has determined that through utilizing multiple products and procedures an integrated communication/tracking system can be installed that would meet the intent of the law … 'to protect miners in an emergency'.

Given the recent focus by our nation's technical and scientific community concerning this issue, the Task Force feels that with heightened oversight, continued and substantial progress can be realized.

The Task Force believes that West Virginia must continue its leadership role for emerging mine safety and health technologies by providing a monthly report of communication/tracking progress to insure development and implementation at the earliest possible opportunity.

BACKGROUND

In the aftermath of a catastrophic accident in an underground coal mine, lack of information severely inhibits decision making both for those underground trying to escape and those on the surface trying to respond. This lack of accurate information in the face of life-and-

death decision making is a problem the military refers to as the 'fog of war'. The current focus on communications and tracking technologies seeks to reduce this fog.

The proliferation of technologies has encouraged a belief that any problem can be fixed with the right device. This mind set has carried over to a regulatory world where 'people's safety is addressed exclusively in engineering terms'[51] this means that human volition has been left out of the equation. We believe this to be unsound. For this reason, we have taken a look at how miners have made decisions in emergency situations.

As part of this effort, the Task Force considered the experiences of its members and others in underground mine accidents and reviewed studies on past mine accidents.

Several insights relevant to setting communication/tracking system requirements emerged. First, emergency activities (including escape) are not individualistic. They tend to be group responses. Therefore, models based on assumptions of individual behavior are inadequate for setting requirements. Second, leaders have a significant impact on people's perceptions and subsequent behavior. Thus, they greatly influence the groups' survival chances. Third, individuals will assist others, even at their own peril. Fourth, informal groups emerge for dealing with non-routine situations. Finally, team decision-making becomes more common under conditions of stress, even among groups that do not encourage teamwork. [52]

[51] Sime J [1985]. Environ and Behav 17(6):697-724
[52] Vaught C et al [2000]. NIOSH Information Circular 9450

Other valuable reference points are the elements of decision making itself; (1) the recognition of a problem, (2) a definition or diagnosis, (3) consideration of options, (4) a choice of what is perceived to be the best option given what is know and (5) execution of the decision.[53]

Simply installing technologies, however, will not eliminate the possibility that a wrong decision may be made under extreme stress. Experience has demonstrated that the greater the stress, the more often data will be ignored, noise will be mistaken for information and information will be misconstrued, thus increasing the possibility for confusion. Emergency communication/tracking system designs must be well thought through. They must be tailored to the geology and operation of the mine and integrate not only hardware but procedures and include experiential training to ensure success.

In its deliberation the Task Force reviewed advanced devices and systems from dozens of vendors. It concluded that although no single device or system presented had all the functional and operational capability for a combined communication/tracking system that satisfies all the requirements set out in SB-247, there is the potential for adapting many of the more advanced communication and tracking technologies to the underground mine environment. Discussions with manufacturers and vendors indicated that attempts to do so have been stymied by the small market size and the high cost of product development and certification. The Task Force found that there has been little progress in mine communication and tracking technology since the disbandment of the US Bureau of Mines communication efforts in the late 1980's. In fact many of the 'new' approaches presented were adaptations of approaches described by the USBM.

[53] Flathers GW et al [1982] Aviat Space Environ Med 53(10):958-963

Therefore, the Task Force recommends that a responsible agency be once again charged with advancing mine communication/tracking technology.

The Task Force believes that rather than the simple selection of a device, miners are best served by the creation of a mine-specific integrated communication/tracking system that provides them the ability to better understand what is happening around them, to communicate with other members of any groups they form in efforts to escape, to communicate with those on the surface to exchange information, to allow those on the surface information as to miners' location that will reduce the time required for rescue if required, and that such systems incorporate as many redundant options as practical to insure survivability. Additionally, the Task Force believes it is critical that all expected participants in the emergency response have knowledge of the capabilities and limitations of the system as installed and have been exposed to experiential training on its use in group decision-making.

DEFINITIONS

- **Emergency communications** – transmission and reception of data and/or information regarding an unexpected event requiring immediate action, including but not limited to voice, text, signal beacons, etc.
- **Wireless** – allowing individual emergency communications with a mine communication system without a physical connection
- **Communication device** – a piece of equipment that is a component of an integrated mine communication/tracking system

- **Physical location** – position in relation to a tracking device at a known location to enhance rescue and communication with miners during an emergency
- **Tracking & location** – knowing the physical position of miners at the moment of the event and as the event progresses if the tracking/location system being used is still functional
- **Tracking/locating device** - a piece of equipment that is a component of an integrated mine communication tracking system for the purpose of providing the physical location of a miner during an emergency

REQUIREMENTS

Each underground mine shall provide an integrated communication/tracking system, a component of which shall be a communication center monitored at all times during which one or more miners are underground. This center shall be staffed by persons holding a valid underground miners certificate, and trained and knowledgeable of the installed communications/ tracking systems, monitoring and warning devices, travel-ways, and mine layout.

Individuals not possessing a valid underground miner's certificate but working full-time as a communication center operator on or before May 25, 2006 shall be allowed to continue as communications center operators at that mine provided they will have successfully completed no later than December 31, 2006, a certified 80-hour underground miners training program and documentation of training is available for inspection.

The communication/ tracking system shall provide the ability for:

- knowing the location of all miners immediately prior to an event by tracking/locating in the escapeways, normal work assignments, or notification of the communication center;

- knowing the location of miners in the escapeways after an event, providing the tracking system is still functional;
- check-in and check-out with the communication center by persons prior to entrance and exit from bleeders and remote or seldom used areas of the mine (all times shall be logged);
- allowing two way communications coverage in at least two separate air courses, one of which being an intake;
- maintaining communication/tracking capabilities with loss of outside power and maintain function both inby and outby of the event site with suitable supply of equipment for rapid reconnection;
- maintain a surface supply of communication/ tracking devices for use by emergency rescue personnel; and
- allow for communication to surface at all required shelter/chambers.

All mine personnel shall be trained in the use, limitations and inter-operability of all components of the communication and tracking/locating system. All training shall be recorded and made available upon request.

The description and operations of the integrated communication/tracking system and its role in emergency response specific to the mine shall be detailed and submitted to the Director and to the mine rescue teams providing coverage for the mine once approved. Copies of the most recent version shall be available at the mine for emergency responders. As changes are made to the system, updated versions shall be submitted to all the above.

COMMERCIAL AVAILABILITY

In completing its charge to evaluate commercial availability and functional and operational capacity of required devices, the Task Force reviewed multiple communication and tracking products, designs, and approaches and has determined that no single product exists to meet all the requirements of a combined communication/tracking system outlined in SB-247. However, the Task Force has determined that products are available to install separate systems, one for communication and one for tracking. Further the Task Force has determined that through utilizing multiple products and procedures an integrated communication/tracking system can be installed that would meet the intent of the law…to 'protect miners in an emergency'.

Although the environment of underground mines presents physical challenges that impose severe limitations to communications options available on the surface, the Task Force has determined that development of options for underground communication and tracking have been held back primarily by the small size of the potential market. The potential sales volume does not warrant the costs of product development and obtaining the required approvals.

The Federal government has traditionally supported the development of critical technologies in areas where there is a public need and the free market can not respond. Millions of dollars have been spent in developing technologies for markets with limited volumes in the energy industry such as the advanced seismic exploration of oil and gas, advanced combustion turbines for power generation, nuclear power, advanced hot gas cleanup systems for boilers, but none for advancement of coal mine technology. The only instances the Task Force found where Federal funds where used to advance mine communication and tracking products to market in the

last 20 years were two projects funded by the US Department of Energy under an energy efficiency program.

With the reductions in funding of the US Bureau of Mines (USBM) starting in mid 1980's and its eventual termination in the 1990's, all efforts to advance mine technology, not just communications and tracking, basically ended in the United States. The cooperative research and development approaches developed under the USBM were successfully adopted by the US Department of Energy and applied to the Clean Coal Technology program and natural gas and oil exploration and production. However, no serious effort has been made by the Federal government to encourage industry to develop or adapt technologies to coal mining.

The Task Force believes that West Virginia should exert the credibility gained through its leadership role in mine health, safety, and training to define a Federal/State partnership that will formalize a program for continuous development of mining technology. Such a program should leverage funding from states with federal dollars to address solutions that are based upon the needs identified by state mine offices in consultation with federal agencies. The program should utilize the Small Business Innovative Research (SBIR) model to seek alignments between mining needs with those of Department of Defense, NATIONAL AVIATION AND SPACE ADMINISTRATION, DOE, etc. The SBIR model solicits solutions from small business for well-defined agency needs. The process has well defined phases, provisions for cost sharing, and commercialization goals. State funds could provide added cost-share money to enhance competitiveness of West Virginia proposals and accelerate development. Until such time as such a program can be established, The Task Force recommends that West Virginia initiate a program

of its own based upon this model to spur solutions and advance small business innovation in the State.

The Task Force has concerns about the current MSHA approval process applied to communication and tracking which only focuses on explosion prevention and not on functionality and operability. Products that are functionally ineffective and impossible to operate can be certified under the current rules. Therefore, the Director needs a means of ensuring that communication and tracking technologies that are MSHA certified actually work in the West Virginia applications for which they are proposed.

The Task Force recommends that the Office of MHS&T employ or obtain the services of an engineer whose duties would include reviewing communication/tracking technologies, communications/tracking plans, modification requests, provide technical assistance to industry and inspectors, and work to encourage the development or adaptation of communication and tracking technologies to West Virginia's underground mines.

OPTIONS REVIEWED

The Task Force reviewed multiple techniques of communication and tracking. All of them offer some advantages and have some limitations. A summary of the techniques follows.

Through-The-Earth Communications Options

Through the Earth (TTE) communications can take different forms. They include ground conduction, seismic, and wireless. Each type has unique characteristics which may be beneficial under certain emergency situations.

TTE Ground Conduction Signaling - Ground conduction signaling, called "the TPS method" by the U.S. Army Signal Corps[54]; consists of injecting and receiving signals through the ground via ground-stake connections.

TTE Seismic Signaling - Seismic signaling consists of using special sensors called geophones, to pick up vibration signatures created by a miner who pounds on roof bolts, the roof, or floor of the mine. [55]

TTE Wireless Signaling - A portable TTE system will likely have the best chance of providing contact with miners since it offers the best resistance to damage from roof falls, fires, and explosions. However, in this type of system frequency, geology, noise, and depth will influence the probability of successful communication.[56]

Through-The-Air Communications Options

Underground coal mines present unique challenges to radio signal propagation. The electrical properties of coal attenuate certain frequencies more than others. The effectiveness of wireless radio transmission in particular coal mines can only be determined through thorough testing in the mine environment.

[54] Jakosky, J.J., February 1924, UG Signaling for Mines by the Ground-Conduction or "T.P.S." Method, U.S. Bureau of Mines, RI 2576.

[55] Kononov, Dr. V.A, November 1999, Develop a trapped miner location system and an adequate strategy and associated technologies, CSIR Division of Mining Technology South Africa and Powell, JA and Watson, RA [1976]: "Seismic Detection of Trapped Miners Using In-Ground Geophones", USBM RI-8158 and Greenfield, RJ [1983]: "Improvements to the Seismic Detection and Location Procedure", Penn State Univ, USDI J0318047 and Fowler, JC [1975]: "Seismic Mine Monitor System", Conoco Geophysical, DOI HO133112 and Greenfield, RJ [1982]: "Theoretical Investigation of Seismic Waves Generated in Mines", G-0155044

[56] Emslie, AG et al, Emergency and Operational Mine Communications, Arthur D. Little, U.S. Bureau of Mines Contract Report No. HO122026.

Research has shown that medium frequencies (MF) offer a viable approach to underground coal mine communications under certain circumstances. MF transmission is feasible for both personnel and vehicular communications. It does not suffer the attenuation characteristics and severe corner losses of Ultra High Frequencies (UHF) communications nor does it require the use of leaky feeder cable. Furthermore, it does not experience the high noise levels of low frequency communications. Research has demonstrated ranges of 1000 – 1500 feet in conductor-free areas, and much greater ranges in conductor-filled areas[57]. 300 kHz to 600 kHz (MF) frequencies work well when in the presence of any conductive medium (e.g., wires, cables, tracks, etc.). Radio signals in the 27 MHz range are absorbed by coal seams[58]. Radio signals in the 150, 500, 900 MHz and 2.5 GHz provide good line-of-sight propagation but typically won't turn more than a few crosscuts.[59]

Through-The-Wire Communications Options

All communications and tracking devices eventually connect to a wired system either above or below ground. Through-the-wire (TTW) communications signals travel over twisted pair, CAT5 (Ethernet cable), trolley cables, leaky feeders, and fiber optic cables.[60] Each of these

[57] Aidala, D.A., Lagace, R.L., Emslie A.G, Ginty, J.J., Roetter, M.F., Spence R.H. Welz, A.W. A Survey of EM and Seismic Noise Related to Mine Rescue Communications, Arthur D. Little Inc. U.S. Bureau of Mines Contract Report HO122026.

[58] Curtis, D.A, Lagace, Robert L, Foulkes, J.D., Rothery J.L., May 1977, Feasibility of Developing Efficient Compact Transmit Antennas for Portable VLF to MF Wireless Mine Communications, Arthur D. Little Inc. U.S. Bureau of Mines Contract Report HO346045.

[59] Conti, Ronald, 2000, White Paper on Technologies for Communications and Locating Trapped Miners.

[60] Moussa, Albert, Lagace, Robert L., 1982, February, Initial Study of Buried Communications Cable for UG Mines, U.S. Bureau of Mines Contract Report No. JO3038037.

cable types have unique properties which generally are selected to suit the characteristics of the signals being conveyed. While TTW communication systems provide a large selection of device options and easily transfer signals between the surface and underground, they are susceptible to failure due to fires, explosions, and roof falls. However, with judicious system design and use of redundant wiring designs TTW systems should survive all but the most severe accidents.[61]

Seismic Communications/Tracking Options

Though not generally thought of as a communication system, a seismic location system can locate a miner with an accuracy of 100 feet and can tell a miner his signal has been located. As a miner moves, the path of these signals can track movement during an escape. Research performed in the 1970's by the USBM produced a system and a method which could provide locations of miners to a depth of 2000 feet. Many advances have been made in seismic equipment with current systems operating off a laptop computer. Miners generate seismic signals by pounding on mine surfaces such as the roof, floor, and ribs, but preferably roof bolts. The system can monitor approximately 1 square mile over most mines[62].

Tracking/Location Identification Options

There are multiple means of locating and tracking a miner. One method involves measuring the strength of the signal from a miner's radio in relation to known receivers. Another involves embedding radio-frequency identification (RFID) tags on each miner that

[61] Forbes, J.J, Griffith, F.E., Cash, F.E., Petersen, Max S., March 1946) Mine Rescue Life-line Telephone Assemblies, U.S.Bureau of Mines Report of Investigation 3875.

[62] Lagace, Robert L., Dobbie, James M., Hawes, William S., Detection of Trapped Miner EM Signals Above Coal Mines, U.S. Bureau of Mines Contract Report No. J0188037, July 1980.

transmit data to an RFID receiver of known location. As the miner passes a receiver, it notifies a central system that records the location via a combination of wireless readers interconnected via leaky feeder, WiFi, or other systems. [63]

IMPLEMENTATION, COMPLIANCE AND ENFORCEMENT

1. The Director shall require, in each underground mine, an integrated communication/ tracking system, a component of which shall be a communication center monitored at all times during which one or more miners are underground.
2. The Director shall acquire, no later than July 1, 2006, the necessary technical/engineering support to evaluate the performance of individual communication/tracking systems and review the effectiveness of communication/tracking plans.
3. The Director shall convene the Mine Safety Technology Task Force not less than once per month through June 30, 2007 for the purpose of reviewing progress by manufacturers, regulators, and operators toward achieving the goals set forth in SB-247 and other mine health and safety technology to promote the availability, functional and operational capability of necessary mine safety and health technologies. The Task Force shall submit a report to the Director of its finding and recommendations.
4. No later than August 31, 2007 all underground mine operators shall submit a communication/tracking plan for approval by the Director. The design, development, submission, and implementation of the communication/tracking plan shall be the responsibility of the operator of each mine.

[63] Grayson, R.L., Unal, A., April 1998, Evolution of RFID technology in UG Mines, Mining Engineering, pp. 75-80.

5. Within thirty (30) calendar days after submission of the communication/tracking plan, the Director shall either approve the communication/tracking plan, or shall reject and return the plan to the operator for modification and resubmission, stating in detail the reason for such rejection. If the plan is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such plan.
6. Within 15 days of approval by the Director, the underground mine operator shall submit as an addendum to its plan, a copy of any contract, or purchase order, or other proof of purchase of any equipment required to complete the communication/tracking system and for installation and ongoing maintenance.
7. After the Director has approved an operator's communication/tracking plan, the operator shall submit revisions to the communications plan at any time that changes in operational conditions result in a substantive modification in the communication/tracking system. In addition, at any time after approval, the operator may submit proposed modifications or revisions to its plan along with reasons therefore to the Director. Within thirty (30) days after receipt by the Director of any proposed revisions or modifications to the communications/tracking plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection.
8. If the Director, in his sole discretion, determines that an operator has failed to provide a communications/tracking plan, has provided an inadequate communications/tracking plan, has failed to comply with its approved communications/tracking plan, or has failed

to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

9. In developing the communication/tracking plan and any revisions, the operator shall take into consideration the physical features of the particular mine, emergency plans, existing communication infrastructure, advances in communication/tracking technologies and any other aspect of the particular mine the operator deems relevant to the development of the communication/tracking plan.
10. The proposed communication/tracking plan shall describe the structure and operations of the separate or integrated communication/tracking system(s) and its role in emergency response specific to the mine shall be detailed and submitted to the Director and, once approved, to the mine rescue teams providing coverage for the mine. Copies of the most recent version shall be available at the mine for emergency responders. As changes are made to the system, updated versions shall be submitted to the above.
11. The proposed communication/tracking system shall include the ability for:
    - a communication center monitored at all times during which one or more miners are underground. This center shall be staffed by persons holding a valid underground miners certificate, and trained and knowledgeable of the installed communications/ tracking systems, monitoring and warning devices, travel ways, and mine layout. Individuals not possessing a valid underground miner's certificate but working full-

time as a communication center operator on or before May 25, 2006 shall be allowed to continue as communications center operators at that mine provided they will have successfully completed no later than December 31, 2006 a certified 80 hour underground miners apprentice training program and documentation is available for inspection;

- knowing the location of all miners immediately prior to an event by tracking/locating in the escape-ways, normal work assignments, or notification of the communication center;
- knowing the location of miners in the escape-ways after an event providing the tracking system is still functional;
- check-in and check-out with the communication center by persons prior to entrance and exit from bleeders and remote or seldom used areas of the mine (all times shall be logged);
- allowing two way communications coverage in at least two separate air courses and at least one of which shall be an intake;
- maintaining communication/tracking after loss of outside power and maintain function both inby and outby of the event site with suitable supply of equipment for rapid reconnection;
- maintain a surface supply of communication/ tracking devices for use by emergency rescue personnel;
- allow for communication to surface at all required shelters/chambers;

- all miners and likely emergency responders shall be trained in the use, limitations and inter-operability of all components of the communication and tracking/locating system. This shall be incorporated into required training. All training shall be recorded and made available upon request;

12. The operator shall provide a schedule of compliance for the communication/tracking plan, which shall include:
    - a narrative description of how the operator will achieve compliance with above requirements;
    - a schedule of measures, including an enforceable sequence of actions with milestones, leading to compliance; and
    - a statement indicating when the implementation of the proposed plan will be complete.
13. The operator shall provide as attachments to its communication/tracking plan:
    - a statement of the analysis and evaluation required in developing its plan;
    - a statement indicating the initial training dates for implementation of the communication/ tracking system and how the communication/tracking system will be incorporated in other required training;
    - a statement regarding how the communications/tracking system will be tested and maintained; and
    - the name of the person or persons representing the operator, including his or her title, mailing address, email address and telephone number, who can be contacted by the

Director for all matters relating to the communication/tracking plan and weekly testing of the system.

V. RELATED SAFETY ISSUES

The Task Force found many related safety and health issues important to miners but was unable to dedicate significant time to any. It provides the following recommendations and will work with the Director and the Board of Coal Mine Health and Safety to better explore these related issues.

LIFELINES

In lieu of installed lifelines in track or belt entries, markers such as floor mats with arrows, fish plate reflectors, red/green lasers shall be installed at distances not to exceed 1,000 feet or line of sight, or other equivalent devices may be used if approved by the Director.

SEALS

'Omega" type blocks shall not be used in future seal construction. They may, however, be used for other type ventilation controls. The Task Force applauds the Director's May 12, 2006 action imposing a moratorium on "Omega" type block installations and MHS&T's ongoing review of all existing installations. It is recommended that immediate corrective action be taken where warranted.

SEISMIC LOCATING DEVICES

The Director shall provide portable seismic locating systems at each regional office for use in locating trapped miners. Each office will maintain a trained staff that shall upon notification from Homeland Security Office, be capable of delivering the system to the mine site and to deploy system immediately and without delay. These persons shall practice with the said systems at least annually at different mine sites.

MINE RESCUE TEAMS

The Task Force supports and applauds the actions taken by the Board of Coal Mine Health and Safety and the Director of the Office of MHS&T for their efforts to address mine rescue capabilities and other mine rescue concerns in the State of West Virginia. The Task Force recommends these efforts be expanded to reflect currently available technology for mine rescue and fire fighting.

All mine rescue teams must participate in at least 2 mine rescue training events that are state or nationally sanctioned each year.

APPENDIX A – SENATE BILL 247 AND THE EMERGENCY RULE

ENGROSSED

COMMITTEE SUBSTITUTE

FOR

Senate Bill No. 247

(By Senators Tomblin, Mr. President, and Sprouse,

By Request of the Executive)

_____

[Originating in the Committee on the Judiciary;

reported January 23, 2006.]

_____

A BILL to repeal §22A-2-69 of the Code of West Virginia, 1931, as amended; to amend said code by adding thereto a new article, designated §15-5B-1, §15-5B-2, §15-5B-3, §15-5B-4 and §15-5B- 5 ; to amend and reenact §22A-2-55 and §22A-2-66 of said code; and to amend said code by adding thereto a new section, designated §24-6-14, all relating to mine and industrial emergencies; creating the Mine and Industrial Accident Rapid Response System; providing requirements for protective equipment in underground mines; providing for criminal penalties for the unauthorized removal of or tampering with certain protective equipment; defining certain terms; providing for notification requirements in the event of an accident in or about any mine and imposing a civil administrative penalty for the failure to comply with such notification requirements; providing rule-making authority; and clarifying the responsibilities of county answering points.

Be it enacted by the Legislature of West Virginia:
That §22A-2-69 of the Code of West Virginia, 1931, as amended, be repealed; that said code be amended by adding thereto a new article, designated §15-5B-1, §15-5B-2, §15-5B-3, §15-5B-4 and §15- 5B-5 ; that §22A-2-55 and §22A-2-66 of said code be amended and reenacted; and that said code be amended by adding thereto a new section, designated §24-6-14, all to read as follows:

CHAPTER 15. PUBLIC SAFETY.

ARTICLE 5B. MINE AND INDUSTRIAL ACCIDENT RAPID RESPONSE SYSTEM.

§15-5B-1. Legislative purpose; Mine and Industrial Accident Rapid Response System created.

(a) The Legislature finds that the health and safety of persons working in and around the mining industry and other industries is of paramount concern to the people of West Virginia and that deaths and serious injuries resulting from dangerous working conditions cause grief and suffering to workers and their families. The Legislature further finds that there is an urgent need to provide more effective means and measures for improving emergency response and communications for dealing with mine and industrial accidents. The Legislature declares that it is in the best interest of the citizens of West Virginia to designate an emergency telephone number for mining or industrial personnel to initiate a rapid emergency response to any mine or industrial accident. Provision of a single, primary emergency number through which emergency services can be quickly and efficiently obtained and through which the response of various state agencies charged by law with responding to mine and industrial emergencies can be coordinated will significantly contribute to the public good. The Mine and Industrial Accident Rapid Response System will provide a vital resource to the citizens of West Virginia by providing a critical connection between the Director of the Office of Miners' Health, Safety and Training, the Division of Homeland Security and Emergency Management, local and regional emergency services organizations and other responsible agencies.

(b) The Mine and Industrial Accident Rapid Response System is hereby created and shall consist of:

(1) The Mine and Industrial Accident Emergency Operations Center established in section two of this article; and

(2) The 24-hour-a-day statewide telephone number established by the Director of the Division of Homeland Security and Emergency Management.

§15-5B-2. Mine and industrial accident emergency operations center.

(a) The Director of the Division of Homeland Security and Emergency Management, working in conjunction with the Office of Miners' Health, Safety and Training, shall maintain the Mine and Industrial Accident Emergency Operations Center, which shall be the official and primary state government twenty-four hour a day communications center for dealing with mine and industrial accidents.

(b) The emergency operations center shall be operated twenty- four hours a day, seven days a week by emergency service personnel employed by the Director to provide emergency assistance and coordination to mine and industrial accidents or emergencies.

(c) The emergency operations center shall be readily accessible twenty-four hours a day at a statewide telephone number established and designated by the Director.

§15-5B-3. Emergency mine response.

(a) To assist the Division of Homeland Security and Emergency Management in implementing

and operating the Mine and Industrial Accident Rapid Response System, the Office of Miners' Health, Safety and Training shall, on a quarterly basis, provide the emergency operations center with a mine emergency contact list: *Provided*, That in the event of any change in the information contained in the mine emergency contact list, such changes shall be provided immediately to the emergency operations center. The mine emergency contact list shall include the following information:
(1) The names and telephone numbers of the Director of the Office of Miners' Health, Safety and Training, or his or her designee, including at least one telephone number at which the Director or designee may be reached at any time;
(2) The names and telephone numbers of all district mine inspectors, including at least one telephone number for each inspector at which each inspector may be reached at any time;
(3) A current listing of all regional offices or districts of the Office of Miners' Health, Safety and Training, including a detailed description of the geographical areas served by each regional office or district; and
(4) The names, locations and telephone numbers of all mine rescue stations, including at least one telephone number for each station that may be called twenty-four hours a day and a listing of all mines that each mine rescue station serves in accordance with the provisions of section thirty-five, article one, chapter twenty- two-a of this code .
(b) Upon the receipt of an emergency call regarding any accident, as defined in section sixty-six, article two, chapter twenty-two-a of this code, in or about any mine , the emergency operations center shall immediately notify:
(1) The Director of the Office of Miners' Health, Safety and Training;
(2) The district mine inspector assigned to the district or region in which the accident occurred;
(3) All mine rescue stations that provide rescue coverage to the mine in question; and
(4) Local emergency service personnel in the area in which the accident occurred.
(c) In the event that an emergency call regarding any accident, as defined in section sixty-six, article two, chapter twenty-two-a of this code, in or about any mine , is initially received by a county answering point, the call shall be immediately forwarded to the Mine and Industrial Accident Emergency Operations Center.
(d) Nothing in this section shall be construed to relieve an operator, as defined in section two, article one, chapter twenty- two-a of this code, from any reporting or notification obligation under federal law.
(e) The Mine and Industrial Accident Rapid Response System and the emergency operations center are designed and intended to provide communications assistance to emergency responders and other responsible persons. Nothing in this section shall be construed to conflict with the responsibility and authority of an operator to provide mine rescue coverage in accordance with the provisions of section thirty-five, article one, chapter twenty-two-a of this code or the authority of the Director of the Office of Miners' Health, Safety and Training to assign mine rescue teams under the provisions of subsection (d) of said section or to exercise any other authority provided in chapter twenty-two-a of this code.

§15-5B-4. Study of other industrial emergencies.

The Director of the Division of Homeland Security and Emergency Management shall immediately cause a study to be conducted to determine the feasibility of providing emergency coverage to other industrial, manufacturing, chemical or other emergencies through the Mine and Industrial Accident Rapid Response System. On or before the first day of November, two thousand six, the Director shall submit a report to the Governor, the President of the Senate and the Speaker of the House of Delegates setting forth the findings of his or her study and recommendations for legislation consistent with the purposes of this article.

§15-5B-5. Rule-making authority.

The Director of the Division of Homeland Security and Emergency Management shall propose emergency and legislative rules for promulgation in accordance with article three, chapter twenty- nine-a of this code regarding the implementation and administration of the Mine and Industrial Accident Rapid Response System. The requirements of this article enacted during the regular session of the Legislature in January, two thousand six, shall not be implemented until the emergency rule authorized herein has been approved.

CHAPTER 22A. MINERS' HEALTH, SAFETY AND TRAINING.

ARTICLE 2. UNDERGROUND MINES.

§22A-2-55. Protective equipment and clothing. (a) Welders and helpers shall use proper shields or goggles to protect their eyes. All employees shall have approved goggles or shields and use the same where there is a hazard from flying particles or other eye hazards.

(b) Employees engaged in haulage operations and all other persons employed around moving equipment on the surface and underground shall wear snug-fitting clothing. (c) Protective gloves shall be worn when material which may injure hands is handled, but gloves with gauntleted cuffs shall not be worn around moving equipment. (d) Safety hats and safety-toed shoes shall be worn by all persons while in or around a mine: *Provided,* That metatarsal guards ~~shall~~ are not ~~be~~ required to be worn by persons when working in those areas of underground mine workings which average less than forty-eight inches in height as measured from the floor to the roof of the underground mine workings. (e) Approved eye protection shall be worn by all persons while being transported in open-type man trips. (f)(1) A self-contained self-rescue device approved by the Director shall be worn by each person underground or kept within his immediate reach and ~~such~~ the device shall be provided by the operator. The self-contained self-rescue device shall be adequate to protect ~~such~~ a miner for one hour or longer. Each operator shall train each miner in the use of such device and refresher training courses for all underground employees shall be held during each calendar year.

(2) In addition to the requirements of subdivision (1) of this subsection, the operator shall also provide caches of additional self-contained self-rescue devices throughout the mine in accordance with a plan approved by the director. Each additional self-contained self-rescue device shall be adequate to protect a miner for one hour or longer. The total number of additional self- contained self-rescue devices, the total number of storage caches and the placement of each cache throughout the mine shall be established by rule pursuant to subsection (i) of this section.

Intrinsically safe battery-powered strobe lights shall be affixed to each cache and shall be capable of automatic activation in the event of an emergency. A luminescent sign with the words "SELF- CONTAINED SELF-RESCUER" or "SELF-CONTAINED SELF-RESCUERS" shall be conspicuously posted at each cache and luminescent direction signs shall be posted leading to each cache. Lifeline cords or other similar device, with reflective material at 25-foot intervals, shall be attached to each cache from the last open crosscut to the surface. The operator shall conduct weekly inspections of each cache, the affixed strobe lights and each lifeline cord or other similar devise to ensure operability.

(3) Any person that, without the authorization of the operator or the director, knowingly removes or attempts to remove any self- contained self-rescue device or battery-powered strobe light, approved by the director, from the mine or mine site with the intent to permanently deprive the operator of the device or light or knowingly tampers with or attempts to tamper with such device or light shall be deemed guilty of a felony and, upon conviction thereof, shall be imprisoned in a state correctional facility for not less than one year nor more than ten years or fined not less than ten thousand dollars nor more than one hundred thousand dollars, or both.

(g)(1) A wireless emergency communication device approved by the director and provided by the operator shall be worn by each person underground. The wireless emergency communication device shall, at a minimum, be capable of receiving emergency communications from the surface at any location throughout the mine. Each operator shall train each miner in the use of the device and provide refresher training courses for all underground employees during each calendar year. The operator shall install in or around the mine any and all equipment necessary to transmit emergency communications from the surface to each wireless emergency communication device at any location throughout the mine.

(2) Any person that, without the authorization of the operator or the director, knowingly removes or attempts to remove any wireless emergency communication device or related equipment, approved by the director, from the mine or mine site with the intent to permanently deprive the operator of the device or equipment or knowingly tampers with or attempts to tamper with the device or equipment shall be guilty of a felony and, upon conviction thereof, shall be imprisoned in a state correctional facility for not less than one year nor more than ten years or fined not less than ten thousand dollars nor more than one hundred thousand dollars , or both.

(h)(1) A wireless tracking device approved by the director and provided by the operator shall be worn by each person underground. In the event of an accident or other emergency, the tracking device shall be capable of providing real-time monitoring of the physical location of each person underground: *Provided*, That no person shall discharge or discriminate against any miner based on information gathered by a wireless tracking device during nonemergency monitoring. Each operator shall train each miner in the use of the device and provide refresher training courses for all underground employees during each calendar year. The operator shall install in or around the mine all equipment necessary to provide real-time emergency monitoring of the physical location of each person underground.

(2) Any person that, without the authorization of the operator or the director, knowingly removes or attempts to remove any wireless tracking device or related equipment, approved by the

director, from a mine or mine site with the intent to permanently deprive the operator of the device or equipment or knowingly tampers with or attempts to tamper with the device or equipment shall be guilty of a felony and, upon conviction thereof, shall be imprisoned in a state correctional facility for not less than one year nor more than ten years or fined not less than ten thousand dollars nor more than one hundred thousand dollars , or both.
(i) The director may promulgate emergency and legislative rules to implement and enforce this section pursuant to the provisions of article three, chapter twenty-nine-a of this code. The requirements of this article enacted during the regular session of the Legislature in January, two thousand six, shall not be implemented until the emergency rule authorized herein has been approved.

§22A-2-66. Accident; notice; investigation by Office of Miners' Health, Safety and Training.

(a) For the purposes of this section, the term "accident" means:
(1) The death of an individual at a mine; (2) An injury to an individual at a mine which has a reasonable potential to cause death; (3) The entrapment of an individual; (4) The unplanned inundation of a mine by a liquid or gas; (5) The unplanned ignition or explosion of gas or dust;(6) The unplanned ignition or explosion of a blasting agent or an explosive; (7) An unplanned fire in or about a mine not extinguished within five minutes of ignition; (8) An unplanned roof fall at or above the anchorage zone in active workings where roof bolts are in use or an unplanned roof or rib fall in active workings that impairs ventilation or impedes passage; (9) A coal or rock outburst that causes withdrawal of miners or which disrupts regular mining activity for more than one hour; (10) An unstable condition at an impoundment, refuse pile or culm bank which requires emergency action in order to prevent failure, or which causes individuals to evacuate an area, or the failure of an impoundment, refuse pile or culm bank; (11) Damage to hoisting equipment in a shaft or slope which endangers an individual or which interferes with use of the equipment for more than thirty minutes; and (12) An event at a mine which causes death or bodily injury to an individual not at the mine at the time the event occurs.
(b) Whenever ~~by reason of any explosion or other~~ any accident occurs in or about any coal mine or the machinery connected therewith, ~~loss of life, or serious personal injury occurs,~~ it is the duty of the ~~superintendent of the mine, and in his or her absence,~~ operator or the mine foreman in charge of the mine to give immediate notice, within fifteen minutes of ascertaining the occurrence of an accident, to the ~~director and the inspector of the district~~ Mine and Industrial Accident Emergency Operations Center at the statewide telephone number established by the Director of the Division of Homeland Security and Emergency Management pursuant to the provisions of article five-b, chapter fifteen of this code stating the particulars of ~~such~~ the accident: *Provided*, That the operator or the mine foreman in charge of the mine may comply with this immediate notice requirement by immediately providing notice to the appropriate local organization for emergency services as defined in section eight, article five of said chapter, or the appropriate local emergency telephone system operator as defined in article six, chapter twenty-four of this code: *Provided, however*, That nothing in this subsection shall be construed to relieve

the operator from any reporting or notification requirement under federal law.
(c) The director shall impose, pursuant to rules authorized in this section, a civil administrative penalty of one hundred thousand dollars on the operator if it is determined that the operator or the mine foremen in charge of the mine failed to give immediate notice as required in this section: *Provided*, That the director may waive imposition of the civil administrative penalty at any time if he or she finds that the failure to give immediate notice was caused by circumstances wholly outside the control of the operator.
(d) If anyone is killed, the inspector shall immediately go to the scene of ~~such~~ the accident and make ~~such~~ recommendations and render ~~such~~ assistance as he or she may deem necessary for the future safety of the men and investigate the cause of ~~such~~ the explosion or accident and make a record. ~~thereof which~~ He or she shall preserve the record with the other records in his or her office. The cost of ~~such~~ the investigation records ~~to~~ shall be paid by the Office of Miners' Health, Safety and Training.~~, and~~ A copy shall be furnished to the operator and other interested parties. To enable him or her to make ~~such~~ an investigation, he or she has the power to compel the attendance of witnesses and to administer oaths or affirmations. The director has the right to appear and testify and to offer any testimony that may be relevant to the questions and to cross-examine witnesses.

CHAPTER 24. PUBLIC SERVICE COMMISSION.

ARTICLE 6. LOCAL EMERGENCY TELEPHONE SYSTEM.

§24-6-14. Notification of mining accidents.

Each county answering point that receives a call reporting an accident in or about any mine shall immediately route the call to the Mine and Industrial Accident Emergency Operations Center created pursuant to section two, article five-a, chapter fifteen of this code.

APPENDIX B – EMERGENCY RULE

EMERGENCY

WEST VIRGINIA LEGISLATIVE RULE

OFFICE OF MINERS' HEALTH, SAFETY AND TRAINING

TITLE 56

SERIES 4

EMERGENCY RULES GOVERNING PROTECTIVE CLOTHING AND EQUIPMENT

§56-4-1. General.

1.1. Scope. -- These emergency rules pertain to the implementation of provisions of West Virginia Code § 22A-2-55, relating to the regulation of protective clothing and equipment worn by persons underground by the Office of Miners' Health, Safety and Training.

1.2. Authority. -- West Virginia Code § 22A-2-55.

1.3. Filing Date. -- February __, 2006.

1.4. Effective Date. -- _____, 2006.

§56-4-2. Preamble.

2.1. Purpose – The primary goal of section fifty-five, article two, chapter twenty-two-a of the Code is to protect the health and safety of this State's coal miners by requiring minimum standards for the protective clothing and equipment worn by each underground miner. The purpose of these rules is to implement the mandate of section fifty-five, article two, chapter twenty-two-a of the Code by requiring coal mine operators to provide each underground miner

with certain protective equipment and by detailing the requirements for such protective equipment. In implementing such mandate, it is recognized that different types of protective equipment may be developed to satisfy the minimum requirements for protective equipment for each mine, depending upon the number of employees of the particular mine, the location of the particular mine, the physical features of the particular mine, and technological advances.

2.1.1. Exiting a mine is the primary escape procedure to be used by miners in the event of an emergency underground. Self-contained self-rescue devices ("SCSRs") are intended primarily to provide miners with breathable air while attempting to exit the mine during an emergency. The secondary purpose of SCSRs, however, is to provide a source of breathable air to miners that cannot exit a mine during an emergency and must await rescue by personnel on the surface. Emergency shelters/chambers also provide a source of breathable air for trapped miners unable to escape from the mine. Wireless emergency communication devices and wireless tracking devices are intended to assist in both directing miners out of an endangered mine and locating trapped miners awaiting rescue by personnel on the surface. In addition to the purposes stated above, the intended purpose of these rules is to establish a regulatory regime enabling the proper implementation of these technologies in West Virginia's underground mines.

§56-4-3. Definitions.

3.1. Unless herein defined, all terms used in this rule shall have the same meaning as they are defined in West Virginia Code §22A-1-2 and West Virginia Code §22A-2-55.

3.2. "Code" shall mean the Code of West Virginia, 1931, as amended.

3.3. "Director" shall herein refer to the Director of the Office of Miners' Health, Safety and Training.

§56-4-4. Mine Safety Technology Task Force.

4.1. Within seven (7) calendar days of the effective date of these rules, the Director shall establish a Mine Safety Technology Task Force to provide technical and other assistance related to the implementation of the new technological requirements set forth in section fifty-five, article two, chapter twenty-two-a of the Code. The task force shall be comprised of three persons from the major employee organization representing coal miners in this state and three persons from the major trade association representing underground coal operators in this state. All actions of the task force shall be by unanimous vote.

4.2. The task force, working in conjunction with the Director, shall immediately commence a study to determine the commercial availability and functional and operational capability of the SCSRs, emergency shelters/chambers, wireless communication devices and wireless tracking devices required hereunder. The task force shall also study issues related to the implementation, compliance and enforcement of the safety requirements contained herein. Additionally, the task force may study related safety measures, including the provision of additional surface openings and/or escapeways in lieu of or in addition to the provision of SCSRs or emergency shelters/chambers. In conducting its study, the task force shall, where possible, consult with, among others, mine engineering and mine safety experts, radiocommunication and telemetry experts and relevant state and federal regulatory personnel.

4.3. The Director, or his designee, shall preside over all meetings of the working group.

4.4. Within ninety (90) calendar days of the effective date of these rules, the task force shall provide the Director with a written report summarizing its findings regarding the commercial availability and functional and operational capability of the SCSRs, emergency shelters/chambers, wireless communication devices, wireless tracking devices and related safety measures required hereunder. The report shall also include the task force's findings and recommendations regarding implementation, compliance and enforcement of the safety requirements contained herein. The report also shall set forth the task force's recommended implementation, compliance and enforcement plans regarding the aforementioned technologies.

4.5. Prior to approving any emergency shelter/chamber, wireless communication device or wireless tracking device pursuant to the provisions of sections 5.4, 8.1, and 9.1 of these rules, respectively, the Director shall review the task force's written report and the findings set forth therein and shall consider such findings in making any approval determination.

§56-4-5. Self-Contained Self-Rescue Devices Provided for Escape from Mines.

5.1. Each person underground shall be provided a SCSR in accordance with the provisions of subdivision (1), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code. In addition, the operator shall provide caches of additional SCSRs or devices providing equivalent protection throughout the mine in accordance with a Storage Cache Plan approved by the Director.

5.1.1. Each SCSR shall be adequate to protect a miner for one (1) hour or longer: Provided, however, That nothing contained herein shall preclude an operator from providing each person underground with a self-rescue device or a SCSR that provides less than one (1)

hour of protection that is nevertheless adequate to provide an amount of breathable air sufficient for travel to the nearest storage cache or escape facility: Provided, further: That the total amount of breathable air provided by the operator meets the minimum amount of three (3) hours of cumulative protection contemplated by the provisions of Section 5.1 and Section 5.2.1 of these rules, as well as the minimum protection amounts mandated by the provisions of 5.3.3 and 5.4.3.

5.1.2. Each cache shall be housed in a container constructed of fire retardant material or material treated with a fire retardant paint or laminate and constructed in a manner capable of protecting the self-contained self rescue devices stored therein from damage by fire.

5.1.3. Each operator shall train each miner in the use of the SCSRs employed at the mine, and refresher training courses for all underground employees shall be held during each calendar year. This training shall be in addition to the annual retraining required by MSHA.

5.2. One cache shall be placed at a readily available location within five hundred (500) feet of the nearest working face in each working section of the mine. One cache shall be placed at a readily available location within five hundred (500) feet of each active construction or rehabilitation site within the mine. Distances greater than five hundred (500) feet not to exceed one thousand (1000) feet are permitted, however, where miners are provided with personal SCSRs rated for less than sixty (60) minutes, travel to these caches is not to exceed five (5) minutes as determined by the height/travel time chart as specified in Section 5.3.2.

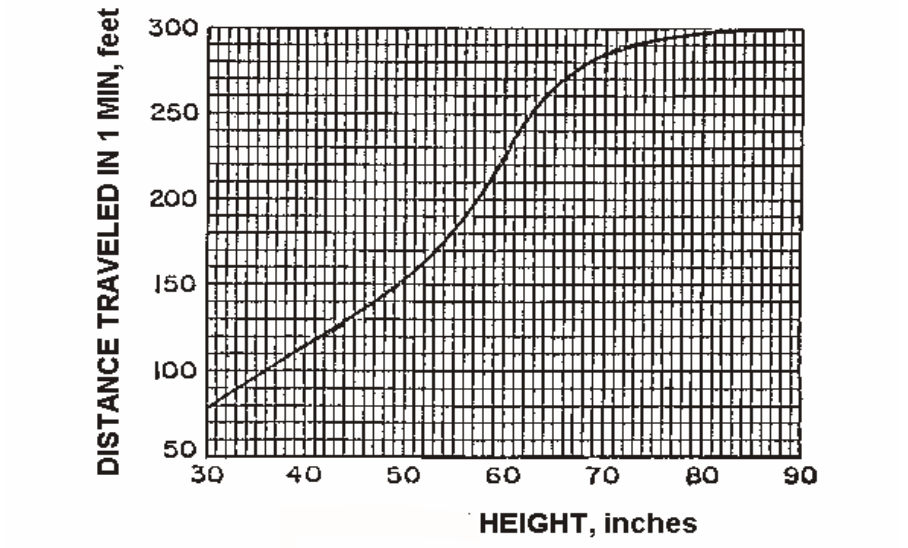
5.2.1. Each cache placed at each working section and each active construction or rehabilitation site shall contain sufficient additional SCSRs to provide each miner reasonably

expected to be at the working section or active construction or rehabilitation site with no less than two (2) additional SCSRs, or an equivalent amount of breathable air for escape. During crew changes involving a mantrip at a working section or an active construction or rehabilitation site, SCSRs stored on such mantrip shall satisfy the total number of SCSRs required for such personnel.

5.3. Additional storage caches shall also be placed in readily available locations throughout the remainder of the mine as follows:

5.3.1. Beginning at the storage cache located at the working section or active construction or rehabilitation site, and continuing to the surface or nearest escape facility leading to the surface, the operator shall station additional storage caches at calculated intervals that a miner may traverse in no more than thirty (30) minutes traveling at a normal pace, taking into consideration the height of the coal seam.

5.3.2. Said intervals shall be calculated in accordance with the following chart:



5.3.3. Each such additional cache shall contain a number of additional SCSRs equal to or exceeding the total number of employees reasonably likely to be in that area.

5.4. Emergency Shelters/Chambers for Use in the Event That Immediate Exit is not Possible.

5.4.1. An emergency shelter/chamber shall be maintained within one thousand (1000) feet of the nearest working face in each working section. Such emergency shelter/chamber shall be approved by the Director and shall be constructed and maintained in a manner prescribed by the Director.

5.4.2. Upon the Director's receipt of the written report required by section 4.4 of these rules, the Director shall review the written report and the findings set forth therein and shall consider such findings in making approval determinations regarding any emergency shelter/chamber.

5.4.3. Any emergency shelter/chamber approved by the Director shall be:

a. equipped to provide each miner at the working section with no less than twenty-four (24) hours of breathable air;

b. constructed in such a manner so as to reasonably exclude dangerous air and gases from the interior of the rescue shelter/chamber;

c. properly equipped with first aid materials;

d. equipped with sufficient amounts of food and water to sustain each miner at the working section for at least twenty-four (24) hours while awaiting rescue;

e. equipped with a device for communication with rescuers or other persons on the surface; and

f. maintained in accordance with applicable MSHA requirements.

5.4.4. As soon as practicable, the Director shall notify all operators of the emergency shelters/chambers approved for use in underground coal mines.

5.4.5. Each operator shall train each miner in the use of the approved emergency shelter/chamber employed at the mine, and refresher training courses for all underground employees shall be held during each calendar year. This training shall be in addition to any annual retraining required by MSHA.

5.4.6. If there are no emergency shelters/chambers approved within one year of the Director's receipt of the task force's report, operators shall install in lieu of an emergency shelter/chamber, caches of SCSRs sufficient to provide each miner reasonably expected to be at the working section with no less than sixteen(16) additional SCSRs, or an equivalent amount of breathable air.

5.4.7. Sixteen (16) SCSRs may be used in lieu of an emergency shelter/chamber when mine design or layout prohibits use of such facilities.

§56-4-6. Storage Cache Plan.

6.1. Within thirty (30) calendar days of the effective date of these rules, all operators of all mines shall submit a Storage Cache Plan for approval by the Director. The design,

development, submission, and implementation of the Storage Cache Plan shall be the responsibility of the operator of each mine.

6.2. Within thirty (30) calendar days after submission of the initial Storage Cache Plan, the Director shall either approve the plan as submitted, or shall reject and return the plan to the operator for modification and resubmission, stating in detail the reasons for such rejection. If the plan is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such plan.

6.3. In developing the initial Storage Cache Plan, the operator shall take into consideration the number of employees of the particular mine, the location of the particular mine, the physical features of the particular mine, and any other aspect of the particular mine the operator deems relevant to the development of the Storage Cache Plan.

6.4. The Storage Cache Plan shall include the following:

6.4.1. The size and physical features of the mine;

6.4.2. The maximum number of persons underground during each working shift;

6.4.3. The proposed location of the various storage caches and the emergency shelter/chamber in relation to persons underground; and

6.4.4. A schedule of compliance, which shall include:

a. a narrative description of how the operator will achieve compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code.

b. a schedule of measures, including an enforceable sequence of actions with milestones, leading to compliance; and

c. a statement indicating when the implementation of the proposed plan will be complete.

6.4.5. Any such schedule of compliance shall be supplemental to, and shall not sanction noncompliance with, the applicable requirements on which it is based.

6.5. Each operator shall submit as attachments to its Storage Cache Plan the following:

6.5.1. A statement that the analysis and evaluation required by section 6.3 of these rules has been completed;

6.5.2. A statement indicating the training dates for the use of the SCSRs; and

6.5.3. The name of the person or persons representing the operator, including his or her title, position, mailing address and telephone number, who can be contacted by the Director for all matters relating to the Storage Cache Plan and the weekly inspections of each cache.

6.6. Within thirty (30) calendar days of the Director's approval of the plan, the operator shall provide to the Director a copy of any contract, purchase order, or other proof of purchase of such number of additional SCSRs consistent with the operator's schedule of compliance.

6.7. At any time after the Director has approved an operator's Storage Cache Plan, the operator may submit proposed modifications or revisions to its plan along with the reasons therefor to the Director.

6.7.1. Within thirty (30) calendar days after receipt by the Director of any proposed revisions or modifications to the Storage Cache Plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection.

6.7.2. The Director may require modifications to a Storage Cache Plan at any time following the investigation of a fatal accident or serious injury, as defined by Title 36, Series 19, Section 3.2, if such modifications are warranted by the findings of the investigation.

6.7.3. Within thirty (30) calendar days of the Director notifying operators of the emergency shelters/chambers approved by the Director under these rules, the operator shall submit a revised Storage Cache Plan in accordance with the provisions of this section setting forth the type of emergency shelter/chamber to be installed pursuant to section 5.4 these rules. The revised storage cache plan shall also include a revised schedule of compliance and information regarding the emergency shelter/chamber that corresponds to the information regarding the storage caches required under this section of these rules.

6.8. If the Director, in his sole discretion, determines that an operator has failed to provide a Storage Cache Plan, has provided an inadequate Storage Cache Plan, has failed to comply with its approved Storage Cache Plan, or has failed to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subdivision (2), subsection (f), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

§56-4-7. Placement of Intrinsically Safe Battery-Powered Lights and Lifeline Cords.

7.1. Intrinsically safe battery-powered strobe lights shall be affixed to each cache of SCSRs and shall operate continuously or be capable of automatic activation in the event of an emergency.

7.1.1. All intrinsically safe battery-powered strobe lights affixed to each cache of SCSRs shall be approved by MSHA and maintained in accordance with applicable MSHA requirements.

7.2. A reflective sign with the words “SELF-RESCUER” or “SELF-RESCUERS” shall be conspicuously posted at each such cache and reflective direction signs shall be posted leading to each cache.

7.3. Lifeline cords installed in primary escapeways shall be attached to each cache and extend from the last permanent stopping to the surface or nearest escape facility, excluding belt and track entries, and must:

7.3.1. be made of durable material;

7.3.2. be marked with reflective material every twenty-five (25) feet;

7.3.3. be located in such a manner for miners to use effectively to escape; and

7.3.4. have directional indicators signifying the route of escape placed at intervals not exceeding one hundred (100) feet.

7.4. The operator shall conduct weekly inspections of each cache of additional SCSRs, the affixed strobe lights, and each lifeline cord or other similar device to ensure that each will function properly in the event of an emergency.

§56-4-8. Wireless Emergency Communication Devices.

8.1. A wireless emergency communication device approved by the Director shall be worn by each person underground and shall be provided by the operator.

8.1.1. As soon as practicable, the Director shall notify all operators of the wireless emergency communication devices approved by the Director for use by each person underground pursuant to subdivision one, subsection (g), section fifty-five, article two, chapter twenty two-a of the Code.

8.1.2. The wireless emergency communication devices approved by the Director must be capable of receiving emergency communications from the surface at any location throughout the mine.

8.1.3. Each operator shall train each miner in the use of the approved device employed at the mine, and refresher training courses for all underground employees shall be held during each calendar year.

8.2. All wireless emergency communication devices approved by the Director shall have received prior approval by MSHA and be maintained in accordance with applicable MSHA requirements.

8.3. Within sixty (60) calendar days of the Director giving notice of the approved wireless emergency communications devices, all operators shall submit to the Director a schedule of compliance.

8.3.1. The schedule of compliance shall include:

a. a narrative description of how the operator will achieve compliance with subsection (g), section fifty-five, article two, chapter twenty-two-a of the Code;

b. a schedule of measures, including an enforceable sequence of actions with milestones, leading to compliance; and

c. a statement indicating when full compliance will be achieved.

8.3.2. Any such schedule of compliance shall be supplemental to, and shall not sanction noncompliance with, the applicable requirements on which it is based.

8.3.3. Within thirty (30) calendar days after submission of the schedule of compliance, the Director shall either approve the schedule of compliance as submitted, or shall reject and return the schedule of compliance to the operator for modification and resubmission, stating in detail the reasons for such rejection. If the schedule of compliance is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such schedule of compliance.

8.3.4. Where applicable, the operator shall submit certified progress reports no less frequently than every sixty (60) calendar days until full compliance is achieved. 8.4. In developing the schedule of compliance, the operator shall take into consideration the number of

employees of the particular mine, the location of the particular mine, the physical features of the particular mine and any other aspect of the particular mine relevant to the provision and operation of the wireless emergency communication devices.

8.5. Within thirty (30) calendar days of the Director's approval of the operator's schedule of compliance, the operator shall provide to the Director a copy of any contract, purchase order, or other proof of purchase of such wireless emergency communication devices consistent with the operator's schedule of compliance.

8.6. If the Director, in his sole discretion, determines that an operator has failed to provide a schedule of compliance, has provided an inadequate schedule of compliance, has failed to meet its approved schedule of compliance or has failed to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subsection (g), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

§56-4-9. Wireless Tracking Devices.

9.1. A wireless tracking device approved by the Director shall be worn by each person underground and shall be provided by the operator.

9.1.1. As soon as practicable, the Director shall notify all operators of the wireless tracking devices approved by the Director for use by each person underground pursuant to subdivision one, subsection (h), section fifty-five, article two, chapter twenty two-a of the Code.

9.1.2. The wireless tracking devices approved by the Director must be capable of providing real-time monitoring of the physical location of each person underground, which at a minimum shall mean the capability to identify the presence of each person underground in the event of an emergency.

9.1.3. No person shall discharge or in any other way discriminate against any miner based on information gathered by such wireless tracking device during non-emergency monitoring.

9.1.4. Each operator shall train each miner in the use of the approved device employed at the mine, and refresher training courses for all underground employees shall be held during each calendar year.

9.1.5. The operator shall install in or around the mine any and all equipment necessary to provide real-time emergency monitoring in accordance with the provisions of section 9.1.2 of these rules.

9.2. All wireless tracking devices approved by the Director shall have received prior approval by MSHA and be maintained in accordance with applicable MSHA requirements.

9.3. Within sixty (60) calendar days of the Director giving notice of the approved wireless tracking devices, all operators shall submit to the Director a schedule of compliance.

9.3.1. The schedule of compliance shall include:

a. a narrative description of how the operator will achieve compliance with subsection (h), section fifty-five, article two, chapter twenty-two-a of the Code;

b. a schedule of measures, including an enforceable sequence of actions with milestones, leading to compliance; and

c. a statement indicating when full compliance will be achieved.

9.3.2. Any such schedule of compliance shall be supplemental to, and shall not sanction noncompliance with, the applicable requirements on which it is based.

9.3.3. Within thirty (30) calendar days after submission of the schedule of compliance, the Director shall either approve the schedule of compliance as submitted, or shall reject and return the schedule of compliance to the operator for modification and resubmission, stating in detail the reasons for such rejection. If the schedule of compliance is rejected, the Director shall give the operator a reasonable length of time, not to exceed fifteen (15) calendar days, to modify and resubmit such schedule of compliance.

9.3.4. Where applicable, the operator shall submit certified progress reports no less frequently than every sixty (60) calendar days until full compliance is achieved. 9.4. In developing the schedule of compliance, the operator shall take into consideration the number of employees of the particular mine, the location of the particular mine, the physical features of the particular mine, and any other aspect of the particular mine relevant to the provision and operation of the wireless tracking devices.

9.5. Within thirty (30) calendar days of the Director's approval of the operator's schedule of compliance, the operator shall provide to the Director a copy of any contract, purchase order,

or other proof of purchase of such wireless tracking devices consistent with the operator's approved schedule of compliance.

9.6. If the Director, in his sole discretion, determines that an operator has failed to provide a schedule of compliance, has provided an inadequate schedule of compliance, has failed to meet its approved schedule of compliance or has failed to provide a copy of any contract, purchase order or other proof of purchase required under this section, in an effort to delay, avoid or circumvent compliance with subsection (h), section fifty-five, article two, chapter twenty-two-a of the Code or these rules, the Director shall issue a cessation order to the operator for the affected mine.

APPENDIX C – MINE SAFETY TECHNOLOGY TASK FORCE PROCESS

The Task Force was established by the Emergency Rules Governing Protective Clothing and Equipment at §56.4.4. The Task Force consists of three persons from the major employee organization representing coal miners and three persons from the major trade association representing underground coal operators in this state. All recommendations contained in this report are unanimously supported by the Task Force members.

James Dean, Acting Director of the West Virginia Office of Miners' Health, Safety and Training, announced March 9, 2006 the names of the Task Force and the group held its first meeting on March 13th. The Task Force met in open public forum with experts from industry, regulators, and academia at five different locations throughout the state, to facilitate public participation in the open public meetings, in addition, representatives of the Task Force visited and reported on visits to vendors, research institutions, and underground mines.

While focused upon the areas addressed in West Virginia Senate Bill 247 and the Office of Miners' Health Safety and Training's Emergency Rules; self-contained self-rescuers, emergency shelters/chambers, wireless communication devices and wireless tracking devices, the Task Force also considered other health and safety issues.

TASK FORCE MEMBERS

Dale Birchfield of Crab Orchard, West Virginia has 35 years of coal mining experience. He is the president of Kingston Resources, a subsidiary of Riverton Coal. His office is located in Kingston, W.Va. and he is responsible for management of the

company's underground mine and prep plant operations. He holds degrees from Glenville State College and West Virginia Institute of Technology.

Theodore Hapney of Reedy, West Virginia has 32 years of coal mining experience. He began his career in the coal industry in 1974 and held several positions in underground mines. He is a certified electrician and has served as president of his local UMWA union as well as chairman of the local organization's mine and safety committees and on the COMPAC. He is currently an international representative for the UMWA.

Terry Hudson of Beckley, West Virginia has 31 years of coal mining experience. He is the Safety and Training Director for Appalachian Operations for Peabody Energy and his office is located in Charleston, W.Va. A Marshall University graduate, Hudson has a bachelor's degree in business management and a master's degree in occupational safety and health. Hudson has 27 years as a certified mine foreman and mine rescue team member and trainer. He has oversight for Peabody's safety, compliance, health and emergency preparedness programs in West Virginia and western Kentucky.

Todd Moore of Fairview, West Virginia has 26 years of coal mining experience. He is the Chief Inspector for CONSOL Energy, Northern West Virginia Operations, located in Monongah, W.Va. He is responsible for the company's health and safety programs in that region. Moore's underground experience is in West Virginia and Pennsylvania. He is a certified foreman in both states, and is an experienced mine rescue team member. He is a graduate of Fairmont College with a degree in mining.

Gary Trout of Leivasy, West Virginia has 33 years of coal mining experience. He is an International Health and Safety Representative for the UMWA, served as

District 29 Executive Board Member for 12 years, member of Diesel Commission since 1999. He began his career in the coal industry in 1973 and has held multiple positions in the underground mining industry and is a certified electrician and coal mine safety inspector.

Stephen Webber of Belington, West Virginia has 43 years of coal mining experience. He is retired from the coal mines. He worked in underground coal mines, as Assistant Safety Director and International Executive Board Member for the UMWA International Union. Mr. Webber served as director of the West Virginia Office of Miners' Health, Safety and Training and the director of the Office of Assessment for the U. S. Department of Labor's Mine Health and Safety Administration before retiring in 2003.

Mr. Dean or his designee will function as ex-officio chair of the meetings. Mr. Randall Harris will function as ex-officio technical advisor.

James Dean of Core, West Virginia has 15 years of mining related experience. He is currently acting Director of the Office of Miners' Health Safety and Training. Mr. Dean is on leave as of February 14, 2006 from his position as Director of Extension and Outreach and Associate Director of the Mining Extension Program at West Virginia University. Mr. Dean holds an Associate Degree in Engineering Technology-Mechanical, a Bachelor's degree in Engineering Technology-Mining and a Master's Degree in Engineering of Mines. He is also a Certified Mine Safety Professional (CMSP) through the International Society of Mine Safety and has MSHA IS IU Instructor Certification.

Randall Harris of Logan, West Virginia has 23 years of energy technology related experience. He is an independent engineer specializing in coal related technology development. Prior to his retirement in 2003 he served as Senior Engineer at the US DOE's National Energy Technology Laboratory. His specific areas of expertise include product development and commercialization, worker safety and health, and strategic decision making. Mr. Harris has an undergraduate degree from the University of Florida in nuclear engineering and health physics. He did his graduate studies in engineering management at University of Tennessee and business management thorough the West Virginia University Executive MBA program. He has advanced course work at the Federal Executive Institute, the Naval War College, and Harvard's Kennedy School of Government.

TASK FORCE MEETINGS

The Task Force met a total of 36 full days between March 13 and May 25, 2006.

March 13th the Task Force met in Charleston. The objective of this meeting was to review the directive for the task force, determine a schedule, and share information collected.

March 17th the Task Force met in Charleston. At this meeting the task force focused on shelters.

March 20th, 21st, and 22nd meetings were held in Beckley. During these meetings the Task Force worked on shelters. The Task Force also started discussion on SCSR's.

March 27th and 28th meetings were held at the Charleston offices. Discussion was focused on SCSR's.

March 30th and 31st meetings were held at the Beckley Mine Academy. The task force worked on SCSR requirements and cache plans.

April 17th, 18th and 19th meetings were held at the Ogleby Conference Center in Wheeling. The task force focused on mine chambers and began background briefings on communications.

April 20th and 21st meetings the Task Force attended the Mining Health and Safety Symposium at Wheeling Jesuit University.

April 24th, 25th, 26th, and 27th meetings were held at the MHS&T office in Fairmont. The task force focused on communication and tracking options.

May 1st, 2nd, 3rd, 4th and 5th meetings were at the Holiday Inn Clarksburg with recess to attend the Sago hearings on May 2nd, 3rd and 4th. The meetings focused on developing outlines for initial draft of communication/tracking, chambers, and SCSR storage sections of the report.

May 8th, 9th, 10th, 11th and 12th meetings were held at the MHS&T office in Charleston with recess to attend MSHA rule hearings on May 9th. The focus was on refining the sections drafts and developing the introduction language and appendix materials.

May 16th, 17th, 18th and 19th meetings were held at the MHS&T office in Charleston. The focus was on refining the draft report.

May 22nd, 23rd, 24th and 25th meetings were held at the MHS&T office in Charleston. The focus was on finalizing the contents of the report with the vote on the document held on the 25th.

Organizations consulted and/or whose material was reviewed during Task Force deliberations and writing of this report included:

3M Mining – St. Paul, MN	Related Safety Issues
Air Systems Inc. -	Shelters/Chambers
AmerCable Inc – Houston, TX	Communications/tracking
Becker Electronics – Alrode, Alberton, South Africa	Communications/tracking
BioMarine Rebreathers – Exton, PA	SCSR Shelters/Chambers
British Cave Rescue Council – Great Hucklow, Buxton, Great Britain	Communications/tracking
Camber Corporation – Chantilly, VA	Communications/tracking Related Safety Issues
ChemBio Shelter – Allentown, PA	Emergency shelter/chambers
Conspec – Charleroi, PA	Communications/tracking
Cowan Manufacturing Pty – Warners Bay, Australia	Emergency shelter/chambers
CSE – Beckley, WV & Monroeville, PA	SCSR's Communications/tracking
Cummins Industries – Burleston, TX	Related Safety Issues
DKL International, Inc. – Vienna, VA	Communications/tracking
Delta Electric, Inc. – Logan, WV	Communications/tracking
Defibrillators of WV – Parkersburg, WV	Related safety issues
Dräger Safety Inc – Pittsburgh, PA	SCSR's Communications/tracking
Ekahau, Reston, VA	Communications/tracking
Engineering Seismology Group, Inc – Kingston, Ontario, Canada	Communications/tracking Related Safety Issues
Firesafe Consulting Group -	Shelter/Chamber
Fiber – Tech Industries, Inc.	SCSR Shelter/Chamber
Geosteering Mining Services, LLC -	Communications/tracking
Grace Industries – Fredonia, PA	Communications/tracking
GrafTech – Parma, OH	Shelters/Chambers
Hannah Engineering – Elkins, WV	Communications/tracking
HLS Hard-Line Solutions Inc. – Dowing, Ontario	Communications/tracking
Head Lites Corporation – St. Paul, MN	Other safety issues
Hughes Supply Company – Pax, WV	Communications/tracking
i-Tex Wireless	Communications/tracking
Innovative Wireless Technologies -	Communications/tracking
Instantel Inc.- Ottawa, Ontario, Canada	Communications/tracking Related Safety Issues
John Hawse – Beaver, WV	Emergency shelter/chambers
Ken Air, Inc.– Eighty Four, PA	Emergency shelter/chambers
Kutta Consulting – Phenoix, AZ	Communications/tracking
Lad Mining Ventilation Services – Charleston, WV	Emergency shelter/chambers

Linde Gas, Parkersburg, WV	Emergency shelter/chambers
Marco North America, Inc – Ona, WV	Communications/tracking
Micropore Inc – Newark, DE	Emergency shelter/chambers
Mine Rescue Service Limited, London, Great Britain	Communications/tracking
Mine Safe House LLC – Gilbert, WV	Emergency shelter/chambers
Mine Site Technologies – Rolla, MO	Communications/tracking
MineArc Systems – Fort Worth, TX	Emergency shelter/chambers
Modern Mine Supply, LLC – Huntington, UT	Emergency shelter/chambers
MSHA – Pittsburgh, PA	SCSR's
	Emergency shelter/chambers
	Communications/tracking
National Energy Technology Laboratory	Emergency shelter/chambers
	Communications/tracking
	Related Safety Issues
Nextech Materials – Lewis Center, OH	Emergency shelter/chambers
NIOSH – Pittsburgh, PA	SCSR's
	Emergency shelter/chambers
	Communications/tracking
Northern Light Digital – Toronto, Ontario, Canada	Communications/tracking
Ocenco inc – Pleasant Prairie, WI	SCSR's
O-Two Systems International – Mississauga, Canada	SCSR's
	Related Safety Issues
Predivcate Logic Inc. - Chesapeake, VA	Communications/tracking
RadarFind – Research Triangle Park, NC	Communications/tracking
Rajant Breadcrumb System-	Communications/tracking
Rana-Medical – Winnipeg, Manitoba, Canada	Emergency shelter/chambers
RM Wilson Company – WV, UT, IL	Emergency
	Shelters/Chambers
Rohmac, Inc – Mount Storm, WV	SCSR's
Shairzal Safety Engineering – Baywater, Australia	Emergency shelter/chambers
Stolar, Inc – Ranton, NM	Communications/tracking
Strata Products Inc – Marietta, GA, Richlands, VA	Emergency shelter/chambers
Time Domain/Concurrent Technologies Corp. -	Communications/tracking
Transtek Inc. – Pittsburgh, PA	Communications/tracking
Tunnel Radio Inc, Corvallis, OR	Communications/tracking
University of Florida – Gainsville, FL	Communications/tracking
University of LEEDS – Great Britain	Communications/tracking
University of Texas – Dallas, TX	Communications/tracking
Varis, Inc – Sudbury, Canada	Communications/tracking
Vital Alert -	Communications/tracking
WebCore Technologies, Inc.	Communications/tracking
West Virginia University – Morgantown, WV	Emergency shelter/chambers
	Communications/tracking
Wholesale Mine Supply – Manor, PA	Communications/tracking

APPENDIX D – ORGANIZATIONAL AND TECHNICAL NATURE OF COAL MINING[64]

To extract coal from an underground mine, a coalbed (or "seam") must be reached from the surface. The term "portal" is generally given to any entrance that provides access to a coal mine. In hilly terrain, such as is found in West Virginia, the coal may "outcrop" on a hillside. This allows direct entry to the coal seam via a horizontal tunnel ("drift") opening. At other locations where there is no outcrop, it may be possible to open a "slope" tunnel that angles down from the surface and intersects with the coal seam. If the seam is too deep for a slope to be feasible, a "shaft" must be constructed. This shaft, which may be 20 ft or more in diameter, is opened vertically from the surface to the coalbed and allows access via a large elevator.

During long-range planning there is a general focus on such essentials as equipment type, deployment, utilization, and haulage. Laying out a mine also involves auxiliary factors including ventilation arrangements, roof support plans, power distribution, and communications. All of these planned systems are incorporated into a "projection map" that is developed by a team of technical specialists. This team will include, at various times, mining engineers, electrical engineers, industrial engineers, and company geologists, among others. The mine map serves the same purpose for a person running an operation that an architect's blueprint serves a building contractor. It provides an overview of the project, shows where features should be located, helps management

[64] Vaught, C [2000]: “Behavioral and Organizational Dimensions of Underground Mine Fires”, NIOSH IC-9450

direct crews effectively, and serves as a tool in the planning of everything from maintenance schedules to capital expenditures for major equipment purchases.

Responsibility for translating the long-range plan into day-to-day operations belongs to a mine superintendent. This person is in charge of the overall mine complex, including surface facilities. An assistant superintendent helps the superintendent perform his duties and at some sites oversees all underground operations. At least one general mine foreman reports to the assistant superintendent. This individual directs day-to-day underground operations. For each working shift at the mine, there is at least one shift foreman ("shift boss") who reports to the general mine foreman. The shift boss is in charge of mining related activities including coal extraction and service work. Each production crew in the mine is placed under the direction of a section foreman ("face boss") who manages mining operations on his or her section and who reports to the shift boss. There are also supervisors who oversee specialized support work underground. These foremen manage (1) maintenance, (2) belt installation, (3) supply activities, and (4) track laying and repair. All of these individuals report to the shift boss or the general mine foreman.

If coal is to be mined productively, it must be obtained systematically. This requires the integration of several weekly plans into a smooth limited projection. One of the most important functions of a superintendent and his subordinates is to maintain an effective extraction cycle at the point of production. To do this extraction, plans must incorporate the following factors: (1) a determination of the shift for each section at which coal production will take place, (2) a decision about when the section will be idled so that belt and power moves can be made, (3) the scheduling of regular equipment

maintenance, (4) provision for special projects such as the installation of belt head drives, and (5) preparation for any tasks that cannot be accomplished during regular workdays, such as shutting down and repairing the ventilation fan. The better a mine superintendent is at planning for and taking care of all of these details, the more smooth-running and efficient an operation will be.

After entering their portal and reaching the underground workings, a typical production crew will board a self-propelled personnel carrier known as a "mantrip" and travel to their "working section." This is where coal is extracted, and may be miles from the portal. "Working faces" are the individual places on a working section where mining activities take place. Here, sets of parallel tunnels ("entries") are driven through the coal seam following a predetermined plan developed by a mining engineer. Mine entries are 16 to 20 ft wide and as high as the coal seam is thick. The number of entries being mined in a working section varies from 2 to 10 or more depending on many factors. As parallel entries are developed, they are connected by perpendicular tunnels ("crosscuts"). Like entries, crosscuts are also usually 16 to 20 ft wide and as high as the coal seam is thick. Crosscuts, or "breaks" as they are sometimes called, allow workers and equipment to move between and among the entries. The walls of entries and crosscuts are called "ribs," while the ceiling above is called the "roof" or "top." The mine floor is typically called a "bottom."

As coal is mined, a working section advances toward the boundaries of the coal property. This advancement is generally known as "development mining" and follows a "room-and-pillar" mining plan. With a room-and-pillar plan, entries and crosscuts are opened through the seam while large blocks of coal ("pillars") are left in place to help

support the mine workings. In the United States, most development mining following a room-and-pillar plan uses "continuous mining" technology. Work crews on a continuous mining section are usually composed of 8 to 10 individuals. A typical crew might consist of (1) one face boss, (2) one continuous miner operator and a helper, (3) two roof bolting machine operators, (4) two shuttle car operators, and (5) one mechanic. These workers perform two operation cycles at the working face that include (1) cutting and loading of coal and (2) support of the mine roof above the entry or crosscut.

With continuous mining, operations progress sequentially at each face on a working section. First, an area from which coal has already been extracted (commonly called a "cut") must have its roof supported. The roof is "bolted" by one or two miners who operate a "roof bolter." The roof bolter is a rubber-tired, electrically powered machine with rotating drill heads. It puts holes in the mine roof. Steel bolts (48 to 96 inches long) are then inserted into these holes and tightened. They bind together layers of rock strata located above the cut. This, in effect, creates a supporting beam between coal pillars and across entries and crosscuts. Thus, the roof is prevented from collapsing. Next, a "continuous miner" is "trammed" into the face. A continuous miner is an electrically powered machine that moves along on crawler tracks similar to bulldozer treads. The machine has a rotating drum ("ripper head") about 10 ft wide and 3 ft in diameter, on which cutting bits are mounted. The ripper head rotates and cuts coal from the face. A pair of mechanical gathering arms, located beneath the ripper head, then sweeps the dislodged coal onto a short conveyor. This conveyor moves the coal to the rear of the machine, where it is dumped into a shuttle car (or "buggy"). A buggy is a rubber-tired electrically powered haulage vehicle that can carry 6 to 10 tons of coal. Usually, two

buggies transport coal from the face to a conveyor belt dumping point. From this dumping point on the working section, coal is typically transported out of the mine via a series of conveyor haulage belts. In some mines, however, coal is dumped directly into small rail cars. Groups of these cars, known as "trips," are pulled by electrically powered locomotives to a main underground dumping point. From there, the coal is transported out of the mine via conveyor belt.

Once a mine (or a portion of it) is developed, the development sections may then become "retreat" mining sections. In retreat mining, coal pillars that were originally left in place for support of the mine entries and crosscuts are themselves extracted. The basic approach is to mine in a series of cuts, supporting the roof with timbers, bolts, or a combination of both. As these pillars are removed completely, the mine roof they once supported collapses.

In many large mines, retreat mining has been replaced by longwall mining. To establish a longwall, two parallel continuous miner sections, each consisting of two to four entries, are advanced 5,000 ft or more to a predetermined point. They are then turned and driven toward each other until they join. Once these sections are joined, they have created a large block of coal, 600 to 1,000 ft wide and approximately a mile long, that is known as a longwall "panel." Crews on a longwall mining section are made up of 8 to 10 individuals. A crew might consist of (1) one supervisor, (2) two shearer operators, (3) two shield operators, (4) one headgate operator, (5) one tailgate operator, and (6) one mechanic. These workers run large specialized equipment, which has been dismantled on the most recently mined longwall section, then brought in and set up at the new face. Panel extraction consists of completely removing this large block of coal that was created

during the development process. Strata are allowed to cave behind the longwall as coal is mined back in the direction from which the parallel "setup" sections were started.

Longwall mining operations depend on the use of self-advancing hydraulic roof supports called "shields." These are massive overhead steel structures supported by large multistage hydraulic jacks. The jack system allows shields to be raised and lowered mechanically as a face is advanced. Shields are placed side-by-side in a row so that they form a protective canopy along the entire length of the working face. Coal is removed from the face by a rotary drum shearing machine or "shearer." This shearer rides on top of a flexible, segmented conveyor ("pan line") that runs along the face. It is attached to the front of the shields by hydraulic jacks. The shearer has circular cutting heads mounted on long arms that are affixed to each end of its main body frame. A cutting head is equipped with carbide bits arranged in a spiral formation. The head rotates to cut a strip of coal 30 to 40 inches deep from the longwall face as it is moved across the panel. This extracted coal falls onto the pan line for transportation across the face to the panel's belt conveyor. The panel conveyor then moves the coal to the mine's main haulage belt for transport outside.

Fresh air must be supplied to all working areas of a mine. Air is drawn into a mine from the outside by one or more propeller-type, axial-vane fans that may be as large as 8 ft in diameter. These fans can move several hundred thousand cubic feet of air per minute. Entries serve as "intake" (fresh) and "return" (contaminated) aircourses that channel the air through a mine. Intake and return aircourses are separated by concrete block walls ("stoppings") that are built in the crosscuts between entries. Where intake and return aircourses must cross each other, air bridges ("overcasts") are used. Air moving

through the mine and sweeping across its working faces carries away smoke, dust, and accumulations of methane gas. The intake and return aircourses also function as escapeways for miners should a fire or other type of emergency occur. Federal mining law requires that underground mines must maintain two separate and distinct travelable passageways designated as escapeways from each working section. At least one of these two escapeways has to be located in fresh air.

While an underground coal mine is in some respects like a factory, the working environment is very different. The only lighting, for instance, comes from miners' battery-operated cap lamps or from localized sources on various equipment. At the face, production crews must contend with work areas that can be dusty, or wet and muddy depending on the amount of water that may be present. These places can also be extremely confined, especially in mines where the seam thickness is not great. To extract coal, miners must operate large machines under such conditions. Outby1 support personnel are scattered through the labyrinth of underground entries. They are needed to help maintain the many auxiliary subsystems found in the mine. Work done by these miners includes building and maintaining air stoppings, installing supplemental roof supports, cleaning coal spills around or under conveyor haulage belts, moving supplies, maintaining electrical installations, and conducting hazard inspections. Generally, these support workers do their tasks singly or in small crews, usually without direct contact with other miners, supervisors, or the outside world. They also have to deal with poor footing due to uneven or muddy bottom. In sum, all miners must do their jobs in an environment that is harsh and potentially dangerous.

APPENDIX E – GLOSSARY

A

Active workings - Any place in a mine where miners are normally required to work or travel and which are ventilated and inspected regularly.

Advance - Mining in the same direction, or order of sequence; first mining as distinguished from retreat.

Air split - The division of a current of air into two or more parts.

Airway - Any passage through which air is carried. Also known as an air course.

Angle of dip - The angle at which strata or mineral deposits are inclined to the horizontal plane.

Angle of draw - In coal mine subsidence, this angle is assumed to bisect the angle between the vertical and the angle of repose of the material and is 20□ for flat seams. For dipping seams, the angle of break increases, being 35.8□ from the vertical for a 40□ dip. The main break occurs over the seam at an angle from the vertical equal to half the dip.

Angle of repose - The maximum angle from horizontal at which a given material will rest on a given surface without sliding or rolling.

Anticline - An upward fold or arch of rock strata.

Aquifer - A water-bearing bed of porous rock, often sandstone.

Arching - Fracture processes around a mine opening, leading to stabilization by an arching effect.

Area (of an airway) - Average width multiplied by average height of airway, expressed in square feet.

Auger - A rotary drill that uses a screw device to penetrate, break, and then transport the drilled material (coal).

Auxiliary operations - All activities supportive of but not contributing directly to mining.

Auxiliary ventilation - Portion of main ventilating current directed to face of dead end entry by means of an auxiliary fan and tubing.

B

Back - The roof or upper part in any underground mining cavity.

Barricading - Enclosing part of a mine to prevent inflow of noxious gasses from a mine fire or an explosion.

Barrier - Something that bars or keeps out. Barrier pillars are solid blocks of coal left between two mines or sections of a mine to prevent accidents due to inrushes of water, gas, or from explosions or a mine fire.

Belt conveyor - A looped belt on which coal or other materials can be carried and which is generally constructed of flame-resistant material or of reinforced rubber or rubber-like substance.

Bench - One of to or more divisions of a coal seam separated by slate or formed by the process of cutting the coal.

Black damp - A term generally applied to carbon dioxide. Strictly speaking, it is a mixture of carbon dioxide and nitrogen. It is also applied to an atmosphere depleted of oxygen, rather than having an excess of carbon dioxide.

Bleeder or bleeder entries - Special air courses developed and maintained as part of the mine ventilation system and designed to continuously move air-methane mixtures emitted by the gob or at the active face away from the active workings and into mine-return air courses. Alt: Exhaust ventilation lateral.

Boss - Any member of the managerial ranks who is directly in charge of miners (e.g., "shift-boss," "face-boss," "fire-boss," etc.).

Brattice or brattice cloth - Fire-resistant fabric or plastic partition used in a mine passage to confine the air and force it into the working place. Also termed "line brattice," "line canvas," or "line curtain."

Breakthrough - A passage for ventilation that is cut through the pillars between rooms.

Brow - A low place in the roof of a mine, giving insufficient headroom.

Brushing - Digging up the bottom or taking down the top to give more headroom in roadways.

Btu – British thermal unit. A measure of the energy required to raise the temperature of one pound of water one degree Fahrenheit.

Bump (or burst) - A violent dislocation of the mine workings which is attributed to severe stresses in the rock surrounding the workings.

C

Cap - A miner's safety helmet. Also, a highly sensitive, encapsulated explosive that is used to detonate larger but less sensitive explosives.

Car - A railway wagon, especially any of the wagons adapted to carrying coal, ore, and waste underground.

Certified - Describes a person who has passed an examination to do a required job.

Check curtain - Sheet of brattice cloth hung across an airway to control the passage of the air current.

Coal - A solid, brittle, more or less distinctly stratified combustible carbonaceous rock, formed by partial to complete decomposition of vegetation; varies in color from dark brown to black; not fusible without decomposition and very insoluble.

Coal dust - Particles of coal that can pass a No. 20 sieve.

Coal mine - An area of land and all structures, facilities, machinery, tools, equipment, shafts, slopes, tunnels, excavations, and other property, real or personal, placed upon, under, or above the surface of such land by any person, used in extracting coal from its natural deposits in the earth by any means or method, and the work of preparing the coal so extracted, including coal preparation facilities. British term is "colliery".

Conveyor - An apparatus for moving material from one point to another in a continuous fashion. This is accomplished with an endless (that is, looped) procession of hooks, buckets, wide rubber belt, etc.

Cover - The overburden of any deposit.

Crib - A roof support of prop timbers or ties, laid in alternate cross-layers, log-cabin style. It may or may not be filled with debris. Also may be called a chock or cog.

Crosscut - A passageway driven between the entry and its parallel air course or air courses for ventilation purposes. Also, a tunnel driven from one seam to another through or across the intervening measures; sometimes called "crosscut tunnel", or "breakthrough". In vein mining, an entry perpendicular to the vein.

Cross entry - An entry running at an angle with the main entry.

D

Detectors - Specialized chemical or electronic instruments used to detect mine gases.

Development mining - Work undertaken to open up coal reserves as distinguished from the work of actual coal extraction.

Diffusion - Blending of a gas and air, resulting in a homogeneous mixture. Blending of two or more gases.

Dilute - To lower the concentration of a mixture; in this case the concentration of any hazardous gas in mine air by addition of fresh intake air.

Dip - The inclination of a geologic structure (bed, vein, fault, etc.) from the horizontal; dip is always measured downwards at right angles to the strike.

Drift - A horizontal passage underground. A drift follows the vein, as distinguished from a crosscut that intersects it, or a level or gallery, which may do either.

Drift mine – An underground coal mine in which the entry or access is above water level and generally on the slope of a hill, driven horizontally into a coal seam.

Dynamic pressure – The pressure increase that moving fluid imparts upon an object in its path and is expressed as a velocity of the object.

E

Entry - An underground horizontal or near-horizontal passage used for haulage, ventilation, or as a mainway; a coal heading; a working place where the coal is extracted from the seam in the initial mining; same as "gate" and "roadway," both British terms.

F

Face – The exposed area of a coal bed from which coal is being extracted.

Face conveyor - Any conveyor used parallel to a working face which delivers coal into another conveyor or into a car.

Fall - A mass of roof rock or coal which has fallen in any part of a mine.

Feeder - A machine that feeds coal onto a conveyor belt evenly.

Fire damp - The combustible gas, methane, CH_4. Also, the explosive methane-air mixtures with between 5% and 15% methane. A combustible gas formed in mines by decomposition of coal or other carbonaceous matter, and that consists chiefly of methane.

Float dust - Fine coal-dust particles carried in suspension by air currents and eventually deposited in return entries. Dust consisting of particles of coal that can pass through a No. 200 sieve.

Floor - That part of any underground working upon which a person walks or upon which haulage equipment travels; simply the bottom or underlying surface of an underground excavation.

Fly ash – The finely divided particles of ash suspended in gases resulting from the combustion of fuel. Electrostatic precipitators are used to remove fly ash from the gases prior to the release from a power plant's smokestack.

Formation – Any assemblage of rocks which have some character in common, whether of origin, age, or composition. Often, the word is loosely used to indicate anything that has been formed or brought into its present shape.

Friable - Easy to break, or crumbling naturally. Descriptive of certain rocks and minerals.

G

Gathering conveyor; gathering belt - Any conveyor which is used to gather coal from other conveyors and deliver it either into mine cars or onto another conveyor. The term is frequently used with belt conveyors placed in entries where a number of room conveyors deliver coal onto the belt.

Gob - The term applied to that part of the mine from which the coal has been removed and the space more or less filled up with waste. Also, the loose waste in a mine. Also called goaf.

Ground pressure - The pressure to which a rock formation is subjected by the weight of the superimposed rock and rock material or by diastrophic forces created by movements in the rocks forming the earth's crust. Such pressures may be great enough to cause rocks having a low compressional strength to deform and be squeezed into and close a borehole or other underground opening not adequately strengthened by an artificial support, such as casing or timber.

Gunite - A cement applied by spraying to the roof and sides of a mine passage.

H

Haulage - The horizontal transport of ore, coal, supplies, and waste. The vertical transport of the same is called hoisting.

Haulageway - Any underground entry or passageway that is designed for transport of mined material, personnel, or equipment, usually by the installation of track or belt conveyor.

Head section - A term used in both belt and chain conveyor work to designate that portion of the conveyor used for discharging material.

Heaving - Applied to the rising of the bottom after removal of the coal; a sharp rise in the floor is called a "hogsback".

Hogsback - A sharp rise in the floor of a seam.

Horseback - A mass of material with a slippery surface in the roof; shaped like a horse's back.

I

Inby - In the direction of the working face.

Incline - Any entry to a mine that is not vertical (shaft) or horizontal (adit). Often incline is reserved for those entries that are too steep for a belt conveyor (+17 degrees -18 degrees), in which case a hoist and guide rails are employed. A belt conveyor incline is termed a slope. Alt: Secondary inclined opening, driven upward to connect levels, sometimes on the dip of a deposit; also called "inclined shaft".

Intake - The passage through which fresh air is drawn or forced into a mine or to a section of a mine.

J

Job Safety Analysis (J.S.A.) - A job breakdown that gives a safe, efficient job procedure.

K

Kettle bottom - A smooth, rounded piece of rock, cylindrical in shape, which may drop out of the roof of a mine without warning. The origin of this feature is thought to be the remains of the stump of a tree that has been replaced by sediments so that the original form has been rather well preserved.

L

Lamp - The electric cap lamp worn for visibility. Also, the flame safety lamp used in coal mines to detect methane gas concentrations and oxygen deficiency.

Layout - The design or pattern of the main roadways and workings. The proper layout of mine workings is the responsibility of the manager aided by the planning department.

Longwall Mining – One of three major underground coal mining methods currently in use. Employs a steal plow, or rotation drum, which is pulled mechanically back and forth across a face of coal that is usually several hundred feet long. The loosened coal falls onto a conveyor for removal from the mine.

Loose coal - Coal fragments larger in size than coal dust.

Low voltage - Up to and including 660 volts by federal standards.

M

Main entry - A main haulage road. Where the coal has cleats, main entries are driven at right angles to the face cleats.

Manhole - A safety hole constructed in the side of a gangway, tunnel, or slope in which miner can be safe from passing locomotives and car. Also called a refuge hole.

Man trip - A carrier of mine personnel, by rail or rubber tire, to and from the work area.

Manway - An entry used exclusively for personnel to travel form the shaft bottom or drift mouth to the working section; it is always on the intake air side in gassy mines. Also, a small passage at one side or both sides of a breast, used as a traveling way for the miner, and sometimes, as an airway, or chute, or both.

Methane – A potentially explosive gas formed naturally from the decay of vegetative matter, similar to that which formed coal. Methane, which is the principal component of natural gas, is frequently encountered in underground coal mining operations and is kept within safe limits through the use of extensive mine ventilation systems.

Methane monitor - An electronic instrument often mounted on a piece of mining equipment, that detects and measures the methane content of mine air.

Mine development - The term employed to designate the operations involved in preparing a mine for ore extraction. These operations include tunneling, sinking, cross-cutting, drifting, and raising.

Miner - One who is engaged in the business or occupation of extracting ore, coal, precious substances, or other natural materials from the earth's crust.

MSHA - Mine Safety and Health Administration; the federal agency which regulates coal mine health and safety.

N

Natural ventilation - Ventilation of a mine without the aid of fans or furnaces.

O

Outby; outbye - Nearer to the shaft, and hence farther from the working face. Toward the mine entrance. The opposite of inby.

Overburden – Layers of soil and rock covering a coal seam. Overburden is removed prior to surface mining and replaced after the coal is taken from the seam.

P

Panel - A coal mining block that generally comprises one operating unit.

Parting - (1) A small joint in coal or rock; (2) a layer of rock in a coal seam; (3) a side track or turnout in a haulage road.

Peak overpressure – The maximum pressure above atmospheric pressure reached in rapidly advancing blast wave.

Permissible - That which is allowable or permitted. It is most widely applied to mine equipment and explosives of all kinds which are similar in all respects to samples that have passed certain tests of the MSHA and can be used with safety in accordance with specified conditions where hazards from explosive gas or coal dust exist.

Permit – As it pertains to mining, a document issued by a regulatory agency that gives approval for mining operations to take place.

Pillar - An area of coal left to support the overlying strata in a mine; sometimes left permanently to support surface structures.

Pinch - A compression of the walls of a vein or the roof and floor of a coal seam so as to "squeeze" out the coal.

Pinning - Roof bolting.

Pitch - The inclination of a seam; the rise of a seam.

Plan - A map showing features such as mine workings or geological structures on a horizontal plane.

Portal - The structure surrounding the immediate entrance to a mine; the mouth of an adit or tunnel.

Portal bus - Track-mounted, self-propelled personnel carrier that holds 8 or more.

Post - The vertical member of a timber set.

R

Raise - A secondary or tertiary inclined opening, vertical or near-vertical opening driven upward form a level to connect with the level above, or to explore the ground for a limited distance above one level.

Ramp - A secondary or tertiary inclined opening, driven to connect levels, usually driven in a downward direction, and used for haulage.

Resin bolting - A method of permanent roof support in which steel rods are grouted with resin.

Respirable dust - Dust particles 5 microns or less in size.

Retreat mining - A system of robbing pillars in which the robbing line, or line through the faces of the pillars being extracted, retreats from the boundary toward the shaft or mine mouth.

Return - The air or ventilation that has passed through all the working faces of a split.

Rib - The side of a pillar or the wall of an entry. The solid coal on the side of any underground passage. Same as rib pillar.

Roll - (1) A high place in the bottom or a low place in the top of a mine passage, (2) a local thickening of roof or floor strata, causing thinning of a coal seam.

Roof - The stratum of rock or other material above a coal seam; the overhead surface of a coal working place. Same as "back" or "top."

Roof bolt - A long steel bolt driven into the roof of underground excavations to support the roof, preventing and limiting the extent of roof falls. The unit consists of the bolt (up to 4 feet long), steel plate, expansion shell, and pal nut. The use of roof bolts eliminates the need for timbering by fastening together, or "laminating," several weaker layers of roof strata to build a "beam."

Roof fall - A coal mine cave-in especially in permanent areas such as entries.

Roof sag - The sinking, bending, or curving of the roof, especially in the middle, from weight or pressure.

Roof stress - Unbalanced internal forces in the roof or sides, created when coal is extracted.

Room and pillar mining – A method of underground mining in which approximately half of the coal is left in place to support the roof of the active mining area. Large "pillars" are left while "rooms" of coal are extracted.

Room neck - The short passage from the entry into a room.

S

Scaling - Removal of loose rock from the roof or walls. This work is dangerous and a long bar (called a scaling bar)is often used.

Scoop - A rubber tired-, battery- or diesel-powered piece of equipment designed for cleaning runways and hauling supplies.

Scrubber – Any of several forms of chemical/physical devices that remove sulfur compounds formed during coal combustion. These devices, technically know as flue gas desulfurization systems, combine the sulfur in gaseous emissions with another chemical medium to form inert "sludge," which must then be removed for disposal.

Seal – An approved structure installed or constructed across openings leading to abandoned or worked out areas that separate the active ventilated areas of the mine. The goal of sealing an area is to create an inert, oxygen deficient atmosphere that prohibits the propagation of an explosion or fire thus protecting the active, ventilated areas underground.

Seam - A stratum or bed of coal.

Section - A portion of the working area of a mine.

Self-contained self-rescuer (SCSR) – A device that either stores oxygen in cylinder or chemical generates oxygen, to aid and protect a miner in escape of a mine in the event of an explosion or fire.

Shaft - A primary vertical or non-vertical opening through mine strata used for ventilation or drainage and/or for hoisting of personnel or materials; connects the surface with underground workings.

Shift - The number of hours or the part of any day worked.

Shuttle car – A self-discharging truck, generally with rubber tires or caterpillar-type treads, used for receiving coal from the loading or mining machine and transferring it to an underground loading point, mine railway or belt conveyor system.

Skid - A track-mounted vehicle used to hold trips or cars from running out of control. Also it is a flat-bottom personnel or equipment carrier used in low coal.

Skip - A car being hoisted from a slope or shaft.

Slate - A miner's term for any shale or slate accompanying coal. Geologically, it is a dense, fine-textured, metamorphic rock, which has excellent parallel cleavage so that it breaks into thin plates or pencil-like shapes.

Slip - A fault. A smooth joint or crack where the strata have moved on each other.

Slope - Primary inclined opening, connection the surface with the underground workings.

Slope mine – An underground mine with an opening that slopes upward or downward to the coal seam.

Sloughing - The slow crumbling and falling away of material from roof, rib, and face.

Solid - Mineral that has not been undermined, sheared out, or otherwise prepared for blasting.

Sounding - Knocking on a roof to see whether it is sound and safe to work under.

Span - The horizontal distance between the side supports or solid abutments along sides of a roadway.

Split - Any division or branch of the ventilating current. Also, the workings ventilated by one branch. Also, to divide a pillar by driving one or more roads through it.

Squeeze - The settling, without breaking, of the roof and the gradual upheaval of the floor of a mine due to the weight of the overlying strata.

Static pressure – The force per unit area exerted across a surface parallel to the direction of the flow.

Steeply inclined - Said of deposits and coal seams with a dip of from 0.7 to 1 rad (40 degrees to 60 degrees).

Support - The all-important function of keeping the mine workings open. As a verb, it refers to this function; as a noun it refers to all the equipment and materials--timber, roof bolts, concrete, steel, etc.--that are used to carry out this function.

T

Tagline - A section of rope provided to allow escaping miners to stay together during an escape in smoke filled environment.

Tailgate - A subsidiary gate road to a conveyor face as opposed to a main gate. The tailgate commonly acts as the return airway and supplies road to the face.

Tailpiece - Also known as foot section pulley. The pulley or roller in the tail or foot section of a belt conveyor around which the belt runs.

Tail section - A term used in both belt and chain conveyor work to designate that portion of the conveyor at the extreme opposite end from the delivery point. In either type of conveyor it consists of a frame and either a sprocket or a drum on which the chain or belt travels, plus such other devices as may be required for adjusting belt or chain tension.

Top - A mine roof; same as "back."

Tractor - A battery-operated or diesel piece of equipment that pulls trailers, skids, or personnel carriers. Also used for supplies.

Tram - Used in connection with moving self-propelled mining equipment. A tramming motor may refer to an electric locomotive used for hauling loaded trips or it may refer to the motor in a cutting machine that supplies the power for moving or tramming the machine.

Tunnel - A horizontal, or near-horizontal, underground passage, entry, or haulageway, that is open to the surface at both ends. A tunnel (as opposed to an adit) must pass completely through a hill or mountain.

U

Underground mine – Also known as a "deep" mine. Usually located several hundred feet below the earth's surface, an underground mine's coal is removed mechanically and transferred by shuttle car or conveyor to the surface.

Underground station - An enlargement of an entry, drift, or level at a shaft at which cages stop to receive and discharge cars, personnel, and material. An underground station is any location where stationary electrical equipment is installed. This includes pump rooms, compressor rooms, hoist rooms, battery-charging rooms, etc.

Upcast shaft - A shaft through which air leaves the mine.

V

Velocity - Rate of airflow in lineal feet per minute.

Ventilation - The provision of a directed flow of fresh and return air along all underground roadways, traveling roads, workings, and service parts.

Violation - The breaking of any state or federal mining law.

W

White damp - Carbon monoxide, CO. A gas that may be present in the afterdamp of a gas- or coal-dust explosion, or in the gases given off by a mine fire; also one of the constituents of the gases produced by blasting. Rarely found in mines under other circumstances. It is absorbed by the hemoglobin of the blood to the exclusion of oxygen. One-tenth of 1% (.001) may be fatal in 10 minutes.

Working face - Any place in a mine where material is extracted during a mining cycle.

Working place - From the outby side of the last open crosscut to the face.

Workings - The entire system of openings in a mine for the purpose of exploitation.

Working section - From the faces to the point where coal is loaded onto belts or rail cars to begin its trip to the outside.